

GOVERNMENT OF THE UNITED ARAB EMIRATES
MINISTRY OF AGRICULTURE AND FISHERIES



MARICULTURE CENTER

UMM AL QUWAIN U.A.E.

VOLUME 2

TECHNICAL SPECIFICATIONS

NOVEMBER 1980

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STATIONARY ENGINE AND DIESEL ENGINE
EQUIPMENT - DIESEL ENGINE

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SECTION 1A

GENERAL

1. This specification shall be read in conjunction with the conditions of contract, the drawings, bill of quantities and other contract documents.
2. Any notes or dimensions shown on the drawings shall take preference over this specification.
3. Reference is made to the standards issued by the American Society for Testing and Materials (ASTM), the British Standards Institution (BS), and the Japanese Industrial Standards (JIS) unless otherwise specified or ordered by the Engineer or this specification. Such reference shall in every case be deemed to include the latest edition or issue of such standards including all revisions issued up to the date of invitation to tender. The Engineer may replace the specified standard with one of BS, ASTM or JIS in case when he deems it equivalent and appropriate for the work to do so.

SECTION 1B

USE OF SITE

1. USE OF SITE

The Contractor, shall, except when authorised by the Engineer, confine his men, materials, and plant within the site of which he is given possession. The Contractor shall not use any part of the site for any purposes not connected with the Works unless the prior written consent of the Engineer has been obtained.

2. STORAGE

The Contractor shall provide at his own expense suitable offices and adequate storage accommodation for plant and materials. In particular, adequate waterproof storage sheds shall be provided for materials requiring protection against weather, humidity or damage. No materials or plant shall be stored on the public highway.

3. ADVERTISING

The Contractor shall treat the Contract and everything within it as private and confidential. In particular, the Contractor shall not publish any information, drawings or photograph relating to the Works and shall not use the site for advertising purposes, except with the written consent of the Engineer and subject to such conditions as he may prescribe.

SECTION 1C

TEMPORARY WORKS

1. DIVERSION OF SERVICES

Where it becomes necessary permanently to divert any cable, sewer, drain, main, etc., the Contractor will be permitted to recover the cost of this work unless, in the opinion of the Engineer, it was due to the Contractor's negligence, bad workmanship, faulty materials, or lack of reasonable foresight. The Contractor is required to make all necessary arrangements with the appropriate authorities for the diversion of their services.

2. TRAFFIC CONTROL

The Contractor shall provide all necessary traffic control sign and signals that may be required by the Police, and shall operate and maintain them efficiently and to the satisfaction of the Police. The contract rated for pipe laying shall be deemed to include all expenses of traffic control, watching and lighting.

3. TEMPORARY WORKS

The Contractor shall be solely responsible for the sufficiency, stability and safety of all temporary works and their care. He shall at his own expense supply detailed drawings and calculations of stability of such temporary works as the Engineer may direct, but no approval given or implied by the Engineer shall relieve the Contractor of his responsibilities in connection with temporary works.

4. EXISTING SERVICES

The Contractor shall avoid all damage to operative gas or water mains or service pipes, sewers, drains, cable, wires, overhead telephone or telegraph lines, telegraph poles, etc., which he encounters in carrying out the Works and he must provide for supporting them to the satisfaction of the Engineer and the responsible authorities. The Contractor must give all notices, pay any charges made and make good at his own expense any damage done. The Contractor must satisfy himself by his own enquiries and observations as to the precise position of all existing services and must take full responsibility in connection with them and shall hold the Employer indemnified against any claims that may arise from any damage caused to such services by this operations.

5. SETTING OUT

The Contractor shall be entirely responsible for accurately setting out all the work, and he shall at his own expense make good any defects arising from errors in the lines or levels. He shall also provide for the use by the Engineer throughout the contract, a modern and accurate theodolite and precision level, both of approved type and make, complete with all ancillary equipment, steel and linen tapes, poles, pegs, stagings, templates, profiles, etc., necessary for setting out and measurement of the work, and the services of an experienced staff. The Contractor shall also provide such rubber boots, oil-skins, and protective clothing as may be required by the Engineer's staff on the site.

6. OFFICE FOR THE ENGINEER

The Contractor shall provide and erect in a position approved by the Engineer, and maintain, clean, heat and light throughout the Contract, one suitable and substantial office measuring not less than 4.5 m x 8.0 m internally, with pinable walls, adequate window, and suitable capacity of an air-conditioning equipment for the Engineer and his staff. The office shall contain suitable size of shelves, one long table, two office desks, one drawing board, six chairs, conference tables for eight persons, one refrigerator and washing facilities. Convenience of copying facilities for blue prints and black-white prints shall be available for the Engineer's use at the Contractor's expense. The entrance door shall be provided with a lock and three keys. There shall be no spare keys in the possession of any person other than the Engineer or his representative. The Contractor shall provide such labour as is reasonably necessary to attend to the office requirements, clean instruments and assist in measuring or testing the work at any time. When the work is completed, the office and accommodations will be returned to the Contractor.

7. TELEPHONE

The Contractor shall arrange for the installation of a telephone in the Engineer's office, which is to be kept directly connected to the public telephone exchange, and the Contractor shall pay all charges for installation, rent, calls and eventual disconnection. The Employer will not reimburse to the Contractor the sums paid to the Telephone Company in this connection except the sums for international calls. The Contractor will not be permitted to have any other telephone on the same line or as an extension from it.

8. SANITARY CONVENIENCES

The Contractor shall provide and maintain at his own expense proper and adequate sanitary conveniences for the use of persons on the site throughout the Contract, and shall remove same on completion. All sanitary accommodation shall be to the approval of the Engineer and the local Public Health Authority.

9. USE OF PUBLIC HIGHWAYS

The Contractor shall take all reasonable precautions to prevent the deposit of mud, filth, or rubbish on the highway and shall from time to time, or as instructed by the Engineer, remove from the highway at his own expense any mud, filth or rubbish which may have been deposited on it.

10. DAMAGE TO ADJOINING PROPERTIES

The Contractor shall not trespass on properties adjoining the site of the Works unless otherwise given permission by the Owner of the property. The Contractor will be held responsible for any damage to the adjoining properties caused through the carrying out of work contained in this Contract. The Contractor shall repair and make good any such damage at his own expense to the satisfaction of the Owners of all adjoining properties.

11. ACCOMMODATIONS FOR THE ENGINEER

The Contractor shall provide to the Engineer, at his own expense, two fully furnished and air-conditioned residence or flat with two bed-rooms and one telephone accommodation and one car with air-conditioning 4 doors sedan type without chauffeur during the whole construction period. Expenses for the house rent and associated charges shall be paid by the Contractor. Charges for calls of the telephone will be paid by the Engineer. Damages or defaces, if any, will not be compensated to the Contractor by the Engineer when the accommodations are returned to the Contractor. The Contractor shall include in his Bill of Quantities the expenses for the said accommodations.

SECTION 1D

MATERIALS REQUIREMENTS

1. PLANT, ETC.

The Contractor shall provide all labour, materials, plant, tools, tackle, etc., necessary for the satisfactory completion of the Works. All mechanical plant used by the Contractor in the execution of the Works shall be of such type and size and subject to such method of working as the Engineer may approve.

2. MATERIAL AND WORKMANSHIP

- 2.1 All materials and components shall be of good quality, appropriate to the class of work involved, and be in full accordance with the Contract requirements. Where an applicable specification issued by the British Standards Institution (BS) or American Society for Testing and Materials (ASTM) or Japanese Industrial Standards (JIS) is currently operating, the materials and components used in the execution of the Works shall comply with that specification, unless otherwise specified or ordered by the Engineer or this specification.

The Engineer may replace the specified standard with one of BS, ASTM or JIS in case when he deems it equivalent and appropriate for the work to do so.

- 2.2 Workmanship shall be of high standard and shall conform to the detailed requirements of the specification and the appropriate sections of any applicable current Codes of Practice issued by BS, ASTM or JIS.

3. SAMPLES, TESTS AND CERTIFICATES

- 3.1 When required by the Engineer, the Contractor shall at his own expense submit to the Engineer, for approval, samples of any of the materials and components to be used. The quality of materials and components subsequently used in the Works shall not be inferior to the approved samples.

- 3.2 The cost of testing shall be borne by the Contractor, who shall give not less than 7 days notice of all tests in order that the Engineer or his representative may be present. Two copies of all test certificates shall be supplied to the Engineer or his representative.

- 3.3 All material which is specified to be tested at the Manufacturer's Works must satisfactorily pass the tests before being painted or otherwise covered.

- 3.4 Test certificates shall be supplied to the Engineer or his representative before the materials or components are used in the Works, unless the Engineer directs otherwise.

4. SHOP DRAWINGS

The Contractor shall prepare 4 copies of Shop Drawings for the Engineer's approval in an ample time before ordering the purchase or execution of the work.

Shop Drawings shall be such those as the Engineer deems necessary for the execution of the work, and shall include such drawings listed below:

Skelton drawings; Drawings for metal fabrication; Drawings for Windows and Doors; Layout drawings for tiles and blocks; Layout drawings for ceiling boards and suspension system; Drawings for structural steel work; Drawings for furnishings and specialities; Drawings for details of finishes; Drawings for joinery work; Drawings requested in the specification; Drawings requested by the Engineer.

Shop Drawings required for Civil work, Mechanical work and Electrical work shall be those specified under sections concerned.

5. WORK PREPARED OFF THE SITE

The Contractor shall give the Engineer written notice of the preparation or manufacture at a place off the site of any material or component to be used on the Works, stating the place and time of preparation or manufacture, so that the Engineer may make inspections at all stages of the production process. Failure to give such notice may result in the rejection of the material or component, if the Engineer considers that his inspection was necessary during the production process. Transportation fares and hotel charges for the Engineer's or his representative's inspection shall be paid by the Contractor.

SECTION 1E

GENERAL WORKING REQUIREMENTS

1. SUSPENSION OF WORKS DURING BAD WEATHER

The Contractor shall, without compensation, delay or suspend the progress of the Works, or any part thereof, during bad weather for such periods as may be required by the Engineer. The Engineer will determine what extension of time (if any) shall be allowed to the Contractor for such suspensions.

2. FACILITIES FOR OTHER CONTRACTORS

The Contractor shall afford all reasonable facilities to other Contractors employed by the Employer, or to any local or other authority, to execute work on the site. The Contractor will not be held responsible for injury to such other work or workmen employed on it, unless the injury is caused by the Contractor's operations or by persons in his employ.

3. CO-ORDINATION WITH OTHER CONTRACTORS

The Contractor shall coordinate his work with that of the other contractors, so as to cause the minimum practical interference with their work. The other contractors will likewise be required to enter into reciprocal arrangements. The Contractor shall bear costs or charges that, in the opinion of the Engineer, are caused by the Contractor's lack of reasonable co-operation.

4. ACCOMMODATION FOR EMPLOYEES

The Contractor shall allow his tender for providing all necessary canteen and first-aid facilities and other accommodations and services for his employees, and shall provide for maintaining them in a clean and tidy condition throughout the construction period, and for clearing away and reinstating the site on completion, all to the satisfaction of the Engineer and other appropriate authorities.

5. KEEP SITE TIDY

The Contractor shall throughout the constructional period maintain the whole of the site and all plant and materials placed on it in a clean, tidy and safe condition to the satisfaction of the Engineer. The Contractor shall clear away all rubbish from time to time as directed and at completion.

The Contractor shall clean down the surfaces of all concrete, cladding and other work from time to time, and wash pavings and flush drains and gullies. He shall clean down the whole of the Works at completion and leave them in a clean and perfect condition to the satisfaction of the Engineer.

6. MEASUREMENT OF WORK

- 6.1 The Contractor shall provide a suitably qualified agent and chairmen to assist the Engineer and/or Quantity Surveyor who will be responsible for measurements, interim valuations and measurement for the final account. The measurement and the form in which the accounts are submitted by the Contractor shall be in accordance with the reasonable demands of the Engineer and/or Quantity Surveyor.
- 6.2 Whenever the Contractor shall carry out work or provide any material for which he may propose to claim an extra, he shall first obtain a written order from the Engineer and then make arrangements for its joint measurement, although this will in no way commit the Engineer to recognition of the claim. The Engineer and/or Quantity Surveyor shall at all reasonable times have access to the Contractor's time-book.

7. PHOTOGRAPHS

A provisional sum shall be included in the Bill of Quantities for Progress Photographs. This sum shall be expended in whole or in part as directed by the Engineer. One copy of the photographs shall be supplied to the Engineer for records.

8. PROTECTION OF WORK

The Contractor shall, at his own expense, cover up and protect all materials and work liable to be stained or injured from any cause, and shall make good any such damage to the entire satisfaction of the Engineer. The Contractor shall adequately protect the Work against hot sun, rain, gust and sand.

SECTION 1F

PROGRAMME

1. PROGRAMME AND PROGRESS RECORD

- 1.1 As soon as practicable after the acceptance of his tender but not later than 15 days, the Contractor shall submit to the Engineer for his approval a programme showing the order of procedure and method in which he proposes to carry out the work.

The programme shall be in a form approved by the Engineer.

The Contractor shall from time to time modify the programme if required to do so by the Engineer. The Contractor shall at all times during the progress of the Works endeavour to adhere to the approved programme.

- 1.2 The Contractor shall supply to the Engineer weekly during the progress of the Works such written particulars and information as will enable the Engineer to maintain a progress record for the Works in the same form as the approved programme.

2. RECORDS

- 2.1 The Contractor shall maintain accurate records, plans and charts showing the dates and progress of operations, and the Engineer shall have access to this information at all reasonable times. Records of tests made shall be handed to the Engineer's representative at the end of the day.
- 2.2 The Contractor shall also maintain records and charts of all strata and materials. The Engineer shall be supplied with a copy of these records as and when required.

SECTION 1G

SCHEDULE OF PRICES AND BILL OF QUANTITIES

The payment to the Contractor by the Employer shall be made in accordance with the following Schedule of Prices. The Schedule of Prices shall be read and interpreted only in conjunction with other Contract Documents; Particularly Conditions of Contract, Specification and Drawings. The following shall be taken as the basis of interpretation and execution of Schedule of Prices.

1. The quantities set out in the Bill of Quantities are the estimated quantities of the work but they are not to be taken as the actual and correct quantities of the Works to be executed by the Contractor in fulfilment of his obligations under the Contract.
2. The price to be paid by the Employer to the Contractor for the whole of works to be done and for the performance of all the obligations undertaken by the Contractor under the Contract Documents shall be ascertained by the measurement of the permanent work only and by the application of the Scheduled Rates as agreed hereinafter to the final quantities of the executed and accepted works as measured in the following manner.

The methods of measurement adopted in the Bill of Quantities will prevail throughout the Contract notwithstanding any trades, local or general customs and shall be used in the adjustment of all measured variation or further measurement or remeasurement. Only net quantities of the works as constructed and incorporated in the permanent works shall constitute the quantities paid for with no allowance made for waste. The Contractor shall allow in his rates throughout the Bills for any cost to which he may consider himself entitled in respect of Compliance with the method specified herein.

3. Descriptions of the items of work in the Bill of Quantities are for the identification purpose only and the scope of each item of work shall be as described in the Specification and as shown on the drawings. This Bill of Quantities is prepared with a view of simplifying the measurements and field control of works by combining integral or incidental works and operations into the representative items of works which are listed in the Bill of Quantities. Therefore, all works and operations required under the various sections of the Specification and all other obligations shall be undertaken by the Contractor under the Contract but items of which are not listed in the Bill of Quantities in particular shall be considered as incidental to or integral with the associated items of works given in the Bill of Quantities.

4. The Bill of Quantities shall be considered to include and cover all costs and expenses payable to the Contractor for the execution and completion of the respective several works and also to include and cover all costs of every kind whatsoever including but not by way of limitation, all overheads and profits of every description, all charges of every kind for patents and licenses, all office charges, preparatory works, supervision, transport, materials and labour, providing, maintaining and using all plants, equipment and appliances of every kind; the construction, maintenance, running and subsequent removal of all temporary works of every description; carrying out of all tests and inspections including supply and maintenance of all equipment and apparatus of every kind, all required samples and manpower and the performance of all services which may be required for the proper execution, completion and protection of the Works in full and complete accordance with the provision of the Contract Documents and undertaking and discharge of all obligations and responsibilities therein specified.
5. The quantities given in the Bill of Quantities are approximate only and any variation therefrom shall not affect the Schedule Rates, extent or description of the works and effect and meaning of the Contract Documents.
6. The sum obtained by the application of the agreed Schedule Rates to the respective quantities of the executed and accepted permanent works shall, except only as and to the extent expressly provided in the Contract, constitute the sole and inclusive payment whatsoever shall be or become due or payable to the Contractor under the Contract.
7. All sums set out in the SUMMARY OF COST which shall be stated to be for provisional sums shall be used only at the decision and discretion of the Engineer and if not used either wholly or in part shall as to the amount not used be deducted from the Contract Price.
8. All units herein used are of the metric system, unless otherwise expressly stated.
9. The following abbreviations are used in the Schedule.

m	.....	Linear metre
Sq m	.....	Square metre
Cu m	.....	Cubic metre
Kg	.....	Kilogramme
DH	.....	Dirham
No	.....	Number or Numbers

SECTION 2

SITE WORK

1. SCOPE

This section shall apply to all excavation, filling disposal of surplus materials and backfilling for building construction.

2. APPLICABLE PUBLICATIONS

The following publications of the issues listed below but referred to thereafter by basic designation only form a part of this specification to the extent indicated by the references thereto:

2.1 American Society for Testing and Materials (ASTM) Publications

- D 1556-64 Density of Soil in Place by the Sand Cone Method
 (R 1974)
- D 1557-70 Test for Moisture Density Relations of Soil Using
 10-lb Rammer and 18-in Drop.
- D 2167-66 Density of Soil in Place by Rubber-Balloon Method.
 (R 1972)
- E 11-70 Wire-Cloth Sieve for Testing Purposes.

3. BORING AND SURVEY DATA

Boring and survey data furnished to the Contractor, if any, shall be for general information only, and variation there from shall not affect the terms of Contract and the bill of quantities.

4. DEGREE OF COMPACTION

Satisfactory material to be used for fill and backfill shall be structurally sound material of native soil free of rocks, lumps, vegetables and other organic materials obtained from suitable excavated material and/or from approved borrow pits at the Contractor's responsibility.

Approved suitable excavated material as specified above shall be used in the backfilling and filling next to footings, foundations, underground structures, under sub-floors etc., and shall be laid in layer not exceeding 20 cm thick and compacted with compaction equipment or mechanical tampers when not possible to use such compaction equipment, as approved by the Engineer. Moisture content shall be adjusted as directed by the Engineer and 95% of dry weight compaction according to AASHTO T-180 shall be achieved.

5. PROTECTION OF EXISTING STRUCTURES, UTILITIES AND IMPROVEMENTS

The Contractor shall protect from damage all existing structures, improvements, or utilities at or near the site of work, the location of which is made known to him, and shall repair or restore any damage to such facilities resulting from failure to comply with the requirements of this contract or failure to exercise reasonable care in the performance of the work. If the Contractor fails or refuse to repair any of such damage promptly, the Engineer may have the necessary work performed and charge the cost thereof to the Contractor. The Contractor shall ascertain of all existing public utilities on the site below ground. Any existing utility lines that are to be retained and that are not shown on the drawings or the locations of which are not made known to the Contractor in sufficient time to avoid damage, if inadvertently damaged during excavation, shall be repaired by the Contractor, and adjustment in payment will not be made. When utility lines that are to be removed are encountered within the area of operations, the Contractor shall notify the Engineer in ample time for the necessary measures to be taken to prevent interruption of the service.

6. EXCAVATION

6.1 General

The Contractor shall demolish and excavate whatever substances encountered to the depth indicated on the drawings or to the extent necessary for the proper construction and completion of the work.

No allowance shall be made for excavation in different materials as the ground is considered to be reasonably uniform in character. The rates for the excavation shall be deemed to cover the cost for any local outcrops of hard material that may be found.

Where rock is encountered it shall be carefully excavated and the Contractor shall not be entitled to additional compensation, unless otherwise specified in the bill of quantities.

Excavation shall extend a sufficient distance from walls and footings to allow for placing and removal of forms, installation of services, and for inspection, except where the concrete for walls and footings is authorized to be deposited directly against excavated surfaces. Excavations below indicated depths will not be permitted except to remove unsatisfactory material.

Unsatisfactory material encountered below the grades shown shall be removed as directed and replaced with satisfactory material; payment therefore will not be made. Satisfactory material removed below the depths indicated without specific direction of the Engineer shall be replaced to the indicated excavation grade with satisfactory materials compacted as specified or concrete class "B" specified under Section: CONCRETE WORK, at the Contractor's expense, except that concrete footings shall be increased in thickness to the bottom of the overdepth excavations.

Determination of elevations and measurements of approved over-depth excavation of unsatisfactory material below grades indicated shall be done under the direction of the Engineer. All excavation, except as otherwise specified or permitted shall be made in the open. The extent of excavation open at any one time will be controlled by the conditions, but shall always be confined to the limits, prescribed by the Engineer. In no case shall the earth be plowed, scraped, or dug by machinery so near to the finished subgrade as to result in the disturbance of material below said subgrade, but the last of the material to be excavated shall be removed with pick and shovel just before concrete or pipe is placed.

6.2 Protection of bank of excavation

6.2.1 Shoring, including sheet piling, shall be furnished and installed as necessary to protect workmen, bank, adjacent paving, structures and utilities. Shoring, bracing and sheeting shall be removed as excavations are backfilled, in a manner to prevent caving. Design of shoring including stress analysis together with working drawings thereof shall be submitted to the Engineer for approval prior to the commencement of excavations. The Engineer's approval there-to shall not relieve the Contractor from any of the responsibility under the Contract.

6.2.2 Slope and Step

Subject to the approval of the Engineer, the Contractor may, as an alternative to shoring, carry out excavations with suitable slopes or steps as necessary or required by the Engineer. In this case, the Contractor shall submit for approval the stability analysis of such slopes and steps and under the Contract. Any extra excavations and backfilling to the requirements beyond the extent specified on account of slopes and steps shall be executed by the Contractor at his own expense.

