

Specifications

Technical Specifications for construction of Official Jetty at Kulhudhuffushi City

CONCRETE WORKS

1 Concrete formwork

1 : General

1.1 Description

This section covers formwork for all concrete.

All forms shall be accurately and properly placed and finished, so that concrete may be placed as indicated on the Approved Design Drawings, the Approved Shop Drawings and as specified. The forms shall produce a smooth concrete finish, free from offsets, or irregularities.

1.1.1 Coordination.

Work performed, and materials used, in conjunction with formwork, for concrete, shall be coordinated with work under the Concrete Works Section.

1.2 Applicable Codes and Standards:

The Codes and Standards, generally applicable to the work under this section, are listed. Codes and Standards current at the time of bid shall be used. In case of contradictions between different standards, the BS shall prevail.

- | | | |
|------------|---|--|
| 1.2.1 DIN | - | Deutches Institute fur Normung
DIN 1045 |
| 1.2.2 BSI | - | British Standard Institute |
| 1.2.3 ASTM | - | American society for Testing and Materials |

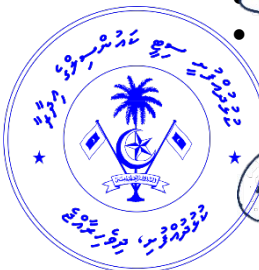
2 : Products

2.1 Materials:

2.1.1 Material List.

Material used shall be:

- Forms
- Steel - Straight, uniform and free of surface defects.
- Plywood - Product Standard PS 1, Waterproof, resin-bonded.
- Lumber - Straight, uniform width and thickness, and free from knots, offsets, holes, dents, and other surface defects.
- Chamfer Strips - Clear lumber, surface against concrete planed.
- Form Coating - Single component, pigmented copolymer resin type, applied in accordance with the manufacturer's recommendations.



2.2 Design Criteria:

Forms, for cast in place or precast concrete, shall be designed to produce hardened concrete, having the shape, lines, and dimensions indicated on the approved Drawings. For all structures, forms for surfaces shall be prefabricated plywood panel forms, steel, or forms that are lined with plywood of fibreboard. Forms for exposed surfaces shall be laid out in a regular and uniform pattern, and all joints aligned. The forms shall produce finished surface that are free from offsets, ridges, waves, and concave, or convex areas, the maximum deviation from a true plane shall not exceed 3mm in 2m.

Formwork shall be constructed to attain the required surface texture of the structures and to be such accuracy, strength and rigidity as to carry the weight and pressure from the concrete to be placed without any deformation, and remaining grout tight during the placing and setting of concrete. When required by engineer, joints between shutter facing boards shall be sealed with foam rubber, sealing strips or other approved material.

Formwork shall be sufficiently rigid so as to prevent any grout loss during concreting and shall not distort due to environmental effects and concreting operations so that member dimensions, shape, required finish and texture are within the tolerances specified. Walers, studs, internal ties, and other form supports shall be sized and spaced so that acceptable working stresses are not exceeded. Plywood or lined forms will not be required for surface of concrete not required to fair faced.

Wherever the top of a wall will be exposed to weathering, the forms on at least one side shall not extend above the top of the wall, and shall be brought to true line and grade. At other locations, forms for concrete, which is to be finished to a specified elevation, slope, or contour, shall be brought to a true line grade; otherwise, or a wooden guide strip shall be provided at the proper location on the forms so that the top surface can be finished with a screed or template. At horizontal construction joints in walls, the forms on one side shall not extend more than 0.6 meters above the joint.

Temporary openings shall be provided at the bottom of wall forms and at other points, where necessary, to facilitate cleaning and inspection.

Face of framework shall be free of projecting nails, adhering grout and other imperfections or defects which would prevent the specified surface finish from being attained. Before each concreting operation is commenced, form work shall be carefully examined and cleaned out and the concrete contact faces of the works shall be treated with an approved release agent comes in contact with reinforcement.

Forms for all exposed surfaces shall be constructed of plywood, metal or glass reinforced plastics at the option of the Contractor.

No concreting shall commence until the Engineer has inspected and approved the erected formwork. Shooting height of concrete shall not be greater than 2 meters. The formwork shall be designed accordingly.

2.2.1 Form Ties.

Forms ties shall be of the removable or permanently embedded body type, and shall have sufficient strength and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders. Cones, for the permanent embedded type shall be provided on the outer ends of each tie and the permanently embedded portion shall



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be at least 25mm back from adjacent outer concrete faces shall not be nearer the surface than the specified thickness of cover to the reinforcement.

Form ties for indirect titch with water walls, shall be provided with water seal washers located on the permanently embedded portions of form ties, and approximately at the centre of the wall. Permanently embedded portions of form ties, which are not provided with threaded ends, shall be constructed so that the removable ends are readily broken off without damage to the concrete. The type of form ties used shall be acceptable to the Engineer.

Form ties in exposed surface shall be uniformly spaced and aligned in horizontal and vertical rows.

2.2.2 Edges and Corners.

Chamfer strips shall be placed in forms to bevel all salient edges and corners, for all vertical and horizontal corners, unless specifically shown otherwise on the Approved Drawings. Unless otherwise noted, bevels shall be 25mm wide.

2.3 Formed Surfaces – Class of Finish:

Finishes to formed concrete surfaces shall be classified as F1, F2, or F3. Where the class of finish is not specified, the concrete shall be finished to class F2. All reinforced concrete shall have a F AIR-F ACED finishing. Concrete surfaces for the various classes of formed finishes specified, shall comply with the tolerances shown in Table 1.

TABLE 1: MAXIMUM TOLERANCE (mm)

<i>Class of Finish</i>	<i>Line and Level</i>	<i>Abrupt Irregularity</i>	<i>Gradual Irregularity</i>	<i>Dimension</i>
F1	-15 to +15	5	5	+15 to -5
F2	-5 to +5	5	5	+15 to -5
F3	-5 to +5	0	5	- 5 to +5

In Table 1, “Line and level” and “Dimension” shall mean the lines, levels, and cross-sectional dimensions indicated on the drawings.

Surface irregularities shall be classified as “abrupt” or “gradual”.

Abrupt irregularities shall be tested by direct measurement. They include, but are not limited to, offsets and fins caused by displaced or misplaced formwork, and loose knots and other defects in formwork materials.

Gradual irregularities shall be tested by means of a 1.5 meter length straight template, for plane surfaces, or its suitable equivalent for curved surface.

2.3.1 Class F3.

Formwork for class F3 finish shall be lined with panels of non-staining material, with a smooth unblemished surface, such as sand plywood, or hard compressed fibre-board. The panels shall be as large as possible, and shall be arranged in a uniform acceptable pattern, and fixed to the back of formwork by oval nails. Unfaced wrought boarding or standard steel panels shall not be permitted.

2.3.2 Class F2.

Formwork for class F2 finish shall be faced with wrought tongue and groove boards, plywood or metal panels arranged in a uniform acceptable pattern, free from defects likely to detract from the appearance of the surface.



2.3.3 Class F1.

Formwork for class F1 finish shall be constructed of timber, sheet metal, or any suitable material which will prevent loss of grout when the concrete is vibrated. Surfaces, subsequently to be rendered, plastered, or tiled shall be adequately scabbled, or roughened, as soon as the formwork is removed to reduce the irregularities to no more than half the thickness of such rendering, plastering, or bedding for tiles, and to provide a satisfactory key.

3 : Products

3.1 Inspection:

3.1.1 Preplacement Inspection.

Prior to rigidly securing all forms, reinforcement, anchor bolts, and embedded parts in their proper position, all dirt, mud, water, and debris shall be removed from the space to be occupied by concrete and all surfaces encrusted with dried concrete from previous placement operations shall be cleaned.

3.2 Installation:

3.2.1 Execution.

Forms shall be constructed to ensure that the finished concrete members will have true surfaces free of offset, waviness, or bulges, and will conform to the indicated shapes, dimensions, lines, elevations, and positions, within the specified tolerances. For the pre-cast units the Contractor shall prepare and submit to the Engineer for approval.

5.2 Concrete reinforcement

1 : General

1.1 Description

This section covers steel reinforcement, for all concrete.

The contractor shall provide all bars, bar supports, ties, spacers, bolsters, inserts, screeds, and other accessories required to maintain fabricated reinforcement in its proper position, and permit proper placement of concrete.

1.1.1 Coordination.

All reinforcing material and work shall be coordinated with related work specified in the Cast-in-Place Concrete Section.

A. Work Specified Elsewhere:

Other items of work that relate to and are referenced in this section include, but are not limited to the requirement shown.



