TECHNICAL SPECIFICATIONS

1 BREAKWATERS AND REVETMENTS

1.1 Scope of Works

The works specified in this Chapter of the Specifications compromises the construction of Breakwaters and revetments.

The works include supply or dredging of all materials required. According to Drawings, the specifications and the instructions from the Employer the Contractor shall furnish all materials, equipment, tools, and labour which are required for the construction, testing, measurement and completion of the works.

1.2 References

The following Standards and Codes of Practice are referred to in this specification:

Designation	Title of Standards/Codes of Practice
BS 812 Parts 100-103	Sampling and Testing of Mineral Aggregates, Sand and Fillers
BS 6349 Part 1, Part 2	Maritime Structures
ISO 5081	Textiles- Woven Fabrics – Determination of Breaking Strength and Elongation (Strip Method)
CEM	Coastal Engineering Manual. U.S. Army Crops of Engineers.

1.3 Materials

1.3.1 General

All stone materials specified in the following as stone class I, II and III shall be of granite, basalt or equal igneous rock. The material shall have an apparent specific gravity of not less than 26KN/m3 with 90% of the stones having a density of at least 25KN/m3 when saturated and surface dry, according to BS 812.

The average water absorption of quarry stone must be less than 2% and the water absorption of nine of the individual stones less than 2.5%.

The loss for magnesium sulphate soundness test must be less than 12% for all rock.
Deleterious secondary minerals shall not be present. For all rock types, this is taken to be indicated by Methylene Blue absorption values of less than (0.7 g/100g).

Average point load index in the planar direction of the most pronounced layering should any visible anisotropy exist and for sampling, testing and reporting in accordance with the ISRM 1986

recommended method must be at least 4.0 Mpa with the average minus the standard deviation of the point load index of at least 3.0 Mpa.

The mill abrasion resistance index must be less than 0.004.

Quarried rock shall not contain visually observable or chemically detectable impurities or foreign matters in such quantities that these are damaging for the constructive application of the quarried stone or for the environment in which the quarried stone is applied.

All stone materials specified in the following as stone class IV, V, VI and VII may as an alternative to the above mentioned rock be obtained from sound coral rock or beach rock. The material shall have an apparent specific gravity of not less than 24KN/m3 when saturated and surface dry.

The stone materials shall be sound, compact, hard, durable and resistant to action of seawater and free of cracks and fissures determined for the proper performance of the material in quest on.

All fill material shall be dredge and stored to suit the specific demands in the structure.

1.3.2 Source of Stone Materials

The contractor shall select the source or sources of rock and shall be responsible for quarrying, supply and transport to the Site of suitable rock in sufficient quantities.
The suitability of the source or sources of rock selected by the Contractor shall be subject to the approval of the Employer. Approval of the quarry is only supplementary to other requirement of the rock.

The Contractor shall submit for the approval of the Employer an experiences geologist's determination of the type of stones based on visual inspection of 10 respective samples.
The coral rock or beach rock dredged may be used for stone classes IV, V, VI and VII if the testing shows it comply with these specifications.

1.3.3 Classification of Stone Materials

Armour layer in the break waters and filters overlaying sand fill and unspecified coral rock fill shall be constructed from the following stone classes specifying the minimum mean weight (or size) and the lower and the upper limit.

Granite:

I: Weight range: 2t to 8t
Mean weight: Min. 4t
II: Weight range: 1t to 4t
Mean weight: Min. 2t
III: Weight range: 350 kg to 1400 kg
Mean weight: 700 kg.
Granite or coral rocks.
IV: Weight range: 100 kg to 400 kg
Mean weight: 200 kg
V (filter): 150 – 300 mm
VI (filter): 75 – 150 mm
VII (filter): 50 – 100 mm

Stone materials shall be well graded between the specified limit and comply with the following filter criteria

$$d_{85} \geq D_{15}/4$$

$$d_{15} \geq D_{15}/7$$

$$d_{50} \geq D_{50}/7$$

In which d represents the finer material and D represents the coarser material.
D_{nn} means that nn% of the material by weight passes a sieve having a square mesh width of D.

For stones used as armour stones or filter stones the following additional requirements shall apply:

- The stones shall be rough and angular in shape
- The maximum stone dimension (length) shall not exceed 2.5 times the minimum dimension (thickness) of the stone.

