

TECHNICAL SPECIFICATIONS

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1 GENERAL AND PRELIMINARIES

1.1 GENERAL

The Particular Conditions of Contract, General Conditions of Contract, Bills of Quantities and the Drawings shall be read in conjunction with the Specifications and matters referred to, shown or described in the former are not necessarily repeated in the latter.

Notwithstanding the subdivision of the Specifications into various headings, every part is to be deemed supplementary to every other part and the various parts are to be read with each other, so far as it may be practicable to do so, or when the context so permits.

1.2 STANDARDS, MATERIALS, GOODS AND WORKMANSHIP

In various places throughout this specification reference is made to the Standards issued by the relevant authorities of Maldives and where such standards are not available to current British Standards or similar international standards or the materials used shall be of the best type available and shall generally be to the Engineer's satisfaction.

Materials, goods and workmanship shall be of the best quality of their respective kinds and, as far as applicable, shall comply in every respect with the requirements of the quoted Standards, Codes of Practice and Specifications or any other National Standards approved by the Engineer. Preambles and descriptions of materials, goods and workmanship given in any one section of the Specifications shall apply throughout the whole of these Specifications unless otherwise described. The substitution of materials, goods, workmanship and the like from that specified shall only be permitted with the written approval of the Engineer.

1.3 SAMPLES

The Contractor shall furnish for approval with reasonable promptness, all samples as directed by the Engineer. The Engineer shall check and approve such samples with reasonable promptness only for conformance with the design concept of the Works and for compliance with the information given in Contract Documents. The work shall be in accordance with the approved samples.

All samples shall be delivered to the Engineer's office with all charges in connection therewith paid by the Contractor and deemed to be included in the Contract price.

Duplicate final approved samples, in addition to any required for the Contractor's use, shall be furnished to the Engineer, one for office use and one for the Site.

Samples shall be furnished so as not to delay fabrication, allowing the Engineer reasonable time for consideration of sample submitted.

Each sample shall be properly labelled with the name and quality of the material, manufacturer's name, name of the project, the Contractor's name and date of submission, and the specification article number to which the sample refers.

1.4 MANUFACTURER'S INSTRUCTIONS

Special items such as waterproofing materials, etc., shall be delivered to the Site in the manufacturer's original unopened containers with the manufacturer's brand and name clearly marked thereon.

All items or materials shall be assembled, mixed, fixed, applied, or otherwise incorporated in the Works in accordance with the printed instructions of the manufacturer of the items or materials unless specifically instructed otherwise by the Engineer.

1.5 ORDERING MATERIALS

The Bills of Quantities shall not be used as a basis for ordering materials and the Contractor is entirely responsible for assessing the quantities of materials to be ordered. Upon receipt of the Engineer's order to commence the Works, the Contractor shall immediately place orders for all required materials and will be held responsible for any delays occurring due to the late placing of such orders. Prior to finalising material orders, the Contractor shall advise the Employer and await the Employer's written approval to complete the same.

The Contractor shall pay all expenses, taxes and dues etc. incurred on the procurement of materials from aboard.

1.6 STORAGE AND PROTECTION

All materials shall be stored in protected areas on site and shall be fully protected against the effects of weather.

All delicate materials shall be carefully handled and stored under cover in a manner to prevent deformation and damage to the materials and to shop finishes, and to prevent rusting and the accumulation of mud, dirt or other foreign matter on the metal work. All such damage and accumulation shall be corrected prior to erection.

Special items shall be stored as per manufacturer's instructions.

1.7 OBVIOUS WORK

Where an item of work is obviously required for the type of work being undertaken then it shall be deemed to have been included even though the item is not specifically mentioned or shown in the Drawings, Specifications or the Bills of Quantities.

1.8 SCAFFOLDING

The Contractor shall provide, erect, maintain, dismantle, and clear away at completion proper and adequate scaffolding including that required for Works. Putlog holes shall be made good to match the adjacent surface as the scaffolding is dismantled. The Contractor shall be entirely responsible for all safety precautions in connection with the scaffolding including the provision of all bracing, scaffold boards, toe boards and the like and for its entire sufficiency for the work.

If in the Engineer's opinion scaffolding is considered dangerous then the Contractor shall rectify the same at his own expense. All work utilising scaffold shall be halted until the scaffold is corrected all to the Engineer's written approval.

1.9 CUTTING AND PATCHING

The Contractor shall be responsible for all cutting and patching and making good required for all trades for all work and his prices will be deemed to include for all such cutting and patching and making good.

1.10 PROTECTION

The Contractor shall cover up and protect the Works from the weather and from damage by his own or other workmen performing subsequent operations. He shall provide all necessary dustsheets, barriers and guard rails and clear away same at completion.

The Contractor shall take all reasonable and proper steps for the protection of all places on or about the Works, which may be dangerous to his workmen or any other persons or to

traffic. The Contractor shall provide and maintain warning signs, red warning lamps and barricades as necessary in all such places.

1.11 SITE HOARDING

The Contractor shall provide a site hoarding at the boundary of the Site as required by the Local Authority bylaws and to the entire satisfaction of the Local Authority and the Engineer. The Site hoarding shall be maintained during the progress of the Works and shall be dismantled and cleared away upon completion.

The Contractor shall be responsible for ensuring the security of the Site, for protecting the same from trespass and providing all necessary watching and lighting in connection therewith.

1.12 WATER FOR THE WORKS

Unless otherwise stated, the Contractor shall make all necessary arrangements and provide all water for the proper execution of the Works, together with all transport, temporary plumbing, storage and distribution, pay all charges and alter, adapt and maintain temporary work as necessary and remove and make good at completion.

1.13 ELECTRICITY FOR THE WORKS

Unless otherwise stated, the Contractor shall make all necessary arrangements and provide all artificial lighting and power for the proper execution and security of the Works and its protection, with all meters, temporary wiring and fittings, pay all charges and alter adapt and maintain the temporary work as necessary and remove and make good at completion.

1.14 EXISTING SITE SERVICES

The Contractor shall follow up and obtain all the required information relating to any existing site services, telephone, electrical, water, drainage and the like on the site before commencing excavation. The Contractor shall be responsible for the protection of all existing services within the site and shall make good at his expense any damage to existing services resulting from his carrying out of the Works to the satisfaction of the Engineer and relevant authority. The Contractor shall be responsible for giving notice to the relevant authority where temporary or permanent re-routing or diverting of existing services is found to be necessary and shall complete same at his own expense to the Engineer's and respective Authorities' approval.

Where diversions of services as aforementioned are not required in connection with the permanent Works, the Contractor shall uphold, maintain and keep same in working order in existing locations.

1.15 PRICING GENERALLY

The Contractor shall satisfy himself as to the scope of the Work shown on the drawings and described in these Contract Documents and his price shall be deemed to cover all his obligations under the Contract and all matters and things necessary for the proper construction, completion and maintenance of the Works. The price shall include for all material, labour and plant - whether mechanical or non-mechanical - required for the completion of the Contract in accordance with the Drawings and Specifications, and removing at completion and making good any surfaces disturbed and if not included in any prices inserted in the Preliminaries for the insurances and bonds required; for the costs of preparing a tender; for the work in connection with measurements and the final account; for profit; and for all other establishment charges and on costs of whatever nature. No claim for additional payment will be allowed for any error or misunderstanding by the Contractor in these respects.

The Contractor has to allow in his pricing for all fees required to obtain the building permit.

1.16 SITE PROGRESS MEETINGS

During the course of the Works, Site progress meetings shall be held at weekly intervals for the purpose of co-ordinating the Contractor's works and to ensure that full compliance is maintained. Minutes of such Site meetings will be recorded, copies will be distributed to all persons concerned and full effect shall be given to all instructions contained therein.

Prior to such meetings the Contractor shall give to the Engineer details in writing of that portion of the Works he proposes to construct during the coming week with details of the plant and method he proposes to employ. These proposals shall be discussed at the meeting and no work based on such proposals shall proceed without the approval of the Engineer.

The Contractor shall submit all reports as instructed by the Engineer in connection with Site progress meetings and the day-to-day management of the Works.

1.17 PROGRESS PHOTOGRAPHS

The Contractor shall supply once a month, at the time of submitting his Valuation, minimum of twelve photographs showing the progress of the Works. The times and position from which the photograph are to be taken shall be directed by the Engineer.

The photograph size shall not be less than 15 x 10 centimetres with the description of the viewpoint stamped in ink on the back. These photos remain the property of the Engineer and no copies may be supplied to others unless previously authorised in writing by the Engineer. These photos also shall be sent electronically to the Engineer in an approved format and resolution.

1.18 SETTING OUT

The Contractor shall be responsible for accurately setting out the Works to the specified positions, dimension, levels and Building Lines and also checking the site surveys for dimensional and level accuracy and reporting any discrepancies before building work commences.

The Contractor shall provide the Engineer with all facilities, equipment and labour to enable him to check the setting out and levels of the Works at all times. The checking of any setting out point, line or level by the Engineer shall not in any way relieve the Contractor of his responsibility.

All setting out points, benchmarks, site rails, pegs and other survey points shall be clearly marked and protected from damage or disturbance during the execution of the Works.

1.19 SIGN BOARD

The Contractor shall provide and maintain a sign board for the Site consisting of a timber framed block board panel size 2.0 m x 2.0 m painted two coats with white oil paint back and front and supported 2.50 m above the ground with steel angle framing and struts painted matt black and let into the ground and fixed in concrete foundations. The board shall be lettered in both Dhivehi and English by skilled sign writer and should include the following.

- ◆ The Project name
- ◆ The Employer's name

- ◆ The Designer's Name and address
- ◆ The Engineer's name and address
- ◆ The Contractor's name and address

A large-scale layout shall be prepared and submitted for the Engineer's approval before fabrication. No advertising material other than the above will be permitted. The siting and layout of Sub-Contractors or Manufacturer's signboards, if allowed, must be submitted for the Engineer's approval.

1.20 DEFECTIVE WORK

Any defective work materials and also deviations from the working details in respect of setting out, correct lines and levels, verticality, sizes of members and/or any other dimensional variation of any kind whatsoever, shall be removed and reconstructed or otherwise rectified without undue delay to the approval of the Engineer and the Contractor shall be responsible for all additional costs incurred.

1.21 ERECTION EQUIPMENT OR OTHER PLANT

If cranes or any other type of plant which places any load on the structure are proposed, all details of such plant shall be submitted to the Engineer for approval before the work is actually commenced. If approved by the Engineer and Engineer rally acceptable, permission may be given for the structure to be strengthened, in order to carry out loads, and the Contractor shall be responsible for any resulting additional costs.

The Contractor shall be responsible for making good to the satisfaction of the Engineer any damage to the permanent structure which may be caused by his plant and equipment.

1.22 LOADING IN EXCESS OF DESIGN LOAD

No loading in excess of the design loading shall be placed on any portion of the structure without the written permission of the Engineer.

If such permission is granted, all beams or other members of the structure which are subjected to loading other than the designed loading shall be strengthened and supported to the satisfaction of the Engineer, and the Contractor shall be responsible for any resulting additional costs. The Contractor shall be responsible for making good to the satisfaction of the Engineer any damage to the permanent structure which may be caused by such excess loading.

1.23 CONSTRUCTION SCHEDULE AND EXECUTION PLAN

The Contractor shall prepare and submit to the Engineer for approval a construction schedule and an execution plan of how he plans to carry out the works including any temporary facilities, stock yards, etc., before the start of the work.

1.24 PERMANENT DRAINAGE, WATER, TELEPHONE, CABLE TV AND ELECTRICITY CONNECTIONS

The Contractor shall allow for arranging and obtaining the permanent drainage, water, telephone, cable TV and electricity connections to the proposed development and he shall be responsible for making all payments in connection therewith.

1.25 DISPOSITION OF EXISTING UTILITIES

Before commencing any construction work, the Contractor shall obtain from the various utilities Departments, Companies or Employer the location of any existing utilities on the Site.

Active utility lines damaged during the course of construction operations shall be repaired or replaced as determined by the Engineer at the Contractor's expense. Immediately an active utility line is damaged the Contractor shall notify the Engineer and the utility owners by telephone and in writing.

Inactive or abandoned utilities encountered during construction operations shall be removed, plugged or capped. The location of such utility shall be noted reported in writing to the Engineer.

1.26 SITE CLEARANCE

Any structure at the proposed site shall be completely demolished including grubbing up of foundations and the proper termination of all services as required by the Drawings including the removal and disposal of all demolished materials. The demolition work shall be executed in a systematic manner.

Demolition operations and the removal of debris shall be carried out to ensure minimum interference with roads, streets, footpaths and other adjacent occupied or used facilities.

All areas of the Site specified for clearance or from which material is to be excavated or upon which filling is to be deposited shall be cleared of all obstructions, walls, and the like and bushes, hedges, trees and the like. Material so cleared shall be removed from Site by the Contractor.

1.27 SAFETY OF ADJOINING EXISTING STRUCTURES

The Contractor shall take all necessary precautions during the excavation for the Works particularly those excavation which are adjoining existing buildings and shall protect such buildings from the damage or collapse by means of temporary or permanent shoring, strutting, sheet piling or underpinning or excavation in short lengths and/or other methods as he deems fit also he shall properly support all foundations, trenches, walls, floors, etc. affecting the safety of the adjoining existing buildings.

The Contractor shall alter, adopt and maintain all such works described above for the whole period of the Contract and shall finally clear away and make good all damages done.

The construction and efficiency of the shoring, underpinning, strutting and the like for the purpose for which it is erected shall be the responsibility of the Contractor, should any subsidence or any other damage occur due to the inefficiency of the shoring, underpinning, strutting and the like or any other support provided, the damage shall be made good by the Contractor at his own expense and responsibility.

The shoring, strutting, piling and the like, shall be executed in such a manner as to cause as little inconvenience as possible to adjoining owners or the public and the Contractor shall be responsible for negotiating with the adjoining owners the means to safeguard their property and for the use of any portion of their land for the purpose of executing the excavations and no claims submitted on this ground will be entertained.

The Contractor shall be held solely responsible for the safety of the adjoining existing buildings, the sufficiency of all temporary or permanent shoring, underpinning, piling, and the like. The Contractor shall keep the Engineer informed as to manner in which he intends to

proceed with the execution of the excavations and obtain his approval; such approval if given shall not absolve the Contractor of his responsibility under this Clause.

The Contractor shall save harmless and indemnify the Employer in respect of all claims, demands, proceedings, damages, costs, charges and expenses whatsoever arising out of or in relation to any such matters in so far as the Contractor is responsible under this Clause.

1.28 HANDING OVER

Prior to handing over the proposed development, the Contractor shall gain the approvals and respective Completion Certificates from all the local government authorities and the like that the work has been completed in accordance with their requirements. Any payments in connection therewith shall be paid by the Contractor.