6.3 Drainage

6.3.1 To ensure proper conditions at all times during construction, the Contractor shall provide and maintain ample means and devices (including spare units kept ready for immediate use in case of breakdowns) with which to intercept and/or remove promptly and dispose properly of all water entering the excavations. Such excavations shall be kept dry until the structures, pipes, and appurtenances to be built therein have been completed to such extent that they will not be floated or otherwise damaged.

6.3.2 All water pumped or drained from the work shall be disposed of in a suitable manner without undue interference with other work, damage to pavement, other surfaces, or property. Suitable temporary pipes, flumes, or channels shall be provided for water that may flow along or across the site of the work.

6.4 Temporary Underdrains

- 6.4.1 Temporary underdrains, if used, shall be laid in trenches beneath the grade of the structure. Trenches shall be of suitable dimensions to provide room for the chosen size of underdrain and its surrounding gravel.
- 6.4.2 Underdrain pipe shall be acceptable vitrified-clay or concrete pipe of standard thickness. Sewer pipe of the quality known as "seconds" will be acceptable.
- 6.4.3 Underdrains, if used, shall be laid at an approved distance below the bottom of the normal excavation and with open joints wrapped in cheese-cloth, and entirely surrounded by graded gravel, or crushed stone to prevent the admission of sand or other soil into the underdrains. The distance between the bottom of the pipe or structure and the top of the bell of the underdrain pipe shall be at least 8 cm unless otherwise permitted. The space between the underdrain and the pipe or structure shall be filled with screened gravel or crushed stone which shall be rammed if necessary and left with a surface suitable for laying the pipe or building structure.

6.5 Drainage Wellpoint System

- 6.5.1 If required by the nature of the Works, the Contractor shall dewater the excavations by means of an efficient drainage wellpoint system which will drain the soil and prevent saturated soil from flowing into the excavation. The wellpoints shall be designed especially for this type of service. The pumping units (including spare pump kept ready for immediate use in case of breakdowns) shall be designed for use with the wellpoints, and shall be capable of maintaining a high vacuum and of handling large volumes of air and water at the same time. The Contractor shall be solely responsible for obtaining permission from the authorities and others concerned for discharging de-watered water to the lots outside boundary and paying any charges for the above concerned.
- 6.5.2 If required by the nature of the Work, the installation of the wellpoints and pump shall be done under the supervision of a competent representative of the manufacturer. The Contractor shall do all special work such as surrounding the wellpoints with sand or gravel or other work which is necessary for the wellpoint system to operate for the successful dewatering of the excavation.
- 6.5.3 Material to be used in the wellpoint system shall be corrosion resistant where possible.
- 6.5.4 Wellpoint shall not be employed if any danger exists of withdrawing water from the foundations of adjoining buildings.

6.6 Utility and Drain Trenches

Trenches for underground utilities system and drain lines shall be excavated to the required alignments and depths. The bottom of trenches shall be graded to secure the required slope and shall be tamped, if necessary, to provide a firm pipe bed. Recesses shall be excavated to accommodate joints so that pipe will be uniformly supported for the entire length. Separate trenches shall be excavated for sewer, water, sea water, gas pipes, and underground electrical and communication service unless otherwise indicated. Care shall be exercised to minimize disturbance to the compacted subgrade.

6.7 Excavated Materials

Satisfactory excavated material required for fill or backfill shall be placed in the proper section of the permanent work required under this contract. Satisfactory material in excess of that required for the permanent work and unsatisfactory material shall be disposed of outside the limits of construction site and at the Contractor's responsibility. Stockpiles shall be placed, graded, and shaped for proper drainage, giving the consideration to drainage from adjacent properties.

6.8 Final Grade of Surfaces to Support Concrete

6.8.1 Care shall be taken not to disturb the bottom of the excavation. Excavation to final grade shall not be made until just before concrete is to be placed.

6.8.2 Inspection of Excavation

All foundation beds and pipe trenches will be inspected by the Engineer during the progress and at the time when excavations are completed and/or foundation and trench beds are adequately prepared. No subsequent work shall be laid on the beds until after the bottom has inspected and approved by the Engineer.

6.8.3 Pile Foundations

Where pile foundations are required, the excavation shall be stopped at an elevation of approximately 300 mm above the bottom of the footing before placing piles. After the piling work has been completed, loose and displaced material shall be removed, and remainder of the excavation shall be completed to the elevations shown, leaving a smooth solid bed to receive concrete.

7. FILL AND SUBGRADE PREPARATION

7.1 Satisfactory materials shall be used in bringing fills to the lines and grades indicated and for replacing unsatisfactory material.

7.2 Preparation of Ground Surfaces

Unsatisfactory material in surfaces to receive fill or in excavated areas shall be removed and replaced with satisfactory materials. The surface shall be scarified to a depth of 150 mm before the fill is started. When subgrades are of less than the specified density, the ground surface shall be broken up to a minimum depth of 150 mm, pulverized, and compacted to the specified density. When subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 300 mm and compacted as specified for the adjacent fill. The placing of satisfactory materials and compaction shall be as specified herein below.

7.3 Placing

Satisfactory material shall be placed in horizontal layers not exceeding 20 cm thick in loose depth and then compacted.

7.4 Compaction

Compaction shall be accomplished by rollers or other approved equipment well suited to the soil being compacted. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction herein before with the equipment used.

7.5 Tests

Laboratory tests for moisture-density relations shall be made in accordance with the procedure referenced in paragraph: Degree of Compaction hereinbefore. Field tests for density and moisture content shall be performed in sufficient number to insure that the specified density is being obtained. The field tests shall be performed in accordance with the procedure shown above. Laboratory and field tests shall be performed by the Contractor at his own expense.

7.6 Reconditioning of Subgrade

Approved compacted subgrades that are disturbed by Contractor's operations of adverse weather shall be scarified and compacted as specified hereinbefore to the required density prior to further construction thereon. Recomaction over underground utilities shall be by hand tamping.

8. BACKFILLING

Backfilling shall not begin until construction below finish grade has been approved, underground utilities systems have been inspected, tested, and approved, form removed, and the excavation cleaned of trash and debris. Backfill shall be brought to indicated finish grade. Backfill shall not be placed in wet areas. Backfill shall be of satisfactory materials placed and compacted as specified under paragraph: Fill and Subgrade Preparation. Heavy equipment for spreading and compacting backfill shall not be operated closer to foundation than a distance equal to the height of backfill above the top of footing; the area remaining shall be compacted in layers not more than 150 mm in compacted thickness with power-driven hand tampers suitable for material being compacted. Backfill shall be placed carefully around pipes to avoid damage to pipes. Backfill shall not be placed against foundation walls prior to 7 days after completion of walls. As far as practicable, backfill shall be brought up evenly on each side of the wall and sloped to drain away from the wall.

9. BLINDING CONCRETE

Blinding concrete shall be placed under structures in uniform thickness greater than 60 mm. Materials and mixes shall conform to the requirements specified under Section: CONCRETE WORK.

10. GRADING

Areas as shown shall be constructed true to grade, shaped to drain, and be maintained free of trash and debris until final inspection has been completed and the work has been accepted.

11. PROTECTION

Settlement or washing that occurs in graded or backfilled area prior to acceptance of the work shall be repaired and grades re-established to the required elevations and slopes.

12. MEASUREMENT AND PAYMENT

No separate payment will be made for the work covered under this section and all costs in connection therewith shall be included in the applicable lump-sum contract price for the structure to which the work pertains.

13. GARDEN

The area indicated as "GARDEN" in the drawings shall be filled with fertile soil, so called "SWEET SOIL" and shall be covered by plantation of lawn. Sweet soil shall be first choice top soil rich in organic material and free from roots, stones and rubbish; suitable for plantation. The agricultural sifted soil as specified above shall be spread in the gardens to the thickness of 30 cm after thorough watering.

Lawn grass seed shall be supplied and cross sown at the rate of 35 gram per square meter. The choice of seed mixture shall be determined according to the climate of the site. The seed bed shall be raked on harrowed and rolled as necessary.

The Contractor shall protect newly seeded areas at all vulnerable points to prevent the destruction of seedlings by traffic, etc.

The Contractor shall maintain at all times until the site is handed over sprinkling with city water as required.

SECTION 3
CONCRETE WORK

1. SCOPE

This section shall apply to all plain, mass, or reinforced concrete.

2. APPLICABLE PUBLICATIONS

The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the thereto.

2.1 American Concrete Institute (ACI) Standards:

- | | |
|------------|-------------------------------------------------------------------------|
| ACI 315-74 | Manual of Standard Practice for Detailing Reinforced Concrete Structure |
| ACI 318-77 | Building Code Requirements for Reinforced Concrete |
| ACI 304-73 | Recommended Practice for Measuring, Mixing and Placing Concrete |

2.2 American Society for Testing and Materials (ASTM) Publications:

- | | |
|---------------------|------------------------------------------------------------------------------------------|
| A 615-75 | Deformed Billet-Steel Bars for Concrete Reinforcement |
| C 31-69
(R 1975) | Making and Curing Concrete Compressive and Flexural Strength Test Specimens in the Field |
| C 33-74a | Concrete Aggregates |
| C 39-72 | Compressive Strength of Molded Concrete cylinders |
| C 40-66 | Organic Impurities in Sand for Concrete |
| C 67-73 | Sampling and Testing Brick |
| C 88-73 | Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate |
| C 94-74a | Ready-Mixed Concrete |
| C 143-74 | Slump of Portland Cement Concrete |
| C 150-74 | Portland Cement |

C 192-69	Making and curing Concrete Test Specimens in the Laboratory
D 1190-74	Concrete Joint Sealer, Hot-Poured Elastic Type
D 1752-67 (R 1973)	Premolded Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Nonbituminous Types)
D 1850-74	Concrete Joint Sealer, Cold-Application Type
E 11-70	Wire-Cloth Sieves for Testing Purposes

3. GENERAL

Full cooperation shall be given other trades to install embedded items. Suitable templates or instructions shall be provided for setting items not placed in the forms. Before placing concrete, embedded items shall have been inspected, and tests for concrete or other materials shall have been completed and approved. Concrete work shall be carried out in full compliance and in accordance with ACI Code 318. All concrete shall be site-mixed or ready mixed as produced by a plant acceptable to the Engineer. Cement for all concrete work up to and including the ground floor slab and where contacts with soil, and sea water such as culture tanks, aqua tanks, filtration bldg., sea water in-take well, sea water reservoirs, open gutters, drainage channels, gate structures, etc. shall be Type V cement as specified in ASTM C150. Ordinary Portland cement shall be used for all concrete work above ground where concrete doesn't contact soil and sea water.

4. MATERIALS

4.1 Aggregates

4.1.1 Coarse aggregate

Coarse aggregate shall consist of well graded gravel or crushed stone conforming to the ASTM Specification C33, and also conforming to the detailed requirements given in Table A. If it is so required by the Engineer the coarse aggregate shall be washed to the state where it shall comply with these specifications. The aggregate shall be obtained from Al Ain, U.A.E. or other sources approved by the Engineer.

TABLE A

ASTM E 11 Sieve Size	Designated Aggregate Size	
	1 in. Percent Passing	3/4 in.
1 in. (25.4-mm)	95 - 100	100
3/4 in. (19.1-mm)	-	95 - 100
1/2 in. (12.7-mm)	25 - 60	-
3/8 in. (9.52-mm)	-	20 - 55
No. 4 (4.76-mm)	0 - 10	0 - 10
No. 8 (2.38-mm)	0 - 5	0 - 5
Fineness Modulus (+0.20)	6.95	6.70
Organic Impurities	The colour shall have an intensity not darker than one-third the intensity of the standard colour solution. (not darker than Plate 1 as determined by the ASTM Test Method C40).	
Silt	Not more than 1.0 percent	
Soundness	Weighted average loss when subjected 5 cycles of the soundness test in accordance with ASTM Test Method C88 using magnesium sulfate, not more than 14 percent.	

Aggregate used in concrete shall not exceed the following maximum designated sizes:

- a. 3/4 in. for slabs, beams and girders.
- b. 1 in. for all other concrete.

4.1.2 Fine aggregate

Fine aggregate shall consist of inert natural sand conforming to the ASTM Specifications C33, and also conforming to the detailed requirements given in Table B. If it is so required by the Engineer the fine aggregate shall comply with these specifications.

TABLE B

Grading:

	<u>Sieve</u>	<u>Percent Passing</u>
	3/8 (9.52-mm)	100
No.	4 (4.76-mm)	95 - 100
"	8 (2.38-mm)	80 - 100
"	16 (1.19-mm)	50 - 85
"	30 (595-micron)	25 - 60
"	50 (297-micron)	10 - 30
"	100 (149-micron)	2 - 10
Fineness modulus		2.50 - 3.15
Organic impurities		The colour shall have an intensity not darker than two-thirds the intensity of the standard colour solution. (not darker than Plate 2 as determined by the ASTM Test Method C40).
Mortar strength		Compression ratio not less than 95 percent.
Soundness		Weighted average loss when subjected to 5 cycles of the soundness test in accordance with ASTM Test Method C88 using magnesium sulfate, not more than 10 percent.

- 4.1.3 The Contractor shall submit samples of fine and coarse aggregate to the Engineer in ample time for determination of the mix design before the Contractor proposes to use the aggregates in the work. At least 10 liters of each size of aggregate shall be submitted in suitable containers. All samples shall be plainly and neatly labeled indicating the source, where proposed to be used, date, and name of collector.

- 4.1.4 Materials shall not be delivered to the site or used until the samples have been approved, and as used, they shall in all respects be equal to the approved samples.

4.2

and inserts for masonry and mechanical items to concrete shall be of standard manufacture and of types required to engage with the anchors to be provided and installed therein, and shall be subject to approval.

4.3 Cement

- 4.3.1 Cement shall be Portland Cement and high Sulphate resisting cement, originating from approved manufacture, obtained in sealed and labelled bags. Cement delivered in bulk shall be accepted only if a central mixing plant is used. The quality of cement shall conform to the requirements of ASTM C150, Type I Type V.
- 4.3.2 All cement to be used in the work shall be subject to testing to determine whether it conforms to the requirements of the specifications. The methods of testing shall conform to the appropriate specification, but the place, time, frequency and method of sampling will be determined by the Engineer.
- 4.3.3 When used in the Works, cement shall be free from lumps and partially or wholly set cement.
- 4.3.4 When the cement is delivered in packages, the name and brand of the manufacture shall be plainly identified thereon. A bag shall contain 50 Kg net. All packages shall be kept in good condition at the time of inspection.
- 4.3.5 All cement shall be stored in suitable weatherproof store rooms which will protect the cement from dampness. These store rooms shall be placed in location approved by the Engineer. Provisions for storage shall be ample, and the consignment of cement as received shall be separately stored in such a manner as to provide easy access for the identification and inspection of each consignment. Stored cement shall meet the test requirements at any time after storage when a re-test is ordered by the Engineer.
- 4.3.6 The Contractor keep accurate records of the deliveries of cement and of its use in the work. Copies of these records shall be supplied to the Engineer in such form as may be required.
- 4.3.7 The cement shall be rejected if it fails to meet any of the requirements of these specifications.

- 4.3.8 Packages varying by 5 percent or more from the specified weight shall be rejected and if the average weight of packages in any consignment, as shown by weighing 50 packages taken at random, is less than that specified, the entire consignment shall be rejected and the Contractor shall remove it forthwith from the Site at his own expense and replace it with cement of satisfactory quality.
- 4.3.9 Stale cement, deteriorated cement or cement reclaimed from cleaning bags shall not be used and cement which for any reason has become partially set, or contains lump or caked cement, shall be rejected.
- 4.3.10 Cement shall be sampled either at the mill or at the Site as provided in the above specifications.
- 4.3.11 The Contractor shall notify the Engineer of dates of delivery so that there will be sufficient time for sampling the cement, either at the mill or upon delivery.
- 4.4 Reinforcement
- 4.4.1 Hot-rolled steel plain rods and bars
- Hot-rolled steel plain rods and bars shall conform to the strength requirements and minimum elongation of ASTM Specification A615, Grade 40.
- 4.4.2 Deformed steel rods and bars
- Deformed steel rods and bars shall conform to ASTM Specification A615, Grade 40.
- 4.5 Premolded-joint filler shall be of the thickness indicated on the drawings, of suitable length and width, and shall be Type 1 or Type 11 filler conforming to ASTM Specification D1752. As far as practicable, sheets shall be of correct width so that no longitudinal cutting will be required in the field. When strips are cut in the field, the cut surface shall be treated as recommended by the manufacturer.
- 4.6 Joint compound for joints in slabs shall conform to ASTM Specification D1190 or D1850.
- 4.7 Water
- 4.7.1 The water for concrete shall be clean, fresh, and obtained from potable water supply system of U.A.E. or equivalent.
- 4.7.2 The Contractor shall use the blended water as distributed for drinking purposes thru the city water supply network for the Works.

4.8 Admixtures

No admixtures of any type shall be used in the preparation of concrete unless directed or approved by the Engineer. In case any such admixtures are used the rates and methods of application shall be strictly in accordance with the manufacturer's instructions.

5. CONCRETE QUALITY AND USAGE

5.1 It is the intent of this specification to secure, for every part of the work, concrete of homogeneous structure which, when hardened, will have the required strength, watertightness, and durability. To this end it is essential that careful attention be given to the selection of materials, mixtures, placing, spading or vibrating, and curing of the concrete.

5.2 Concrete shall meet the limiting requirements given in Table C.

TABLE C (a)

Concrete above grade

Class of Concrete	Compressive Strength At 28 Days ^c (in kg/cm ²) Cylinder	Minimum Cement Content Kgs.	Coarse Aggregate Size	Max. Water Content Liters Per Bag	Consistency (Range in Slump)	
					Vibrated	Non-Vibrated
					mm	mm
A	210	350	3/4 in. or 1 in. - No.4 as required by the Engineer	27	50 - 100	75 - 125
B	140	250	2 in. - No.4	30	25 - 50	50 - 75

Class of Concrete	Cylinder Compressive Strength at 28 Days Kg/cm ²	Approximate Weights (Saturated Surface-Dry) of Fine and Coarse Aggregate Per Sack (50 Kgs) of Cement			
		Rounded Aggregate		Angular Aggregate	
		Fine Kgs.	Coarse Kgs.	Fine Kgs.	Coarse Kgs.
A	210	95	180	100	160
B	140	140	370	160	340

TABLE C (b)

Concrete in foundations and slabs on grade

Class of Concrete	Compressive Strength at 28 Days (in kg/cm ²) Cylinder	Minimum Cement Content Kgs.	Coarse Aggregate Size	Max. Water Content Liters Per Bag	Consistency (Range in Slump)	
					Vibrated mm	Non-Vibrated mm
A	210	375	3/4 in. or 1 in. - No.4 as required by the Engineer	27	50 - 100	75 - 125
B	140	250	2 in. - No.4	30	25 - 50	50 - 75

Class of Concrete	Cylinder Compressive Strength at 28 Days Kg/cm ²	Approximately Weights (Saturated Surface-Dry) of Fine and Coarse Aggregate Per Sack (50 Kgs) of Cement			
		Rounded Aggregate		Angular Aggregate	
		Fine Kgs.	Coarse Kgs.	Fine Kgs.	Coarse Kgs.
A	210	85	170	95	150
B	140	140	370	160	340

5.3 The total sodium chloride content used for making Class A concrete shall be less than 0.02 percent by the absolute dry weight of proportionally mixed fine and coarse aggregates.

In calculations made under the provisions of this Clause, any chlorides, other than sodium chloride, in the materials shall be converted to the equivalent of sodium chloride and be added to the amount of sodium chloride. The sulphate content shall not exceed 0.5 percent by the absolute dry weight of proportionally mixed fine and coarse aggregates.

5.4 Usage

5.4.1 Class A concrete shall be used for all reinforced and plain concrete not otherwise specified or noted on the drawings.

5.4.2 Class B concrete may be used wherever low-strength concrete is approved, including concrete fill under foundations in blinding and elsewhere as specified or indicated on the drawings.

6. CONSISTENCY

- 6.1 Concrete shall be of such consistency that it can be worked readily into all parts of the forms and around embedded work, without permitting the materials to segregate, or free water to collect on the surface. The slump of the freshly mixed concrete shall be determined in accordance with ASTM C143 at least morning and afternoon and whenever directed by the Engineer. In any event, the slump shall be less than 10 cm determined at the condition of difficulties pouring concrete to forms, and at the use of mechanical vibrator.
- 6.2 When concrete is compacted by high-frequency mechanical vibration, the above consistencies shall be regulated to lower values and the limiting consistencies may be modified by the Engineer.
- 6.3 Slump tests shall be made in the field by the Contractor as directed by the Engineer.

7. TESTING AGGREGATES AND DETERMINING PROPORTIONS

- 7.1 No concrete shall be used in the work until the materials and mix design have been approved by the Engineer.
- 7.2 The conformity of aggregates to the specifications hereinbefore given, and the actual proportions of cement, aggregates, admixtures where used, and water necessary to produce concrete conforming to the requirements set forth before shall be demonstrated and determined by tests made with representative samples of the materials to be used on the work. All such tests shall be made by the Contractor, under the supervision of the Engineer, without additional cost to the Owner.
- 7.3 Aggregates shall be tested in accordance with the methods referred to in the specifications therefore. Unless required by the Engineer the magnesium sulfate soundness test need to be made only if such test is considered by the testing laboratory to be necessary.
- 7.4 The water-cement ratio of the concrete to be used in the work shall be based on a curve showing the relation between water-cement ratio and 28-day compressive strength of concrete made using the proposed materials. The curve shall be determined by four or more points, each representing an average value of at least four test specimens, and shall have a range of values sufficient to yield the desired data without extrapolation. All procedures and tests shall conform strictly to the ASTM Standard C192, and the ASTM Standard C39.
- 7.5 The water-cement ratio of concrete to be used in the work shall correspond to a laboratory test strength at 28 days of 210 kg/cm² for Class A concrete and 140 kg/cm² for Class B concrete.

