

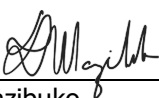
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1. INTRODUCTION

This Specification covers the variations to SANS 2001-CC1, Construction works, Part CC1: Concrete works (structural), for the supply, delivery, handling, fabrication, storage and installation of concrete works required for use on marine structures.

2. SCOPE

2.1. General

This specification contains clauses that are applicable to construction of the Port Elizabeth Foreshore Seawall, the extent of which is indicated on the drawings:

- XPE.E.0030-001-S-LA-0001-01: Overall Layout of Project Area

3. INTERPRETATIONS

3.1. Supporting specifications

The following specifications, inter alia, be read in conjunction with this specification:

- SABS 1200D
- Seawall Armor Units Generic Technical Specification
- Dredging Particular Technical Specification
- Hydrographic Surveys Generic Technical Specification

3.2. Definitions

For the purposes of this specification the following definitions will apply:

- Aggregate: Sand, gravel and crushed rock aggregates for construction purposes.
- Armourstone/Armour rock: Coarse aggregate used in hydraulic structures for protection against waves or currents.
- Block: Individual piece of rock or concrete armour unit (CAU).
- CAU: Concrete Armour Unit.
- Dolos: Precast concrete armour unit (CAU) forming the outer layer to the seawall.
- Engineer: To be interpreted as *Supervisor* or *Project Manager* depending on the context if the NEC conditions of contract are used.
- Filter: Graded rock placed on layers to prevent the migration of granular materials through the filter.
- GVM: Gross vehicle mass.
- Mean layer thickness: The ratio of the area under the mean actual profile and the length of the survey profile.
- Mean Sea Level: Land Levelling Datum, abbreviated as MSL.

- k) Nominal diameter D_n : The nominal diameter, D_n , is calculated as the cube root of the volume of the unit. The volume is calculated by dividing the mass of the unit by the saturated surface dry density. Where a numbered subscript is given to D_n , this refers to the percentage by weight of rocks in the grading having a smaller nominal rock diameter.
- l) Nominal layer thickness t : Theoretical layer thickness used to prepare design drawings and for the estimation of bulk volume of armour and underlayer.
- m) Rock: Natural rock material imported from a quarry or sourced from demolished structures and utilized in the works according to specified gradings.
- n) Seawall/Revetment: A structure consisting of rock rubble and armoured with armourstone or concrete armour units (CAUs) constructed along the shoreline primarily to protect landside infrastructure from waves and storm surges as well as protect the shoreline from erosion.
- o) Tonne (abbreviated t): metric ton, 1000 kg.
- p) Underlayer: Filter constructed with graded rock layers enclosing the core and supporting the armour.
- q) Unit: Individual piece of rock or CAU.
- r) Wearing course: A course which has no internal structural function but protects the underlying course from wear and the ingress of water.

4. CONTRACTOR'S EQUIPMENT

4.1. General

The Contractor is fully responsible for the sufficiency of its equipment.

The requirements of SABS 1200D (Clause 4.3) applies to all vehicles that are required to operate on or over any public road. Spillage of materials, generation of dust, or contamination of public roads with mud from the site must be controlled. The Contractor is responsible for cleaning the haul route of any spilled material from its vehicles at its own expense.

Audible reversing warning signals must be provided for all transport vehicles exceeding a GVM of 3 tonnes.

All equipment to be used for the Works must comply with the law and with any safety and environmental requirements specified in the Contract.

4.2. Safety

The Contractor is at all times responsible for preventing public access to the site of the works.

Construction equipment must only be operated by personnel who are suitably trained, licensed and qualified for the particular item of equipment.

Stockpiles and stacking areas for armour rock and CAUs must each be monitored and controlled by an experienced supervisor to ensure that they present no unnecessary health and safety risk to personnel working in the vicinity.

4.3. Lifting machinery

All cranes and/or gantries together with all slings, ropes and hooks to be used on site of the Works must be tested and certified as required by legislation. Seawall construction cranes must be equipped with load measuring devices and must be provided with a means to monitor the location of the crane hook in three degrees of freedom, whether in air or underwater.

4.4. Nuisance and environmental control

The Contractor must comply with the environmental controls specified in the Contract.

4.5. Transportation

The Contractor provides its own transport onshore and offshore for the duration of the works.

5. MATERIALS, EQUIPMENT AND WORKMANSHIP

5.1. Method statements

The Contractor must, before work commences, submit for the Engineer's acceptance method statements describing its proposed method of construction. The method statement must be revised and resubmitted for acceptance every time the Contractor wishes to change its method of construction. The Contractor must ensure that the works are constructed in accordance with the latest accepted method statement.