The final payment to the Contractor shall be withheld until all the damages to the adjacent buildings are completed.

2 GROUND WORKS

2.1 NATURE OF SOIL

The Contractor is to visit the Site and ascertain for himself the condition of the surface of the ground and the type of substrata likely to be encountered in the excavation of the proposed development.

2.2 ORIGINAL LEVELS

A survey of the existing site shall be made and the results to be submitted to the Engineer before commencement of the work.

2.3 EXCAVATION

The Contractor shall perform all excavation as required for all work under this Contract as indicated on the Drawings.

Excavation shall be carried out in all materials and by whatever means are necessary accurately to the lines and levels shown on the Drawings, or as ordered by the Engineer.

No blasting of any kind will be permitted.

Except where indicated on the drawings to remain undisturbed, the Contractor shall remove all topsoil, plants, roots, vegetation, rubbish, rocks, etc. from areas lying within limits of structures and from areas to receive fill, embankment, surfacing, road construction, concrete or other construction.

Footings and foundations shall rest on firm undisturbed soil free from loose materials.

Excavation shall extend a sufficient distance from walls, footings, etc. to allow space for placing and removing shoring and formwork, for performing all work in the excavations and for the inspection of the same.

Slopes and formation surfaces shall be trimmed true to line and the required profiles shall be left well consolidated, neat and smooth.

Any additional excavation occasioned by slips, falls, wash-ins, etc., shall be made good at the Contractor's expense with mass concrete or approved filling materials as ordered by the Engineer's Representative.

2.4 FINISH OF EXCAVATION AND INSPECTION

The Engineer shall inspect all the excavations before commencement of further work and the Contractor shall notify the Engineer when excavations are ready for inspection.

In such inspection the Engineer found the soil at the bottom of excavation loose to provide the required bearing capacity, the Contractor shall, at his expense, remove any unsuitable material from the bottom of the excavation and compact the soil to provide sound foundation for the structure.

No excavation shall be backfilled nor any permanent work commenced until the formation has been inspected by the Engineer and his permission to proceed given. If required by the Engineer the bottom 150mm of excavation shall not be removed until just before the commencement of construction of permanent work.

2.5 DEWATERING

Where the excavation level is below the natural water table and it is necessary to pump continuously from the excavation or to install a specialist form of dewatering equipment around the perimeter of the site or excavation, the Contractor will be responsible for ensuring the safety and stability of all adjoining structures and services or utilities above or below ground level. It will also be the responsibility of the Contractor that the equipment installed shall ensure that the excavation and subsequent construction is carried out in dry conditions. This dewatering shall continue until the concrete is dry enough to withstand contacts with water.

Continuous or permanent dewatering of the excavation or Site may not be undertaken without the written approval of the Engineer to the work and the methods to be employed which shall also comply with Codes of Practice and Local Authority requirements.

The water pumped from the excavations or well points shall be pumped to disposal points or sumps as approved by the Engineer and/or Local Authority and if so required be passed through settling tanks before disposal. Under no circumstances must water be disposed of in the Municipality's sewer systems.

2.6 SHEETING AND SHORING

Sheeting and shoring shall be provided at excavations to ensure complete safety against collapse of soil at sides of excavations, to provide protection of workmen and to prevent damage to adjacent property, structures, paving and utilities. The Contractor shall submit for approval, shop drawings with details of the sheeting and shoring method before commencement of this work.

2.7 STORAGE AND DISPOSAL OF EXCAVATED MATERIAL

Excavated material shall not be piled along sides of excavations in a manner that will overload or increase danger of collapse of excavation sides. All excavated material shall be neatly piled in stockpiles but where this is not practicable the excavated material shall be removed from site.

Excavated material shall be separated into those suitable for fill and those unsuitable for fill as directed by the Engineer. Materials unsuitable for fill shall, as soon as practicable, be removed from site.

Material suitable for fill shall be put to immediate use or stockpiled at the option of the Contractor. Under no circumstances shall material declared to be suitable for fill be stored next to materials declared to be unsuitable for fill. Stockpiles of materials suitable for fill shall be located in areas as approved by the Engineer in the vicinity of the work, located so as not

to interfere with the progress of the works. Stockpiles shall be kept in a neat, well-drained workable condition at all times.

2.8 FILLING AND BACKFILLING

The excavated material arising from all excavations declared by the Engineer to be suitable for fill is to be used as filling. All other filling material shall be. Filling material shall contain no perishable or organic rubbish and no particles in excess of 150mm in diameter. The maximum dry density of the material shall be not less than 1600 kg/m³.

Care shall be taken when filling or backfilling to avoid any wedging action or eccentric action upon or against the structure of the work. Before placing of fill, the surface of the sub-grade shall be compacted at optimum water content to the same percentage of maximum dry density required of subsequent layers.

Filling and backfilling shall be placed in layers not exceeding 150mm thick (after compaction). Each layer shall be uniformly spread and shall be moistened or dried by aeration when required to ensure the optimum water content and shall be compacted uniformly by hand or machine methods of specified density as follows:

Filling under footings, concrete beds, side walks and other bearing situations	At least 98% maximum dry density
Fill within 300mm, measure horizontally, of foundation walls, retaining walls, edges of footings, and other below grade vertical surface. When machine compacted, compaction shall be by means of a 6 ton smooth wheeled roller.	At least 95% maximum dry density

The Engineer shall have the right to disapprove any compacting device of inadequate capacity or in his opinion, of type unsuited to the character of the material being compacted. Heavy equipment for spreading and compacting fill and backfill shall not be operated closer to walls than a distance to the difference in height between the top of the footings and the layer being compacted

When backfilling behind retaining walls, basement walls and the like the said structures shall be kept propped during the complete operation. The hydraulic compaction of fill shall not be permitted and the backfilling shall be carried out in layers not exceeding 150mm thick. Each layer shall be compacted to 90% of the modified compaction. No backfilling shall be carried out until the wall concrete has achieved its full works cube strength and care shall be exercised so as not to damage the external tanking membrane and its protection.

Trenches shall not be backfilled until all required pressure tests have been performed and until the utility systems, as installed, conform to the requirements of the Specifications governing mechanical, electrical, and utility work.

Where, in the opinion of the Engineer, damage is likely to result from withdrawing sheeting, the sheeting shall be left in place. The trenches shall be carefully backfilled with approved backfilling materials, as hereinbefore specified, deposited in 150mm layers and thoroughly and carefully hand tamped until the pipe has a cover of not less than 300mm for electric ducts, and 600mm for sewers and water mains. Where the pipe is specially coated for protection against corrosion, care shall be taken not to damage the coating. The remainder of the backfill material shall then be placed in 150mm layers, and compacted by hand hammers or mechanical tampers to at least 90% maximum dry density. Settling the backfill with water will be permitted, and will be a requirement, when so directed by the Engineer.

Any trenches improperly backfilled, or where settlement occurs, shall be reopened to the depth required for compaction, then refilled and compacted, with surface restored to the required grade and compaction, mounded over and smoothed off.

Trenches under buildings, open trenches across parking areas and trenches at other areas to be paved shall be backfilled as specified above, except that the entire depth of the trench shall be backfilled in 150mm layers and each layer shall be moistened and compacted to at least 98% of maximum dry density, to provide the required bearing value, so that construction or paving over the area can proceed immediately after backfilling is completed. Along all other portions of the trenches, the ground shall be graded to a reasonable uniformity and the mounding over of the trenches left in a uniform and neat condition to the satisfaction of the Engineer.

3 CONCRETE WORKS

3.1 CONCRETE

3.1.1 CEMENT

Cement shall, unless otherwise stated, be Ordinary Portland Cement of approved brand and shall comply with the requirements and shall satisfy the tests contained in BS12.

Cement shall be of recent manufacture and shall be used within a period of 6 months of manufacture.

The Contractor shall with each fresh consignment of cement delivered to the site furnish the Engineer with a copy of the Manufacturer's statement of compliance with the above Standard Specifications together with the date of manufacture, certified by an independent agency in the country of origin and its date of delivery to Site.

Check tests will be required by the Engineer. These tests shall be carried out at the Contractor's expense. Any cement failing to meet the required standards will be rejected and replaced at the Contractor's expense.

3.1.2 NORMAL WEIGHT AGGREGATE

Fine aggregate for use in the production of concrete shall be of river sand and shall conform to the requirements of BS 882. Its grading shall be to Zones 1, 2 or 3 as defined in BS 882 and shall have not more than 10% retained on the 5 mm sieve.

Course aggregate for use in the production of concrete shall be composed of crushed gravel or stone. It shall conform to the requirements of BS 812 and shall have not more than 10% passing the 5 mm sieve.

Sources of aggregate shall be to the approval of the Engineer and samples of aggregate from the proposed sources shall be submitted to the Engineer at least 28 days before intended use. No new sources of aggregate will be permitted without prior approval of the Engineer.

The aggregates shall be free from salt, mud, clay, organic impurities or any such material and shall contain not more than 0.03% by weight of chlorides nor 0.4 % by weight of sulphates.

Any aggregates which fail to meet these requirements shall be rejected and removed from the site, following which the Contractor's sources of supply shall be re-examined for suitability. All the expenses subject to such incidence shall be borne by the contractor.

3.1.3 WATER

Water used for mixing and curing concrete or washing aggregate shall not contain vegetable matter, acid, sulphates, chlorides or other salts in such quantities as to cause efflorescence on the face of the concrete nor to effect adversely the setting time or strength of the concrete nor to instigate electrochemical corrosion of the reinforcement. Potable water containing not more than 10 parts per million dissolved solids shall be used for all reinforced concrete work. Potable water supplied from MWSC shall be used for concreting as well as all the other parts of the works.

3.1.4 MIX PROPORTIONS

The Contractor, having knowledge of the source and type of cement, aggregates, plant and method of placing he intends to use for the aggregate/cement ratios and water/cement ratios which he considers will achieve the strength requirements specified and will produce a workability which will enable the concrete to be properly compacted to its full depth and finished to the dimensions and within the tolerances shown on the Drawings, shall be responsible for designing his concrete mixes within the following limitations. The aggregate/cement ratios and the water/cement ratio shall not exceed the upper limits specified below. Furthermore, the quantity of cement per cubic metre of concrete shall in no case be less than the minimum specified:

Normal weight concrete grades	Characteristic compressive strength of cubes at 7/28 days		Maximum aggregate size (mm)	Maximum free water cement ratio	Kg of cement per cubic metre of compacted concrete	
	7 days	28 days			Max	Min
25	20	25	20	0.45	550	350

As soon as possible after commencement of the Contract, the Contractor shall prepare such trial mixes as required to satisfy the Engineer that the specified concrete strengths will be obtained using the materials and mix proportions in accordance with the above clauses. The proportion of cement shall be increased if necessary to obtain the strengths required.

From each trial mix, six preliminary Test Cubes shall be made and tested two at 7 days and four at 28 days, the test at 7 days being intended to give an early indication of possible variation from the required strength. If the difference between the highest and lowest results from any one trial mix is more than 15 per cent of the average of the strength test results, the test is to be discarded and a further trial mix made, unless all test results so obtained are above the required strength.

3.1.5 BATCHING AND MIXING OF CONCRETE

All concrete shall be batched by weight and mixed mechanically. Hand mixing will not be allowed.

Concrete may either be batched and mixed on Site or outside the Site and transported thereto.

When mixed outside the Site and transported to it, batching and mixing shall be in accordance with ASTM Specification C94 "Standard Specification for Ready Mixed Concrete".

When mixed on Site, batching and mixing shall be as follows;

Batching by Weight: The cement and each size of aggregate shall be measured by weight. The water may be measured by weight or volume. The weight batching machines used shall be of an approved type, and shall be kept in good condition while in use on the Works. Checks are to be made as required to determine that the weighing device are registering correctly.

Batching Aggregate by Volume: When batching aggregates by volume is allowed, as and when required, the cement shall be batched by weight and the water by weight or volume. Each size of aggregate shall be measured in metallic containers the depth of which is at least equal to their greatest width. The containers shall be of such shape that their volume can be easily checked by measurement.

Mixing Concrete:

Mixing shall be done in a mechanical mixer. The mixer drum shall be free of hardened mortar adhering to its inner surface. Before mixing commences the drum shall be primed by washing with rich cement grout. A measured quantity of dry course aggregate shall be first placed in the hopper. This shall be followed with the measured quantity of sand and then cement. The skip shall be raised and the dry material slipped into the drum.

The dry materials shall be mixed for at least four turns of the drum after which the correct quantity of water shall be added gradually while the drum is in motion, to ensure even distribution of the materials.

The total quantity of water for mixing shall be introduced before 25% of the mixing time has elapsed and shall be resulted to achieve the specified water cement ratio. The complete contents of the mixer shall be emptied before recharging. When the mixer is closed down for the day or for any period exceeding 20 minutes, the drum shall be flushed clean.

Concrete mixture shall be constantly controlled to obtain required workability and mix strength. Mixing time for each batch shall be not less than 3 minutes.

3.1.6 PLACING

Concrete shall be conveyed from the mixer to its final position in any suitable manner, provided there is no segregation, loss of ingredients or contamination. It shall be placed in its final position before initial setting takes place and within 20 minutes of the addition of the water to the mixer. However, when agitating equipment is used to convey concrete such as in ready-mixed concrete, the elapsed time between the addition of the water and placing may be increased to 45 minutes.

The order of placing concrete shall be such as to prevent water from collecting at the ends, corners and along the faces of forms. It shall not be placed in large quantities at any given point and allowed to run or be worked over a long distance in the form. Whenever possible concrete shall be placed and compacted in even layers with each batch adjoining the previous one.

The thickness of each layer shall be between 150 and 300 mm as agreed with the Engineer. The layer thickness will depend on the width of forms, the amount of reinforcement and the need to place each layer before the previous one stiffens.

Concrete shall not be allowed to drop freely for more than 1.50 m except for the columns. To convey the concrete as near as possible to its final positions, drop chutes of rubber or metal shall be used for small sections and bottom dump buckets or other suitable vessels for large sections.

Concrete shall be carefully compacted when placed to ensure a dense and uniform mass free from air holes and cavities. Concrete shall be compacted by vibrations. Vibration shall be performed by mechanical or electromechanical vibrators. The vibrators shall be of the plunger (poker) type for insertion in the concrete.

The poker type vibrators shall have a diameter compatible with spacing of reinforcement, a sufficiently high frequency and be properly handled by experienced personnel. They shall be immersed at regular intervals close enough to vibrate all the concrete, but not so close as to affect previously vibrated and partially set concrete. Each immersion shall continue until shortly after air bubbles cease to appear on the surface of the concrete, but shall not last more than 30 seconds. The vibrators shall be withdrawn gradually to ensure that no air pockets are formed.