1.2 Applicable Codes and Standards:

The Codes and Standards, generally applicable to the work under this section, are listed. Codes and Standards current at the time of bid shall be used. In case of contradictions between different standards, the British Code Standard shall prevail.

- 1.2.1 DIN - Deutsches Institut für Normung
DIN 1045
- 1.2.2 BSI - British Standard Institute
- 1.2.3 ASTM - American society for Testing and Materials
- 1.2.4 AASHTO- American Association of State Highway and
Transportation Officials.
- 1.2.5 ACI - American Concrete Institute.

Generally all clauses mentioned in BSI 8007, BSI 8110 shall be thoroughly followed for all types of joints as well as ACI, ASTM, AASHTO & DIN Requirements.

1.3 Product handling:

1.3.1 Protection:

Material shall be delivered, stored, and handled in accordance with the General Equipment and Material Stipulations.

Rubber and plastic materials shall be stored in a cool place and shall not be exposed to direct sunlight.

2 : Products

Unless otherwise specified in other sections of these specifications, the following products shall be utilized:-

2.1.1 Material List.

- Expansion Joint Filler.
- Prefomed sponge rubber.

2.2 Performance and Design Requirements:

2.2.1 Construction Joints:

Construction joints, shall be made at locations indicated on the Approved Design Drawings and Shop Drawings, or as specified or directed by the engineer.

Construction joints, shall not be made at other locations, without the concurrence of the Engineer. All joints shall be provided in compliance with the structural Engineer Practice and shall comply with BS 8007 and 8110.



A. Location:

Construction joints shall be located as follows:

1. In beam and Girders:

At the middle of the span, unless a beam intersects a girder at that point, in which case the joint in girder shall be offset a distance equal to twice the width of the beam. Provisions satisfactory to the Engineer shall be made for transfer of shear and other forces through the construction joint.

B. Watertight Joints:

2.2.2 Contraction Joints:

Contraction joints shall be provided at the locations indicated on the Approved Drawings. Also, they shall comply with BS 8007 and 8110 requirements and according to Engineering Structural calculations and Practice to the satisfaction of Engineer. Accessible edges of each contraction joint shall be sealed as specified in the Sealants and Caulking Section.

2.2.3 Expansion Joints:

Expansion joints shall be provided at the locations indicated on the Approved Drawings. Also, they shall comply with BS 8007 and 8110 requirements and according to Engineering Structural calculations and Practice to the satisfaction of the Engineer. Expansion joint filler shall be firmly bonded to the previously poured joint face with a suitable adhesive, and the new concrete shall be poured directly against the joint filler. Accessible edge of each expansion joint shall be sealed as specified in the Sealants and Caulking Section.

3 : Execution:

3.1 Installation:

3.1.1 Placement sequence:

Construction joints not indicated on the Design Drawings shall be spaced at intervals for reducing, (to a minimum), the effect of shrinkage in production cracks as recommended by the cement manufacturer, and acceptable to the Engineer.

No two abutting sections shall be placed within a period of 72 hours, unless otherwise authorized by the Engineer. Works shall comply with BS 807 and BS 8110.

4 : Measurement:

Expansion joint filler shall be measured per linear meter, complete in place, and will be paid for at the contract unit price per linear meter working drawings with method statement for the executing of these units. Form surfaces that will be in contact with concrete shall be thoroughly cleaned before each use. **No concreting shall commence until the Engineer has inspected and approved the erected formed.**

3.2.2 Form Removal:

Forms shall not be removed or disturbed until the concrete has attained sufficient strength to safely support all dead loads, live loads and to be lifted, transported installed. Form for beam



and girder sides, columns, and similar vertical structural members, may be removed after 48 hours, provided concrete is sufficiently hard, not to be injured thereby.

Care shall be taken to avoid spoiling the concrete surface or damaging concrete edges. Wood forms shall be completely removed.

3.2.2 –B Tie Rods.

Toe rods, to be entirely removed from the wall, shall be loosened 24 hours after concrete is placed, and form ties, except for a sufficient number to hold forms in place, may be removed at that time. Ties wholly withdraw from the wall, shall be pulled toward the face that will be concealed from view, in the permanent work.

5.3 Concrete Works

1 : General

1.1 Description

This section covers all concrete works, which shall be completely provided by the Contractor, including labour materials, proportioning, batching, mixing, delivering, testing, receiving, placing, compacting, finishing, curing, and other appurtenant work.

The Concrete shall be proportioned and mixed as specified herein.

All concrete shall be accurately formed and properly placed and finished as indicated on the Drawings, and as specified herein.

The contractor shall inform the Engineer at least 24 hours in advance of the times and places at which he intends to place concrete, for inspection and approval, and shall present and approve the works by Concrete Cast Permits as per the requirements of the Engineer.

1.1.1 Related Work

Other items of work that relate to and are referenced to work specified in this section are included in the following sections:

- Concrete Formwork
- Concrete Reinforcement
- Concrete Accessories

1.2 Applicable Codes and Standards:

The Codes and Standards, generally applicable to the work under this section, are listed. Codes and Standards current at the time of bid shall be used. In case of contradictions between different standards, British Code Standard shall prevail.

- 1.2.1 DIN - Deutsches Institut fur Normung
DIN 1045
- 1.2.2 BSI - British Standard Institute
- 1.2.3 ASTM - American society for Testing and Materials



1.2.4 AASHTO- American Association of State Highway and Transportation Officials.

1.2.5 ACI - American Concrete Institute.

1.3 Quality Assurance:

1.3.1 Tolerances:

Tolerances formed surfaces shall be as specified in BSI, ASTM & ACI code.

1.4 Submittals:

1.4.1 Material Report:

At least 31 days prior to start of concrete delivery, the following shall be submitted by the contractor to the Engineer for review.

Submittals should be as specified below.

- 1- Recommended suppliers and sources of all ingredients for making concrete, including cement, water, fine (sand) and coarse aggregates, and additives. (Item 1 Schedule 2).
- 2- Recommended suppliers and product data of the following:
 - a) Materials for curing concrete
 - b) Joint sealants
 - c) Joint filler
 - d) Bonding compound
 - e) Non-shrink grout
 - f) Reinforcement supports
- 3- A quality inspection plan to ensure continuing quality control of ingredients by periodic sampling, testing, and reporting to the Engineer on the quality of materials being supplied. (Item 2 Schedule 2).
- 4- All design mixes, using the “Standard mix Design Presentation”, Schedule 3, for each class of concrete, indicating that the concrete ingredients and proportions will result in a concrete mix meeting requirements specified (Item 3 Schedule 2).
- 5- The proposed program, methods, and details of plant and equipment to be used for batching and mixing of concrete. (Item 5 Schedule 2).

The Contractor shall submit the mix design as a report with his recommendation to obtain Engineer's acceptance prior to commencement of concreting work. This report shall compare the proposed mix design with specified requirements and shall be summarized on a form similar to that shown in schedule 3.

1.4.2 Hot Weather concreting:

A report shall be submitted for proposed methods of compliance with hot weather concreting requirements. (Item 6 Schedule 2).



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1.4.3 Certificates:

Laboratory test reports and mill or manufacturer's certificates attesting to conformance of ingredients with the specifications shall be submitted with each mix design. (Item 8 Schedule 2).

In case the source, brand or characteristics properties of the ingredients need to be varied during the term of the Contract, a revised laboratory mix report shall be submitted. (Item 1, 2, & 3 of Schedule 2).

1.4.4 Test Reports:

The Contractor shall keep (or obtain from his concrete supplier if any) copies of the results of all tests, which shall become part of the Contractors Weekly Quality Control report to the Engineer.

1.4.5 Summary of Submittals:

Schedule 2 is the complete list and frequency of reports which the Contractor shall prepare (or obtain from his concrete supplier if any) and submit.

1.4.6 Field Report:

Filed test reports shall be submitted as specified in this section, and in accordance with the Submittals and Quality Control Sections.

1.4.7 Reinforcements:

Certifications of tests on reinforcements shall be submitted for review as specified in the Concrete Reinforcement Section.

1.4.8 Layout of Joints and Lifts:

The Contractor shall submit to the Engineer for review as soon as practicable after the Issue of Order to Commence and not less than three weeks before the commencement of concreting, detailed drawings showing his proposals for placing concrete on which the position of all construction joints shall be indicated. These shall take into account any specific requirements detailed on the Drawings and specified in the Concrete Accessories Section. No concreting shall be started until the Engineer has accepted the method of placing, the positions and form of the construction joints.