- 7.6 In no case, however, shall the resulting mix conflict with the limiting values for maximum water-cement ratio and minimum cement content as specified in Table C.
- 7.7 Reports on the tests of aggregates, the above-mentioned water-cement ratio strength curve, and a statement of the proportions proposed for the concrete mixture, shall be submitted in triplicate to the Engineer for approval as soon as possible, but not less than five days prior to the proposed beginning of the concrete work. If the Contractor furnishes in writing, similar, reliable detailed information from an acceptable source, and of date not more than four months prior to the time when concrete will be used on this project, the above requirements for laboratory tests may be modified by the Engineer. Such data shall derive from mixtures containing constituents of the same type and from the same sources as will be used on this project.
- 7.8 The Engineer shall have the right to make check tests of aggregates and concrete, using the same materials, and to order changes as may be necessary to meet this specified requirements. Cylinders made in the field shall be made and cured in accordance with ASTM Standard C31, except that wherever possible molds shall be left in cylinders until they have reached the laboratory. Laboratory tests and laboratory-made-cylinders shall conform to the appropriate tests and procedures specified above for testing aggregates and for determining the relation between water-cement ratio and compressive strength except that molds may be left in cylinders as long as necessary.
- 7.9 A minimum of 6 cylinders shall be taken from each concrete pour of 50 cubic meters or part thereof in one location. An absolute minimum of 6 cylinders shall be taken of each day's concrete production or as otherwise ordered by the Engineer.
- 7.10 Half the cylinders so manufactured shall be tested at 7 days and the other half shall be tested at 28 days. If the 7 day cylinders indicate a weaker than required concrete, no additional concrete works shall be built over the concrete so tested.
- 7.11 Any concrete indicating a weaker strength at 28 days than that specified shall be broken up and removed and replaced by the Contractor with acceptable concrete, all at the Contractor's expense.
- 7.12 If concrete of the required characteristics is not being produced as the work progresses, the Engineer may order such changes in proportions or materials, or both as may be necessary to secure concrete of the specified quality. The Contractor shall make such changes at his own expense and no extra compensation will be allowed because of such changes.
- 7.13 If, as the work progresses, the characteristics of the materials originally approved undergo a change, or if the Contractor wishes to use other materials, he shall submit, for approval, evidence that the new combination of materials will produce concrete meeting the stated requirements and will not result in objectionable changes in the colour or appearance of the work.

8. ASSURING MATERIALS

- 8.1 All materials for concrete, including water, shall be measured with equipment and facilities suitable for their accurate measurement and capable of being readily adjusted to changing conditions as required.
- 8.2 Cement in whole standard sacks need not be measured.
- 8.3 Water shall be measured by volume or weight; the error of measurement shall not exceed one-half of 1 percent.
- 8.4 Unless otherwise authorized, cement shall be measured in full sacks or by weight, and each size of aggregate shall be weighed separately. The error of measurement for successive quantities shall not exceed 1 percent.
- 8.5 Where volumetric measurements of aggregates are authorized, the weight proportions shall be converted to equivalent volumetric proportions and suitable allowance shall be made for variations in the moisture condition of the aggregates, including the bulking of fine aggregate, due to moisture and the method of compaction.

9. SITE-MIXED CONCRETE

- 9.1 Concrete to be produced at the Site shall be mixed in an approved batch mixer with a capacity of not less than 400 liters, except for small quantities which, by permission may be hand mixed. The volume of the mixed batch shall not exceed the manufacturer's rated capacity of the mixer. The site-mixed concrete plant and all operations pertaining to the production of the concrete shall be subject to the inspection and specific approval of the Engineer.
- 9.2 The minimum mixing time for each batch (from the time when all solid materials and water are in the drum) shall be 1-1/2 minutes for mixers of 800 liters capacity or less; for mixers of larger capacity, the mixing time shall be increased 30 seconds for each additional 400 liter or fraction thereof. The mixer shall revolve at uniform peripheral speed of about 60 rpm. The entire batch shall be discharged before the mixer is recharged.
- 9.3 Hand mixing shall be subject to the approval of the Engineer. If the concrete is mixed by hand, it shall be done on a suitable surface. The cement and aggregates shall be mixed dry until an even and uniform colour has been attained throughout. Then the proper quantity of water shall be added and the whole mass turned with square-edged shovels until it has become intimately mixed.

10. READY-MIXED CONCRETE

- 10.1 Ready-mixed concrete will be permitted provided that all requirements therefore herein set forth are fully complied with. The ready-mixed concrete plant and all operations pertaining to the production of the concrete shall be subject to the inspection and specific approval of the Engineer. Methods of batching mix constituents shall conform to the requirements set forth above under "Measuring Materials". All constituents shall be batched at the central plant.
- 10.2 All central-plant and rolling stock equipment and methods shall conform to ACI 304-73 and with Sections 6 to 14, inclusive, of the ASTM Specification C94, insofar as applicable.
- 10.3 Ready-mixed concrete shall be transported to the Site in watertight agitator or mixer trucks. The quality of concrete to be mixed or delivered in any one batch shall not exceed the rated capacity of the mixer or agitator for the respective conditions as stated on the nameplates.
- 10.4 Central-mixed concrete shall be plant-mixed a minimum of 1-1/2 minutes per batch, and then shall be truck-mixed or agitated a minimum of 8 minutes. Agitation shall begin immediately after the premixed concrete is placed in the truck and shall continue without interruption until discharged. For transit-mixed concrete the major portion of the mixing water shall be added and mixing started immediately after the truck is charged. The amount of water initially added shall be recorded on the delivery slip for the Engineer's information; no additional water shall be added, either in transit or at the site, except as directed. Mixing (at mixing speed) shall be continued for at least 10 minutes followed by agitation without interruption until discharge. Concrete shall be discharged at the site within 30 minutes after water was first added to the mix, and shall be mixed at least 5 minutes after all water has been added.
- 10.5 Attention is directed to the importance of dispatching trucks from the batching plant so that they shall arrive at the Site of the work just before the concrete is required, thus avoiding excessive mixing of concrete while waiting, or delays in placing successive layers of concrete in the forms.
- 10.6 Delivery slips shall contain the following information:
 - Ticket number
 - Load number
 - Truck number
 - Class of concrete
 - Cement brand, type, and weight in kilograms
 - Fine aggregate, source and weight in kilograms
 - Water in liters
 - Time mix left plant
- 10.7 Concrete delivered without a complete delivery slip will be rejected.

11. REMIXING CONCRETE

- 11.1 Concrete which has become compacted or segregated during transportation to or on the Site of the work shall be satisfactorily remixed just prior to begin place in the forms.
- 11.2 Partially hardened concrete shall not be deposited in the forms. The retempering of concrete which has partially hardened (that is, the remixing of concrete with or without additional cement, aggregate, or water) will not be permitted.

12. FORMWORK

- 12.1 Forms shall be used for all concrete including footings, except as otherwise permitted. Forms shall be so constructed and placed that the resulting concrete will be of the shape, lines, dimensions, and to the elevations indicated on the drawings or specified, and exposed (Fairfaced) concrete will be substantially free from board or grain marks, poorly matched joints, and other irregularities or defects.
- 12.2 For surfaces to be fairfaced, the form surface in contact with the concrete shall be made of:

- (a) Plywood forms

Plywood forms shall have a minimum thickness of 15 mm and minimum dimensions of 90 x 180 cm for individual segments of large forms. All edges of plywood sheets shall be straight and when fixed in place, all individual segments shall butt up tightly against each other to form an even and tight joint. Plywood forms may be reused provided the surfaces are cleaned of all scale and are free from openings, scars or other surface damage, and provided they are free from warping.

- (b) Wood forms lined with plywood

Plywood lining shall have a minimum thickness of 1cm and shall meet the requirements specified above for plywood forms. In order to provide the best appearance of the concrete surface, the plywood shall be held against the wood form by nails driven from the outside of the form into the plywood utilizing a nail length which will not pierce the inner surface of the plywood against which concrete is to be placed. Should the lining become separated from the form between the time the form is set and the placing of concrete starts, finishing nail, driven through the plywood lining, may be used to bring it back into proper position.

Properly cleaned, unscarred and unwarped plywood lining may be reused. In borderline cases, the decisions of the Engineer as to whether or not the form lining may be reused shall be final.

(c) Steel forms

The use of steel forms or forms with steel lining is mandatory in the case of curved surfaces. Steel forms shall be keyed together in final position by wedges or bolts, so arranged that the forms may be stripped from the finished work without prying against the concrete. Before each use, steel forms shall be cleaned of all rust, scale and cement crust, and covered with a film of clean oil. Cleaning and oiling should be accomplished immediately after steel forms are stripped to prevent the formation of rust.

(d) Steel form lining

Steel form lining having a minimum thickness of 2 mm may be used in conjunction with any suitably supported and well aligned form to provide the desired surface hardness, smoothness and texture. Such lining will be securely held in place by countersunk, flat head wood screws. Such lining will have square edges and be accurately butted and aligned at all joints.

12.3 For surfaces other than those to be fairfaced forms shall be made of wood, metal, or other approved material. Wooden forms shall be constructed of sound lumber or plywood of suitable dimensions, free from knotholes and loose knots. Plywood shall be reasonably good, as approved. Metal forms shall be of an approved type for the work involved. Edges of forms in contact with concrete shall be flush within 10 mm.

12.4 All forms shall be of suitable material, design and construction so as to be rigid, tight enough to prevent the passage of mortar, and plane surfaces shall be plane within 1 mm in 1 meter. Particular care shall be taken to ensure that forms are true to line where deviations in the concrete would be obvious or objectionable, as where building superstructures are to be built thereon, or where the tops of walls are exposed. All such deviations which may occur shall be corrected by, and at the expense of the Contractor as directed, even to the extent of tearing down and rebuilding the concrete.

12.5 Forms for walls, or columns shall have removable panels at the bottom for cleaning, inspection, and scrubbing-in of bonding grout. Forms for thin sections of considerable height shall be arranged with suitable openings so that the concrete can be placed in a manner that will prevent segregation and accumulations of hardened concrete on the forms of reinforcement above the fresh concrete, unless special spouts are used to place concrete, and so that construction joints can be properly keyed and treated.

- 12.6 Forms shall be sufficiently rigid to prevent displacement or sagging between supports, and so constructed that the concrete will not be damaged by their removal. The Contractor shall be entirely responsible for their adequacy.
- 12.7 All forms shall be oiled with an approved nonstaining form oil or liquid form coating before reinforcement is placed.
- 12.8 Before form material is reused, all surfaces that are in contact with the concrete shall be thoroughly cleaned, all damaged places repaired, and all projecting nails withdrawn.
- 12.9 Form ties to be encased in concrete shall not be made of through-bolts or common wire, but shall be of a well-established type, so made and installed as to embody the following features:
- (a) After removal of the protruding part of the tie, there shall be no metal nearer than 3 cm to the face of the concrete.
 - (b) That part of the tie which is to be removed shall be at least 1 cm in diameter, or if smaller, it shall be provided with a wood or a plastic or a metal cone 3 cm long placed against the inside of the forms. Cones shall be carefully removed from the concrete after the forms have been stripped.
 - (c) Ties which pass through walls subject to hydrostatic pressure shall be provided with approved water stops, such as washers, securely fastened to the ties.

12.10 Removing forms

- 12.10.1 Except as otherwise specifically authorized by the Engineer forms shall not be removed until the concrete has aged for the following number of days:

Columns	<u>FORM</u>
Columns	3 days
Slab Soffit	6 days
Beam Soffit	6 days
Walls	4 days
Beam Sides	3 days

- 12.10.2 Posts under beams and slabs shall not be removed until the concrete has attained at least 80 percent of the specified cylinder strength and also sufficient strength to support safely its own weight and the construction live loads upon it.

- 12.10.3 Any work showing signs of damages through premature loading is to be entirely reconstructed at the Contractor's expense. The responsibility for the safe removal of the formwork rests with the Contractor, however, the Engineer has the right to fix the time of striking if he decides this to be beneficial to the work.

12.10.4 Control Test

Results of suitable control tests will be used as evidence that concrete has attained sufficient strength to permit removal of supporting forms. Cylinders required for control tests shall be provided in addition to those otherwise required by this specification. Test specimens shall be removed from moulds at end of 24 hours and stored in the structure as near points of sampling as possible, shall receive in so far as practicable the same protection from the elements during curing as is given those portions of the structure which they represent, and shall not be removed from the structure for transmittal to the laboratory prior to expiration of three-fourths of the proposed period before removal of forms. Cylinders shall be tested by and at the expense of the Contractor.

13. CONCRETE REINFORCEMENT

13.1 General

All reinforcement shall be placed strictly in accordance with the Drawings and as instructed in writing by the Engineer. Nothing shall be allowed to interfere with the required disposition of the reinforcement, and the Contractor shall make a particular point of seeing that all parts of the reinforcement are placed correctly in every respect, and are temporarily fixed where necessary to prevent displacement before or during the process of tamping and ramming the concrete in place. The ties, links or stirrups connecting the bars shall be taut so that the bars are properly braced; the inside of their curved parts shall be in actual contact with the bars, around which they are intended to fit. Reinforcement detailing and placement, including concrete protection for steel reinforcement, unless otherwise indicated or specified, shall conform to ACI 318 and 315.

13.2 Wire

Wire for binding reinforcement bars shall be of soft black annealed mild steel wire. The diameter of the wire shall not be less than 16 SWG (1.6 mm) and the binding shall be twisted tight with proper pliers. The free ends of the binding wire shall be bent inwards.

13.3 Protection of material

Steel reinforcement shall be protected at all times from injury. When placed in the work, it should be free from dirt, detrimental scale, paint, oil, loose rust, grease or other foreign substances.

13.4 Fabrication

Bar reinforcement shall be bent to the shapes shown on the drawings. All bars shall be bent cold, unless otherwise permitted by the Engineer. No bars partially embedded in concrete shall be field bent except as shown on the plans or specifically permitted by the Engineer.

13.5 Placing and fastening

13.5.1 All steel reinforcement shall be accurately placed in the positions shown on the drawings and firmly held during the placing and setting of concrete. Bars shall be tied at all intersections except where spacing is less than 30 cm in each direction, in which case alternate intersections shall be tied.

13.5.2 Distances from the forms shall be maintained by means of stays, ties, hangers, reinforcement from contact with the forms shall be precast mortar blocks of approved shape and dimensions or approved metal chairs. Metal chairs which are in contact with the exterior surface of the concrete shall be galvanized. Layers of bars shall be separated by precast mortar blocks or by other equally suitable devices. The use of pebble pieces of broken stone or brick, metal pipe and wooden blocks shall not be permitted. Reinforcement in any member shall be placed and then inspected and approved by the Engineer before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and removal required. Spacers for fairfaced concrete shall be of an approved shape and manufacture.

13.6 Splicing

13.6.1 All reinforcement shall be furnished in the full lengths indicated on the Drawings. Splicing of bars, except where shown on the drawings, will not be permitted without the written approval of the Engineer. Splices shall be staggered as far as possible.

13.7 Cover

Minimum clear concrete cover to main steel reinforcements shall be as follows unless otherwise instructed on the drawings.

Concrete cast against and permanently exposed to earth	75 mm
Concrete exposed to earth or weather	
#6 bar and larger	50 mm
#5 bar and smaller	40 mm
Concrete not exposed and in contact with ground	
Beams, columns: (main steel, ties, stirrups)	40 mm
Slabs, walls	20 mm

14. PLACING AND COMPACTING CONCRETE

- 14.1 At least 24 hours before the Contractor proposes to make any placement of concrete, he shall notify the Engineer of his intention and planned procedure. Unless otherwise permitted, the work shall be so executed that a section begun on any day shall be completed during daylight of the same day.
- 14.2 No concrete shall be placed until the subgrade, forms and preliminary work have been approved. No concrete shall be placed until all materials to be built into the concrete have been set and have been approved by the various trades and by the Engineer. All such materials shall be thoroughly clean and free from rust, scale, oil, or any other foreign matter.
- 14.3 Forms and excavations shall be free from water and all dirt, debris, and foreign matter when concrete is placed. Except as otherwise directed, wood forms and embedded wood called for or allowed shall be thoroughly wetted just prior to placement of concrete.
- 14.4 No restrictions will normally be placed on concreting in hot weather, i.e., when the temperature at any time during the day may exceed 35 deg. C., but should the Contractor wish to mix and place concrete in such weather he shall take the following precautions.
- (a) Aggregate stock piles shall be sprinkled with water to encourage cooling by evaporation. Successive layers shall be sprayed when stockpiling.
 - (b) Concrete materials shall be protected from direct sunlight as far as possible before, during and after mixing.
 - (c) Cool water shall be used for mixing, arrangements being made to cover, bury, insulate and/or paint white the storage tanks and pipes.
 - (d) Shuttering, formwork and reinforcement shall be mist-sprayed with cool water immediately before the concrete is placed and all surplus water lodging in the forms shall be removed.
 - (e) Special emphasis on and care with the protection and curing of the concrete shall be exercised; shuttering shall be kept cool and protected from direct sunlight by damp sacking or other approved insulation continuously until the time of its removal.
 - (f) Only fresh portable water shall be used for the above-mentioned cooling processes.
- 14.5 Concrete shall be transported from the mixer to the place of final deposit as rapidly as practicable and by methods which will prevent separation of ingredients and avoid hardening.

- 14.6 Chutes for conveying concrete shall be metal or metal lined and of such size, design, and slope as to ensure a continuous flow of concrete without segregation. The slope of chutes shall be not flatter than 1 on 2 and all parts of a chute shall have approximately the same slope. The discharge end of the chute shall be provided with a baffle, or, if required, a spout; and the end of the chute or spout shall be kept as close as practicable to, but in no event more than 1.5 meters above, the surface of the fresh concrete. When the operation is intermittent, the chute shall discharge into a hopper.
- 14.7 In thin sections of considerable height (such as walls and columns), concrete shall be placed in such manner as will prevent segregation and accumulations of hardened concrete on the forms or reinforcement above the mass of concrete being placed. To achieve this end, suitable hoppers, spouts with restricted outlets, etc., shall be used as required or approved unless the forms are provided with suitable openings.
- 14.8 Chutes, hoppers spouts, etc., shall be thoroughly cleaned before and after each run and the water and debris shall not be discharged inside the form.
- 14.9 For any one placement, concrete shall be deposited continuously in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams and planes of weakness within the section, and so as to maintain, until the completion of the unit, an approximately horizontal, plastic surface.
- 14.10 No wooden spreaders shall be left in the concrete.
- 14.11 During and immediately after being deposited, concrete shall be thoroughly compacted by means of suitable tools and methods, such as internal-type mechanical vibrators operating at not less than 5000 rpm., or other tool spading to produce the required density and quality of finish. Vibration shall be done only by experienced operators under close supervision and shall be carried on in such manner and only long enough to produce homogeneity and optimum consolidation without permitting segregation of the solid constituents, "Pumping" of air, or other objectionable results. All vibrators shall be supplemented by proper spade puddling approximately 5 cm away from forms to remove included bubbles and honeycomb. Excessive spading against the forms, causing the deposition of weak mortar at the surface, shall be avoided.
- 14.12 The concrete shall be thoroughly rodded and tamped about embedded material so as to secure perfect adhesion and prevent leakage. Care shall be taken to prevent the displacement of such materials during concreting.
- 14.13 Construction joints shall be made as specified hereafter.

15. BONDING CONCRETE AT CONSTRUCTION JOINTS

- 15.1 In order to secure full bond at construction joints, the surface of the concrete previously placed (including vertical, inclined, and substantially horizontal areas) shall be thoroughly cleaned of foreign materials and laitance, if any, and then roughened so that the aggregate will be slightly exposed over 90 percent of each 5 cm square area. Such cleaning and roughening shall be done by the use of suitable tools and methods, such as picks, wire brushes, wet sand-blasting, etc., and shall be followed by recleaning by means of a stream of clean water or compressed air.
- 15.2 The previously placed concrete at the joint shall be saturated with clean water and kept thoroughly wet overnight, after which all pools shall be removed by an air jet. After free or glistening water disappears, the concrete shall be given a thorough coating of neat cement mixed to a suitable consistency. The coating shall be 3 mm thick on vertical surfaces and 5 mm thick on horizontal surfaces, and shall be well scrubbed in by means of stiff bristle brushes wherever possible. New concrete shall be deposited before the neat cement dries.

16. CONSTRUCTION AND EXPANSION JOINTS

- 16.1 Construction and expansion joints shall be of the types indicated on the drawings and shall be constructed wherever and only in such places as are indicated on the drawings or otherwise directed or approved. The Contractor shall plan the work to minimize the use of joints in addition to those indicated.
- 16.2 Footings, beams and slabs shall have no horizontal joints. Unless otherwise indicated, all construction joints shall have keyways the widths of which are equal to one-third the thickness of the member in which the keyways are placed.
- 16.3 Premolded expansion joint filler
 - 16.3.1 Joints with joint sealant

At expansion joint in concrete slabs to be exposed and at other joints indicated to receive joint sealant, premolded expansion-joint filler strips shall be installed at the proper level below the finished floor with a slightly tapered, dressed-and-oiled wood strip temporarily secured to the top thereof to form a groove not less than 20 mm deep. The wood strip shall be removed after the concrete has set. The groove, when surface dry, shall be cleaned of foreign matter, loose particles, and concrete protrusions, then filled approximately flush with joint sealant so as to be slightly concave after drying.

16.3.2 Joints with compound

When slabs on grade are to receive resilient flooring and premolded expansion-joint filler is required between the slabs or between the slabs and vertical surfaces, the filler strips shall be installed at the proper level below the finished floor with a slightly tapered, dressed-and-oiled wood strip temporarily secured to the top thereof to form a groove not less than 6-mm deep. The wood strip shall be removed after the concrete has set.

16.3.3 Finish at joints

Edges of exposed concrete along expansion joints shall be neatly finished with a slightly rounded edging tool.

17. METAL WORK IN CONCRETE

- 17.1 All castings, inserts, conduits and other metalworks shall be accurately built into or encased in the concrete by the Contractor as directed, and all necessary precautions shall be taken to prevent the metalwork from being displaced or deformed.
- 17.2 Anchor bolts for structural steels and miscellaneous steels shall be set by means of substantial templates.
- 17.3 Anchor bolts for plant equipment shall be set by the Contractor in sufficient time prior to placing concrete. Tolerances of setting shall conform to the plant equipment manufacturer's requirement. Grouting and finishing of plant equipment foundations shall be performed by the Contractor, in accordance with the requirement stated in the Specifications, after plant equipment has been installed. Grouted surfaces shall be finished smooth to give a uniform appearance with finish of the adjacent.
- 17.4 The Contractor shall build into new concrete against which concrete blocks are to be laid, suitable, approved, noncorrodible metal, dovetailed grooves for ties for securing the blockwork to the concrete.