All vibrations, compaction and finishing operations shall be completed within 15 minutes from the time of placing the concrete in its final position.

Concreting for any one part or section of the work shall be carried out in one continuous operation, and no interruption of concreting work will be allowed. Where beams and slabs together form an integral part of the structure, they shall be poured in one operation, unless provision is made to form a construction joint. A record is to be kept by the Contractor on Site of the time and date of placing the concrete in each portion of the works and the number and identification of the Works Tests Cube corresponding to these portions.

3.1.7 TESTING

The frequency of testing shall be as noted in the clauses of this section. The Works Test Cubes shall be made at least once for each individual part of the structure as agreed with the Engineer.

At least six cubes shall be made at one time. Three of the six cubes are to be tested at 7 days. The remaining three cubes are to be tested at 28 days, and their average strength must not fall below the minimum strength specified and the lowest test result shall not be more than 20% below the average of the four cubes.

When the result of the 7-day test is unsatisfactory, The Contractor may elect to remove and replace the defective concrete without waiting for the 28-days test. If the result of the 28-days test is unsatisfactory, all concreting shall be stopped at the Contractor's expense and shall not proceed further without written permission from the Engineer.

If concrete is unsatisfactory, and where requested by the Engineer, the Contractor shall remove and test cores or conduct in-situ load tests from/on suspect portions of the works. Concrete found to be defective shall be cut out, removed and replaced by the Contractor at his own expense.

3.1.8 CURING

Freshly placed concrete shall be protected from rain, dust, chemical attack and the harmful effects of heat, wind, flowing water, vibrations and shocks. This protection shall continue until the concrete is sufficiently set such that it can no longer be damaged by these factors which shall not be less than 24 hours after the time of placing.

Concrete shall be cured for at least 7 days or longer if instructed.

Timber formwork covering the concrete shall be moistened with water at frequent intervals to keep it from drying during the curing period. Metal formwork exposed to the sun must be shaded from its direct rays, painted white or otherwise protected during the curing period.

3.1.9 FORMWORK

The Contractor shall supply, design, erect, strike and remove the formwork and be entirely responsible for its stability and safety so that it will carry the wet concrete and all incidental loadings and preserve it from damage and distortion during its placing, vibration, ramming, setting and curing. It shall be so constructed as to leave the finished concrete to the dimensions shown on the Drawings and of a material capable of providing the surface finish specified. In any event, the maximum permissible deflection under all loads shall not exceed 2mm or 1/600 of the free span, whichever is less.

Formwork shall be constructed so as to prevent the loss of any liquid from the wet concrete and to be removable without shock to the partially set concrete. When the concrete is to be vibrated, all wedges must be nailed so as to prevent slipping or distortion.

Drip moulds of size 12mm shall be provided in the bottom of extended slabs, fascia and above window beams.

Formwork shall be of timber and/ or metal and shall include all temporary concrete moulds and their supports.

For concrete surfaces which are to be plastered, clean sawn boards should be used.

For concrete surfaces which are to remain exposed wrought formwork shall be of timber framing lined with 12mm thick smooth polyurethane faced plywood or an equal approved lining or of metal, suitable to obtain a fair-faced finish on the concrete. Where columns or beams are shown as chamfered wrought hardwood fillet shall be planted in the angles of the formwork. Except where shown otherwise on the drawings, all exposed concrete corners and arises shall have a 10 x 10mm chamfer.

All formwork is to be thoroughly cleaned of any concrete or any other deposits. Immediately before concreting, formwork shall be thoroughly hosed down with water, temporary openings being provided to permit the escape of sawdust, shavings etc., with the water.

Wherever required and prior to placing of the reinforcement the internal surfaces of all formwork shall be treated with an approved mould oil.

Unless otherwise specified, the minimum period before striking formwork shall be as follows.

Columns	2 days
Beams, sides	2 days
Beams, soffits	14 days
Beam props	21 days
Suspended slabs, soffits	21 days
Cantilevers soffits	21 days

Any work showing signs of damage through premature loading is to be entirely reconstructed at the Contractor's expense.

The Contractor is entirely responsibility for the safe removal of formwork and all other temporary works.

3.2 CONSTRUCTION JOINTS

Whenever placing of concrete is discontinued within a bay or prior to completing a member, a construction joint shall be formed. Construction joints are to be made only along a horizontal or vertical plane except that in the case of inclined or curved members

they shall be at right angles to the principal axis. Care shall be taken to prevent offsetting of the joint and to ensure water tightness.

Unless otherwise shown on the Drawings, construction joints will not be allowed in the unsupported sections of slab, beams and beamlike members. At construction joints the laitance film and porous layer of the already set concrete shall be removed and the surface keyed by hacking and then wire brushed and thoroughly cleaned. Immediately before adding the fresh concrete, the surface is to be thoroughly wetted and an approved concrete bonding material shall be applied on the surface. The new concrete is then to be well compacted against the old.

3.3 REINFORCEMENT

Reinforcement shall be high yield deformed bars or mild steel complying with B.S. 4449 or welded wire fabric complying with B.S. 4483, except that the characteristic strength for mild steel reinforcement shall be 250N/mm² and for high yield steel shall be 450 N/mm².

High yield bars will be shown on drawings with T prefix. Mild steel bars will be shown on drawings with R prefix.

Reinforcing bars are to be stored clear off the ground and shall be truly straight. Suitable covering shall be provided to protect against windblown sulphates, chlorides and other deleterious matter.

Manufacturer's test certificates for all classes of reinforcement shall be supplied when required. Specimens sufficient for three tensile tests and three cold-bending tests per ten tonne of bars or fraction thereof and for each different size of bars shall be sampled. Testing shall be in accordance with B.S.4449 and batches shall be rejected if the average results for each batch is not in accordance with BS4449.

All steel is to be totally free from dirt, paint, loose rust or scale and is to be thoroughly brushed and cleaned after positioning and immediately prior to concreting.

The bars are to be accurately bent to the shapes indicated, and the bending must, wherever possible, be completed before the steel is fixed in position. Straight portions of bars must be true and bends must be kept out of winding. The internal radius of bends shall not be less than four times the diameter of the bar, except for stirrups and column binders. Great care is to be taken to bend stirrups and column binders to fit closely around the main bars. In the absence of reinforcement bending schedules the bending requirements of B.S. 4466 "Bending Dimensions of Bars for Concrete Reinforcement" or other similar approved standard shall govern.

Except where agreed by the Engineer all bars are to be bent cold.

Lengthening of bars by welding and re-bending of incorrectly bent bars will not be permitted.

Unless otherwise stated splices in reinforcing bars shall be formed by lapping. Such laps in bars in any member shall be staggered. Except as otherwise indicated on the Drawings, the minimum overlap of lapped splices shall be 40 bar diameters or 300mm, whichever is greater.

The steel is to be fixed in position exactly as indicated and the bars are to be securely wired together with 1.6 or 1.4mm soft iron wire or approved spring steel slips wherever necessary to prevent any displacement during concreting. Spacers, chairs and the like, temporary or permanent, are to be used as required to ensure that the steel has the exact amount of cover indicated. No permanent spacers may show on a surface where a fair faced concrete finish or brushed aggregate finish is required.

Unless otherwise indicated, the minimum cover to the reinforcing bars and to binding wire shall be as follows:

POSITION	COVER mm
Main bars in columns	40-45
Main bars in floor slabs and soffits of roof slabs	30
Main bars in top of roof slabs	30-35
Bars in top ground slabs	30-35
Bars at faces in contact with soils	50-55
Clear cover in beams	35-40

The Contractor is to ensure that no steel is displaced from its position during the placement of concrete.

All reinforcement to be sprayed with water two hours before concreting commences.

3.4 ADMIXTURES

No admixtures of any type shall be used in the preparation of concrete or concrete products without prior approval of the Engineer. The rates and methods of application shall be strictly in accordance with the manufacturer's written instructions.

3.5 WATERTIGHT CONSTRUCTION

All concrete work below ground level shall be designated as watertight.

The Contractor shall include in his rates for such waterproof additives as he deems to be necessary, subject to the prior approval of the Engineer, or as instructed on the drawings.

When in the opinion of the Engineer, damp patches or leakage of water in the finished work are due to failure of the Contractor to comply with the specification, the affected work shall be made good at the Contractor's expense.

Water bars shall be provided as shown on the drawings and at all construction joints and the type of water bar will be as specified or to the approval of the Engineer. All water bars shall be jointed and supported strictly in accordance with the manufacturer's instructions.

3.6 MORTAR

3.6.1 DESCRIPTION

Mortar for bedding kerbs, channels, cover frames etc shall be 1:3 cement: sand mortar. Mortar for grouted stone pitching shall have 5% by weight of hydrated lime added to it. Mortar for use with block work shall be 1:4 cement: sand mortar.

3.6.2 MATERIALS

Cement shall be Portland cement to BS12 and sand shall be a natural sand or crushed natural stone or a combination of both as specified in BS 1200.

3.6.3 MIXING

Mortar shall be mixed thoroughly either by hand or mechanically until its colour and consistency are uniform. The constituent materials shall be accurately gauged, allowance being made for bulking of sand. Mortar shall be made in small quantities only as and when required. Mortar which has begun to set or which has been mixed for a period of more than one hour shall be discarded.

Mortar plasticisers may be used with the Engineer's approval, but in no circumstances shall calcium chloride be permitted.

4 MASONRY AND RENDERING

4.1 MATERIALS

4.1.1 CEMENT

Ordinary Portland Cement shall be used as described under concrete work. White or coloured cement shall comply with the physical requirements of B.S 12.

4.1.2 WATER

Water shall be as described under Concrete Works.

4.1.3 SAND

Sand shall be imported river sand, free from silt, quality to be approved by the Engineer.

For use in plastering, sand is to comply with the requirements of BS1198 Table 1.

4.1.4 SOLID BLOCKS

Blocks shall be 300mmx150mmx100mm size solid blocks manufactured with cement and sand with no defects and sample shall be submitted to the Engineer for the approval before ordering the material.

The average compressive strength for the gross area of hollow blocks shall be not less than 25 kg/cm² and the minimum block shall be 20 kg/cm².

4.2 MORTAR

Mortar shall consist 1 part cement to 4 parts of sand by volume. For work not in contact with earth or sand, one part lime may be added to the mix. Mortar for pointing facing concrete blocks shall be prepared using white cement. When blockwork is constructed below ground level sulphate resisting cement shall be used.

Should the Contractor wish to use a plasticiser with mortar, then the mortar shall consist of 1 part cement to 4 parts sand with plasticiser added and used strictly in accordance with the manufacturer's instructions. The plasticiser must be approved by the Engineer before use.

Mixing shall be carried out by means of an approved mechanical mixer. The mortar shall be mixed dry until a uniform mix is obtained. Sufficient water shall then be added and the mixing continued until a homogenous mix is obtained. Excess water shall not be used in the mix.

All mortar shall be used before the initial set has taken place and on no account shall mortar which has commenced to set be remixed with water or new batches and used.

4.3 WORKMANSHIP

Generally in accordance to BS 8000.

Blockwork shall be set out and built to the respective dimensions, thicknesses and heights shown on the Drawings and/ or as instructed in writing by the Engineer.

Unless otherwise ordered, solid blocks shall be used In all closures, end blocks such as at door jambs, window openings, etc., and blocks of special lengths or size, shall be solid. The blocks shall be well soaked before being used and the tops of walls left off shall be wetted before work is recommenced.

Blocks shall be laid in true and regular courses on a full bed of mortar of 10 mm average thickness, exclusive of any key in the jointing surfaces of the blocks. Sufficient mortar shall be used in bedding and jointing to ensure that all keys are solidly filled. Where blocks abut against concrete each third course shall be tied thereto by means of approved galvanised steel ties.

All horizontal joints shall be properly level. The Vertical joints shall be properly lined and quoins, jambs and other angles plumbed as the work proceeds.

All walls shall be plumbed vertical.

Standard sized block shall be used wherever possible. Broken blocks shall not be used except where required for bonding purposes. Walls and partitions shall be bonded to one another at angles and junctions.

Joints of faces of block walls which are to be rendered or plastered shall be raked out for depth of 10 mm as the work proceeds.

Walls shall be carried up regularly without leaving any part more than one metre lower than another unless the permission of the Engineer is first obtained. Work which is left at different levels shall be racked back.

The Contractor shall cut and fit blockwork as required, leave or form chases for edges of concrete slabs, steps, ends of partitions, etc cut chases for pipes, conduits, etc., and generally perform all cutting away for all trades. Wooden plates and door and window frames shall be bedded and exposed edges pointed in mortar and cramps shall be built in.

Finished blockwork shall be to the following tolerances;

- Adequately straight on plan, with a ± 5 mm maximum deviation in any length of wall up to 5m; and adequately straight in section, with a tolerance of ± 4 mm per storey height (up to 3m)
- A maximum of 4mm from plumb in any storey up to 3m. Taller walls should be a maximum of 5mm from plumb per storey and 10mm in total
- A maximum deviation of 4mm over 2m at external reveals.
- A maximum deviation from straightness of ± 6 mm in any 5m section of wall.
- Corners of walls should be straight, with no zigzag.

4.4 PROTECTION OF FINISHED BLOCKWORK

The Contractor shall ensure that the finished blockwork walling is not damaged by subsequent operations.

The Contractor is to protect newly or partially built walling against it being dried out too rapidly by the sun's heat or from any other adverse climatic effects and is to follow the Engineer's instructions in this matter.

The Contractor shall in all cases cover all newly erected walling with hessian or other material approved by the Engineer and shall keep the same wet for at least three days.

4.5 POLYSULPHIDE SEALANT

Gun quality sealant shall be used where specified on the drawing or where requested by the Engineer including external joinery and metal work bedded against blockwork or concrete. The colour shall be to the approval of the Engineer.

The primer shall be supplied by the same manufacturer as the sealant. The joints will first be thoroughly cleaned to the satisfaction of the Engineer and shall be primed before sealing with sealant. Application of these materials shall be strictly in accordance with the manufacturer's printed instructions.

4.6 LINTELS

Prefabricated lintels shall comply with the requirements of B.S 5977, Part 2. All lintels shall be bedded on cement and sand mortar and the Contractor shall allow for a minimum bearing at each end of 150 mm.

4.7 REINFORCEMENT

Wire mesh reinforcement shall be used every connection to concrete. The type of reinforcement, method and the sample shall be approved by the Engineer.

4.8 STORAGE OF MATERIALS

Cement shall be stored in a weatherproof ventilated housing off the ground and away from any source of water and dampness. These materials shall be stored in such a manner that they are used in rotation in order of delivery.

Sands shall be stored separately according to type, on clean concrete hard standings and protected from contamination.

Blocks shall be delivered to Site stacked and stored to permit ventilation and protected from rain, dampness and the like.