The Contractor must provide the following method statements:

- a) Health, Safety and Environmental method statement and risk assessment;
- b) Access to site, traffic management, and access control;
- c) Management of the site, with special emphasis on how the materials on site will be managed;
- d) Removal of dolosse and armour rock in preparation of dredging and placement of underlayers;
- e) Storm management and temporary protection of landside from water and wave ingress while dredging and placing underlayers
- f) Production and testing of CAUs;
- g) Handling, stacking and transport of CAUs;
- h) Placement of CAUs, indicating how this ties in with other construction activities;
- i) Transport and placement of rock, indicating how this ties in with other construction activities;
- j) Quarry(ies) operation(s);
- k) Production, sorting, and testing of rock;
- l) Handling, stacking and transport of rock;
- m) Placement of rock;

5.2. Concrete armour units

5.2.1. Concrete

Concrete for use in the CAUs is covered in the Seawall Armour Units Generic Technical Specification.

5.2.2. Production, transport, and stacking of CAUs

Three (3) tonne dolos units are required for the Works.

Methods and procedures for the production, transport, and stacking of CAUs are covered by the Seawall Armour Units Generic Technical Specification.

5.3. Rock

5.3.1. Rock for construction

The following rock gradings are required in the Works.

Table 5-1: Armour rock: 2t to 4t.

Grading class designation (kg)	Median Mass (M ₅₀) [kg]	ELL y < 5%	NLL 0% < y < 10%	NUL 70% < y < 100%	EUL 97% < y
2 000 kg – 4 000 kg	3 000	1 400	2 000	4 000	6 000
Where y is the percent by weight lighter on the cumulative weight plot.					

Table 5-2: Underlayer rock: 100kg to 500kg.

Grading class designation (kg)	Median Mass (M ₅₀) [kg]	ELL y < 5%	NLL 0% < y < 10%	NUL 70% < y < 100%	EUL 97% < y
100 kg – 500 kg	300	70	100	500	750
Where y is the percent by weight lighter on the cumulative weight plot.					

Table 5-3: Filter layer rock: 10kg to 50kg.

Grading class designation (kg)	Median Mass (M ₅₀) [kg]	ELL y < 5%	NLL 0% < y < 10%	NUL 70% < y < 100%	EUL 97% < y
10 kg – 50 kg	30	7	10	50	75
Where y is the percent by weight lighter on the cumulative weight plot.					

5.3.2. Production of materials from a quarry

The sourcing of materials from a quarry must be in accordance with local environmental and legal requirements. The testing of materials is specified in the Rock Generic Technical Specification.

5.3.3. Transport and stockpiling of armourstone

Methods and procedures are covered in the Rock Generic Technical Specification.

5.3.4. Rock placement

Rock layers must be constructed according to standard placement as defined in the Rock Manual (CIRIA; CUR; CETMEF, 2007). Minimum orientation control is applied so that the block attitude is effectively governed by its orientation in the stockpile before lifting. However, a minimum of three points of contact within the layer being placed must be ensured.

5.3.5. Test panels

At the commencement of constructing each new section of works that involves rock, the Contractor must if required by the Engineer, construct a test panel or test section of the permanent structure, which is used to demonstrate the quality of placing of armourstone for all required layers, for approval by the Engineer. For structures or parts of structures above water, a 10 m length (commonly designated as the "test panel") is adequate. For reasons of constructability, when a substantial part is under water the total test section must be considerably longer. The Contractor must obtain approval of each layer or element prior to commencing with subsequent elements and must make any adjustments necessary to obtain the Engineer's approval.

For each approved test panel or test section, the Contractor must record accurately for agreement:

The grading of each type of armourstone used.

The quantity (tonnes) and volume (m³) of material used of each armourstone type.

In addition, for the cover layer, the slope area covered and the number of pieces of armourstone placed.

The average layer thickness(es).

During the progress of the Works, the Contractor may, from time to time, be required to demonstrate that the placed packing density being achieved is in accordance with the approved test panel for that particular section of the Works. The visual quality achieved in test panels must be maintained throughout the remainder of the Works. Areas of placed armourstone that show an appearance distinguishably different from the agreed test panel in terms of quality of the construction finish, may be rejected. Block counting methods may be used to further substantiate grounds for rejection or acceptance by the Engineer. Rejected panels must be reworked until acceptable test panel quality is achieved.