18. TRIMMING AND REPAIRS

- 18.1 It is the intent of this specification to require forms, mixture of concrete, and workmanship so that concrete surfaces, when exposed, will require no patching.
- 18.2 As soon as the forms have been stripped and the concrete surfaces exposed, fins and other projections shall be removed, recesses left by the removal of form ties shall be filled, and surface defects which do not impair structural strength shall be repaired.

- 18.3 Defective concrete shall be cut normal to the surface until sound concrete is reached, but not less than 3 cm deep. The remaining concrete shall be thoroughly roughened and cleaned.
- 18.4 Concrete around the cavity or the form-tie recess shall be thoroughly wetted and promptly painted with a 2 mm brush coat of neat cement mixed to the consistency of lead paint. The hole shall then be filled with mortar.
- 18.5 Mortar shall be a 1:1-1/2 cement and sand mix with sufficient white cement, or fine limestone screenings in lieu of sand, to produce a surface matching the adjoining work. Cement and sand shall be from the same sources as in the parent concrete.
- 18.6 For filling form-tie recesses, the mortar shall be mixed slightly damp to the touch (just short of "balling") hammered into the recess until it is dense and an excess of paste appears on the surface, and then troweled smooth. Mortar in patches shall be applied so that after partial set it can be compressed and rubbed to produce a finish flush and uniform in texture with the adjoining work. All patches shall be warm-moist cured as specified hereinafter.
- 18.7 The Contractor shall be responsible for the adherence of mortar used in repairing concrete. He shall prepare the cavity and apply the repair material in such manner that this end may be attained. Unless otherwise specifically required, mortar shall not be applied as a coating or plastering over the surface, but each void shall be individually filled.
- 18.8 The use of mortar patching as above specified shall be confined to the repair of small defects in relatively green concrete. If substantial repairs are required, the defective portions shall be cut out to sound concrete and the concrete replaced by means of a cement gun, or the masonry shall be taken down and rebuilt, all as the Engineer may decide or direct.

19. SURFACE FINISH

- 19.1 Fins and irregularities on formed surfaces to receive no other finish shall be smoothed.
- 19.2 The top of concrete on which other concrete or unit masonry will later be placed shall be struck off true at the surface indicated on the drawings or approved, as the concrete is being placed. As soon thereafter as the condition of the concrete permits and before it has hardened appreciably (normally within 2 hours after being deposited), all water, scum, laitance, and loose aggregate shall be removed from the surface by means of wire or bristle brooms in such manner as to leave the coarse aggregate slightly exposed and the surface clean. Raking or other methods which cause weak serrations shall not be employed. The formation of depressions and general unevenness shall be avoided. Thereafter the Contractor shall taken all necessary

precautions to ensure that the surface thus prepared shall be kept free from storage piles, drippings, staining, or accumulation of substances which would adversely affect the concrete or the bond between layers of concrete and which cannot be adequately removed by the cleaning specified under Paragraph "Bonding concrete at construction joints".

- 19.3 Where the top surface of structural concrete is to be left in a finished condition, the concrete shall be brought monolithically to the finished grade therefor, as indicated on the drawings or required; subsequent addition of a layer of mortar ("topping") or concrete to bring the finished surface to the correct grade will not be permitted.
- 19.4 Fairfaced concrete finish shall be given to all formed surfaces which will be exposed to view on completion of the work.
- 19.5 Concrete surfaces to which roof insulation or roofing are to be applied shall be finished sufficiently smooth to receive the roofing material, as obtained by steel trowel or very smooth wood-float finish.
- 19.6 The finishes to be given to certain other concrete surfaces are as indicated on the drawings or as ordered by the Engineer.
- 19.7 Steel trowel finish

Surfaces to be given a steel-trowel finish shall first be given a wood-float finish. This shall be followed by hand trowelling with steel trowels to bring the surface to a uniform, smooth, hard, impervious surface free from marks and blemishes. Trowelling shall be avoided. Dusting with dry cement or other mixtures or sprinkling with water will not be permitted in finishing.

20. CURING AND PROTECTION

- 20.1 All concrete work shall be protected against damage from the elements and defacement of any nature during construction operations.
- 20.2 Water shall not be permitted to rise on concrete within 24 hours after it is placed.
- 20.3 All concrete, particularly slabs and including finished surfaces shall be treated immediately after concreting or cement finishing is completed, to provide continuous moist curing for at least seven days, regardless of the adjacent air temperature.

21. RECORDS

Records shall be kept by the Contractor of the positions in the works of all batches of concrete, of their grade, of all tests, cores or other specimens taken from them, placement of concretes and reinforcements, progress of works, approved items, climatic records, etc. Copies of these records shall be supplied to the Engineer.

22. PRECAST CONCRETE ITEMS

Precast concrete items such as kerb stones, frames for wall exhausters and PC desks shall be cast as specified hereinbefore for in-situ concrete and as shown on the drawings. Concrete shall be class A and cement may be ordinary portland cement. Forms shall be clean and virgin and constructed stably to the satisfaction of the Engineer. Curing shall be executed in water tanks fully submerged for at least 7 days. For PC desks, specification shall also referred to Section: FURNISHINGS AND SPECIALITIES.

23. VAPOUR BARRIER

Vapor barriers shall be installed under all interior slabs on grade as shown. Vapor barriers shall be a pure polythene film of 0.15 mm minimum thickness conforming to JIS K 6781, free of pinholes, nozzle scars, or other imperfections. All joints shall be lapped 15 cm minimum. Tears and breaks, shall be sealed with waterproof tape of a type recommended by the vapor barrier manufacturer.

SECTION 4

BLOCKWORK

1. SCOPE

This section shall apply to all blockwork for building construction.

2. APPLICABLE PUBLICATIONS

The following publications of the issues listed belows, but referred to thereafter by basic designation only form a part of this specification to the extent indicated by the references thereto:

2.1 American Society for Testing and Materials (ASTM) Publications

- C 140-75 Sampling and Testing Concrete Masonry Units.
- E 11-70 Wire-Cloth Sieve for Testing Purpose.

2.2 British Standards Institution Publications

- BS 493-1967 Airbricks and Gratings for Wall Ventilation.
- BS 882-1965 Aggregates from Natural Source for Concrete.
- BS 1200-1971 Sands for Mortar for Plain and Reinforced Brickwork, Blockwalling and Masonry.
- BS 1243-1972 Metal Ties for Cavity Wall Construction.
- CP 211-1966 Internal Plastering.

3. MATERIALS

3.1 Cement

Cement for solid and hollow concrete blocks and mortar shall be ordinary portland cement as specified under Section: CONCRETE WORK.

3.2 Aggregates

Fine aggregate used for concrete blocks shall comply with the grading of Table 2, Grading Zone 1, B.S. 882, and for mortar Table 2 of B.S. 1200.

3.3 Water

Water to be used in blockwork shall conform to the requirements specified for water under Section: CONCRETE.

3.4 Concrete Blocks

- 3.4.1 Concrete blocks shall be made from a mix of 250 kg. of cement to 1500 kg. of fine aggregate. If for any reason, the strength requirement is not achieved, the cement shall be increased at the Contractor's expense.
- 3.4.2 Concrete blocks shall be obtained from approved local factories. Concrete blocks shall be hard, sound, durable, sharp, rectangular shape, clean with well defined arrises, free from cracks and flaws or other defects.
- 3.4.3 Concrete blocks (solid and hollow) shall be of the following dimensions (except screen block).

Hight - 19 cm \pm 3 mm
Length - 39 cm \pm 2 mm
Width - 10, 14, 19 cm, as required \pm 2 mm

The Engineer may request and approve a change in the dimensions of concrete blocks. The width of blocks shall be as indicated on the drawings and as directed in writing by the Engineer.

- 3.4.4 Hollow concrete blocks shall comply with the following minimum requirements.

(a) Compressive Strength at Twenty Eight (28) Days Over Cross-Sectional Area for Non-Bearing Walls:

30 kg/cm² average of 12 blocks
25 kg/cm² for any block

(b) Water Absorption:

20% or less of dry weight

- 3.4.5 Sampling and testing for the above requirements shall be in accordance with ASTM Method C 140, and whenever required by the Engineer, at the Contractor's expense.
- 3.4.6 The design of the cavities and webs of the hollow concrete blocks shall be submitted to the Engineer prior to manufacture. The thickness of the face shell and of the membrane of solid portions shall be no where less than 35 mm. The combined thickness of the solid portions shall be not less than one-fourth (1/4) of the width and length of the block respectively.
- 3.4.7 Screen Block

Blocks shall be strong cast concrete blocks of approved pattern of the size 190x190x190 mm complying with BS 493.

3.4.8 Handling and storage

Blocks shall be handled, stored and protected in an approved manner to avoid chipping, brakage, contact with soil or contaminating material, and exposure to the element.

3.5 Mortar

- 3.5.1 Mortar shall be prepared in the following proportions with the addition of the minimum quantity of clean water for workability.

Cement and sand mortar (1:2:5) mix, shall be composed of one part cement to parts of sand by volume. Plasticizers for mortar of methyl cellulose of an approved manufacturer as specified under Section: PLASTER WORK shall be used in strict accordance with the manufacturer's instructions. The above mix proportions may be modified according to the instruction of the manufacturer under the approval of the Engineer. Printed instructions for usage of the plasticizer shall be submitted and approved by the Enginer.

- 3.5.2 The ingredients for mortar shall be measured in proper clean gauge boxes and the mixing shall be carried out by means of an approved mechanical batch mixer.

- 3.5.3 The mortar shall be thoroughly mixed dry until a uniform mix is obtained. Excess water shall not be present in the mix. The mix shall in every way satisfy the Engineer. Mortar shall be mixed in an approved location and care shall be taken that no foreign matter enters the mix or a loss of liquid occurs during mixing. Mortar shall be used in the works as soon as possible after mixing but in no case after the initial set commences. In no event shall mortar be re-mixed and used after initial set has taken place.

- 3.6 Reinforcing steel shall conform to the requirements specified under Section: CONCRETE WORK.

4. WORKMANSHIP

- 4.1 All blockwork shall be set out and built to the respective dimensions, thickness and heights, shown on the drawings and/or as instruction in writing by the Engineer.
- 4.2 All walls, and partitions, where shown on the drawings without indicating the type of the block to be used, shall be built in hollow concrete blocks unless otherwise directed by the Engineer in writing.

- 4.3 The blocks shall be well soaked before the used and the top of walls left off shall be wetted before work is recommended. All blocks shall be well buttered with the appropriate mortar before being laid and all joints shall be thoroughly flushed up as the work proceeds. All joints shall be uniform in 1 cm wide and shall not exceed 1.5 cm. No one portion shall be raised more than 1.00 meter above another at one time, and wall or partition necessarily left at different levels shall be raked back. All perpends, quoins, internal and external angles, etc... shall be kept strictly true and square and the whole properly bonded together and levelled round. All blockwork shall be plumbed vertically.
- 4.4 The surface of the walls and partitions prepared for plastering, shall have the joints raked out 1.5 cm from the face of the wall to form key for the plaster.
- 4.5 All walls and partitions shall be properly cured by sprinkling water for a period not less than three (3) days after completion of laying the courses.
- 4.6 Walls and partitions terminating against soffits of beams or slabs shall be lightly wedged with metal wedges after mortar in bed joints attained its set, and the joints packed with mortar.
- 4.7 Cutt and fit block work next to reinforced concrete, door, window, jambs and sills, and form chases for the ends of door and window lintels. Hollow concrete blocks abutted on any built-in fixtures e.g. door and window frames, apertures, louvers, etc. shall be reinforced with steel bars and filled with cement mortar into the hollows.
- 4.8 Blocks containing reinforcement shall be filled with cement mortar specified under this section.
- 4.9 Hot-weather installtion
- Block erected when the ambient air has a temperature of more than 31 degrees C., in the shade, and has a relative humidity of less than 50 percent shall be protected from direct exposure to wind and sun for 48 hours after installation.
- 4.10 Two thcikness of cavity walls shall be bonded together with wall ties spaced one meter apart horizontally and approximately 40 cm apart vertically and staggered. Extra ties shall be provided at reveals, quoins and openings. Ties shall be of butterfly twist type 3.2 mm mild steel wire, zinc coated to comply with B.S. 1243 or approved by the Engineer. The length of ties shall be suitable for the thickness of the wall. The cavity shall be kept clear by lifting screeds or other means approved by the Engineer and shall be left clean at completion.

4.11 Block walls shall be reinforced and bonded to columns and soffits' of beams and slabs as shown on the drawings and/or directed by the Engineer.

SECTION 5

PLASTER WORK

1. SCOPE

This section shall apply to all portland cement plaster and cement mortar work indicated on the drawings.

2. APPLICABLE PUBLICATIONS

The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto.

--- British Standard (B.S.)

BS 12	Portland Cement (Ordinary and Rapid Hardening)
BS 1199: 1971	Sands for External Rendering, internal plastering with Lime and Portland Cement, and Floor Screeds
BS 1369: 1947	Metal Lathing (steel) for Plastering.
BS 4027: 1966	Sulphate-resisting Portland Cement
CP 211: 1966	Internal Plastering

3. MATERIALS

3.1 Cement and water used for plaster work shall comply with the requirements specified under Section: CONCRETE and of BS. Sulphate-resisting Portland Cement shall be used for cement plaster, cement mortar (both waterproofed and ordinary) which contact with sea water. Sand for plastering shall be clean and shall be washed in potable water if necessary. Sand shall be sieved and graded to meet the following requirements:

- (i) For plaster undercoats and cement mortar, the grading shall be as in B.S. 1199, Table 1.
- (ii) For plaster finish coats, the grading shall be as in B.S. 1199, Table 2.

3.2 Metal Lathing shall comply with BS 1369, plain expanded type not lighter than 1.6 Kg/m².

3.3 Water Proofed Cement Mortar

The water proof stuff shall be high polymer emulsion type and obtained from an approved manufacturer and supplied in the manufacturers' sealed and branded containers. Details of mixing and application shall be in accordance with the specifications of the manufacturer concerned and to the approval of the Engineer. Surface shall be finished with steel trowels.

4. WORK ON SITE

4.1 General

The whole of the work shall be executed in a workmanlike manner, to the satisfaction of the Engineer. Any work rejected through non-compliance with the specification shall be removed and replaced at the expense of the Contractor. The Contractor shall commence work when instructed, and shall clear all unused materials and waste from the site when the work is complete.

4.2 The Contractor shall supply all necessary labour, materials, tools and scaffolding necessary for the completion of the work detailed. Sufficient labour shall be provided at all times to complete the work without delays and at a reasonable speed. All scaffolding used shall comply with the requirements of local by laws.

4.3 All branded materials shall be delivered to the site in their original packages, bearing the trade names of the material concerned. Cement shall be stored off the ground, under cover and away from all possible sources of damp. Sand should be stored under clean conditions to prevent its contamination with soil or other deleterious substances.

4.4 Proportioning

The materials used for plastering shall be proportioned by volume by means of gauge-boxes. Alternatively it may be required to proportion the materials by weight.

Mix proportioning for the use of cement mortar and cement plastic shall be as specified below:

MIX PROPORTIONS (CEMENT: SAND, BY VOLUME)

GROUP	USE	FIRST COAT	MIDDLE COAT	FINISHING COAT	STANDARD THICKNESS (mm)
1	Cement mortar for floor topping and water proofed cement mortar	-	-	1:2.5	25 - 30 (as specified)
2	Cement plaster for internal wall	1:2.5	1:3	1:3	20
3	Cement plaster for internal soffit	1:2.5	-	1:3	12
4	Cement plaster for external wall	1:2.5	1:3	1:3.5	25
5	Cement plaster for external soffit	1:2.5	-	1:3	12

Mix proportions for tile setting shall be as specified in the respective sections hereinafter.

4.5 Plasticizers of methyl cellulose of an approved manufacturer as "Hi-Metolose" of Shinetsu Chemical Company, Ltd. (Telex: J24790 SHINCHEM, International phone: +81.3.242.1211) shall be used in strict accordance with the manufacturer's instructions. The above mix proportions may be modified according to the instructions of the manufacturer under the approval of the Engineer. Printed instructions for usage of the plasticizer shall be submitted and approved by the Engineer.

4.6 Mixing

Unless otherwise approved by the Engineer, all cement mortar and cement plaster shall be mixed by an approved mortar mixer equipped with accurate devices to control volume of water used. Hand mixing, if permitted, shall be carried out on a metal sheet or watertight wooden panel.

Mixing shall be made from time to time to produce only required quantity of mortar for use within 30 minutes after mixing.

The cement and sand shall be thoroughly mixed together until the mixture percent homogeneous colour and consistency.

The mixing time, except for hand mixing, shall be not less than 5 minutes; approximately 2 minutes of which shall be consumed for mixing the dry cement and sand, 3 minutes for mixing after the water has been added. Timing to add particizer shall be in strict accordance with instructions of the manufacturer.

Quantity of water to be added shall be so determined as to produce suitable consistency, and shall be adjusted according to the moisture content of sand and the instructions of the plasticizer's manufacturer.

Cement mortar and cement plaster shall in no case be used after the initial set commences. In no event shall mortar be remixed and used after the initial set has taken place.

5. DISSIMILAR BACKGROUNDS

All junctions between different materials to receive cement plaster shall be reinforced. This shall apply to where concrete block walls joint concrete columns, walls and beams and similar situations where cracks are likely to develop and as directed by the Engineer.

The reinforcement shall consist of a strip of galvanized wire mesh (10 to 15 mm hexagonal mesh) 15 cm wide which shall be plugged, nailed or stapled as required at intervals of not exceeding 15 cm at both edges. Angles shall be reinforced as described above and rounded to 5 mm radius by cement plaster unless otherwise directed on the drawings, to provide corner beads.

6. WORKMANSHIP

6.1 Cement plaster

Surfaces to receive cement plaster shall be thoroughly cleaned with wire brush, washed down and continuously kept wet with water, by means of fog spray or appropriate method approved by the Engineer, for at least 24 hours before application of cement plaster. Surfaces of concrete walls, columns and beams shall be cut to the required true surfaces and shall be roughened by chipping to increase adhesion of cement plaster.

Immediately before applying first coat, thin layer of dash-bond coat of cement paste shall be uniformly brushed on to prepared surfaces. First coat shall be applied and floated with trowel and slightly scratched with wire scratcher. First coat shall be kept moist with fog spray for two days without interruption and then be left for free drying for at least seven days.

Before applying middle coat, wooden or metal plaster grounds shall be provided at every internal and external corners, ends of plaster and at other appropriate positions to obtain the required true surfaces. Middle coat shall be applied, floated and finished with rods or straightedges to a flat true surface.

Finishing coat shall be applied while middle coat is nearly but not quite dry, and floated and finished with metal trowel. Finishing coat shall be finished flat, smooth and true to the lines as approved by the Engineer. Finished surfaces shall be free from rough areas, trowel marks, checks and other defects.

Finishing coat shall be kept moist with fog sprays for at least two days without interruption and thereafter it shall be properly protected from quick drying until it is adequately and thoroughly set and dried.

All surfaces which are likely to be stained or damaged shall be properly protected from such stain or damage. Plastering on external surfaces shall be provided with control joints as shown on the drawings.

6.2 Cement mortar for floor topping

Surfaces to receive cement mortar topping shall be washed clean, free from dirt, laitance or other foreign substances. Cement mortar shall be applied on the prepared surfaces and tamped thoroughly. Quantity of water in cement mortar shall be reduced to the extent practical. Proper wood grounds shall be provided to keep the required thickness. While cement mortar is still wet and plastic, cement mortar shall be floated with a straightedge along wood grounds and finished with metal trowel to the required flat and true surfaces.

SECTION 6

METAL WORK

1. SCOPE

This section shall apply to all metal works not covered under Section: CONCRETE WORK, BLOCK WORK, CARPENTRY AND JOINERY, DOORS AND WINDOWS, and AQUA TANKS.

2. APPLICABLE PUBLICATIONS

The following publications of the issues listed below, but referred to thereafter by basic designation only, for a part of this specification to the extent indicated by the references thereto:

2.1 British Standards (BS)

BS 4:	Structural Steel Sections
BS 449:	The Use of Structural Steel in Building.
BS 497: 1967	Cast Manhole Covers, Road Gully Gratings and Frames for Drainage Purposes
BS 1615: 1972	Anodic Oxidation Coatings on Aluminium.
BS 1474: 1972	Wrought Aluminium and Aluminium Alloys for General Engineer Purposes. Extruded Round Tube and Hollow Sections.
BS 1494: part 1 and 2: 1951	Fixing Accessories for Building Purposes.
BS 4870: ---	Approval Testing of Welding Procedures. Part 1: 1974 Fusion Welding of Steel.
BS 4871: ---	Approval Testing of Welders Working to Approved Welding Procedures. Part 1: 1974 Fusion Welding of Steel.

3. GENERAL

All materials shall be obtained from approved reputable manufactures usually engaged for supply of the similar materials. The Contractor shall verify all measurements and shall take all field measurements necessary before fabrication. The Contractor shall prepare and submit to the Engineer for approval detailed shop drawings before fabrication. The drawings shall show dimensions, materials, including bolts, screws, etc., and other necessary informations. The Contractor shall also submit all necessary catalogues and samples of the material as may be required by the Engineer. Welding to or on structural steel shall be in accordance with BS 449. Exposed fastenings shall be compatible materials. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. Miscellaneous bolts and anchors, supports, braces, and connections necessary for completion of the work shall be provided. The necessary rebates, lugs, and brackets shall be provided so that the work can be assembled in a neat and substantial manner. Holes for bolts and screws shall be drilled or punched. Poor matching of holes will be cause for rejection. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall give ample strength and stiffness.

4. DISSIMILAR MATERIALS

Where dissimilar metals are in contact, or where aluminium is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surface shall be protected with a coat of bituminous paint or other approved method to prevent galvanic or corrosive action.