In the event that any materials for use in this Section deteriorate and become unusable due to inadequate and poor storage they shall be removed from Site as instructed by the Engineer and replaced at the Contractor's expense.

4.9 PREPARATION OF SURFACES FOR PLASTERING

Surfaces to receive plastering, beds and the like are to be dry brushed to remove all loose particles, dust, laitance, efflorescence and the like, any projecting fins on concrete surfaces shall be hacked off. All traces of mould oil shall be removed from concrete surfaces by scrubbing with water containing detergents and rinsing with fresh water.

Surfaces are to be wetted and re-wetted as required to equalise suction before the first coat of plaster or the like is applied. Particularly dense, hard concrete surfaces are to be wetted and re-wetted as required before bonding plaster is applied.

Where surfaces are out of line, they are to be brought to level by hacking or dubbing out in similar mix to the undercoat prior to commencement of finishing. Irregularities in surfaces to be plastered shall be filled with mortar (without lime) twenty-four hours before plastering commences.

Joints in blockwork and the like shall be well raked out before re-plastering to form a good key. Smooth concrete surfaces to be plastered shall be treated with an approved proprietary bonding agent.

Plastering shall not be commenced until all mechanical and electrical services, conduits, pipes and fixtures have been installed.

The Contractor shall satisfy himself as to the suitability of all surfaces prior to the commencement of the application of the finishing material.

4.10 PLASTERING

Internal plastering is to comply with BS 5492.

The plaster for use internally is to be composed of 1 part cement, and 4 parts of sand, and is to be applied in 2 coats to the finished stated thickness.

The render for use externally is to be composed of 1 part cement and 4 parts of sand, and is to be applied in 2 coats to the finished stated thickness externally. The plaster shall have waterproofing quality by adding approved waterproofing additives into the mix.

The working time permissible after the addition of water to the plaster or render mix is to be 30 minutes. Mixed plaster or render that has exceeded this limit is to be removed from the site and not re-tempered and used in the works. Any excess mortar fallen on to the ground during plastering shall not be re-used in the works.

The Contractor is to ensure that before plastering or rendering commences the junctions between differing base materials are reinforced with a strip of galvanised expanding metal lath secured at both edges. All angle beads and the like shall also have been fixed.

All surfaces to be plastered or rendered are to be sprayed with water, with is to be allowed to dry out before a key coat of cement slurry is applied.

All undercoats are to be scratched to form an adequate key for the next coat. The setting coat is not to be applied until the floating coat has been left in a moist condition for at least three days. Both coats must be cured with water for minimum of three days or as directed by the Engineer.

All Plastering shall be executed in a neat workmanlike manner and made good to wood frames, skirting, pipes, fittings and the like.

Plasterwork is to be finished with a smooth, trowelled face, free from blemishes and fit to receive decoration. Render is to be finished with a wood float. Any blown, cracked or otherwise damaged plaster or render shall be condemned by the Engineer and is to be hacked off and made good with quick setting plaster at the Contractor's expense.

Full use is to be made of grounds, rules and angle trowels to ensure that all wall faces finish plane and true to line in all direction and that all angles are straight, true and plumb. Prices

for plastering and rendering are to ensure that work to walls and ceilings are effectively 'cut' at the joint so as to minimise damage due to movement.

All finished plastered and rendered surfaces shall conform to the following tolerances:

- A maximum deviation from straightness of ± 4 mm in any 5m section of wall.
- Be consistent in texture, finish and colour
- Be free from crazing (hairline cracks, generally less than 1mm in depth and no more than 0.2mm wide).
- No shrinkage cracks shall be observed at junction of floors, walls and ceilings

Applying of dry cement on to the surface, in any condition, shall not be allowed.

4.11 SAND CEMENT SCREED

Floor screeds are to compose of one part cement and five parts sand and are to be smooth and level. Final difference in levels in any part of the building shall not exceed 2 mm, otherwise the Contractor shall be required to apply an approved self levelling screed to finish the surface.

Where beds are to be laid direct on to a concrete sub-floor that has set, the surface of the sub-floor is to be thoroughly cleaned and prepared to ensure a good bond, the surface being chipped with a pick if necessary, brushed well and washed out to remove all dust and dirt, and thoroughly soaked with water left on overnight. Surplus water is to be mopped up and immediately prior to laying the bed, the sub-floor is to be coated with a grout of neat cement wash well brushed on as the work proceeds. The grout must not be permitted to set before the bed is laid.

Alternatively the Contractor may use a bonding agent applied in conformity with the manufacturer's instructions.

Pipes, conduits and the like to be embedded in a screed or topping shall be securely fastened to the concrete sub base, then apply cement and sand haunch to the side of pipes/conduits and a layer of chicken wire mesh overlaid at least 200 mm wide at each side. When these operations have been completed the Contractor may commence the laying of screed/toppings.

The Contractor shall lay screeds or toppings in bay sizes as instructed by the Engineer including filling joints between bays as directed. Joints in the concrete sub base shall be continued through the screeds or toppings.

The screeds or toppings shall be finished to give the surface stated using either a hand trowel, mechanical power float or the like. All finishes shall be uniform, smooth and free from ridges, trowel marks and other blemishes. For a non-slip finish apply carborundum particles between successive trowelling operations to give a smooth surface.

The beds shall be protected from excessively rapid drying out by means of tarpaulins or polythene sheeting for a minimum of 7 days after laying. Laying beds is preferably to be carried out when the building is fully protected from adverse weather, however, the Contractor is to protect all beds as necessary from damage by wet weather.

In the terrace the screed shall have a gradient as shown in the plan about 1% in the directions indicated by the arrows.

5 ROOFING AND WATER PROOFING

5.1 ROOFING

Roofing sheets, flashings, ridge capping and gutters shall be BHP Lysaght or the co similar quality to the approval of the Engineer. All other material to be used in the roofing work shall be good quality and approved type, if non-standard type to be it is subject to Engineer's approval. Down pipe shall be diameter 75mm PVC as shown in the drawings.

Workmanship shall be to the highest standards and codes of practice.

The Contractor is to be solely responsible for providing a roof that is completely watertight and corrosion resistant and able to withstand expansion extremes likely to be encountered with temperature fluctuations. The Contractor is to ensure that the completed roof will be able to withstand normal pedestrian traffic at occasional intervals without sustaining damage of any description.

All the fixing accessories to be used in the roofing works shall of good quality and shall be approved by the Engineer before installation in the Works.

5.2 WATER PROOFING

5.2.1 GENERAL

All waterproofing systems shall be carried out as per the manufacturer's written prescriptions and is subject to the approval of the Engineer before used in the Works. Appropriate number of coatings and thickness shall be maintained as specified by the manufacturer.

5.2.2 PREPARATION OF SURFACES

All surfaces shall be clear of all deleterious matter and dry all in accordance with the manufacturer's written instructions. Prior to the application of any waterproofing material or primer the Contractor shall grind the concrete surface using a mechanical grinder to ensure all surface irregularities are removed and obtain the Engineer's written approval that he may commence the said works, without same all works shall be rejected and replaced at the Contractor's expense.

5.2.3 SUBSTRUCTURE WATERPROOFING

All surfaces below ground shall be waterproofed by waterproofing system approved by Engineer.

5.2.4 SUPERSTRUCTURE WATER PROOFING

All the balconies, toilets, pantries and Roof gutter shall be waterproofed using appropriate water proofing material as approved by the Engineer. The screed provided should slope leading to the drainage points shown. Where the waterproofing layer meets a wall, the waterproofing chemical shall be continued up the wall at least 150mm above the floor. The same shall be treated as pipe connections to the floor.

5.2.5 PROTECTION OF WATERPROOFING LAYER

Finished and part finished surfaces shall be suitably protected to ensure no damage by other trades. Any waterproofing so damaged due to non-protection shall be removed and replaced at the Contractor's expense. The Contractor shall submit to the Engineer his proposed methods of protecting the various surfaces and locations prior to their completion

or application of finishing layers such as tiling and the like. The waterproofing layer shall not be covered by finishes before the layer has been inspected by the Engineer.

5.3 TESTING

The Contractor is to test, to the satisfaction of the Engineer, all areas of roofing, waterproofing, terraces, bathrooms, and the like for water penetration. These tests are to be carried out after the membrane has been laid.

The Contractor is to allow in his rates for such areas to be flooded with water, and left for a minimum of 48 hours.

On completion of roofing works the Contractor is to leave the roof clean in a sound and watertight condition, to the approval of the Engineer, and in a satisfactory state for handing over.

6 METALWORK

6.1 STAINLESS STEEL WORK

6.1.1 HAND RAILS

Handrails in main staircase shall be made with stainless steel pipe and those at balconies shall be fabricated with stainless steel unless otherwise stated in the drawings. All welding shall be properly ground and polished to give a smooth finish all over the railings. All the bolts, cleats, brackets and plates used in the stainless steel work in this works shall also be stainless steel.

7 ALUMINIUM DOORS AND WINDOWS

7.1 GENERAL

All windows and doors are to be constructed by approved specialist suppliers of light, medium or heavy section to suit location, local building regulations, and particular requirements noted on the drawing as to weight and profile. All aluminium sections used shall be powder coated with a minimum thickness of 80 microns.

The Contractor shall submit shop drawings of all aluminium doors and windows for approval of the Engineer. Works for procurement shall proceed only after approval from the Engineer.

All frames should be made to fit the actual openings with a 5mm clearance all round. Discrepancies in overall width or height exceeding 5mm will not be allowed and the frames will be rejected in such cases. Any small discrepancies shall have the gaps suitably backed and then filled with gun-applied water and fungus repellent mastic sealant.

All nuts, bolts, washers and screws used for assembly and fixing shall be of adequate strength for their purpose within the design and shall be stainless steel grade 18/8.

All sealants used in the assembly of, and in the fixing of cladding and window framing, shall be non-setting to allow thermal movement without detriment to those joint sealants used for peripheral caulking and shall be one part silicone sealant and shall conform to BS 4245 or ASTM C920. All spliced joints between mullions will be sealed with an approved silicone product, compatible with other sealants and packings used.

All ironmongery shall have the same finish as the frames and shall be approved by the Engineer.

7.2 SIDE HUNG WINDOWS, DOORS AND VENTILATORS

All Windows and doors should be weather-stripped. The weather protection should be achieved by a positive compressive action against the section and should not depend on external contact. At every contact between two profiles two weather-stripping sections should be provided to complete weather protection.

The bottom sections for hinged doors must be capable of being adjusted vertically if necessary. The gap between the bottom section and the floor should be covered with a pair of special splay-type sections.

The shutters of the windows and doors should be assembled with concealed corners of high rigidity. Hinges should be concealed within the sections.

Hinges shall be anodised aluminium with stainless steel pins and nylon washers. Handles shall be anodised aluminium finished to match the aluminium sections and mounted with self-lubricating nylon washers.

Windows shall have anodised aluminium handles, colour as framing and a latching mechanism securing the shutter to the frame both at the top and bottom.

7.3 WORKMANSHIP

Take site dimensions and submit Drawings as detailed elsewhere in these documents, showing elevations, plans and full size sections, proposed methods of fixing, proposed methods of forming joints, any proposals for fabricating large components in more than one piece.

Prepare control samples as requested and obtain Engineer's written approval of appearance before proceeding with manufacture.

Fabricate metalwork carefully and accurately to ensure compliance with design and performance requirements, using types and grades of metal appropriate for the purpose. Finished work must be free from distortions and cracks. Use proprietary products to manufacturer's recommendations.

Pre-finished metal may be used if the finish complies with this specification, the methods of fabrication do not damage or alter appearance at finish and the finish is adequately protected during fabrication.

Cold formed work, use brake presses or cold rolling to produce accurate profiles with straight arises. Unless specified otherwise, mitre junctions of identical sections. Remove all burrs and sharp arises which would be visible after fixing or a hazard to the user. After thermal cutting stainless steel grind off material which is liable to corrode.

When assembled all moving parts must move freely and without binding.

Prepare surfaces of metals to receive adhesives by degreasing and abrading mechanically or chemically and form bond under pressure. Use adhesives in accordance with manufacturer's written recommendations.

Mechanical joints shall be tight with no visible gaps. Where screw heads will be visible after component is fixed, or raised screw heads would interfere with any moving part of component, use countersunk machine screws unless specified otherwise. Mechanical

joints of components which will be located externally shall be bedded in bedding compound, including all mating surfaces, cleats and other fixings.

Position metalwork accurately, plumb, level and true to line. Fix securely to prevent pulling away, deflection, or other movement during use. Do not distort when tightening fastenings and the like.

Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall give ample strength and stiffness. Joints exposed to weather shall be formed to exclude water. Do all cutting, punching, drilling and tapping required for attachment of hardware and of work by other trades.

7.4 INSTALLATION

Aluminium work shall be installed adjusted and glazed by experienced workmen all in accordance with the manufacturer's installation instructions and in full conformity with the approved shop drawings, samples and other submitted data. Under no circumstances shall materials be installed on surfaces that contain condensation, dirt, grease or other foreign encountered materials that would hinder or prevent proper installation and functioning for the use intended.

Aluminium work shall be carefully and accurately assembled with proper and approved provision for contraction and expansion and set in correct locations as per approved detailed shop drawings, all level, square, plumb and aligned with other work. All joints between framing and structural building shall be sealed in order to be watertight and weatherproof and to satisfy all other requirements of the Engineer.

Frames shall be designed and manufactured with a maximum 2.5mm tolerance around the opening in the structure. These joints are to be finished by applying an approved sealant into a polystyrene foam backing strip.

All aluminium works are to be fully protected for the duration of the contract from damage by other trades. The Engineer shall approve the method of protection.

If for any reason final finishes become scratched, abraded or damaged during transport, delivery, storage or erection, it shall be the Contractor's responsibility to remove or repair those defective areas or components as directed and to the complete satisfaction of the Engineer.

Repair work shall be identical to the manufacturer's applied finish with regard to gloss, finish and visual appearance. Field touch up of painted aluminium is permitted only with the written permission of the Engineer. Where touch up is not an authorised means of repair the damaged materials must be replaced by new.

Upon completion of work all protective coverings from all exposed surfaces shall be removed. All surfaces shall be cleaned using soap or detergents as recommended by the aluminium manufacturers to remove sealants, discolouration and any other foreign material. Windows and doors are defective if, when closed, they allow the entry of water. Defection of any type determined by the Engineer shall be repaired at the Contractor's expense.

Extreme care shall be taken when cleaning the exterior portion to protect all other adjacent works.

7.5 SAMPLES

Submit duplicate samples of all finished materials for approval by Engineer. The samples will show the full range of finishes and mechanical properties to be expected in the

finished product. Where physical samples would otherwise be too large, examples will be given that can be readily inspected locally, or the Contractor will provide facilities for the Engineer's inspection at the Contractor's expense.