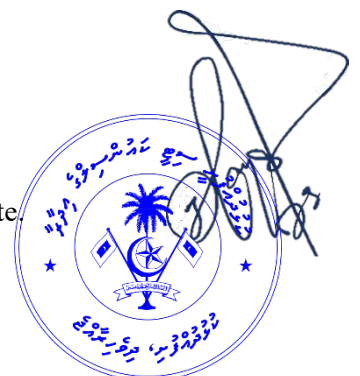
1.5 Delivery storage and handling:

Do not deliver concrete until vapor barriers, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement.

Materials shall be handled and stored as follows:-

1.5.1 Aggregates:

Coral aggregates shall not be accepted to be used for producing concrete.



Aggregates shall be transported and stockpiled separately according to their sources and gradations. Aggregates shall be handled in manner which will prevent segregation and contamination with earth or foreign materials.

If aggregates show segregation, or if the different grades become mixed, the aggregates shall be re-screened before placing in the proportioning bins. Contaminated aggregates will not be used.

Muddy or oil-leaking equipment shall not be allowed to operate on the stockpiles. The moisture content in the aggregate shall be frequently checked and taken in consideration during mixing to fulfil the design mix water content.

1.5.2 Package Cement:

If the cement is delivered in bags it shall be stored in a dry and waterproof shed or building. The bags shall not be laid directly on ground, to prevent deterioration or contamination from any cause, a 20cm gap shall be maintained from ground by wooden platforms. Any bag that contains lumps of hardened cement it will not be used and will be removed from the Site.

Bags of cement which vary in weight by more than 3 percent shall not be accepted.

The bags shall be made of several layers (more than 4) to be strong enough for handling and storing. Any bag that found broken will be removed from stores and will not be used.

Cement shall be fresh when delivered to site and the consignments shall be used in the order of their delivery. The manufacturer name and brand of cement and weight shall be written on each bag.

1.5.3 Bulk Cement:

Bulk cement shall be stored separately from package cement. Bulk cement shall be stored in dry, weather-tight, well-ventilated bins with provisions for prevention of moisture absorption or the intrusion of foreign matter.

Facilities for sampling of cement shall be provided at the weighing hopper, or at the feed line immediately before entering the hopper.

Different brands of cement, or the same brand of cement from different sources, shall not be used without prior notification by the Contractor.

1.5.4 Admixtures:

Dry admixtures shall be stored in dry, weather-tight, well-ventilated housing or silos. Liquid admixtures shall be stored in clean, weather-tight tanks.

1.5.5 Temperature Limits:

TABLE 1.5.5: Temperature Under Limits at Point of Placement

<i>Concrete Thickness (mm)</i>	<i>Temperature of Concrete at time of Placement (in °C)</i>
Not greater than 400mm	38 °C
Not greater than 750mm	32 °C



Greater than 750mm

25 °C

1.5.6 Temperature Control:

The concrete supplier shall provide procedures and facilities to control or reduce the temperature of all materials used in the concrete mix during “hot weather” as defined by air temperature over 32 °C. Some hot weather concreting difficulties can be reduced by the use of concrete with up to 100 percent flaked ice lieu of mixing water. The Contractor shall place concrete with as much ice as deemed necessary by the Engineer to surmount hot weather concreting difficulties. Separate payment shall not be made for any ice.

The following may also have to be used to assist in lowering the temperature of concrete to meet the temperature limits at the point of placement.

- 1- Exposed water tanks and piping, the roofs and vertical walls of cement storage silos or buildings, the tops and vertical walls of mixer discharge hoppers, and the sides of truck bodies carrying batched aggregate or mixed concrete may be painted white or silver.
- 2- Weighing hoppers, mixer drums, and tops of mixer discharge hoppers may be shaded from the ray of the sun when it is 30 °C or more above the horizon, and may also be protected from drying winds by screens.
- 3- Water for concrete may be chilled by the use of heat exchanger coils, or by the addition of flaked ice.
- 4- Shade may be used to cover the aggregates and elevating conveyor of the batching plant from direct sun.

1.6 Quality Assurance:

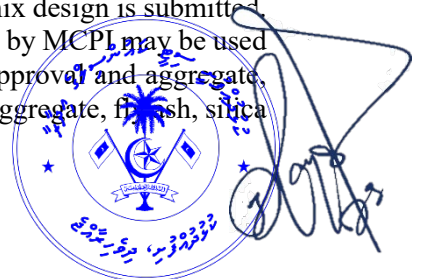
1.6.1 Concrete Mixture Design:

At least 30 days prior to concrete placement, submit proportions for a concrete mixture for each strength and type of concrete.

Submit a complete list of materials

- including type;
- brand;
- source and amount of cement,
- aggregate,
- fly ash, (or slag pozzolans),
- silica fume,
- ground slag,
- polypropylene fibers,
- anti-washout and
- other admixtures for underwater concreting,
- corrosion inhibitors; and applicable reference specifications.

Submit additional data regarding concrete aggregates if the source of aggregate changes. Submittal shall clearly indicate where each mixture will be used when more than one mix design is submitted. An identical concrete mixture previously approved within the past 12 months by MCPI may be used without further approval, if copies of the previous approval and aggregate, fly ash, silica fume, and pozzolan test results are submitted. The approval of aggregate, fly ash, silica



fume, and pozzolan tests results shall have been within 6 months of submittal date. Obtain acknowledgement of receipt prior to concrete placement. The mixture shall be prepared under the direction of a licensed/ registered civil engineer, who shall sign all reports and designs.

1.6.2 Drawings:

1.6.2.1 Reinforcing Steel:

Provide bending and cutting diagrams, assembly diagrams, splicing placement and laps of bars, shapes, dimensions, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars. Only complete drawings will be accepted.

1.6.2.2 Formwork:

Include design calculations indicating arrangement of forms, sizes and grade of supports (lumber), panels, and related components. Indicate placement schedule, construction, and location and method of forming control joints. Include locations of inserts, pipework, conduit, sleeves, and other embedded items.

1.6.3 Certificates:

1.6.3.1 Curing concrete elements:

Submit proposed materials and methods for curing concrete elements.

1.6.3.2 Form removal schedule:

Submit schedule for form removal indicating element and minimum length of time for form removal. Submit technical literature of forming material or liner, form release agent, form ties, and gasketing to prevent leakage at form and construction joints. Provide a full description of materials and methods to be used to patch form-tie holes.

1.6.3.3 Concrete Placement and Compaction:

a- Submit technical literature for equipment and methods proposed for use in placing concrete. Include;

- a. pumping or conveying equipment including type,
- b. size and material for pipe,
- c. valve characteristics,
- d. and the maximum length and height concrete be pumped.

No adjustments shall be made to the mixture design to facilitate pumping and or placing.

b- Submit technical literature for equipment and methods proposed for vibrating and compacting concrete. Submittal shall include;

- a. technical literature describing the equipment including vibrator diameter,
- b. length,
- c. frequency,
- d. amplitude,
- e. centrifugal force,
- f. and manufacturer's description of the radius of influence under load. Where flat work is to be cast, provide similar information relative to the proposed compacting screed or other method to ensure dense placement.

1.6.3.4 Quality Assurance:



Develop and submit for approval a quality control plan in accordance with the guidelines as specified herein. The plan shall include plans for the concrete supplier, the reinforcing steel supplier, and installer.

1.6.3.5 Field Testing Technician and Testing Agency:

Submit data on qualifications of proposed testing agency and technicians for approval by the Contracting Officer to performing any work.

1.6.3.6 Mixture Designs:

Provide a detailed report of materials and methods used, test results, the field test strength (fcr) for marine concrete required to meet durability requirements.

1.6.4 Test reports:

1.6.4.1 Concrete Mixture Proportions:

Submit copies of test reports by independent test labs showing that the mixture has been successfully tested to produce concrete with the properties specified and that mixture will be suitable for the job conditions. Test reports shall be submitted along with the concrete mixture proportions. Obtain approval before concrete placement.

1.6.4.2 Aggregates:

Submit test results for aggregate quality in accordance with ASTM C 33, and the combined gradation curve for grading proposed for use in the work and used in the mixture qualification. Where there is potential for alkali-silica reaction, provide results of tests conducted in accordance with ASTM C 227 or ASTM C 1260. Submit results of all tests during progress of the work in tabular and graphical form as noted above, describing the cumulative combined aggregate grading and the percent of the combined aggregate retained on each sieve.

1.6.4.3 Cement:

Submit current mil data

1.6.5 Field Samples:

Install minimum of 4m of quay wall and finish as required by the specifications.

2. Products:

2.1 Materials:

2.1.1 General:

Generally, all materials used shall comply with the requirements of the BS (12), ASTM, AASHTO, ACI or DIN requirements of each material. The Engineer shall be provided with Reports of Laboratory Tests or samples assuring this compliance.