5. WORKMANSHIP

Metals shall be well formed to shapes and sizes, with sharp lines and angles. Drilling and punching shall produce clean true lines and surfaces. Welding shall be continuous along the entire area of contact except where tack welding is permitted. Exposed connections of work in place shall not be tack welded. Exposed welds shall be ground smooth. Exposed surfaces of work in place shall have a smooth finish. Where tight fits are required, joints shall be milled to a close fit. Corner joints shall be coped or mitered, well formed, and in true alinement. Work shall be accurately set to established lines and elevations and securely fastened in place. Work shall be executed and finished in accordance with approved drawings, cuts, details and samples.

6. QUALIFICATION OF WELDERS

Welding to or on structural steel or miscellaneous items of structural steel shall be performed by certified welders qualified in accordance with procedures covered in BS 4870 and BS 4871; using procedures and materials and equipment of the type required for the work.

7. ANCHORAGE

Anchorage shall be provided where necessary for fastening metal items securely in place. Anchorage not otherwise specified or indicated shall include slotted inserts, expansion bolts, and powderdriven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; through, lag bolts, and screws for wood. Slotted inserts and expansion bolts shall be of types required to engage with the anchors and shall be approved. They shall be procured from reputable manufactures approved by the Engineer upon submission of the samples and technical literatures by the Contractor.

8. MATERIALS

Materials shall conform to the requirements specified for the particular item; and where these requirements are not specified in detail, the materials shall be suitable for the intended usage of the item.

9. HANDRAILS, SHOWER CURTAIN RAILS, LADDERS AND COAT HANGERS FOR CLOSETS

Handrails, shower curtain rails, ladders and coat hangers for closets shall be of stainless steel polished with fire grit and conforming to BS 1449 part 4 and BS 3014. They shall be installed rigid and stable at the locations indicated. Necessary anchors shall be provided as required for rigid installation. Rail joints shall be finished flush. Dimensions shall be as indicated.

10. MANHOLE COVERS AND FRAMES

Manhole covers and frames shall be of cast iron for medium duties conforming to BS 497. They shall be installed rigid and stable at the location indicated.

11. Roof drains shall be of cast iron and the shape and dimensions shall be as shown. Roof drains shall be of suitable for collecting and outletting rain water on the roof, also suitable for the material of waterproof membrane and shall maintain fully watertight. They shall have demountable gratings to prevent dust entering into the drain. Associated fixing materials such as screws shall be provided. A sample shall be submitted to the Engineer for his approval.

12. Stainless items such as ladders, steps, etc. shall be of 18-8 stainless steel (18% chromium, 8% nickel of steel alloy). Fixing materials for them shall also be of 18-8 stainless steel.

13. ALL OTHER METAL ITEMS

All other metal items such as suspension system for suspended ceilings, expansion joint cover, dust collection pit and trench, cable trench covers and frames, open gutter drains, metal shoes for timber columns, etc. shall be supplied and installed necessary for proper and successful completion of the work.

Necessary anchors shall be provided as required. Material for these items shall comply with the respective standards given hereinbefore, or shall be as directed by the Engineer.

Suspension system for suspended ceilings shall also referred to Section: SUSPENDED CEILINGS.

14. SHOP PAINTING

Unless otherwise specified, surfaces of ferrous metal, except stainless steel and galvanized surfaces, shall be cleaned and shop coated with one coat of anti-rust paint specified under Section: PAINT.

SECTION 7

CARPENTRY AND JOINERY

1. SCOPE

This section shall apply to all wood work of whatever nature or description, including mill work, etc.

2. APPLICABLE PUBLICATIONS

The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto.

2.1 British Standards (B.S.)

BS 144:1954	Coal Tar Creosote for the Preservation of Timber
BS 1186:-----	Quality of Timber and Workmanship in Joinery Part 1: 1971 Quality of Timber and Workmanship in Joinery Part 2: 1971 Quality of Workmanship
BS 1202: -----	Nails
BS 1203: 1963	Synthetic Resin Adhesive for Plywood
BS 1204: -----	Synthetic Resin Adhesives for Wood
BS 1282: 1959	Classification of Wood Preservatives and their methods of application
BS 1455: 1963	Plywood Manufactured from Tropical Hardwoods
CP 98: 1964	Preservative Treatment for Constructional Timber

3. MATERIALS

3.1 Timber shall comply with BS 1186: Part 1: 1971. Samples for each use shall be submitted to the Engineer for his approval.

3.2 Species

Softwood	Group 1	Douglas fir, Longleaf pine, European redwood
Hardwood	Group 1	Burma teak
	Group 2	Ahmar, Faini, Zan
	Group 3	Abulhaz, Montaig

Generally structural timber work shall be executed in Group 1 Softwood or other coniferous timbers considered by the Engineer to be similar and equal.

Group 2 or Group 3 Hardwood or other deciduous timbers considered by the Engineer to be similar and equal may be used for structural timber work at the approval of the Engineer.

In general, joinery work shall be executed in first grade Burma teak. Where required by the drawings to be painted or work which remains unexposed shall be executed in Group 2 Hardwood or other deciduous timbers considered by the Engineer to be similar and equal. Group 3 Hardwoods shall not be used for joinery work.

3.3 Plywood shall comply with BS 1455. Adhesive shall comply with BS 1203, Grade WBP (weather and boil-proof). Face veneers shall be of Grade 1 in accordance with BS 1455. Face veneers to be finished with clear paint shall be sliced veneer.

3.4 All hardware for woodwork, such as screws, nails, bolts, anchor plates, etc. shall comply with relevant JIS, BS or ASTM.

4. HANDLING AND STORAGE OF MATERIALS

All materials shall be handled and stored at the site of the work in such a manner that materials will not warp, crack, split or damaged in any manner.

All millwork items such as door and window frames, panels, etc. shall be stored under cover for protection from rain, wind, sunlight, dust, sand and moisture.

5. MOISTURE CONTENT OF TIMBER

The moisture content of the timber used for internal joinery shall be less than 20 per cent when the joinery is delivered to the site, and the moisture contents shall be maintained until the building is finished. The Engineer will require evidence of correct moisture content to be submitted to him before the joinery is fixed.

6. WOOD PRESERVATIVES

Timbers indicated as "Treated Wood" on the drawings and timbers which contact with concrete, hollow concrete block, cement mortar and metal shoes shall be treated with wood preservatives for the prevention and curative treatment of fungal and insect attack. Treatment shall be carried out after all cutting and shaping are completed and care shall be taken to avoid damage to surfaces of treated timber in subsequent handling.

If treated timber is unavoidably cut or damaged, liberal application of preservatives shall be made to cut or damaged surfaces. Material and treatment shall be in accordance with BS 144, BS 1282 and BS code of practice CP 98. Creosote shall not be contaminated with other materials. Surface coating shall be applied on the surfaces of the timber to form an unbroken film. All treated timber shall be dry before incorporation in the works.

7. WORKMANSHIP

7.1 Dimensions

All "wrought" timber is to be sawn, planed, drilled or otherwise machined or worked to the correct sizes and shapes shown on the drawings or specified. Where "nominal" dimensions are stated for "wrought" timber, an allowance of 3 mm (1/8 in.) shall be permitted for each "wrought" surface. The full-size detail drawings shall be held to show the "actual" dimensions.

7.2 Exposed faces

All timber that is to be exposed in the finished surfaces of joinery works shall be "wrought" on the appropriate faces, unless otherwise specified.

7.3 Shrinkage

The arrangement, jointing and fixing of all joinery works shall be such that shrinkage in any part and in any direction shall not impair the strength and appearance of the finished work, and shall not cause damage to contiguous materials or structures.

7.4 Tolerance

Reasonable tolerance shall be provided at all connections between joinery works and the building carcass, so that any irregularities, settlements or other movements shall be adequately compensated.

7.5 Fabrication

The joiner shall perform all necessary mortising, tenoning, grooving, matching, tonguing, housing, rebating, and all other metal plates, screws, nails and other fixings that may be ordered by the Engineer, or that may be necessary for the proper execution of the joinery works specified. The joiner shall also carry out all works necessary for the proper construction of all framings linings, etc., and for their support and fixing in the building.

7.6 Joints

- 7.6.1 The joinery shall be constructed exactly as shown on the details. Where joints are not specifically indicated they shall be the recognized forms of joints for each position. The joints shall be made so as to comply with BS 1186, Part 2: 1971. Loose joints shall be used where provision must be made for shrinkage or other movements acting other than in the direction of the stresses of fixing or loading.
- 7.6.2 Glued joints shall be used where provision need not be made for shrinkage or other movements in the connections, and where sealed joints are required. All glued joints shall be cross-tongued or otherwise reinforced.
- 7.6.3 All nails, sprigs, etc. are to be punched and puttied. Surfaces in contact shall have a good sawn or planed finish. All cutting edges of tools shall be sharp to avoid "burnishing". The surface of plywood to be glued should be lightly dressed with sand or glass paper. The sand or glass paper must not be allowed to clog and cause "burnishing".
- 7.6.4 Members in construction to be joined by glueing shall be of similar conversion. All surfaces to be glued shall be kept clean, free from dirt, dust, saw-dust, oil and any other contamination. Adequate pressure should be applied to glued joints to ensure initial contact and maintained whilst the glue is setting.
- 7.6.5 Mixing, application and setting conditions should be in accordance with the glue maker's instructions. For joints in non-loadbearing internal work and for joints in work where the moisture content is always less than 16 per cent, organic glues or casein may be used.

7.7 Mouldings

All moulded work shall be accurately worked to the details supplied by the Engineer and/or shown on the drawings. All mouldings shall be worked on the solid, except where otherwise stated.

7.8 Scribing

All skirtings, architraves, plates and other joinery works shall be accurately scribed to fit the contour of any irregular surface against which they may be required to form a close butt connection.

- 7.9 Structural timber work shall be properly jointed together, wedged and bolted where necessary in accordance with the principles of good construction and to the satisfaction of the Engineer.

8. JOINERY COMPONENTS

8.1 Door Frames

Door frames in internal walls shall be framed, rebated, or moulded and shall be constructed of the dimensions shown on the drawings. The frames shall be "fixed-in" or wedged and nailed or screwed to grounds or wood bucks.

8.2 Architraves

- 8.2.1 Architraves shall not be installed until after the wall coverings have been formed or constructed.
- 8.2.2 Where architraves are required to be installed before the wall coverings have been formed or constructed because of their design and detail, they shall be protected against damage by suitable casings and the plasterer should be advised so that he may make the necessary arrangements and charges for extra screedings.
- 8.2.3 Provide architraves, moulded to detail, and secure to grounds, plugged or otherwise fixed to the walls and partitions.

9. PROCEDURE

9.1 Measurements for joinery

The Contractor shall take all measurement for joinery works at the building, and not from the drawings, except where the work is specified to be "Built-in".

9.2 Built-in joinery

Where joinery works are to be erected in position before the surrounding or enclosing works of the main building carcass have been carried out, it shall be the responsibility of the contractor to ensure that the joinery works are set plumb and true, and shall not be damaged or displaced by subsequent operations. Where necessary, the joinery works shall be temporarily encased and braced.

- 9.2.1 The contractor shall also provide and secure suitable anchors or other fixings so that these may be "built-in" to the carcass while it is being constructed. The anchorage connections shall be constructed so that they will permit settlements in the building carcass without stressing or otherwise loading the joinery works.

9.3 Fixed-in joinery

Where joinery works are to be inserted in the positions they are to occupy after the surrounding or enclosing carcass has been constructed, it shall be the responsibility of the contractor to ensure that the necessary fixings are incorporated in the carcass; alternatively, the contractor shall construct such groundworks as are required to provide of suitable base and fixing for the joinery works.

9.3.1 The contractor shall secure "fixed-in" joinery works so that they are plumb and true to the shapes and dimensions shown on the drawings and details. Vertical junctions shall be solidly bedded with mortar, wedged or otherwise secured, as may be specified or as is most appropriate in the circumstances, but a clearance is to be maintained in all overhead junctions so that settlements in the building carcass may take place without stressing or otherwise loading the joinery works.

9.3.2 Joinery works shall not be fixed in position until after all floor, wall and ceiling surfaces have been formed or constructed, unless otherwise specified.

10. TIME FOR DELIVERY

None of the joinery shall be delivered until it is required for fixing in the building. Joinery which does not require to be built-in as the work proceeds shall not be brought to the site and fixed until the building is enclosed.

11. TRANSPORT AND PROTECTION

The joinery shall be kept under a water-proof cover during transit and it shall be similarly covered and kept clear of the ground on the site. It shall be handled and stacked carefully to avoid damage.

12. MAKE GOOD DEFECTIVE WORK

Should any shrinkage or warping occur or any other defects appear in the joiner's work before the end of the defects liability period, such defective work shall be taken down and renewed to the Engineer's satisfaction and any work disturbed in consequence shall be made good at the Contractor's expense.

SECTION 8A
WATERPROOFING

1. SCOPE

This section shall apply to the installation of bituminous roof waterproofing system indicated on drawings as "waterproofing". Application and workmanship shall be in accordance with instructions of the roofing manufacturer.

2. APPLICABLE PUBLICATIONS

The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto.

2.1 British Standard (BS)

CP 144: Roof coverings. Built-Up
Part 3: 1970 Bitumen felt.

BS 747: Part 2: 1970 Roofing felts.

2.2 American Society for Testing and Materials (ASTM)

D 41-73 Primer for Use with Asphalt in Damp-
proofing and Waterproofing.

D 312-71 Asphalt for Use in Constructing
Built-Up Roof Coverings.

D 491-41 Asphalt Mastic for Use in Waterproofing
Asphalt Cement, Mineral Filler, Mineral
Aggregate.

3. MATERIALS

3.1 All materials shall be of tropical type and suitable for use in temperature of the project site.

3.2 Asphalt primer shall comply with ASTM D41-73.

3.3 Asphalt shall comply with ASTM D 312, Type 111.

3.4 Asphalt caulking shall comply with ASTM D 491-41.

3.5 Waterproofing membrane shall be for one ply water proofing method and composed of bitumen/rubber reinforced with 100 percent synthetic non-woven fabric in core and surfaced with mineral granule on both sides. Thickness and weight shall be not less than 2mm and 2.3 kg per square meter.

Waterproofing membrane shall be of approved equal, at the decision of the Engineer, to "custom sheet waterproofing" of Nissin Kogyo Co., Ltd., 23-4 Azuma 2-chome Senju, Adachi-ku, Tokyo, Japan (Telex: J2655042 MARUBSU, International phone: +81.3.882.2424).

Asphalt caulking shall be suitable for sealing purpose and shall have suitable softness of cold application. The residue of the caulking obtained from the distillation shall be 70 percent minimum. Asphalt caulking shall comply with ASTM D491.

Roofing materials shall be stored in an approved manner and shall be protected from contact with soil and exposure to the elements. Immediately before laying, roofing membrane rolls shall be stacked on end and stored for 24 hours in an area maintained at no lower temperature than 10°C.

4. PREPARATION

The surface on which the roofing or flashings are to be applied shall be free from moisture, dirt, projections, and foreign materials, and shall be smooth and firm. Pipes and other items penetrating the roof shall be secured in position and properly prepared for flashing. Surfaces shall be inspected and approved by the Engineer immediately prior to application of roofing and flashings.

5. APPLICATION OF ROOFING

Unless specified otherwise application of roofing shall be in accordance with CP 144, Part 3 and the manufacturer's instruction. Asphalt shall not be heated above 230 degree C. Kettlemen shall be in attendance at all times during the heating to insure that the maximum temperature specified does not exceed.

Asphalt primer for concrete surfaces to receive asphalt products, shall be applied at a rate of not less than 0.3 litre per square meter.

Roofing shall be laid free of wrinkles or buckles at right angles to the slope of the deck, immediately behind the mop. Layer of roofing shall be rolled in place and laid in not less than 1 Kg of asphalt per square metre for solid mopping. Over-laps shall be 100mm minimum. Asphalt shall uniformly cover all roof areas to be mopped to provided effective bond. All ends of asphalt roofings and perimeter of roof drains, pipes, etc., passing through waterproofing shall be sealed by asphalt caulking with trowel or spatula. For roof waterproofing except internal waterproofing, insulation shall immediately follow roofing as a continuous operation as specified under Section: THERMAL INSULATION.

6. REINFORCINGS

Reinforcing consisting of synthetic mesh fabric and mopping shall be provided over the membrane at floor drains, roof drains and pipes and other items penetrating the slab, and where the membrane may be subject to unusual stress in accordance with the manufacturer's recommendation. At drains and elsewhere as indicated, membrane and two layers of reinforcing shall be extended into a clamping device and clamped securely.

At pipes penetrating the slab, membrane and two layers of reinforcing shall be bent up to proper height and fastened with copper wires.

All ends of waterproofing membrane shall be waterproofed in accordance with the manufacturer's recommendation.

All exposed waterproofings which subject to direct sunshine shall be coated with aluminium paint recommended by the waterproofing membrane manufacturer.

7. PROTECTION

All cares and provisions shall be taken against all traffic and plant by the use of sheets of hardboards or similar materials. Care shall be taken to keep waterproofings free from all droppings and injurious materials and any damage shall be made good during application of surfacing.

SECTION 8B
THERMAL INSULATION

1. SCOPE

This section shall apply to application of insulation board on waterproofing of concrete roof decks and Cultivation room's walls and door.

2. APPLICABLE PUBLICATIONS

The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto.

2.1 Federal Specification (Fed. Spec.)

SS-C-135B Cement, Bituminous, Plastic.

2.2 American Society for Testing and Materials (ASTM)

D 312-71 Asphalt for Use in Constructing Built-Up
Roof Coverings.

3. GENERAL

Insulation shall be applied to the waterproofed roof surfaces indicated. In the application for roof, asphalt shall be used. Asphalt shall not be heated above 230°C. Kettlemen shall be in attendance at all items during the heating to insure that the maximum temperature specified is not exceeded. Bitumen shall be hot when applied. The waterproofed surface shall be free from surface moisture and shall be smooth, firm, free from dirt, projections, and foreign materials. Application of materials shall not be performed under excessive wind conditions. Insulation work shall be coordinated with waterproofing work so that all material applied each day is waterproofed and insulated the same day with the complete waterproofing and insulation system. Wet materials shall not be used and shall be removed from the worksite. Materials shall be stored in an approved manner and shall be protected from contact with soil and from exposure to the elements.

4. MATERIALS

Materials shall conform to the following requirements.

4.1 Asphalt

ASTM D 312, Type 111

4.2 Insulation

Insulation shall be poly-styrene foam board and its density shall be more than 20 kg per cubic meter. Thickness of insulation to be used shall be more than 40 mm. For door and wall insulation of cultivation room, same material of 30 mm thick shall be used.

5. APPLICATION OF INSULATION

Insulation shall be in one or more layers to the thickness as specified on the drawings. Hot bitumen shall be dripped in spot at an interval approximately 30 cm on both direction and while bitumen is still hot units of insulation board shall be laid in parallel courses with horizontal joints in moderate contact with adjoining units without forcing, and cut to fit neatly against adjoining surfaces and tamped throughly to have good bond. Successive layers shall be applied with approved glue as directed by the manufacturer of insulation, and joints shall be staggered with respect to joints of preceding layer. Bitumen shall not be applied further than one panel length ahead of roof insulation being installed. The insulation shall be kept dry at all times and shall be laid just before application.

Concrete or concrete block wall of cultivation room to receive insulation shall be cleaned free from dirt and foreign materials. Insulation shall be applied after wood furrings have been installed and before furring strips and wall boards are applied, to concrete or concrete block wall with approved glue as directed by the manufacturer of insulation.

6. PROTECTION

All cares and provisions shall be taken in the manner described in the Section: WATERPROOFING.

7. SURFACING

Paving tiles specified under Section: PAVING TILES shall be laid directly on insulation in closed joints as shown on the drawings. Direction of joints shall be parallel with co-ordinates of the building applied. Insulation shall not be damaged by dropping of tiles or traffic of any kind, etc.

SECTION 8C

CAULKING AND SEALING

1. SCOPE

This section shall apply to caulking and sealing of all joints between concrete or masonry and metal or wood frames or as specified on the drawings.

2. APPLICABLE PUBLICATIONS

The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto:

2.1 Federal specifications

HH-P-117	Packing; Jute, Twisted
TT-C-00598B (COM-NBS) & Int Am 1	Caulking Compound, Oil and Resin Base Type (for Building Construction).
TT-S-00230C (COM-NBS) ‡ Am 2	Sealing Compound, Elastomeric Type, Single Component (for Caulking, Sealing, and Glazing in Buildings and Other Structures).
TT-S-001543A	Sealing Compound, Silicone Rubber Base (for Caulking, Sealing, and Glazing in Buildings and Other Structures).
UU-P-270F & Int Am 1	Paper, Wrapping, Waxed (Dry).
UU-T-00106D (GSA-FSS)	Tape, Pressure-Sensitive Adhesive, Masking, Paper.

3. REQUIREMENTS FOR CAULKING AND SEALANTS

3.1 General

Caulking or sealant shall be provided in joints as indicated or specified. Materials shall conform to the respective specifications and other requirements specified and shall be of the approved by the Engineer. Asphalt caulking shall be referred to Section: WATERPROOFING.

3.2 Sealant formulation

3.2.1 Intended application

Each container brought to the job site with a different sealant formulation shall be marked for the intended use. For each intended use, the colour shall be one of the approved colours as closely matching the adjacent surfaces as possible. The sealant formulation shall conform to the requirements specified herein and the Contractor shall submit proposed sealant, which he intends to use, to the Engineer for approval.

3.2.2 Components of each formula shall be used only with that formula. Intermixing of components of different formulas will not be permitted. Thinners or other additives shall not be used to modify the formula.

3.3 No.1 sealant shall be oil base caulking compound conforming to TT-C-598B.

3.3.1 Openings 5 mm (1/4 in.) and less between walls and partitions and adjacent casework, shelving, door frames, built-in or surface-mounted equipment and fixtures, etc. as required on the drawings.

3.3.2 Perimeters of frames of doors, windows, and access panels which adjoin exposed internal concrete and masonry surfaces as required on the drawings.

