

# TECHNICAL SPECIFICATIONS

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## COASTAL STRUCTURES PARTICULAR TECHNICAL SPECIFICATIONS

Project Name:

CONSTRUCTION OF THE MARINE WORKS FOR THE UPGRADE OF BREAKWATER (NEW DOLOSSES) PROJECT AT PORT OF RICHARDS BAY

Transnet Project Number:

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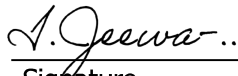
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# TECHNICAL SPECIFICATIONS

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## RICHARDS BAY BREAKWATER UPGRADE AND REPAIRS

### Coastal Structures Particular Technical Specifications

FEL 4

S2072-01-TS-CS-Rbay Spec coastal-001-R0

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## RICHARDS BAY BREAKWATER UPGRADE AND REPAIRS COASTAL STRUCTURES PARTICULAR TECHNICAL SPECIFICATIONS

FEL 4

### 1. SCOPE

#### 1.1 General

This specification contains clauses that are applicable to construction of the Richards Bay North and South Breakwaters, indicated on the drawings:

- 4126515-1-001-S-GA-0001-01 – General Arrangement
- 4126515-1-001-S-SE-0001-01 – South Breakwater Plan and Sections
- 4126515-1-001-S-DE-0001-01 – South Breakwater Demolition of Capping
- 4126515-1-001-S-SE-0002-01 – South Breakwater New Crane Base Plan and Sections
- 4126515-1-001-S-DE-0006-01 – South Breakwater Cap and Plinth Reinforcement Sheet 1
- 4126515-1-001-S-DE-0006-02 – South Breakwater Cap and Plinth Reinforcement Sheet 2
- 4126515-1-001-S-DE-0006-03 – South Breakwater Cap and Plinth Reinforcement Sheet 3
- 4126515-1-001-S-DE-0006-04 – South Breakwater Cap and Plinth Reinforcement Sheet 4
- 4126515-1-001-S-GA-0002-01 – North Breakwater General Layout
- 4126515-1-001-S-SE-0003-01 – North Breakwater Sections Ch320 to Ch450
- 4126515-1-001-S-SE-0004-01 – North Breakwater Sections Ch530 and Ch550
- 4126515-1-001-S-DE-0002-01 – North Breakwater Temporary Navigation Light Plinth
- 4126515-1-001-S-DE-0003-01 – 30t Dolos Unit
- 4126515-1-001-S-DE-0004-01 – 20t Dolos Unit
- 4126515-1-001-S-DE-0005-01 – 65t Antifer Unit

#### 1.2 Extent

The extent of the works is the Richards Bay South and North Breakwaters, as shown in the drawings.

### 2. INTERPRETATIONS

#### 2.1 Supporting specifications

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

- SABS 1200D
- Breakwater Armor Units Generic Technical Specification

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- Dredging Particular Technical Specification
- Hydrographic Surveys Generic Technical Specification

## 2.2 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 CAU.

Breakwater: A structure consisting of rock rubble and armoured with armourstone or concrete armour units (CAUs) constructed in the sea primarily to shelter marine facilities and coastal structures from waves.

CAU: Concrete Armour Unit.

Concrete Rubble: Concrete material sourced from demolished structures and utilised in the works according to specified gradings.

Core: Graded rock or concrete rubble forming the central bulk of the breakwater cross section.

Dolos: Precast concrete armour unit (CAU) forming the outer layer to the breakwater.

Engineer: To be interpreted as *Supervisor* or *Project Manager* depending on the context if the NEC conditions of contract are used.

Filter: Graded rock or concrete rubble 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.

Nivel Medio de Bajamares en Siciqias Ordinarias: Abbreviated as NMBSO. This level will be taken as 0.50 m above Mean Sea Level.

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.

Nominal layer thickness  $t$ : Theoretical layer thickness used to prepare design drawings and for the estimation of bulk volume of armour and underlayer.

Rock: Natural rock material imported from a quarry or sourced from demolished structures and utilized in the works according to specified gradings.