The Reports shall clearly record that the materials comply with the mentioned standards to the satisfaction of the Engineer.



2.1.2 Cement:

The cement used for all reinforced concrete works shall be:

A low heat Portland pulverised fuel ash cement complying with BS 6588.

Equivalent cement suitable for marine environment and the actual works subject to the Engineers approval.

The cement used for lean concrete C20 may be ordinary Portland cement shall comply with BS (12) except otherwise mentioned.

Sulphate resisting cement shall be used for embedded concrete as mentioned on Contract drawings.

Each consignment of cement shall be accompanied by the manufacturer's certificate documenting the following:

- Specific surface (fineness)
- Setting time (Vicat apparatus)
- Bending strength and compression strength of motor prism,
Cement: Aggregate = 1:3, w/c = 0.5
- Chemical Composition
- Heat of hydration (Solution method).

If his certificate is not made available, then samples may be taken from different bags or of the consignments suitably packed and send for testing to any approved laboratory or the laboratory on site, at the Contractors expense.

2.1.3 Admixtures and Additives:

Chemical admixtures are not to be used until the supplier has verified their use in accordance with the Specifications and has also demonstrated by trail batches that two (2) times the admixture proposed can be used and still meet the specified concrete strength without noticeable deleterious effect.

The admixtures shall comply with BS (81110 & 5075), ASTM and DIN Requirements.

Chemical admixtures may be:

1. Type A. Water reducing admixtures.
2. Type D. Water reducing and retarding admixture (Acceptance based on Contractor's report and recommendation shall be obtained from the Engineer before using).
3. Type F. High range water reducer (super plasticizers) based upon sulfonated melamine or mapthelens formaldehyde condensates.

Provide minimum concentration of corrosion-including chemicals as shown in Table below.

Limits on Corrosion-Inducing Chemicals

<u>Chemical *</u>	<u>Limits, Percent **</u>	<u>Test Method</u>
Chlorides	0.01	ASTM D 512
Fluorides	0.01	ASTM D 1179



Sulphites	0.13	ASTM D 1339
Nitrates	0.17	ASTM D 3867

* Limits refers to water-soluble chemicals

** Limits are expressed as a percentage of the mass of the total cementitious materials.

2.1.4 Water:

Water to be used for cooling and washing aggregates and for mixing and curing concrete, shall be clean and free from injurious amounts of oil, acid, salt, alkali, organic matter or other deleterious substances. Concreting water shall not be used until tested and until the report of testing has been reviewed by the Engineer showing its compliance with BS (3148), BS (5328), ASTM and DIN Standards.

Mixing water for use with cement shall be suitable to ensure that the salts content of the total concrete mix does not exceed the limitations set out in Table 2-2.5A "TOTAL ALLOWABLE SALTS CONTENT". Mixing water shall not contain more than 500 parts per million of chlorides as Cl and not more than 100 parts per million of sulfates as SO4.

2.1.5 Fine Aggregate:

Fine aggregate shall consist of natural sand, and shall be composed of clean, hard, durable spherical particles in conformance with BSI, ASTM and DIN Specifications. CORAL SAND SHOULD NOT BE USED FOR ANY CONCRETE WORKS.

The salt content of fine aggregate shall not exceed the limitations as set out in Table 2-1.5A "TOTAL ALLOWABLE SALTS CONTENT" as well as all the given standards specified.

TABLE 2-1.05A

Total Allowable Salts Content, and Maximum Allowable Percentages

Salt	In fine aggregate By weight of fine Aggregate	In coarse aggregate by weight of coarse Aggregate	Total by weight of cement
Chlorides (NaCl)**	0.06	0.10	0.20* for OPC 0.40* for OPC
Sulphates (SO3)	0.40	0.50	4.00* BS (8110)

* Include salts in cement and water.

** Equipment determined by chloride ion x 1.6

The total chloride content of the concrete mix arising from the aggregate together with that from any admixtures and any other source expressed as a percentage of chloride ion shall not in any circumstances exceed 0.1 %.

Deleterious substances shall be limited in fine aggregate to the amounts shown in TABLE 2-1.5B, "ALLOWABLE DELETERIOUS SUBSTANCES IN FINEWE AGGREGATE".

TABLE 2-1.5B

Allowable Deleterious Substances in Fine Aggregate.



Item	Maximum Allowable Percentage by Mass
Clay lump and friable particles	1.0
deleterious substances (such as shale, alkali, mica, coated grains, soft particles)	5.0
Material finer than 75 micron, ASTM (No . 200) sieve	5.0

Fineness module for fine aggregate shall be between $(2.3 - 3.1) + 0.2$. the grading of fine aggregate shall comply with BS 812, BS(882 and 120 I), BS 8007, BS 8110, BS 5328, ASTM 04.02 and DIN 1045.

2.1.6 Coarse Aggregate:

Coarse aggregate shall consist of crushed gravel, crushed stone or a combination of the two, and shall be composed of clean, hard, uncoated particles. The Laboratory Test Report shall prove its compliance with all requirements of BS 812, BS 882 and 1201, BS 8007, BS 8110, BS 5328, ASTM 04.02 and Din 1045. CORAL AGGREGATES SHOULD NOT BE USED FOR ANY CONCRETE WORKS.

The salt content of coarse aggregate shall not exceed the limitations as set out in TABLE 2-1.5A "TOTAL ALLOWABLE SALTS CONTENT".

Deleterious substances shall be limited in coarse aggregate to the amount shown in TABLE 2-1.6A "ALLOWABLE DELETERIOUS SUBSTANCES IN COARSE AGGREGATE".

TABLE 2-1.06A

Allowable Deleterious Substances in Coarse and Medium Aggregate

Item	Maximum Allowable (Coarse)	Percent by Mass (Medium)
Clay lumps	2.00	1.5
Material passing 0.075mm (No. 200) sieve	1.50	4.0
Other deleterious substances (such as shale, alkali, mica, Coated grains, soft particles)	5.00	

Wearing Resistance of aggregate when tested in accordance with Los Angeles abrasion test, AASHTO (T96) should not exceed 40%.

Water absorption of aggregate should not exceed 6% when tested in according with AASHTO (T84).

Specification gravity of aggregate should be minimum of (2.5) when tested in accordance with AASHTO (T19) .

Sodium and Magnesium Sulphate soundnesses, when tested according to AASHTO (T-104), should not exceed 10% and 16% respectively.

Flakiness and Elongation when determined according to BS 812 should not exceed 25% for each.



The grading of combined aggregate shall comply with BS (812, 882 and 1201, 8007 & 5238).

The maximum aggregate size to be used for Reinforced Concrete shall be 20mm (3/4 inch); through a size may be used (32mm) upon the special approval of Engineer for specific places, in BOTH cases special compliance with BS 812 BS 882 and BS 5328 Grading and Sieve Analysis is compulsory.

2.2 Performance and Design Requirements:

Generally concrete shall be specified, produced and tested for compliance with BS 5328 or Equipment ASTM, DIN standards, unless other clauses of this section are more strict or higher standards.

2.2.1 Classes of Concrete:

Classes of concrete are denoted by designations which consist of a letter followed by a numeral indicating the 28-day compressive strength in mega Pascal (MPa) as determined by BS 1881, BS 5328 and BS 8110, and as shown in Schedule 1.

Each class of concrete may consist of one or more mixes determined by the maximum size of aggregate, slump and types of admixtures used.

Each mix within a class shall be considered a specific type, requiring acceptance of the design mix.

2.2.2 Concrete Mix Design Criteria:

Design concrete mixes shall have minimum cement content per cubic meter of concrete consistent with the required slump, a water content corresponding to the appropriate water-cement ratio, the specified maximum size of coarse aggregate, and the required grading of aggregates, in accordance with those limits as set forth in Schedule 1. Design mix proportions shall be as recommended by BSI, ASTM & DIN Specifications, unless otherwise specified herein. Trial mix water-cement ratio shall be used in accordance with BS (5328), ASTM & DIN Specifications, or the supplier's previously obtained field data for proportioning the design mix, as determined by the type of structure and exposure conditions, and shall be adjusted to meet specified design mix requirements. Design mixes shall be tested and reported on as specified herein.

The design mixes for each class of concrete shall be as determined by the Contractor through an acceptable design laboratory and accepted by the Engineer to produce the results as specified herein.

For each class of concrete there shall be as many mix designs as there are different combinations of ingredients anticipated to cover the requirements of the work. Mix designs may vary to meet field conditions, but after acceptance by the Engineer no change shall be made without notice to and acceptance by the Engineer based on the Contractor's report and recommendation.

Unless otherwise specified, strength requirements shall be based on 28-day compressive strength determined on 150mm cubic specimens.