Unless specifically called for, size and form of each sample shall be as directed by the Engineer.

7.6 SEALING JOINTS

The Contractor shall ensure that joints are dry and remove all loose material, dust and grease.

Joints shall be prepared in accordance with sealant manufacturer's recommendations using recommended solvents and primers where necessary.

Adjoining surfaces which would be impossible to clean if smeared with sealant shall be masked.

Backing strips shall be inserted in all joints to be pointed with sealant. When using backing strips, the Contractor shall not leave gaps and shall not reduce depth of joint for sealant to less than the minimum recommended by the manufacturer.

Cavities shall be filled and jointed with sealant of type Dow Corning 914 or similar type suitable for porous and non-porous substrates in accordance with the manufacturer's recommendations.

Sealant shall be tooled to form a smooth flat bead.

Excess sealant shall be removed from adjoining surfaces using cleaning materials recommended by the sealant manufacturer, and shall be left clean.

7.7 MIRRORS

Mirrors shall be of uniform thickness, free from waviness, air bubbles and the like. Representative samples of mirror shall be submitted for the Engineer's approval. The mirror glass shall be clear and silvered by nitrate precipitation, protected by copper plating with a protective plastic coating on the reverse side. The mirrors shall be 6 mm thick and cut to sizes as shown with ground and polished edges. The mirrors shall be set on 20 mm thick plywood backing plugged and screwed to wall.

7.8 GLASS OPENINGS

The glass framing shall both structurally support and adequately cushion the glass. To prevent mechanical and thermal stresses on the glass, the framing system shall provide openings that are within the tolerances for square ness, corner offset and bow. These tolerances are listed below.

Square ness	-	3mm difference in lengths of the diagonals.
Thickness of glass	-	Unless otherwise specified in drawings, shall be 6mm
Corner Offsets	-	0.8mm maximum offsets at corners.
Bow	-	1.6mm bow in a 1.22m length of frame.

If the variations from these tolerances are anticipated, details of same shall be advised to the Engineer. If site conditions are found to be outside these tolerances corrections must be made before the openings are glazed.

7.9 GLASS INSTALLATION

Workmanship shall generally be in accordance with CP 152 and respective British Standards.

The glass is to be delivered to the site with adequate protection to prevent damage and where possible it is to be fixed in position immediately after delivery. When fixed the Contractor is to take all necessary precautions to prevent damage during succeeding building operations and will be entirely responsible for the replacement of any broken or damaged glass at his own cost.

The Contractor is to be solely responsible for determining the exact sizes of glass required, including a tolerance of 2mm to each edge and he is recommended to check the necessary dimensions on site.

No glazing is to be carried out until rebates have been painted with primer. Glazing beads as applicable are also to be primed before fixing.

All mastic is to be neatly struck off to agree exactly with site lines inside and out.

Rates are to include for all necessary springs, clips, setting blocks, location blocks and distance pieces and for taking off and later re-fixing loose beads.

Glass apertures in timber doors are to be bedded in chamois leather glazing strip, black ribbon velvet or P.V.C. glazing strip to the approval of the Engineer.

7.10 CLEANING

All glass shall be thoroughly cleaned and polished on both sides and all paint spots and the like completely removed to the satisfaction of the Engineer.

7.10.1 PERFORMANCE REQUIREMENTS

The complete installation should be capable of withstanding minimum inward and outward pressures of 195 kg/mm².

The complete installation shall provide for expansion and contraction over an ambient temperature of 65°C without buckling, sealed joint failure, glass breakage and other detrimental affects.

Make provision to drain water and condensation to exterior face of wall.

Provide tight joints and effectively seal the component of the windows and their joints with other works against leakage and air infiltration. Water leakage is defined as the appearance of water, other than condensation, inside the sealed wall, either during testing or under actual weather condition.

Sound insulation between floors and adjoining rooms shall be to 50dB.

8 CARPENTRY, JOINERY AND TIMBER DOORS

8.1 TIMBER GENERALLY

Joiner's work shall be carried out in accordance with the drawings and the principles of first class construction.

Full details of the timber to be used are to be submitted to the Engineer and the quality for any purpose is to be approved before any timber is delivered to site.

The timber is to be of the best quality available having due regard for the purpose for which it is required and it is to be seasoned to a moisture content of 14%-15% before transportation.

The Contractor is to take a site reading to determine the moisture content of all joinery by Moisture Meter. Documentation is to accompany each batch shipped to verify the moisture content. Without such documentation the whole batch will be rejected.

The Engineer shall reject all unsound timber caused by decay, insect attack, sapwood, splits, shakes, and waney edges, pith pockets, together with large, loose or dead knots.

Unless stated otherwise, sizes shown on drawings are finished sizes. All timber is wrot on all faces unless otherwise stated.

8.2 TIMBER

Timber for carcassing and joinery generally is to be Red Meranti (prime grade) or Kapur, free from decayed or loose knots, splits and any sign of fungus/live insect attack, and to the approval of the Engineer. All such faulty timber shall be removed from the site and replaced by the contractor.

The structural timber wood is to be straight, close grained, with not less than eight annular rings to 25 mm. Unless otherwise described all sawn members are to be of a permissible species which has been visually or machine stress graded and which meets the requirement of BS 4978 may be used with the Engineer's permission.

8.3 HARDWOOD OR JOINERY

Hardwood if specified in drawing shall be first quality Balau unless otherwise stated.

Hardwood is to be quarter sawn unless otherwise indicated and is to show a straight and regular grain throughout without shakes or other defects which would reduce the mechanical or physical properties of the timber. Timber in the finished stage is to be free from wooly texture, soft heart, sapwood, splits, shakes, dote, all evidence of fungus/insect attack and all faults caused by compression failures. There are to be no waney edges. It is to be free from unsound knots and there are to be no knots of any description on exposed faces, unless specifically agreed. Plugging or piecing in will not be permitted.

Colour of hardwood throughout is to be consistent and to the approval of the Engineer.

8.4 PRESERVATIVE TREATMENT

The preservative treatment to all timber shall comply with the requirements of BS 5268 or equivalent for any species not listed therein. The Contractor shall provide a certificate of assurance that treatment has been carried out as specified. Any ends cut after treatment are to be given two coats of preservative. Factory fabricated timber and components shall be treated therein. If required, in-situ treatments shall be carried out with approved preservative chemicals. All timber used in the works shall be treated with appropriate chemical before fixing in place.

8.5 PLYWOOD

Plywood generally is to comply with BS 1455, and is only to be obtained from a dealer approved by the Engineer.

The plywood bonding is generally to be type WBP, except where otherwise stated. The Contractor is only to use plywood of the required thickness, and under no circumstances is he to make up thickness by gluing together sheets of thinner plywood.

The surface grading is to be Grade 1 where to receive clear finish and Grade 2 elsewhere, unless otherwise described. The Contractor is only to use a fine tooth saw when cutting plywood.

8.6 NAILS AND SCREWS

Nails are to comply with BS 1201 and screws with BS 1210. They are to be of the appropriate approved type for their intended use.

8.7 METALWORK

Metalwork fixings are to be galvanised and of a make and pattern approved by the Engineer.

Bolts are to comply with BS 4190.

Fixing accessories are to comply with BS 1494.

Timber connectors are to comply with BS 1579.

Expanding bolts to the approval of Engineer.

8.8 ADHESIVES

Adhesives are to be synthetic resin type complying with BS 1204 Part 1.

8.9 ACCESS PANELS AND THE LIKE

The Contractor is to provide access doors, panels and traps to the complete satisfaction of the Engineer, wherever access may be necessary in order to maintain the services within the building.

Accesses which are likely to be used regularly are to be formed with hinged lockable panels; those used irregularly are to be capable of being removed by releasing screws or clips.

8.10 WORKMANSHIP

Joinery shall comply with BS 1186 Part 2 and CP 112 for structural carpentry, and where possible shall be fabricated in a manufacturer's shop prior to delivery. It shall be accurately, properly and soundly constructed with all moulds and arrises clean and sharp. Joinery shall be protected from damage during storage at Site and throughout the construction period subsequent to fixing.

The terms "frame" or "framed" or "framing" mean work put together by proper carpentry or joinery joints, such as morticing and tenoning, dovetailing, dowelling, etc., and the joints are to be as shown, specified or directed. Butted and screwed or nailed joints or halved joints and the like will not be deemed framed and will not be accepted for framed work.

Fixing of all joinery work, including fillets, architraves, frames, glazing beads and the like shall be by means of screws. Nailed work will not be permitted.

Screw heads in work to be painted shall be countersunk and stopped. Screw heads in wood to be oiled, varnished or polished shall be pellated, with the grain of the pellat in the same direction as the grain of the member.

Unless otherwise described, work described as "plugged" shall be fixed by drilling holes in the wall or floor, plugging with "Plastic Plugs" well rammed in and fixing the member with screws. Centres of the fixings must not exceed those necessary to provide adequate support, and in any case must not exceed 600 mm.

8.11 PACKAGING AND STORAGE

The timber is to be properly stored and protected on site until immediately prior to fixing when the polythene is to be removed and the timber stacked above the ground in the shade.

The Contractor is to ensure that the timber is covered in wet weather and uncovered in dry weather and is to replace any damaged or otherwise affected items at his own expense.

All factory fabricated units and components shall be stored in their packing until fixing of same commences to ensure that damage is kept to a minimum.

8.12 DOORS

Doors shall be properly fitted to give a uniform clearance of not more than 3 mm all round and hinges shall be let into doors and frames.

Flush doors are to be constructed in accordance with BS 459 Parts 1 and 2. All edges are to be lipped with hardwood lipping tongued into the edge of the door.

Flush doors generally shall be solid core flush faced with a teak veneer finish prepared to receive varnish decoration.

The core of solid core flush doors shall be constructed of longitudinal laminations of precision planed timber, butt jointed and glued with resin based adhesive under hydraulic pressure, the whole forming a rigid, fire resistant raft.

All doors, solid/semi solid core, shall be constructed with blocking pieces to receive hinges, door closers and other ironmongery as specified.

Where flush doors are to have an observation panel or are to receive a grille panel the framing of the door must be designed to suit the required size of panel and must be properly framed and rebated around all sides of the panel. Loosely fixed hardwood glazing beads of adequate size are to be provided with the door when delivered to the site for removal and later final fitting.

Where flush doors are to have rebated or rounded stiles the lippings at the edges must be increased sufficiently to allow for these labours. Cutting rebates or forming roundings on standard sized lippings will not be permitted.

For toilet doors, inside of the door shall have oil based paints and on the outside and the edges shall have approved quality wood dye and marine grade varnish finish. Doors shall be solid timber unless otherwise specified.

Frames should be within 3mm of plumb over the height of the frame and not out of plumb in two directions. The gap between the door and head or jamb should be a maximum of 3mm (for double doors, the gap at the meeting stiles should be within 3mm) and uniform. Distortion across doors should be limited to a maximum of 2mm in height and width.

8.13 PROTECTION, FINISHING AND RE-EXAMINATION

All the wood for joinery works, whether it is to be painted or left clear finished, shall be supplied properly planed and rubbed down.

The joinery shall be properly protected during fixing and work by other trades, especially frames and door linings which may require temporary casings.

The frames shall be fitted with a temporary threshold to retain frame shape which can be removed before floor finishes are laid.

Units supplied "pre-finished" (veneered doors, pre-painted doors etc) shall be supplied with an appropriate wrapping, and the Contractor shall repair or replace any defective work, no matter from whatever cause, in order to hand over the works in perfect condition.

After the setting, placing and fixing of the joinery, the Contractor shall examine all the works and ensure that they are fixed correctly. Until the issue of the Practical Completion Certificate and handover of the entire work, the Contractor shall replace at his own expense, all missing or defective parts.

At the end of the works, the Contractor shall check all opening units and their proper functioning, and shall grease all moving parts, if necessary.

After handover, the Contractor shall maintain his work and shall, on request, carry out all easing and adjustments as required.

In the case where defects appear especially, twisting of doors and the like, the Contractor shall rectify such defects at his own expense.

8.14 IRONMONGERY

8.14.1 GENERAL

All ironmongery shall be selected for the appearance and performance required and shall be obtained from a well known reputable manufacturer and shall bear the stamp of the manufacturer. Unless specified otherwise all ironmongery shall be supplied from the same manufacturer.

The Contractor shall not use in the works types or classes of ironmongery other than those specified except with approval in writing of the Engineer.

The main entrance door to the house shall have a one-way lock approved by the Engineer.

The type, location, quality and finish of ironmongery shall be as shown on the drawings and the Contractor shall submit for approval a comprehensive schedule of ironmongery covering all items required to complete the works. This schedule shall give catalogue references and locations for all ironmongery.

All screws used for fixing ironmongery shall be supplied and shall be of the correct type, material, finish, size and shape to the satisfaction of the Engineer.

The base metals for finishes shall be as follows:

- aluminium finish : aluminium
- nickel plated : bronze or brass

- stainless steel finish : stainless steel

8.14.2 WORKMANSHIP

All ironmongery shall be carefully wrapped and protected until the completion of the work and any items or parts which are damaged shall be replaced at the Contractor's expense before hand-over of the works.

All ironmongery shall be securely fixed or housed and all rebates, holes, etc., to take ironmongery shall be neatly and cleanly executed.

All hinges shall be carefully housed or let into the hinged elements and to the frames.

All fitting shall be removed before starting any painting operations and refixed in place after all painting work is completed and approved by the Engineer.

The Contractor shall check and adjust all ironmongery, and oil or grease moving parts to ensure good performance.

On completion, all locks, catches and similar types of ironmongery shall be properly cleaned, tested and oiled or greased.

8.15 KITCHEN FITTINGS

Kitchen fittings as shown on the drawings shall be proprietary floor and wall units complete with worktops, drawers, doors, shelves, plinths and the like all to the Engineer's approval.

The proprietary fittings and fixtures shall be fixed in the positions indicated on the drawings after all floor, wall and ceiling surfaces have been formed or constructed. All work next to walls, floors and ceiling shall be soundly fixed and scribed to fit snugly against same.

9 FINISHES

9.1 CEMENT

The cement shall be as described in 'Concrete work'.

9.2 WATER

Use water as specified in the Concrete works.

9.3 SAND

The sand is to be clean, sharp, river sand free from earth, loam, saline materials or other impurities and well graded from coarse to fine.

9.4 ADMIXTURES AND PLASTICISERS

All additives and the like shall only be used when approved in writing by the Engineer and in strict accordance with the manufacturer's written instructions.

9.5 TILES

Tiles shall be of superior quality as type of tile shall be as per the description given in the bills of quantities. Unglazed ceramic floor tiles and coved skirting are to comply with the requirements of BS 1286. The glazed ceramic wall and floor tiles are to comply with the requirements of BS 1281.