Tonne (abbreviated t): metric ton, 1000 kg.

Underlayer: Filter constructed with graded rock layers enclosing the core and supporting the armour.

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Unit: Individual piece of rock or CAU.

Wearing course: A course which has no internal structural function but protects the underlying course from wear and the ingress of water.

## 3. CONTRACTOR'S EQUIPMENT

### 3.1 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.

### 3.2 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.

The breakwaters, and specifically the south breakwater, can be overtopped during storms. The Contractor must ensure an efficient storm prediction approach is followed to avoid danger to personnel and equipment during storms.

### 3.3 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. Breakwater 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.

### 3.4 Nuisance and environmental control

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

### 3.5 Transportation

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

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## 4. MATERIALS, EQUIPMENT AND WORKMANSHIP

### 4.1 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:

- Health, Safety and Environmental method statement and risk assessment;
- Access to site, traffic management, and access control;
- Management of the site, with special emphasis on how the materials on site will be managed;
- Staged approach to demolishing the cap and constructing the new cap to minimize the period in which any part of the excavated crest is exposed to wave action;
- Removal of dolosse and rock in preparation of demolishing the south breakwater cap;
- Demolition and removal of the south breakwater cap;
- Temporary measures to protect demolished sections from wave attack;
- Staged approach to construction of the new south breakwater cap to minimize the period in which shutters are in position, reinforcing steel is fixed and the first concrete cast is completed;
- Production and testing of CAUs;
- Handling, stacking and transport of CAUs;
- Placement of CAUs, indicating how this ties in with other construction activities;
- Transport and placement of rock, indicating how this ties in with other construction activities;
- Quarry(ies) operation(s);
- Production, sorting, and testing of rock;
- Handling, stacking and transport of rock;
- Placement of rock;
- Storm management; and
- Dismantling the breakwater crane and moving it off the breakwater in case of an extreme storm event

### 4.2 Concrete armour units

#### 4.2.1 Concrete

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

#### 4.2.2 Production, transport, and stacking of CAUs

The following units are required:

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- 20 t dolos units;
- 30 t dolos units; and
- 65 t antifer units.

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

## 4.3 Rock

### 4.3.1 Rock for construction

The following rock gradings are required in the Works.

**Table 4-1: Underlayer rock: 1 t to 5 t.**

Grading class designation (kg)	Median Mass ( $M_{50}$ ) [kg]	ELL $y < 5\%$	NLL $0\% < y < 10\%$	NUL $70\% < y < 100\%$	EUL $97\% < y$
1 000 kg – 5 000 kg	2 600	1 000	1 300	3 300	5 000
Where y is the percent by weight lighter on the cumulative weight plot.					

**Table 4-2: Filter rock: 20 kg to 100 kg.**

Grading class designation (kg)	Median Mass ( $M_{50}$ ) [kg]	ELL $y < 2\%$	NLL $0\% < y < 10\%$	NUL $70\% < y < 100\%$	EUL $97\% < y$
20 kg – 100 kg	50	20	30	70	100
Where y is the percent by weight lighter on the cumulative weight plot.					

### 4.3.2 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.

### 4.3.3 Transport and stockpiling of armourstone

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

### 4.3.4 Rock placement

The rock underlayer must be constructed according to random placement as defined in the Rock Manual (CIRIA; CUR; CETMEF, 2007). In addition, bulk placement will be permitted for underlayer rocks provided that the coordinates of each dump location is recorded.

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Filter rock placement and shaping must be done by excavator to ensure the required tolerance on surface profile is met.

#### 4.3.5 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 be 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 (m<sup>3</sup>) 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.

#### 4.3.6 Armour layer thickness and quantities

The design assumes a layer thickness coefficient of approximately 0.87, 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)

$\rho_s$  = armourstone density (t/m<sup>3</sup>)

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.

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## 5. EXECUTION

### 5.1 South breakwater capping

The existing south breakwater capping is too narrow to fit the crane required for the works. Therefore, the contractor must demolish the end of the existing capping and construct a new concrete slab that has been designed to provide a wider and more stable working platform for the crane operations.