3.3.3 Seats of metal thresholds for external doors.

3.4 No.2 sealant curing type shall be one-component, polysulfide sealant, conforming to TT-S-230C.

3.4.1 Joints and recesses formed where frames and subsills of windows, doors, louvers, and vents adjoin masonry, concrete, or metal frames. Use sealing compound at both external and internal surfaces of external wall penetrations.

3.4.2 Joints in wash surfaces of stonework.

3.4.3 Expansion and control joints.

3.4.4 Internal face of expansion joints in external concrete or masonry walls where no metal expansion joint covers are required.

3.4.5 Openings where items pass through external walls.

3.4.6 Where flashing is inserted into masonry joints.

3.4.7 Metal-to-metal joints where "sealing" or "caulking" is shown or specified.

3.4.8 Bottoms of external doorway frames.

3.4.9 Decks and walkways.

No.2 sealant should be used on external applications for sealing control joints and expansion joints and other movable joints in concrete, masonry, and metal where cyclic movement is anticipated. This type of caulking should not be used for sealing joints adjacent to or above membrane surfaces of asphaltic or bituminous materials.

3.5 No.3 sealant shall be one-component silicones sealant conforming to TT-S-1543 and as recommended by the supplier of acrylic aquarium panels. No.3 sealant shall be applied to joints of acrylic panels and joints of acrylic panels and adjacent materials as shown on the drawings.

3.6 Sealant to be used for waterproofing shall be based on asphalt or bituminous materials similar to those in the membrane waterproofing, and specified under Section: WATERPROOFING.

4. SEALER

Sealer for use with No.1 sealant shall be readymixed aluminium paint conforming to TT-P-38.

5. BACK UP MATERIAL

Backup material shall be closed-cell resilient urethane or polyvinylchloride foam, closed-cell polyethylene foam, closed-cell sponge of vinyl or rubber, polychloroprene tubes or beads, polyisobutylene extrusions, oilless dry jute, or rope yarn. Backup material shall be nonabsorbent, nonstaining, and compatible with the sealant used. Tube or rod stock when used shall be rolled into the joint cavity.

Rope yarn shall conform to HH-P-117, type I.

6. BOND PREVENTIVE MATERIALS

Bond-preventive materials shall be one of the following, as recommended by the sealant manufacturer.

6.1 Polyethylene tape, pressure-sensitive adhesive

The adhesive is required only to hold tape to the construction materials as indicated.

6.2 Wax paper

Wax paper shall conform to UU-P-270F.

7. MASKING TAPE

Masking tape shall conform to UU-T-106D.

8. SURFACE PREPARATION

The joint design, shape, and spacing shall be as indicated. The surfaces of joints to be sealed shall be dry. Oil, grease, dirt, chalk, particles of mortar, dust, loose rust, loose mill scale, and other foreign substances shall be removed from all joint surfaces to be sealed. Oil or grease shall be removed with solvent and surfaces shall be wiped with clean cloths.

8.1 Concrete and masonry surfaces

Where surfaces have been treated with curing compounds, oil, or other such materials they shall be removed by sandblasting or wire brushing. Laitance, efflorescence and loose mortar shall be removed from the joint cavity.

8.2 Steel surfaces to be in contact with sealant shall be sandblasted or, if sandblasting would not be practical or would damage adjacent finish work, the metal shall be scraped and wire brushed to remove loose mill scale. Protective coatings on steel surfaces shall be removed by sandblasting or by a solvent that leaves no residue.

8.3 Aluminium surfaces of windows and door frames in contact with sealants shall be cleaned off temporary protective coatings. When masking tape is used for a protective cover, the tape and any residual adhesive shall be removed just prior to applying the sealant. Solvents used to remove protective coatings shall be as recommended by the manufacturer of the aluminium work and shall be nonstaining.

9. APPLICATION

9.1 Paper masking tape shall be placed on the finish surface on one or both sides of a joint cavity to protect adjacent finish surfaces from primer or compound smears. Masking tape shall be removed within 10 minutes after joint has been filled.

9.2 Backstops

The back or bottom of joints constructed deeper than indicated shall be packed tightly with backstop material to provide a joint of the depth indicated. Where necessary to provide a backstop for oil and resin sealant, the joint shall be packed tightly with rope yarn.

- 9.3 Primer shall be used on concrete masonry unit, wood, or other porous surfaces in accordance with instructions furnished with the sealant manufacturer. Primer shall be applied to the joint surfaces to be sealed. Surfaces adjacent to joints shall not receive primer.

9.4 No.1 sealant

Compound shall be gun-applied with a nozzle of proper size to fit the width of joint indicated and shall be forced into grooves with sufficient pressure to expel air and fill the groove solidly. Caulking shall be uniformly smooth and free of wrinkles and shall be left sufficiently convex to result in a flush joint when dry. One coat of sealer shall be applied over joint after compound has dried sufficiently to develop a surface skin so as not to deform the surface of the joint.

9.5 No.2 and 3 sealant

Compound shall be gun-applied with a nozzle of proper size to fit the width of joint indicated and shall be forced into grooves with sufficient pressure to expel air and fill the groove solidly. Sealant shall be uniformly smooth and free of wrinkles. Joints shall be tooled slightly concave after sealant is installed. When tooling white or light-colour sealant, dry or water-wet tool shall be used. No.2 and No. 3 sealant shall be applied in accordance with instructions provided by the manufacturer of the sealant.

10. CLEANING

The surfaces adjoining the caulked and sealed joints shall be cleaned of smears and other soiling resulting from the caulking and sealing application as work progresses.

SECTION 9A

ALUMINIUM DOORS AND WINDOWS

1. SCOPE

This section shall apply to the manufacture and installation of all aluminium doors, frames, windows and louvers. Ironmonger is specified under Section: IRONMONGER unless otherwise specified in this section.

2. APPLICABLE PUBLICATIONS

The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto.

2.1 British Standards (B.S.)

BS 1470: 1972	Wrought Aluminium and Aluminium Alloys for General Engineering Purposes, Plate, Sheet, and Strip.
BS 1474: 1972	Wrought Aluminium and Aluminium Alloys for General Engineering Purposes-bars, extruded round tubes and sections.
BS 1615: 1972	Anodix Oxidation Coating on Aluminium
BS 3987: 1974	Anodized Wrought Aluminium for External Architectural Purposes.
BS 4300/4: 1973	Specification (Supplementary Series) for Wrought Aluminium and Aluminium Alloys for General Engineering Purposes. BTR E6 Solid Extruded Bars and Sections Suitable for Bright Trim Reflector Applications.

3. SHOP DRAWINGS

Shop drawings of doors, frames, windows and louvers shall be submitted for approval prior to start the work. Shop drawings shall indicate location and elevation of each type of doors, frames, windows, and louvers and shall show type and location of ironmonger, weatherstripping, detail of construction including anchorage, and methods of assembly.

4. PROTECTIVE COATING OR COVERING

Prior to shipment from the factory, finished surfaces of aluminium shall receive a protective covering. Protective covering shall not chip, peel, or flake due to temperature or weather and shall protect against discoloration and surface damage from transportation, storage, and construction activities. Protective covering shall be readily removable without affecting the finish. Covering shall be either adhesive paper, waterproof tape or strippable plastic.

5. DELIVERY AND STORAGE

Materials delivered to the site shall be inspected for damage; unloaded and stored with a minimum of handling. The storage spaces shall be in dry locations with adequate ventilation, free from dust or water, and shall permit easy access for inspection and handling. Materials shall be stored neatly on the floor, properly stocked on non-absorptive strips or wood platforms to the satisfaction of the Engineer.

6. GENERAL REQUIREMENTS

6.1 General Description

Aluminium doors and frames at locations indicated shall be swing type of size and design shown on drawings. Doors shall be complete with frames, framing members, sub-frames, transoms, adjoining sidelights, trim and other accessories indicated and specified.

Aluminium windows and louvers shall be of the types and sizes indicated. Each window shall consist of a unit including frame, sash, ironmonger, mullions where indicated. Glass and glazing are specified under Section: GLASS AND GLAZING. The glass and ventilating areas of the windows furnished shall be not less than such areas of the windows indicated.

- 6.2 Shapes of extruded aluminium sections shown on the drawings are representation of design intention, function and required profile. Shapes of equivalent design, dimensions, profile and function may be submitted. For such alternation, the Contractor will be approved by the Engineer to contact with the manufacturer submitting samples, drawings or descriptive materials explaining such shapes for which he intends to use.

The contractor shall have responsibility of the stability and strength of the aluminium doors and windows against wind speed of 90 mile per hour (40 meter per second). The contractor shall verify the stability and submit calculation sheets to the Engineer for his approval.

6.3 Ironmonger

- 6.3.1 Ironmonger for aluminium doors and frames is specified under Section: IRONMONGER. Ironmonger templates for use in fabrication of aluminium doors and frames shall be obtained by door manufacturer from ironmonger supplier. Doors and frames shall be cut, reinforced, drilled and tapped at the factory to receive all template ironmonger. Doors to receive surface applied ironmonger, except push plates, kick plates and mop plate, shall be provided with reinforcing only; drilling and tapping shall be done in the field. Metal for ironmonger reinforcements shall be cadmium plated steel, stainless steel, or steel with a hot-dipped galvanized finish and shall be secured by welding. Wood blocks shall be provided in core of flush doors as required to receive locks and door closers. Where locations of ironmonger are not shown, requirements specified under Section: IRONMONGER shall apply.
- 6.3.2 Aluminium windows shall have a manually operated adjustable latch, operable by latch handle from inside only unless otherwise requested on the drawings. Pulls shall be provided for both inside and outside of operable panels of windows. Exposed ironmonger shall be aluminium or stainless steel finished to match frame finish. Ironmonger for aluminium windows shall be as specified under Section: IRONMONGER.

6.4 Provisions for Glazing

Glazing of aluminium doors, transoms, sidelights and windows is specified under Section: GLASS AND GLAZING. Metal glazing beads, vinyl inserts and glazing gaskets for securing glass shall be supplied by the manufacturer.

6.5 Anchors

Provide anchors of sizes and shapes as approved or shown on the drawings for securing aluminium frames to adjacent construction. Anchors shall be of steel with hot-dipped galvanized steel having thickness more than 1.25 mm. Securely anchor transom bars at ends and mullions at head and sill. Anchors shall be placed near top and bottom of each jamb and near ends of head and sill, and at intermediate points not more than 600 mm apart. Anchor bottom of each frame to rough floor construction with 2 mm thick stainless steel angle clips secured to buck of each jamb and to floor construction, using stainless steel bolts and expansion bolts for fastening clip anchors.

Gaps between adjacent concrete or concrete block construction, and door and window frames shall be filled with cement mortar to have rigid stability. During filling of cement mortar and finishing work of walls, protective coating or covering specified herein before under this section shall be applied so as to keep free from dirt of chemical erosion by surplus mortar.

6.6 Weatherstripping

All four sides of each window panel and all surrounding frames shall be provided with weatherstripping. Weatherstripping shall provide maximum protection against elements and be designed so it may be replaced.

6.7 Fastening

Exposed screws or bolts will be permitted only at inconspicuous location, and shall have heads countersunk. Concealed reinforcements for ironmonger shall be provided.

7. MATERIALS

7.1 Aluminium for Windows, Doors and Frames

Aluminium shall consist of extruded aluminium and steel materials. Extrusions shall comply with BS 1474 and BS 4300/4. Aluminium sheets and strips shall comply with BS 1470. Alloy shall be best suited for the purpose. Extrusions and press-formed members shall be a minimum nominal thickness of 1.5 mm except glazing bead of a minimum nominal thickness of 1.0 mm. Screws, nuts, washers, rivets, and other miscellaneous fastening device shall be of hard aluminium or stainless steel.

7.2 Natural Finish

Aluminium doors, frames and windows shall be of natural coloured anodized (min. 9 um thick) finished with clear baked enamel (min. 7 um thick) conforming to BS 1615.

8. FABRICATION OF ALUMINIUM FRAMES FOR DOORS AND WINDOWS

Aluminium frames to receive doors, transoms, adjoining sidelights and windows shall be fabricated of extruded aluminium shapes to contours approximately as shown on drawings. Frames that are to receive fixed glass shall have removable glass stops and glazing beads. Joints in frame members shall be mitred to a hairline watertight fit, reinforced and either welded along concealed lines of contact or secured mechanically and by concealed welding.

9. FABRICATION OF ALUMINIUM DOORS AND WINDOWS

9.1 Sizes, Clearances and Edge Treatment

Doors shall be of type, size and design indicated and not less than 45 mm thick. Door sizes shown are nominal and shall include standard clearances as follows: 2 mm at hinge stiles, 3 mm at lock stiles and top rails and 5 mm of meeting surface of threshold and 12 mm at floor. Single-acting doors shall be beveled 3 mm at lock stile and meeting edges. Double-acting doors shall have rounded edges of hinge stile, lock stile and meeting stile edges.

9.2 Full Glazed Doors and Windows

Doors shall have profile as shown and shall be fabricated from extruded aluminium hollow seamless tubes or from a combination of open-shaped members interlocked or welded together. Top and bottom rail shall be fastened together by means of welding or suitable approved method of fastening. Extruded aluminium snap-in glazing beads or fixed glazing beads shall be provided on external or security side of doors. Glazing beads shall have sealing compound specified under Section: CAULKING AND SEALING. Glazing beads shall be designed to receive glass of thickness shown.

9.3 Flush Doors

Flush doors shall be one of the following constructions and shall have glazed openings and fixed louvers where so indicated.

9.3.1 Flush doors shall have a phenolic resin impregnated kraft paper honey-comb core, surrounded at edges and around glass and louvered areas with extruded aluminium shapes. The impregnation of core shall have a minimum of 18 percent resin content. Door facings shall be sheet aluminium, not less than 0.8 mm thick laminated to a 2.5 mm thick tempered hardboard backing, and the backing shall be bonded to the honey-comb core. The facing sheets shall be bonded to core under heat and pressure with a thermosetting adhesive, and mechanically locked to the extruded shapes at edges of door. Facing sheets shall have a plain smooth surface and be of colour and finish as specified.

9.3.2 Flush doors shall have a phenolic resin impregnated kraft paper honey-comb core. Aluminium facing sheets shall be not less than 1.5 mm thickness and formed into 2 pans which will eliminate seams on the faces. Honey-comb core shall be bonded to the face sheets using an epoxy resin or contact cement type adhesive. Facing sheets shall have a plain smooth pattern and be of colour and finish as specified.

9.3.3 Flush doors shall have a solid fibrous core, surrounded at edges and around glass and louvered areas and cross-braced at intermediate points with extruded aluminium shapes. Aluminium facing sheets shall be not less than 1.25 mm thickness, and shall be bonded under heat and pressure to the core with a thermosetting adhesive, and mechanically interlocked to the extruded edge members. Facing sheets shall have a plain smooth pattern and be of colour and finish as specified.

10. FABRICATION OF ALUMINIUM LOUVERS

Frames of louvers shall be fabricated as specified under Paragraph 8 of this Section. Fins shall be extruded aluminium of the same material, colour and finish as frames and shall be rigidly fastened horizontally to frames accurately in position using screws concealed.

11. INSTALLATION OF WINDOWS, DOORS, FRAMES AND ACCESSORIES

11.1 Doors, Frames and Accessories

Frames and framing members to receive doors, transoms and adjoining sidelight, shall be set accurately in position, plumb, square, level and in alignment. Frames shall be securely anchored to adjacent construction and in accordance with manufacturers printed instructions. Metal-to-metal joints between framing members shall be sealed as specified under Section: CAULKING AND SEALING. Doors shall be hung accurately with proper clearances and with ironmonger as specified under Section: IRONMONGER. After erected and glazed, ironmonger shall be adjusted to operate properly and doors and frames shall be thoroughly cleaned.

11.2 Windows and Louvers

Windows shall be installed without forcing or distortion so that sills and heads are level and jambs are plumb. Window frames shall be securely anchored into the supporting construction. Joints between metal windows and metal members including mullions shall be set in mastic of the type recommended by the window manufacturer to provide completely watertight joints. Excess mastic shall be removed before hardening. Ventilators and operating parts shall be protected against accumulation of dirt and foreign matter by keeping ventilators tightly closed. Aluminium shall be insulated from direct contact with dissimilar materials other than stainless steel as specified hereinafter. Ironmonger shall be securely fastened to the windows. After installed and glazed, each window shall be checked for proper operation and adjusted as necessary to provide even sash edge contact of operating sash. Metal surfaces shall be cleaned and any staining or discolouring of the finish shall be restored or the unit replaced.

11.3 Protection of Aluminium

11.3.1 Aluminium to Dissimilar Metals

Where aluminium surfaces come in contact with metals other than stainless steel, zinc, or white bronze of small area, keep aluminium surfaces free from direct contact with incompatible metal by one or a combination of the following methods unless otherwise shown.

- 11.3.1.1 Painting the dissimilar metal with one coat of heavy-bodied bituminous paint.
- 11.3.1.2 Applying a good quality caulking material between the aluminium and the dissimilar metal.
- 11.3.1.3 Painting the dissimilar metal with a prime coat of zinc-chromate primer, or other suitable primer, followed by one coat of aluminium paint or other suitable protective coating, excluding those containing lead pigmentation.
- 11.3.1.4 Use of a nonabsorptive tape or gasket in permanently dry locations.

11.3.2 Drainage from Dissimilar Metals

Dissimilar metals used in locations where drainage from them passes over aluminium shall be painted to prevent staining of aluminium.

11.3.3 Aluminium to Masonry and Concrete

Aluminium surfaces in contact with cement mortar, concrete, or other masonry materials shall be given one coat of heavy-bodied bituminous paint.

11.3.4 Aluminium to Wood

Aluminium surfaces in contact with wood or other similarly absorptive materials, which may become repeatedly wet, and aluminium surfaces in contact with treated wood, shall be given two coats of the aluminium paint or one coat of heavy-bodied bituminous paint. In lieu of painting the aluminium, the contractor may have the option of painting the wood and other absorptive surfaces with two coats of aluminium paint, and sealing the joints with caulking compound.

11.4 Protection

When windows, doors and frames are installed, they shall be protected from damage. Windows, doors and frames that are damaged prior to completion and acceptance shall be restored to the original condition or replaced, as directed, at the contractor's expense.

SECTION 9B

WOOD DOORS

1. SCOPE

This section shall apply to manufacture and installation of all wood doors and door frames. Ironmonger is specified under Section: IRONMONGER.

2. APPLICABLE PUBLICATIONS

The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto:

2.1 British Standards (B.S.)

BS 459 : ----	Doors Part 1: 1954 Panelled and Glazed Wood Doors Part 2: 1962 Flush Doors. Part 3: 1951 Fire Check Flush Doors and Wood and Metal Frames (half-hour and one-hour types)
BS 1567: 1953	Wood Door Frames and Linings.

3. SUBMITTALS

3.1 Shop drawings

Shop drawings, catalog cuts, or descriptive materials showing each type of door units shall be submitted to and approved by the Engineer before the work is started. Drawings and cuts shall indicate sizes, thickness, construction methods of assembly, glazing, door louvers and operating ironmonger as specified herein, and all other necessary information.

3.2 Samples of doors

Prior to start the work, a sample section of each type of door which shows the stile, rail, vanner, and core construction shall be submitted to and approved by the Engineer.

4. DELIVERY AND STORAGE

Doors shall be delivered to the site in an undamaged condition and shall be protected against damage and dampness. They shall be stored under cover in a well-ventilated building and shall not be exposed to extreme changes of temperature and humidity. They shall

not be stored in a building under construction until concrete, masonry work, and plaster are dry. Defective or damaged doors shall be replaced by the contractor at his expense.

5. REQUIREMENTS

5.1 Factory sealing

Before shipment, the top and bottom edges of doors shall be sealed with spar varnish or other approved water-resistant sealer standard with the manufacturer.

5.2 Sizes and designs

Doors shall be of the sizes, designs, and thicknesses as indicated.

6. MATERIALS AND CONSTRUCTION

6.1 Materials shall be as specified under Section: CARPENTRY AND JOINERY.

6.2 Full glass doors shall be composed of top rails, stiles and bottom rails and conform to the applicable requirements of BS 459 Part 1 and BS 1567. Width of stiles and top rails shall be more than 12 cm and bottom rails 20 cm. Stiles and rails shall hold in place a flush.

6.3 Flush doors shall conform to the applicable requirements of BS 459 Part 2 and BS 1567 except for dimensions. Wood blocking for hardware and louvers shall be provided in the core of doors. View windows and louvers requested in the drawings shall be provided. Flush doors for external use shall be of solid core or of expanded cellular or honey-comb core.

Internal flush doors may be of hollow core having proper reinforcing strips inside. Details of construction of doors shall be submitted to and approved by the Engineer.

6.4 Door louvers

Door louvers shall be fabricated from aluminium. Louvers shall be of the manufacturer's standard design and shall transmit a minimum of 50 percent free air. Louvers shall be slat type. Doors shall be adequately blocked to provide solid anchorage for the louvers. Materials and finishes shall comply with Section: ALUMINIUM DOORS AND WINDOWS. Colour shall be as directed by the Engineer.

6.5 Unless otherwise indicated, all doors, windows and frames shall be enamel painted specified under Section: PAINT.

7. INSTALLATION

Doors shall be installed only after completion of all other work which would raise the moisture content of the doors or damage the surface of the doors. Doors shall be fitted, hung and trimmed as required by the openings they will close. Doors shall have a clearance of 3 mm at the sides and top and shall have a bottom clearance of 5 mm over thresholds and 12 mm for non-threshold doors unless otherwise shown. The lock edge of doors shall be beveled at the rate of 3 mm in 50 mm. Cuts made on the job shall be sealed immediately after cutting, using a clear water-resistant varnish or sealer. Ironmongers shall be installed as specified under Section: IRONMONGER.

SECTION 9C

GLASS AND GLAZING

1. SCOPE

This section shall apply to all glass and glazing indicated on the drawings.

2. APPLICABLE PUBLICATIONS

The following publication of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto:

2.1 British Standards (BS)

BS 952: 1964	Classification of Glass for Glazing and Terminology for Work on Glass.
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3. MATERIALS

Materials shall conform to the respective specifications and other requirements specified below.

3.1 Clear glass

Clear plate glass shall be ordinary glazing quality (O.Q.). Thickness shall be as shown on the drawings.

