Black Rocks Harbour Saba

Tender Documents - Volume 2 Employer's Requirements
Part 2: General Technical Specifications

Public Entity of Saba

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INTRODUCTION

1.1 General

This document deals with Volume II Part 2: Technical Specifications.

The General Technical Specification provide the quality requirements for plant, material, equipment, procedures etc., whereas the Particular Requirements and Design Criteria (Volume II, part 1b) provide the specific technical requirements for the Works. In case of ambiguities or discrepancies between the two documents, the Particular Requirements and Design Criteria shall prevail.

Where reference is made to the Particular Requirements and Design Criteria in the General Technical Specification, but this topic is not explicitly discussed in the Program of Requirements and Design Criteria it shall be considered that these elements must follow from the Contractor's Design.

Notwithstanding that the Contractor shall follow the requirements, performance specifications and technical specifications set out in Volume 2 shall not relieve him of his responsibility or liability under the Contract or any permit.

The costs for the provision of the requirements of the General Technical Specification and Particular Requirements and Design Criteria shall be deemed to be included in the unit rates as inserted in the Bill of Quantities, unless for such provision a separate item has been included in these Bill of Quantities.

2

MATERIALS, SAMPLING AND TESTING

2.1 General

Unless specifically stated otherwise, the Contractor shall supply all materials, equipment, temporary structures, tools and labour necessary for the execution of the Works described in 'Employer's Requirements.

2.2 Quality of materials

Except where otherwise stated or approved by the Engineer, all materials used in the Works shall be of the best quality of their respective kinds and shall comply with the current issue of the appropriate British Standards, Eurocodes or other approved standard.

The omission of a specification for any material implied in the Employer's Requirements or Bill of Quantities or Drawings or necessary for the completion of the Works in every respect, in no way relieves the Contractor of his responsibility for providing the best quality available and to the approval of the Engineer.

In all cases where the name or a make of proprietary materials is referred to in the Drawings or elsewhere in the Employer's Requirements, this is intended to indicate only the acceptable standard.

2.3 Climate

The Contractor shall provide full details of all Equipment and Materials proposed, including proof or evidence that they have successfully been used in conditions equal to those prevailing in the country to be applied.

2.4 Sources and types of materials and plant

The Contractor shall make all arrangements for locating and selecting and processing of natural materials according to the Employer's Requirements and shall submit to the Engineer for approval full information regarding the proposed location well before commencement of working of the materials. Approval of a source does not imply that all material from that source is approved.

Before placing any order for materials or plant for incorporation in the Works, the Contractor shall submit to the Engineer for approval the names of suppliers and manufacturer and the origin, manufacturer's specification, quality, weight, strength, description, etc. of the Materials or Plant.

The Contractor shall supply a copy of each order placed, which copy shall be retained by the Engineer. No materials shall be ordered or obtained from any firm or source that the Engineer has not previously approved in writing.

2.5 Laboratory

All samples shall, when required, be tested in a laboratory to be proposed by the Contractor and to be approved by the Engineer.

The Contractor shall make arrangements with the laboratory staff for the testing procedure. Any costs involved in complying with the Clause shall be deemed to be included in the rates.

2.6 Alternative materials

The Contractor may propose alternative materials to those specified, provided that they are of at least equivalent quality. In case alternatives are proposed, the Contractor shall submit for the Engineer's approval details including technical descriptions, drawings, test results and specifications to show that such alternatives are at least equivalent to those specified.

2.7 Supply and use of materials

Materials shall be used or installed according to the instructions of the manufacturer unless otherwise required.

The Contractor shall be responsible for payment of royalties, duties or taxes, if any, arising due to the obtaining of materials for use in the Works. No separate payment will be made by the Employer as a royalty for materials for use in the Works.

The Bills of Quantities shall NOT be used as a basis for ordering materials and the Contractor is entirely responsible for assessing the quantities of materials to be ordered.

All materials or manufactured items that are liable to damage shall be delivered in the original package, containers, etc., bearing the name of manufacturer and the brand.

2.8 Transport and protection

The Contractor shall carefully load, transport, unload and store materials or manufactured items in an approved manner and protect them from damage and exposure to weather or dampness during transit and after delivery to the Site. Damaged material or manufactured items damaged before or during fixing in position shall be removed, repaired or replaced by and at the expense of the Contractor.

The Contractor shall erect and maintain ample temporary and weatherproof sheds for proper storage and protection of his own and of Subcontractor's materials. Sheds for cement and other perishable material shall have floors raised at least 150 mm off the ground. The Contractor shall clear away at completion and restore all work disturbed.

2.9 Sampling and testing

2.9.1 General

When required in the Employer's Requirements, or when instructed by the Engineer, samples shall be taken and tested according to the relevant standards. Materials whereof the tests have demonstrated that they meet the requirements and that are subsequently supplied shall not be changed without prior written approval of the Engineer.

2.9.2 Samples and certificates

The Contractor and other suppliers of materials necessary for the execution of the Works, shall be willing to admit the Engineer or his representatives to his premises for the purpose of obtaining samples. Alternatively, if required or agreed by the Engineer, the Contractor shall deliver the samples to the Engineer's office without charge. Materials subsequently supplied shall conform within any specified tolerances to the quality of samples that have been approved by the Engineer. Materials failing to meet with the Engineer's approval shall be replaced at the Contractor's expense. Samples of materials approved will be retained until the Work is Completed. No source of supply shall be changed without the authority of the Engineer.

In all cases test certificates shall be capable of being related to the actual consignment of materials delivered to the Site. Test certificates are to be delivered to the Engineer.

2.9.3 Testing

The Contractor shall use an officially recognised independent laboratory for all testing. The Particular Requirements and Design Criteria (Volume II, part 1b) may include a provision for testing in a site laboratory. In such instances, the tests specified in the clause entitled 'Site Laboratory' shall be carried out in the site laboratory, all remaining tests being carried out under the provision of this Clause.

The laboratory requires approval by the Engineer.

Any testing by the laboratory shall not relieve the Contractor of his responsibilities under the Contract for the quality of work and materials used.

The Contractor shall furnish all results of all tests carried out to the Engineer for his approval and consent.

Material shall only be used in the Works after approval of the related and relevant testing.

3

SETTING-OUT OF THE WORKS

3.1 General

The Contractor shall carry out the detailed setting-out, including the marking of all points for the Works to be constructed, as required during the progress of the Works.

The Contractor shall be responsible for the true and proper setting-out of the Works and for the correctness of the position levels, dimensions and alignment of all parts of the Works and for the provision of all necessary instruments, appliances and labour in connection therewith. If at any time during the progress of the Works any error shall appear or arise in the position, levels, dimensions or alignment of any part of the Works the Contractor on being required to do so by the Engineer shall at his own expense rectify such error to the satisfaction of the Engineer. The checking of any setting-out or of any line or level by the Engineer or the Engineer's Representative shall not in any way relieve the Contractor of his responsibility for the correctness thereof and the Contractor shall carefully protect and preserve all benchmarks, site-rails, pegs and other things used in setting-out the Works.

3.2 Data for setting-out

When requested by the Contractor, the Engineer will provide the Contractor with a local benchmark for setting out the works. The setting-out of the main points of the alignments and centrelines of structures shall be executed by the Contractor. The Contractor shall provide the necessary number of personnel and materials to set out the lines and levels of the main parts of the Works.

3.3 Temporary benchmarks

The Contractor may, as deemed necessary, or as requested by the Engineer, establish temporary benchmarks during the period of construction. The Contractor shall take all reasonable precautions to protect all temporary benchmarks from deliberate or accidental damage.

The Contractor shall express the co-ordinates of the benchmarks in the Saba Island grid and UTM grid, or as directed by the Engineer.

The levels of the temporary benchmarks shall be expressed relative to a level to be made available by the Engineer. Once established the level of temporary benchmarks shall be checked periodically by the Contractor.

Temporary benchmarks shall be located not further than 200 m from any construction activity or as approved by the Engineer. Temporary benchmarks shall comprise a steel pin set in a buried, well founded and sturdy concrete base.

The Contractor shall carefully preserve all survey reference pegs, except where construction requires their removal, and before such removal the approval of the Engineer shall be obtained.

3.4 Records and preservation

The Contractor shall, as soon as practicable, supply the Engineer with records in approved form relating to all reference pegs and benchmarks and shall keep such records up to date by formal notice to the Engineer.

The Contractor shall carefully preserve all survey reference pegs, except where construction requires their removal, and before such removal the approval of the Engineer shall be obtained.

3.5 Tolerances

Unless otherwise specified the following tolerances for setting-out the locations of the individual main parts of the Works are:

- In situ concrete works: 0.01 m horizontal 0.003 m vertical.
- Precast concrete works: 0.01 m horizontal 0.002 m vertical.
- Dredging and or excavation works: 0.5 m horizontal 0.10 m vertical.
- Pile driving works 0.02 m horizontal 0.02 m vertical.

3.6 Equipment and instruments

The Contractor shall provide, install, operate and maintain all instrumentation and equipment necessary to obtain a high degree of precision of all surveys and measurements to be carried out during the execution of the Works.

The Contractor shall make appropriate proposals as to type, brand, make and number of such instrumentation and equipment, and obtain the written approval of the Engineer before such instrumentation and equipment may be used.

All instruments and equipment shall be in perfect state of repair and working order, to the satisfaction of the Engineer and fully adapted to the local conditions.

The Contractor shall accurately maintain, repair or replace all instrumentation and equipment and use his best endeavours for the proper operations. Regular calibration shall be undertaken by the Contractor under supervision of the Engineer. The Contractor shall make suitable provision for the calibration of al instruments and equipment. All costs involved shall be borne by the Contractor.

The Contractor shall arrange that at all times during the survey period the instruments and equipment shall be accurately operational to the satisfaction of the Engineer.

4

SURVEYS AND MEASUREMENTS

4.1 General

The Contractor shall timely carry out all surveys and measurements in the survey area as required in the Particular Requirements and Design Criteria. The Contractor shall give the Engineer full and reasonable opportunity to be present at such surveys and measurements.

Prior to the Commencement of the Works the Contractor shall prepare a Digital Terrain Model of the Survey Area, covering both land and sea (Bathymetric Survey).

4.2 Labour

In case the Engineer wishes to carry out surveys or measurements himself, the Contractor shall provide for sufficient competent workmen to be solely and permanently available to the Engineer and his principals.

4.3 Contractor's attendance during surveys

If requested by Owner, the Contractor shall attend third party independent surveying. Whenever the Contractor fails to attend, such survey shall be deemed to have been carried out in the presence of the Contractor.

4.4 Results

The Contractor shall prepare survey charts, cross-sections and the like, in consultation with the Engineer, showing the full results of the surveys and measurements carried out.

4.5 Drawings

The results of the final surveys and measurements shall, when approved by the Engineer, be used for the preparation by the Contractor of the drawings of the survey area. The scale and form and distance between contour lines of these drawings shall be to the satisfaction of the Engineer.

The Contractor shall submit the drawings to the Engineer for his approval within two weeks after completion of the survey of the part of the works concerned. The Engineer will review these drawings and inform the Contractor of any that are not acceptable, and the Contractor shall modify these drawings to the satisfaction of the Engineer.

4.6 Instruments and equipment to be provided

4.6.1 Positioning system

The Contractor shall provide an electronic positioning system, including shore stations, power supply and mobile stations for floating equipment of the Contractor.

The electronic positioning system shall, at all times, maintain a repeatable horizontal accuracy of plus or minus 1 m, for any point within the Dredge or Project Area.

The Contractor shall submit drawings of the intended location of the shore stations with the complete and accurate lane pattern. This lane pattern shall have been calibrated by means of check observations before the actual dredging operations start, and corrected for possible deviations from the theoretical pattern.

Notwithstanding the use of the positioning system, the Contractor shall operate conventional installations to enable the verification of the position of his floating equipment.

4.6.2 Survey vessel

The Contractor shall provide and operate a sea-worthy survey vessel as further detailed in the Particular Requirements and Design Criteria. Propulsion shall be by an engine giving a free running speed of 7-8 knots. The vessel shall be provided with navigation lights, search light, VHF radio, fenders, mooring lines, anchor(s) and anchor lines, life vests and all gear required for operation. The survey vessel shall be equipped with heave, pitch and roll compensation, an echo sounder and a receiver of the electronic position finding system, as specified below.

4.6.3 Multibeam echo sounder

The multibeam system shall meet the following criteria:
- Minimum frequency of 200 kHz.
- Minimum depth below the transducer of 0.5 m.
- Maximum cross and along ship beam angle of 0.5 degrees.
- Minimum path width of 120 degrees.
- Maximum path width of 150 degrees.

The Contractor shall make suitable provisions for calibration, witnessed by the Engineer, of the multibeam before and after each survey and whenever required by the Engineer.

4.6.4 Receiver positioning

A receiver of the electronic positioning system shall be installed on every floating equipment used on the project.

4.6.5 Tide gauge

The Contractor shall for the duration of the Contract operate and maintain at least one recording tide gauges (with a 15 minutes interval measurement frequency) with all appliances, suitable to the local climatic conditions.

The recording tide gauges shall record the tide and other water level fluctuations in such a way that the tidal data can be used for immediate adjusting of the surveys.

Besides the recording tide gauges, the Contractor shall install staff gauge on an appropriate location in Fort bay, approved by the Engineer, for continuous check and calibration of the recording tide gauges.

The Contractor shall take all precautions to protect the tide gauges and the staff gauges and shall keep them in a clean and tidy condition. Any damage during the execution of the Works shall be rehabilitated at Contractor's expense.

4.6.6 Wave recorder

A floating 'Wave-rider' anchored to the seabed, or alternatively a wave height meter fixed to a pile shall be supplied, placed, installed, operated and maintained by the Contractor during the whole Contract period. The records shall be submitted to the Engineer on line.

The wave height measuring device shall comply with the following requirements and specifications:
- Continuous registration of short period water level fluctuations, wave periods between T = 1 sec and T = 30 sec including wave direction.
- Results of the measurements to be produced on tables and graphs showing significant wave height, maximum wave height, mean wave period, maximum wave period, direction, and energy density spectrum diagrams.
- Recordings and results available online which shall be updated at least every 30 minutes.

The procedure of processing the registrations requires the approval of the Engineer. Except as otherwise approved by the Engineer such processing shall be carried out by an independent agency or institute.

The location of the wave recorder will be indicated by the Engineer, and shall be at an offshore location with a water depth of 8 to 10 m.

The rates and prices for supply, installation and maintenance of the entire system shall include all auxiliary equipment and anchorages or support structures. In case of a pile-mounted device, the supporting pile shall be adequately lit in order to guarantee safe navigation.

4.7 Bathymetric surveys

4.7.1 Definition

All depth measurements in the water areas are defined as bathymetric surveys.

4.7.2 General

The Contractor shall perform bathymetric surveys by means of multi beam echo sounding instruments.

The surveys shall only be carried out

Within the limits of the equipment used and upon approval of the Engineer.

4.7.3 Position fixing

For position fixing during bathymetric surveys the Contractor shall make use of a positioning system to the satisfaction of the Engineer.

4.7.4 Calibration

The Contractor shall calibrate the multibeam, witnessed by the Engineer, by means of surveying a specified area that is not sensitive to change during the duration of the dredging activities before and after he carries out any Bathymetric Surveys unless otherwise required by the Owner. At least an up the slope and down the same slope shall be included in the calibration.

The vertical accuracy of the measurements shall be plus or minus 0.05 m

The multibeam survey will result in a full cover of the dredge area and at least 25 additional meters at the border of the dredge area. In order to achieve a full cover, the minimum overlap shall be 50 % using a beam angle > 1 degree. If the beam angle < 1 degree, 20 % overlap is required. Data will only be used when the survey vessel is at constant speed and on track. No data will be recorded during turning and/or manoeuvring.

4.7.5 Results

In order to express all results relative to the reference level, the Contractor shall eliminate the influences of waves and the vertical tide and other water level fluctuations on the measurement results.

Immediately on completion of each bathymetric survey, the Contractor shall submit to the Engineer for his approval drawings consisting of survey charts and cross-sections of the area surveyed showing the full results of the relevant survey. On completion and agreement of the contents of these drawings, the Contractor and the Engineer shall sign these drawings for approval. Scales of these drawings shall be agreed upon between Contractor and Engineer. These drawings shall upon approval by the Engineer become the property of the Employer.

The following surveys are witnessed by The Engineer as a minimum:

1 Start of the project - pre survey.
2 Post dredging surveys per dredging area.
3 Post dredging of the trench which is used for the placement of caissons.
4 Before placement of the crushed granular rock foundation.
5 Post placing of the crushed granular rock foundation.
6 Post placing caissons.
7 Post backfill in trench area.
8 Post scour protection.

In addition to the above the Contractor shall also supply the Engineer of each survey a digital copy with all raw data (unprocessed).

4.8 Topographic surveys

4.8.1 Definition

Full coverage aerial surveys of the site shall be conducted, resulting in:

- High quality georeferenced orthomosaic photo(s).
- Georeferenced Digital Terrain Model(s) with a resolution of 10 cm.
- Calibration and cross checking shall be performed using sufficient benchmarks spanning the survey areas.
- Survey maps to be provided in hard copy and digital formats (DWG, GeoTiff) or as agreed with the Engineer.
- The vertical accuracy of the topographic survey shall be plus or minus 0.01 m.

- All corner points of quay wall, breakwater, terraces, roads, etc. shall be measured.
- The Contractor shall calibrate the measuring devices for topographic surveys whenever required by the Engineer.

4.8.2 Results

Immediately after completion of each topographic survey, the Contractor shall submit drawings consisting of survey charts and cross sections as surveyed of the respective areas showing the full results of the relevant survey. On completion and agreement of the contents of such drawings the Contractor and Engineer shall sign these drawings for approval. Scales of these drawings shall be agreed upon between Contractor and Engineer.

These drawings shall upon approval by the Engineer become the property of the Employer.

These Drawings shall be provided prior to Test on Completion.

4.9 Frequency

Surveys shall be performed:
- Pre-construction surveys 2 weeks prior to start of the works and/or part of the works.
- Progress surveys after completion of every distinct activity, like after excavations, after each sand layer, each revetment] layer, placement of geotextile, subbase, roads, pre pavement, post pavement etc.
- Progress surveys of the whole Site at monthly intervals.
- During construction: continuous monitoring and surveying of existing surrounding structures and building.

Post-construction surveys every 3 months until expiry of warranty.

5

EXISTENCE OF CABLES, PIPELINES AND/OR OTHER OBSTACLES

5.1 General

Arrangements with the relevant authorities concerning the collection of data of the systems will be made by the Employer or the Engineer. Drawings and/or relevant information with an indication of cables and/or pipelines, if available, will be submitted to the Contractor.

The Contractor shall carry out an inspection to determine the existence and the location of any obstacles within the project area. Copies of the reports concerning the results of the inspection shall be submitted to the Engineer.

The Contractor shall select a construction method that results in minimum risks at installation and minimum noise.

5.2 Information and instructions

If there are any cable and/or pipe-line systems within the project area, full information and instructions of measures to be taken before and during the execution of the Works will be submitted by the Employer or the Engineer in co-operation with the relevant authorities. In this case, the Contractor shall follow the instructions as given by the Employer, the Engineer or the relevant authorities. The Contractor shall protect, provide, support from and take all necessary precautions to ensure that the existing services shall remain in their present undamaged state during the Works. If damage occurs to cable and/or pipe-line services which were included in the information provided to the Contractor due to the works carried out by the Contractor or any persons nominated to do works for him, the Contractor shall be held fully responsible for the necessary repair work, to be carried out by the relevant authorities or an expert company acceptable to the Engineer and under his supervision. All costs of repairing damaged services (pipes and/or cables) that are the property of the Employer of the Site and other employers of pipes and cables crossing the Site, and the cost to the above mentioned parties due to inconveniences that arise from the said damage, shall be paid by the Contractor.

5.3 Permission

The permission to remove existing obstacles as mentioned before shall be given in writing by the Employer or the Engineer. The permission to remove the obstacles shall be provided according to the agreed time programme of the Contractor.

No removal shall take place before the area has been provided with all necessary relevant Temporary Works and/or precautionary measures to the approval of the Engineer.

The Contractor shall use drilling and piling equipment with sufficient capacity to drill through obstacles and bedrock.

5.4 Protection of objects

The Contractor shall not demolish or remove objects, whether shown on the Drawings or not, unless on specific instructions from the Engineer. The Contractor shall take every precaution to protect from damage any of these objects that are situated on or near the Site.

The Contractor shall protect any property situated in the direct proximity of the Works against any damage that could be caused by vehicles, ships, barges, cranes, subsidence, vibration, etc.

The Contractor shall repair any damage to objects and properties that were (made) known to him before he started working in the vicinity of such objects or properties so as to conform to the condition of the property prior to damage.

6

DREDGING

6.1 Materials to be dredged

The main characteristics of the soils to be dredged are presented in Volume V.

Dredging shall be carried out in any type of material which may be encountered, which may include sediments, consolidated sediments, rock in varying states of weathering including fresh rock, and materials or items of a manufactured nature, such as, inter alia., chains, wires, cables, ropes, anchors, pipes, castings, steelwork, concrete, timber, tyres or similar.

The Contractor shall satisfy himself as to the nature of the material to be dredged by examination of the Site and study data and samples obtained in the course of investigations on behalf of the Employer and made available to him and shall carry out any further investigations considered necessary by him to cater for such intent.

6.2 Dredging by marine based plant

This section is intended for use where a dredged area of specified dimensions is to be dredged by marine based plant.

6.2.1 Control of sediments

The Contractor shall take all reasonable measures within accepted dredging practice, including the use of settling basins if considered necessary for run-off water if necessary, to ensure that spillage is reduced as low as practically possible and sediments arising from the Works are not carried outside the Site or downstream of the limit of dredging and reclamation to be carried out under the Contract.

The Contractor shall follow at all times the turbidity restrictions following from the permits. All downtime related to this topic shall be at Contractor's expense.

6.2.2 Removing siltation

The Contractor shall be responsible for removing any siltation caused by carrying out the works under the Contract. The Contractor shall be responsible throughout the duration of the Works for removing any siltation in navigation channels and / or berthing areas, as directed by the Engineer, notwithstanding previous acceptance of these areas. Such removal and disposal shall be at the Contractor's expense.

6.3 Dredging tolerances

6.3.1 Dredging limits

The Contractor shall execute the dredging within the plan limits indicated on the Drawings or as directed by the Engineer and ensure that no portion of the finished dredged work shall, at the time of completion for the whole of the Works, be higher than the levels shown on the Drawings.

The Contractor shall be paid to dredge only up to the lines and levels specified in the Drawings. Under no circumstance whatsoever shall the Contractor claim for any additional time and cost over volumes dredged beyond these lines and levels.

The lines shown on the Definition Drawings indicate theoretical boundaries of the dredging. Dredging shall be carried out to the specified levels and slopes, as indicated on the Definition Drawings, within the following tolerances.

In addition, the Engineer may direct the Contractor to replace any material dredged beneath the tolerance limit with the same type of material, i.e., meeting the same gradation limits (or, in the case of over dredging in clay, suitable granular material as specified by the Engineer), and the placement of additional material due to over dredging will be to the Contractor's account.

The tolerances for dredging within 10 m of the nearest point of breakwaters, revetments and/or other structures shall be 0 mm above and 250 mm below. Should over dredging occur, the Contractor shall, at his own expense, backfill to the design level with gravel or crushed stone having a maximum aggregate size of 75 mm, and as instructed by the Engineer.

6.3.2 Horizontal tolerance

Horizontal tolerances shall be 3 m (outside)/0 m (inside) from the theoretical dredging boundary line.

However, no progress payment will be made for dredging beyond the theoretical boundary lines.

In addition, the Engineer may direct the Contractor to replace any material dredged beyond the 3m tolerance limit with the same type of material, i.e., meeting the same gradation limits (or, in the case of over dredging in clay, suitable granular material as specified by the Engineer), and the placement of additional material due to over dredging will be to the Contractor's account.

6.3.3 Slope tolerance

Slope tolerances shall be defined by two theoretical lines, parallel to the theoretical slopes of the Contractor's dredging design, drawn from the horizontal tolerance points on the theoretical bottom level, as applicable.

6.3.4 Rectification of overdredged areas

Dredging or disturbance of the seabed to levels more than 250 mm below the specified levels shown on the Drawings will not be accepted in the case of:

- Dredging in locations within 30 m horizontally of an existing or notified intended structure or natural embankment whose stability might be adversely affected.
- Where dredging is required to form foundations for quay walls or similar structures, whether to be constructed under this Contract, or not.

If over-dredging in excess of the limits specified above should occur, the Contractor may be instructed at his own cost to clean out disturbed material and fill the void up to such limits with 25mm to 150 mm evenly graded crushed rock or other filling material as directed and approved by the Engineer. In any case the Contractor shall take such appropriate measures to correct the over-dredging in order not to jeopardise the (quality and intended use of the) Works

6.3.5 Dredging adjacent to structures

The Contractor shall give particular attention and care when dredging at or adjacent to existing structures so as to minimise any disturbance that may be caused thereto, and he shall employ only suitable plant approved by the Engineer for such dredging. Approval of such plant shall not relieve the Contractor of his liabilities and obligations under the Contract.

6.3.6 Obstructions

Sunken objects (boulders, metal scrap, wood, debris, ordnance, etc.) and/or wrecks may be encountered within the areas to be dredged. Furthermore, Contractor is advised that the work is partly to be carried out in an operational port, and he should expect to encounter sunken objects, debris, etc., while dredging, even if it has not been identified before.

All such objects shall be raised by the Contractor as part of the normal dredging operations and shall be disposed of as instructed by the Engineer, at no additional cost.

No payment will be made for raising objects (such as rocks, boulders, timber, debris, garbage, scrap and scrap metal, plastic ropes, rubber tires, fishing nets, trash, pipes, etc.) on the seabed during normal dredging operations, nor shall it be a reason for any other claim and/or delay in the completion of the works.

Where the Contractor encounters objects that are dangerous to public health and safety, or the health and safety of the personnel and equipment operating at the site (unexploded ordnance, munitions etc.), he shall notify the Engineer and relevant authorities and immediately cease work in the vicinity.
The Contractor will not be compensated in any manner for locating and mapping objects that cannot be raised.

6.3.7 Side slopes

Side slopes at quays, retaining walls and other structures shall be dredged and trimmed to the slopes shown on the Drawings or to such other slopes as may be necessary for stability, taking into account the natural properties of the material. Where alternative slope profiles are required the Contractor shall determine the profile in order to maintain stability of the slope and submit details to the Engineer for approval.

In locations other than those referred to above, dredged slopes flatter than those shown on the Drawings, or in the case of hard stable material, steeper than shown, may be permitted subject to the approval of the Engineer. No projection beyond the line of the toe of the slope indicated on the Drawings will be accepted.