#### 5.1.1 Demolition of the south breakwater capping

The demolition will require the contractor to carry out the following:

- Demolish approximately 36m of existing reinforced concrete capping and dispose
  - Demolished concrete is to be removed and placed at **the toe of the breakwater** outside the area to be dredged. The planned area is to be submitted by the Contractor for acceptance by the Project Manager/Supervisor.
  - Concrete blocks that contain reinforcement and heavy steel sections must have these protruding steel sections cut flush with the concrete surface prior to disposal.
- Remove dolos units surrounding the capping in area where new capping will be constructed, as indicated on the drawings. All dolos units that are undamaged and suitable for re-use should be stockpiled and re-used. All units not suitable for re-use should be disposed of as indicated for demolished concrete.
- **Include for removal of an existing blinding layer (separate from 1-5t rock) between the capping wall and the 1-5 t underlayer rock. If approved, this rock may be re-used as part of the new 1-5 t underlayer rock, alternatively it can be disposed of as indicated for demolished concrete.**
- Excavate existing underlayer rock (1-5 t) down to a level of +1.6m CD below footprint of new cap and temporarily stockpile rock for re-use.

Staged demolition of the breakwater cap needs to be considered to ensure maximum protection for casting of the new breakwater cap. This will also assist with access to the area where the new cap is to be constructed.

#### 5.1.2 Construction of new south breakwater capping

The contractor must construct the new capping as indicated on the drawings and as specified in the Concrete Works (Structural) For Marine Works Technical Specifications. In addition, the capping should comply with the following, as indicated on the drawings:

- Concrete strength grade C30/19
- Minimum concrete cover 75 mm
- 50 x 50 mm chamfer to all exposed edges

Since the bottom layer of the cap can be exposed to wave action at high tides, it is important to plan temporary protection against overtopping waves that could damage shuttering and preparations for concrete



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casting. In addition, the operation should be well planned to minimize the period of exposure and getting the first layer of concrete cast soon after placing the shutter.

Staged construction will be required to assist with rapid placement of reinforcement and casting of concrete. Once the initial layer of concrete is cast the risk of damage due to wave action reduces and future stages of constructing the cap will be less critical.

Shuttering for rock and the mass concrete layer may be left in place if approved by the Project Manager/Supervisor.

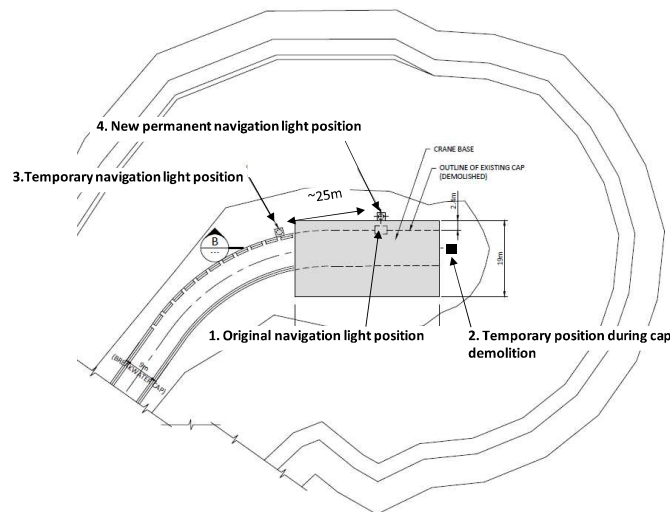
## 5.2 Relocation of navigation lights

To avoid damage during construction, the existing navigation lights at the end of each breakwater need to be temporarily moved.