9.6 ADHESIVES AND SEALANTS

3-4mm high performance tropical grade thin flat bed waterproof membrane adhesive by BASF or Fosroc or equal and approved - applied in accordance to manufacturer's written instructions. Specifically designed for the fixing of tiles in wet areas and provide a waterproof membrane to substrate.

9.7 WORKMANSHIP GENERALLY

Workmanship shall conform to the recommendations of the appropriate Codes of Practice. The Contractor is responsible for the provision of all labour, scaffolding, materials, tools, plant, etc., required for the completion of the execution of the Works, to the full satisfaction of the Engineer.

9.8 DEFECTIVE/DAMAGED WORK

All defective or damaged work shall be cut out and patched as directed by the Engineer. All patched surfaces shall match the consistency and finish of the original surface and shall be level with adjoining surfaces.

Damaged or deteriorated materials and manufactured items shall not be used in the Works. Any materials or manufactured items damaged during and after bedding or setting in position shall be removed and replaced by and at the Contractor's expense.

9.9 STORAGE

All branded materials delivered to site are to be properly stored in a watertight shed on a dry floor, or in equivalent conditions to avoid deterioration prior to use. Any materials which deteriorate or become damaged before use are to be removed from site and replaced at the Contractor's expense.

9.10 BEDS FOR FLOOR TILING

Beds for floor tiling shall be composed of 1 part cement and 4 parts of sand by volume. Mixing, all as previously described.

Prices shall include surface preparation, temporary rules, laying to falls and cross falls as required by the room location, making good and the like.

9.11 WALL TILING

Glazed ceramic wall tiles shall comply with the requirements of BS1281.

The agreement of the Engineer to the setting out of tiles is to be obtained before commencing work and a sample room is to be set out for the Engineer's approval prior to continuing work on other rooms.

Shop drawings shall be prepared where patterns in the wall tiling are required.

Tiles shall be fixed with true horizontal and vertical joints of an even width of 1-2 mm to a true vertical plane.

Tiles adhesive shall be approved in writing by the Engineer prior to the commencement of this work.

Adequate time shall be allowed to enable complete setting of the tile bedding before joints are grouted. Grout of a plastic mix of neat cement, colour to Engineer's selection,

shall be used in grouting up the joints. The whole of the tiled surface is to be thoroughly cleaned down on completion and left in perfect condition.

Any cut tiles are to be neatly and cleanly cut using an approved method and cut tiles are to be used only at internal corners or in other locations to be approved by the Engineer. All service points in wall tiling shall be of drilled holes if the tiles in which they are located are central to the tile.

9.12 FLOOR TILING

Prior to commencing the floor tiling the Contractor shall satisfy himself that the surface on which the tiles are to be laid is satisfactory to receive the tiles. It is the responsibility of the Contractor to provide a satisfactory surface and or bedding and any remedial work necessary is to be carried out at the Contractor's expense.

Before laying commences the base is to be free from dust, loose material, grease, plaster, and the like.

Shop drawings shall be prepared for floor tiling.

Tiles adhesive shall be approved in writing by the Engineer prior to the commencement of this work.

Care is to be taken in cutting and fitting and the setting out of tiles and colour patterns are to be as shown on the drawings or as directed by the Engineer. Shop drawings are required where patterns in the floor tiling are required. Any adhesive on tile surface or any other finished surface is to be completely cleaned off; the tiles shall be laid with true aligned joints of an even width of 2 mm and grouted up on completion.

The work shall be set out from the centre of rooms using whole tiles and working outwards. Rates are to include for the all cut margins and make up pieces at limits and boundaries.

The flatness of tiled or paved floors must be such that a two metre rule moved in all directions shows no bump or hollow of over 4 mm.

All floor tiling in wet area such as bathrooms, toilets, kitchen, washing area, balconies, mechanical rooms, roof terrace and the like above ground floor level shall be laid over a waterproof layer on the concrete sub base. Provide continuous skirting up walls at least 300 mm high. Floor tiling shall be laid to falls towards drainage outlet of respective rooms. For wet areas the grout used to fill the joints shall have waterproofing quality by adding approved waterproofing additives into the mix.

Protect floor tiling with slurry or like material on completion and clean off and prepare flooring to satisfaction of Engineer.

Homogeneous tiles shall be good quality polished or matt-finished floor tiles with edges smooth. All the tiles shall be of specified dimension with no faults. Faulty tiles will not be accepted in the works will be replace at Contractor expense.

Where wall tiles do not meet the wall tiles, skirting shall be provided on all vertical surfaces touching the floor including the bottom of the columns. Skirting as well as nosing tiles shall be provided in the staircases.

9.13 KITCHEN AND WASH BASIN BENCH TOPS

The vanity top shall be 75 thick reinforced concrete sheet supported on masonry walls. Ceramic tiles of approved quality shall be installed on the walls as well as the front, and the side of the bench. The Top surface shall have good quality homogeneous polished tiles. The

flexible hose delivering water to the tap shall be done such ways removable for repair. Valve control shall be installed for supply line.

10 CEILINGS

10.1 GENERAL

The Contractor shall be responsible for the co-ordination of the service and suspended ceilings, including checking the ceiling heights and setting to module, which shall be to the exact locations required by the Engineer, who shall confirm and approve the setting out and location of all fittings, luminaires, switches, and the like.

All ceilings shall be gypsum board panels with exposed grid system, installed according to specialist's instructions, unless otherwise stated in the drawings. Ceiling boards used in any particular area shall be decided by the use of the space and shall be approved by the Engineer. When completed they shall be resistant to the weather and capable of taking outstanding normal air pressure and suction forces action both below the ceiling and within the ceiling void.

The Contractor shall prepare, and submit for approval, fully dimensioned working drawing prepared from the general working drawings of the Engineer and from a site survey. These drawing shall coordinate the service and ceiling installation. Setting out points common to all trades including service shall be established early in the manner described and shown on the working drawings.

Under no circumstances shall work of other sections be concealed by suspended ceilings until same has been inspected and approved by the Engineer.

Rod type suspension system hangers and hook bolts for suspension systems shall be fixed to structural concrete soffits. Self-drilling threaded metal sockets of an approved type shall be used for fixing to concrete. Suspension and framing shall be of metal sections only. No timber framing will be accepted.

Finished ceiling heights shall be rigorously respected; they shall be measured from the finished floor levels.

The ceilings shall be left perfectly flat and shall not show a deviation of more than 3 mm from a 3 metre straight edge. The Contractor shall take all possible precautions to eliminate any defects.

Price shall include for cutting and fitting ceilings around obstacles and neatly finishing the edges of the work.

Tiles and ceiling forming a grid or pattern shall be set out on the axis of the room in both directions.

Suspended ceilings shall not be erected until the windows have been glazed, the building closed in, the plasterwork dried out, all wet work completed and the building suitably air conditioned; relative humidity must not exceed 70% and the temperature must be maintained within the range 15-30°C.

The design of and dimensional tolerances set by the manufacturer for accessory items such as formed wire hangers, spring spacer clips, tile retainers, and spacer bars shall be such as to assure satisfactory performance of their intended function in the suspension system. Failure attributable to such accessories to control alignment, prevent undesirable rotation or other unsatisfactory performance which results in unfavourable appearance will be cause for their rejection.

General installation procedures shall be as follows:

- ◆ The area to receive treatment shall be dry and be satisfactorily closed against excessive traffic and be protected against weather before work is started.
- ◆ Installation shall be in strict accordance with manufacturer's specifications except as modified by this Specification.
- ◆ Install units in a true and even plane, in straight line course laid out symmetrically about centre lines of ceiling or panel, continuing pattern, through wall openings or as indicated. Border tile shall not be less than 15 cm wide.
- ◆ Fit border units neatly against vertical surfaces.
- ◆ Seal joints in units around pipes, ducts, and electrical outlets with acoustical sealant.
- ◆ Ceilings should be level within a 3mm deviation per 2m for ceilings up to 6m across (measured at the furthest points across the full width of the ceiling)
- ◆ A maximum of 5mm out of level for ceilings over 6m across
- ◆ Flat within a ± 3 mm deviation, measured using a 3m straight edge
- ◆ Grooves in ceilings that are 5mm or less should be within a ± 1 mm deviation, grooves more than 5mm should be within ± 2 mm deviation

10.2 GYPSUM PLASTER BOARD CEILINGS

Gypsum plaster ceilings comprising flat tiles, units, mouldings, cornices and the like shall be fabricated in accordance with the relevant Standards and Practices. Before commencing manufacture of the components the Contractor shall submit

Fully detailed shop drawings. These drawings shall indicate overall dimensions of the unit together with fixing details and the interrelationship with other components. On receipt of the written approval of the Engineer, the Contractor may commence work on this section.

Gypsum plaster shall comply with the requirements of BS 1191 Parts 1 and 2 ensure the highest standard of workmanship. All gypsum components shall be reinforced using 13 mm diameter hollow plastic tubes in a grid pattern with plastic mesh infill. At junction and unions between tiles and cornices, mouldings and the like natural fibres shall be used to reinforce the joints. All exposed surfaces shall be used to perfectly flat and smooth, free from blemish and scar. All units with an external angle shall be moulded to achieve perfectly straight and slightly rounded arises. The components shall be fixed on to a rigid framework so as to provide a level and even surface with all joints and irregularities made good with gypsum plaster. The Contractor shall submit his mix proportions for approval, which shall include gypsum, vermiculite and fibreglass crystals. The minimum thickness of the gypsum components shall be 20mm irrespective of their purpose. All finishes shall be left clean and smooth to receive the specified finish.

10.3 CEMENT FIBRE BOARD CEILINGS

In wet areas such as toilets, aluminium framed concealed ceiling with cement fibre boards shall be provided. The joints and edges be sealed with an appropriate sealant and finished with exterior quality non-textured paints as per paints supplier's specifications.

11 PAINTING

11.1 GENERAL

The painting materials shall be obtained from an approved manufacturer and shall be supplied ready mixed in the manufacturer's sealed and branded containers. Each container shall bear the maker's brand name, identification of contents and directions for its proper use. All material must be thoroughly stirred before use. All painting work must be carried out according to paint manufacturer's instructions unless otherwise directed by the Engineer. Appropriate primers and under coats shall be used on all surfaces to be painted.

All sealers, primers, undercoats and thinners shall be the products recommended by the manufacturers of paint used for the finishing coat.

The paint type shall be Nippon, SKK or similar brand and the Engineer shall approve the colour before placing the order.

11.2 PAINT SPECIFICATION

For interior apply Acrylic or similar alkali resisting primer sealer, apply putty grind by sanding to level uneven surfaces, and finish with two coats of matt finish as per manufacturer's specifications.

For exterior, apply Acrylic or similar waterproofing quality primer sealer and apply two coats of finish as per manufacturer's specifications.

Marine grade timber varnish for all timber doors, cupboard doors and other exposed timber members. Apply approved quality wood dye before application of varnish on the specified surfaces of timber.

11.3 MATERIALS

11.3.1 STOPPING

Stopping for woodwork to receive clear finish shall be tinted to match surrounding woodwork, to approval.

Stopping for internal woodwork, plywood, hardboard, and fibreboard shall be linseed oil putty to BS 544. tinted to match the colour of the undercoat.

Stopping for external woodwork shall be white lead paste and gold size well mixed.

11.3.2 THINNERS

Thinners shall be approved turpentine or white spirit to B.S. 245.

11.3.3 STAIN

Stain for woodwork shall be an approved brand of oil stain complying with B.S. 1215.

11.3.4 PRIMING PAINTS

Priming paints shall be the primer recommended by the manufacturer of the finishing paint or:

- ◆ For woodwork -lead-based or priming paint to comply with B.S 2521 and 2523.
- ◆ For steel work-red oxide priming paint to comply with B.S 2524.
- ◆ For galvanized, zinc or aluminium work- grey zinc chromate priming paint.
- ◆ For concrete, block work, plaster, plasterboard and the like- alkali priming paint.

11.4 WORKMANSHIP

11.4.1 GENERAL

The Contractor shall carry out all tests necessary for determining the colours and shades of the finishes and the appropriate methods of application. Sample panels shall be completed in accordance with Engineer's instructions.

All work shall be performed in accordance with the manufacturer's written instructions.

Before application of any paint or finish all surfaces shall be cleaned, dried and prepared as specified hereinafter, all to the Engineer's approval, no work shall commence until this approval is given in writing to the Contractor.

The Contractor shall coordinate work to ensure that factory primed items are primed or painted as required in the Specifications.

All metal fittings such as hardware and fastenings, etc., not required to be painted shall first be fitted and then removed before the preparatory processes are commenced. When all painting is completed the fitting shall be cleaned and re-fixed in position.

Before painting floors must be washed and every possible precaution shall be taken to keep down dust before and during the painting processes. No paint shall be applied to surfaces structurally or superficially damp and all surfaces must be ascertained to be free from condensation, efflorescence, etc., before the application of each coat.

No exterior or exposed painting shall be carried out under adverse weather conditions such as rain , extreme humidity, dust storms, high temperature of surface etc.

All coats of paint must be thoroughly dry before subsequent coats are applied, and rubbed down with fine waterproof abrasive where necessary.

All coating shall be well applied, leaving no sags, laps, brushes or other defects. Each coat must thoroughly dry before next coat is applied. All work must be carefully cut into a true line and left smooth and clean.

Details of mixing and application shall be in accordance with the Specifications of the manufacturer concerned and to the approval of the Engineer. The mixing of paint, etc., of different brands before or during application will not be permitted. No dilution of painting materials shall be allowed except strictly as detailed by the manufacturers and as approved by the Engineer.

On surfaces which are not accessible to paint brushes or rollers paint shall be applied by spraying or with sheep skin daubers. All surfaces to be painted shall be thoroughly covered with paint. Method of paint applications shall be approved by the Engineer prior to the commencement of the work.

Brushes, pails, kettles and all other tools and equipment used in carrying out the work shall be maintained in good working order, and shall be clean and free from foreign matter. They shall be thoroughly cleaned before being used for different types or classes of materials.

The Contractor will be required to repaint, at his own expense any work on which the paint is found to be incorrectly applied. The Contractor shall be responsible for protecting from damage the paint work and all other work during and after operations including the provision of all necessary dust sheets, covers, etc. All paints dropping shall be cleaned up as the work proceeds.

All loose and defective paint shall be removed from previously painted surfaces before re-painting. All burning off must be done by skilled workmen. The blow-lamp must not be used on surfaces adjoining glass. Damage to adjacent surfaces shall be made good at the Contractor's expense.

Prior to hand over the Contractor shall carry out all remedial painting work due to damage caused by others, adjustment and easing of joinery and metal work testing and commissioning of service installations and the like all as instructed by the Engineer. On completion, leave Works clean and tidy to the Engineer's approval.