5.3.6. Armour layer thickness and quantities

The design assumes a layer thickness coefficient of approximately 0.94, where the layer thickness is defined as: $t_d = n k_t D_{n50}$

where:

t_d = theoretical orthogonal layer thickness (m)

n = number of rock layers

k_t = layer thickness coefficient

D_{n50} = $(M_{50}/\rho_s)^{1/3}$

M_{50} = median rock mass (t)

ρ_s = armourstone density (t/m³)

If the layer thickness coefficient as determined in test panels differs significantly from the value of 0.87 used in the design, the test panel value must be used to adjust the theoretical layer thickness and armour volumes must be calculated with the adjusted layer thickness coefficient.

6. EXECUTION

6.1. Concrete armour units

6.1.1. General

The Contractor must produce, handle, transport, and place CAUs as specified in the Seawall Armour Units Generic Technical Specifications.

6.1.1.1. Precautions

The Contractor must when selecting its equipment and methods take account of prevailing site and weather conditions and programme its operations accordingly. The Contractor must include in its programme enough allowance for weather related downtime.

CAU placement must be programmed to limit the area of unprotected rock. Any loss of unprotected rock must be rectified at the Contractor's expense.

6.1.1.2. Handling and placing of armour units

CAUs must be placed at slope packing densities as specified in Table 6-1. The specified profiles and packing densities must be adhered to as closely as practically possible.

Theoretical spacing between units to achieve the required packing densities for units is also indicated in terms of a grid placement dimension, x , parallel to the slope. The distance between units on the same row is x and the distance between rows is $x/2$, as illustrated in Figure 6-1.

The value of x can be calculated as:

$$x = 2^{0.5} n^{-0.5}, \text{ for a double layer square grid (Figure 6-1)}$$

where n is the number of units per m²

For square grid placement both layers are placed in a single operation

Figure 6-1 are intended to show the sequence of placing, and the Contractor may elect to place more units in each panel.

The co-ordinate of each armour unit must be predetermined, and each predetermined location must be numbered. In placing the armour units, care must be taken not to impact on the rock underlayer or previously placed or existing units. Units must only be released after they have come to rest on the underlayer or previously placed units. After a unit has been placed the number on the unit and the location number must be recorded as well as its actual X and Y co-ordinate.

The dolos and armour rock must be placed to form a smooth transition to the existing structure at Papenkuils river canal.

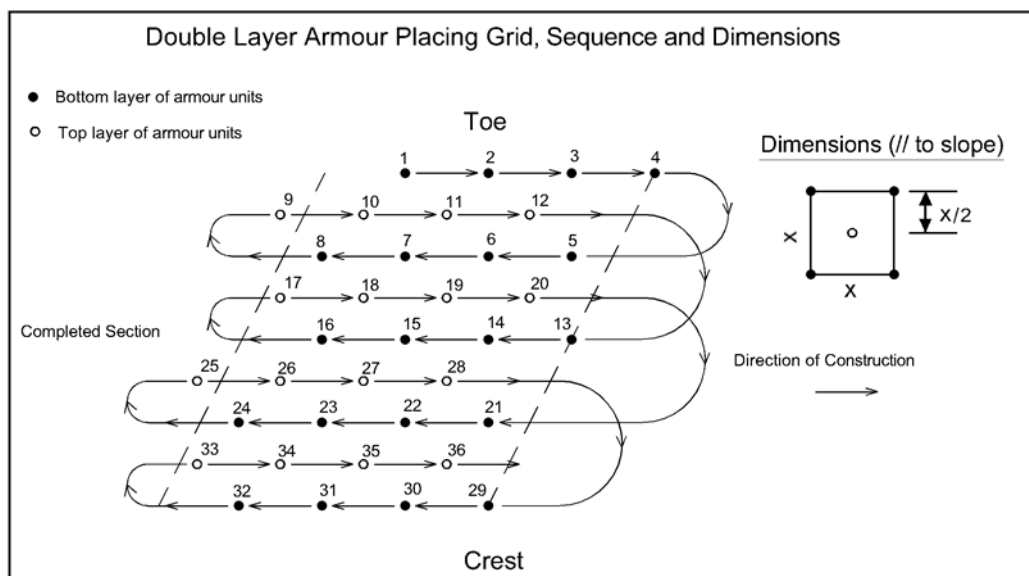


Figure 6-1: Example of a theoretical armour placing grid, sequence and theoretical armour spacing (double dolos layer square grid placed as a single operation).

Table 6-1: Armour unit packing density and grid spacing.