3.2 Obscure Glass

Obscure sheet glass shall be not less than nominal 1/8 inch (3 mm) thick ordinary glazing quality.

4. DELIVERY AND STORAGE

Glazing shall be delivered to the site in unopened containers, labeled plainly with the manufacturers' names and brands. Glass and setting materials shall be stored in safe, dry locations and shall not be unpacked until needed for installation. Handling and installation of materials shall be in a manner that will protect them from damage.

5. INSTALLATION

5.1 General

The sizes to provide the required edge clearances shall be determined by measuring the actual opening to receive the glass. Labels shall be left in place until the installation is approved. Movable items shall be securely fixed, or in a closed and locked position until glazing compound has thoroughly set.

5.2 Sheet glass setting

Items to be glazed may be shop-glazed or field-glazed using glass of the quality and thicknesses specified or indicated. Aluminium windows and doors, and wood windows and doors may be glazed in conformance with one of the glazing methods described in the standards under which they are produced. Manufacturer's printed instructions for installation shall be submitted and approved by the Engineer. Glass shall be handled and installed in accordance with the manufacturer's instructions. Beads or stops which are furnished with the items to be glazed shall be used to secure the glass in place.

5.3 Obscure glass

Glass with one surface obscured, shall be set with smooth surface on the weather side. When used for interior partitions the surface obscured shall be placed in the same side in all openings.

6. CLEANING

Glass surfaces shall be thoroughly cleaned with labels, paint spots, putty, and other defacements removed, and shall be clean at the time the work is accepted.

SECTION 9D

IRONMONGER

1. SCOPE

This section shall apply to ironmongers for interior and exterior doors.

2. APPLICABLE PUBLICATIONS

The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto.

2.1 British Standards (B.S.)

BS 455 : 1957	Schedule of Sizes for Lockes and Latches for Doors in Building.
BS 1227: -----	Hinges Part 1A: 1967 Hinges for General Building Purposes.
BS 2088: 1954	Performance Tests for Locks.
BS 3621: 1963	Thief Resistant Locks for Hinged Doors.

3. SUBMITTALS

Samples of each type of ironmongers shall be submitted to the Engineer for approval.

4. DELIVERY, STORAGE, AND MARKING

Items of ironmonger shall be delivered to the job site in their original individual containers, complete with the necessary appurtenances including screws, keys, and instructions. Each individual container shall be marked with the manufacturer's name and catalogue number.

5. IRONMONGER PRODUCTS

5.1 General

As far as practicable, all locks shall be of one lock manufacturer's make, all hinges and pivots shall be of one hinge and pivot manufacturer's make, and all door-closing devices shall be of one door-closing device manufacturer's make. All modifications to

ironmonger that are necessary to conform to the construction shown or specified shall be provided as required for the specified operative and functional features.

5.2 Material

Materials of exposed portion of all ironmongers shall be aluminium. Items not normally manufactured in aluminium shall be provided in stainless steel, except surface type door closers, which shall have aluminium coloured lacquer finish.

5.3 Template ironmonger

Ironmonger to be applied to metal and to prefinished doors shall be made to template. The template shall be furnished promptly to the metal door, frame and prefinished door manufacturers in order to avoid delay in door and frame manufacturing. Proper coordination shall be effected between the manufacturers of different ironmonger items in order that each manufacturer may furnish templates that will allow installation of ironmonger without interference with the installation and operation of other ironmonger.

5.4 Ironmonger items

5.4.1 Hinges

Butt hinge conforming to BS 1227, Part 1A, except as specified otherwise therein. Loose pin hinges for exterior doors and reverse-bevel internal doors shall be so constructed that the pins will be non-removable when the door is closed. Hinges shall bear the name or trademark of the manufacturer.

5.4.1.1 Material

Hinges shall be aluminium.

5.4.1.2 Type of hinges

a) Size and Grade

Size and grade shall be determined with Table shown below:

<u>Door thickness</u> (mm)	<u>Door width</u> (mm)	<u>Minimum Hinge height</u> (mm)
22 or 25	any	64
29	to 910	76
35	to 910	89
35	over 910	102
45	to 1,070	114
45	over 1,070	114 Heavy duty
45 to 60	any	127 Heavy duty

Note: Heavy doors and those that get high frequency use as indicated on the drawings should be equipped with heavy grade hinges.

b) Type of bearing

Oil-impregnated, ball or nylon bearing. Use ball-bearing hinges on all high-frequency operation and heavy doors. Plain-bearing hinges may be used on low frequency operating doors up to 910 mm wide.

c) Type of tip

Flat button tip.

d) Width of hinge

Width of hinge shall be measured when leaves are fully open. Width shall be determined according to the conditions of architraves, trims etc. Use swing-clear hinges in locations where it is necessary to keep the door opening completely clear when the door is opened to 90 degrees. Use wide-throw hinges in locations where it is necessary to keep door leaf or leaves clear of wall, casings, jambs or reveals. For references, maximum clearance possible for regular stock size is as follows:

<u>Door thickness (mm)</u>	<u>Hinge width (mm)</u>	<u>Maximum Clearance (mm)</u>
35	76	18
	89	30
	102	43
45	102	23
	114	36
	127	48
	152	74
50	114	25
	127	38
	152	63
60	127	18
	152	43

Note: The clearances are calculated in case for hinges set back 6 mm.

e) Numbers of hinges

Two numbers of hinges per leaf shall be provided for the door less than 1,500 mm in height. For the door more than 1,500 mm high, hinges shall be provided in every 750 mm maximum in height.

5.4.2 Locks and latches shall conform to the requirements of BS 445, 2088, 3621 and the following:

5.4.2.1 Lock and latch sets shall be mortise bit key with lever handles. All lock and latch sets shall be the product of the same manufacturer. Trim for locks and latches shall be wrought construction and of modern design.

5.4.2.2 Mortise locks shall be furnished with escutcheons.

5.4.3 Door closing devices

5.4.3.1 Surface door closers

a) Identification marking

Each closer shall be marked with the name or initials of the manufacturer, or with other markings by which the source of manufacture can be readily identified. Each closer shall also have the manufacturer's size designation permanently marked in the case, cover, arm, or cap in letters or figures of legible size.

b) Material of exposed parts

Arms and brackets for all types shall be of steel, malleable iron, or high-strength ductile cast iron. End caps or plugs shall be of iron or steel for cast iron cases, and of brass or bronze for bronze cases. Plates or brackets not integral with case to attach cast iron cases to doors shall be of iron or steel.

c) Operation and control

closers shall close doors positively and be quiet in operation. Closing of door shall be controlled by means of two adjustments for closing speed, the first being effective up to point within 125 mm of the closed position and the second becoming thereafter, but not less than 50 mm from the closed position, when the opening is measured at a point 760 mm from the closed position. Under the first adjustment the door shall close smoothly and uniformly, and the second serve to increase or relieve the checking action at final closing as desired. Regulating valves shall be accessible and shall provide and maintain close, positive adjustment; they shall provide ample grip surface for adjustment without slipping by means of a wrench or screw driver, or thumbturn, or by key.

d) Construction

Door closers shall be of rack-pinion construction, which meets all applicable requirements.

e) Hold-open features shall provide automatic hold-open and release by push and pull on door, with adjustable holding tension. Hold-open shall hold door at approximately 90 degrees unless otherwise specified. Hold-open features shall not be required unless otherwise requested on the drawings.

f) Size of door closers

Sizes of door closers shall be determined from the Table below. The Contractor shall submit to the Engineer for approval, samples and manufacturer's recommendation or catalogues verifying the proposed products are appropriate for the use of types classified below.

<u>Closer Size</u>	<u>Amount of Use</u>	<u>Max. Dimensions of Doors (mm)</u>	
		<u>Exterior</u>	<u>Interior</u>
III	Standard duty	760 x 2,150 x 45	1,050 x 2,150 x 45
IV	Standard duty	910 x 2,150 x 45	1,220 x 2,150 x 45
V	Heavy duty	1,070 x 2,150 x 45	1,220 x 2,150 x 45
VI	Extra Heavy duty	1,220 x 2,150 x 60	1,220 x 2,450 x 60

g) Electro-magnetic holder release shall be provided on fire doors, if any shown, with hold-open features which shall be operated by: (1) Smoke detector system, (2) by manually operated fire alarm boxes, and (3) by fire detection systems and/or sprinkler water flow devices.

5.4.3.2 Checking floor hinges

a) Identification marking

Each checking floor hinge shall be clearly marked with the name or initials of the manufacturer, or with the marking by which the source of manufacture can be readily identified.

b) Finishes

Exposed cover plates, arms, and pivots shall be finished with dull chromium plated or satin stainless steel.

c) Mounting and operation

Mechanism shall be set in floor with all parts concealed except cover plates and pivots. Arm may be exposed when door is open. Spring adjustment and checking regulation shall be conveniently accessible after installation and shall maintain close, definite adjustment. Floor hinges shall close doors smoothly and evenly and be quiet in operation. A suitable adjusting wrench shall be provided.

d) Construction

Checking floor hinges shall be any of the styles described below:

- (1) Horizontal-acting piston check and helical torsion spring, operating through linkage to crank on spindle.
- (2) Horizontal-acting piston check and compression spring-operating through rollers against cams on spindle.

e) Material

Mechanism shall be housed in cast-iron or steel case. Outer case (cement case) shall be of iron or steel. Steel spindle, malleable iron or forged bronze arms, stainless steel floor plate. Other parts normally visible after installation shall be of stainless steel.

f) Performance

Checking floor hinges shall be double-acting, centrally pivoted under hinge stile of door opening to 90 degrees or more with hold-open feature and with liquid-controlled closing action.

g) Type of checking floor hinges

Type of checking floor hinges shall be determined from the Table classified as below. The Contractor shall submit to the Engineer for approval samples and manufacturer's recommendation or catalogues verifying the proposed products are appropriate for the use of types classified below.

Type of Checking
Floor Hinges

Use

1	Double Acting, Standard Duty
11	Double Acting, Heavy Duty

5.4.4 Door bolts

Furnish flush bolts at top and bottom of inactive leaf of each pair of doors. Provide dust-proof strikers for bottom bolts, except for doors having metal thresholds.

5.4.5 Combination push and pull

Furnish one pair of combination push and pull on each leaf of doors where indicated. Design of push and pull shall be selected from the catalogue by the Engineer.

5.4.6 Door stops

Wall or floor mounted door stops shall be provided where indicated on the drawings. Size, material and style shall be in accordance with the Engineer's instructions.

5.4.7 Bi-fold door ironmonger shall be made for the intended use and composed of top track rail and rollers sliding along the rail. Hinges for the bi-fold doors shall be secret hinges. Aluminium small pull shall be provided. All shall be approved by the Engineer.

6. ALUMINIUM WINDOW IRONMONGER

Ironmonger for aluminium windows may be provided by the window manufacturer using the types of ironmonger standard with the window manufacturer and approved by the Engineer.

7. INSTALLATION OF IRONMONGER

7.1 General

All ironmonger shall be installed in a neat, workmanlike manner, following manufacturers' instructions. Except as indicated or specified otherwise, fasteners furnished with the ironmonger shall be used to fasten ironmonger in place. Fasten ironmonger to wood surfaces with full-threaded wood screws or sheet metal screws. Use machine screws set in expansion shields for fastening ironmonger to solid concrete and masonry surfaces. Use toggle bolts where required for fastening to hollow core construction. Use through bolts where indicated or specified and where necessary for satisfactory installation. After installation, protect ironmonger from paint, stains, blemishes and other damage until acceptance of the ironmonger from paint, stains, blemishes and other damage until acceptance of the work. All ironmonger shall be adjusted properly and checked in the presence of the Engineer and all hinges, locks, latches, bolts, holders, closers and other items shall operate properly. The Contractor shall also demonstrate that the tagged keys operate the respective locks. After ironmonger is checked, tagged keys shall be delivered to the Engineer. All errors in cutting and fitting, and all damages to adjoining work shall be corrected, repaired and finished as directed at the Contractor's expense.

7.2 Location of ironmonger on hinged doors

Location shall be as follows, unless otherwise indicated or specified therein and drawings.

a) Locks

Knobs and handles shall be so located that the centre line of the strike is 1,050 mm above the finish floor.

b) Deadlocks

Deadlocks shall be so mounted that the centre line of the lock and strike is 1,150 mm above the finish floor. Deadlocks shall not be mounted in conjunction with push and pull plates.

c) Door pulls

Locate so that the centre line of the grip, or of the bar where a single bar is used, is 1,050 mm above the finish floor.

d) Push plates

Locate so that the centre line of the push plate is 1,050 mm above the finish floor.

e) Combination push and pull

Mount independent of other ironmonger and so locate that centre line of push and pull bar is 1,050 mm above the finish floor.

f) Hinges

- Top Hinge : Not over 300 mm from the inside of frame rabbet at head to centre line of hinge.
- Bottom Hinge : Not over 300 mm above the bottom of the door to centre line of hinge.
- Centre Hinge : Midway between top and bottom hinges for doors over 1,500 mm in height.

7.3 Door silencers

On hollow metal frames for single doors, locate silencers directly opposite hinges. On frames for double doors, locate silencers on head rabbet of door frame, approximately 150 mm each side of meeting line of doors.

SECTION 10A

PAINT

1. SCOPE

This section shall be applied to painting on wood, metal, concrete, masonry and other surfaces requiring painting.

2. APPLICABLE PUBLICATION

The following publications of the issues listed below, but referred to hereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto.

2.1 British Standard (B.S.)

BS 544: 1969	Linseed Oil Putty for Use in Wooden Frames
BS 1336: 1971	Knotting
BS 4800: 1972	Paint Colours for Building Purposes
CP 231: 1966	Painting of Buildings

3. MATERIALS

Materials shall conform to the requirements specified. Paints and paint materials shall be delivered in original sealed containers that plainly show the brand and manufacturer's name, type of material, batch number, colour, date of manufacturer, manufacturer's directions.

- 3.1 Emulsion paint shall be of synthetic resin emulsion paint of internal use as ENVY #30 of SHINTO PAINT obtained from an approved manufacturer. Two coats shall be applied with brush or roller over primer. Precise specification shall comply with the manufacturer's normal practice.
- 3.2 Acrylic enamel paint, solvent type, shall be of gloss and external use as ACRYL #6000 of SHINTO PAINT obtained from an approved manufacturer. Primer may be omitted. Three coats shall be applied with roller. Precise specification shall comply with the manufacturer's normal practice.
- 3.3 Alkyd enamel paint, solvent type, shall be of gloss and external use as MARINE PAINT N of SHINTO PAINT obtained from an approved manufacturer. Primer may be omitted on wood surfaces. Anti-rust paint specified herein after shall be applied on all ferrous metals except metals cast in concrete or mortar. Two coats of Alkyd paint shall be applied in conformity with the manufacturer's normal practice.

3.4 Anti-rust paint for ferrous metals shall be such type that the resin penetrates into rust, makes the rust inactive and forms itself strong anti-rust film. Anti-rust paint of this type may omit powered wire brushing, surface blasting or sanding to remove rust. Anti-rust paint shall be of such as NEO DE RUST or SHINTO PAINT obtained from an approved manufacturer. One coat shall be applied with brush. Application shall conform to the manufacturer's normal practice.

3.5 Shinto paint

7-20 Yaesuguchi kaikan, Yaesu 1-chome Chuo-ku, Tokyo, Japan 103.
Telex: J2222998 SHINTO, International phone: +81.3.272.4011

3.6 Epoxy paint shall be referred to Section: AQUA TANKS.
Preservative paint shall be referred to Section: CARPENTRY and JOINERY.

4. DELIVERY AND STORAGE

Paint proposed for use shall be stored at the project site in sealed and labeled containers, or segregated at the source of supply, and made available for sampling not less than 30 days in advance of required approval for use to allow sufficient time for testing.

5. SAMPLES

Samples of one sq. metre painted with actual proposed paints on asbestos cement and plywood boards shall be submitted to the Engineer for approval demonstrating the each type of paint materials and workmanship before start to work. Paint colours shall be as directed by the Engineer.

6. GENERAL REQUIREMENTS

Paint work shall not be executed under condition of more than 80 percent in humidity in spaces to be painted. The contractor shall take care to prevent fire hazards especially in painting solvent type paints. Ironmonger, ironmonger accessories, machined surfaces, plates, lighting fixtures, and similar items in contact with unpainted surfaces and not to be painted shall be removed, masked, or otherwise protected prior to surface preparation and painting operations. Following completion of painting, removed items shall be reinstalled. Such removal and reinstalling shall be done by workmen skilled in the trades involved. Exposed nails and other ferrous metal on surfaces to be painted with water-thinned paints shall be spot-primed with red lead, zinc chromate, basic lead silicon chromate, or zinc dust-zinc oxide primer. Surfaces to be painted shall be thoroughly clean and shall be dry when the paint is applied. Interior areas shall be broom clean and dust free before and during the application of any painting materials. Surfaces concealed by

portable objects and by articles mounted on the surfaces readily detachable by removal of fasteners such as screws and bolts are included in the work. Surfaces concealed and made inaccessible by panelboards, fixed ductwork, machinery, and equipment fixed in place are not included. Articles obstructing access to those surfaces specified to be included in the work shall be removed for access and restored to their original position on completion. Surfaces in spaces above suspended ceilings, furred spaces, attic spaces, and chases are not required to be painted unless specifically so stated. Surfaces of steel to be imbedded in concrete shall not be painted. Succeeding coats of the same type and/or colour of paint shall vary sufficiently from the colour of the preceding coat to permit ready identification. Damaged painting shall be retouched before the succeeding coat is applied. Reduction of paints to proper brushing consistency shall be accomplished by adding fresh paint except that when thinning is mandatory for the type of paint being used, written permission to use thinners shall be obtained from the Engineer. The written permission shall include quantities and types of thinners to use. Thinners shall not be permitted upon the job site unless written permission for thinning has been given by the Engineer. Thinning shall not relieve the Contractor from obtaining complete hiding. Finished surfaces shall be smooth, even, and free from defects. The number of paint coats specified shall be in addition to the shop-priming coats. Storage of paints and paint materials and the mixing of paints shall be restricted to the locations directed by the Engineer. Cleaning and painting shall be so programmed that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

7. PREPARATION OF SURFACES

All dirt, rust, scale, splinters, loose particles, disintegrated paint, grease, oil, and other deleterious substances shall be removed from all surfaces that are to be painted or otherwise finished. Putty and caulking compounds shall be allowed to set one week before painting.

- 7.1 Wood surfaces to be painted shall be free from dust and other contaminants. Wood to be painted shall have an instrument-measured moisture content no greater than 20 percent. The use of water on unpainted wood shall be avoided. Prior to application of paint, knots and resinous wood shall be treated with an application of knot sealer. Puttying of cracks and nail holes shall be done after the priming coat has been applied and has dried properly. Sandpapering, when required, shall be done after the undercoats are dry. Wood doors and trim shall be given the priming coat immediately following delivery to the job site.
- 7.2 Concrete and masonry surfaces shall be repaired and made good. Surfaces to be painted shall be clean and free from surface salts, dirt, fungus, grease, oil efflorescence, asphalt, tar, surface irregularities and other foreign substances. Mortar droppings, glaze and scale shall be removed before application of paint.

- 7.3 Asbestos cement board and ceiling tile surfaces shall be dry and clean prior to application of the specified paint. Oil and grease shall be carefully removed by the use of suitable solvents. Wire brushing will not be permitted.
- 7.4 Plaster and cement mortar surfaces shall be dry, clean, and free from surface salts, grit, loose plaster, and surface irregularities before paint is applied.
- 7.5 Ferrous surfaces to be painted shall be solvent cleaned to remove oil and grease.

8. PAINT APPLICATION

8.1 General

The finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks and variations in colour, texture and finish. The hiding shall be complete, and each coat shall be so applied as to produce film of uniform thickness. Special attention shall be taken to insure that all surfaces including edges, corners, crevices, welds, and revets receive a film thickness equivalent to that of adjacent painted surfaces. Respirators shall be worn by persons engaged or assisting in spray painting. Adjacent areas and installations shall be protected by the use of drop cloths, or other approved. Precautionary measures shall be taken on metal or wood surfaces adjacent to surfaces to receive water-thinned paints. The first coat on plaster and gypsum wallboard shall include such repeated touching up suction spots or overall applications of primer sealer as necessary to produce a uniform colour and gloss. The first coat on both faces of wood doors shall be applied at essentially the same time.

8.2 Coating Progress

Sufficient time shall be elapse between successive coats to permit proper drying. This period shall be modified as necessary to suit adverse weather conditions.

8.3 Mixing and Thinning

At time of application, paint shall show no signs of hard setting, excess skinning, livering, or other deterioration. Paint shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Paints of different manufacturers shall not be mixed together. Where necessary to suit condition of surface, temperature, weather, and method of application, packaged paint may be thinned immediately prior to application in accordance with the manufacturer's directions with the permission of the Engineer.

8.4 Time between Surface Preparation and Painting

Surfaces that have been cleaned, pretreated, and otherwise prepared for painting shall be given a coat of the specified first-coat material as soon as practicable after such preparation has been completed, but in any event prior to any deterioration of the prepared surface.

8.5 Method of Paint Application

8.5.1 Metal

Anti-rust paint shall be applied except that where the item has been shop primed. Anti-rust paint shall be applied by brush.

8.5.2 Concrete, concrete block, cement mortar and cement plaster surfaces which accept Emulsion Paint shall be primed with recommended sealer by the emulsion paint manufacturer.

8.5.3 Surfaces may be coated by brush, roller or spray as specified and at the direction of the Engineer.

8.5.4 Brushes used for emulsion paint shall be soaked in water for a period of 2 hours prior to brushings.

8.6 Metal surfaces indicated to be painted with alkyd paint shall be coated with two coats of alkyd paint.

8.7 Concrete, concrete block, cement mortar and plaster surfaces indicated to be coated with acrylic enamel paint shall be coated with three coats of acrylic enamel paint.

8.8 Concrete, concrete block, cement mortar and plaster surfaces indicated to be coated emulsion paint shall be coated with two coats of synthetic emulsion paint.