Box cutting of side slopes shall not be permitted without the Engineer's approval.

6.4 Dredging method

The permitted method for dredging and removal of large rock boulders is by barge and excavator. Breaking of oversized rock boulders by hydraulic hammer is allowed.

Should the Contractor wish to use other methods, he shall submit details of the proposed method for the approval by the Engineer and the Contractor shall arrange for the necessary permits.

6.5 Transport of dredged material

The transportation of dredged material from the dredging unit to and within the Disposal Areas shall be carried out by the Contractor and shall be in accordance with the Method Statement submitted by the Contractor.

The Contractor shall avoid the loss of spoil during transport caused by leakage from floating transport equipment. The floating barges used for transport should be inspected for leakages by Contractor prior mobilisation to site. Suggestions and instructions of the Engineer in this respect shall be binding.

7

RECLAMATION WORK

7.1 Specific requirements of the fill soil

The upper 0.5m of any fill location shall not contain parts larger than 0.1 m.

Contractor shall be responsible to prove the suitability of the dredged and excavated materials for the purpose of this project and shall do this in his design works, monitoring of his activities and testing of the realised works.

7.2 Operational requirement

7.2.1 Fill placing

The placing of soil for reclamation and filling shall be in accordance with the Contractor's method statement in which special attention shall be given to the methods for obtaining a homogeneous reclamation fill, without silt layers or silt pockets.

The Contractor shall clear those areas over which the reclamation fill is to be placed by removing vegetation, debris, loose soil, contaminated soil, organic material, rubbish and the like. Disposal of such material shall be to an approved location and in accordance with local and national laws. The Contractor is responsible for identifying and certified disposal of hazardous materials.

7.2.2 Compaction

Any fill above (mean) water level shall achieve compaction of at least 95 % of the maximum dry density as per Proctor test (ASTM 1557). Fill below mean water level has to be compacted to meet the seismic requirement. The minimum relative density (Re) of the fill below mean water level shall be 50 %.

To prove the compaction, alternatives for the Proctor test might be suggested by the Contractor for approval of the Engineer.

7.2.3 Preloading

The defined areas on Drawings shall be preloaded in its entire extent after placing of the fill to at least the operational load.

7.2.4 Completion of works

The reclamation work shall be completed when the required slopes and thickness of reclamation have been achieved at all different work parts, provided that requirements with respect to compaction and other relevant requirements are being met.

7.3 Soil improvement work

Soil improvement (i.e. vertical drain and/or surcharge) shall be designed such that the requirements for residual settlements and required compaction are met after the time of handover. During construction work, the behaviour of the soil has to be monitored . Adequate control of the drainage conditions in the areas with vertical drains and preloading will help to reduce the residual settlements and speed up construction times.

Other type of ground improvement (i.e. (dynamic) compaction) might be used by the contractor (for example at the location of the landside crane beam), however approval from the Engineer is required.

7.4 Geotechnical monitoring and testing program for land reclamation

7.4.1 General

Prior to the start of the works, the Contractor shall submit to the Engineer a methodology for the geotechnical monitoring and testing programme. This includes field and laboratory testing, as well as performance monitoring. The program shall give detailed information on the proposed methods to perform geotechnical monitoring and testing including at least:

- Parameters to be tested/monitored.
- Types of tests (including Standards) for each parameter, techniques and equipment (both in-situ and lab). If a given parameter is to be obtained indirectly (e.g. relative density from CPT), details on how the correlation is derived should be presented.
- Monitoring/testing location (map in case of fill material, location within dredging vessel for samples).
- Frequency of testing/measurement.
- Accuracy of results.
- Accept/reject criteria for test/monitoring results and action to be undertaken in case of rejection.
- Timeframes between testing and action.
- Frequency of reporting.

The Engineer will be granted access to the dredging vessel, survey vessel or truck, to site or to the (independent) laboratory to supervise the testing and monitoring procedures. Samples will be sent to the Engineer upon Engineer's request.

7.4.2 Definition of the basis for the monitoring and testing plan

The main purpose of the geotechnical monitoring and testing plan is to safeguard quality during and after construction. Two aspects of quality control are considered:

- Quality control of the construction process.
- Quality control of the contractual requirements.

The geotechnical monitoring and testing plan gives the ability to continuous record parameters and to compare them with predefined criteria and expectations. If specific criteria are exceeded or expectations are not met, the work plan or control plan should provide measures to mitigate possible negative effects of these deviations.

The key parameters to be monitored and tested are:

- Prediction of residual settlements. This is done through:
  - Verification (measurement) and optimisation (and mitigation) of settlement predictions made during the detailed design.
  - Measurements of excess pore pressures at various depths in time (for settlement analysis and stability analysis of slopes).
  - Performance evaluation of the prefabricated vertical drainage (PVD) if any or any other drainage or settlement acceleration measure.
- Stability performance monitoring. A distinction is made between:
  - Stability performance monitoring of sand fill, including slopes.
  - Stability performance monitoring of the breakwater.
  - Stability and strength performance monitoring of the quay wall or any other type of retaining structure.
  - Stability and strength performance and damage monitoring for any relevant structure within the influence area of the works.
- Monitoring of ground water levels in reclamation area and within the area of influence as defined in the Particular Requirements and Design Criteria and in that respect monitoring of settlement in that area.
- Verification of the required properties of the dredged soil to be used for the fill.
- Verification of the required properties of the sand fill.
- Verification of the required bearing capacities by means of CPT(U)'s including measurement of local friction.
- Verification of the fill levels below and above water in time.

7.4.3 Minimum requirements for the monitoring plan

Placed fill and influence area

Monitoring and testing for all parameters for the fill (fill soil requirements, compaction, settlements, etc.) should be done, with a minimum of 2 investigation points per defined area as in definition drawing 118421-3303, only if there is fill in an area. In addition, any locations thought to lead to critical parameter readings (e.g. settlement where clay is in place, breakwater stability where rock is deepest) should be closely monitored, in a tighter grid if necessary. Monitoring of the area influenced by the fill shall be monitored as well.

The Contractor shall prepare a detailed testing plan for the sand to be used in the Works. This plan shall detail the type and source of the materials, the intended use in the Works, material specifications following from the Employer's Requirements and the Contractor detailed design, testing methods and testing frequency. The testing method and frequency shall be tailored to the scope and size of the Works, and as a minimum comply with the requirements in the relevant standards and guidelines.

The plan shall be submitted to the Engineer for approval prior to the sourcing of the materials.

7.4.4 Geotechnical instrumentation programme

Instrumentation is part of the Works and shall remain in good condition and operational both during and after the construction contract as specified in the Particular Requirements and Design Criteria, unless as agreed by the Engineer. The Contractor shall inform the Designer at least 2 day prior to undertaking installation of the equipment. The Contractor shall make due allowances in his construction programme for delays which may arise on account of the installation of the instruments and of their maintenance.

8

ROCK WORKS AND GEOTEXTILES

8.1 General

This work consist of furnishing all labour, materials, equipment and incidentals necessary for the construction of rock slopes, scour protection and/or breakwater foundation.

It is the intention to maximize the (re-)use of locally sourced rock in the construction of the Works, where possible. High quality rocks may be used in cover layer applications or as crushed rock foundation under gravity structures. Lower quality rock may be used as filter layer, or in the core of revetments and breakwaters.

All personnel employed shall be experienced and skilled in the work to be performed and adequate supervision shall be provided by the Contractor at all times when work is in progress. All equipment shall be of satisfactory capacity and dimensions, to be approved by the Engineer.

8.2 Codes and Standards

The following codes, standards and guidelines shall apply:
- EN 13383-1: Armourstone Specification.
- EN 13383-2: Armourstone Test methods.
- Rock Manual, The use of rock in hydraulic engineering (2nd edition), CIRIA, CUR, CETMEF, Published by C683, CIRIA, London, 2007.
- Standards used for testing of the rock as mentioned in section 8.3.2.

Similar ASTM or BS standards may be used, as approved by the Engineer.

Geotextiles
All geotextiles shall be shop made by a certificated manufacturer which operates under the ISO 9000 series. Geotextiles shall be fabricated according the governing BS, BS EN, BS EN ISO and PDCRI-SO 13434 and 6533.

8.3 Rock materials

8.3.1 Rock sources

The Contractor shall provide details of the selected quarry the production of quarry stone in the Method Statement, for approval by the Engineer prior to start of production.

Possible royalties to be paid are assumed to be included in the Contractor's tender.

8.3.2 Quality

Rock shall be hard and durable, free from laminations, (drill) holes, organic matter, clays, cracks, seams and weak cleavage planes. The rock shall not contain visually observable or chemically detectable impurities or foreign matters.

Rock for cover layers and the caisson foundation shall be classified as follow:
- nominally 'good' in accordance with table 3.12 in the CIRIA C683 Rock Manual.

Rock for filter layers, scour protection and volume filling applications will have relaxed requirements, to allow use of local rock.

Specifications shall be in accordance with table below.

Property	**Cover layers and caisson foundation**	**Filter layers & scour protection**	**Volume filling / core material**	**Testing standard**
Grading	CP/LMA/HMA	CP/LMB/HMB	declared	EN13383-1
Shape	LT_A	-		EN13383-2
Crushed or broken surfaces	RO_5	RO_5	-	EN13383-1
Particle density	≥ 2.6 t/m3	≥ 2.5 t/m3	≥ 2.3 t/m3	EN 13383-2, or EN 1097-6
Water absorption	≤ 2%	-	-	EN 13383-2, or EN 1097-6
Micro-Deval (wear)	≤ 20%	≤ 30%	-	EN 1097-1
$MgSO_4$ soundness[1]	≤ 10%	≤ 20%	-	EN 1367-2
Compressive strength	≥ 80 MPa	≥ 60 Mpa	-	EN 1926

[1] In locations where armourstone is permanently submerged (< 2m below low water) or in case the water absorption is ≤ 0.5 %, this test can be waived.

The requirements of the rock material (grading and intrinsic properties) may be modified subject to availability and Engineer's approval of local quarry material.

Inspection and approval

The Contractor shall prepare a detailed testing plan for the rock materials to be used in the Works. This plan shall detail the type and source of the materials, the intended use in the Works, material specifications following from the Employer's Requirements and the Contractor detailed design, testing methods and testing frequency. The testing method and frequency shall be tailored to the scope and size of the Works, and as a minimum comply with the requirements in the relevant standards and guidelines.
The plan shall be submitted to the Engineer for approval prior to the sourcing of the materials

For the initial quarry approval, the following documents shall be submitted to the Engineer for approval prior to start of production:
- Quarry description.
- Quarry petrographic report.
- Intrinsic property tests as per the table above.

Quality control testing during production shall be carried out by the Contractor at the quarry, prior to transportation to the site, in accordance with the approved Quality Control Procedures. In case material is re-used from site, testing shall take place at an agreed stockpile location prior to installation in the final location.

The results of tests and all non-conformances and proposed corrective actions shall be reported to the Engineer without delay.

Rock already delivered to site, but failing to meet the acceptance criteria shall be removed from the site immediately and disposed of at the Contractor's expense, unless an alternative use is agreed with the Engineer.

8.3.3 Delivery of rock

The Contractor is responsible for arranging all licenses, permits, certificates etc required to source, load, transport, export and import, and discharge/offload the rocks on Site. Each consignment of rocks shall have a certificate stating the quarry source, rock quality, category (grading), quantity, and other information as required by the authorities.

Different qualities and gradings of rock shall be stored separately at the storage area. Every category shall be marked by clear signs.

8.3.4 Placement of rock

General

Floating equipment used for placement of rock shall be equipped with positioning devices and shall be proposed by the Contractor in his Method Statement.
Stone layers shall consist of two layers of stone unless the design indicates otherwise.

Armour rock (cover layer)

- The method of construction shall be approved by the Engineer prior commencement of the works.
- The armour rock cover layer shall consist of two or more rock layers with a minimum total thickness of $2*D_{n50}$ for each layer.
- Heavy rock grading shall be individually placed to achieve a dense and fully interlocked armoured slope. Each armour stone is securely held in place by its neighbouring stone by means of interlocking and friction.
- Light rock grading may be placed either individually or with several stones at a time. Stones shall not be compacted.
- Placing of the stones shall start at the toe structure and proceed upwards towards the crest.
- Tipping of rock armour from vehicles, bulldozing or dumping from hoppers or barges into final position is not allowed within prior approval of the Client. Permission may only be granted following successful placing trials.
- Minimum "three-point-support" should be ensured and stable to the levels as per drawings by means of random placement.
- The surface of the armoured slope shall present an angular / uneven face to the water to achieve the desired wave energy dissipation (rough surface). Rocks smaller than ELL value of the associated grading shall not be used to fill interstices.
- Pieces of rock armour broken during handling or placing shall be removed immediately at no additional costs. Broken pieces of rock may be used in smaller gradings, subject to Client's approval.
- Any void below the finished profile as per drawings exceeding $0.75D_{n50}$ shall be filled with an appropriate sized stone or stones. Determination of the acceptability of any void shall be by means of use of a survey or any other appropriate method.

Underlayers/filter layers/core material/back fill

- The underlayer(s)/core material/back fill shall consist of rock layer with a minimum total thickness of $2D_{n50}$.
- The core material shall be placed to the positions and slopes as per drawings and in accordance with the method and sequence of construction approved by the Client.

- The Contractor shall ensure that the underlayer(s) and core material are placed such that dense layers are achieved. The materials shall not be compacted.
- Underlayer, rock backfill and core rock shall be placed so as to achieve an even distribution of rock sizes without concentrations of smaller rock sizes.
- Underlayer(s) and core material shall be placed with great care to avoid damage of the surface below and to ensure even distribution of stone sizes without (large) concentrations of smaller stones.
- Rocks in underlayers & filter layers should be placed to achieve a layer porosity in the range of 35% - 40% to avoid instability (pressure built-up).
- Tipping of rock armour from vehicles, bulldozing or dumping from hoppers or barges into final position is not allowed within prior approval of the Client. Permission may only be granted following successful placing trials.
- Light rock grading as recorded may be placed either individually or with several stones at a time. Placing rocks for the underlayers with a side stone dumping vessel is permitted provided that the position of the vessel and the rate of dumping can be controlled in such a way that the materials are placed according to the levels as per drawings. Damage to the rocks shall be avoided.
- Placing the core material with a split-hopper and / or flat-top barge is permitted provided that the position of the vessel and the dumping can be controlled in such a way that the materials are placed according to the levels as per drawings.
- The core material shall be graded to ensure that fine material does not migrate through the underlayer and armour layers under the influence of tidal and wave actions or other effects.

8.4 Geotextiles

8.4.1 Materials

Non-woven geotextile shall be used. They must be elaborated from long chain synthetic polymers, composed by a minimum of 95% in weight polyolefin or polyester. The geotextile must meet the mechanic properties indicated below.

PROPERTY	TEST STANDARD	VMPR* NON WOVEN GEOTEXTILE
Elongation	ASTM D4632/D4362M-08	≥ 50%
Grab strength (N)	ASTM D4632/D4362M-08	900
Seam strengths (N)	ASTM D4632/D4362M-08	810
Strength for puncture with 50 mm diameter piston (N)	ASTM D6241-04(2009)	1925
Trapezoidal tear strength (N)	ASTM D4533-11	350

* VMPR is “Average minimum value per roll”. The average of the results of the tests carried out on any roll of the batch being analyzed, must be greater than or equal to the value presented.

Stitching yarn of the geotextile shall be made of the original polyester or polyolefin homopolymers, Only the required materials added for increase of the mechanical properties, for protection against the influence of sun light and ultra violet light and the increase of the life time are allowed.
The geotextile shall be carefully protected against sun light during transport, trans-shipment and storage.

Laying of geotextiles
The Contractor shall submit a plan for laying geotextile in his Method Statement. The plan must include the following information:
- Storage and transport method on site.

- The order in which the different sections will be laid.
- The use of equipment.
- The manner of ballasting and sinking.

The Contractor shall spread the geotextile tight and evenly. The individual strips shall be combined to the required design dimensions, according the manufacturers prescription. Laying, dumping, covering or riveting a geotextile must be carried out in such a way that no damage occurs that could result in (localised) failure to meet the objective for which the geotextile was laid. Overlaps parallel to the shoreline are not permitted. In case of overlaps perpendicular to the shore-line, the overlap between two strips shall be at least 0.5 m and maximum 1 m.

Sewn seams must be made with plastic yarn that has the same expected life span as the geotextile. The tensile strength around the seams must comply with the required design value.
The sewing of the individual strips shall be according the manufacturer's prescription.

Certificate of origin

The Contractor shall provide a certificate of origin for the synthetic geotextile that the Contractor delivers. This certificate must be issued and signed by the producer and state all relevant technical data.

9

EARTHWORKS

9.1 General

This Chapter comprises requirements for earth works not being capital reclamation works.

The Contractor shall inform himself about the nature of the strata, materials, and the likely volume of water in excavations, open cuttings and trenches.

The Contractor shall satisfy himself as to the nature of the material to be excavated by examination of the Site and by review of existing ground investigation data which has been made available by the Employer. The Contractor shall carry out any further investigations deemed necessary by him to enable him to assess and foresee the nature of the material and to decide on the most suitable type of plant and method of operation and to achieve the performance requirements of this document.

The Contractor shall carefully assess the effect of any excavation and removal of vegetation on the potential increase in erosion and take appropriate measures to mitigate that. These measures shall include as a minimum: adequate water runoff control measures, stabilization of exposed slopes and areas (by pavement, slope protection, planting of vegetation, netting or similar), etc.

Once the proposed earthworks plan is approved by the Engineer, the Contractor shall not deviate from the content of the approved plan schedule without the approval of the Engineer.

All excavations shall be carried out to the length, width, depth, profile, line and level required for the construction of the Works shown on the Drawings, or to such other dimensions as may be ordered by the Engineer in writing. The Contractor shall carry out excavation in a safe and careful manner such that the excavation is adequately supported and stable. The excavation shall be excavated and supported by methods which will not endanger the stability of the surrounding structures, roads, Works, services or buildings. The Contractor shall make it verifiable for the Engineer that these conditions are met.

9.1.1 Ponding water

The Contractor shall be responsible for keeping excavations free from ponding water from whatever cause arising and shall provide such measures as may be necessary for this purpose.

9.1.2 Haul roads

Haul roads will be constructed and maintained by the Contractor as necessary to allow delivery of fill to site and movement of fill on site. The Contractor shall obtain the approval of the Employer for the location of his temporary haul roads. The Contractor is responsible for controlling dust from haul roads which is deemed excessive by the Engineer or Employer.

9.1.3 Excavations beyond true line and level general excavations

If over-excavation occurs, the Contractor may be instructed at no cost to the Contract to clean out disturbed material to the Engineer's satisfaction and fill the void with acceptable fill, up to the over dig tolerance level, or other level detailed on the Drawings. The risk of over-excavation shall be mitigated and in the event of occurrence the consequences on stability shall be assessed.

9.2 Trench earthworks

9.2.1 Inconvenience by excavation works

The excavated ground shall be stored next to the excavation, in such a way that the works can be performed efficiently and inconvenience for traffic and local residents is minimised. Accessibility of nearby buildings and houses should be maintained. The Contractor is responsible for informing the involved persons or institutions in advance and for consulting them on the possibilities to preserve accessibility.

9.2.2 Trench excavation and backfill

Trench excavation and backfill plans must be approved by the Engineer.

The Contractor shall examine the influence of the excavations on stability of the nearby structures and buildings. If the stability of the nearby structures or buildings is influenced, the Contractor shall notify the Engineer and propose the precautions that are to be taken. All measures to be taken to maintain the stability of the nearby structures and buildings shall be paid by the Contractor.

If a road obstruction is located where the excavation needs to take place, the asphalt or block paving shall be removed over a width that is necessary to create the excavation. Asphalt shall be cut with adequate sawing equipment and removed. Afterwards the asphalt road shall be reconstructed to the satisfaction of the Engineer. The block pavement shall be removed and the bricks shall be stored in a nearby place in order to reconstruct the road after the works are completed. Reconstruction of the block pavement after the works shall be in accordance with the original state of the pavement and to the satisfaction of the Engineer.

Excavated ground shall be stored alongside the trench for use as backfill. The Contractor shall dis-pose of all surplus excavated material. The topsoil, supporting vegetation, shall be stored separately, for backfill.
Back filling and compaction of trench excavations shall be performed equally at both sides in order to prevent horizontal movement or wave movements of the pipes.

Trenches created by removed sheet piles shall be back-filled and compacted to the satisfaction of the Engineer.

9.3 Excavations in general

9.3.1 Extent of excavation

The extent of excavations shall be minimum practicable for the construction of the Works.
The Contractor shall limit the construction of open trenches at any one time.

9.3.2 Fill material for structures

Fill material shall be in compliance with Section 7.1 of this document.

9.3.3 Compaction of fill

Fill shall be placed in horizontal uniform layers with a thickness not exceeding 500 mm before compaction.

Compaction of fill and test for compaction shall be in compliance with Section 7.2.2 of this document.

9.4 Excavation for structures

9.4.1 Excavation for concrete structures

Unless otherwise specified, the Contractor shall keep the excavations free from water during construction and for such further period as may be necessary to avoid the submersion of the structures.

The method of keeping excavations free from water, dewatering and disposal of water shall be pro-posed by the Contractor in his Method Statement.

The Contractor shall provide sufficient stand by equipment on site to ensure at all times that no interruption in the continuity of the dewatering will occur.

The formation of the excavation shall be finally trimmed, prior to the construction of the concrete structures. The formation shall be excavated and backfilled as specified.

9.4.2 Trimming at formation level

Where the formation level of any excavation is to receive concrete or compacted fill, this level shall be carefully levelled or shaped as indicated as mandatory on the Contractor's Design Drawings.

9.4.3 Selection and compaction of backfill

Wherever backfilling below ground level and adjacent to structures is required, the material to be used shall be carefully selected and compacted.

Material shall be in compliance with Section 7.1 of this document.

Where backfill is to be placed on both or more sides of structures, it shall be placed on opposite sides together so that the difference in level never exceeds 300 mm. Generally, backfilling for structures shall be carried out as soon as practicable, however, an exception will be made for retaining structures where backfilling shall be carried out after the concrete has sufficiently hardened.

9.4.4 Tests for compaction

Compaction of fill and test for compaction shall be in compliance with Section 7.2.2 of this document.

9.4.5 Levelling of areas

The Contractor shall level areas around or on structures to the required levels as indicated as mandatory on the Basic Design Drawings. The Contractor shall take due precautions to prevent any damage to the structures during the execution of levelling. The levelling of areas around the structures shall be carried out by means of approved methods. Any damage shall be replaced or repaired at the Contractor's expense and to the satisfaction of the Engineer.

10

DEWATERING WORKS

10.1 General

The Contractor shall carry out the Works in accordance with the specifications contained in this Clause and all cost in relation thereto are deemed to be included in the Contract Price.

Prior to drainage of (part of) the Works the Contractor must submit a methodology to the Engineer for approval, comprising the amount of water to be extracted and the effect on the groundwater table and aquifers in the influence area of the extraction. The Contractor must obtain permits prior to the actual extraction of (ground) water with the relevant Authorities.

10.1.1 Operations

Both the pumping installation and the method of draining away excess water require the approval of the Engineer. If well-pumping is used, the pumps shall have sufficient capacity to lower the groundwater table to at least 0.40 m below the level of the Works.

The Contractor is not required to have a spare pumping station available, but the Contractor shall be held responsible for any damage occurring as a result of complete or partial interruption of the pumping. During temporary interruption of pumping the Contractor shall take adequate measures to prevent damage to completely or partially finished parts of the Works.

10.1.2 Termination

The Contractor shall not terminate any pumping abruptly, but he shall gradually reduce the amount of water being drained, to allow a gradual rise of the groundwater table.

10.1.3 Disposal of water

The contractor needs to ensure that no contamination is discharged with the pumping water. The Contractor shall take adequate measures to prevent damage as a result of the discharge of water. Any sand deposited by the discharge shall be removed.

10.2 Pumping

10.2.1 General

The Contractor shall use well-pumping or sump pit to lower the groundwater table to below the level of all excavations, in order to enable all activities to be performed in the dry and to prevent completed Works from floating.

10.2.2 Capacity

The pumping installation shall have sufficient capacity to lower the groundwater table to at least 0.40 m below the level of the excavations.

10.2.3 Installation

The Contractor shall be fully responsible for the pumping installation. The Engineer may allow installation of the pumping station and pumping wells by a qualified Subcontractor.

11

PILE INSTALLATION

11.1 General

The work covered under this section consists of furnishing all necessary plant, labour, equipment, appliances and materials in performing all operations in connection with the permanent piling works of piles for combi walls and foundation piles.

When steel piles are applied, those shall be new and factory produced and welded.

11.2 Codes and Standards

All EN standards relevant to Construction Methods are applicable, especially but not restricted to the following:
- EN 12699.
- EN 1536.
- EC7 (NEN 9997-1).
- EN 1993-1-1.
- EN 10210-1 en 2.
- EN 10219-1 and 2.

11.3 Submissions

Prior to the start of piling operations, the Contractor shall submit for approval by the Engineer his Method Statement including a description, accompanied by specifications, drawings and detailed working programme, of the method he proposes to drive the piles, giving full particulars of the piling and ancillary plant and equipment to be employed. These particulars shall include the type and make of hammers, the weight of the rams, the maximum drop heights, energy output and rating, the anvils, cushion materials, driving caps, piling frame, offshore cages, and all other working details including the type of craft to be employed and details of the pile frames and supports to be used.

Specific information to be submitted with his Method Statement shall include the following:
- Manufacturer's specification data of the proposed hammer.
- Complete description and dimensions, including thickness of all cushion material between the pile and the helmet.
- Complete description and dimensions, including total thickness of cushion material in the cap block including direction of grain if wood is used.
- Design of the piling frame.
- Piling sequence.
- Calculated expected vibrations (accelerations, velocity, deformations) of existing structures and parts of structures due to driving.
- Calculated expected noises at locations as specified by the Engineer (see also the permit, Volume V)).
- Noise reduction measures.

- The effect of driving on the stability and integrity of existing structures and slopes above and under water (in case of slopes a.o. liquefaction of soils).
- Inspection and test plan agreed with the Engineer.
- Details of the pile driving frame and leads.

11.4 Equipment

11.4.1 General

The Contractor shall provide and maintain in good operating condition, all equipment necessary for the proper and efficient handling and installation of piles. Barges and other floating equipment shall be of ample size to be stable under average sea conditions without excessive movement or tilting during pile installation.

All pile driving / drilling / installation equipment to be used shall be as generally used for such a purpose and shall be maintained in excellent condition and good running order.

All equipment shall be accompanied by manuals and specifications.

All equipment, the manuals and specifications as well as the method used for this purpose are subject to the approval of the Engineer, prior to mobilisation of the pile driving equipment.