### 5.2.1 South breakwater navigation light

The contractor must relocate the south breakwater navigation light as indicated in the sequence below:

1. Preconstruction position
2. During cap demolition with no crane. Duration ~14 weeks.
3. Temporary position once crane is in position. Crane to be well lit. Duration ~ 52 weeks.
4. New permanent position post breakwater repair



**Figure 5-1: South breakwater temporary navigation light sequencing.**

Further details on the navigation light plinths is provided in the drawings. The contractor shall be responsible for the temporary relocation of the navigation lights and their associated plinths as part of their temporary works requirements. **However, guidance has been given for the plinth design in the drawings.** The contractor shall be responsible for the electrical supply to the temporary and permanent plinths.

The contractor must comply with the following requirements for the navigation light fasteners, as indicated on the drawings:

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1. All structural fasteners (bolts, nuts and washers) shall be in accordance with EN 14399.
2. Hot dip galvanising of fasteners shall be in accordance with ISO 10684.
3. Hot dip galvanising of structural steel shall be in accordance with iso 1461 (SANS 121) and ISO 14713-2.
4. All structural fasteners shall be hot dip galvanised by the centrifuging process to a local coating thickness (min) of 160  $\mu\text{m}$  and a mean coating thickness (min) of 175  $\mu\text{m}$  respectively.
5. All hot dip galvanised nuts shall be over-tapped after galvanising, in accordance with the specified limits of size and tolerances given in ISO 965-5.
6. Bolt external screw threads shall conform to maximum size of tolerance position 'h' before galvanising.
7. Nut internal screw threads shall be tapped with tolerance position 'h' or 'g' after galvanising.
8. All bolts shall be in accordance with ISO 898-1 and external threads with ISO 965-4.
9. All nuts shall be in accordance with ISO 898-2 and internal threads with ISO 965-5.
10. All anchor bolt thread undercut, lead-in and runout shall be in accordance with ISO standards.
11. All hot dip galvanised bolts and nuts shall be supplied as assembled sets with matched bolt and nut thread pairs.
12. External thread protrusions and nuts shall be assembled with an anti-corrosive thread lubricant, Molykote P37 paste or similar approved.
13. Anchor bolts and nuts shall be installed and tightened in accordance with an approved procedure for controlled torque tightening, according to the recommendations in the SAISC Red Book.
14. Tightening torque values shall be determined in accordance with the specified bolt preload and the friction coefficient for the thread lubricant. The contractor shall provide proof of calibration for the torque wrenches used.
15. Design bolt preload shall be 100 kN. Minimum torque shall be 300 N.m.

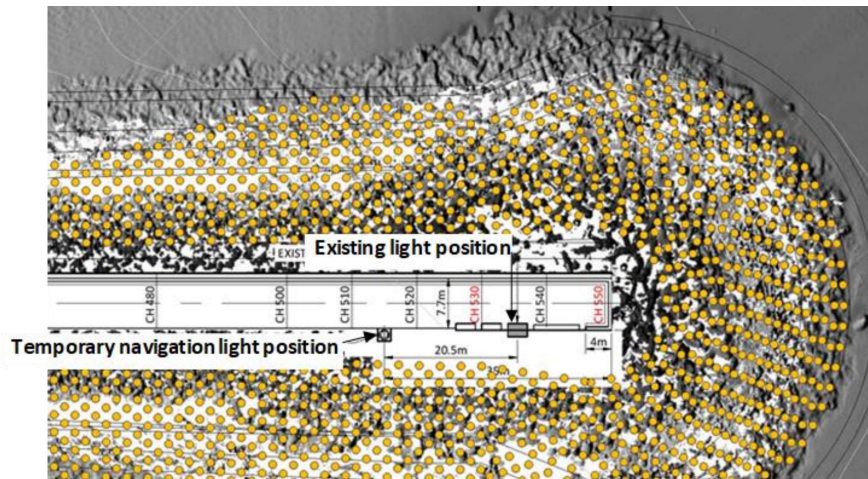
The contractor must comply with the following requirements for the starter bars, as indicated on the drawings:

1. Starter bars for the temporary navigation light plinth connection to be grouted using Sikagrout 212 or similar approved. Drilling and reinforcement installation shall be in accordance with the manufacturer's recommendation.