11.4.2 PAINTING TO CONCRETE, BLOCK OR PLASTER

Concrete, blockwork and plaster surfaces to be painted or decorated shall have all cracks cut out and made good to the satisfaction of the Engineer.

Plasterboard surfaces shall have taped joints and the surface puttied to the satisfaction of the Engineer. The surfaces shall be completely dry and shall be brushed free of impurities immediately prior to the commencement of the painting work.

Efflorescence shall be completely removed by rubbing down with dry coarse cloths followed by wiping down with damp cloths and allowed to dry. All surfaces shall be rubbed down with fine glass paper and brushed free of dust before applying any form of decoration.

Concrete blockwork and plastered surfaces which are to receive paint shall be given one thin coat of oil putty and allowed to dry for at least two days. The surfaces shall then be rubbed down with fine glass paper and given a second thin coat of oil putty and when completely set shall be rubbed down again with fine glass paper before applying the painting system.

Emulsion paint shall be applied by brush or roller and shall consist of primer and two full coats of paint.

Oil paint shall be applied by brush or roller and shall consist of a priming coat, two undercoats and one finishing coat of paint.

11.4.3 LACQUER TO WOODWORK

Woodwork in areas such as door frames and panels which has to be lacquered shall be cleaned of impurities.

Knots shall be treated with two coats of knotting.

Where shown on the Drawings or required by the Engineer the wood shall be stained with a water or spirit stain to the approval of the Engineer.

The coats of lacquer shall be applied on joinery by brush or spray, either in the joinery shop or on Site as directed by the Engineer.

11.4.4 OIL STAIN FINISH TO WOODWORK

The stain finish to woodwork shall be an approved manufacturer's oil stain system applied strictly in accordance with the manufacturer's instructions.

All surfaces are to be thoroughly dry and cleaned and sanded down and all nail holes or similar defects shall be filled and levelled up with approved stopping.

The finish shall be applied in two coats. The first coat shall be pigmented stain wax brush applied. The surface shall be allowed to dry for 2 -10 minutes and then rubbed with a cloth in a rotary motion to remove excess stain and produce an even surface.

The first coat shall be allowed to dry completely before application of the second coat.

The second coat shall be natural (clear) stain wax, buffed.

The Engineer shall select the stain colour and the Contractor shall allow for preparing sample panels for approval and these sample panels will provide the standard for the work.

11.4.5 VARNISHING

All surfaces to be varnished shall be thoroughly dry and cleaned and sanded down and all nail holes or similar defects shall be filled and levelled up with approved hard stopping. Sanding shall follow the line of the grain. Knots shall be treated with two coats of knotting.

Two or three coats of clear varnish shall be applied as recommended by the manufacturer of the varnish or as directed by the Engineer.

11.4.6 PAINTING TO WOODWORK

Woodwork to be painted shall be cleaned of impurities.

Knots shall be treated with two coats of knotting.

Priming paint shall be applied by brush. Two coats shall be applied to end grain. Priming paint shall be applied on Site after the Engineer has approved the joinery and before it is fixed.

11.4.7 PAINTING TO METALWORK

Steelwork delivered to the Site unprimed shall be cleaned of impurities, scrapped and wire brushed to remove rust and painted with one coat of priming paint applied by brush.

Steelwork delivered to Site primed shall be cleaned of impurities and damage to the priming paint and made good with priming paint.

Galvanized metalwork to be painted shall be cleaned of impurities. Where rusting has occurred the rust shall be removed by wire brushing and made good with an approved rust inhibitor. The surfaces shall be coated with a mordant solution, washed with clean water and painted with two coats of priming paint applied by brush.

Metal which is concealed shall be prepared and primed as above and shall be painted with two priming coats and one finishing coat of paint applied by brush.

12 SANITARY FIXTURES, PLUMBING AND DRAINAGE WORK

12.1 GENERAL

The pipe runs shown in the Drawings must be checked on site by the Contractor and their exact locations determined at the site in consultation with the Engineer. All pipes, fittings etc. shall be kept closed against moisture and foreign matter when stored at site and during installation. All pipes shall be fixed clear of one another and be so arranged as to provide easy access for maintenance. All plumbing work shall be carried out by suitably qualified plumbers in accordance with the relevant British Code of Practice and regulations and requirements of related Authorities in Maldives.

Materials for the piping and service requirements shall all basically conform to the service pressures encountered. Each part of the installation of the plumbing work shall be completed in all details as shown in the Drawings or as specified and provided with all necessary control valves, etc. that will be necessary for their satisfactory operation. All piping shall be run plumb, and straight and parallel to walls, except drain lines which shall pitch 6mm per foot in the direction of flow. Pockets, unnecessary traps, turns and offsets shall be avoided. All pipes, fittings, valves and accessories shall be thoroughly cleaned both internally and externally before installation and shall be cleaned again before putting into service.

Opening for all WC, floor drains in toilets, balconies, shower cubicles shall be done by coring the slab after the start of masonry work. The gap between the pipe and the slab shall be filled made completely waterproof as per waterproofing specifications.

Water supply line and waste water line shall be provided for the washing machine as shown in the drawing. Provision for hot water supply shall be made for the shower area. Each apartment shall have separate water meters.

12.2 PIPING MATERIALS.

All piping and joints which are chased in walls or exposed shall be done with uPVC (unplasticised polyvinyl chloride) conforming to BS.3505 Grade C unless otherwise specified. PPR pipes shall be used for the hot water supply lines as per the specialist's requirement and those shall be approved by the Engineer before installation. Joints and fittings for use with UPVC pipe shall conform to BS. 4346

12.3 SANITARY FIXTURES AND FITTINGS

All sanitary fixtures and fittings shall be Cotto or equivalent brand. All valves shall be installed in accessible position for convenient operation and repair. The size of valve shall be of the diameter as the pipe to which it is connected. All connections between each valve and adjacent piping or equipment shall be made either, with flange or union connections. All valves shall be of heavy body construction with adequate length of spindle for ease of operation.

12.4 PIPING

A. All pipes shall be cut square and true to the pipe axis by means of suitable tools without reducing pipe diameter and cut ends shall be finished smooth. Before making connections, chips, dirt and other foreign matter shall be removed from inside interior of each pipe. Fixing of clips and embedding of pipe sleeves shall be carried out without delay along with the progress of the work, where required.

B. Where pipes are to be laid in the ground, bed shall be sufficiently deep and compacted, necessary protection for piping shall be taken.

C. Cleaning Eyes and Inspection Openings Inspection openings and cleaning eyes shall be provided for soil and waste pipes on each change of direction of piping. Rectangular openings shall be equal in width to the full diameter of the pipe and in length one and half times width of openings. Oval access openings shall have an area not less than the cross sectional area of the pipe. All covers for access openings shall be airtight and watertight: suitable washers shall be provided for all covers. Any bolts used for the access opening covers shall be of non-corrosive material and bolt thread shall be greased before fastening.

D. Floor Traps Floor traps comprising 150mmx150mm gully traps complete with hinged chromium plated/PVC gratings shall be provided and installed as required.

E. All water supply line into toilets, washrooms, pantry etc shall have valve controls.

12.5 DRAINAGE

Roof drainage shall be with 75 diameter pipes as per the drawings. The pipe laid underground to deliver storm water shall have at least 1% gradient to allow smooth flow of water through the pipe.

12.6 TESTING

The Contractor shall insure that the piping system and fittings and accessories are watertight by carrying out all necessary tests before the appliances are connected as well as after it. Hydraulic performance discharge test shall be made from all appliances. Any obstruction in the pipeline shall be traced including the retention of an adequate water seal in each trap. The water supply system shall not be covered up until the whole system has been pressure tested for any leakage and the Engineer has approved the system. Any leaks that may be observed shall be repaired immediately at the Contractors expense.

12.7 PUMPS

The pumps shall be Davey or equivalent model to provide sufficient uninterrupted flow water in each outlet in the building during the simultaneous use. The pump manufacturer or supplier shall recommend shall be submitted to the Engineer for approval.

13 ELECTRICAL WORKS

13.1 GENERAL

The work shall be carried out strictly in accordance with the standard specifications and shall also conform to the requirements of Electricity Rules in force in Republic of Maldives.

All materials to be used in the Works shall be of standard make and shall bear the certification marks of local authorities. All materials shall be approved by the Engineer before use in the Works.

Earthing shall invariably be done in the presence of the Engineer or his representative.

All the conduits shall be continuously earthed. Check nuts shall be provided at the point where the conductor enters the I.C. box and junction box.

The Contractor shall arrange for the inspection of all Medium Pressure Installation by the Electrical inspector of the local electric supply authority from where the electricity connections has to be obtained, and see that they are passed by him.

The Contractor shall be responsible for all necessary permits, approvals, fees, deposits etc., required for the completion of Electrical works in accordance with the Contract. Each apartment shall have separate electricity meters and the ground floor shop shall two meters.

Ceiling fans shall be KDK or equivalent brand and switches and sockets etc shall be "Clipsal", "Hager" or equivalent brand.

13.1.1 QUALIFICATION

A licensed Electrical Contractors should have the following qualifications:

- (a) Must have in his employment a competent Electrical Engineer registered with Maldives Utility Regulatory Authority.
- (b) Must have in its employment an Electrical Engineer having certificate of competency who will exclusively supervise this work.
- (c) Must have necessary tools, plant and instruments.
- (d) Must have adequate experience of similar works.

If a contractor does not possess the above qualifications he shall be allowed to sublet the Work to a competent Sub-Contractor provided an application for his pre-qualification is made to the engineer for his approval. Decision of the Engineer in this case shall be binding on the Contractor.

13.1.2 SPECIFICATIONS

The Contractor shall furnish all material and equipment at site, conforming fully to the specifications given herein and to the accepted standards, the Institution of Electrical Engineers, London, and the Utility Regulatory Authority. It is not the intent of these Specifications to include all details of design and construction of various material and equipment to be supplied under this contract. The Contractor shall supply and install all material and equipment specified herein and also all installation and small material such as nuts, bolts, washers, shims angles, levelling material, insulation, tape, solder, etc. and all such required for complete installation as intended by the Specifications.

The contractor shall provide for all the required technical and non - technical personnel, skilled and non - skilled labour, construction equipment, transportation etc., as required for the completion of Work in strict accordance the Technical Specifications laid hereinafter. All material and equipment supplied by the Contractor shall be new and in all respects conforming to the high standard of engineering design and workmanship. All material and equipment, which have to be supplied and installed by the Contractor, shall be passed/approved by the Engineer; even if the same is exactly in accordance with the Bills of Quantities and Drawings.

13.1.3 SUBMITTAL

The Contractor, after the award of work, shall submit for approval of the Engineer all drawings and cuts of equipment, appliances, fixtures and accessories. Cuts, catalogues and drawings shall be clearly marked to indicate, the items furnished.

13.1.4 APPROVAL OF DRAWINGS AND DATA

The Contractor shall provide detailed electrical drawings, wire diagrams, etc. for all electrical switch gear, fuse gear and all other systems etc. for the Engineer to review and approval. Three sets of equipment drawings shall be provided for obtaining approval.

13.1.5 DRAWINGS & DATA

Three sets of drawings and data for each equipment shall be furnished by the Contractor for the Engineer approval before commencement of work. The drawings to be supplied by the Contractor shall be as follows:-

Electrical Drawings showing:

- (a) One-Line diagram
- (b) Detailed wiring diagram
- (c) All interconnections
- (d) Relays, their locations, and internal wiring diagrams
- (e) Other electrical devices including meters instruments and their wiring diagram

13.1.6 SHOP DRAWINGS

The design drawings do not show conduit routes and depict only the position of various fixtures and outlets. All the planning for the conduit routes shall be carried out, well in advance of the actual execution of work, by the Contractor to the satisfaction of the Engineer. For this purpose the Contractor shall prepare and submit shop drawings and obtain prior approval from the Engineer before commencement of the work.

No work should be carried out without the availability of approved shop drawings. These shop drawings shall clearly depict the load balancing chart of each Distribution Board. Time required for the preparation and approval of shop drawings shall be considered to have been included in the total time allowed for the completion of the work.

13.1.7 GUARANTEE

The Contractor shall furnish written guarantee in triplicate of the manufacturer for successful performance of each equipment. Such guarantee shall be for replacement, which may be found defective in material or workmanship. The guarantee shall cover a minimum period of 12 months effective from the date of completion certificate.

13.1.8 TEST REPORTS

The Contractor shall be responsible for the submitting the test reports/certificates and get the installation inspected passed by the State Electric Company.

13.2 CONDUIT AND CONDUIT ACCESSORIES

The main wiring for the building will be taken inside the slabs through a conduit system. Before concreting the slab the Contractor should produce a detailed conduit layout drawing and obtain approval from the Engineer. A system of access for power and communication lines below the carpet flow should be provided.

13.2.1 CONDUIT PIPE

The conduit for the wiring go flights, socket outlets and other systems shall be made of PVC confirming to BS 3505/1968 Class-D.

The conduit shall have following wall thickness and standard weights:

Pipe Size	Wt/100Rft.	Wall thickness
20mm dia	3.4 kg	0.04 to 0.05
25mm dia	4.5 kg	0.045 to 0.055

13.2.2 CONDUIT ACCESSORIES

The use of factory made round PVC junction boxes shall be used and should have nipples to receive PVC pipe with force fit, shall be used for ceiling outlets. The wall type junction box shall also be PVC. Each junction box shall be provided with one piece cover which shall be fitted on the box with screws.

Conduit accessories such as switch boxes, socket outlet boxes, pull boxes and inspection boxes shall be made of PVC having dust tight covers. All boxes shall have required number of conduit entry holes. All the rectangular or square shaped boxes shall have nipples to receive PVC conduit force fit.

Manufactured smooth bends shall be used where conduit changes direction. Bending of Conduit by heating or otherwise shall be allowed only at special situations with the permission of the Engineer. Use of sharp 90 degree bends and tees is prohibited. Bends shall have enlarged ends to receive the conduit without any reduction in the internal diameter of the PVC pipe.

All accessories e.g. boxes, coupling, bends, solid plugs, bushes, reducers, check nuts etc. shall be equal in quality to the specified conduit.

The drawings do not show conduit routes and all the planning for arranging conduit routes shall be carried out by the Contractor to the satisfaction of the Engineer.

The entire conduit system shall be essentially completed before the wiring pulling is taken in hand. Each conduit run shall be tested for continuity and obstructions. All obstructions shall be cleared in an approved manner. Water and moisture that has entered any section of the conduit installation must be dried with suitable swabs to the satisfaction of the Engineer.

Adequate expansion joints shall be provided in all conduit runs passing across the expansion joints in the concrete slab of the buildings.

All the free ends of conduit shall be solidly plugged till such time as final and proper terminations are made.