The Engineer's decision in this respect shall be final and conclusive. Any delay as a result of mechanical failure of the equipment shall not relieve the Contractor of his obligation to finish the work within the time limit of the agreed time schedule for pile driving works. Whenever the equipment or any part of it at any time in the opinion of the Engineer becomes unserviceable, malfunctions or operates poorly, the Contractor shall replace it after written notice by the Engineer, without delay.

11.4.2 Selection of hammer

Hammers shall be hydraulic powered and either single acting or differential type. Before mobilisation of pile driving equipment, the Contractor shall supply the Engineer with information about the selected type of equipment and obtain the Engineer's approval.

Hammers shall be the type generally used in standard pile driving practice such as diesel or hydraulic powered and either single acting or differential type, and shall be in good operating condition. The hammers shall have sufficient energies to install the piles in one continuous operation and shall be operated at full speed, pressure, and stroke as shown in the manufacturer's printed instructions.

The use of vibration type hammers shall be carefully assessed in view of the prevailing soil conditions.

Piles shall not be stressed beyond 90% of the yield stress or allowable tensile stress during sustained hard driving.

The Contractor shall base his selection of hammer type on the results of a dynamic wave equation analysis.

Any hammer failing the above requirements or not in good operating condition shall be taken out of service and repaired or replaced at Contractor' s expense.

Specific information to be submitted to the Engineer shall include the following:
- Manufacturer's specification data of the proposed hammer.
- Complete description and dimensions, including thickness of all cushion material between the pile and the helmet.
- Complete description and dimensions, including total thickness of cushion material in the cap block.

Sufficient boiler or compressor capacity shall be provided at all times to maintain the rated speed of the hammer during the full time of driving a pile. The Contractor shall maintain the valve mechanism and other parts of the hammer in first-class condition so that the length of stroke for which the hammer is designed, will be obtained.

The hammer shall have enough rated energy capacity and hammer-weight to drive the piles to the design penetration depth.

11.4.3 Driving heads

The Contractor shall install an adequate pile driving head between the hammer and the pile head. The driving head shall accurately match the pile size to prevent bulging and distortion of the head of the pile.

11.4.4 Cap blocks

The Contractor shall use a cap block between the drive head and the hammer to protect the pile and hammer from damage. The cap block shall effectively transmit the hammer energy to the pile without excessive energy losses. If in the opinion of the Engineer, the cap block begins to become highly compressed or has been crushed or burned out, it shall be replaced immediately. A new block shall be provided with the same specifications as the previous block(s). Noise reducing cap blocks shall be used. Reference is made to the maximum allowed noise levels as indicated in the relevant Permit and local legislation.

11.4.5 Noise reduction measures

The piling / drilling equipment shall be equipped with noise insulation measures. Reference is made to the maximum allowed noise levels as allowed according to relevant
relevant Permit and local legislation.

11.4.6 Pile driving criteria

In his Method Statement the Contractor shall determine the net penetration rates and refusal rates necessary to achieve the required penetration depths and resistances for the various pile hammer combinations he intends to use in the works. The rates shall be established by wave equation analysis or similar dynamic method. The predicted maximum driving stresses in the piles shall be included in the report. The penetration rate shall be defined as the number of blows per 25 cm. This rate shall be achieved for at least 150 consecutive centimetres of driving.

11.5 Preparatory piling works

11.5.1 General

The Contractor shall pick up all steel piles in such a manner so as not to cause permanent local bending or deformation and so as not to induce permanent bending. Preferably quick release shackles are used for lifting steel piles taking into account safety precautions related to the use of quick release shackles:

The piles shall be handled with great care and all precautions shall be made to avoid any damage to coatings. The head of the pile shall be rigid and even. Proper centring of the piles in the leads and under the

hammer shall be carried out. The hammer shall be held in the leads in such a way that it does not exert an eccentric or deflecting blow. A stable pile driving rig is essential.

The Contractor shall employ all necessary safety regulations, which shall include the provision and maintenance of all necessary safety and temporary aids to navigation and other measures.

11.5.2 Control of leads alignment

The Contractor shall install piles with leads constructed in such a manner as to afford freedom of movement of the hammer. Leads shall be held in position to give the required support to the pile during driving. Inclined leads shall be used for driving batter piles. Leads shall be of sufficient length because the use of a follower shall not be permitted.

The verticality or the batter angle of the leads shall be easily controllable. Batter piles shall be supported so as to reduce the gravity bending as much as possible.

11.5.3 Positioning

The Contractor shall assure correct positioning by accurate setting of the pile in accordance with the Drawings. All piles shall be checked for their proper position and special attention shall be paid to the batter angle of the piles after lowering by its dead weight and hammer weight prior to driving. Correction of position after the pile driving has commenced, is not allowed.

The Contractor shall use a steel pile driving frame to ensure that piles will not rotate during piling and centre to centre distances relative to the adjacent pile will be correct.

The piling frame shall contain rollers for smooth guidance of the piles in order to prevent damage to coating.

11.5.4 Pile driving record

The Contractor shall keep a daily record. The pile driving record shall include, but not be limited to:

- Pile identification number and location, pile type , dimensions or diameter, wall thickness.
- Date and time of driving, redriving including stopping and delays, including field splice stoppages.
- Length of pile and extensions.

a) Type of hammer, falling weight, stroke (drop), rated energy and mechanical condition (efficiency), the number of piston blows per minute for diesel hammers.
b) Type of anvil and cushion or capblock used.
c) Seabed or ground level referred to project datum at commencement of installation of pile.
d) Depth penetrated under own weight and after placing anvil and hammer.
e) Number of blows per 250 mm penetration over the full pile length and especially for the penetration of the hard layers (but at least last 5 metres) and final set.
f) Final pile toe level and cut off level.
g) Level of soil and water inside open-ended pile at completion of installation.
h) All information regarding obstructions, delays and other interruptions to the sequence of work.
i) Pile Bearing Capacity.

A pile driving sheet shall be made for each pile.

The Contractor shall submit the format for the pile driving record sheet to the Engineer for approval prior to pile driving. A pile driving sheet shall be made for each pile and shall be signed by the Engineer. Additional information shall be given for the reason of any delay, with the day and the time.

11.5.5 Test piles

At a number of locations, the pile, which is to be driven as near as possible to the position of a boring, CPT or Dynamic CPT shall be considered as a test pile. Recording of the pile driving operation shall be carried out in accordance with section pile driving record. The test pile shall be positioned at its proper location and shall, in principle, be driven to its design penetration depth.

The driving record of the test pile shall serve as standard for the review of the driving records of nearby piles.

11.5.6 Monitoring

Existing and newly built structures within a range of 100 m shall be monitored during driving. The induced accelerations and velocity shall be measured at adequate positions in conformity with the Standards. The vibrations induced by the driving shall not exceed the requirements mentioned in the Standards.

Furthermore the deformations of the structures should be monitored continuously. The Contractor is responsible for any damage to or decrease in safety of the present Port infrastructure or the top side facilities and the cost for rehabilitation shall be borne by the Contractor.

11.6 Driving

11.6.1 General

No pile driving shall be performed within a radius of 50 m from any concrete structure being poured, or from any concrete structure that was poured less than six days previous.

11.6.2 Piles

General

In principle, Contractor shall drive all piles to the design penetration depth, as per the approved Detailed Design. The driving of each pile shall be continuous as far as practicable. When driving is resumed after an interruption, the blow count shall not be taken into consideration until the temporary set of the pile resulting from the interruption has been broken. If in the opinion of the Engineer the final blow count cannot be considered as assurance of sufficient bearing capacity, the pile shall be driven to a greater depth until, in the opinion of the Engineer, refusal is obtained.

All piles shall be driven truly vertical or to the batter as shown on the Drawings. No remunerations shall be made for piles that have been driven deeper than the design penetration depth, unless decided by the Engineer.

Whenever any pile is heaved by the subsequent driving of adjacent piles, it shall be re-driven by the Contractor at no additional cost to the Employer.

The piles shall be driven in such a manner as not to damage them. The Contractor shall install the piles by driving to attain the designed penetration depth.

Each pile shall be driven continuously and without interruption until the designed depths have been reached.

Any remedial work required, in case where the pile head is driven below the required elevation or beyond the tolerances specified herein, or where the pile is damaged below cut off level or otherwise damaged or does not meet all provisions of the specification, shall be at the Contractor's expense.

Concrete piles
Concrete piles shall not be installed before the required characteristic compressive cube strength is achieved.

All concrete piles shall be new.

Vibro combination piles
The concrete or steel element (pile) shall be placed centric in the steel tubular casing.

In case of pulling of the casing, the pressure in the fresh mortar at the toe of the casing shall be at least equivalent to the ground water pressure, increased with the free water column. The water level in the casing shall be at least 1 m higher than the ground water level until the casing is fully pulled.

The grout quantity shall be registered.

No soil or ground water may enter the casing during installation of the casing, pulling of the casing and injection of the grout.

In case soil or ground water has entered the casing, the casing shall be filled with sand and pulled. A casing with a new toe plate shall be installed subsequently.

Within 24 hours after installation of a pile it is not allowed to install piles within 2 metres distance.

Steel piles
Reference is made to Chapter "Steel Works" for further specifications.

11.6.3 Inspection

The Contractor shall have available at all times a suitable drop-light for the inspection of each pile.

11.6.4 Tolerances

The maximum permissible erection tolerance in the horizontal plane measured at the head of the pile will be 50 mm in every direction for foundation piles and 20 mm for combi wall piles.

The maximum variations of foundation piles from the vertical shall not exceed 50 mm per 5 metres (1%) of free length of pile. The maximum variations of piles applied for combi walls from the vertical shall not exceed 10 mm per 5 metres (0.2%) of free length of pile.

The distance between adjacent pile heads shall not vary more than 50 mm from those shown on the Contractor's Design Drawings.

The piling rig shall be set and maintained to attain the required rake.

In order to determine the alignment tolerances, inclinometer measurements shall be carried out.

All piles shall be x,y,z surveyed.

For the installation of the combined wall piles, a steel driving frame is required, see section 11.5.3. This driving frame must be able to control the spacing between the piles to ensure a proper installation of the intermediate

sheet piles. The combi wall piles must be positioned at a center-to-center distance as indicated on the design drawings.

11.6.5 Misalignment

The Contractor shall not subject piles driven outside the tolerances to force in order to place them in correct alignment or horizontal position. Piles exceeding the allowable tolerances shall be considered unacceptable unless the Contractor submits a satisfactory work plan showing the corrective work he proposes. Such work shall not proceed until the work plan has been approved by the Engineer. All costs for removing, re-driving and extra pile length or alterations to the superstructure (to be constructed on top of the piles) shall be borne by the Contractor.

11.6.6 Refusal

In case boulders are encountered (or any other reason for refusal) at the location of the piles (when installing the pile or a casing), the Contractor shall stop driving and drill through the pile or the casing in order to remove or crush the obstacle. The drilling equipment must have sufficient capacity to drill through hard obstacles.

11.6.7 Cut-off elevations

The Contractor shall cut off all piles at the elevations as shown on the Drawings after being driven. Cutting methods shall be used which shall in no way damage the permanent portion of the piles.

Pile cut-offs may not be used in other piles.

All cut-off elevations shall be within a tolerance of plus or minus 10 mm. Distorted and bulged pile heads shall also be cut off. All costs for extension of piles due to bulged or distorted pile heads shall be borne by the Contractor.

The Contractor is responsible for removal of all unused parts and excess material remaining from the piles at his cost.

Reinforcement bars and pretension strings shall stick out unharmed for at least 600 mm after cutting the pile head.

In the event of cement on piles, the cement skin shall be removed by blasting until a relief depth of at least 1 mm is achieved. The blasted planes of the piles shall be thoroughly cleaned and loose pieces of concrete, sand and gravel shall be removed.

The prefabricated prestressed concrete piles that are applied for the “Vibro Combination” piles shall have a rough surface on all sides. The rough surface shall be realised by blasting or application of suitable shuttering.

11.6.8 Fill of steel piles

All steel piles must be filled with compacted sand or non-cohesive granular material up to the concrete level in the pile as indicated in the drawings. The characteristics of material or soil used for filling the piles must be presented to the Engineer for approval.

11.6.9 Acoustic measurements

100 % of the installed prefabricated concrete piles shall be measured by acoustic apparatus to investigate discontinuities in the pile diameter. Discontinuities that lead to decrease of the pile bearing capacity are not allowed.

11.6.10 Marking

The Contractor shall mark at least the top 5.00 metres, or more if necessary, of each pile with small line markings of water-resistant white paint. Numbers shall indicate the depth levels.

Spacing of the marks shall be as follows:
- From head of pile to 5.00 m below: 0.25 m.

If a pile has to be extended, the built-up pile section shall be marked in such way that a proper reading can be obtained.

While starting the pile driving, the Contractor shall take care that the marks on the piles shall face to the nearest benchmark onshore.

11.6.11 Method Statement of piling

The Contractor shall submit a detailed Method Statement of piling, including a list of equipment the Contractor proposes to use. The Method Statement shall also include the method of unloading the piles, storage of piles, the handling of piles, the anchorage of the barge (in case working over water is allowed), the method of positioning the piles, sequence of pile driving and noise reduction measures. The Method Statement shall be submitted to the Engineer for approval, prior to commencement of the related work.

11.6.12 Defective piles

Piles damaged by reason of internal defects or by improper handling or driving shall be rejected. The Contractor shall submit corrective measures to the Engineer for approval. Approved corrective measures undertaken by the Contractor shall be at no additional cost to the Employer.

11.7 Materials

Vibro combination pile
The grout mixture of "Vibro Combination" piles shall be design by the Contractor and submitted for approval to the Engineer.

Steel piles
Reference is made to the chapter "Steel works".

Prefabricated concrete piles
- Piles shall be prestressed over the full length of the pile.
- The remaining pretension pressure in the concrete shall be at least:
  - for piles 350*350 mm^2 or smaller> 5 N/mm^2.
  - for piles lager than 350*350 mm^2 >4.5 N/mm^2.
- Additional pre tensioning and pile head reinforcement of the pile for hammering purpose or absorbing of bending moments shall be determined by the Contractor.
- The prefabricated pretensioned piles shall meet the following requirements:

- CEMIII/B.
- Pretension steel FeP 1860, relaxation level 2.

- The prefabricated prestressed concrete piles that are applied for the 'Vibro Combination' piles shall have a rough surface on all sides. The rough surface shall be realized by blasting or application of suitable shuttering.

Certificate of origin

Prefabricated prestressed piles shall be fabricated by a manufacturer that operates under the ISO 9000 series. All piles shall be delivered with a certificate of origin and shall be kept by the Contractor.

11.8 Insufficient penetration depth

Any pile driving works that is less than the required design penetration depth due to early pile driving refusal and that is approved by the Engineer shall be measured by reading out the painted marks on the pile. Measuring shall be rounded off down to 0.25 m.

11.9 Preparation works steel piles (welding of piles)

11.9.1 General

The Contractor shall take every measure to protect the welds against damp and draught during the welding on the Site.

11.9.2 Bevelling

Where required, the Contractor shall perform additional bevelling on the Site by skilled personnel and approved equipment. The angle of bevelling shall be between thirty-five degrees and fifty degrees. The bevelled ends shall be finished smooth and rigid.

11.9.3 Joint socket

Prior to pile driving, the Contractor shall provide all bevelled ends of those piles to be welded to required lengths with internal joint sockets, to guide the piles for assembling and welding.

11.9.4 Welding of connections

The minimum length of a section of pile to be used in assembling steel piles shall not be less than 3.00 m. The maximum number of sections for a pile is three (3).

11.9.5 Testing

The Contractor shall appoint an independent inspection and testing company to undertake all aspects of inspection and Non-Destructive Examination (NDE) of welds. A Method Statement with welding procedure for inspection and testing shall be approved by the Engineer prior to appointment of the independent testing company. Draft and final reports of inspection and testing shall be submitted to the Engineer.

11.9.6 Material and testing

Steel piles shall conform to Standards as mentioned in sections 11.1 and 11.2 of this chapter and chapter 'Steel Works'.

12

SHEETPILE INSTALLATION

12.1 General

This work consist of furnishing all labour materials, equipment and incidentals necessary for the fabrication and installation of steel sheet pile constructions.

Sheet pile lengths are shown on the Drawings.

All sheet piles and steel piles for combi walls shall be new.

12.2 Scopes and Standards

The following scopes and standards shall apply:
EN 12063.
EN 10248.

12.3 Submissions

Prior to the start of sheet piling operations, the Contractor shall timely submit his Method Statement as mentioned in Chapter 'Pile Installation' section 'Submissions', including the specific information.

12.4 Equipment

12.4.1 General

The Contractor shall provide and maintain in good operating condition all equipment necessary for the proper and efficient handling and installation of sheet pile constructions. The equipment shall be of ample size to be stable under all working conditions during which pile driving operation will be carried on, and to permit proper handling of sheet piles and pile driving equipment without excessive movement or tilting.

All sheet pile driving equipment to be used shall be those generally used for such a purpose and shall be maintained in excellent condition and good running order.

All equipment shall be accompanied by manuals and specifications. All equipment, the manuals and specifications as well as the method used for this purpose shall presented in the Method Statement.

Any delay as a result of mechanical failure of the equipment shall not relieve the Contractor of his obligation to finish the work within the time limit of the agreed time schedule for sheet pile driving works. Should the equipment or any part of it any time become unserviceable, malfunction or operate poorly, the Contractor shall replace it, without delay.

Steel sheet piling shall be driven by hammers having an energy rating sufficient to drive the sheet piles to the required penetration as designed.

12.4.2 Selection of Hammer

Hammers shall be the type generally used in standard sheet pile driving practice and must be hydraulically powered and either single acting or differential type, and shall be in good operating condition. The hammers shall have sufficient energies to install the sheet piles in one continuous operation and shall be operated at full speed, pressure, and stroke as shown in the manufacturer's printed instructions.

The use of vibration type hammers shall be carefully assessed in view of the stability of the present structure and excavated slopes (liquefaction) as well as the noise restrictions as stated in the permit (Volume V).

Sheet piles shall not be stressed beyond 90 % of the yield stress during sustained hard driving.

The Contractor shall base his selection of hammer type on the results of a dynamic wave equation analysis.

Any hammer failing the above requirements or not in good operating condition shall be taken out of service and repaired or replaced at Contractor' s expense.

Sufficient compressor capacity must be provided at all times to maintain the rated speed of the hammer during the full time of driving a sheet pile. The valve mechanism and other parts of the hammer shall be maintained in first-class condition so that the length of stroke for which the hammer is designed will be obtained.

12.4.3 Sheet pile driving criteria

Before sheet pile driving commences the Contractor shall submit for information to the Contractor a report with the net penetration rates and refusal rates necessary to achieve the required penetration depths and resistances for the various pile hammer combinations he intends to use in the works. The rates shall be established by wave equation analysis or similar dynamic method. The predicted maximum driving stresses in the sheet piles shall be included in the report. The penetration rate shall be defined as the number of blows per 25 cm. This rate shall be achieved for at least 150 consecutive centimetres of driving.

12.4.4 Spare Hammer

A workable spare hammer to be used with the same energy output, weight of ram and total weight as the primary hammer shall be available at any time during the pile driving works in the event of break down.

12.4.5 Driving head and capblocks

An adequate sheet pile driving head and cap shall be installed between the hammer and the top of the sheet pile. The driving head and cap shall fit time to prevent bulging and distortion of the head of the sheet pile.

The cap block shall effectively transmit the hammer energy to the pile without excessive energy losses. A cap block of laminated material, such as aluminium or micarta is preferred, however, hardwood may be used. If hardwood is used, the hardwood block shall be enclosed in a tight fitting steel sleeve and shall be placed in the drive head so that the grain shall be parallel to the pile axis. If the hardwood block begins to become highly compressed or has been crushed or burned out, it shall be replaced immediately. A new block shall be provided with the same specifications as the previous block(s).

12.5 Preparatory sheet piling works

12.5.1 General

All steel sheet piles shall be picked up in such a manner as not to cause definitive local bulging or deformation and so as not to induce definitive bending. The sheet piles shall be handled with great care and all precautions shall be made to avoid any damage to the coating. The head of the sheet pile shall be rigid and even. Proper centering of the sheet piles in the leads and under the hammer shall be carried out. The hammer shall be so held in the leads that it does not exert an eccentric or deflecting blow. A stable sheet pile driving rig is essential.

12.5.2 Control of Leads Alignments

Sheet piles shall be driven with leads constructed in such a manner as to afford freedom of movement of the hammer. Leads shall be held in position by guys or stiff braces to give the required support to the sheet pile during driving. Leads shall be of sufficient length, as the use of a follower will not be permitted.

The verticality of the leads shall be easily controllable.

12.5.3 Positioning

The Contractor shall ensure that individual sheet piles are placed in the correct position. The sheet piles shall be placed along straight lines, between two temporary beams of sufficient rigidity. Long sheet piles shall also be supported at a point between the capping block and the temporary beams.

12.6 Sheet pile driving

12.6.1 General

No sheet pile driving shall be performed within a radius of 50 m from any concrete construction being poured, or from any concrete construction that was poured less than 6 days previous.

12.6.2 Sheet piles

Single sheet pile walls
No remunerations shall be made for piles which have been driven deeper than the design penetration depth.

The sheet piles shall be driven in such a manner as not to damage them. The Contractor shall install the sheet piles by driving to attain the designed penetration depth.

Each sheet pile shall be driven continuously and without interruption until the designed depths have been reached.

Driving shall not be continued after refusal.

Sheet piles may not be pulled or, jacked into position after driving. Sheet piles driven beyond the tolerance specified or shown on the Contractor's Design Drawings shall be withdrawn and replaced with satisfactory sheet piles except demonstrated that such out of tolerance sheet pile may remain as driven.

After the sheet piles are driven, they shall be cut off to true planes at the elevations designed. Cutting methods shall be used which shall in no way damage the permanent portion of the sheet piles.

Fluidisation or pre-drilling is not allowed unless approved by the Engineer or stipulated in the Particular Requirements and Design Criteria.

Combi walls
For steel piles of combi walls reference is made to chapter 'Pile Installation' with respect to hammering.

12.6.3 Working method

Single sheet pile wall
- Sheet piles shall be configured as double sheet piles with shop pinched interlocks with the following requirements:
  - At the toe of the sheet piles a double side weld a= 6 mm over a stretch of 1 m.
  - At the head of the sheet piles a double side weld a= 6 mm over a length of 0.5 m.
  - Intermediate positions 3 punches per m' with a tensile (shear) strength of at least 75 kN/m'.
- In case it turns out that already installed sheet piles tend to settle with the sheet piles under execution, these installed sheet piles shall be welded by weldings of sufficient strength to the preceding sheet piles.
- Sheet piles shall be hammered in the straight in both directions, in such a way that a soil and water tight construction is achieved.
- Declutching detection by means of a interlock control device shall be installed to prove that the sheet piles are installed to the required depth and that the locks are not declutched.
- Sheet piles that are hammered too deep shall be elongated (electric welding) until the required design level with pieces of the same profile, the same quality and the same wall thickness.

Combi walls

General
- Combi walls must be installed in such a way that a water and soil tight construction is achieved.
- Combi walls shall be installed until the design level.
- The water level in the piles shall be MSL after installation of the piles.
- Declutching detection by means of a interlock control device shall be installed to prove that the sheet piles and piles are installed to the required depth and that the locks are not declutched.
- Piles and sheet piles that are hammered too deep shall be elongated (electric welding) until the required design level with pieces of the same diameter or profile, the same quality and the same wall thickness.
- In order to measure the inclination of the piles, on average every tenth pile shall be equipped with measurement tubes (2 per pile). Inclination measurements shall be carried out via these measurement tubes. Measurement tubes must be lengthened through the concrete capping beam to make them accessible for future measurements.

Piling frame
- In order to drive the piles and sheetpiles in the required position, guidance must be ensured by means of a piling frame. The piling frame shall have such dimensions that 5 to 7 piles (tubular) can be driven in one time. The piling frame shall be moved to the next position overlapping one pile.
- The piling frame shall have guiding structures/spaces in order to prevent rotation of the piles. The piling frame shall be applied for after hammering as well.
- The piling frame shall contain rollers for smooth guidance of the piles in order to prevent damage to coating.

Intermediate sheetpiles

- 2 successive piles must be hammered prior to installation of sheet piles in between these 2 successive piles.
- Combi walls shall comprise of steel tubular piles with welded interlocks combined with double or triple sheet piles with shop pinched locks.
- Driving of sheetpiles shall be carried out in one time (no interruption) to the required level.
- Handling of sheetpiles shall be with quick release shackles.

12.6.4 Refusal

Sheet piles

In case boulders are encountered (or any other reason for refusal) at the location of the quay structure, the Contractor shall stop driving or vibrating and must change his installation method as described in his Method Statement, in such a way that all functional and structural requirements are met.

12.6.5 Tolerances

The maximum variations of sheet piles from the vertical shall not exceed 5 mm per 1 metre (0.5 %) of free length of sheet pile with a maximum of + or – 50 mm.

The maximum deviation of a sheet pile width when replaced by a fitting or wedge sheet pile shall be less than 0.25 m.

Tolerances for combi walls are determined by the tolerances for the piles for combi walls as mentioned in chapter ' Pile Installation'. In contradiction with the requirements of EN 10248 for double sheet piles the tolerance in width is 2 % with a maximum of 30 mm.

If the top of a sheet pile is damaged along a length of more than 0.5 m during placement, placement of this sheet pile must be discontinued.

The jaws of steel sheet piles to be placed must be deburred and cleaned.

12.6.6 Driving records

The Contractor shall provide qualified personnel to keep a daily record. The sheet pile driving record shall include, but not be limited to the requirements mentioned in chapter 'Pile Installation'.

12.6.7 Drawing down

If during driving, sheet piles placed earlier are drawn down by sheet piles placed later, suitable measures shall be applied to prevent this drawing down, i.e. using temporary clamps.

12.6.8 Obstacles

The Contractor shall take into account the possibility of obstacles and sandstone and suchlike in the subsoil. The existence of such obstacles shall not relieve the Contractor of his obligation to place the sheet piles in the correct location, close-fitting and to the correct level.

The Contractor shall clean sheet piles of excrescences and burrs and shall grease the sheet piles before driving. Sheet piles that have not been driven at the correct position, or have run out of lock, shall be

removed and replaced at the Contractor's expense. Adjusting the top of the sheet piles and the supply and placing of necessary adaptor-sheets shall not be eligible for additional payment.

12.6.9 Unloading, transportation, storage

Unloading, transportation and storage shall be carried out by skilled personnel and in such a way as not to damage the sheet piles.

The Contractor shall store the sheet piles on a reserved lay-down area and in such a way that access to the Engineer's office, the Contractor's office, the labour camp and Site shall be continuous and unobstructed during the entire duration of the Works.