1.4 Testing of Materials

Inspection and testing of rock materials shall be carried out as an integral part of the Contractor's quality control programme with the objective to ensure the quality of all parts of the work. The requirement in the following subsection shall be understood as minimum requirements. Extended testing of properties shall always be when opening new quarry fronts and in connection with any significant change in the material properties from an existing quarry front.

The test specifications given in the following subsections shall be understood as 'State of art' specifications. Other test standards may, subject to the Engineers acceptance, be introduced for compliance with the Contractor's test procedures or procedures used by existing procedures. Test procedures related to possible stockpiling of rock materials near the construction site and in connection with placement of materials in the permanent works are not covered by this section of the Specification.

1.4.1 Basic Procedures

From each quarry front the following properties shall be tested and fully documented prior to commencement of any production, in connection with any significant change of materials in the opinion of the engineer and as a minimum for every 5 000 m3 of delivery (all classifications) from the quarry front should be tested for the following:

- density
- water absorption
- resistance to weathering
- resistance to impact
- resistance to abrasion

The tests shall be carried out in accordance with the test specification accepted by the Engineer.

1.4.2 Testing of Stone Weights and Stone Gradation

The Contractor shall at any time during working hours at the direction of the Engineer carry out test weighing of stones and the determination of the gradation of stones as indicated below:

Stone Class I, II and III

Test weighing of armour stones will be carried out at random. The Contractor shall include in his unit prices one control weighing per 80m3 of armour stones. Stones which do not meet the weight requirements shall not count.

Stone Class IV and V

A test of the weight distribution of stone classes IV and V will be carried out on a representative sample of not less than 3.0 m3 which is spread out on a clean, hard surface (e.g. a floor of wooden boards or a concrete floor) provided by the Contractor. The Engineer

selects 10 largest and the 20 smallest stones are then weighed/measured individually. The remaining stones are then weighed and counted and the mean weight determined.
The Contractor shall include in his unit prices the cost of one weight distribution test as the one described above per 1 000 m3 of stones. Tests which do not meet the requirements shall not be counted.

Stone Classes VI and VII
A test of the weight distribution of the stones in classes VI and VII shall be carried out as described under Stone Classes IV and V above, except the sample shall not be less than 1.5 m3.

1.4.3 Testing of Coral Rock and Beach Rock Durability

One durability test shall be made for each 1 000 m3 of coral rock and beach rock to be used as Stone Classes IV, V, VI and VII.
The test result shall be made available for the Engineer's immediate approval.

1.5 Workmanship

1.5.1 Placing of Stone Materials

Placing of stones shall take place in a manner which will not damage the under laying layers of stones. When placing stones up to a theoretical boundary as defined by lines in the cross sections the Drawing, the Contractor shall aim at having the stones protrude the theoretical boundary over one third of its area.

The construction of rubble mound structures must be planned and carried out with due regard to the weather and sea conditions. The responsibility for the stability of the breakwaters and revetments under the various stages of completion rests solely with Contractor.

Construction of filters shall not commence prior to the Engineer's acceptance of the fill and the filter materials. The responsibility for the stability and integrity of the breakwaters and revetments under the various stages of completion tests solely with Contractor. To protect the structures against the wave action the Contractor shall place a shield of stone material in front of the structures. The individual filter layers shall be built up and trimmed from the bottom in such a manner, that the underlying layer is completed before commencing the overlying layer. The filter materials shall be placed with caution in order to ensure that the underlying layers already completed will not by disturbed. All materials shall be placed and compacted firmly in such a manner that the filter materials will remain fixed at the site.

1.5.2 Amour Stones

When completed the armour layer shall be in a thoroughly stable condition and with the exposed surfaces reasonably uniform in appearance.

Haphazard dumping of armour stones will not be permitted. Above level of –0.5m armour stones shall be carefully place by crane. Below this level armour stones – one piece at the time- may be dumped at the waterline immediately over their final position and care shall be taken to produce as dense and stable layer as possible.

Elongated stones shall be placed with their long axis perpendicular to the slope.

Voids in armour layers shall not be filled with small rocks.

1.5.3 Other Stones and Core Material

All materials not forming part of the armour layers may be dumped, but undue segregation shall be prevented.

1.6 Tolerances

At the time for completion the following tolerances shall be respected unless otherwise indicated or directed by the Engineer.

Slope of core/fill	±0.1
Filter layer, thickness of individual layer	+100/-50 mm

The surface of each layer shall be levelled before construction of the next layer in order to ensure that excess thickness of one layer shall not reduce the thickness of the next beyond the tolerance above.