A. Design Mix



When a design mix for any class of concrete has been accepted by the Engineer, it shall not be changed as to source, quality, proportioning, grading of materials, or in any other way that reduces durability.

All proposed changes shall be accomplished by preparing a new design mix as specified herein.

B. Sampling and Testing

Prior to use, all concrete ingredients shall be sampled and tested by a laboratory acceptable to the Engineer in accordance with the methods specified to determine compliance with this Section.

Sampling and testing of fresh and hardened concrete shall be done in accordance with BS 1881 & DIN 1048 with all equipment, material transport & labour shall be provided by the contractor.

C. Slump

The slump range as specified shall be maintained for concrete at the point of delivery.

D. Minimum Cement Content

The minimum cement content per cubic meter shall be as specified in Schedule 1 for each class of concrete as determined by analysis of fresh concrete.

2.2.3 Structural Concrete:

Coarse aggregate shall be Class C35A, C30, C25, and C20 Concrete.

2.2.4 Concrete Fill:

Concrete fill shall be provided in the locations indicated on the Design Drawings and shall be Class C20 concrete.

2.2.5 Cement Mortar:

Cement mortar shall be composed of fine aggregate and cement in the proportions of 3 to 1 by volume.

The ingredients shall be thoroughly mixed while dry by machine or hand until the cement colour can no longer be distinguished from the fine aggregate in any part of the mass and then shall be uniformly wetted by means of hose while undergoing further thorough mixing.

The mortar shall be prepared and used in quantities such that no longer than 30 minutes shall elapse between the first wetting and complete use of mortar in the Works and, if mixed by hand, no single batch shall exceed ¼ cubic meter.

2.2.6 Blinding Concrete:

Blinding concrete (mud mat) shall be Class C20 concrete and shall be as specified and not less than 75mm thick. In aggressive soil conditions Class C25 concrete shall be used for blinding (Reference should be made to the Soil Investigation Report).

2.3 Proportioning:



2.3.1 Mix Design:

Mix design shall be determined by one of two methods:

- A. Proportioning on the basis of field experience.
- B. Proportioning by laboratory trail batches.

A. Proportioning on the Basis of Field Experience

1. where a concrete production facility has a record, based on at least 30 consecutive strength test results that represent similar materials and conditions to those expected, required average compressive strength used as the basis for selecting concrete proportions shall exceed required design strength at designated test age by at least the following required margins based on standard deviation of existing strength test result:

Required Margin (MPa)	Standard Deviation (MPa)
4.1	2.0 to 3
5.7	3.1 to 4
7.4	4.1 to 5
9.0	5.1 to 6
11.5	6.1 to 8

2. Strength test data for determining standard deviation shall be considered to comply with Subsection (2.3.1 A.1), if data represents a group of at least 30 consecutive results.
3. Strength test results used to establish standard deviation shall represent concrete produced to meet a specified strength or strength within 5.0 MPa of that specified for the proposed class.
4. Variation of materials and proportions within the population of background test results used to establish standard deviation shall not have been more tightly controlled than for the proposed.

B. Proportioning on the Basis of Laboratory Trail Batches.

1. When laboratory trail batches are used as the basis for selecting concrete proportions, strength tests shall be made in accordance with BS 1881, on cubes prepared in accordance with BS 1881.
2. A curve shall be established showing the relationship between the water content and the compressive strength. The curve shall be based on at least three points, each point being the average of at least three cubes tested at 28 days, and representing batches which produce strengths above and below the required average compressive strength. The required average compressive strength shall be 30% greater than the design strength (i.e. the minimum characteristic concrete strength).

3. the minimum cement content for any concrete shall be that show by the curve to produce the average compressive strength required for that class, unless a higher cement content is required by the value shown in Schedule I.



C. Reduction of Margin Based on Field Data

After sufficient test data becomes available from the job, the margin (the amount by which the average strength must exceed the design strength) can be reduced below those values indicated in Subsection 3.0 I, A.1, in accordance with ACI 214 "Recommended Practice for Evaluation of Compressive Test Results of Concrete", provided:

1. That the probable frequency of strength tests falling more than 3.5 MPa below the design strength will not exceed 1 in 100.
2. That the probable frequency of the average of three consecutive strength tests falling below the design strength will not exceed 1 in 100.
3. That the acceptance of the Engineer has been obtained for such reduction on the basis of the Contractor's report and recommendation.

2.3.2 Plant and Mixture Trial Runs:

Prior to the delivery of any concrete to the Work Site, the Contractor shall demonstrate the suitability of the mix designs by plant trial mixes.

Trail batches of concrete shall be produced for all the classes of concrete proposed, and shall be designed in accordance with Subsection 2.3.01. Trail mixtures shall be designed for maximum permitted slump, air content, and ambient temperature range of use.

A minimum of six (6) test cubes shall be made and cured in accordance with BS 1881, for each water-cement ratio, using mix materials all of which shall be in the same temperature range of the materials which will be used in the concrete to be delivered to the Work Site. Ambient temperatures and the temperature of each trail batch shall be recorded and made part of the test report.

The report shall be submitted to the Engineer for acceptance based on the Contractor's recommendation (Item 9 Schedule 2).

2.3.3 Batching and Mixing:

Concrete shall be either batched and mixed at a central batching and mixing plant, or batched at a central batching plant and mixed in a truck mixer. The amount of concrete mixed in anyone batch shall not be more than the rated capacity of the mixer, nor less than the mixer manufacturer's recommended minimum mix volume.

A. Batching

Batching of cement in any plant shall be by weight.

Batching of aggregates shall be by weight in any plant whose noted capacity is less than 100 cu.m/hr.

Batching of water and of admixtures may be by weight or volume.

The accuracy of the measuring equipment shall be:

Cement	(+/-) 1 percent
Water	(+/-) 1 percent
Aggregates	(+/-) 3 percent



Admixtures (+/-) 3 percent

Batching accuracy shall be assured by the Contractor by calibration test of all measuring devices. Reports of calibration and of adjustments made shall be obtained, and also accompanied by a statement as to the accuracy of all measuring devices. This record shall be maintained at all times by the Contractor, and shall be available for inspection by the Engineer at any time

B. Mixing

Central Mixing Plant:

Measuring tolerances, and mixing capability and time shall be as stated herein.

The fine and coarse aggregates and the cement shall be mixed for not less than four turns of the drum or paddle before the water is added. Water is to be added gradually while the drum or paddle remains in motion, and the concrete shall be mixed until a uniform consistency and colour have been obtained.

The quality of water added to each batch shall be the net water, excluding moisture content for aggregate and free water, if any, but including water that will be absorbed by the aggregate, dependent on absorption and moisture content values determined daily and before any mixing takes place.

Water shall be added to the batch of concrete by means of a measuring device with an automatic cut-off of entry water while emptying into the mixer. All valves, etc. shall be regularly maintained to ensure there is no leakage of water into the mixing drum. The gauging receptacle shall be kept clean and must be completely emptied after each batch.

The whole of the mixed batch shall be removed before materials for a fresh batch enter the drum, unless the plant is designed for continuous mixing.

Retempering of concrete which has partially hardened by the addition of cement aggregate or water shall not be allowed. Concrete which has been overmixed to the extent that addition of water is necessary to preserve the required consistency during discharge shall not be used.

C. Transportation

The temperature of concrete leaving the mixing plant shall be such that at the time of placement, the maximum temperature does not exceed that specified for is placement, in Subsection 1-5. 05.

Concrete shall be so transported and placed that contamination, segregation, or loss of the constituent materials does not occur.

Concrete shall be compacted in its final position within 30 minutes from the time of introduction of the cement into the aggregates, but in all cases at least ninety (90) minutes less than the certified initial set time of the cement.

The slump of delivered concrete shall be determined on-site and shall not exceed the working limit shown below:

Working Limit	Margin for Error	Rejection Limit
100mm	20mm	120mm



The margin for error can only be used for a maximum of one truckload out of ten consecutive truckloads of concrete.

Contractor is to assess slump at jobsite for acceptable workability special high slump easily worked mixes shall be used as required provided prior acceptance by the engineer has been granted as based on the contractor's report and recommendations.

Where the slump is deemed in appropriate for acceptable workability, the contractor's quality control supervisor can authorized adding additional admixture and/or water to the mix to obtain acceptable workability, but within the limitations of the water-cement ratio as required by this specification. However, plasticizers shall be used upon the convenience of the engineer.

3. Execution:

Inspection:

Preplacement Inspection.