12.6.10 Shape of sheet piles

The Contractor shall restore all imperfections such as burr sides and sharp edges, caused by transportation prior to welding and/or pile driving.

All costs related to smoothing, levelling, grinding etc., shall be deemed to be included in the rate for preparation works.

13

ANCHORS

13.1 General

This work consist of furnishing all labour materials, equipment and incidentals necessary for the fabrication and installation of anchors for sheet pile constructions all in accordance with the Contractor's design drawings and Employer's Requirements.

All personnel employed shall be experienced and skilled in the work to be performed and adequate supervision shall be provided by the Contractor at all times when work is in progress.

Anchor systems shall be used for which successful experience with respect to performance and durability has been documented.

13.2 Codes and Standards

- EN 1537.
- BS EN 445.
- BS EN 446.
- BS EN 447.
- Eurocode 7 (NEN 9997-1).
- ASTM.
- BS 8081.

13.3 Anchor walls and anchors in cofferdam

The diameter of the holes in sheet piles shall not be larger than the diameter of the element to be conveyed, increased by 5 mm. Wire edges in the holes shall be removed and after installation of the anchorage including all parts, the remaining openings shall be made soil and water tight.

The maximum pre-stress is 60 % of the Ultimate Strength.

13.4 Grout anchors, screw- and groutinjection anchors

The diameter of the holes in sheet piles shall not be larger than the diameter of the element to be conveyed, increased by 5 mm. Wire edges in the holes shall be removed and after installation of the anchorage including all parts, the remaining openings shall be made soil and water tight.

The arching of the anchor rods (for application of anchor plates) shall be realised by placement of wooden supporting blocks prior to the tensioning of the rods.

In case arching is carried out on earth fill, arching shall only be carried out after settlement of the fill.

Anchor support blocks are not allowed to move during installation

The grout material may not come in contact with the part to be anchored (sheet piles)

Measures are to be taken that within 48 hours after grouting no undesirable vibrations can occur.

The design and execution of grout anchors and screw injection anchors shall be according to Eurocode 1537.

No rods are to be applied with a characteristic tensile strength >1100 N/mm^2.

The diameter of the rod shall be ≥ 32 mm.

Rods shall have a double corrosion protection system:
- Directly on the rod a layer of cement.
- The secondary protection layer shall be enwrapped with a synthetic material.

13.4.1 Specifications

The general procedures and design methods outlined in the following standards and manuals shall be used for ground anchor design where applicable:
- BS 8081:2015 British Standard Code of practice for ground anchorages.

The Contractor shall submit the design of the anchors to the Engineer for approval prior to installation.

Measures are to be taken to avoid vibrations near the anchors during the first 48 hours after grouting.

During the first 48 hours after grouting, the anchors may not be loaded.

In case of obstructions: a new anchor shall be installed under a different angle at the cost of the Contractor.

13.4.2 Installation plan

An anchor installation plan shall be prepared and shall be available on Site containing the technical specifications related to the anchor system to be used.

The installation plan requires to be approved by the Engineer prior to installation of the anchors.

The anchor installation plan shall contain at least the following information:
- The anchor type with designation.
- Number of anchors.
- The location and orientation of each anchor and tolerances in position.
- Free anchor length and fixed anchor length.
- Required anchor load carrying capacity and lock-off load.
- Installation technique (drilling, placing, grouting and stressing).
- Known obstructions.

13.4.3 Testing

Types of testing
Two types of tests shall be carried out:
- Suitability test.

- Acceptance tests.

Standards
The testing shall be performed in accordance with BS 8081.

Suitability tests
A suitability test shall be carried out prior to the installation of the working anchors to confirm:
- The ability to sustain a proof load.
- The creep or load loss characteristics of the anchor system up to proof load.
- An apparent tendon free length.

Acceptance tests
Acceptance tests shall be carried out to confirm, for each individual anchor:
- The ability of the anchor to sustain a proof load.
- The creep or load loss characteristics at the serviceability limit state.
- The apparent tendon free length.

General requirements
The Contractor shall submit the test method and the associated interpretation system which shall be used in each test class to the Engineer for his approval.

During all testing the load shall be applied and released smoothly so that the anchor is not subjected to any shock or dynamic loads.

13.4.4 Record

For every anchorage element the following shall be registered:
- Date of grouting.
- Type of cement.
- Type of admixtures.
- Mixture.
- Type of mixture equipment.
- Mixing time.
- Grout pressure per m installation.
- Quantity of grout per m injection.
- Samples available.
- Date of testing of samples.
- Results of testing.

The results of testing shall be presented in accordance with BS 8081.

A copy of the above mentioned data of each anchor element shall be submitted by the Contractor to the Client's Representative directly after installation of the anchor element.

13.5 Foundations of buildings at quay

The Contractor shall verify by all means the possible presence of foundations of buildings behind the anchor and shall ensure that the installation of the anchors will not influence these foundations and vice versa.

14

CONCRETE WORKS

14.1 General

Reference is made to Volume II, part 1b for the applicable standards.

14.2 Definitions

The requirements and specifications for concrete works as stipulated in this Clause concern in-situ concrete, precast concrete and pre-stressed concrete.

The Works shall include but not necessarily be limited to:
- Supply and storage of all materials, such as cement, aggregates, water, etc.
- Supply and installation of formwork and reinforcement steel.
- Mix designs, sampling and testing.
- Mixing and batching.
- Transport, placing and compaction.
- Construction and expansion joints.
- Protection and curing.
- Removal of formwork, inspection tests and repair of imperfections.
- Completion works, finishing, coating.
- Etc.

Specific requirements with respect to precast and prestressed units are described in separate clauses.

14.3 Standards

The production and placing of concrete and all concrete constructions shall in all respects fully comply with the requirements and recommendations of Eurocodes and European Standards with Dutch annexes, unless explicitly stated otherwise after this, or approved by the Engineer.

The general procedures, design methods and requirements, outlined in the following standards and manuals, shall be used for all design and construction of concrete elements (non-exhaustive list):

EN 1992-1-1:	Eurocode 2: Design of concrete structures-Part 1-1 General rules for buildings.
EN 206:	Concrete: Specification, performance, production and conformity.
EN 13670:	Execution of concrete structures.
EN 13369:	Common rules for precast concrete products.
EN 10080:	Steel for the reinforcement of concrete - Weldable reinforcing steel - General (+NA: 2010).
EN 10138:	Prestressing Steels Part1: General requirements.
EN 12504-1:	Testing concrete in structures - Part 1: Cored specimens - Taking, examining and testing in compression.

EN 13623-1:	Silica fume for concrete - Part 1: Definitions, requirements and conformity criteria.
EN 13623-2:	Silica fume for concrete - Part 2: Conformity evaluation.
EN 1504	Products and systems for the protection and repair of concrete structures- Definitions, requirements, quality control and evaluation of conformity- Part 1: Definitions.
ASTM C 1260:	Standard Test Method for Potential Alkali Reactivity of Aggregates.
NEN 8500	Dutch supplement to NEN-EN 206: Concrete - Specification, performance, production and conformity.
CIRIA C674:	Use of concrete in maritime engineering.
CIRIA C660:	Early age thermal crack control in concrete.
ACI 305	Guide to hot weather concreting.
ACI 306	Guide to cold weather concreting.
NEN 5905	Dutch supplement to NEN-EN 12620 'Aggregates for concrete'.

14.4 Concrete production

Prior to the commencement of the Works, the Contractor shall furnish full details to the Engineer regarding:
- Name and qualifications of supplier(s).
- Certificates and test reports on concrete production and products.
- Source(s) of aggregates, cement, etc.
- Quality of water, aggregates and cement.
- Production capacities.
- Any other relevant data.

Concrete shall be supplied from ISO 9001 accredited manufacturers only.

Concrete shall be produced and tested in accordance with EN 206-1.

Alkali-silica reaction shall be controlled in accordance with the recommendations of EN206, EN 12620 and ASTM C 1260.

14.5 Method Statements

Each main activity shall be covered by the Method Statement.

The Method Statement prepared for the activities during construction shall be prepared in parallel to the Quality Plan. Work procedures and work instructions shall be identified.

The Method Statement and Quality Plan shall be submitted for approval by the Engineer.

The Contractor's proposal for a division of activities related to concrete works shall be part of his Method Statement.

14.6 Organisation of concrete production

Prior to the start of the concrete Works, the Contractor shall submit for the approval of the Engineer a Method Statement detailing his proposals for both the organisation of concreting activities at the Site and those off-site.

14.7 Material use

All materials used in concrete, including cements, additions, aggregates, water and admixtures shall be in accordance with the requirements of EN 206-1 and EN 197-1.

14.8 Limiting values for concrete composition

Limiting values for concrete composition shall be in accordance with EN 206-1 and this Specification. In the case of conflicting requirements, this Specification shall take precedence.

The limiting values shall be based on the following exposure classes:
- XS3 – sea water tidal, splash and spray zones.
- XS2 – permanently submerged in sea water.
- XS1 – exposed to airborne salt, but not in direct contact with sea water.
- XF4 – sea water splash zones.

The maximum free water/cement ratio for reinforced concrete shall be:
- 0.45 in exposure classes XS1 & XS2.
- 0.40 in exposure class XS3.

The minimum cement content for reinforced concrete shall be 350 kg/m^3.

The minimum strength class for durability shall be in accordance with EN 206. Regardless of durability requirements, the minimum strength class shall not be less than that required for structural purposes.

The chloride class of the concrete shall be as follows:
- Reinforced concrete Cl 0,20.
- Pre-stressed concrete Cl 0,10.
- Un-reinforced concrete Cl 0,50.

The total sulphate content of the constituents of each mix, expressed as SO_3, shall not exceed 3 % by weight of the cement in the mix.

The classes of concrete to be used in the Works, the types of cement, the concrete quality requirements defined as the 28 days' characteristic (cube) compressive strength (CCS), the minimum cement content by weight, the maximum water cement ratio by weight, the admixtures and the application for each Class are given in the applicable standards.

14.9 Cement

14.9.1 General

Only cements or combinations from the following lists shall be used in concrete:
- CEM II/B-V.
- CEM IV/B-V.
- CEM III/A.
- CEM III/B.

SRPC (sulphate-resisting Portland cement) shall not be used in reinforced concrete.
Aggregates shall comply with the typical requirements in Table 5.7 of CIRIA C674 - 'The use of concrete in maritime engineering - a guide of practice' and EN 12620.

14.9.2 Testing of cement

Before any cement is ordered in quantity or brought onto the Site, the Contractor shall submit to the Engineer for his approval a detailed list of the sources and manufacturer's brand names of the types of cement that he proposes to use.

The Contractor shall submit to the Engineer, without charge, test certificates with date relating to each consignment of cement. Each certificate shall show that a sample of the consignment has been tested by the manufacturer or by an approved laboratory and that it complies in all respects with the requirements of the Employer's Requirements.

When required by the Engineer, the Contractor shall supply samples of cement taken on delivery to, or during storage on the site, for testing at a nominated laboratory without extra charge.

No cement from any consignment shall be used without the approval of the Engineer and the Contractor shall maintain a record of the locations of the concrete made from each consignment. This record shall be available for inspection by the Engineer.

If for any reason the Contractor wishes to vary the source or manufacturer in respect of any type of cement already approved by the Engineer at any time during the Contract, he shall give adequate notice of every such variation and shall carry out all the tests called for by the Engineer of the proposed substitute cement, and shall obtain written approval of the variation before ordering any substitute material.

If cement has been stored for more than two (2) months the Engineer may call for new tests, at the Contractor's expense, to check whether the cement is still conforming to the requirements.

14.9.3 Delivery and storage of cement

All cement shall be delivered to the Site in properly and permanently marked, sound, sealed paper bags or other approved containers, unless written approval from the Engineer is obtained for the handling of cement in bulk.

Cement shall be delivered in quantities sufficient to ensure the proper progress of the Works, and quantities held in stock on Site shall be to the approval of the Engineer. Cement from abroad shall be packed in sealed plastic bags inside the paper bags.

The Contractor shall adequately protect cement, when conveying it to the Site, from the weather and from contamination by dust, sand or organic materials. Any cement that shall prove to have been exposed to damage by water will be rejected upon delivery.
The Contractor shall store all cement in a weatherproof, waterproof and reasonably air tight building provided solely for that purpose. The floors of the building shall be raised at least 300 mm above the ground level to prevent the absorption of moisture.

Storage in the open is not permitted and it is not permitted to store bags to a greater height than two metres. In case of delivery of cement in bulk, the Contractor shall store the cement in a properly designed silo. The silo shall be provided with walls properly insulated against solar radiation.

The Contractor shall store each consignment of cement separately to provide easy access for inspection and testing.

After they have been approved by the Engineer, consignments shall be used in the order in which they were delivered. No cement shall be taken from the storage unless it is needed for immediate use.

14.9.4 Cement measured by weight

All cement to be used in the Works shall during production be measured by weight.

14.9.5 Use of cement

Any cement intended to be used at any time during the Contract for any part of the Works, shall only be used within a period of three (3) months after delivery to the Site.
Cement from partly filled or unsealed bags or containers shall not be used.

The temperature of the cement as it enters the concrete mix shall not exceed 75 degrees Celsius.

14.9.6 Rejection of cement

Notwithstanding the receipt of the test certificate as stipulated above and the approval of the Engineer, the Engineer may reject any cement as a result of further tests. The Engineer may also reject cement that has deteriorated owing to inadequate protection or other causes, or in any other case where the cement is not to his satisfaction.

The Contractor shall remove all rejected cement from the Site without delay and at the Contractor's expense.

14.10 Water

14.10.1 Quality of water

Water for use in the production of concrete shall be in accordance with EN206.

14.11 Aggregates

14.11.1 General

The Contractor shall obtain fine and coarse aggregates from sources approved by the Engineer. Fine aggregates shall consist of natural sand unless specifically otherwise approved.

Aggregates shall be hard and durable, and they shall be fully in compliance with the requirements of EN 12620 with the supporting CIRIA C674, or other relevant standards, to be approved by the Engineer.

Recycled aggregates shall not be used.

14.11.2 Quality of Aggregates

Aggregates shall contain no impurities in excess of the limits as specified in NEN-EN 12620.

The Aggregates shall not contain chemicals or any other material to such extent that they might adversely affect the strength, durability, quality or appearance of the concrete, or the strength and durability of any embedded reinforcing steel. Complying with these requirements is fully for Contractor's risk and account.

If, in the opinion of the Engineer, the aggregates fail to comply with the requirements as set forth herein, the Engineer may order the Contractor to wash all aggregates. The Contractor shall then carry out such washing

with water fully complying with the requirements as stipulated above, and with methods and plant which have obtained the approval of the Engineer. All costs arising from such washing shall be borne by the Contractor.

14.11.3 Alkali reactivity

The Contractor shall pay special attention to the alkali reactivity in the aggregates. The aggregates shall not contain any materials that are reactive with alkalis in the aggregate itself or in the cement or in the mixing water, in such amounts sufficient to cause excessive localized or general expansion of the concrete or mortar.

Alkali-silica reaction shall be controlled in accordance with the recommendations of EN 206, EN 12620 and ASTM C1260.

14.11.4 Grading of Aggregates

The grading of fine Aggregates shall be within the limits as given in NEN 5905 The Contractor's attention is drawn to the fact that it may be necessary to combine two or more fine Aggregates, or remove some fractions by hydraulic classification, to achieve the grading specified.

The grading of fine Aggregates shall be such that when mixed with the coarse Aggregates and cement, a concrete of maximum attainable density is produced. The use of crushed sand alone as fine Aggregate is not allowed unless specifically approved by the Engineer, in which case proof of suitability by means of comparative tests shall be the responsibility of the Contractor.

The grading of coarse Aggregates shall be within the limits as given in NEN 5905. The Contractor shall, if required by the Engineer, obtain the specified grading by combining single sized Aggregates proportions to give the specified grading.

14.11.5 Storage of Aggregates

The Contractor shall store each size of fine and coarse Aggregate in separate bins or on areas covered with concrete or other hard and clean surface, which shall be self-draining and be protected from salt spray, contamination by earth or other deleterious matter.

The Contractor shall store fine and coarse aggregates in such a way that the different kinds of Aggregates cannot become intermixed.

14.11.6 Delivery of samples

The Contractor shall deliver samples of cement, water, fine and coarse aggregates called for in the foregoing Clauses to the Engineer for testing sufficiently before the commencement of the concreting operations, so that the necessary tests on the materials and the preliminary concrete cubes tests specified hereunder can be completed before the related work is due to start.

14.12 Mix designs, testing and batching

14.12.1 Test laboratory

All testing shall be carried out by an independent laboratory to be approved by the Engineer as specified.

14.12.2 Concrete mix design

The Contractor shall design the mixes for the concrete classes as mentioned on the Drawings or in the Particular Requirements and Design Criteria, and submit same to the Engineer for his approval.

The water content of all concrete shall be rigidly controlled and kept to the minimum required to obtain a workable concrete, suitable for the nature of the work to be executed.

The Contractor shall not add proprietary admixtures intended to change the flow characteristics, cohesion or rate of setting of the concrete without the approval of the Engineer.

The Contractor shall carry out preliminary mix tests before the commencement of the main concreting operations to determine for each class of concrete the minimum water/cement ratio and the actual mix proportions of the fine and coarse aggregates required. The quantities of materials for the preliminary mixes shall be accurately determined by weight and the necessary adjustment shall be made to allow for the moisture content of the aggregates. The preliminary mixes of concrete shall be tested for strength and workability observing to the appropriate requirements of the Specification. The Contractor shall repeat preliminary mixes with adjusted proportions as necessary until concrete mixes meeting the relevant requirements have been produced.

The Contractor shall use the water/cement ratio and mix proportions that have been determined as a result of the preliminary mix tests throughout the course of the Works and no variation shall be made without the approval of the Engineer. Notwithstanding any such variation the Contractor shall ensure that the strengths specified in the Particular Requirements and Design Criteria are obtained.

After the value of the water/cement ratio and the mix proportions been determined and approved by the Engineer the Contractor shall carry out trial mixes as specified hereafter.
Further tests shall be carried out if materials or mixes are changed during the course of the Works.

No concrete shall be placed in the Works until the relevant mix has been successfully subjected to preliminary mix and trial mix tests and has been formally approved by the Engineer.

14.12.3 Mixes for concrete under water

Where concrete is to be placed in or under water, the actual mix proportions and selection of aggregates shall be such as to ensure a resulting concrete with good flow and cohesion characteristics. The cement content shall be 25 % greater than for a comparable mix for use in dry conditions. The minimum works cube strength for all concrete shall be as given in for the comparable mixes for use in dry conditions. The slump of the concrete when tested in the dry, shall not be less than 125 mm.

14.12.4 Admixtures

The Contractor shall only use admixtures compliant to EN 480-series for application in concrete mixes when approved by the Engineer. Chloride based admixtures shall not be used. The suitability and effectiveness of any admixture shall be verified by trial mixes with the materials to be used in the Works.
If two or more admixtures are to be used simultaneously in the same concrete mix, the Contractor shall provide data to assess their interaction and to ensure their compatibility.

14.12.5 Proportions of materials

The proportions of cement, fine and coarse aggregates, admixtures and water for use in the Works for each class of concrete require the approval of the Engineer which will be based on satisfactory results of preliminary tests.

14.12.6 Trial mixes and preliminary tests

The Contractor shall prepare trial mixes having workability, strength and surface finish as criteria, to satisfy the Engineer regarding these qualities. The trial mixes shall be made and compacted in the presence of the Engineer, using the same type of plant and equipment as will be used for the Works.

Curing of specimens shall take place as nearly as possible under the same conditions as the structures, especially with regard to moisture and temperature. The Contractor shall make trial mixes for all classes of concrete and from each trial mix, preliminary concrete test cubes 150 mm x 150 mm x 150 mm shall be made in sets of nine; three for tests at 7 days and six for tests at 28 days. The Contractor shall make, cure and test the preliminary test cubes according to EN 12390-2.

The Contractor shall protect the test specimens from drying and temperature and shall transfer same to the nearby laboratory to continuous moist curing site conditions. The certified copies of the results of all tests shall be submitted to the Engineer. The difference between the maximum and the minimum strength shall be not more than 10 % of the average.

A trial mix shall be acceptable with respect to strength when three sets of six preliminary test cubes (tested at 28 days) made from different trial batches of concrete satisfy the requirements for the specific type of concrete.

The Contractor shall determine the consistency of the concrete from the same mix as that from which the preliminary test cubes are made according to EN 12390-3 or other method approved by Engineer.

The remainder of the mix shall be cast in a wooden mould and compacted. After 6 hours the sides of the mould shall be struck and the surface examined to satisfy the Engineer that an acceptable surface can be obtained with this mix.

When a proposed mix has been approved, no variation shall be made in the mix proportions, or in the type, size, grading zone or source of any of the constituents without the written consent of the Engineer, who may require further trial mixes to be made.

14.12.7 Rebound hammer tests

When making rebound hammer tests each result shall be the average of at least nine individual readings. Readings shall not be taken with 25 mm of the edge of concrete members and it may be necessary to distinguish between readings taken on a wet or dry surface, on troweled face or moulded face . When making the test on precast units, the Contractor shall take special care to bed them firmly against the impact of the hammer.

14.12.8 Works cubes tests

The Contractor shall make test cubes with sides of 150 mm x 150 mm x 150 mm during the course of the Works from each day's pour for all concrete classes except the class used for non-reinforced (lean) concrete on Site or at the location of the precasting.

The minimum number of test cubes shall be three.

The samples shall be tested at the laboratory as mentioned in this Clause according to EN 12390-3.

The Contractor shall take particular care to ensure that the test cubes are stored under uniform conditions throughout the year, including a complete covering of damp, thick, hessian sheet or similar approved material constantly sprayed with water while in the moulds and during any transit between Site and laboratory, and including subsequent storage immersed in water kept strictly within the specified temperature range.

The test cubes shall be tested as follows:
a. One at 7 days.
b. One at 28 days.
c. The third to be tested at the discretion of the Engineer.

The cubes shall reach the minimum 28 days' CCS values according to the Employer's Requirements.

For in situ concrete: If the cubes fail to attain the CCS-values as specified, the Contractor shall cut out the concrete that they represent, remove it and replace it with concrete complying with the Employer's Requirements at no extra cost.

For prefabricated concrete (block): elements should not be placed until the 28 days design compressive strength has been reached and in any case, not until they are 21 days old.

The cost of sampling, making and curing of works test cubes with the provision of cubes moulds, all other necessary equipment, apparatus and the packing and transport to the laboratory, shall be included in the rates, and lump sum price for Concrete.

All cubes shall be marked at the time of casting with the date, the class of concrete and other necessary remarks to specifically identify the part of the Works, from which such cubes were taken.

14.12.9 Concrete cores

If the results for the CCS-requirements of the concrete do not fulfil the requirements as described in the Particular Requirements and Design Criteria or if defects of workmanship during construction cause doubt as to the strength, durability and/or safety of the structure or of part hereof, supplementary testing may be performed at locations chosen and ordered at the discretion of the Engineer.

The Contractor shall, where ordered by the Engineer, drill or cut at least six concrete cores from the Works and test them according to EN 12504-1.

The cores shall be approximately either 100 mm or 150 mm in diameter depending on upper aggregate grading size and performance specification under assessment and, where possible, have a length/diameter ratio of two. Where it is not possible to take a core of this length/diameter ratio of two, the correction factor given in EN 12504-1 shall be applied to give the equivalent strength of the cylinder having a length/diameter ratio of two. If the compressive strength of the cores, adjusted for length/diameter ratio and age, fails to attain the 28 days' CCS-value as specified in the Particular Requirements and Design Criteria, the Contractor shall cut out and remove the concrete that they represent and replace it with concrete to the satisfaction of the Engineer at no extra cost.

The cost of sampling, drilling or cutting and preparing cores, with the provision of equipment and apparatus and the packing and transporting to the laboratory, shall be included in the rates, and lump sum for concrete works.

14.12.10 Water and slump tests

The Contractor shall make a check on the moisture content of the aggregate before concreting begins, to assess the amount of free water to be added at the mixer. The Contractor shall provide himself with a chart, a copy of which shall be given to the Engineer for approval, relating moisture content in the aggregate to water be added at the mixer for all classes of concrete in use.

The amount of water introduced into the mix shall be strictly controlled and shall be the minimum amount consistent with complete compaction. The device for measuring water shall show accurately the quantity and be so designed that the water supply will be automatically cut off while water is being discharged into the mix.

Frequent slump tests and fresh density tests shall be carried out according to respectively EN 12350-2 and EN 12350-6 on samples of fresh concrete taken immediately before placing to determine the consistency of concrete. The slumps and fresh density shall be recorded for identification purposes and for subsequent use as a rough routine check on quality and therewith general compliance to specifications of the approved mix-design. Slump shall, however, not be used as an officially acceptable measure of the workability of any concrete.

14.12.11 Concrete batching and mixing

The quantities of all materials for concrete Classes applicable to reinforced concrete shall be accurately determined by weight, in weight batching machines approved by the Engineer. To ensure the accuracy of weight batching the machine shall be tested and adjusted, before the commencement of the Works, and at frequent intervals thereafter and shall be kept clean at all times.

The Contractor shall adjust the weight of fine and coarse aggregate to allow for the absorbed and adsorbed (free) water contained in it. The water to be added to the mix shall be reduced by the quantity of free water contained in the fine and coarse aggregates. This shall be determined by the aforementioned method to be approved by the Engineer immediately before mixing begins each day and further during the day as the Engineer may require.

The Contractor shall mix the concrete materials in a mechanical batch mixer approved by the Engineer. Mixing for each batch shall continue until there is a uniform distribution of the materials and uniformity of colour and consistency of the concrete.

If admixtures are introduced into the concrete they shall be added by approved automatic dosing equipment that feeds a fixed quantity of admixture either into the mixing water before the mixing water is discharged into the plant’s stationary mixer or at the end of water-discharge-cycle or straight after discharge of the mixing water. The equipment shall include a glass measuring cylinder for calibration.

The Contractor shall take particular care to ensure that no residual materials remain in the mixer after depositing each batch of concrete and he shall wash and clean out the mixer drum immediately following the completion of each concreting operation or when changing to a mix using a different type of cement.

The Contractor shall not load the mixer in excess of the manufacturer's rated capacity or below 60 % of rated capacity unless proof of continuously homogenous proportioned constituents can be provided to the Engineer.

In case mixing of concrete used for blinding layers/lean concrete is permitted to be done by hand, the cement and fine - and coarse aggregate shall be mixed on a close-fitting stage. All materials shall be turned at least twice in the dry state and three times after having added the water until the mix has attained a

uniform colour and consistency. Materials other than cement for blinding layers/lean concrete may be proportioned by volume.

14.13 Transport, placing and compaction

14.13.1 Transport of concrete

The Contractor shall handle concrete from the place of mixing to the place of final deposit as rapidly as practicable by methods that will prevent the segregation or loss of any of the ingredients.