13.3 WIRES, CABLES AND CORDS

13.3.1 WIRES & CORDS

The wires & cords for the conduit wiring shall be single core, made of stranded copper conductors, PVC insulated, tested to B.S. 6004, 1975. The voltage grade shall be 300/500 volts or 450/750 V unless otherwise specified on Drawings and Bills of Quantities.

- (a) For light or fan point wiring with 1.5 mm square or as specified in the BOQ.
- (b) For light circuit wiring with 2.5 mm square or as specified in the BOQ.
- (c) For power plug 15A wiring with 4mm square or as specified in the BOQ.

13.3.2 INSTALLATION INSTRUCTIONS

All wiring shall be continuous between terminations and use of connectors or joints is not be allowed. Spur and tee connections are strictly prohibited.

Manufacturers recommended lubricant shall be allowed to facilitate pulling of wires. Use of any kind of oil and soap is prohibited.

13.4 WIRING ACCESSORIES

13.4.1 SWITCHES

Indoor switches controlling lights and fans shall be single pole, 5A, one or two way, suitable for 250V,50 Hz. The body of the switches shall be made of moulded plastic, one, two, three or four gang with integral built in moulded plastic face plate.

Weatherproof switches shall conform to B.S. standard.

13.4.2 SWITCH SOCKET OUTLET UNITS

Switch & socket units shall be single, pole, 3 pin rated 5A, 15A or 20A, 250V, 50 Hz. These shall be moulded plastic type with white integral built-in face plate. Each socket shall have its control switch by the side of it on a common face plate. Thus the complete unit specified in BOQ shall be as switch and a socket outlet unit.

13.5 LIGHT FIXTURES

13.5.1 GENERAL

The description of light fixtures is given in the Bills of Quantities, and stated on the Drawings, and all relevant material are described in this Section. The determination of quality is based on certified photometric data covering the coefficient of utilisation, light distribution curves, construction material, shape, finish, operation, etc.

The Contractor shall submit samples of each and every lighting fixture specified for approval of the Engineer.

Outdoor lights shall be weather proof and is subject to the approval of the Engineer.

13.5.2 INCANDESCENT LIGHT FIXTURE

The glass globes/ shades/ diffusers of the incandescent light fixtures shall be first class quality glass free from any air bubbles or voids. The glass shall generally be of opal white colour unless otherwise specified. The shape of the glass may be spherical, hemispherical, flattened bottom or tablet shaped as required.

Surface mounted fixture shall have stove enamelled sheet steel body. It may also be satin brass or aluminium anodised finish as required. The fixing holes shall match the outlet box. Wall bracket light fixtures shall have back plates with matching holes of the outlet box and decorative finish as required.

All the lighting fixtures shall be suitable for local climatic conditions.

13.5.3 FLUORESCENT LIGHT FIXTURE

All the light fixtures shall have lamps and electronic ballast's of the wattage specified. The fluorescent lamp shall be either ft - 18 watts or 4 - 35 watts and the colour shall generally be warm light from 1st floor above.

The ballast shall be totally enclosed electronic type suitable for operation on 220 V, 50 Hz, single phase supply, a wiring diagram, wattage, voltage and current ratings shall be printed on the body of the ballasts. The power loss shall not more than 10 watts for '6 watts ballast. The ballast shall be noiseless in operation without any whistling sound. the manufacture shall be called upon to guarantee a trouble free life of 1 years, effective from the date of completion certificate.

The internal wiring of the light fixtures shall be carried out at manufacturers factory with heat resistance wires of size not less than 1.5 mm square.

The louvers of light fixtures shall be made of anodized aluminium and/or moulded plastic. The diffusers shall be made of acrylic perspex.

All the lighting fixtures shall be suitable for local climatic conditions and approved by the Engineer.

13.5.4 INSTALLATION INSTRUCTIONS

The light fitting shall be installed according to manufacturer's recommendations or as approved by the Engineer.

Flexible connecting wires from outlet box to the fixture shall be provided by the contractor; connector made of porcelain or thermoplastic material shall be provided and installed in the outlet boxes for connecting flexible wires to the point wires.

Outlet boxes or any openings in the ceilings and walls shall be covered with appropriately fabricated accessories to provide an architectural entity to conceal them.

The locations of sockets and switches on the drawings are indicative, the final locations of such item shall be marked on the building and approved by the Engineer.

13.5.5 MAIN PANEL BOARD AND L.T SWITCH BOARD

The main panel board shall be indoor type, free standing, free supporting, floor mounted, totally enclosed, sheet clad, dust and suitable for operation on a single phase system, 415 v , 50 Hz, AC supply . The board shall be suitable for installation back to the wall and capable of front attendance. The switch board shall be designed to suit service conditions and ensure security and safety during operation, inspection, operation, cleaning, and maintenance. The switch board shall be designed and tested to IEC recommendations. Each panel shall withstand strain of 2000 volts insulation level for one minute power frequency test. The L.T. switch board shall contain the STELCO incoming panel board.

Individual electric meters for each floor or as specified in the drawings. A separate electric meter for all the pumps and staircase and general space lightings.

13.5.6 DISTRIBUTION FEEDER PANEL

Single diagram of the L.T. switch board shall be approved by the Engineer before placing order for the switch board. It is the responsibility of the contractor to design and submit the single line diagram of the L.T. switch board

13.5.7 EARTHING

The switchboard shall be effectively earth by means of a copper strip of 25mm x 3mm (1" x 1/8") cross -section bolted to connections near the bottom of the switchboard.

13.5.8 ACCESSORIES

Designations labels, lifting lugs , foundation bolts, interconnecting nuts bolts, and washers, thimbles, lugs, levelling shims cable glands and/or cable end box for all the sizes of incoming and outgoing cable shall be supplied with the switchboard.

13.6 TESTING

13.6.1 TESTS

The following tests shall be conducted on each completed switchboard

Type Tests

- (a) Temperature rise test
- (b) Mechanical endurance test
- (c) Making/Breaking Capacity test

Routing Test

- (a) High Voltage test

The Switchboard shall be tested to MEB Standard. Preference shall however, be given to Switchboards fabricated from all components manufactured by only one manufacturer.

13.6.2 INSTALLATION INSTRUCTION

The Switchboard shall be fixed firmly on the floor in perfect line, plumb and level position. All incoming and outgoing cable connections shall be made from the bottom including Earth connections.

13.7 DISTRIBUTION BOARD

The distribution boards shall be either free standing cubical type or wall mounting type suitable for recessed mounting. Each distribution board (DB) shall be tropical in design, fully dust and vermin proof and liquid repellent.

13.8 AS-BUILT DRAWINGS OF CONDUITS

The Contractor shall submit during the construction of the Works all the conduit layouts in the floor as well as in the wall, with appropriate dimensions, acceptable to the Engineer.

14 TELEPHONE

The cabling shall be of cat 5 or equivalent and shall be done through appropriate ducting as required. The shop drawings of the system shall be submitted for approval before installation. The locations of telephone points on the drawings are indicative, the final locations shall be marked and approved by the Engineer.

15 CABLE TV WIRING AND OUTLETS

Cable TV wiring shall be done as per the specialist's instruction. Shop drawings shall be submitted to the Engineer and before the installation. The locations of cable TV points on the drawings are indicative, the final locations shall be marked and approved by the Engineer.

16 FIRE ALARM SYSTEM

16.1 GENERAL

The Contractor shall be under obligation to plan, supply, install, test, commission and maintain for the period specified elsewhere, a fire alarm system for this building. The proposed system shall consist of manual call points & alarm bells on every floor as shown in the drawings. Ionisation/optical smoke detectors where shown in the drawings. Plus Fire alarm control panel as shown in the drawing.

16.2 SPECIFICATIONS

The system shall facilitate the detection of fires occurring in any part of the building by subsequent audible and visual indications. The system shall generally comprise of the following :-

16.3 MAIN CONTROL PANEL

The control panel will be perspex fronted panel and will display all screened labelling and indications by block LEDs mounted behind the front hinged cover. The control panel shall be mounted in pressed steel housing and provide the following functions and indications.

Fully monitored two wire circuit for each sensor zone (24V D.C.) as required.

Fully monitored two wire sounded circuit (24V D.C.) as required.

Change over relay contacts each rated 5 amps 240V A.C. (Resistive load).

Full test and isolate functions via a key-board located on the fascia of the main termination housing to provide the following:-

Ability to isolate sensor zones.

Ability to isolate sounder zones.

Ability to test automatically zones with an auto reset facility to enable a single person to carry out testing.

Full LED display of all functions comprising of:-

- (a) System on, system fault, processor fault, alarm, zone supply fault, system supply fault, battery fault, charger/mains fault, sounder fault and sensor fault together with a test mode display which provides zone clears , zone open

circuit and zone short circuit indication for individual sensor and sounder (bells) lines.

Sequence of sounder operation- All sounder (bells) and relay out-put sequences shall be completely programmable to enable future changes to be carried out with only soft ware changes.

The control panel shall provide the following functions and indications:-

- a) Twin LED display for system on, system fault, sounder fault, alarm, mains/ charger fault, main processor fault, sensor fault, alarm silenced, battery fault, supply fault and earth fault.
- b) Also five dedicated control functions on illuminated push buttons, which are key - isolated. These shall provide Evacuate, Buzzer Mute, Alarm silence, Lamp test and Reset controls.

Battery charger - the battery charger shall be an integral part of the main fire alarm control panel cabinet and shall be capable of fully recharging the stand - by batteries after a main's failure within 12 hours. The capacity of the batteries shall be sufficient to supply the standing load for the least 24 hours and the maximum alarm load for one hour. The system shall be suitable for operation on 220v single phase or 415v , 3- phase 50 hz supply.

16.4 SENSORS AND SOUNDERS

The main control panel as described in the foregoing shall be capable of working with the following devices having common specification as under :-

- | | |
|-------------------------|--|
| (a) Operating voltage | 10-30 volts d.c (two wire system) |
| (b) Ambient temperature | 10 C to +80 C. |
| (c) Humidity range | 20 to 90 RH |
| (d) Altitude range | Sea level to 6000 meters |
| (e) Alarm mode | Self latching producing a resistance of 680 ohms across the supply line. |

Photocell (optical) smoke detectors- the units shall operate on light scattering principle. An internal infra-red light source shall be pulsed, with the light beam ranged so as to by-pass a receiving unit. The presence of smoke shall scatter the light beam, causing it to be reflected on to the receiving photocell. An evaluation circuit shall measure the amount of light and shall compare it to a reference. The detector shall trigger in to an alarm state when the amount of smoke exceeds a pre-set level. To ensure against false alarms several pulse readings shall be taken and compared before the detector shall be triggered into alarm. The detectors shall conform to BSS 5446 part -1 and shall have the following specifications:-

- | | |
|-----------------------|--------------------------------------|
| (a) Quiescent Current | Less than 100 microamps at 20 volts. |
| (b) Alarm Current | Maximum 60 mA |
| (c) Maximum Coverage | 300 cubic meters |
| (d) Weight | 250 grams approx. |

(e) Diameter x Height 92 mm x 80 mm

Manual stations - this unit also named call point shall be break glass type that do not require a hammer. The frangible glass is pressed hand to break the glass, which shall activate the alarm. The call point shall conform to b.s. 5839 part-2

Alarm bells - the alarm bells shall be centrifugal type and the gong shall be 100 mm diameter or as specified. The unit shall be suitable for an input of 24 v d.c. and shall provide a normal output of 94 db at 1 meter.

Electronic sounders - the unit shall be primarily designed to operate on 24v.d.c. And arranged easily to generate a variety of sound signals: intermittent, continuous or warble tones.

16.5 WIRING

The wiring for the fire alarm system shall be carried out in PVC conduit in accordance with instructions contained herein relevant section. 2x2.5 mm square or 4x2.5 mm square PVC heat resistance insulated single core cable 300/500 volts grade shall be pulled in 1” dia PVC conduit laid for the purpose. Any spurs and tee joints in the wiring are strictly prohibited. Instructions contained in section -E.2.2 and 2.3 shall be followed.

16.6 INSTALLATION

The installation as a whole shall be tested and commissioned, in accordance with manufacturer’s instructions, to the entire satisfaction of the Engineer.

16.7 SHOP DRAWINGS

Shop drawing of the fire alarm system and firefighting system shall be submitted to the Engineer for approval.

16.8 CABLE LADDER / CABLE TRAY SYSTEM

General

The cable ladder system shall generally be installed in vertical riser ducts provided for the purpose for parallel runs of cables of various services. The cable tray shall be used on ground floor to run the cables to the respective riser ducts from electrical main panel.

The Contractor shall be under obligation to supply all labour, material and accessories for the completion of cable ladder installation strictly in accordance with the specification laid as under and as illustrated on drawing to the entire satisfaction of the Engineer.

Design

The cable ladder system shall be fabricated from 16SWG (2.5 mm) thick sheet steel strip and then hot dip galvanized. All fixing accessories e.g. rawl bolts, cable clamps, nuts and bolts used for the cable ladder system shall be hot dip galvanised. All cable ladder shall have standard length of 4000 mm and a width of 500 mm. The ladder and accessories shall be subject to the prior approval of the Project Manager before mass production is taken in hand.

Installation

The cable ladders shall be installed in perfect line and plumb on the surface of walls in riser ducts by means of galvanized rawl bolts 1/2" dia x 3" long. Alternate ladder step in each length of ladder shall be clamped to the ladder in a neat and orderly manner by means of cable clamps. Depending upon the number of multiple cable runs two or three parallel ladders may be installed, side by side, in the same riser ducts in case one ladder is unable to accommodate all the cable runs. Each cable ladder (or an assembly of two or three parallel cable ladders laid side by side) shall be solidly earthed with 1" x 1/8" copper tapes on both sides.

This system shall be installed by specialist lightning protection system supplier or under guidance of a specialist. The arrestor top at the highest point of the building shall have sharp tip or as per specialist recommendations and the delivery conductor shall be copper plate continuous from the arrestor to and earthing rod not less size not less than 2m length and diameter 16mm.

17 AS-BUILT DRAWINGS

The Contractor shall, during the progress of work keep a careful record of all changes and where the actual work or installation differs from that shown on shop drawings. These changes and revisions shall be accurately carried out on the shop drawings and submitted to the Engineer for approval. After approval these drawings shall become the property of the Owner. These updated and approved shop drawings depicting clearly all changes and revisions made on site shall be called As-Built Drawings. A compact disc containing all the drawings with all the changes brought in during the construction in AutoCAD format of all these As-Built Drawings shall be handed over to the Engineer.

The final payment to the Contractor shall be withheld until all such drawings have been submitted and approved by the Engineer.

18 GUARANTEE

18.1 GENERAL

The Contractor shall guarantee that his work shall be free from all defects for a period of one year after turn over and accepted of the project and shall agree to repair and make good at his own expense any and all defects arising due to poor workmanship or materials furnished and installed by him.