**8 TECHNICAL SPECIFICATION**

# DREDGING AND EARTHWORKS

**Scope of Works**

The dredging works consists of excavation of sand below the existing seabed regardless of the nature of the materials encountered during the course of dredging.

The works include supply of all materials and the provision of all labour, plant and equipment required for the actual dredging, reclamation and other reuse of dredged material as well as for all preparatory works, surveys and testing required for the proper execution and completion of the works. In addition the works shall include all required measures for reduction of the environmental impact of the dredging and be included in the Contractors Environmental Control Programme

* 1. **References**

The following Standards and Codes of Practice are referred to in this specification and fully or partly incorporated herein as specified:

Designation Title of Standards/Code of Practice

BS 812 Sampling and Testing of Mineral Aggregates, Sand and Fillers

BS 6349, Part 5 Maritime structures. Code of Practice for dredging and land reclamation

CIRIA/CUR: Manual on the use of rock in coastal and shoreline engineering. Report no. 83/154

CEM Coastal Engineering Manual. U.S. Army Crops of Engineers.

* 1. **Utilization of Dredged Material**

Fill is required for reclamation. Graded variations of the dredged materials may be reused subject to the approval by the Engineer.

No materials from the dredging shall be dumped at open sea unless approved by the Employer.

All suitable material removed from the dredging areas shall, subject to the approval by the Engineer mainly be used for reclamation or, either be initially sorted by excavator and manual labour or by means of a grizzly plant and/or hauled to a stockpile for screening, or shall be used for reclamation, sub-grade for paving work, backfill for structures, or for other purposes shown on the drawings and / or specifications or as directed. Materials which are otherwise suitable but contain excess moisture shall be processed and utilized for fill.

Material from the dredging determined by the Engineer as suitable for slope protection in revetments, filter or core material or other purposes shall be conserved and utilized as directed.

Materials from the dredging determined by the Engineer to be unsuitable for use in the Works shall be disposed of at the designated disposal areas or other areas approved by the Engineer. Unless otherwise specified, compaction will not be required. However, the materials taken to disposal areas shall be levelled and shaped attractively to the approval by the Engineer.

All excess material shall be delivered for other utilization on the island or disposed of as directed. It is the Contractor’s responsibility to determine if sufficient material is available for the completion of the works before delivering or disposing of any materials. Any shortage of suitable materials for completion of the work caused by premature disposal of materials by the Contractor shall be replaced by the Contractor at no cost to Employer.

* 1. **Materials**

The specific gravity of the coral sand may be ranging from 15 to 26 kn/m3. Actual geotechnical parameters including specific gravity and density of dredged materials shall be verified according to the function of the materials used in the structures and the specified quality requirements. Fill and backfill shall consist of selected coral aggregate and sand surplus from the dredging operation and complying with Highway Works, clause 804 Granular Subbase Material Type 2.

* 1. **Testing of Materials**

Testing will be required when the dredged material is used for the reclamation. This testing shall provide sufficient documentation of the material quality and ensure fulfilment of all requirements specified for the material when used in the actual structures.

* 1. **Workmanship**
     1. *Setting out of Dredging Works*

All boundaries of dredging areas shall be established on the site by installation of markers in the appropriate reference lines or electronically established subject to the Engineer’s approval.

Markers shall be robust and clearly visible from all parts of the dredging area.

All setting out of dredging works shall be carried out by the Contractor.

* + 1. *Execution of Dredging*

All dredging works and earthworks shall be carried out in compliance with the criteria and environmental mitigating measures outlined in Section 8.2.

Prior to dredging or disposal of materials in any area, such area shall be cleared and its surface level shall be surveyed in the presence of the Engineer.

The survey shall be detailed sufficiently for the recording of any major irregularities in the surveyed surface.

No separate payments would be made for dredging the edge slopes. This dredging is deemed included in the contract price (shown on drawings and / or specifications).

Prior to any dredging and reclamation works, the Contractor shall submit and get the approval from the engineer for a detail dredging and reclamation plan including plant details, discharge and handling methods and mitigation measures to meet the requirements specified in section 02. The Contractor shall notify the Engineer min. 48 hours in advance of dredging or disposal of materials in any area.

Dredging shall be carried out by using a Trailer Suction Hopper Dredger, or other dredging equipment with sufficient capacity.

The Contractor’s method and sequence of dredging and reclamation shall be such that localised deterioration of water quality is kept to a minimum. And the Contractor is responsible for undertaking at his own cost, all appropriate mitigation measures deemed necessary to protect the environment.

The supply, placement and compaction of fill and backfill shall be in accordance with the Specification for Highway Works: 1994 – Department of Transport, London.