Wherever practicable the Contractor shall empty the concrete from a mixer directly into a receptacle-device such as a bottom-discharging skip. The Contractor shall then transport the skip to the place of final deposit and shall discharge the concrete as close as possible to its final position to avoid rehandling or flowing. The concrete may be deposited at a maximum vertical height of 1.50 m without the use of tubes, provided suitable measures are taken to prevent segregation.

If the Contractor proposes the use of concrete pumps for the transporting and placing of concrete, he shall submit full details of the equipment and operating techniques he proposes to use for the approval of the Engineer. In the event of the Engineer's approval being obtained the Contractor shall ensure that shocks induced by pumping shall not be transferred from the pipeline to the formwork and on to previously laid concrete.

The Contractor shall discard the initial 350 l discharge of any pumped concrete and it shall not be incorporated in the Permanent Works.

Where concrete is conveyed by chuting or pumping, the plant shall be of a size and design to ensure continuous flow in the chute or pipe. The slope of the chute or the pressure of the pump shall allow the concrete to flow without the use of any water or 'pumping-agent' additional to that approved by the Engineer to produce the required consistency and without segregation of the ingredients. The delivery end of the chute or pipe shall be as close as possible to the point of deposit.
The Contractor shall thoroughly flush the chute or pipe with water before and after each working period or when previous discharge deposits build up causing lumps that possibly inhomogenize following discharges and shall keep it clean prior to using public roads. The water used for this purpose shall be discharged outside and away from any Permanent Works.

If concrete is mixed off-Site it shall be transported in truck mixers, complying with the following requirements:

- Fresh concrete shall be delivered to the Site and discharged into the transportation-device or the formwork within one hour after production including time necessary to perform on-site hand-over testing, unless agreed otherwise by the Engineer.
- Delivery tickets from each batch of concrete shall be provided by the supplier with the necessary information on type, and data and exact time of production.

14.13.2 Placing and compacting concrete

The Contractor shall obtain the approval, in writing, of the Engineer to his proposed arrangements before commencing concreting.

The Contractor shall carry out all placing and compacting of concrete under the direct supervision of a competent member of the Contractor's staff and in a manner to produce a watertight concrete of maximum density and strength.

The Contractor shall give the Engineer at least 24 hours notice in writing before placing any concrete. Concrete shall be placed in its final position before initial setting has commenced and shall subsequently not be disturbed. All fresh concrete for precast elements shall be placed within fifteen minutes of mixing unless carried in purpose-made agitators when it shall be placed within one hour of the introduction of water to the mix including compensation for decrease in workability during transit by use of retarding-agents as admixtures.

The Contractor shall place the concrete in one continuous operation rising uniformly in the formwork at the rate of maximum 0.5 m per hour as appropriate or as directed by the Engineer. The concrete shall not be placed directly against a vertical formwork but shall only be permitted to flow on to this surface during the compaction process.

The Contractor shall take care to avoid the formwork face being splashed with mortar during the placing operation. The concrete shall be compacted by immersion vibrators having a frequency of at least 8,000 cycles/minute, and be operated only by staff experienced in the work continuously witnessing horizontally overlapping working spheres, meanwhile preventing segregation and avoiding unnecessary vibration of rebars.

Compaction shall start as soon as there is sufficient concrete within the formwork to immerse the vibrator and vibration shall continue during the placing operation so that at no time shall there be a large volume of uncompacted concrete in the formwork.

Sufficient vibrators shall be available to ensure that delays, or incomplete compaction are not caused by mechanical breakdowns. Care shall be taken not to burr the face of the formwork with the vibrators during compaction.

Concrete shall be thoroughly compacted during the operation of placing and shall be thoroughly worked around the reinforcement and any embedded fixtures and into corners of the formwork and moulds. Mechanical vibrators shall be of a design approved by the Engineer. A sufficient number of operators with vibrators shall be used to handle the maximum rate of concrete production with an allowance for spares. Concrete shall not be disturbed after compaction and placing in its final position despite the fact that revibration is permitted to compensate for local plastic settlement and initial set has not yet occurred. Concrete that has partially set before placing shall not be used and shall be removed from the Site. Vibration of concrete shall generally comply with the requirements as specified in the Standards.

Winter precaution (in case of off-site casting)
The planning of placing and compaction shall ensure that the fresh concrete temperature, or the substrate which the fresh concrete is poured against, does not fall below 5 degrees C before the temperature is increased due to the autogenous development of hydration heat (e.g. ACI 306).

Summer precaution
The Contractor shall take every precaution to prevent the occurrence of honeycombing, porosity and grout/matrix loss e.g. at joints.

The Contractor shall take every precaution during hot weather to prevent the formation of plastic- or drying shrinkage cracking, delamination or crazing as result of premature mixing-water evaporation induced drying-out of concrete.

The Contractor shall take particular regard and measures to follow the recommendations for hot weather concreting prepared by recognized institutions (e.g. ACI 305).

The Contractor shall shade formwork from direct exposure to solar radiation both until the placement of concrete and during its setting. The Contractor shall take appropriate measures to ensure that reinforcement in and projecting from the section to be concreted is maintained at the lowest temperature practicable.

Concrete, immediately after compaction has ceased, shall have a temperature of not more than 32 degrees Celsius. If necessary the Contractor shall cool the aggregates and mixing water or any method brought forward by the Contractor to be approved by the Engineer.

The Contractor shall protect concrete from adverse conditions after placing to prevent excessive rates of evaporation of water from all surfaces due to high temperatures and/or drying winds. Concrete shall be protected for at least ten (10) days unless the Engineer approves a lesser period.

Retempering of concrete grout or mortar that has partially hardened will not be permitted.

14.13.3 Placing of concrete underwater

The method of placing concrete in or under water shall be such as to keep as much as possible of the concrete being placed out of direct contact with the water to avoid wash-out of constituents by any rapid movement or agitation of the exposed surface.

The Contractor shall where possible carry out the work in one operation. Where this is impracticable washed out aggregate or foreign matter that may have accumulated on the previously placed concrete shall be completely removed and washed with potable water prior to additional concrete being placed. This concrete shall then be placed directly on the cleaned surface that is completely free from any salt water.

Tremie pipes shall be smooth bored watertight fitted with quick release joints and have an adequate cross-section for the size of aggregate to be used.

Bottom opening skips shall be straight sided perfectly smooth and fitted with externally operated bottom opening doors and overlapping canvas flaps.

Toggle bags shall only be used for small pours and for depositing small discrete quantities of concrete. Bagged concrete shall not be used for the permanent Works.

The Contractor shall submit and obtain the approval of the Engineer to his detailed proposed method for concreting in or under water.

During pouring of underwater concrete a diver experienced in underwater concreting shall be assisting.

14.13.4 Placing of concrete on previously completed work

Where concrete is to be deposited against or on top of previously executed work, the Contractor shall thoroughly wire brush, hack and clean the surface of the old concrete with water and/or compressed air to expose the surface of the aggregate and to remove all loose material, laitance and grime. Special care shall be taken to ensure that the new concrete is thoroughly pre-wetted, compacted and rammed against the old. In certain cases, depending on the grade of concrete in use, the elapsed time between successive concreting operations and the weather conditions at the time of recommencing concreting, the Engineer may require the old concrete surface to be treated differently, including the use of ‘wash-off’ and ‘dry-bond’ techniques, wire brushing, etc.

14.13.5 Concreting in unfavourable weather

Concreting will not be permitted during heavy rain or when the concrete temperature rises above thirty-two degrees Celsius. When the air temperature exceeds thirty degrees Celsius, concreting will only be permitted after special precautions, to be approved by the Engineer, have been taken by the Contractor to prevent early setting of the concrete. Such can include lowering the temperature of constituents in the mix or by

means of a cooling system, keeping the aggregates and formwork continuously sprayed with water mist, using liquid nitrogen injected into the fresh concrete or crushed ice as partial substitute for mixing water and erection of temporary sun shades over the working area.

During concreting operations the initial- as well as the peak temperature of the placed concrete shall continuously be recorded, and the results hereof shall be submitted to the Engineer

14.13.6 Protection and curing of concrete

The Contractor shall protect the concrete from all damage caused by atmospheric and climatic conditions.

The Contractor shall cover all exposed surfaces, as finishing proceeds, with a wet hessian sheet followed by a reflective polyethylene sheet. These shall be securely fastened round the edges and supported in order not to damage the finished concrete surface. As soon as practicable the hessian and polyethylene sheets shall be lowered into close contact with the concrete and securely weighed or fastened down and draught-free to prevent wind from blowing underneath. The Contractor shall maintain the hessian sheet in a moist condition at all times and shall inspect same at intervals not exceeding six hours.

Concrete shall be kept moist with fresh, clean water on exposed surfaces for not less than ten (10) days or by spraying consecutive layers of liquid membrane forming curing-compound for sufficient duration as proven to be adequate at the approval of the Engineer.

The Contractor shall propose methods of curing and protection of the concrete for the Engineer's approval.

Sufficient materials to fully protect a concrete pour shall be available at the place of work prior to the commencement of a concrete pour.
The Contractor is fully responsible for any unacceptable cracking that may appear in the concrete surfaces.

14.14 Concrete construction

Precast and in situ concrete construction shall be carried out in a manner that minimises thermal and shrinkage cracking. The Contractor shall submit all proposed construction jointing arrangements to the Engineer for consent.

Measures shall be taken in the Design and casting of concrete sections in order to control the risk of early-age thermal cracking in accordance with the recommendations CIRIA Report C660. The maximum temperature of the concrete shall not exceed 70°C, or 80°C depending on usage of supplementary cementitious materials comprising at least 20 % fly ash or at least 40 % ggbs by mass. The maximum temperature difference across the section of an element (centre to surface) shall not exceed the limiting value for internal restraint in Table 7.1 of CIRIA C660 for the aggregate type(s) being used. If the coarse and fine aggregates are of different geological types then the coefficient of thermal expansion shall be calculated on the basis of 0.67 x the value for coarse aggregate + 0.33 x the value for fine aggregate, and the limiting temperature calculated by interpolation between the values in C660.

All concrete shall be cured and protected from exposure to chlorides for at least the minimum periods shown in EN 13670: 2009 or as the applicable Curing Class demands. For marine structures the curing class shall be 4; for other structures the curing class shall be 3. Concrete shall be adequately cured. Curing shall be monitored and recorded to ensure that concrete meets the specified requirements. All marine concrete shall be thoroughly wetted with fresh water to ensure the surface is saturated immediately prior to the first contact with sea water.

The Contractor shall carry out cover meter surveys, at appropriate intervals, on all concrete sections upon striking of formwork. The cover shall not be less than the minimum value required for durability. Any

undercrossing shall be reported to the Engineer and appropriate measures proposed to consider for corrective measures to safeguard design service life.

14.15 Joints

14.15.1 Construction joints

The Contractor shall form construction joints either on horizontal or vertical planes. The exact positions of construction joints, if not shown on the Drawings, shall be agreed with the Engineer before depositing the concrete.

Construction joints shall generally be made across planes of minimum shear. They shall, in addition, be so located, and the amounts of concrete placed at any time shall be so limited in size and shape, as to minimize shrinkage and temperature effects.

Formwork for construction joints shall be square to the work and shall incorporate continuous shear keys of substantial proportions to produce a watertight joint.

The Contractor shall form the outside edges of all construction joints by means of dressed timber edgings, secured to the formwork to ensure an exact straight finish. Stop-ends shall be firmly fixed and made grout-tight and closely fitting to all reinforcement and other obstructions.

Upon removal of the Formwork the joint face shall be inspected, and if the soundness of the concrete is not approved by the Engineer, the Contractor shall remedy defects.

Before concrete placing is resumed at a construction joint, the Contractor shall roughen the set surface to remove laitance and to expose the aggregates, without damaging these. The Contractor shall clean the roughened surface by compressed air or jets with clean water, and crash and water immediately before the next concrete layer is placed.

Chemical surface-retarders shall not be used.

Construction joints shall be sealed with an approved sealant at external and at liquid-contact faces.

The Contractor's proposals as to position, number and design of construction joints shall be subject to the approval of the Engineer before the work starts.

14.15.2 Expansion joints

Where continuous concrete structures are included in the Works (e.g. capping beams, quay wall etc.), allowance shall be made for thermal effects. Expansion joints shall be included as appropriate. Expansion joints shall be constructed according to the details and to the dimensions as shown on the Drawings or where otherwise ordered by the Engineer.

Non-water-retaining structures

Expansion- or contraction joints shall form a fully discontinuing plane between adjacent members. Only where specifically indicated, dowel bars shall be installed at expansion joints. Such dowel bars shall then be installed in such a way that expansion and contraction of the adjacent concrete members can freely take place.

The concrete face first cast shall be painted with two coats (primer and finishing respectively) of approved rubberized bitumen paint (or coal tar epoxy coat) before the adjacent concrete is poured. The adjacent

concrete shall include a groove against the joint for sealant, and the exposed edges shall be sealed with an approved compound.

In case the joint is likely to be contaminated, the joint shall be sealed immediately with an approved free-flowing sealing fluid as soon as the formwork has been removed. Resin-bonded cork filter or equally acceptable material shall be included, to allow the adjacent concrete members to expand.

Water-retaining structures
A continuous waterstop strip of either copper, or rubber, or rubber and steel, or UPVC shall be fixed across the joint.

Concrete shall be free from honeycombing and shall be poured against the embedded part of the strip. The Contractor shall protect projecting parts of the strips from any damage during the concreting operations.

The Contractor shall apply bituminous paints to the loops of copper or any metal waterstop and fill the loops with bituminous compound before embedding such in the concrete.

The method of joining waterstops shall be fully according to the manufacturer's instructions, and shall further be to the approval of the Engineer.

14.16 Record of concreting

The Contractor shall make and keep on Site a complete record of daily weather conditions containing besides precipitation nature and volume, at least data on air temperature, air-velocity, and relative humidity every 12 hours per calendar day. This record shall also include frequent checks on fresh- and hardened concrete temperature as delivered and after placing of the concrete.

The Contractor shall also make a complete record of the works showing the date, time and quantity of the concrete delivered from the batch plant and the time and quantity when the same concrete is placed in each part of the Works.

The record shall be completed with the results of the test cylinders.

14.17 Faulty work

The Contractor shall cut out and reconstruct any portion of the work that is honeycombed or otherwise inferior, on the written instruction of the Engineer, in an approved manner without extra charge. Plastering of defective work will not be permitted. The Contractor shall seal any leaks or cracks in excess of the allowable crack width by injection with a synthetic resin.

14.18 Blinding concrete

The Contractor shall place a blinding layer of concrete Class as specified in the Particular Requirements and Design Criteria under foundations where shown on the Drawings or ordered by the Engineer. The blinding layer shall be allowed to harden before the structural concrete in the foundation is placed.

14.19 Tolerances

The Contractor shall place precast concrete and formwork to comply with the following tolerances:
- Horizontal alignment : ± 0.01 m.
- Level : ± 0.01 m.

The variation from either mean line shall not exceed 5.0 mm over a length of 5.0 m.

14.20 Permanent and temporary holes and recesses

14.20.1 General

The Contractor shall make all permanent and temporary holes and recesses in structures according to the Drawings and/or to the directions of the Engineer. After fixing of the several constructions or other items to their correct position, and after approval by the Engineer, the temporary holes and recesses shall be filled or grouted with concrete of the same type and quality as the adjacent concrete.

14.20.2 Cutting or diversions of reinforcement

If shown on the Drawings, the reinforcement shall pass through the recesses. During the fixing of the several structures or items in the holes and recesses, the reinforcement shall, if necessary, be cut or diverted. Cutting or diversion of reinforcement shall only be permitted after inspection and approval by the Engineer.

14.20.3 Cleaning before grouting

Before filling or grouting, the Contractor shall roughen the temporary recesses and clean them from excess water, dust, grime or other impurities. The recesses shall be surface-moistened with potable water before filling or grouting and the result of this process and materials shall prove non-susceptible to segregation

14.21 Finishing of concrete surfaces

All concrete surface finishes shall be in compliance with EN 13670 and in addition NEN 8670.

Buried formed concrete finishes shall be provided class C according to NEN 8670 as a minimum.

Concrete finish class A shall be permitted in the design on formed permanently exposed surface of the Works.

Unformed surfaces shall be provided class “Ordinary finish” according to NEN-EN 13670 table F.4.

All exposed structural in-situ concrete in the design for each structure shall be batched and supplied from a single batching source.

All concrete surfaces shall be of a uniform colour at each structure.

A plain non-discoloured finish shall be provided for all exposed surfaces, unless otherwise specified.

Subject to the other provisions of the Contract, the design shall ensure that structures shall have a consistency of form, arrangement and finish that shall be achieved throughout the Works, giving the appearance of a ‘family’ of structures.
A single type of formwork shall be utilised for all exposed concrete faces throughout the Works.

Permanent formwork, where used, shall be in accordance with the requirements of DMRB BA 36/90 ‘The Use of Permanent Formwork’.

Timber shall not be used as permanent formwork in the design.

14.22 Protection of concrete surfaces

14.22.1 General

The Contractor shall apply protective measures to concrete structures to protect the exposed concrete-surface against aggressive effects of seawater or unwanted action such as graffiti, surface-discoloration, impact-staining from floating debris or other matters. The protective system shall be applied to the surfaces of structures as listed in the Particular Requirements and Design Criteria.

The Contractor shall deliver and apply all materials and additional products (if any), according to the description. The type of protective system shall be a two-component elastomeric waterproofing/protective system with a thickness of 1.5 mm.

Where applicable, all priming-coats for underlayers shall be obtained from the same manufacturer and shall be the type of primer as recommended by the manufacturer for that particular finish.

All the materials shall be delivered to the Site in sealed containers with the manufacturer's name clearly stated.

14.22.2 Preparation

Before applying any coating, the Contractor shall clean the surface of the concrete of all dirt, adhesion-decreasing agents like e.g. grease or curing compound, dust and loose material and, where necessary, make good any surface, so that the surface is smooth and free from air or water holes and moisture. The surfaces of the concrete shall comply to all requirements provided by the manufacturer of the coating and e.g. be clean and dry before application of the coat. No coating shall be applied until the Engineer has approved the preparatory work by checking compliance to required substrate properties. The Contractor shall ensure that all of the required quantity of materials are on Site in time, to avoid interruptions during the execution and to ensure that local conditions during application fully comply to ambient conditions required by the manufacturer of the product.

14.22.3 Applications

The Contractor shall treat the items to be protected with a two-component elastomeric waterproofing/protective system that shall be applied according to the recommendations and instructions of the manufacturer and to the satisfaction of the Engineer.

All the coatings shall be executed by skilled labour under supervision of a competent foreman and to the satisfaction of the Engineer. No coating shall be applied until the concrete has been cured for the required period or prior to the approval of the Engineer.

The Contractor shall protect protective layers by hardboard or similar during backfilling.

14.23 Repair of imperfections of concrete

All hardened concrete designated ‘non-compliant to design specifications’ pro-actively brought forward by the Contractor to the attention of the Engineer, or designated to be so at the discretion of the Engineer in opposite direction, shall be registered and marked and duly notified in writing to each Party. The contractor shall assess nature and possible gravity of the non-compliance and propose, in strict accordance to EN 1504-series, corrective measures to prevent repetition in the production process and provide a repair proposal

comprising of repair methodology, materials and perceived optimal moment to perform required corrective actions to be approved by the Engineer.

Unreinforced concrete blocks designated “non-compliant to design specifications” or show imperfections will be rejected by the Engineer and shall be removed from Site. Costs for removal shall be borne by the Contractor.

14.23.1 Method I - Repair by hand placed mortar

Preparation of surfaces to be repaired

The Contractor shall remove unsound or imperfect concrete by chipping. Edges and areas where concrete has been chipped out shall be sharp and squared with the surface, leaving no feathered edges. The chipped area shall be washed with water to remove all loose material and concrete dust.

The Contractor shall keep surfaces within the trimmed areas wet for several hours, preferably overnight, before the repair replacement is made. All surfaces in areas to be repaired shall be damp, but not wet, when the material is applied.

Placement of the mortar

The mortar used for repair shall contain the same proportions of cement and sand as the mix from which the structure was made. This mortar shall be pre-shrunk by mixing it to a plastic consistency as far ahead of its use as possible. Trial mixes shall be made and aged to determine the longest period the mortar's use can be delayed while retaining sufficient plasticity to permit good workmanship.

Immediately prior to the application of the mortar, the Contractor shall thoroughly scrub the damp surface of the area to be repaired with a small quantity of neat cement grout, using a wire brush. Remaining loose sand particles shall be swept away immediately before application of the mortar.
In applying the mortar, it shall be compacted into the space to be filled, care being taken to eliminate air pockets and to secure bond at the edges. The surfaces shall be shaped and finished to correspond with the adjacent surfaces of the structure.

Curing

The Contractor shall keep the newly repaired surfaces damp for 24 hours after the repair is completed. A membrane coating of an approved white pigmented sealing compound shall be applied.

14.23.2 Method II - Bonding mortar repairs with epoxy resin adhesive

The Contractor shall remove unsound or imperfect concrete by chipping. The edges shall be left sharp and square with the surface. The area to be repaired shall be kept dry. Loose material and concrete dust remaining after the chipping operation shall be removed by means of an air jet.

Epoxy resins previously approved for such use by the Engineer shall be used in the manner prescribed by the Engineer. The prepared area shall be primed with the epoxy resin compound sets. Mortar shall be applied as described above.

14.24 Structures to be cast in

14.24.1 General

The Contractor shall fix and cast in all steel structures and other items to be cast in, such as anchor bolts, steel frames, sockets, pipes, strips, etc., according to the Drawings.

14.24.2 Templates and supplementary means

The Contractor shall provide templates and other supplementary means for the correct positioning of the structures and items as mentioned above.

14.24.3 Delivering

The Contractor shall ensure that all of the structures and items, as mentioned above, are on Site in time to avoid interruptions during the execution of concrete works.

If recesses are provided, these shall be sufficiently larger in size than the dimensions of the structures or items to be cast in.

14.25 Cleaning and greasing

The Contractor shall clean and grease the screw-thread of anchor bolts or other items immediately after filling or grouting.

15

PRECAST CONCRETE UNITS

15.1 General

Precast concrete units shall comply with the other requirements of the General Technical Specification where applicable, unless otherwise specified in this particular Section for precast units.

All precast concrete units shall have the date of casting engraved on top of them before the concrete has fully hardened. Any undated units will be liable to be rejected by the Engineer. The Contractor shall take all measures concerning the curing and protection of the units after fabrication.

Rejected units shall immediately be removed from Site at Contractor's expense.

The production of all precast units shall take place in areas covered with sheet metal roofs, or otherwise as agreed. Precast concrete units comprise the manufacturing, and placing of units in reinforced concrete and pre-stressed concrete, if any. Detailed specifications on dimensions of the required units are given on the Drawings.

15.2 Quality and tests of concrete

The concrete for these items shall comply with the quality requirements of concrete and trial mixes and test cubes of the concrete shall be made as described in the Employer’s Requirements. Generally, quality control shall be according to EN 12390-serie.

15.3 Cast-in parts

The Contractor shall fix the cast-in parts, such as lifting lugs, fasteners, jointing materials, supporting structures, etc. in the positions as will be shown on the working drawings. Cast-in parts shall be free from dust, dirt or grease and be properly stored before using.

The delivering, processing and fixing of the cast-in parts shall be deemed to be included in the rates for precast concrete units.

15.4 Transport, storage and placing

Transportation, storage and placing of the precast concrete units shall be done carefully and in such a way as to avoid damage and to keep the surfaces of the units free from direct sun radiation, dirt or other unwanted spots. Loading and unloading, storage and placing of the precast concrete units at the Site shall be done by skilled labour and under supervision of a competent supervisor. Any unit that is damaged or has any perceptible objections will be liable to be rejected by the Engineer.

15.5 Time schedule

The Contractor shall submit a specified time schedule to the Engineer concerning the following subjects:

- Dates of commencement of manufacturing of the several concrete items.
- Dates of delivering the items to the Site, plus a sequence of placing and duration of the execution; concreting records that show the results of the test cubes, concrete temperature and relative humidity for each delivery of the items to be included.

Commencement of this part of the Works shall only take place after approval of the time schedule by the Engineer.

16

QUAY WALL CONCRETE BLOCKWORK

16.1 General

16.1.1 Section includes

- Mass (plain/unreinforced) concrete gravity blocks.
- Mass (reinforced) concrete gravity blocks.
- Blockwall construction.

16.1.2 Standards and references

The following Codes and Standards shall be used when carrying out the Works: see Chapters Concrete Works.

16.1.3 Submittals

- Material Submittals: Provide all test certificates, mill certificates, technical data sheets, source, supplier, manufacturer details.
- Samples / Mock-up samples: Provide all samples and or mock-up samples of all materials tested for approval in accordance with the requirements of the Employer's Requirements prior to placing in the Works.
- The Contractor shall cast three test samples of block units. These shall be cast compacted and cured in the manner intended for the rest of the units and monitored and tested in accordance with chapter 'Concrete Works'.
- Method Statements: Provide a detailed Method Statement of the Contractors method of Work regarding placing precast gravity blocks in accordance with the Drawings.

  This shall include but not be limited to the following information:
- Programme of Works.
- Details of the proposed pre-casting yard and associated facilities.
- Details for pre-cast blockwork formwork.
- Details for casting and curing the blocks, including block dimensions.
- Quality Control and Quality Assurance.
- Details for excavating/trimming and cleaning the foundation trench for the quay wall.
- Method of verifying foundation material.
- Details for placing and levelling the foundation.
- Details for rectifying sections which do not comply with required tolerance limits.
- Method of lifting, storing, transporting and placing the blocks, including any relevant structural calculations regarding lifting equipment. This shall include details of achieving the correct line and level of the toe.
- Method for preloading and monitoring settlement.

- Method of setting and placing the units to the required tolerances.
- Method of Construction in the Wet.
- Method of Construction in the Dry.
- Details of proposals for casting the capping block to the quay wall and for incorporating all fittings.
- Details for Preloading.
- Details and hold points as to when the capping beam should be cast.
- Details/ method/ frequency for Post Construction Monitoring, stability checks movement checks, settlement checks and out of alignment checks.

- Shop Drawings: Information shown on Shop Drawings shall be complete and sufficient for Engineer to review for compliance with Contract requirements. Information shall include but not necessarily be limited to the following; indicate layout, unit locations, locator key locations, fabrication details, unit identification marks, reinforcement, connection details, support items, dimensions, openings, and relationship to adjacent materials, signed by a Structural Engineer.
- As built drawings.
- Design Mix: The Contractor shall submit to the Employer for approval details of all imported and local materials which he proposes to use in the concrete including the names of manufacturers or suppliers and sources of supply. If the Contractor proposes to use admixtures others than specified, he shall submit full detail of the proposed materials to the Engineer for approval.
- Plant & Equipment: Contractor shall provide details of all plant and equipment used to carry out the Work (as per Chapter 3) including independently certified Health and Safety documentation as required.
- Others:
  - Records: Contractor shall submit records of inspection to the Engineer containing the date of casting, date of striking, date and location of installation and any other information requested.
  - Special reports: For Special blocks not conforming the requirements.

