PORT OF PORT ELIZABETH

DOM PEDRO QUAY REFURBISHMENT

ANNEXURE A3 - VARIATIONS TO STANDARD SPECIFICATION SANS 2001 CONCRETE (STRUCTURAL)

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1. SCOPE (CLAUSE 1]

This specification covers the *Employer*'s requirements for all structural concrete work.

2. REQUIREMENTS

All structural concrete work is in full compliance with SANS 2001 : Concrete (Structural), except for the following variations and additions to the standard specification required to ensure durability in a marine environment. The references in square brackets refer to the particular clause in SANS 2001 : Concrete.

3. MATERIALS [CLAUSE 3]

3.1 Cements [clause 3.2]

All cements used for concrete work comply with SANS ENV 197-1. All cement extenders used for concrete work comply with SANS 1491. The cement types given below are acceptable for use in the Works, however the proportion of extender in factory blended cements conform to the requirements of set out in 4.3.4. On no account are masonry cements used for concrete work, even if the strength designations are the same as for common cements.

Acceptable cement types:

i)	CEM I 42,5	Portland Cement
ii)	CEM I 42,5R	Portland Cement, rapid hardening
iii)	CEM II/B-V	Portland fly ash cement
iv)	CEM II/B-W	Portland fly ash cement
v)	CEM III/A	Blast furnace cement

3.2 Applicable specifications [clause 3.2.1]

In addition to the specifications listed in Clause 3.2.1 of SANS 2001: concrete, the following specifications also apply where relevant:

SANS 0100-2:1992	The Structural use of concrete - Part 2: Materials and execution of work
SANS ENV 197-1	Cement – composition, specifications and conformity criteria. Part 1: Common cements
SANS 1491-1:1989	Portland cement extenders - Part 1: Ground granulated blast furnace slag
SANS 1491-2:1989	Portland cement extenders - Part 2: Fly ash
SANS 1491-3:1989	Portland cement extenders - Part 3: Condensed Silica Fume

3.3 Aggregates [clause 3.4]

Should the *Contractor* use a coarse aggregate type, which is reactive with alkali, the *Contractor* ensures that the equivalent Na_2O content in the concrete mix is such that it is below the threshold value, which causes the deleterious reaction in the concrete.

Alkali Reactive Aggregates shall not be used in this project.

The equivalent Na_2O content of the concrete shall not exceed 2,0 kg/m^3

where % Na_2O equivalent = %Na_2O+ (0,658 x %K_2O).

A laboratory report by the *Contractor* on the mix design and trial mixes prior to construction elaborates on the above matter. If required by the *Supervisor*, the *Contractor* submits 40kg samples for acceptance at least 6 weeks before concreting is to commence. No aggregate is delivered for use in the Works until the *Supervisor's* written acceptance is given.

The use of plums in concrete is not permitted unless otherwise specified in the individual project specifications

3.4 Admixtures [clause 3.5]

Admixtures containing chlorides is not permitted in reinforced concrete.

3.5 Curing compound

In all cases where a concrete curing compound is specified, the curing compound is grey or white pigmented membrane forming material complying with ASTM specification C 309, except that the maximum permissible water loss in the test is 0.40 kilograms per square metre.

Alternatively, the concrete curing compound is acceptable if the treated concrete retains 90% or more of its mixing water when subject to the test set out in BS 8110: Part 1, Clause 6.6 (c).

4. CONSTRUCTION [CLAUSE 5]

4.1 Reinforcement [clause 5.1]

Minimum concrete cover to all steel reinforcement is as shown on the drawings or as given in the Works Information, and maintenance of this minimum cover during casting of concrete is strictly enforced. Concrete, which is cast with insufficient cover to the reinforcement is demolished and re-cast at the *Contractor's* cost.

Cover blocks used to ensure the cover to reinforcement are made of cement mortar. They are dense and have a minimum 28 day crushing strength of 50 MPa, and are cured in water for at least 14 days before being used. Spacer blocks made of plastic are not permitted.

4.2 Formwork [clause 5.2]

All exposed concrete surfaces require a smooth finish to a Degree of Accuracy II as specified in clause 6, SANS 2001: Concrete, unless otherwise specified in the Works Information.