Before concrete is placed, forms, reinforcements, water stops, anchor bolts, and embedment shall be rigidly secured in proper position. Furthermore, dirt, sand, water, and debris shall be removed from the space to be occupied by concrete. All surfaces encrusted with dried concrete from previous placement operations shall be cleaned, and the entire installation shall be subjected to the approval of to the Engineer.

Preparation:

Limit of Pours.

The limits of each concrete pour shall be predetermined by the Contractor and shall be acceptable to the Engineer. All concrete within such limits shall be placed in one continuous operation.

Embedment.

Anchor bolts, castings, steel shapes, sleeves, and other materials that are to be embedded in the concrete shall be accurately positioned in the forms and securely anchored.

Unless installed in pipe sleeves, anchor bolts shall have sufficient threads to permit a nut to be installed on the concrete side of the form or template. A second nut shall be installed on the other side of the form or template, and the two nuts shall be adjusted so that the bolt will be held rigidly in proper position.

Embedments shall be clean when installed. After concrete placement, surfaces not in contact with concrete shall be cleaned of concrete spatter and other foreign substances.

Bonding to hardened concrete.

The surface of the hardened concrete upon which fresh concrete is to be placed shall be rough, clean, and damp. Surface mortar shall be removed to expose the aggregate. The hardened surface shall be cleaned of all foreign substances (including curing compound), washed with clean water, and kept saturated during the 24 hour period preceding placement of fresh concrete.

Installation:



Placement.

The limits of each concrete pour shall be predetermined by the contractor and shall be acceptable to the Engineer. All concrete within such limits shall be placed in one continuous operation. Before concrete is placed, forms, reinforcements, anchor bolts, and embedment's shall be rigidly secured in proper position; all dirt, mud, water, and debris shall be removed from the space to be occupied by concrete; all surfaces encrusted with dried concrete from previous placement operations shall be cleaned; and entire installation shall be acceptable to the Engineer.

All horizontal and sloping excavated surfaces on which concrete is to be placed and excavated shall be covered with binding concrete immediately after completion of the final trimming of excavation.

Place concrete as soon as practicable after the forms and the reinforcement have been inspected and approved. Do not place concrete when weather conditions prevent proper placement and consolidation; in uncovered areas during periods of precipitation; or in standing water. Prior to placing concrete, remove dirt, construction debris, water from within the forms. Deposit concrete as close as practicable to the final position in the forms. Do not exceed a free vertical drop of one m from the point of discharge. Place concrete in one continuous operation from one end of the structure towards the other lifts for vertical construction.

A. Conveying Concrete.

Concrete shall be conveyed to the point of final deposit by methods which will prevent separation or loss of ingredients. Concrete shall be placed in final position without being moved laterally in the forms more than 1.5 m.

B. Placing Concrete.

Concrete shall be placed in approximately horizontal layers of proper depth for effective compaction; however, the depth of a layer shall not exceed 0.5 m. Each layer of concrete shall be plastic when covered with the following layer and the forms shall be filled at a rate of vertical rise of not more than 0.5 m per hour. Vertical construction joints shall be provided as necessary to comply with these requirements.

Concrete shall be thoroughly settled when top finished. All laitance, debris, and surplus water shall be removed from concrete surfaces, scraping, or other effective means. Wherever the top the finished concrete will be exposed to weathering, the forms shall be filled completely and after the concrete has settled, the excess shall be screeded off and the top surface shall be finished smoothly.

Unless otherwise agreed by the Engineer on the basis of satisfactory site trials, concrete shall not be dropped in to place from a height exceeding 2 meters. Chutes or funnel tubes shall be used where heights exceed 2 meters.

The top part of all reinforced concrete walls shall be given special consideration to avoid segregation of fine and coarse aggregates, that may occur during vibration and gives lowered compression strength in the wall crest. To avoid this effect the concrete shall be filled to at least 3.0 cm over the final wall crest elevation before the concrete is hardened the upper surplus layer of the wall crest has to be drawn off to the final elevation.

3.3.2 Compaction.



During and immediately after placement, concrete shall be thoroughly compacted and worked around all reinforcements and embedments and into the corners of the forms. Mechanical vibrators shall be used which will maintain at least 9,000 cycles per minute when immersed in the concrete. Each vibrator shall be driven by a motor not smaller than 1.1 KW. Number and type of vibrators shall be acceptable to the Engineer.

Compaction by hand may be used only with the prior approval of the Engineer.

3.3.3 Hot Weather Concreting.

Except as modified herein, hot weather concreting shall comply with ACI 305. At air temperature of the concrete when placed in the work shall kept as cool as possible during placement and curing. The temperature of the concrete when placed in the work shall not exceed 32° C. If the ambient temperature reaches 40° C, which is unlikely happen in Maldives Concentrating operations shall be discontinued the Contractor has the adequate means of cooling the ingredients and keeping the temperature of mixed concrete below 32° C.

Plastic shrinkage cracking, due to rapid evaporation of moisture, shall be prevented Concrete shall not be placed when the evaporation rate (actual or anticipated) equals or exceeds 1 kg per square meter per hour.

To achieve the specified requirements, the Contractor shall provide sunshades over stockpiles of aggregate, cement silos, mixing water tanks, parked concrete trucks, in addition shall carry out one or more of the following procedures which shall be submitted to the Engineer for review.

1. Cool the mixing water and/or replace part of the water by chipped ice. The ice shall be completely melted by the time mixing is completed. Shade or wet the outside of the formwork.
3. Apply a fine moisture (fog) spray of clean cool water to shaded areas immediately prior to placing concrete.
4. Pour concrete at night.

Water used for cooling purposes shall be as specified.

In all times the surface of freshly placed concrete shall be protected against drying by covering it with wet hessian cloth or burlaps and where practical continuous water curing shall be applied during the first few hours after placement. In addition to DIN 1045 it has to be considered that spraying cold water for ulterior treatment of concrete in hot weather leads to quenching and surface cracks. Only fine sprinklers will be allowed.

3.3.5 Underwater Concrete.



Structural reinforced concrete shell not be placed under water. Instead, proper dewatering system shall be used to avoid such Concrete shall not be deposited under water except with the specific written permission of the Engineer. For concrete deposited under water, the limiting requirements shall be adjusted to provide not more than 150 mm of slump and to increase the cement factor by 50 kilograms per cubic meter.

Underwater concreting shall be carried out through tremies having hoppers at the upper end. After the flow of concrete is started, the lower end of the tremie shall be kept below the surface of the deposited concrete. Stirring of the deposited concrete shall be avoided. The tremie shall be moved by lifting it free of the concrete and lowering it vertically at the new location. The entire mass of concrete shall be placed as quickly as possible so that it will flow into place without the necessity of horizontal shifting below water.

The water shall be quiescent when concrete is deposited therein. Velocity of water flow shall not exceed 0.6 m per minute in any direction within the space where the concrete is placed. After concrete is placed, the water level in the space shall be kept static until the concrete has hardened.

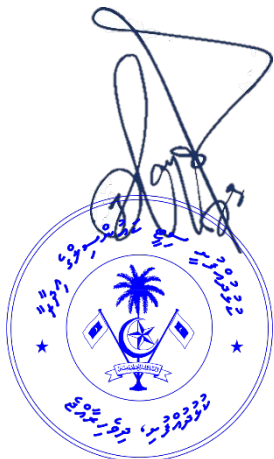
3.3.6 Concrete Placement in Large Pours.

Subject to the requirements for construction and movement joints and for preliminary test blocks specified herein, the Contractor shall not be limited to the size of individual pours of concrete. With large pours, defined as a pour where the least dimension is greater than 1.5 meters, the following precautions shall be taken to limit thermal gradients and internal stresses:

1. The temperature of the concrete at the time of placing shall not be more than 32°C and, in any event, shall be such as to ensure that the maximum internal temperature attained during setting does not exceed 70 ° C.
2. Final batch of concrete in a large pour shall be a layer approximately 150 mm thick, the placing of which shall be completed within one hour of placing of the concrete at any point beneath it.
3. Concrete shall be protected as soon as practicable, after placing, by covering the surface with a minimum thickness of either 100 mm of water or 50 mm of sand (kept wet) and by shading from direct sunlight.
4. Sets of thermometers shall be provided in the concrete to measure the temperature at the centre and near each face of the concrete, the sets being at centers not exceeding 5m or as otherwise agreed with the Engineer.
5. Formwork shall be at least 19 mm thick, or such other combination of materials having an equivalent insulation value, which shall not be removed until there has been sufficient time for the temperature difference between the centre and any face of the concrete to drop to less than 20°C.

3.4 Finishing Unformed Surfaces:

Concrete encasement will require no finishing except that necessary to obtain the required surface elevations or contours. The unformed surfaces of loading unloading



area at the top shall be screeded and given an initial float finish followed by additional floating, and toweling where required. All top of walls shall have a Class U3 finish.