16.1.4 Quality assurance

- The supply and delivery of precast concrete shall comply with chapter 14 and 15 of this document.

16.1.5 Regulatory requirements

Conform to EN 1992 design load and construction requirements applicable to Work of this section.

16.2 Products

16.2.1 Materials

- See Chapter "Concrete Works" for all concrete materials and jointing materials.
- See Chapter "Concrete Works" for concrete mix design, concrete batching, concrete mixing, transporting concrete, placing of concrete, testing requirements, finishes and joints.
- All pre-cast concrete is to be in accordance with the chapters 'Concrete Works', Chapter 'Precast Concrete Units, and Chapter'Quay Wall Concrete Blockwork'.

16.2.2 Fabrication

- Manufacturing procedures shall be in general compliance with Standards referred to in Chapters 'Concrete Works'.
- Maintain plant records and quality control program during production of precast members. Make records available upon request.

- Ensure reinforcing steel, anchors, inserts, plates, angles, and other cast-in items are embedded and located as indicated on drawings.
- Splays, joggles and recesses shall be accurately positioned as shown on the drawings.

16.2.3 Finishes

- Requirement of the surface finish see Section 14.21.
- All visible faces above LAT shall be provided class A according to NEN 8670.
- Cure members under identical conditions and identical duration of curing measures to develop required concrete quality, and minimize appearance blemishes such as non-uniformity, staining or surface cracking.
- Contact surfaces of blocks with adjacent, overhead and underlaying blocks shall have an plain finish.
- On completion of concreting of each block, the top surface thereof shall be struck off true and level by means of a long straight vibrating screed and finally floated off with a hand float to give the required face. The top surface of blocks shall be roughened similar to broom finish to increase frictional resistance. Details to be agreed with the Engineer.
- The bottom of the first course blocks shall be serrated with isosceles trapezium shaped profiles to create roughness required to transfer friction forces to the foundation layer. The isosceles trapezium profiles shall have the following dimensions: long base 10 cm, short base 5 cm, height 5 cm. The free horizontal space (measured at the level of the long base) between each trapezium shall be 10 cm (which results in a c.t.c. space of each trapezium of 20 cm).

16.2.4 Fabrication tolerances

- The dimensions of precast concrete blocks as shown on the drawings are theoretical. The tolerances to be allowed in the manufacture of the blocks shall be agreed on Site taking into consideration the local conditions of manufacture and placing. The layout of the blocks shown on the drawings is indicative, based on setting out points and a nominal gap of 10 mm. The Contractor shall produce shop drawings showing actual block dimensions to suit programme and placement progression, dimensions of blocks at locations at which tolerance is to be taken out shall be adjusted to suit actual requirements.
- The dimensions and location of locator keys show indicative requirements. The Contractor shall determine and check exact requirements in his details of precast blocks.
- The agreed dimensions of blocks shall not be varied during manufacture.
- The top and bottom surfaces of blocks shall be nominally flat and shall not be concave or convex to ensure even bearing and to prevent rocking once placed.
- Maximum variation from nominal dimension: 5 mm.
- Maximum out of square: 3 mm per 3 m length, non-cumulative.
- Maximum misalignment of inserts and openings: 3 mm.

16.3 Execution

16.3.1 Delivery, storage, and protection

- Handle precast members in a manner consistent with their shape and design. The units shall only be lifted at the support points detailed by the Contractor and at maturity levels proven compliant to permit transportation and placement as accorded by the Engineer. The Contractor shall note that the precast units on the project are plain concrete elements and he shall plan his lifting points/method accordingly.
- Provide and use lifting or handling devices capable of supporting member in positions anticipated during manufacture, storage, transportation, and erection.
- The Contractor shall submit his proposals for lifting blocks to the Engineer for approval. The Contractor will not be permitted to embed steel bars or anchorages in blocks for the purpose of lifting or any other use unless specifically prescribed in Particular Requirements and Design Criteria .

- Protect members to prevent staining, chipping or spalling of concrete.
- Mark each member with a unique reference number, incorporating date of production before lifting or placing in the block stacking yard. All marking details shall be agreed with and supplied to the Engineer.
- Keep record for inspection by the Engineer of the reference number, date of casting, date of striking, method and duration of curing, date of transporting and stacking, location in the stacking yard, date and location of installation and any other information requested.
- Moulds may be removed from the blocks twelve hours after completion of concreting unless compliance with required maturity have not been reached yet. The Engineer may instruct an increase in this time if the climatic conditions or the properties of the cement used should warrant.
- Blocks shall not be removed from the beds until the Contractor has first demonstrated that the necessary cube strengths maturity in the objects surface derived from the block lifting analysis are being achieved in accordance with the Employer's Requirements.
- Blocks stacked temporarily prior to use shall be placed on a firm hard horizontal surface prepared for the purpose and capable of withstanding the loads from the blocks and the handling plant without movement or deterioration. The concrete curing process shall be continuous during lifting, stacking and storage.
- The Contractor shall stack the blocks in a pattern agreed with the Engineer to enable easy loading and transporting for use in the construction of the quay wall. The blocks shall be stacked so as to have sufficient air space around each block.
- The lifting, transporting and stacking of blocks shall be undertaken without shock or vibration or undue stress to or in the block.
- Lifting points shall not be permitted in any surfaces which will be permanently exposed.

16.3.2 Examination

- Verify that Site conditions are ready to receive Work and field measurements are as drawings.
- Verify that bedding layer has been placed and levelled to the required slope within the tolerances required to achieve the final tolerances on the block wall and is free from silt and debris.
- Verify that units have achieved the specified strength before lifting.

16.3.3 Preparation

- Prepare support equipment for the erection procedure, temporary bracing, and induced loads during erection.

16.3.4 Precast units - general

- The manufacture of precast concrete components shall be in accordance with the recommendations contained in EN 1992 and EN 206.
- Moulds shall be thoroughly cleaned prior to each casting. Unshuttered faces shall be trowelled smooth. All edges of the precast units shall be formed with a chamfer as shown on the drawings.
- The mould beds shall be formed on a properly constructed floor with a smooth level top surface, such that the remainder of the mould may be fixed true and square.
- Prior to each use the beds on which blocks are cast shall be cleaned and covered with polythene sheeting or other material to be approved by the Engineer and the sides of the moulds shall be treated with approved formwork release agent.
- Moulds for blocks shall be of robust construction in accordance with Chapter 'Concrete Works', close-jointed and fixed true and square on the beds. The moulds shall permit blocks to be accurately cast to achieve the tolerances in placing without the need for in-situ grinding. Bulging, distortion and spreading shall be prevented when the concrete is poured. Moulds shall permit damage free removal without causing damage to the blocks.

- Placing and curing of the concrete shall be in accordance with the requirements of Chapters 'Concrete Works'.
- Detailed records of mixes, cubes, curing methods, dates of manufacture, workability measurements, etc. shall be kept and submitted to the Engineer within 7 days of manufacture.
- The blocks shall contain voids for use with lifting toggles. The use of permanent void formers, metal inserts and reinforcements are not permitted due to the possible corrosion which could occur.
- The Contractor shall be fully responsible for designing and supplying adequate lifting points and equipment as necessary to ensure the safe handling, transport and erection of the precast members.
- Holes left in the precast units to facilitate lifting may be instructed by the Engineer to be neatly pointed with an approved expanding cementitious repair grout as soon as the units are finally positioned, or gravel filled at the Engineer's discretion following submission of the lifting detail.
- Stoppage of concreting at the end of a period of work shall be made only after completion of concreting a block. If for any reason the concreting of a block has to be stopped before completion, then that block shall be rejected.
- Blocks shall not be removed from the beds until they have gained sufficient maturity to be moved without damage. Removal of formwork or movement of blocks shall not interfere with or interrupt duration of curing processes. Curing measures are deemed to be effective for a duration of at least 14 consecutive calendar days after formwork removal.
- Blocks shall not be placed until the 28-day design compressive strength has been attained but, in any case, not until they are 21 days old.
- The standard of workmanship and the quality of materials used in the manufacture of all precast components shall comply with the relevant clauses of this General Technical Specification.
- Stacking of precast units shall be properly carried out after curing in a separate area set aside for that purpose and so arranged that the units may be removed and used in the order in which they were cast.
- At all stages of construction, the Contractor shall adequately protect installed precast concrete units and other concrete associated therewith to prevent damage to permanently exposed concrete surfaces.
- Damaged concrete elements shall not be dispatched to the Site and elements that sustain damage during transportation shall be removed from the Site and replaced. The same provision shall apply to precast elements damaged prior to or during erection into the Works or thereafter. Only minor repairs as approved by the Engineer may be carried out to precast elements at the Site. Notwithstanding this, under no circumstances will repair of the visible face be permitted.
- Where blocks are rejected by the Engineer they shall be immediately marked in his presence and shall be stored in a separate area especially assigned for the purpose and subsequently removed from Site by the Contractor if so, required by the Engineer. Blocks shall be rejected, at the discretion of the Engineer for failure to meet this specification.
- All blocks of special size, shape or weight which may be required as construction of the quay wall proceeds shall be manufactured to the approval of Engineer when occasion for the use of such blocks shall arise.

16.3.5 Placing of blocks

- The foundation trench shall be formed to the required levels and to the dimensions on the Drawings.
- The Contractor shall excavate disturbed material from foundation trenches and shall clean out all loose and soft material until a uniform competent stratum is reached and is agreed by the Engineer. The trench shall be prepared in 10 m minimum lengths for inspection by the Engineer. If undertaken underwater the inspection shall be undertaken by divers who will inspect the trench for cleanliness and will sample the material of the trench bottom. If the Employer considers that the section is unacceptable after inspection, he will issue instructions to the Contractor on the further measures to be taken before final inspection and approval. On receipt of approval from the Engineer, the Contractor shall immediately proceed to place the foundation.
- The foundation shall be rock. The approved trench section shall receive its foundation material as soon as practicable after approval.
- Rock fill shall comply with the Rockwork Specification (Chapter Rock Works). It shall be placed in the foundation so as to ensure the minimum of voids. The top surface shall be blinded with layers of

approved stone as shown on the drawings to provide a surface suitable to receive in- situ concrete or concrete blocks as appropriate.

- Surfaces which are to receive concrete blocks shall be cleaned of all loose rock and debris and shall be accurately levelled to a tolerance of +25 mm and - 0 mm. The rear edge of the foundation shall not be higher than the front edge and no portion of the surface shall be convex such that blocks placed thereon would rock.
- Blocks shall only be placed on underlying materials that comply with the specified tolerances for line and level. No block shall be placed until the underlying material has been approved by the Engineer as ready to accept the block. Such approval shall not relieve the Contractor of any of his responsibilities under the Contract.
- Blocks shall not be placed under water or within the tidal zone until they have attained the correct strength in accordance with the Employer's Requirements.
- Each precast concrete block shall be carefully set with close joints at the levels and with the bonds shown on the Drawings. Care shall be taken to ensure that the block and the surface on which any block is placed are clean and free from stone or other obstructions which may affect the bedding of the block or its frictional resistance.
- Except where otherwise stated, blocks shall be set hard up against one another to make a close bond; joints or parts of a joint shall not be open by more than 10 mm. Blockwork not fully bedded or bonded shall be rejected.
- The foundation course of the blockwork shall be set with special care to ensure that the blocks are laid to the correct levels, alignment and arrangement; any irregularities of line or level or high points, shall be corrected by lifting and resetting blocks. The foundation course of blocks shall be inspected and approved by the Engineer before superimposed blocks are set thereon.
- Precast units shall be placed to achieve the lines and levels stated on the Drawings within the tolerances stated herein (If any). Should construction vary outside these tolerances, or the face become bowed, then remedial action shall be taken immediately to correct such defects either by taking up and resetting the blockwork or by adding compensating blocks made to fit.
- The Contractor shall take immediate similar remedial action should the working face become out of square with the face line of the wall, so that the correct bond and square of the works shall be maintained throughout.
- Should any blocks in any completed section of the works be removed, shaken, disturbed or damaged by any cause whatsoever, the Contractor shall make good such work as necessary to the satisfaction of the Engineer.
- Units shall be placed without damage to structural capacity, shape, or finish. Replace or repair damaged members.
- Align and maintain uniform horizontal and vertical joints as erection progresses.
- The Contractor shall submit for the approval of the Employer the method of handling and setting blocks with details of the equipment to be used. The crane used for setting blocks shall lower by power and not on the brakes.

16.3.6 Erection tolerances

- The Contractor shall determine and check exact requirements for the dimensions and location of locator keys, including whether to provide mid-point of the key to suit the radius, in order to achieve specified tolerances in his details of precast blocks.
- Erect members level and plumb within prescribed tolerances.
- Vertical joints from Course 3 and above shall align and shall be within 50 mm of the theoretical position shown on the Drawings. Vertical coursing joints below Course 3 shall be within 100 mm of the theoretical position shown on the drawings.
- Blocks shall be placed to the following tolerances:
  - Total alignment: - Bottom 3 courses and top two courses: toward water 0 mm in total / toward land 20 mm in total. / Other courses: toward water 0 mm in total / toward land 50 mm in total.
  - Individual alignment: - Step between front faces of individual blocks- top 2 courses and bottom 3 courses not to exceed 10 mm.

- Individual alignment: - Step between front faces of individual blocks other courses not to exceed 25 mm.
- Level: - ± 20 mm (in total), with change between adjacent blocks not exceeding 6 mm.

- Final Tolerance:
  - The cope line of the capping block after settlement and rotation from the placing shall comply with the following tolerances.
  - Alignment:
    - toward land 10 mm.
    - toward water 0 mm.
  - Level:
    - +/- 5 mm.
    - The variation from the mean line or level shall not exceed 5 mm over a 5 m length.

16.3.7 Cleaning

Remove and or repair any marks, dirt, or blemishes from surface.

17

REINFORCEMENT STEEL FOR CONCRETE

17.1 Type and quality

17.2 Reinforcement

Reinforcement steel shall comply with EN 10080.

Zinc or epoxy coated steel reinforcement shall not be used.

The Contractor shall provide at his own cost and to the approval by the Employer working drawings of all reinforcement accompanied by bending schedules.

The working drawings and bending schedules shall be submitted to the Employer at least 45 days prior to commencing actual work. The Employer's approval of working drawing and bending schedules shall in no way relieve the Contractor of the responsibility for the correctness of same.

17.3 Fixing wire

Tying wire used for fixing reinforcement steel shall be annealed soft iron wire and shall be removed prior to pouring of the concrete. Clippings shall be removed prior to pouring of the concrete.

17.3.1 Testing

The Contractor shall prepare test specimens of reinforcement steel to be used in the Works. Test specimens shall be taken in the presence of the Employer and shall be of a size sufficient to carry out the tests as described below.

They shall be tested in an approved laboratory and the certified copies of the results of the tests shall be submitted to the Employer. The specimens shall be tested on bending and tensile properties and the wire fabric also on weld shear strength. The methods and requirements for testing shall be carried out according to the applicable specifications of EN ISO 15630-1.

No reinforcement steel shall be used in the Works until the testing results show satisfactory results.

Required test procedures shall be repeated at the Contractor's expense, for any new supply of reinforcement used during the course of the Works.

17.4 Handling, cutting and bending

The steel shall be decently stored on the work site in a way as to avoid contamination and/or corrosion to the extent possible. Reinforcement steel bars effected by severe rust will be rejected.

The Contractor shall cut reinforcement steel from straight bars, free from kinks and bends or other damage. Bars shall be bent cold by experienced, competent workmen. Bars of diameter greater than 19 mm shall be bent in a bending machine designed for the purpose. Any reinforcing bar that has already been bent shall not be re-bent at the place of the previously made bend.

No reinforcement shall be cut by burning. Bars shall not be bent in an ambient temperature below 5°C.

17.5 Wire fabrics

All steel wire fabric shall be delivered in flat sheets. The Contractor shall submit drawings and calculations to the Engineer according to the requirements in the Employer's Requirements.

If necessary, wire fabric shall be cut straight from the sheets. Cutting of sheets shall be done in such a way as to limit the loss of material.

17.6 Placing and fixing

At the time concrete is placed, reinforcement shall be free from loose rust or loose mill scale, dirt, mortar spillage, salt, oil, grease or other coating which might destroy or impair the bond between the concrete and the reinforcement. Rust will not be considered loose if, on rubbing with a finger, it leaves only a stain thereon.

All reinforcement is to be sized, shaped and placed in exact accordance with the Drawings provided by the Contractor and approved by the Engineer and kept in the correct position in the forms without displacement during the process of vibrating, tamping and ramming the concrete in place.

The Contractor shall provide all necessary distance pieces and space bars to maintain the reinforcement in the correct position. Spacers shall be of such materials and design as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete cover.

Any ties, links or stirrups connecting the bars shall be taut so that the bars are properly braced, and the inside of their curved parts shall be in actual contact with the bars around which they are intended to fit. Bars shall be bound together, in at least every other point of intersection, with best black annealed mild steel wire or other approved binders. Binding wire shall be bent inwards.

Unless specified otherwise the minimum cover to reinforcement, as measured to the outside of stirrups or outer bars, shall be as stipulated in the Particular Requirements and Design Criteria, -0 mm +10 mm for all faces.

Bars shall not be displaced laterally from the specified position by more than half a bar spacing nor into the specified cover zone in order to clear embedded items or penetrations unless permitted by the Employer.

The distance between any two parallel bars shall not be less than 30 mm or the diameter of the larger bar whichever is the greater.

The blocks shall be fitted with semi-circular hollowing and double bend cast-in binding wires. The water-tightness of these blocks must be at least similar to the concrete into which they are concreted. The use of pebbles, pieces of broken stone or brick, or other materials shall not be permitted. Steel shall be bound and tied in its correct position using steel wire. Apart from any other requirement, the reinforcing steel shall be fixed in such a manner that it will support its own weight and any loads, which may be imposed upon during construction without displacement, permanent deflection, or movement of any kind.

All reinforcing steel shall be furnished in full lengths. Splicing will generally not be permitted.

The length of lap joints and anchorage bonds shall comply with EN Standards. No welding of reinforcement steel shall be carried out unless authorised by the Employer. Welding and testing of the reinforcement steel shall comply with the requirements as specified in the appropriate specifications or Standards.

Lapping of adjacent sections of wire fabric shall generally be carried out as follows:
End to End by lapping the two pieces, one full mesh (measured from the ends of the longitudinal wires in one piece to the ends of the longitudinal wires in the other piece), and securing the two pieces together with wire ties placed at intervals of about 45 cm.

17.7 Welding

Welding of rebars is generally not permitted and shall in all cases be subject to the Engineer's approval.

17.8 Approval before concreting

All reinforcement steel, after having been fixed in position, shall be inspected before any concrete is placed. Any concrete placed contrary to this requirement shall, be removed together with the reinforcement steel and replaced by the Contractor at his own expense.

17.9 Embedded items

All embedded items such as inserts, holding-down bolts, frames, sleeves, pipes and conduits shall be placed accurately and secured against displacement before concreting commences, and voids formed shall be protected from being clogged with concrete. Galvanized embedded items shall comply to ASTM A143/A143M-07(2020) "Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement" preventing the risk of hydrogen gas development in the interface zone with fresh concrete.

17.10 Exposed reinforcement

The Contractor shall cover all reinforcement projecting from construction joints or likely to be exposed to the weather for long periods before concreting is commenced, with polyethylene, binding tape, cement grout or other materials in order to prevent excessive rusting or staining of surrounding concrete. If, in spite of these precautions, rust staining occurs on any permanently visible surfaces, it shall be removed at once.

18

FORMWORK

18.1 General

The specifications, stipulations and requirements as set forth in this Section concern formwork for in-situ concrete and for concrete precast on Site.

Formwork shall include all temporary moulds for forming the concrete, with all temporary structures and constructions required to support such moulds.

18.2 Drawings and calculations

The Contractor shall submit drawings and calculations, showing details of the formwork and supporting structures he intends to use, for approval by the Engineer. The drawings shall show the materials proposed; show details of construction such as sizes of members; spacing and position of beams, struts, bolts and wedges; means of sealing panel joints, form tie holes, and at construction joints; and surface of forms to obtain required finishes.

The Contractor shall not construct formwork and supporting structures until the Contractor's Design Drawings and the calculations, if applicable, have been approved by the Engineer.

Any changes or modifications to the formwork required by the Engineer shall be for Contractor's risk and account.

18.3 Design and construction requirements

Formwork and supporting structures shall be of suitable design and substantial construction to carry the loads of the formwork, the wet concrete reinforcement, construction loads including dynamic effects of placing compacting, and any incidental loads without excessive bulging, distortion or deflection.

Formwork shall be sufficiently tight to prevent loss of water or mortar from the concrete. Special attention shall be paid to formwork where pokers or formwork vibrators are to be used.

Adequate propping shall be provided to prevent deflection and damage; such props shall be carried down to sufficiently strong supports.

The requirements with respect to the locations of cast-in parts, recesses and holes for services and for other purposes shall be fully complied with.

18.4 Materials for formwork

18.4.1 Rough formwork

The Contractor shall make rough formwork from good quality timber, free from loose knots, shakes and warped surfaces. Timber for formwork shall not be less than 30 mm in thickness, and the board faces in contact with concrete and the board edges shall be planed smooth. Joints shall be tongued and grooved.

18.4.2 Wrought formwork

The Contractor shall make wrought formwork from either:
- Metal or GRP with accurately aligned and close fitting joints, or
- Plywood 5 mm thick supported by 17.5 mm close boarded timber, or
- Plywood or hardboard not less than 17.5 mm in thickness.

The plywood shall be resistant to deterioration by water and shall be fixed and jointed in such a manner as to give a perfectly smooth, fine and even finish to the concrete.

18.5 Construction of formwork

18.5.1 Fixing general

The Contractor shall fix formwork in perfect line and the true plane, without crevices at joints, and securely brace, support and wedge same, to retain its position without displacement or deflection during the placing and compaction of the concrete. Joints in formwork shall be made so that no leakage of grout can occur from the concrete.

All joints shall be either horizontal or vertical, unless the form of the finished concrete requires them to be otherwise.

The Contractor shall make chamfers measuring 25 mm x 25 mm to all exposed edges of concrete.

18.5.2 Internal ties

Internal ties may be used and in that case the ties shall be located so that the specified cover of reinforcement is maintained. All such fastening shall be so arranged that when the formwork is removed, no metal left permanently in the work shall be within 50 mm of any surfaces. Any holes left in the face of the concrete by these ties shall be filled immediately after removal of the formwork with a mortar of sand and cement in the same proportion as that used in the concrete. The type of internal ties shall be suitable for watertight works.

18.5.3 Coating to prevent adhesion

The Contractor shall treat all formwork in contact with concrete with an approved release agent before usage to prevent adhesion of the concrete. Such composition shall be carefully applied in such a manner that there is no contamination of the reinforcement or previously placed concrete by the composition. Any material that will adhere to or discolour the concrete shall not be used.

18.5.4 Access holes

Where necessary access holes shall be left for cleaning out the formwork and for placing and compacting the concrete.

18.6 Cleaning and reuse of formwork

18.6.1 Cleaning and checking

Before any concrete is placed, the Contractor shall clean and wash out the formwork with fresh water and air under pressure to remove sawdust, shavings and all other foreign matter. All water shall then be drained and mopped out from the formwork.

Concrete shall only be placed in the formwork after the formwork has been checked.

18.6.2 Reuse

If formwork is to be reused, all surfaces shall be cleaned and shall be completely free from remnants of concrete or mortar. If, in the opinion of the Engineer, formwork or moulds are non-acceptable for reusing, they shall be either properly repaired or be substituted by other formwork or moulds.
Substituting formwork or moulds shall comply with the requirements as specified in these Clauses.

18.7 Removal of formwork

18.7.1 General

The Contractor shall remove formwork only under skilled supervision and in such a manner that no damage to the concrete shall occur. Formwork shall not be removed before the concrete is sufficiently set and hardened. External loading shall not be applied before the concrete has reached the 28 days - CCS. Due to variations in site temperatures and dependent on the curing conditions the Engineer may, at his discretion, vary the time between pouring the concrete and removal of the formwork.

18.7.2 Minimum periods

The following minimum periods between placing the concrete and striking the formwork are given as a guide:
For OPC concrete (CEM II):
- Vertical sides to beams, walls, columns: two days.
- Soffits to slabs and beams: fourteen days.
- Props to beams and slabs: twenty-eight days.

The Contractor shall delay the removal of the formwork in all cases where, in the opinion of the Contractor or the Engineer, the concrete contained therein has not attained sufficient strength.

Alternatively, the removal of the formwork may be determined by the required compressive strength of the concrete at the time of removing. In this case, the demanded strength shall be according to the requirements of the pertaining concrete classes.

18.8 Damage

Any damage to the concrete, which may occur during removal of the formwork or by overloading, shall be repaired at the Contractor's expense and to the satisfaction of the Engineer.

18.9 Formed finishes

18.9.1 Plain smooth finish

The Contractor shall produce an even finish with a sheet material (e.g., plywood), with panels arranged in a regular pattern as a feature of the surface.

Abrupt irregularities shall be less than 5 mm. Gradual irregularities, expressed as maximum permissible deviation from a 1 m straight edge, to be not greater than 5 mm.

Variation in colour resulting from the use of an impermeable form lining will be permitted but the surface shall be free of discolouration due to contamination or grout leakage.

Blowholes less than 5 mm in diameter will be permitted but otherwise the surface shall be free of voids, honeycombing, segregation and other large defects.

The Contractor shall remove and rub down projecting fins with a carborundum stone but otherwise the finish is to be left as struck. Making good of small defects will normally be permitted after inspection by the Engineer. Arises shall be as shown on Contractor's Design Drawings.

Formwork tie holes shall be in an approved regular pattern, filled with matching mortar compliant to the nature of the substrate concrete to be approved by the Engineer.

The Contractor shall complete a sample area of the finished work, size 2 m^2, in advance of the remainder, in an approved location, and obtain approval of appearance before proceeding.

18.9.2 Fine smooth finish

The Contractor shall produce a smooth even finish with an impervious sheet material (e.g., resin film faced plywood), with panels as large as is practicable and arranged in an approved regular pattern as a feature of the surface. The Contractor shall not replace parts of formwork panels where this may cause a change of colour in the concrete.

Abrupt irregularities shall be not greater than 3 mm. Gradual irregularities, expressed as maximum permissible deviation from a 1 m straight edge shall be less than 3 mm.