Placement and compaction of fill and backfill shall be in accordance with clauses 801 and 802.

Unless otherwise permitted, fill and backfill materials from dredging work shall contain no organic or other deleterious matter. The contractor shall ensure that the reclamation is free from accumulation of fines, including pockets of silt. Rock or other solid matter may be placed in a reclamation area subject to the Engineer’s approval.

For reclamation below seawater level, dredged materials shall be placed directly in reclamation areas. Large pieces of coral deposited in reclamation areas shall be spread over the full width of the reclamation area with sufficient small coral pieces or other fine material used to fill the voids in order to produce a dense, compact reclamation.

For reclamation above the seawater level, coral material shall be placed in level, horizontal layers not exceeding 0.3 meter (loose measurement) thick and be compacted before the next layer is placed. Effective spreading equipment shall be used on each lift to obtain a uniform thickness prior to compacting.

As the compaction of each layer progresses, levelling and adjustments shall be performed continuously to ensure uniform density.

Material containing more than 25 per cent of large pieces of coral with the greatest diameter of more than 150 mm, and which cannot be placed in layers of the prescribed thickness without crushing, pulverizing or further breaking down the pieces, shall be removed and used for some other purpose.

* 1. **Tolerances**

Dredging shall be carried out to the designated depths in all parts of dredging areas with a maximum permissible over dredging of 0.3 m below the specified level (Maximum Depth) unless noted otherwise by or as agreed with the Engineer.

Excess dredging below Maximum Depth of 2.0m below sea bed is not accepted unless approved by the Engineer and shall be replaced by suitable material at no cost to the Employer.

The tolerances relative to the Specified Depth for dredging in general is

+0 mm to 200 mm.

The natural profile of slopes resulting from the dredging has in general been indicated as 1:3 reflecting the expected result of dredging in sand and gravel exposed to moderate wave impact only.

The tolerance on the levels of the land reclamation fill is –100 mm to +100 mm.

**Loss of material in the fill area**

The Contractor shall allow, in the Contract Sum, for any loss of fill material, which may occur during the course of the works, including but not limited to erosion and losses due to settlement. No claims for payment for filling other than in accordance with the specifications and in the Bills of Quantities will be allowed.

* 1. **Inspection**
     1. *General*

The Contractor shall, prior to commencement and after completion of dredging works carry out surveys of the respective areas (in-survey and out-survey)

* + 1. *In-survey of Existing Bottom or Ground*

An area covering the entire working area, bid document shall be surveyed in the presence of the Engineers representative. Maps and “raw” data shall be submitted to the Engineer not later than one week after the scheduled execution of the in-survey. If the contractor fails to carry out this survey before the commencement of dredging operations (ANY DREDGING OR EXCAVATION WORKS) it would be deemed that the contractor accepts the survey information given and as such any in-surveys carried out would not be accepted.

* + 1. *Inspection after Completion*

Before the Work is handed over, an out-survey shall be made covering the entire working area.

The verification of slopes shall be made by soundings. Maps and “raw” data shall be submitted to the Engineer not later than two weeks after the execution of the respective survey.

# ENVIRONMENTAL REQUIREMENTS

It is the contractors’ requirement to undertake environmental monitoring during the construction stage of the project. Monitoring shall be carried out on a monthly basis and a single report should be produced at the completion of the physical works in each island.

The contractor shall follow all Environmental laws and regulations of Maldives in design and during implementation of the project, specifically the following

* Dredging and Reclamation Regulation 2013
* Environment Impact Assessment Regulation 2012.

The contractor shall specifically ensure that each area of reclamation is properly bunded before reclamation commences.

* 1. **BREAKWATERS AND REVETMENTS**

# Scope of Works

The works specified in this Chapter of the Specifications compromises the construction of rubble mound 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.

# 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)

Highway Works Manual of Contract Documents fro Highway Works, Volume 1 – Specifications for Highway Works, August 1994, The Department of Transport, The Stationary Office, UK (abbreviated as ‘Highway Works’)

CIRIA/CUR: Manual on the use of rock in coastal and shoreline engineering, Report no. 83/154

BS EN 13253:2001 Geotextiles and geotextile-related products Ð Characteristics required for use in erosion control works (coastal protection, bank revetments)

CEM Coastal Engineering Manual. U.S. Army Crops of Engineers.

**Materials**

### *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.

*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.

*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 crite







In which d represents the finer material an D represents the coarser material.

Dnn 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.

# 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.

# *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.

# *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 Contarctor. 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.

# *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.

# Workmanship

# *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.

*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.

# *Other Stones and Core Material*

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

**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.