Armour type	Placement method	Mass	Nominal diameter (D_n)	Waist ratio (w_r)	Packing density parameter (ϕ)	Layer thickness (t)	Grid placement dimension (x)	Packing density (per slope area)
-	-	t	m	-	-	m	m	units/m ²
Dolos	Square	3	1.075	0.30	0.83	2.03	1.667	0.72

Concrete armour units which only meet "Acceptance Grade 2 quality levels for placement in designated zones", as identified in the Seawall Armour Units Generic Specifications, may only be placed within the toe of the structure.

6.1.2. Surveys

The CAU armour layer must be inspected visually above (Section 6.4.4 Photographic records) below water (Section 6.4.3 Underwater video survey) jointly by the Contractor and the Engineer to ensure a consistent and well interlocked armour layer has been accomplished. The Engineer may require the Contractor to relocate existing units or place additional units at locations where the armour placing does not conform with the specification.

Surveys must be carried out as specified in the Hydrographic Generic Technical Specifications and Drone Surveys Generic Technical Specifications.

6.2. Rock

6.2.1. General

The Contractor must handle, transport, and place rock as specified in the Rock Generic Technical Specifications.

6.2.1.1. Precautions

The Contractor must when selecting its equipment and methods take account of prevailing site and weather conditions and programme its operations accordingly. The Contractor must include in its programme enough allowance for weather related downtime.

6.2.1.2. Sequence of works

The sourcing, transportation, handling and placement of rock to the lines and tolerances are specified in the Rock Generic Technical Specifications.

6.2.2. Surveys

Surveys must be carried out as specified in the Rock Generic Technical Specifications, the Hydrographic Generic Technical Specifications and Drone Surveys Generic Technical Specifications.

6.2.3. Placement

Rock must be placed as specified on the drawings.

Rock must be placed to ensure that dolos flukes do not protrude more than 0.5 m above the rock layer. The *Contractor* is notified that the quantity of rock required for this purpose is uncertain.

6.3. Dredging

Dredging must be carried out as specified in the Dredging Particular Technical Specifications and as shown on the drawings.

6.4. Surveys

6.4.1. Drone survey

Drone surveys of the extents of the works, including a 30 m offset perimeter, must be carried out at the following stages:

- a) In-survey
- b) Directly after rock underlayer placement and before CAU placement
- c) Out-survey directly after CAU placement
- d) Drone surveys must be carried out as per the Drone Surveys Generic Technical Specifications.

6.4.2. Hydrographic surveys

Hydrographic surveys of the extents of the works, including a 30 m offset along the seaward perimeter, must be carried out at the following stages:

- a) For dredging works as per the Dredging Particular Technical Specifications
- b) In-survey before commencement of work

- c) Directly after rock underlayer placement and before CAU placement
- d) Out-survey directly after CAU placement

Hydrographic surveys must be carried out in accordance with the Hydrographic Surveys Generic Technical Specifications. Resolution must be sufficient to enable clear identification of individual armour units and rock boulders. Surveys must be planned for high tides to ensure maximum coverage up to a level of approximately -1 m CD. This will require tilting of the transducer to cover shallow areas.

6.4.3. Underwater video

The underwater inspections must be done using underwater video recording of the underwater side slopes of the seawall with suitable equipment, such as a video recording device mounted on the crane or a remotely operated vehicle (ROV). It is considered unlikely that wave conditions will allow safe diving at Port Elizabeth and therefore the Contractor needs to have alternative methods available for video recordings.

The date and time must be recorded on the video image and referenced to the location on the seawall.

The video survey recordings must be submitted to the Engineer for evaluation.

In addition to progress videos for areas where units are being placed, a complete video of the entire repair areas must be carried out:

- a) As soon as practical after Contract award
- b) On completion of all repair work

All underwater videos will require fair visibility and the Contractor must plan video recording accordingly.

6.4.4. As-built photographic records

Photographs must be taken as per the Drone Surveys Generic Technical Specifications.

7. TOLERANCES

7.1. Concrete armour units

7.1.1. Armour unit manufacture

Tolerances for the manufacture of the CAUs are given in the Seawall Armour Units Generic Technical Specifications.

7.1.2. Placement of armour units

The accuracy of placement of all armour units in the horizontal plane must be 0.5 m relative to their predetermined locations using the unit's centre of gravity to define its location.

Armour units must be placed to obtain optimum interlocking (where applicable). The placing density must be 95 percent to 105 percent of the theoretical packing density given in the drawings.

7.2. Rock

Tolerances are specified in the Rock Generic Technical Specifications.