## 5.2.2 North breakwater navigation light

The contractor must temporarily relocate the navigation light as indicated in Figure 5-2 and on the drawings. Once the project is navigation light must be reinstated to its original position. The contractor shall be responsible for the temporary relocation of the navigation lights and their associated plinths as part of their temporary works requirements.

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**Figure 5-2: North breakwater temporary navigation light position.**

## 5.3 Concrete armour units

### 5.3.1 General

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

#### 5.3.1.1 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.

### 5.3.2 Handling and placing of armour units

CAUs must be placed at slope packing densities as specified in Table 5-1. 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 5-3 and Figure 5-4.

The value of  $x$  can be calculated as:

$$x = 20.5 n^{-0.5}, \text{ for a double layer square grid (Figure 5-3)}$$

where  $n$  is the number of units per  $m^2$

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

For staggered grid placement each layer is placed separately, and  $x$  can be calculated as:

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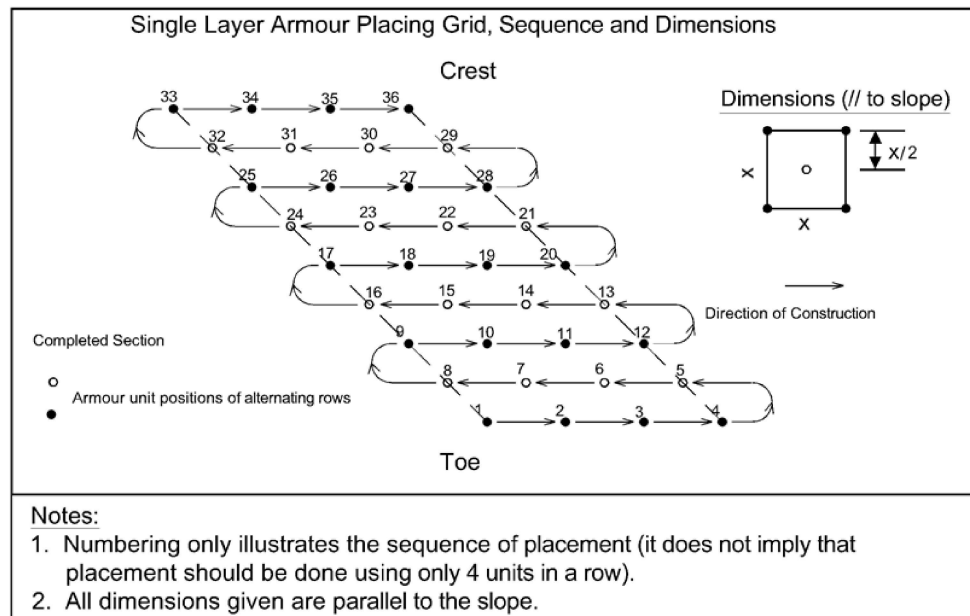
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$$x = 2 n^{-0.5}, \text{ for each layer (Figure 5-4)}$$

Figure 5-3 and Figure 5-4 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 30 t dolosse must be placed to form a smooth transition between the 65 t Antiflers and existing structure as per the drawings. It should be noted that the quantity of 30 t dolosse required is uncertain.



**Figure 5-3: Example of a theoretical armour placing grid, sequence and theoretical armour spacing per layer (staggered grid).**