Variation in colour resulting from the use of an impermeable form lining will be permitted but the surface is to be free of discolouration due to contamination or grout leakage.

Blowholes less than 5 mm in diameter will be permitted, but otherwise the surface shall be free of voids, honeycombing, segregation and other defects.

The Contractor shall remove and rub down projecting fins with a carborundum stone but otherwise the finish is to be left as struck. Making good will not normally be permitted.

Formwork tie holes shall be in an approved regular pattern, filled with matching mortar compliant to the nature of the substrate concrete to be approved by the Engineer.

A similar type and quality of finish can be seen to all new construction structural members.

18.9.3 Proprietary form lining finish

The form lining shall be Neoplast 5639 or similar.

The operational requirements are as follows:

Blowholes less than 5 mm in diameter will be permitted but otherwise the surface is to be free of voids, honeycombing, segregation and other defects.

The finish is to be left as struck. Making good will not normally be permitted.

Formwork tie holes shall be in an approved regular pattern, filled with matching mortar compliant to the nature of the substrate concrete to be approved by the Engineer.

The Contractor shall complete a sample area of the finished work, size 2 m2 in advance of the remaining work due, in an approved location; approval of appearance is required before proceeding.

19

STEEL WORKS

19.1 General

The work covered under this section shall consist of furnishing the materials, the necessary plant, labour, equipment and appliances and performing all steel work in connection with the fabrication, installation and welding of the (temporary) structures in accordance with the Employer's Requirements.

On the Contractor's drawings, the level of treatment and fitting of materials shall be declared.

Cut and punch edges shall be removed and sharp edges shall be rounded.

All profiles, sheet material and the like shall be transported and assembled flat, tight and straight.

Tools used for stainless steel shall be made of stainless steel and may not be used for other materials.

All structural steelwork shall have a minimum grade of S355 J2 G3 as per EN 10025 and EN 10210 or equivalent standard to be approved by the Engineer.

All structural connections nuts and bolts shall be high strength friction grip and a minimum grade of 8.8 galvanised as per NEN EN ISO 4014, NEN EN ISO 4017, NEN EN ISO 4032, NEN EN ISO 7091 or equivalent standard to be approved by the Engineer.

Steel sheet piles shall have a minimum grade of S355 GP as per NEN EN 10248 or equivalent standard to be approved by the Engineer.

Stainless steel shall have a minimum grade of 1.4462 as per EN 10088 or equivalent standard to be approved by the Engineer. Stainless steel connections shall be fit for their application and environment as per IS EN ISO 3506 or equivalent standard to be approved by the Engineer.

Where corrugated steel structures are used in the Works, each structure shall have a secondary protective coating system applied to permanently accessible surfaces with a design life to the first major maintenance of 20 years.

Exposed structural steelwork shall not be used in the substructures of structures.

19.2 Codes and standards

All standards relevant to the Contractor's design (detailing) and construction methods shall apply, especially but not restricted to are referred to in section 2.1:

EN1090-2	Execution of steel structures and aluminium structures. Technical requirements for the execution of steel structures.
EN 1990	Eurocode 0: Basis of structural Design.
EN 1991	Eurocode 1: Actions on structures.

EN 1993	Eurocode 3: Design of steel structures.
EN 1994	Eurocode 4. Design of composite steel and concrete structures.
EN 10025	Hot rolled products of structural steels. General technical delivery conditions – parts 1, 2 & 5.
EN 10027	Designation systems for steel. Steel names.
BS 6349	Parts 1-8 Maritime structures.
EN ISO 12944-4	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Types of surface and surface preparation.
EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods.
EN ISO 14713-2:2009	Zinc coatings. Guidelines and recommendations for the protection against corrosion of iron and steel in structures. Hot dip galvanizing.
EN ISO 2560	Welding consumables. Covered electrodes for manual metal arc welding of non alloy and fine grain steels. Classification.
API 5L and 2B	Specification for Line Pipe/Specification for the Fabrication of Structural Steel Pipe.
EN 10219-1 and 2	Cold formed welded structural steel hollow sections.
EN 10248	Hot rolled sheet piling of non alloy steels - Part 1: Technical delivery conditions.
NEN EN 10204	Metallic products - Types of inspection documents.
NEN EN 10025	Hot rolled products of structural steels.
NEN EN ISO 3183	Petroleum and natural gas industries - Steel pipe for pipeline transportation systems.

The following standards shall also apply:

DIN 17100	Steels for general structural purposes.
DIN 17172	Steel pipes for pipe lines for the transport of combustible fluid and gases
EN 10224	Non-alloy steel tubes and fittings for the conveyance of water and other aqueous liquids — Technical delivery conditions.
NEN EN 10296	Welded circular steel tubes for mechanical and general engineering purposes - Technical delivery conditions - Part 1: Non-alloy and alloy steel tubes.
AWS	American Welding Society.
EAU 2020	Recommendations of the Committee for Waterfront Structures - Harbours and Waterways.

19.3 Workmanship

19.3.1 General

The Contractor shall carry out all activities, such as cutting, welding and shotblasting in well covered and well equipped workshops. No welding shall be carried out outside the workshop unless necessary. The Contractor shall take every measure to protect the welds against damp and draught during the welding on the site.

19.3.2 Cutting and sawing

Cuttings at edges of steel sheets and angles will only be accepted if these edges are to be welded into a connection and fully melted during the welding. Burr-sides and sharp edges caused by cutting or sawing shall be removed by means of grinding.

19.3.3 Smoothing

The Contractor shall smooth the surface of steel strips, sheets and/or other members of the structures that have to be assembled by bolting so that a plane surface will be formed and seams will hardly be visible after assembling.

19.3.4 Straightening and levelling

The Contractor shall level sheets and strips and he shall straighten deformations before assembling.

19.3.5 Bending

Cold bending is allowed for non-bearing structures that are not welded in the bending zone.

For all other structures, warm bending shall be used.

19.3.6 Boring and countersinking

The Contractor shall execute countersinking and enlarging of holes with conical-shaped spiral-drills with a minimum of five cutting edges. The Contractor shall use boring machines with a fixed drilling line.

The Contractor shall remove burr-sides and sharp edges caused by boring.

19.3.7 Bolted joints

The protruding lengths of bolt-shanks after tightening shall be three to ten mm, depending on the diameter.

The Contractor shall degrease all nuts and washers before use.

Holes to be made for bolts in base-plates may be larger in diameter than the bolts used, for example, 4 mm larger for bolts with a diameter up to 25 mm and 8 mm larger for bolts with a diameter of more than 25 mm.

For other connections, holes to be made for bolts may be 2 mm larger in diameter than the bolts used.

All key-holes and/or slotted holes shall be applied with lock washers and/or inclined washers.

The Contractor shall supply all the necessary connectors for fixing the steelwork with a suitable number of spare parts.

19.3.8 Bolt holes

All bolt holes in members built up by welding shall be drilled after welding has been completed.

19.3.9 Close butted joints

The shafts of all stanchions shall be machined at all butt joints and at both ends. The caps and bases shall be truly at right angles to the axes of the stanchions in all planes unless shown otherwise in the Drawings.

19.3.10 Splices

The ends of all joints, beams and girders shall be truly square. Where required, the joint flanges shall be neatly cut away or notched where necessary and well radiuses.

The shop welding of structural steelwork profiles to farm the required length of any element indicated in the Drawings will not be allowed without the express permission of the Employer.

19.3.11 Protection

All steelwork shall be efficiently and sufficiently protected against damage in transit to Site, from any cause whatsoever.

19.3.12 Storage of steel work

Steelwork, which is to be stored prior to erection, shall be stacked clear of the ground with packing between parts. The stacks shall be arranged so as to avoid the accumulation of dirt and water on the surface and if cover is provided it shall be ventilated.

19.4 Materials

19.4.1 General

The Contractor shall include in his Fee all pile works steel, all structural steel and miscellaneous metal work where detailed on the Drawings or assumed as necessary to support or complete a structure. Included but not limited to this work are the following items: piles for marine structures and foundations, catwalks and miscellaneous metal work.

The applied steel quality shall be named on the Drawings.

19.4.2 Steel for piles

Piles shall be delivered according to EN 10219-1 and 2.

Steel quality of steel piles shall be in accordance with API 5L and 2B X52= yield stress σ_y= 358 N/mm^2 or StE 360.7 TM. to Steel quality X70= yield stress σ_y= 482 N/mm^2 or StE 480.7 TM according to DIN 17172.

The non-coated area of piles shall be at least rust grade B according to ISO 8501-01:1998.

19.4.3 Interlocks

Steel quality of the interlocks shall be according to EN 10025, steel quality S355.

The interlocks shall be straight, sound, true and, unless otherwise directed, in one length.

Cathodic protection or coating shall be applied on all temporary and permanent walls according to section 21.

Steel quality of sheet piles shall be of grade S355 GP in accordance with EN 10027 and EN 10248-1 σ_y = 355 N/mm² or ST SPS (52.3) in accordance with EAU/DIN 17100 or grade 50C in accordance with BS 4360 $\sigma_y \geq 355$ N/mm² .

19.4.4 Tie rods

Tie rods shall meet all specified requirements such as allowable tension (including a corrosion allowance of 1.5 mm/side).

The manufacturer's test certificate (works certificate 3.1 according to EN 10204) shall be supplied with all tie rods delivered to Site and each individual steel item shall be properly marked for identification.

The Contractor shall carefully examine the tie rods at the time of delivery and all damaged tie rods shall be repaired or replaced.

19.4.5 Waling and connections

Type and quality of steel shall be according EN 10025 minimum S355 and shall meet all specified requirements (including a corrosion allowance of 1.5 mm/side).

The manufacturer's test certificate (works certificate 3.1 according to EN 10204) shall be supplied with all walings delivered to Site and each individual steel item shall be properly marked for identification.

The Contractor shall carefully examine the walings at the time of delivery and all damaged walings shall be repaired or replaced.

No protective coating needs to be applied.

The maximum bolt quality to be applied is 8.8.

19.4.6 Structural steel for catwalks

Structural steel shall be delivered according to EN 10208-2 and EN 10225. Steel quality shall be S355 according to EN 10025.

19.4.7 Other steel

Structural steel shall be of minimum grade S355 in accordance with EN 10025 and EC3 (or ST 37 EAU/DIN 17100 or 43C BS 4360). σ_y = 355 N/mm².

19.4.8 Alternative sections

The Contractor may propose alternative grades of structural steel for use in the works. Such alternative grades shall satisfy the requirements of the above mentioned standards.

19.5 Tolerances

19.5.1 Dimensional tolerances for steel piles

For steel piles the tolerances shall be as follows:
- Pipe ovality shall be held to a maximum difference between major and minor axes of 1 % of the nominal diameter.
- The diameter at any point as determined by circumferential measurement shall be maintained within 1 % of the nominal outside diameter.
- All individual piles, or structural members shall be straight within a tolerance of 5 mm in length of 10 m.
- Piles shall not contain dents larger than 0.05 rad and /or depth of 3 mm or more.
- Sheet pile length tolerance is -50 and +250 mm.

The Contractor shall verify the tolerances mentioned in NEN-EN 10219-1 and 2 and apply these tolerances above the aforementioned.

Longitudinal and spiral welds of pile sections shall be staggered at least 300 mm at the location of a circumferential connection weld of pipe sections.

The high-low tolerance of two pile sections welded together shall be smaller than 0.1 x t with a maximum of 3 mm (t= smallest wall thickness). At the location of interlocks (piles for combined walls) the high-low tolerance shall be <1 mm.

The tolerance of the wall thickness shall be – 0 mm and + 0.5 mm.

19.5.2 Dimensional tolerances for sheet piles

For steel sheet piles the dimensional tolerances shall be according to EN 10248 and EN 12063:
- Mass: +5 %.
- Length: ± 200 mm.
- Height Z-Profiles:
  - Height ≤ 200 mm: ±5 mm.
  - Height 200≤ H ≤ 300: ±6 mm.
  - Height ≥ 300 mm: ±7 mm.
- Height U-profiles:
  - Height ≤ 200 mm: ±4 mm.
  - Height > 200 mm: ±5 mm.
- Thickness t ≤8.5 mm: ±0 mm.
- Thickness t ≥8.5 mm: ± 6 %.
- Width: ±2 %.
- Width double sheetpile: 3 %.
- Straightness: 0.2 % of the length.
- Ends out of square: 2 % b.

19.6 Fabrication of steel piles

All steel piles (including interlocks for combined walls) shall be shop made by a certified supplier which operates under ISO 9000 series and can manufacture under the required standards of EN 10219-1 and EN 10219-2. Fabrication of steel piles shall be common practice to the supplier.

Inspection of piles shall be written down in certificates according to EN 10204 type 3.1 and shall include at least:
- Name producer.

- Quality with reference to applicable code or standard.
- Dimensions.
- Charge number.
- Chemical substance.
- Test results mechanical tests.
- Approval stamp name and company.

Furthermore each pile shall:
- Be straight, sound, true and, unless otherwise directed, arrive on site in one length.
- Be marked properly for identification.
- Be new.
- Consist of a maximum of three sections.

19.7 Fabrication of interlocks on piles (combined wall)

In case of piles applied for combined walls, locks have to be welded to the pile over a length corresponding with the length of the sheet pile.

The locks shall also fulfil following requirements:
- The welding of interlocks shall be in accordance with section 20 hereinafter.
- Locks shall be free of wire edges and have a minimum rust grade B according to NEN-EN ISO 8501-1.
- The end of locks shall be squared.
- Locks shall be welded at least 300 mm from the longitudinal weld of piles.
- Locks shall be straight with a tolerance of 5 mm over the total length of the lock.
- Locks shall be welded under a powder cover s= 9 mm and a= 6 mm.
- The torsion between an imaginary connecting plane between two locks at both sides of a pile may not be more than 10 mm.

The Contractor shall pre-investigate/check the straightness of all welded interlocks by sliding a test sheet pile of 2 m length with a anti-rotation brace along the total length of the lock.

19.8 Fabrication of steel sheet piles

All steel sheet piles including interlocks shall be shop made by a certificated supplier which operates under ISO 9000 series and can manufacture under the required standards of NEN-EN 10248-1 and 2 taking into account the following options:
- Option 4: The maximum value of Carbon Equivalent CEV smaller than or equal to 0,45 % (because of welding).
- Option 7: Not applicable.
- Option 8: Testing in accordance with NEN-EN 10204, certificate 3.1.
- Option 10: Carry out a product analysis.
- Option 11: Sheetpiles shall be marked with the name of the project.

Fabrication of steel sheet piles shall be common practice to the supplier.

Steel sheet piling shall be so fabricated that when driven into place, they will form a continuously interlocked wall which is soil- and water tight.

The sheet piles shall be straight, sound, true and in one length.

All steel sheet piles shall be new.

19.9 Bolts and nuts

19.9.1 General

All bolts and nuts shall have quality 8.8 and 8 respectively. All bolts and nuts shall be hot dip galvanised according EN-ISO-10684. These prescriptions do not apply if, for the benefit of the constructions, eminent steel bolts have to be applied.

On all bolt junctions a washer shall be applied under the head of the bolt as well as under the nut. The material of these washers shall be the same as the bolt.

On all bolt junctions of powder coated parts a nylon ring shall be applied between the washer and the part.

Only metrical threats are allowed for bolt junctions. All fastening parts shall satisfy current European rules, latest issue.

Hot dip galvanised bolts and nuts that are in contact with soil shall be treated with bitumen paint.

With bolt junctions the length of the bolt shaft shall be such that the threat is active over the full height of the nut and such that the shaft of the bolt no more than one half of the diameter rises above the nut. With anchor bolts the anchor is allowed to rise above the nut by maximum one time the diameter.

All anchors to be carried out in stainless steel, quality AISI 316.

Before assembly all bolt junctions to be foreseen with Never-Seez grease of equivalent to benefit unproblematic assembly and disassembly and to prevent corrosion.

With application of different materials for fasteners and fastened materials galvanic separation shall be applied by means of synthetic cartridges and washers.

19.9.2 Forged out of solid

The heads of bolts shall be forged out of solid. The nuts and shanks of bolts shall be cleanly cut with standard threads and the nuts shall fit the bolts accurately and sufficiently tightly that they can just be screwed down by hand. All bolts shall have hexagonal heads and nuts.

19.9.3 Foundation bolts

Foundation bolts for steelwork shall be provided under the contract and built into prepared pockets or cast into the concrete foundations by use of suitable templates. The foundation bolts shall be set to permit adjustments to the level of the steelwork in the event of differential settlement of the foundations.

19.9.4 Washers

All bolts and nuts shall be completed with standard or tapered washers. All washers shall have quality St-type B. All washers shall be hot dip galvanised according EN-ISO-10684.

19.9.5 Steel for miscellaneous items

All steel for miscellaneous times such as edge profiles, safety ladders, catwalks, hand railing, guard rail etc. shall be hot dip galvanised according to EN-ISO-10684, unless specifically indicated otherwise in the Employer's Requirements.

19.10 Erection of steelwork

19.10.1 General

The Contractor shall supply all labour and materials, plant, haulage, storage and all services and things necessary for the erection of the steel superstructures complete.

19.10.2 Stability of structures

The Contractor shall be responsible for the stability of the structures at all stages of their erection on site and shall take all necessary measures, by the addition of temporary bracing and guys, to ensure adequate resistance to wind.

19.10.3 Quality and testing of materials

At least two (2) weeks before ordering materials, the Contractor shall send a written notice to the Employer specifying:
Type, quality and quantities to be ordered from a steel mill.
Type, quality and quantities to be ordered from available (local or non-local) stocks.

Certificates of the steel manufacturers shall be required for the ordered materials. The Contractor shall submit these certificates to the Employer. Material obtained from stocks shall be checked by the Employer on exterior defects either in the workshop or on the Site.

19.10.4 Delivery of fixing materials and associated parts

The Contractor shall ensure that all relevant fixing materials and associated parts are supplied to Site prior to commencement of the erection works for which they will be used to facilitate alignment and fixing into the primary concrete work.

19.11 Fasteners

All anchor bolts, assembly bolts, screws, nuts, dowels and other fasteners shall be of ample section. Anchor bolts shall be furnished with at least two nuts to facilitate installation.

19.11.1 Unavailability of materials

In the event of unavailability of certain materials and steel sections, require deviations from the original designs, the Contractor shall submit his own calculations. Such calculations shall be submitted for approval to the Employer, in two-fold, simultaneously with the corresponding working drawings. All cost related to making of calculations shall be borne by the Contractor.

20

WELDING

20.1 Electrodes

Welding electrodes shall be manufactured in accordance with the requirements of the most recent edition of AWS Standards. Rods shall be suitable requirements for the position and conditions of their intended use. The maximum size of electrode permitted for the fabrication of tubular members shall be 5/32 inch for stringer or starting beads and 3/16 inch for passes following starting beads in multipass welds. The maximum size electrode permitted for any other steel work shall be 1/4 inch.

20.2 Qualification of welders and welding procedures

All materials for weld testing shall be furnished by the Contractor. All welders shall be qualified in accordance with the requirements of the specified codes for the various work as follows and in the presence of the Engineer if it is so desired and who may, at his discretion, accept the results of previous and authenticated tests which meet the requirements of these standards.

The Contractor shall be responsible for keeping up-to-date records of welding operators and welding qualification tests.

20.3 Workmanship

20.3.1 General

Welding shall be in accordance with API-1104 and AWS D 2.0, where applicable. Surfaces to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign material. The surface before welding shall be cleaned of rust, loose scale, oil and dirt, slag and spatter of each pass shall be cleaned from all welds, after completion.

All structural welds shall be continuous and shall be properly sized to develop the full strength of the smaller of the two members being joined.

Welding must be carried out by skilled experts who own diplomas from a local or international certified Institute for Welding Technique.

The electrodes and adding material must be in accordance with the concerning regulations. The electrodes must be in excellent condition and must be clean, dry and undamaged. The electrodes must be stored in accordance with the guidelines of the supplier.

The edges of the welds must be smooth, without burrs, cracks and the like. At the front opening sides must be rounded.

The sides of the welds and the material in their immediate vicinity must be clean, dry, fat-free, paint-free and rust-free. Removal of paint or rust may only take place mechanically. Attachment and aid welds must be of equal quality and composition as the final weld and must be completely being melted into the final weld.

The maximum electrode diameter for the first layer of corner welds is 4mm.

During welding, sufficient measures must be taken to protect the welds against moisture and draft air. No welding can take place below 0°C. When necessary, the welds have to be pre-heated. During welding, the least possible amount of heat must be transferred into the material. The arc may only be ignited within the weld.

The final welding must take place in such an order that distortions and internal tensions will be adequately prevented. The parts that are connected must be aligned prior to the welding and not moved during the welding.

The welding must be executed following the appropriate guidelines. The removal of slag from each weld using a mechanical technique is obligated. Weld spatters must be removed after finishing the welding.

All welds must be applied continuously and all around the connection. The welding must be carried out long enough to secure an excellent weld. If there is not enough time due to possible distortions, connection welds must be used. In that case, the remaining welds have to be glued together.

The weld connections may not contain binding errors, cracks and other imperfections that can lead to cracks, as well as sharp grooves and notches. The welds must be free of notches, holes, deep burning notches, porosity, gas holes, gas channels, slag enclosure, slag tracks and impurities caused by treatment, oxidation of materials or mechanical damage.

The welds have to be finished carefully, where necessary for an excellent performance of the installation.

Connection strips etcetera must be made of the same material as the parts that are to be weld. The connection strips must be carefully grinded away. The treated plane must be free of cracks, grooves or notches.

Parts that are assembled at the site prior to hot-dip galvanisation may only be connected temporary, after which the parts have to be welded in the factory.

The Engineer can request for a welding plan for important parts. This welding plan has to be presented ultimately four weeks before the start of the welding. The following aspects must be included In the welding plan:

- Way and order of putting together welding materials, as well as tools to be used.
- The method of welding, information on welding instrumentation and use of protection and backing gas.
- Type and thickness of the electrode and/or welding wire that will be used.
- Type and way of pre-treatment of the welding sides.
- Measures that will be taken to put the installation in its correct form after the welding.
- Way of connection of parts (connection welds, connection strips etcetera).
- Way of filling of welds.
- Pre-heating and treatment with heat.
- Checking procedures during the welding.
- Checking procedures after the welding.
- Way of after-treatment.

20.3.2 Compatibility of welds

All welds shall develop the strength and energy absorption characteristics specified for the material being welded. All butt welds shall attain 100 % penetration. All welds forming connections between steel of different grades shall develop the strength specified for the higher steel and shall develop the maximum energy absorption characteristics specified for either steel being joined. Skip welding will not be permitted unless specifically on the Contractor's Design Drawings. Down vertical welding is not acceptable.

20.4 Additional regulations for the welding of X70 steel

For API 5LX-X70 steels, the following procedure shall be employed:

1. Preheating:
   The joint to be welded, shall be preheated to 70-100°C for a strip not less than 150 mm on either side of the joint.
2. First passes
   First 2-3 passes shall be carried out using manual welding depositing thin and tight beads and without oscillations. The electrodes shall be ASTM E 6010 type of equivalent.
3. Filling passes
   The filling may be done manually using ASTM E 7018 type electrodes or equivalent. Automatic welding may be done.

20.5 Additional regulations for the welding of stainless steel

Welding must take place in a separate workshop. Materials must be protected against any form of pollution and against particles of other metals.

When the backside of a weld cannot be cleansed with glass beads or brushes, backing-gas must be used during the total process of welding, for all welding methods. No formation of cracks is allowed with respect to crack corrosion.

When the welding takes place in several layers, all layers must be cleansed with a stainless steel brush before the next layer is put on. Immediately after the welding, slag and other impurities must be removed with stainless tools.

The use of connection strips must be avoided as much as possible.

When tension corrosion is to be expected a treatment with heat must be carried out after the welding. The procedures, the way and extension of this treatment with heat must be according to the instructions indicated in the material specifications of the supplier.

Material used for welding must be supplied together with certificate concerning the suitability of the stainless steel involved.

Autogenous welding of stainless steel is forbidden.

All welds and welding zones must be pickled and made passive on the inside and the outside. After pickling and making passive, cleansing must take place with halogen-free water.

Colours that come up due to welding must be removed with stainless brushes.

Grinding after welding must be avoided. The surfaces must be made smooth. The smoothed surfaces must be pickled and made passive.

20.6 Testing of welds

20.6.1 Inspection tests of welds

All welds considered to be vital to the strength and integrity of a structure shall be called critical welds and the Contractor's shop drawing shall show the approximate location of all critical welds.

All welds in those structural members essential to the integrity and strength of the structures and considered as critical welds will be radiographed throughout their full length, or inspected by ultrasonics wherever radiography is not possible. Circumferential welds on all pipe piles, if applied, are considered critical welds.

On radiographing circumferential pipe welds the first 30 cm of longitudinal welds shall also be radiographed. In addition, 5 % of all other welds will be subjected to radiography.

Radiography shall be carried out in accordance with API 1104. The sensitivity of the radiography shall not be inferior to 2 % of the thickness to be penetrated.

Rejection of welds may be made on the basis of the following factors: inadequate penetration, incomplete fusion, burned through areas, slag incursion, gas pockets, cracking and undercutting. No weld containing cracks regardless of size shall be acceptable.

Welds that have minor defects, can be repaired within the limits and in accordance with API 1104. The repaired weld shall be radiographed again, and if defects are again present; even if minor, further repairing shall not be allowed, and the weld shall be eliminated by cutting.

20.6.2 Additional tests

The Engineer may order an expert to inspect welds and passes. In case the expert believes that a defect exists in any weld or pass, the Contractor shall use appropriate test methods to determine the soundness of the welds. If the weld proves to be defective, it shall be repaired to the complete satisfaction of the Engineer. The type of tests that may be used include cutting and testing coupons and radiography.

20.6.3 Coupons

Test procedure shall comprise cutting out and removal of a section of steel plate or welded area and restoring the area by welding back in a piece of steel similar in quality, thickness, and size of plate. Test shall be in accordance with American Welding Society. Contractor shall also furnish the Engineer an accurate tabulated report for each test.

20.6.4 Interpretation of radiographic tests

Radiographic interpretation procedure for all welding shall be according to API 1104. Ultrasonic testing procedure shall according to ASTM designated E 164 or other agreed equivalent.

20.6.5 X-ray testing

X-ray examination may be carried out with any of a variety of equipment and techniques. The Contractor shall inform the Engineer about the way of examination and type of equipment. The method of testing requires the prior approval of the Engineer.

The Contractor shall appoint a weld expert to the approval of the Engineer. The expert shall be qualified by education and experience and shall be knowledgeable in the area of welding technology, inspection, and testing procedures.

When ordered by the Engineer, the weld expert shall pass a practical screening test for the welding and shall employ a realistic mock-up of prototype connection with a typical weld profile, with sufficient built-in defects (artificial and/or natural) to provide a fair measure of the capability of the expert. The expert shall be able to correctly locate the defects and estimate their true size within a factor of 2.