The *Contractor* takes particular care to ensure that formwork joints are tight enough to prevent leakage of cement mortar. Shutters that are damaged, or that leave a surface that is unacceptable to the *Supervisor*, are removed and repaired or discarded.

4.3 Concrete [clause 5.5]

4.3.1 Concrete Quality

The *Contractor*'s quality management plan provides for all the necessary operations, tests and/or inspections to ensure compliance with this specification. Before any concrete work commences, the *Contractor* provides the *Supervisor* with documentary proof that all specified operations have been carried out satisfactorily.

4.3.2 Potential Heat Generation

Measures, subject to the acceptance of the *Supervisor*, are applied to reduce heat development in concrete of which the minimum dimension to be placed during a single pour is larger than 600 mm, and the cement content exceeds the values given in table 1.

TABLE 1. – HEAT GENERATION – LIMITING CEMENT CONTENTS

STRUCTURAL ELEMENT	CEMENT TYPES I AND III/A (kg/m^3)	CEMENT TYPES II/B-V AND II/B-W (kg/m^3)
Reinforced Concrete	400	450
Precast Concrete	500	550

4.3.3 *Chloride Content [Clause 5.5.1.4]*

The chloride content in steel reinforced concrete at the time of placing is not greater than 0,15% by mass of the cement.

4.3.4 *Durability [Clause 5.5.1.5]*

In order to enhance durability and notwithstanding strength considerations the concrete mixes satisfies one of the mixes given in Table 2 below and prior written acceptance for the mix is obtained from the *Supervisor*.

TABLE 2 - CONCRETE MIXES

CONCRETE TYPE	CEMENT TYPE & % CONTENT	EXTENDER TYPE & % CONTENT	MINIMUM CEMENT + EXTENDER CONTENT kg/m^3	MAXIMUM WATER/CEMENT RATIO
STEEL REINFORCED	CEM I 50% – 60%	GGBS 40% – 50%	420	0.40
STEEL REINFORCED	CEM I 70% - 75%	FA 25% –30%	420	0.40
PLAIN	CEM I 100%	NIL	340	0.50
PLAIN	CEM I $\geqslant$ 75%	FA $\leqslant$ 25%	340	0.50
PLAIN	CEM I 35% - 65%	GGBS 35% – 65%	340	0.50
PLAIN	CEM I 65% – 74%	FA 26% – 35%	300	0.55

NOTE:
1) CEM I may be CEM I 42,5 or 42,5 R.
2) GGBS - Ground Granulated Blast furnace Slag
3) FA - Fly Ash

4) Factory blended cements (CEM II/B-V, CEM II/B-W or CEM III/A) are accepted provided that they conform to one of the blends specified in the table. The Contractor supplies certification thereof.
5) Water-reducing admixtures may be used to improve workability (See also Clause 3.4 above). The water cement ratio includes the water content of admixtures.

Blends of CEM I and Condensed Silica Fume (CSF) are not acceptable for steel reinforced concrete. Ternary blends such as CSF with CEM I and FA or GGBS may be considered provided that they can be shown to be equivalent in durability to the mixes given. The onus will be on the *Contractor* to prove to the *Supervisor* the adequacy of the blend.

4.3.5 Strength Concrete [Clause 5.5.1.7]

The strength of the concrete mixes as specified on the drawings or given in the Works Information, shall conform to the following requirements, as Class x/y, where:

x = minimum 28 day crushing strength in MPa.
and y = maximum aggregate size in mm.

4.3.6 Batching [Clause 5.5.2]

Because of the limited size of the available site and the need to remain well clear of the adjacent mess and ablution facility, it will not be possible to accommodate a batching plant on site and the *Contractor* will be required to make use of premix concrete for the project.

4.3.7 Off-Site Batched Concrete [Clause 5.5.3.2]

The use of ready-mixed concrete is required. Concrete test results obtained from the production facility are acceptable, provided that the tests are carried out in accordance with the specifications.

4.3.8 Underwater Concrete

Casting concrete underwater is subject to the acceptance of the *Supervisor* with respect to the methods, Equipment and Materials that the *Contractor* intends to use. Use of concrete admixtures such as Fosroc Conplast UW or Conplast U447 to minimise the washout of cement paste are recommended.