3.4.1 Class of Finish.

Finishes to unformed surfaces of concrete shall be classified as U₁, U₂, U₃, “spaded” or “bonded concrete”. Where the class of finish is not specified or indicated on the Drawings the concrete shall be finished to Class tJ2.

A. Screeding (Class U₁).

Screeding Class U₁ shall provide a concrete surface conforming to the proper elevation and contour with all aggregates completely embedded in mortar. All screeded surfaces shall be free of surface irregularities with a height or depth in excess of 15 mm as measured from a 3 m straightedge.

B. Floating: (Class U₂).

Screeded Class U₁ surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance with no unnecessary working of the surface.

Initial floating shall be followed by a second floating at the time of initial set. The second floating shall produce a finish of uniform texture and colour.

Floating shall be performed with hand floats or suitable mechanical compactor- floats.

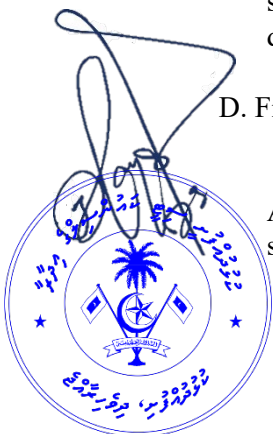
C. Towelling: (Class U₃)

Interior floor surfaces which will be exposed after construction is completed, surfaces to be covered with floor coverings, the exposed portion of the top of equipment bases, the top of curbs, and other surfaces designated on the Drawings shall be steel trowel finished.

Towelling shall be performed after the second floating when the surface has hardened sufficiently to prevent an excess of fines being drawn to the Towelling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks.

D. Finishing: Surfaces for Bonding.

All surfaces to be covered with concrete or topping shall be float finished. All laitance, surface mortar, and unsound material shall be removed by brushing or air blasting at the



time of initial set. Surfaces shall be rough, clean, and sound. Floors and other flatwork surfaces to receive topping shall be given a broom finish following the second floating.

E. Spaded Finish.

A spaded finish shall be a surface free from voids and brought to a uniform appearance by the use of shovels as it is placed in the work.

F. Edging.

Unless specified to be bevelled, exposed edges of floated or towelled surfaces shall be edged with a tool having 6mm corner radius.

G. Concrete Surface Tolerances

Concrete surfaces for the various classes of uniformed finishes specified shall comply with the tolerances shown in Table 3-4.1 except where different tolerances are expressly required by the specifications or indicated on the Drawings.

TABLE 3-4.1

Maximum Tolerance (mm)

Class of Finish	Line and level	Abrupt irregularity	Gradual Irregularity
U1	(+ / -) 15	5	5
U2	(+ / -) 5	0	5
U3	(+ / -) 5	0	5

In table 3-4.1, “Line and level” shall mean the lines, and levels, indicated on the Drawings.

Surface irregularities shall be classified as “abrupt” or “gradual” Abrupt irregularities include, but shall not be limited to, offsets and fins caused by displaced or misplaced form work materials, and shall be tested by direct measurement.

Gradual irregularities shall be tested by means of a straight template for plane surfaces or its suitable equivalent for curved surfaces, the template being 3.0m long for unformed surfaces.

Defects in unformed surfaces shall be repaired in accordance with the relevant requirements of this section.

3.5 Finishing Formed Surfaces:

Fins and other surface projections shall be removed from all formed surfaces except exterior surfaces that will be in contact with sand backfill and surfaces not specified to be damp-proofed. A power grinder shall be used, if necessary, to remove projections and provide a flush surface. Surfaces to be damp-proofed shall have fins removed and tie holes filled, but no additional finishing will be required.

All reinforced formed concrete shall have a fairface surface finish.

3.3.1 Tie Holes.

Tie holes in all formed surfaces shall be cleaned, wetted, and filled with patching mortar. Tie hole patches shall be finished flush and shall match the texture of the adjacent concrete.



3.6 Curing:

Concrete shall be protected from loss of moisture for at least 14 days after placement (according to DIN.1045) Curing of concrete shall be by methods which will keep the concrete surfaces adequately wet during the specified curing period. Precast members should not be placed in seawater before completion of specified curing.

3.6.1 Water Curing.

Water saturation of concrete surfaces shall begin as quickly as possible after initial set of the concrete and shall be continuous for an initial curing period of 14 days. The rate of water application shall be regulated to provide complete surface coverage with a minimum of runoff. The application of water to walls may be interrupted for grout cleaning only over the areas being cleaned at the time, and the concrete surface shall not be permitted to become dry during such interruption. Horizontal concrete surface shall be cured by ponding and vertical surfaces shall be wrapped with wet Hessian. Other means can be used to the approved of the Engineer. Only portable water should be used for wet curing.

3.6.2 Membrane Curing.

Membrane curing compound may be used in lieu of water curing on concrete which will not be covered later with topping, mortar, or additional concrete.

Membrane curing compound shall be spray applied at coverage of not more than 5.0 square meters per litre. A second coat shall be applied within 4 hours of initial coating or as recommended by the manufacturer. Unformed surfaces shall be covered with curing compound within 30 minutes after final finishing or following the initial 7 day water curing period. If forms are removed before the end of the specified curing period, curing compound shall be immediately applied to the formed surfaces before they dry out.

Curing compound shall be suitably protected against exposure to direct sunlight and abrasion during the curing period. The curing compound shall be degradable pigmented type.

3.7 Field Quality Control:

3.7.1 Testing.

Field control tests, consisting of aggregate tests, slump tests, air content tests, and making compression tests, shall be performed as directed by the Engineer.

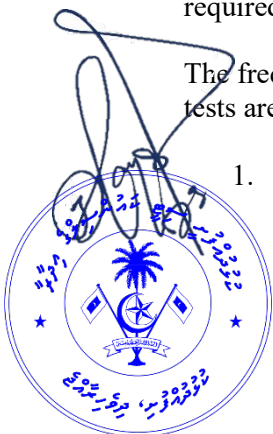
All tests to be performed according to BSI and ASTM and DIN standards and results shall not be approved unless proving its compliance with given specifications and standards.

All tests required for preliminary review shall be made at the expense of the contractor. Tests required during the progress of the work shall also be made at the expense of the contractor.

The frequency specified herein for each field control tests is a minimum. If additional field control tests are necessary, in the opinion of the Engineer, all such tests shall be made.

1. Aggregate:

Aggregate tests shall be performed as specified by the Engineer and to comply with BSI, ASTM and DIN requirements. The test shall include crushing, abrasion, absorption, grading and chemical composition.



2. Sampling Concrete:

Representative samples of fresh concrete shall be obtained in the field, according with BS 1881 or equivalent standards.

3. Slump:

A slump test shall be made for each 5 to 7 cu.m. of concrete or as directed by the Engineer. Slump shall be determined in accordance with ASTM, AASHTO and BSI Specifications. Tolerances shall not exceed 20 mm.

4. Air Content:

An air content test shall be made from one of the first three batches mixed each day, and from each batch of concrete from which concrete compression test cubes are made. Air content shall be determined in accordance with ASTM, AASHTO and BSI Specifications.

5. Water:

Water shall be tested as specified by the Engineer and according to ASTM and BS (3148) Standards.

6. Compression tests:

One set of six concrete compression test cubes shall be made each day when less than 10 cubic meters of concrete are placed. If quantity placed per day within 50 MC then two sets of six cubes will be taken, or a set for each type of concrete. If quantity of placed concrete per day is more than 50 MC then, one set of six cubes will be taken for every 25 MC and for every type of concrete, or as directed by the Engineer. Two cubes of each set shall be tested at age of 7 days, another two cubes shall be tested an age of 28 days. The third two will be crushed if the 28 days results are odd and need to be verified. Compression tests will be evaluated in accordance with BS 1881.

Test specimens shall be made, cured and tested in accordance with BS 1881. While still in the field, the test cubes shall be stored and cured after transport to the laboratory, in accordance with BS 1881.

Each set of compression test specimens shall be marked of tagged with the date and time of day the specimens were made, the location in the work where the concrete represented by the specimens was placed, the delivery truck or batch number, the air content, and the slump.

3.7.2 Test Reports.

Test reports shall be prepared and distributed by the Contractor in accordance with the Quality Control Section.

3.8 Adjust and clean:

3.8.1 Repairing Defective Concrete

Defects in formed Concrete surfaces shall be repaired within 24 hours, to the satisfaction of the Engineer, defective concrete shall be replaced within 48 hours after the adjacent forms have been



removed. All concrete which is honeycombed or otherwise defective shall be cut out and removed to sound concrete, with edges square cut to avoid feathering.