X-ray examination shall be carried out according to the following general principles:
- All welds to be examined shall be uncoated.
- 10 % of all welds to be indicated at random by the Engineer.
- Calibration of the X-ray test system for proper operation shall be carried out every 75 m of tested length of weld.
- A written and certified report shall be prepared giving the following data for sound and/or rejectable or near-reject size indications:
    - Article identification.
    - Location along weld-axis and length.
    - Location in weld cross section and size (width).
    - A sketch shall be submitted.
    - Type of X-ray equipment.

Imperfect pile welds

If to the opinion of the Engineer, a pile weld is unsound, imperfect or otherwise inferior with respect to the X-ray testing, the Contractor shall cut off the steel pile at least 50 mm below the weld, and make the surface of the top side of the pile smooth and levelled straight. The Contractor shall reconstruct all work appearing from the disapproval in an approved manner without any extra charge.

21

CORROSION PROTECTION OF STEEL ELEMENTS

21.1 General

This Chapter covers surface preparation, priming and coating of the exposed areas of steel elements . Sheet piles shall be handled in similar manner as piles referred below.

The Contractor shall furnish all labour, materials and equipment, including paints and solvents of the best quality.

All personnel employed shall be experienced and skilled in the work to be performed and adequate supervision shall be provided by the Contractor at all times when work is in progress. It is intended that all equipment shall be finish painted by the supplier and that repairs of damage in transit and installation shall be carried out on site.

The Contractor may decide to supply the steel piles shop coated.

21.2 Codes and standards

Assessment of the corrosivity and corrosion categories shall be in line with:
- EN 1993-5 and PIANC WG44-2005 for steel in sea water.
- EN 12944-2/-3/-5.
- EN 13174.
- EN 14490.
- EN12501.
- DNV-RP-B401 Coatings.

The design and application of the coating systems shall comply to:
- EN 12944-2/-3/-5.
- SIS 05 59 00.
- ISO 8501-1.
- ISO 8503.
- The paint manufacturer's product data sheets and instructions for paint application.

21.3 Equipment

All equipment shall be maintained in good order. Mechanical mixers shall be provided for paint mixing. Compressed air shall be produced in adequate quantities at full pressure at the point of use; it shall be substantially free from oil and water, for which traps and/or filters shall be fitted and emptied regularly.

All scaffolding for surface preparation, painting and inspection shall be safe and stable and adequate in extent for these purposes.

21.4 Surface preparation

Surfaces shall be prepared for coating as follows:

- All sharp edges, burrs, fins, weld spatters, etc., shall be dressed off, care being taken to ensure that grinding cracks are not produced during grinding operations.
- Contaminations such as oil or grease, dirt, crayon marks, etc., shall be removed with suitable solvents.
- Loose, heavy rust deposits and mill scale may be removed by means of wire brush or manual scrapers before blast cleaning.
- The surface shall be blast cleaned to SA 2.5 standards as defined in Swedish standard SIS 05 59 00 or ISO 8501-1 and ISO 8503 by using selected abrasives of particle size necessary to provide a resultant amplitude of surface finish i.e. height from base of a trough to an immediately adjacent peak should be as low as practicable and shall not exceed 100 microns. Blast cleaning shall not be conducted on surfaces that will be wet after blasting and prior to the cast application, or when the surfaces are less than 3 degrees Celsius above the dew point, or when the relative humidity of the air is above 80 %.
- Laminations, shelling, laps, and other surface defects apparent either before or after blast cleaning shall be dressed off and the area re-blasted.
- Cleaned surface shall be air blasted, vacuum cleaned or otherwise free from abrasive materials immediately after blast cleaning.

21.5 Coating application

In all cases, the following general instructions shall apply:

- The first coat or primer shall be applied within four hours of surface preparation or before re-rusting occurs, whatever is earlier.
- Precautions shall be taken to prevent the deposition of dust, moisture or other foreign matter on the surfaces prepared for coating, on the surfaces between various coating or on wet coats.
- Paints shall be thinned only to a degree permitted by the manufacturer's instructions.
- Two pack materials shall be mixed according to the manufacturer's instructions and used before the end of their stated pot life.
- Mechanical stirring shall be used for mixing but small quantities may be mixed by hand. Micaceous iron or paints and inorganic since silicate primers shall be agitated during spraying.
- Manufacturer's instructions regarding intercoat intervals shall be strictly observed.
- Care shall be taken to ensure complete coverage of re-entrant angles and edges.
- Care shall be taken to ensure that bolt holes receive the necessary thickness of each coat of primer and paint.
- 50 mm of bare metal shall be left uncoated at edges to be site welded.
- Any coat that becomes contaminated with dirt etc. shall be washed down and the area allowed to dry before over-coating.
- Friction grip surfaces between structural steelwork shall be coated with inorganic zinc silicate primer only.
- Each coating application shall use paint products confined to one manufacturer.

21.6 Paint supplies

Paint and solvents shall be purchased from manufacturers in accordance with the Employer's Requirements.

21.7 Repair of coating damage

Welds and areas of damage shall be blast cleaned, primed and painted.

For site repairs, a zinc epoxy primer is acceptable on small areas, instead of inorganic zinc silicate. The primer shall be applied in two or more coats to provide a dry film thickness of 75-125 microns. The finish shall be in accordance with specified coating.

21.8 Inspection

The Engineer reserves the right to inspect all aspects covered by the Employer's Requirements. Such inspection does not relieve the Contractor of his obligations under the Contract to ensure the quality of the work.

Dry film thickness shall be measured by means of an approved type of dry film thickness gauge e.g. 'Micro-test', calibrated shortly before start of the related measurements.

Inspection of all stages of surface preparation, priming and painting shall be generally to the relevant clause of BS 5493: 1977 code of practice for protection coating of iron and steel structures against corrosion.

21.9 Coating material

The priming coat shall be a polyamide epoxy primer of a type recommended by the manufacturer as suitable for the ambient conditions during application and for overcoating within 24 hours. The Subcontractor may purpose the use of a holding primer which shall be an inorganic zinc silicate formulation compatible with the main primer. The primers shall be applied by spray to a dry fill thickness (including any holding primer) of 75-125 microns.

The primers shall be allowed to cure before overcoating. A tie coat shall be applied without delay if recommended by the paint manufacturer. Should surface contamination by zinc salts inadvertently occur, it shall be 'sweep blasted' to clean the surface before application of the following coat.

The tie coat, if used shall be applied to a dry film thickness of approximately 25 microns. It shall be a formulation compatible with the primer and the finish and shall be allowed to dry before overcoating.

The finishing paint shall be high solids glass flake reinforced epoxy system with an improved resistance to abrasion and impact. It shall be applied by airless spray to a total dry film thickness not less than 350 microns.

21.10 Painting zones

In case the Contractor chooses to apply coating in combination with over thickness of steel, steel piles and sheet piles shall be painted in accordance with the following requirements:

- A shop (supplier of piles and sheet piles) primer shall be applied at the areas to be coated for piles and sheet piles (75 microns).
- A finishing paint system shall be applied (350 microns) from the top of the piles (or at least from bottom level concrete structure) until 1.0 meter below the level of the seabed. The finishing paint system comprises an intermediate layer and a top layer.

21.11 Schedule and guarantees

The Contractor shall propose in his method statement a schedule of protective coating procedures and operations. The Contractor shall obtain from manufacturers of all protective coatings a guarantee of such coatings for a period of ten (10) years.

21.11.1 Painting of other steel elements

Protective measures and painting systems for other steel elements than piles and sheet piles shall be in accordance with manufacturer's recommendations.

21.12 Cathodic protection by sacrificial anodes

The design and application of cathodic protection (CP) by sacrificial anodes shall comply to EN 12473 and EN 12496 and EN 13174 and DNV-RP-B401. CP by sacrificial anodes may be applied to all steel structures in the submerged zone (sea side).

Basically the following system shall be used:

- Galvanic anodes made of zinc or aluminum based alloys.
- Application of anodes in the submerged zone (between tidal zone and buried zone).
- The anodes shall be distributed over the whole surface and shall not interfere with normal operations.
- All tubular piles and sheet piles shall to be protected by CP. Coating might be combined with CP in the submerged zone.
- The individual anodes should have a lifetime of 20 years or more.
- The anodes should be inspected every 5 year.
- Inspection and replacing of the anodes should be possible by divers.
- Anodes that weight less than 50 % of the initial weight should be replaced.

CP system proposed by Contractor shall meet all specified requirements, subject to the Engineer's approval.

22

HOT DIP GALVANISING

22.1 General

This chapter gives the requirements for hot dip galvanizing of steel elements. The thickness of a hot dip galvanising zinc layer shall be at least 80 micron. Screw thread shall be brushed after galvanisation.
Any deformed materials shall be straightened without any loss of strength and functionality.

22.2 Codes and standards

The following codes and standards shall apply:

EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods.
EN ISO 14713-1	Zinc coatings - Guidelines and recommendations for the protection against corrosion of iron and steel in structures - Part 1: General principles of design and corrosion resistance.
EN ISO 14713-2	Zinc coatings - Guidelines and recommendations for the protection against corrosion of iron and steel in structures - Part 2: Hot dip galvanizing.
EN 10240	Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic plant.
EN 15773	Industrial application of powder organic coatings to hot dip galvanized or sherardized steel articles [duplex systems] - Specifications, recommendations and guidelines.
EN ISO 10684	Fasteners - Hot dip galvanized coatings.

22.3 Construction

All mechanical processing such as welding, boring, sawing etc. shall be executed before hot dip galvanising. Welding slag and spatter shall be removed thoroughly. To avoid excessive growth of the zinc coating on the welding spot a welding wire or electrode shall be used a maximum of 0,7 % silicon. Air holes and inflow and outflow holes shall be applied on the right positions. Parts of the installation that need to be recognised has to be marked with a numbering stamp or using identification labels. Marking by means of paint or chalk is not permitted.

22.4 Inspections

Acceptance tests shall be performed at the galvanising facility. All hot-dip galvanising shall be in conformance with Standards as mentioned in paragraph 22.2. This test comprises:
- Visual check on the exterior of the zinc layer.
- Check on the layer thickness or the weight of the zinc layer.
- Check on the resistance of mechanical damages.

22.5 Storage on site

All hot-dip galvanised objects shall be stored on wooden beams and preferably placed at a slope. To avoid formation of white rust when piling up objects sufficient space for air circulation shall be provided between each object.

22.6 Damages

Damages due to transport or erection shall be reconditioned with zinc coating and a finishing coating. Damages, which are recovered, shall be thoroughly cleaned by rubbing and brushing. Next two layers of zinc coating shall be applied with a brush. After drying the object shall be provided with an aluminium cover coating or two layers of zinc/aluminium spray.

The total layer thickness shall be at least 150 % of the minimum zinc layer thickness prescribed in International Standards. Zinc coating layers for reconditioning purposes shall obtain at least 92 wt.% of zinc in the dried layer.

The total reconditioned surface area shall not exceed 1 % of the total galvanised area of that particular object. Reconditioning is only allowed if the surface area of the damaged spot does not exceed 100 cm^2. Also reconditioning by means of a solder stick of a zinc alloy is allowed if the damaged spot is relatively small.

22.7 Welding hot-dip galvanised steel

Hot-dip galvanised objects shall not be welded.

In this case a slow solidifying electrode or wire shall be applied.

If the wall thickness of the object exceeds 8mm, filing and grinding before welding shall remove the applied zinc layer. The weld shall be thoroughly cleaned as described in the previous section ‘Damages’.

22.8 Preservation of hot-dip galvanised steel

If a (wet) paint system, a powder coating or a thermoplastic shall be applied after hot-dip galvanising than the object that need to be preserved shall be properly prepared. An acceptance test at the galvanising shop shall be required in case the coating will not be applied in that shop. Paint or coating shall be applied in conformance with the EN 15773 (Hot-dip galvanised steel - industrial methods for applying organic coatings). This directive gives prescriptions for pre-treatment of galvanised objects to be preserved and for paint or coating systems.

23

MARINE FITTINGS

23.1 General

The Work covered under this section shall consist of the supply, delivery and installation of quick release hooks, bollards, safety ladders, boat lifts, pedestals etc. complete and in accordance with the Drawings, the Employer's Requirements and the Conditions of Contract.

23.2 Codes and standards

The following codes and standards shall apply:
- BS MA 12.
- BS 6349.
- EN 21-78.
- NEN-EN ISO 683-1 and 2.
- DIN EN 10293.

23.3 Delivery of bollards

Delivery shall be according to EN 21-78.

23.4 Materials

Cast steel bollards shall be supplied and fixed in the location shown on the Drawings and shall be provided with all bolts and other items necessary for anchorage to the concrete structures in accordance with manufacturers recommendations.

The bollards shall be suitable for the maximum design pull mentioned in the Particular Requirements and Design Criteria or definition drawings. The manufacturers test certificates shall be provided.

Holding down bolts, nuts and washers shall be hot dip galvanised.

The bollard hold down bolts shall be cast into the concrete using a template to hold the anchors in the correct horizontal and vertical position. Bollards shall be installed level on a dry mortar bed tamped firmly home in order to ensure compile filling under the bollard base.

Bollards shall be cast steel Gst60.3 according to DIN 1681.

The carbon equivalent value Ceq. shall be< 0.5 %.

The bollard anchorage shall be of stainless steel grade 316 (A4) or 42C2M04V according to EN 10083-1 and 2. Nuts shall be quality 8.8.

23.4.1 Protection

The bollards shall be primed and painted with 2 coats of an approved bituminous paint to BS 3416, type 1.

Tests and inspection
Material tests shall be carried out according to EN 21-78: certificate shall be in conformity with section 43231.

All notch impact values shall be recorded according to EN 10045-1.

Fixing materials
All fixing materials shall be visually inspected and at least 5 % of each item shall be tested according to the applicable specifications.

Material tests
The material tests shall be carried out according to the test method as described in the ASTM Standards. The following tests shall be carried out:
- Tension test.
- Bending test.

23.5 Safety ladders

Ladders shall be hot-dip galvanised.

24

CRUSHED AGGREGATE BASE COURSE

24.1 General

24.1.1 Summary

This section covers the work of a crushed aggregate base layer (course) as required by the Contract.

Extent of base layer (course) work is shown on Drawings.

The base course shall consist of placing and compacting crushed aggregates on a prepared sub-grade in accordance with the Specification and in conformity with the lines, grades, thickness and typical cross sections shown on Drawings.

24.1.2 Submittals

Submit listed submittals in accordance with conditions of the contract and specification sections.
- Equipment list and manufacturer's product data.
- Samples of all materials.
- Test reports and materials certificates as specified hereinafter.

24.1.3 Quality control

In the event of conflict between various codes and standards, the most stringent conditions shall apply.

Installer qualifications
Engage an experienced installer who has completed a base course similar in material, design and extent to that indicated for the project.

Weather limitations
Construct base course only when atmospheric temperature is above 4°C and when sub-grade is dry.

Testing
Materials and installed work may require testing or retesting at any time during the progress of the works. Tests, including retesting of rejected materials or installed work, shall be done at the Contractor's expense.

All sampling and testing shall be performed by site testing laboratory or an approved independent laboratory according to Section 01400 “Quality Control”.

The following tests should be carried out unless otherwise directed by the Engineer and at frequencies laid down by the Engineer.

Table 24.1 Tests to be carried out

Test	Standard	Limit
Sampling	AASHTO T2	-
Soundness (Sodium Sulphate Solution)	AASHTO T104	12 % max.
Liquid Limit	AASHTO T89	25 % max.
Compaction Test Modified Proctor	ASTM 1557/BS 1377 (Method D)/(Test 13)	-
CBR at 95% of Modified Proctor Density (96 hr. Soaked)	ASTM D 1883 BS 1377 (Test 16)	80 % min.
Field Density	AASHTO T191	98 % min.
Linear Shrinkage	BS 1377	3 % max.
Sulphate Content	BS 1377	0.5 % max.
Chloride Content	BS 812, Part 117	1 % max.

Grade control
Establish and maintain required lines and elevations.

24.2 Products

24.2.1 Materials

General
Use locally available materials and gradations which exhibit a satisfactory record of previous installations and which shall after addition of water and compaction form a uniform and homogeneous section conforming with the Employer's Requirements.

Borrow pits and quarries shall be cleared and grubbed in accordance with the requirements and approved before crushing operations started.

Base course granular
Base course aggregate shall comply with RBA Specifications. It shall consist of well-graded coarse, fine aggregates and filler from clean crushed rock or crushed aggregates stone.

Crushed aggregate
Crushed aggregate shall consist of hard, durable particles or fragments of stone; crushed to the required size well graded and a filler from same crushed material.

Particle size analysis and sieve analysis of aggregates shall be carried out in accordance with AASHTO T 27 and T 88.

General requirements for crushed aggregate
In addition to the requirements in proceeding Paragraphs crushed aggregate shall be uniformly graded from coarse to fine and shall conform to the requirements given in the following table for the grading.

The maximum size of particles shall be 50 mm and shall not exceed 1/3 the thickness of the base course after compaction (table 24.1).

The portion of the material retained on a No. 10 sieve shall be known as coarse aggregate; the portion passing a No. 10 sieve shall be known as fine aggregate; and the portions passing a No. 30 sieve 100 % and No. 200 sieve for at least 65 % shall be known as filler.

The material shall be free from vegetable matter, clay balls, loam or other deleterious materials.

Percentage of absorbed water, by weight shall be 10 % maximum. Percentage of dissolution in water for coarse and fine aggregates shall be 5 % maximum.

Coarse aggregate shall have a percentage of wear by Los Angeles Test of not more than 50 at 500 revolutions as determined by AASHTO T96.

The grading percentage specified in the following Table 24.2 shall apply to the material after it has been processed on the road as well as when tested at the pit or other source of supply.

Table 24.2 Grading base course aggregate (percentage by weight) AASHTO T 88-57

Sieve Size		Percentage passing by weight (%)		
		Maximum size (mm)		
		50.8 (2")	38.1 (1 ½")	25.4 (1")
50.8 (2")		100	-	-
38.1	(1½")	70-100	100	-
25.4	(1")	55 - 85	70 - 100	100
19.0	(3/4")	50 - 80	60 - 90	70 - 100
9.51	(3/8")	40 - 70	45 - 75	50 - 80
4.76	(No. 4)	30 - 60	30 - 60	35 - 65
2.00	(No.10)	20 - 50	20 - 50	25 - 50
0.425	(No. 40)	10 - 30	10 - 30	15 - 30
0.074	(No. 200)	5 - 15	5 - 15	5 - 15

The fraction passing the No. 200 sieve shall be not more than one half the fraction passing the No. 40 sieve.

The fraction passing the No. 40 sieve shall have a liquid limit not exceeding 25 and a plasticity index not exceeding 6.

The mixture shall have a soaked California Bearing Ratio CBR of not less than 80 %.

Blending materials

If fine aggregate or filler in addition to that naturally present in the base course material, is necessary in order to meet the grading requirements, or for satisfactory bonding of the material, it shall be uniformly blended with the base course material at the screening and crushing plant or on the road. The material for such purpose shall be obtained from sources approved by the Engineer and shall be free from hard lumps.

24.2.2 Equipment

The Contractor shall use types of earth moving compaction equipment that are most suitable for the work and of numbers, sizes and capacities that can perform the work of the base course as determined in the time schedule and they shall include: Tamping, smooth-wheel steel roller, pneumatic-tired rollers etc. and watering equipment.

Water sprayer
Shall be truck mounted, equipped with a pump, with a separate power unit including a spray bar.

The design of the spraying equipment shall be such as water shall be applied and added to soils at uniform and controlled rated to provide the optimum, moisture content.

24.2.3 Operation

The particular type of roller to be used, as described above shall be designated by the Engineer to suit the type of material used.

24.3 Execution

24.3.1 Preparation of subgrade

The work shall be performed after infrastructure works, and the earthwork has been substantially completed and tested. Immediately before placing base course, sub-grade shall be rolled with pneumatic tired roller of sufficient weight or heavy smooth wheel roller, to satisfy the adequate levels shown on Drawings and to detect soft spots.

For vehicle areas compact with a roller weighing not less than 8 to 10 tons. For pedestrian areas compact with a roller weighing not less than 2.5 tons. After the sub-grade has been constructed, prepared and substantially completed, and if after compaction any soft spots are found the full width shall be conditioned by removing any soft or other unstable material that was not compacted properly or serve the intended purpose. The resulting areas and all other low sections, holes, or depressions shall be brought to grade with suitable selected material. The entire sub-grade shall then be shaped and compacted, for at least a depth of 25 cm. Scarifying, blading, dragging, rolling, or other methods of work shall be performed or used as necessary to provide a thoroughly compacted sub-grade shaped to grades and cross sections shown on the Drawings.

The finished sub-grade shall be continuously maintained in a condition suitable for traffic until the next course of material is placed or until final completion of the work. Compaction soil test shall be made to determine the maximum dry density and optimum moisture content of soil.

Relative compaction of sub-grade shall be 95 % according to the modified AASHTO Designation T 180. Surface elevations shall conform to the theoretical values indicated on Drawings within a tolerance of maximum + 2.0 cm.

24.3.2 Application base course

Contractor shall make the survey required for the reference grade; he shall erect a reference string line parallel to the centerline of the road, and operate the compacting equipment to conform the string line. Elevation control point stakes for the crushed aggregates course shall be set at maximum spacing of 25 m.

Sufficient uniform material mixture shall be spread on the road surface by a motor grader and well mixed with water with the specified equipment to reach the maximum density after compaction and so that the surface of the base after compaction is just above the specified grade.

Placing

The wet granular base material shall be spread in layers (first spread the granular material and then add water) on the prepared sub-grade and compacted to grade and cross section shown on the Drawings. When more than one layer is required, each layer shall be shaped and compacted before the succeeding layer is placed.

The placing of material shall begin at the point designated by the Engineer. Placing shall be from spreader boxes or from vehicles especially equipped to distribute the material in a uniform layer of windrow on the existing surface for immediate spreading by a motor grader.

The layer or windrow shall be of such size that when spread and compacted, making allowance for any blending material that is to be added on the road, the layer shall have the required thickness of 150 mm after compaction.

Slope base course to the required crown elevations and cross slope grade. When hauling is done over previously placed material, hauling equipment shall be routed as uniformly as possible over the entire area of previously constructed layers.

Adding blending material

When additional fine aggregate or filler is required and it is to be blended with the material on the road, the blending material shall be uniformly placed with spreader boxes or other approved devices.

Mixing and spreading

After layer of base course material has been placed and blending material added when required, it shall be thoroughly mixed to its full depth by means of power graders, traveling mixers, or other mixing equipment.

During the mixing, water shall be added in the amount necessary to provide the optimum moisture content for compacting as specified in Item 3.2.4. When uniformly mixed, the mixture shall be graded smoothly to a uniform thickness, to the cross section shown on the Drawings.

The Contractor shall so schedule his operations as to assure completion of grading within 48 hours after processing.

Compaction

Immediately following the spreading and water addition compact with a pneumatic-tire roller and for the final grading and smoothing, the layer shall be compacted to the full width by means of smooth wheel power rollers meeting the requirements of the Employer's Requirements. Each 100 square meters, compacted material placed shall receive at least 1 hour of continuous rolling. Rolling shall progress gradually from the sides to the centre parallel with the centreline of the road, and shall continue until all the surface has been rolled.

Any irregularities or depressions shall be corrected by loosening the material at these places and adding or removing material until the surface is smooth and uniform. Along curbs, headers, and walls, and at all places not accessible to the roller, the granular base material shall be tamped thoroughly with mechanical tampers. The material shall be both bladed and rolled until a smooth, even surface has been obtained.

The amount of rolling and tamping as required above is estimated as the minimum necessary for adequate compaction. During the progress of the work, the Engineer may make density tests in accordance with AASHTO T-180, modified to include only materials passing a 19 mm sieve, and if the density is less than 100 percent of the maximum density as determined by AASHTO T 180 Method C, the Contractor shall perform additional rolling tamping as may be necessary to obtain that density. Other types of field density

tests may be used for control purposes after density value corresponding to those obtained by AASHTO T 180 have been established.

The Engineer may permit compaction with types of equipment other than those specified above, provided he determines that use of the alternative equipment will consistently produce densities of not less than 100 percent according to the modified AASHTO Designation T180.

California Bearing Ratio (CBR) shall not be less than 80 %, according to AASHTO Designation T 193.

Thickness requirements

The thickness of the completed base shall not vary more than 20.0 mm from the thickness shown on the Drawings for roads, parking areas and landscape design.

Immediately after final compaction of the base, the thickness shall be measured at one or more points in each 150 m length of base. Measurements shall be made by means of test holes or other approved methods. The points for measurement shall be selected by the Engineer at random locations within each 150 m section in such a manner as to avoid any regular pattern. Various points on the cross section shall be covered. Whenever a measurement indicates a variation from the thickness shown on the Drawings of more than the allowable tolerance, additional measurement shall be taken at intervals of approximately 50 m length. Any area not within the allowable tolerance shall be corrected by removal or adding base course material as necessary and shaping and compacting as specified.

The cutting of test holes and refilling with materials properly compacted shall be done by the Contractor under the Engineer's supervision.

The levelling of the finished course shall be performed by the Contractor in a grid as indicated by the Engineer. The Contractor shall submit all levels in due time to the Engineer for checking and approval. Any deviation of the finished elevations from the design elevations outside the tolerances, shall be corrected by the Contractor by scarifying, removing and/or adding materials, sprinkling, rolling, reshaping, and finishing in accordance with the Employer's Requirements.

Surface requirements

Surface at completion of compaction shall be well closed, free from movement under compaction equipment and free from ridges, crack or loose materials. Base course shall be tested for straightness of the surface.

When tested by a crown template, conforming to the typical cross section shown on the Drawings and a 3 m straight edge applied at right angles and parallel, respectively, to the centerline of the road, the variation of the surface from each testing edge between any two contacts with the surface shall at no point exceed the requirements of the "Thickness requirements" in this Section.

24.3.3 Protection and Maintenance

Protection

Work on the base course shall not be carried out when the subgrade is too wet.

Hauling equipment may be routed over completed portions of the base course, provided no damage results and provided that such equipment is routed over the full width of the base course to avoid rutting or uneven compaction.

The Engineer shall have full and specific authority to stop all hauling over completed or partially completed base course when, in his opinion, such hauling is causing damage.

Any damage resulting to the base course from routing equipment over the base course shall be repaired by the Contractor at his own expense.

Maintenance

Following the completion of the base course the Contractor shall perform all maintenance work necessary to keep the base course in a condition satisfactory for priming. The base course shall be properly drained at all times.

Remove loose materials from compacted base surface immediately before spreading the prime coat. The road base shall be maintained in condition satisfactory to receive any subsequent base or surfacing material.