After commencement, the placing of concrete shall be continuous until completion, unless otherwise permitted by the *Supervisor*.

No vibration is carried out until the top of the concrete is above water or tide level.

The maximum size of aggregate is 50 mm, and the aggregates is well graded. The slump is not less than 80 mm or more than 150 mm for all concrete structures, excluding concrete paving.

The bed is cleaned of silt and loose material, and is passed by the *Supervisor* before concrete is placed.

4.3.9 Methods Of Depositing Concrete

(i) By Tremie

The top section of the tremie consists of a hopper of greater capacity than the pipe.

The tremie is sturdily constructed of steel, and be not less than 200 mm in diameter. It is strong enough to withstand the full hydrostatic pressure, even if a partial vacuum develops in the pipe, and is completely watertight.

The lower end of the tremie is equipped with an automatic check valve, which is watertight.

Initial filling of the tremie is carried out with the valve closed, in such a manner as to avoid air locks.

When concrete is deposited, the tremie penetrates the concrete bed and is slowly raised to discharge a uniform flow of concrete. The end of the tremie is under concrete during the whole operation.

Concreting continues to such a point that laitance can be removed and a sound surface left at the final finished level.

(ii) By Pumping Concrete

The same conditions and criteria as for concreting by tremie as described in (i) above, apply.

(iii) By Grouting Aggregate

Coarse aggregate, 40 mm or larger, is first placed and compacted in position.
Grout in a colloidal state is pumped into the voids through a pipe, which reaches to the bottom of the aggregate. The grout rises through the aggregate until all voids are filled.

4.3.10 Placing [Clause 5.5.5]

(i) Inspection of Area to be Concreted

No concrete is placed until the size, shape and depth of the particular area is accepted by the *Supervisor*.

(ii) Inspection of Reinforcement.

No concrete is placed until the fixed reinforcement is accepted by the *Supervisor*.

The *Supervisor's* prior written acceptance is obtained before any concrete is cast.

4.3.11 Construction Joints [Clause 5.5.7]

It is essential that a good bond is achieved between casts at construction joints. The joint surface of the concrete is to be roughened while still green by means of brush and water spray to expose the coarse aggregate. Retarders may be used on stop-ends, which should be removed after 12 hours for green cutting. Mechanical roughening of hardened concrete using power tools is not permitted as it may break or dislodge the coarse aggregate.

All surfaces are cleaned and kept continuously wet for 24 hours before pouring of the adjoining cast.

Unless otherwise shown on the drawings, the exact position of horizontal construction joints are marked on the formwork by means of grout checks in order to obtain truly horizontal joints.

Stub columns, stub walls and stays on footings are cast integrally with the footings and not afterwards, even where another class of concrete is being used.

Joint lines are so arranged that they coincide with features of the finished work.

At contraction joints (joints having no reinforcement passing through the joint), no bond is required between casts. Contraction joints are smooth, and have one coat of limewash or PVA applied to the older surface prior to casting the newer concrete.

The *Supervisor's* prior written acceptance is obtained before the adjoining concrete is cast.

4.3.12 Curing [Clause 5.5.8]

In order to enhance the long term durability of the concrete in the marine environment it is essential that it is correctly cured so that adequate hydration of the cement and extenders may take place.

All water for curing shall be clean, fresh water and under no circumstances is seawater permissible.

The curing period for concrete containing CEM I only is 7 days. The curing period for concrete's containing CEM I plus cement extenders (GGBS, FA) is 10 days. The period starts on completion of the concrete pour and for formed surfaces includes the time for which forms are still in place after the pour.

The *Supervisor's* prior written acceptance of the curing method to be used is obtained before any concrete is cast.

Concrete, of which the adequacy of the curing has not been accepted by the *Supervisor*, is removed from the Works and re-cast at the *Contractor's* cost.

The following curing methods are permissible:

(i) Covering with burlap or hessian or similar moisture retaining materials. The materials are kept continually moist and are not allowed to dry out as alternate wetting and drying is detrimental to the curing process. The material is free of injurious amounts or substances such as sugar or fertiliser that may harm the concrete or cause discoloration.

(ii) Sprinkling or spraying with water. This may be done at frequent intervals provided that the concrete surface remains continuously moist and is not allowed to dry out between wetting. Erosion of the fresh concrete surface is avoided.