**Two layers of 65 t Antiflers are placed on top of each other using this placement grid.**

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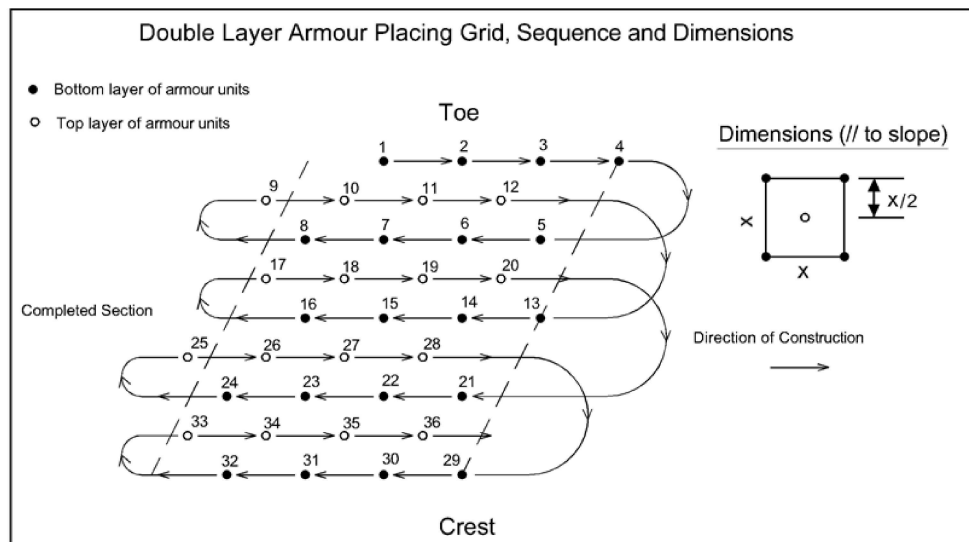


Figure 5-4: Example of a theoretical armour placing grid, sequence and theoretical armour spacing (double dolos layer square grid placed as a single operation).

Table 5-1 lists the grid placement dimension for the various armour types.

Table 5-1: Armour unit packing density and grid spacing.

Armour type	Placement method	Mass	Nominal diameter ( $D_n$ )	Waist ratio ( $w_r$ )	Packing density parameter ( $\phi$ )	Layer thickness (t)	Grid placement dimension (x)	Packing density (per slope area)
-	-	t	m	-	-	m	m	units/m <sup>2</sup>
Dolos	Square	20	2.027	0.34	0.8	3.7	3.206	0.195
Dolos	Square	30	2.321	0.36	1	5.0	3.282	0.186
Antifer	Staggered	65	3.003	-	1.17	6.6	5.553	0.130

Concrete armour units which only meet “Acceptance Grade 2 quality levels for placement in designated zones”, as identified in the Breakwater Armour Units Generic Specifications, may only be placed within the designated placement zones shown in Table 5-2.

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Table 5-2: Designated placement zones for Acceptance Grade 2 armour units.

Armour unit type	Designated placement zone
20 t dolos	Structure toe <sup>(1)</sup>
30 t dolos	Lower than –8 m CD
65t antifer	Lower than –8 m CD

<sup>(1)</sup> The toe is defined here as the last row on sea-side dolos units

## 5.3.3 Surveys

The CAU armour layer must be inspected visually above (Section 5.6.4 Photographic records) and below water (Section 5.6.3 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.

## 5.4 Rock

### 5.4.1 General

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

#### 5.4.1.1 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.

#### 5.4.1.2 Sequence of works

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

### 5.4.2 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.

### 5.4.3 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.

*Note: In all cases check against online version for the latest revision prior to use*

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## 5.5 Dredging

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

## 5.6 Surveys

### 5.6.1 Drone survey

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

- In-survey
- Directly after rock underlayer placement and before CAU placement
- Out-survey directly after CAU placement

Drone surveys must be carried out as per the Drone Surveys Generic Technical Specifications.

### 5.6.2 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:

- For dredging works as per the Dredging Particular Technical Specifications
- In-survey before commencement of work
- Directly after rock underlayer placement and before CAU placement
- 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.

### 5.6.3 Underwater video

The underwater inspections must be done using underwater video recording of the underwater side slopes of the breakwaters 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 Richards Bay 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 breakwater.

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:

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

# TECHNICAL SPECIFICATIONS

*Note: In all cases check against online version for the latest revision prior to use*

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

## 5.6.4 As-built photographic records

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

## 6. TOLERANCES

### 6.1 Concrete armour units

#### 6.1.1 Armour unit manufacture

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

#### 6.1.2 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.

### 6.2 Rock

#### 6.2.1 Placement of rock layers

Tolerances are specified in the Rock Generic Technical Specifications.