Concrete repair work shall be performed in a manner that will not interfere with through curing of surrounding concrete. Repair work shall be adequately cured.

3.9 cracks:

All cracks over 0.2 mm wide in concrete surfaces shall be cut out and the groove filled with epoxy grout.

3.10 Protection of buried concrete:

All concrete surface of walls and anchor block in contact with soil shall be protected by applying a waterproofing layer to it. The waterproofing material used shall comply with B.S and ASTM requirements and the other given specifications to the satisfaction of the Engineer.

SCHEDULE 1

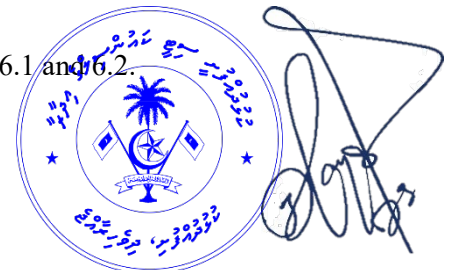
Concrete Mix Design Standard Parameters

Concrete Class Designations	28 day Minimum Characteristic Compressive Strength MPa	Minimum Cement Content kg/cu.m	Maximum Free water Cement Ratio (ByWei@t)	Maximum Slump mm	Max Chloride ion content by wt of cement %	
**C35A	35	370	0.40	110	0.20	R.C structures
C30	30	360	0.50	100	0.20	R.C structures
C25	25	310	0.55	100	0.30	Blinding in aggressive soils
C20	20	280	0.55	120	0.40	Blinding and Fill Concrete
C15	15	220	0.60	120		Concrete Fill material

** Super plasticizer or plasticizer admixture shall be used to achieve slump. This concrete shall comply with BS 8007 requirements. Slump may be increased upon the Engineer and to his convenience.

Notes for above table:

1. Water-reducing admixtures shall be used as required to meet the limits specified in this table.
2. Special high slump easily worked mixes may be used, if required, provided the other limits of this table are not exceeded and prior Engineer acceptance has been granted, as based on the contractors report and recommendation.
3. Cement content shall not be less than quantities specified in BS8110 table 6.1 and 6.2.



4.(SRPC) Sulphate Resistant Portland Cement shall be used for buried concretes where mentioned.

5.Slump may be increased upon the convenience of the Engineer and shall be increased by means of water reducing / plasticizing admixture.

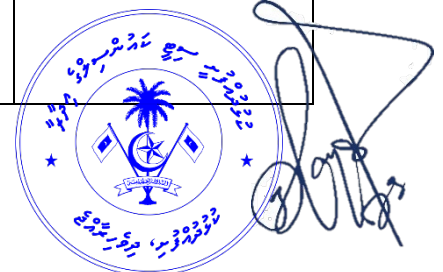
6.28 day characteristic compressive strengths shown are based on cube samples according to BSI Standards.

7.Nominal maximum aggregate size shall be 20 mm.

SCHEDULE 2

Reports to be submitted by the contractor in regard to concrete works

NO.	TITLE	REPORT SUBMITTED	FREQUENCY OF REPORT
1	Sources of Materials	a) 31 days prior to delivery of concrete. b) On apparent change.	a) One time. b) As required.
2	Supplier Quality (if any)	a) 31 days prior to delivery of concrete.	a) One time.
3	Mix design for all classes of concrete (Reference Schedule 3)	a) 31 days prior to delivery of concrete. b) When mix is redesigned for any purpose.	a) One time. b) As required.
4	Certificate for cement from manufacturer	a) 31 days prior to delivery of concrete. b) For each new delivery from manufacturer.	a) One time. b) As required.
5	Certificate for admixtures from manufacturer	a) 31 days prior to delivery of concrete. b) If any changes occurs.	a) One time. b) As required.
6	Report on plant trial mixes with 7 day & 28 day test results for all classes of concrete required for the work.	a) 31 days prior to delivery of concrete. b) If changed.	a) One time. b) As required.
7	Reports on concrete cube strength Tests.	a) 7+7 days after casting b) 28+7 days after casting	a) After each 25m3 of casting. b) As required.
8	Concrete casting check list	24 hours before casting	Before each casting
9	Reports of the following tests on water (if it is not from the public service) for mixing concrete, washing and/ or cooling aggregates and curing: 1) Sulphates (as SO ₃) 2) Chlorides (as NaCl)	a) 31 days prior to delivery of concrete. b) During production of concrete.	a) One time. b) Monthly.



TIMBER WORKS

Material - Hardwearing durable Yellow Balau decking.

Class - D50 strength rating.

Density - average weight 980 kilos per m³.

Decay resistance – high, longevity - 25 years +.

5.1.2 MATERIAL PROPERTIES

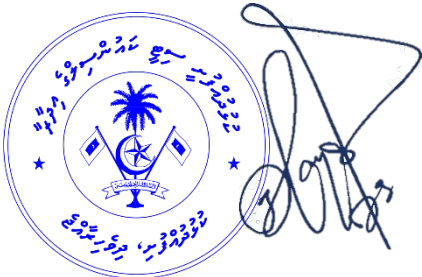
- Compressive strength of 1250 psi (8.618×10^3 KN/m²)
- Bending stress of 1950 psi (1.34×10^4 KN/m²)
- Shear strength of 160 psi (1.1×10^3 KN/m²)
- Elastic modulus of 1500000 psi (1.03×10^7 KN/m²)



Bill of Quantities or Activity Schedule

[The following units of measurement and abbreviations are recommended for use].

Unit	Abbreviation	Unit	Abbreviation
cubic meter	m ³ or cu m	millimetre	mm
hectare	ha	month	mon
hour	h	number	nr
kilogram	kg	square meter	m ² or sq m
lump sum	sum	square millimetre	mm ² or sq mm
meter	m	week	wk
metric ton (1,000 kg)	t		



Here is a detailed list of the reports that need to be submitted as specified:

Material-Related Reports

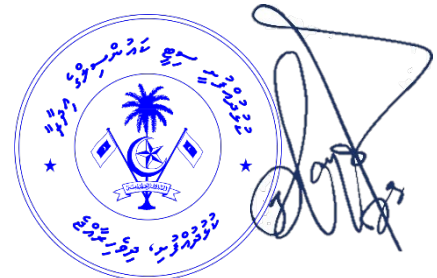
1. **Material Report** (At least 31 days before starting concrete delivery):
 - Recommended suppliers and sources of ingredients for concrete, including cement, water, fine and coarse aggregates, and additives.
 - Product data for:
 - Curing materials.
 - Joint sealants and fillers.
 - Bonding compounds.
 - Non-shrink grouts.
 - Reinforcement supports.
 - Quality inspection plan to ensure quality control through sampling, testing, and reporting to the Engineer.
 - Design mixes for each class of concrete, presented in the “Standard Mix Design Presentation” format.
 - Proposed program, methods, and details of batching and mixing equipment
2. **Certificates:**
 - Laboratory test reports and manufacturer’s certificates verifying material compliance.
 - Revised reports if there are changes in the source or properties of materials during the contract term] .
3. **Concrete Mix Design Report:**
 - Detailed proportions, materials, and test results for each mix.
 - Information about the location of use for different mixes.
 - Summary of past approvals, if applicable (e.g., within the past 12 months)

Execution and Implementation Plans

4. **Hot Weather Concreting Report:**
 - Detailed methods to meet requirements for hot weather concreting conditions.
 - Procedures for cooling materials, using ice or other techniques as necessary
5. **Form Removal Schedule:**
 - Minimum duration and technical literature on forming materials, release agents, and gasketing methods.
6. **Layout of Joints and Lifts:**
 - Detailed drawings showing concrete placement plans, including construction joint positions and forms

Testing and Field Control Reports

7. **Test Reports:**
 - **Concrete Tests:**



- Compression test results, with specimens tested at 7 and 28 days.
 - Slump test results.
 - Air content test results from each batch
 - **Aggregate Tests:**
 - Crushing, abrasion, absorption, grading, and chemical composition testing results.
 - Certification of compliance with standards
 - **Water Tests:**
 - Quality testing reports verifying compliance with standards (e.g., BS 3148)
8. **Field Test Reports:**
- Weekly quality control reports documenting testing procedures and results during work progress
-

Miscellaneous Reports

9. **Curing Plan:**
- Proposed materials and methods for curing concrete, including details of water curing, membrane curing, or other approved methods
10. **Plant and Equipment Reports:**
- Proposed batching and mixing equipment details and trial mix reports
11. **Reinforcement Reports:**
- Certification of reinforcement tests conducted in accordance with the specifications
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