(iii) Releasing the forms slightly and allowing a flow of water between the form and the concrete.

(iv) Liquid membrane-forming curing compounds, which comply with the requirements of 3.5 may be used. Only resin type compounds are permitted. The formulation must be such as to form a moisture retentive film shortly after being applied and must not be injurious to Portland cement paste. White or grey pigments or dyes are incorporated to enable the compound to be visible on the surface for inspection purposes.

For unformed surfaces the compound is applied after finishing and as soon as the free water on the surface has disappeared and no water sheen is visible, but not so late that the liquid curing compound will be absorbed into the concrete. For formed surfaces, when forms are removed, the exposed concrete surface is wetted with water immediately and kept moist until the curing compound is applied. Immediately prior to application, the concrete is allowed to reach a uniformly damp appearance with no free water on the surface. Application of the compound then begins at once. The compound is applied at a uniform rate with two applications at right angles to each other to ensure complete coverage, and is applied by hand or power sprayer. Pigmented compounds are adequately stirred to assure even distribution of the pigment during application, unless the formulation contains a thixotropic agent which prevents settlement.

The compound manufacturer supplies a certificate confirming compliance with 3.5 and the manufacturer's directions with respect to preparation and application. The manufacturer's preparation and application directions for the compound are strictly adhered to.

The total application rate is as specified by the Manufacturer, or 0,30 litres per square metre, whichever is the greater.

In the case of concrete surfaces with run-off problems, it may be necessary to apply more than one coat of membrane forming curing compound to obtain the specified total or cumulative application rate.

When the wind velocity exceeds 5 m/s and/or the ambient temperature is above 25 deg C and/or the relative humidity is below 60%, the initial 24 hour curing of concrete surfaces not covered by formwork is carried out by ponding, covering with constantly wetted sand or mats, or continuous spraying in accordance with SANS 1200G.

4.3.13 Concrete Surfaces [Clause 5.5.10]

All exposed concrete surfaces have a neat, smooth, even and uniform finish, free from any honeycombing and blow holes.

4.3.14 Records [Clause 5.5.15]

The *Contractor* maintains the following daily records for every part of the concrete work and makes these available at all times during the progress of the work for inspection by the *Supervisor*:

(i) The date and times during which concrete was placed.
(ii) Identification of the part of structure in which the concrete was placed.
(iii) The mix proportions and specified strength.
(iv) The type and brand of cement.
(v) The slump of the concrete.
(vi) The identifying marks of test cubes made.
(vii) Curing procedure applied to concrete placed.
(viii) The times when shuttering was stripped and props were removed.
(ix) The date of despatch of the cubes to the testing laboratory.
(x) The test results.

The records are delivered to the *Supervisor* each week except in the case of sub-standard concrete, when the *Supervisor* is informed immediately.

5. TOLERANCES [CLAUSE 6.2]

Deviations are within the limits listed in SANS 2001: Concrete, for Degree of Accuracy II, specified in clause 6, unless stated otherwise on drawings or elsewhere in the Works Information.

6. TESTING [CLAUSE 7]

6.1 Concrete

Before the start of any concrete work on the site, the *Contractor* supplies the *Supervisor* with a statement of the mix proportions which he proposes to use and the target strength for each grade of concrete.

6.1.1 Frequency Of Sampling

Frequency of sampling and testing are as specified in SANS 2001: Concrete, sections 7.1 and 7.2, subject to the testing of a minimum of 3 sets of samples per day from each grade of concrete placed in each independent structure if the concrete quantity from which these samples were taken exceeds 40 m^3, and the testing of a minimum of 2 sets of samples per day when such quantity is equal to or less than 40 m^3.

Where required, the two-point loading method of the flexural strength tests, as described in SANS Method 864 (1994) is used.

6.1.2 Acceptance Criteria

Acceptance criteria are as specified in SANS 2001: Concrete, section 7.3. If the *Contractor* disputes test results on concrete cubes, the concrete represented by the cubes are considered acceptable if the *Contractor*, at his own cost, proves to the satisfaction of the *Supervisor* that the estimated actual strength of the cores taken from the structure, determined in accordance with SANS Method 865, is not less than the specified strength.