8.9 Wood surfaces indicated to be painted with alkyd paint shall be coated with two coats of alkyd paint.

9. CLEANING

Cloths and cotton wastes that might constitute a fire hazard shall be placed in closed metal containers or destroyed at the end of each day. Upon completion of the work, staging, scaffolding, and containers shall be removed from the site or destroyed in a approved manner. Paint spots, oil, or stains upon adjacent surfaces shall be removed and the entire job left clean and acceptable.

SECTION 10B

CERAMIC TILES

1. SCOPE

This section shall apply to all ceramic tile floors and walls shown on the drawings.

2. APPLICABLE PUBLICATIONS

The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto:

2.1 British Standards (B.S.)

CP212:	Wall Tiling Part 1 : 1963 Internal Ceramic Wall Tiling in Normal Conditions
BS 12: ---	Portland Cement (Ordinary and Rapid Hardening)
BS 1200: 1971	Sands for Mortar for Plain and Reinforced Brickwork, Blockwalling and Masonry.
BS 1281: 1974	Glazed Ceramic Tiles and Tile Fittings for Internal Walls

3. MATERIALS

- 3.1 Mosaic floor tile shall be of unglazed fully vitreous 25 mm square tile of colour selected by the Engineer.
- 3.2 Non-slip nosings tile shall be nonslip type unglazed fully vitreous tile. Colour and size shall be selected and approved by the Engineer.
- 3.3 Ceramic wall tile shall be glazed and 108 mm square of plain colour selected by the Engineer.
- 3.4 Ceramic floor tile shall be of glazed approximately 200 x 100 mm or 200 x 200 mm ceramic tile of floor use and of plain colour of no pattern. Colour and size shall be selected by the Engineer.
- 3.5 Cement shall be as specified under Section: CONCRETE WORK.
- 3.6 Sand for setting beds and grout shall conform to BS 1200 Table 1, except that 100 percent shall pass the 3.0 mm sieve for general use and 1.5 mm sieve for mosaic tiles. Plasticizers of methyl cellulose specified under Section : PLASTER WORK shall be used. The mix proportions may be modified according to the instruction of the manufacturer under the approval of the Engineer.

4. SAMPLES

Samples of tiles proposed for use shall be submitted to the Engineer for approval before materials represented by the samples are delivered to the project site.

5. INSTALLATION OF TILES

5.1 General

The cement mortar shall be mixed in such a quantity that the whole mixed mortar is consumed within 30 minutes after mixing. All tiles shall be installed while the bonding coat is still fresh and plastic. Floor tile installation shall not be started in areas having wall tiles until the wall tiles have been installed completely. Surfaces to receive application of setting mortar or tiles shall be clean and free from dirt, dust, oil, grease, and other objectionable matter and thoroughly moistened before applying mortar or tiles on them. Concrete surfaces shall be hacked or chipped to form good keys.

Tiles shall be installed with the respective surface in the true even planes to the elevations and grades shown on the drawings. Each tile shall be brought to true and level plane by use of a beating block, and a test of plane distortion shall be carried out with a straight edge. Positive beat-in of each tile is required to establish proper bond. Tiles that are out of true plane or misplaced shall be removed and reset.

Tiles shall be laid from the lines shown on the drawings and adjustments made along walls, partitions, and borders, if any, so as to make the pattern with no cuts less than one-half the tile width unless otherwise directed on the drawings or approved by the Supervisor.

Joints between tiles shall be of uniform width as specified, and they shall be straight and parallel over the entire area.

The tiles shall be cut with a suitable cutting tool, and rough edges shall be smoothed. Cut tiles which misfit shall be replaced with properly cut tiles.

Installation of tile shall be deferred until door bucks, and electrical and mechanical work that is to be in or behind tile have been installed and satisfactory protection of adjoining work has been provided.

Stops, returns, trimmers, caps, and special shapes shall be provided as required for sill, jambs, recesses, offsets, external corners, and other conditions to provide a complete and neatly finished installation. Tile bases or cove shall be solidly backed with mortar.

5.2 Mix of cement mortar in volume shall be as follows:

For wall tiles: Scratch and Middle coat; 1 part cement and 2.5 parts sand

For floor tiles: Under coat; 1 part cement and 3 parts sand

The above specified mix proportions may be modified according to the recommendation of the plasticizer's manufacturer.

5.3 Ceramic wall tiles

Scratch coat for application as the under coat shall be 7 to 8 mm thick. Retempering will not be permitted. The under-coat, applied in sufficient quantity and with sufficient pressure to cover the entire area and obtain an even flat surface, shall be finished with a wood trowel and deeply scored or scratched and cross-scratched to form good keys. The under-coat shall be kept moist and an interval of at least 24 hours shall be provided between the application of the under-coat and application of the middle coat.

The middle coat shall be applied in the same manner with the under-coat as above. The middle coat shall be brought up flush with temporary screeds or guide strips so placed as to give a true even surface at the proper distance from the finished surface of the tile, and shall have a surface suitable for reception of cement paste for setting tiles.

The bonding coat shall be applied on both the finished surface of the middle coat and the back surface of tile. Thickness of the bonding coats shall be 6 mm and 4 mm respectively.

Area of bonding coat, spread at one time, shall be only as large as can be covered with tile while the surface is still plastic.

Tile joints shall be straight, level, perpendicular, and of even width not exceeding 2 mm. Damaged or defective tiles shall be replaced. Tiles shall be installed by the following method.

Before setting, tile shall be thoroughly soaked in clean water and drained so that no free water remains on the back of the tile. While the middle coat is still plastic, tile shall be set by troweling a bonding coat on the middle coat and back of the tile and immediately floating the tile into place.

Tile set by the bonding coats shall have the edges wetted and shall be grouted full with a plastic mix of cement paste of the approved colour equal in quality with the bonding coat immediately after a suitable area of tile has been set. The joints shall be tooled slightly concave, and the excess paste shall be cut off and wiped out from the face of the tile. Interstices or depressions, left in the joints after the grout has been cleaned from the surface, shall be roughened at once and filled up to the edge before the grout begins to harden.

Upon completion, tiled wall surfaces shall be thoroughly cleaned. Acid shall not be used for cleaning glazed tiles. After the grout has set, tiled wall surfaces shall be given a protective coat of a noncorrosive soap or other approved method of protection. Damaged or defective tiles shall be replaced.

5.4 Mosaic floor tiles

Scratch coat for application as the under-coat shall be approx. 20 mm thick. The under-coat shall be spread and tamped to force out air pockets, screed to a true plane, and sloped to drains or leveled as shown on the drawings.

The sheets of ceramic mosaic tiles shall be laid with joints equal in the width to the joints between the tiles on the sheets.

As soon as the setting bed has set sufficiently to work thereupon, an approx. 2 mm thick coat of cement paste as the bonding coat shall be applied on the surface of the bed and lightly worked out with a trowel. Tile sheets shall be laid on the freshly prepared bonding coat while the surface is still plastic and then tamped into the coat to insure solid bedding to the exact slope or level of finished floor surface.

When the installation has hardened sufficiently, paper sheets and plastering glue shall be removed from face-mounted tile sheets, by brushing as much water as necessary onto the paper. Misplaced tiles shall be repositioned and reset, and damaged or defective tiles shall be replaced.

A thick slurry of Portland cement and fine-screened sand of equal parts mixed with a minimum amount of water shall be brushed or squeegeed over the floor until all joints are thoroughly filled, and excess slurry removed. Following the beat-in and adjustment, the excess slurry shall be washed clean from the face of tile. Portland cement paste of a colour directed by the Supervisor, including necessary amount of pigments and additives approved, shall then be applied to the floor and forced into the joints with the edge of a wood block or trowel. Excess grout shall be removed by use of a sponge, squeegee, or burlap to finish the joints and clean the surface with disturbing the floor surface.

5.5 Ceramic floor tile

Portland cement paste shall be prepared on setting bed as described before. While the surface is still plastic and then wetted tile shall be laid on the surface. Joints shall be straight, level, and of even width of 3 mm. Then tiles shall be tamped into the mortar to insure solid bedding to the exact slope or level of finished-floor surface.

Excess cement paste shall be cleaned from tile surfaces washed with sponge, squeegee or burlap.

After cement mortar has hardened, a thick slurry of gray Portland cement and fine-screened sand of equal parts mixed with a minimum amount of water shall be grouted into joints with grouting trowel until all joints are thoroughly filled and excess slurry removed by use of a sponge, squeegee, or burlap to finish the joints and clean the surface without disturbing the floor surface.

Ceramic floor tiles used for outside floor shall be provide 2 cm width expansion joints at every approx. 3 meter each on both way. Joints shall be filled with asphalt specified under Section: WATERPROOFING. Shop drawings for expansion joint lay-out shall be submitted to the Engineer for his approval.

6. CLEANING AND PROTECTING

Upon completion, tile floor and wall surfaces shall be thoroughly cleaned. Acid shall not be used for cleaning glazed tile. After the grout has set, tile wall surfaces shall be given to protective coat of a noncorrosive soap or other approved method of protection. Tile floor areas shall be covered with building paper before foot traffic is permitted over the finished tile floors. Board walkways shall be laid on tiled floors that are to be continuously used as passageways by workmen. Damaged or defective tiles shall be replaced.

SECTION 10C

TERRAZZO TILES

1. SCOPE

This section shall apply to all terrazzo tile floors shown on the drawings.

2. APPLICABLE PUBLICATIONS

The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto:

2.1 British Standards (B.S.)

BS 4131: 1973 Terrazzo Tiles

BS 12: ----- Portland Cement (Ordinary and Rapid Hardening)

BS 1200: 1971 Sands for Mortar for Plain and Reinforced
Brickwork, Blockwalling and Masonry

3. MATERIALS

3.1 Terrazzo tile shall be of 200 mm square 20 mm thick conforming to the requirements of BS 12. Material and size of the aggregate in the facing layer shall be marble of up to 12 mm in size. The surface treatment shall be by grinding and polished. Any slight surface imperfections shall be filled by grouting with a neat cement paste coloured to match the original mix and well worked into the surface. Colour of tiles shall be designated referring to the approved manufacturer's samples by the Engineer. The overall colour of tiles shall be practically uniform in any one delivery.

3.2 Terrazzo (Terrazzo block) shall be of pre-cast terrazzo blocks used for footboards of stairs, edge stone of terrazzo tile floor and door sills as shown on the drawings. Dimensions shall be as shown. Materials used for terrazzo shall be as specified above for terrazzo tiles. Colour shall be as directed by the Engineer and shall be practically uniform.

3.3 Cement, Sand and Plasticizers shall be as specified under Section: CERAMIC TILES.

4. DELIVERY AND STORAGE

The stacking area shall be clean and level, and protected from the weather by means of suitable waterproof covering. Tiles shall also be protected against penetration of water from the ground. Tiles shall always be stacked face to face. Laths or thin battens shall be inserted between rows of tiles.

5. INSTALLATION OF TILES

Installation of tiles shall be executed as specified for ceramic floor tiles under Section: CERAMIC TILES except joint width of 6 mm.

6. CLEANING AND PROTECTING

Cleaning and protecting shall be executed as specified under Section: CERAMIC TILES.

SECTION 10D

PAVING TILES

1. SCOPE

This section shall apply to all paving tile installation shown on the drawings including paving tile surfacing over thermal insulation on waterproofing of roof slabs.

2. APPLICABLE PUBLICATIONS

The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto:

2.1 British Standards (B.S.)

BS 368: 1971

Precast Concrete Flags

3. MATERIALS

Ordinary Portland cement, coarse and fine aggregate and water shall be referred to Section: CONCRETE WORK, except that the normal maximum size of the aggregate shall not exceed 14 mm as specified in BS 882.

Any pigments are not to be used.

4. DIMENSIONS AND FINISHES

Dimensions shall be approximately 300 x 300 mm x 30 mm thick. Trim tiles, cave base tile, round shaped tile, etc. are not required. Surface finishes shall be textured finish by brushing off cement from the surface of the paving tile to expose the aggregate. The sample shall be submitted to the Engineer for approval.

Paving tiles used for pavement and roof may be the same materials, dimensions and finishes.

5. SHOP DRAWINGS

Before installation of paving tiles, 4 copies of tile layout shop drawings for pavement and roof shall be submit to the Engineer for his approval. End of tile layout facing to roof gutter may be left un-paved as shown on the drawings. In such case tile cutting may be omitted by means of adjusting gutter width.

Cut tiles shall be used where necessary with suitable cutting tools approved.

6. INSTALLATION

6.1 Paving tile for pavement

Before laying tiles, clean sand shall be filled over compacted earth as shown on the drawings. Tiles shall be laid on clean sand. The manner of laying tiles shall be referred to Paragraph: Installation of ceramic floor tiles in Section: CERAMIC TILES. Joint width shall be butt joint and straight joint.

Tiles shall be tamped into sand to insure even backing to the exact slope or level of finished floor surface.

Tiles shall be cut with suitable cutting tools approved. Misfit cut tiles shall be replaced with properly cut tiles.

6.2 Paving tile for roof

Paving tile for roof shall protect insulation materials, specified under Section: THERMAL INSULATION, from damage caused by direct sun light and traffic on it.

Tiles shall be laid directly on insulation in a same lay-out manner described in Paragraph: Installation of ceramic floor tiles under Section: CERAMIC TILES. Damaged insulation materials caused by over loading of stock tiles, dropping of tiles, traffic of any kind, etc. shall be replaced with proper insulation. Sheets of hardboards or similar materials shall be provided for traffic and stock tiles during installation.

SECTION 10E

SUSPENDED CEILINGS

1. SCOPE

This section shall apply to all suspended ceilings indicated on the drawings.

2. APPLICABLE PUBLICATIONS

The following publications of the issues listed below, but referred to hereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto:

2.1 Federal Specification

SS-S-118A & Am-3 Sound-Controlling Blocks and Boards
 (Acoustical Tiles and Panels, Prefabricated).

2.2 American Society for Testing and Materials (ASTM) Publications

A 164-71 Electrodeposited Coatings of Zinc on Steel.

A 366-72 Steel, Carbon, Cold-Rolled Sheet, Commercial Quality.

A 526-71 Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.

C 635-69 Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.

C 636-69 Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.

3. GENERAL

- 3.1 Suspension system shall be of mechanical concealed suspension system and composed of galvanized steel. Suspension by timber work may be accepted by the Engineer. The timber work shall be executed as specified under Section: CARPENTRY AND JOINERY. Shop drawings shall be submitted for the Engineer's approval.
- 3.2 All internal finish work, such as plastering and concrete work, shall be complete and dry before installation. All mechanical, electrical, and other work above the ceiling line shall be completed and approved prior to the start of ceiling installation.

3.3 Materials shall be carefully handled and stored under cover in dry, watertight enclosures. Immediately before installation, ceiling units shall be stored for not less than 24 hours at the same temperature and relative humidity at the space where they will be installed. Mineral acoustical tiles shall be stored approx. 1 m above ground surface unopened and covered with suitable water-tight vapour barriers in a manner approved by the Engineer.

3.4 Environmental Conditions

A uniform temperature of not less than 16°C (60°F) nor more than 50°C (122°F) and a relative humidity of not more than 90 percent shall be maintained continuously before, during, and after installation of mineral acoustical tiles.

4. SAMPLES

Samples shall be representative of the materials to be supplied and those upon which the specified tests have been made. The following samples shall be submitted and approved prior to delivery of ceiling system components to the project site:

- 4.1 One of each type of accoustical unit proposed for use showing the specified texture, finish, and colour of the exposed-to-view surfaces.
- 4.2 One of each fastening device, including anchors.
- 4.3 One linear foot of ceiling frame and furring members, intermediate support member if required, hanger strap, and edge moulding.

5. MATERIALS

Mineral accoustical tiles shall be delivered to the site in the manufacturer's original unopened containers with brand name and type clearly marked.

- 5.1 Mineral acoustical tiles shall be non-combustible mineral-fibre ceiling tiles. Mineral acoustical tiles shall conform to following requirements.

Material	: Rockwool fibre
Manufacturing	: Wet process fabrication
Pattern	: Fissured or Travertine design
Size	: approx. 300 x 600 mm
Thickness	: 9mm or more
Edge detail	: Square edge

Materials shall be as "Solar-tone" of Nitto Boseki Co., Ltd.
(Nittobe bldg., 1 Yaesu 6-chome, Chuo-ku, Tokyo, Japan,
International phone: +81-3-272-1211, Telex: J 222-3678 NTBJ).

5.2 Suspension system

5.2.1 Suspended ceiling frames shall hang down from concrete slabs or beams by means of 9 mm diameter steel hanger rods and hanger plates at 900 mm O.C. on both ways unless otherwise directed by the Engineer.

Rods shall be anchored by means of galvanized steel inserts or cast iron inserts which have been cast into the soffit of concrete slabs or beams. Inserts shall be of the approved by the Engineer submitting samples.

5.2.2 Ceiling frames shall be of "C" shaped as shown and of not less than 15 mm (W) x 38 mm (H) x 1.2 mm (T) spaced at 900 mm O.C. unless otherwise directed by the Engineer.

5.2.3 Furrings shall be clipped to ceiling frames. Furring shall be of the size not less than 45 mm (W) x 22 mm (H) x 0.5 mm (T) (double-furring) for board joints and 22 mm (W) x 22 mm (H) x 0.5 mm (T) (single-furring) for board intermediate. Furrings shall be installed parallel to the boards to be applied.

Accessories such as hanger plates, bolts and nuts, screws and nails, clips, etc. shall be provided.

All members for suspension system shall be of galvanized steel and of approved products by the Engineer submitting samples and catalogues of the system proposed.

All materials of suspension system shall conform to the requirements specified under Section: METAL WORK.

The system shall also be of the recommended by the manufacturer of the mineral acoustical tiles to be used.

5.2.4 Spacing of furrings

(a) For mineral acoustical tile ceiling, furrings shall be installed on one way along the direction of shorter border of gypsum wallboards at intervals not more than 45 cm O.C. Double-furrings shall meet the joint of gypsum wallboard underlayment.

(b) For asbestos cement board ceiling, furrings shall be spaced at interval of not more than 45 cm O.C. on one way and 90 cm O.C. on cross way. Double-furrings shall meet the joint of asbestos cement boards which shall be cut to the size of 45 cm x 45 cm unless otherwise directed by the Engineer. Accessories to fix furring to furring shall be provided.

- 5.2.5 Extra reinforcement for ceiling frames and furrings shall be provided where lightings fixtures, air-conditioning diffusers and return grilles, ceiling accessories, wide air ducts, etc. are installed on the suspended ceilings. Extra reinforcing hangers and frames shall be provided where necessary to ensure the safety of the ceiling suspension system.
- 5.2.6 Gypsum wall-boards shall be composed of a core of set gypsum plaster enclosed between and bonded to two sheets of heavy paper. The core shall be solid or cellular gypsum and shall contain a small proportion of fibre. The face shall be designed to receive paint direct. The edge shall be square. Thickness of boards shall be not less than 9 mm. Samples and catalogues shall be submitted to the Engineer for his approval.
- 5.2.7 Asbestos cement boards shall be composed of asbestos fibre which shall be combined with inorganic bonding agent substantially insoluble in water. The product shall be non-combustible. The boards shall be rectangular and shall have square edge. The finished boards shall be flat and free from surface defects and shall be suitable for nailing and screwing. Thickness of the boards shall be more than 6 mm. Samples and catalogues shall be submitted to the Engineer for his approval.
- 5.2.8 Ceiling trims shall be of extruded hard plastics. On completion, trims shall be painted with approved paint specified under Section: PAINT. Shapes are shown on the drawings for reference. Proposed samples and catalogues shall be submitted for the Engineer's selection.

6. SHOP DRAWINGS

Shop drawings shall be submitted to the Engineer for his approval. Shop drawings shall indicate construction of suspended ceilings, ceiling tile layout, layout of fixtures and apparatus such as lighting fixtures, ceiling access, air diffusers, etc., details for installation of fixtures, trims, etc.

7. INSTALLATION

7.1 Ceiling suspension system

Installation of ceiling suspension system shall be executed according to the manufacturer's instruction. The system upon completion shall be flat and horizontal in any direction unless otherwise indicated on the drawings.

7.2 Mineral acoustical ceiling tiles

Before installation of tiles, gypsum wallboards shall be fixed to furrings at intervals not less than 90 mm pitch with recommended nails by the board supplier such as galvanized flat head nails 25 mm long.

Unevenness, irregularity, unflatness, bend of boards shall be prohibited. Joints of gypsum wall-board underlayment shall not overlap with joints of ceiling tiles.

Mineral acoustical tiles shall be fixed to gypsum wallboards with adhesives and galvanized finishing nails at intervals recommended by the tile supplier. Adhesives and nails shall be of the recommended by the tile supplier.

Joints of gypsum wallboards and mineral acoustical tiles shall be butt jointed.

After completion, ceiling surface shall be painted with designated colour by the Engineer specified under Section: PAINT.

7.3 Asbestos cement board ceiling

Asbestos cement boards shall be directly fixed to furrings with galvanized casing nails (25 mm long) at intervals 150 mm along joints and 225 mm along intermediate furrings.

Joints shall be recessed joints and dimensions shall be as shown. Paint work shall be executed as specified under Section: PAINT and as shown on the drawings.

SECTION 10F

CARPET

1. SCOPE .

This section shall apply to carpetting to Lecture Room in Aquarium.

2. MATERIAL

Carpet shall be of 100 percent virgin wool threads and shall be woven carpet with threads running continuously through the backing and appearing as the pile. Carpet shall be suitable for medium domestic or light contract use.

Thickness of carpet shall be not less than 7mm. Colour shall be selected by the Engineer. Patterned carpet may not be required. Felt underlay shall be mothproofed, porous and made in such a way that it does not creep. Felt shall not crumble or fluff up over the years. Materials shall be wool with synthetic fibres or foam latex.

3. INSTALLATION

Carpets shall be laid by specialists approved by the Engineer in close compliance with the manufacturer's printed instruction. Joints of underlay shall be butt joints. The felt shall be stuck with an approved paste as directed by the Engineer.

Prior to laying the underlays or carpets, surfaces to receive them shall be thoroughly cleaned of foreign substances and shall be approved by the Engineer. Grippers of an approved type shall be used for laying carpets. The grippers shall be securely nailed, screwed or stuck along the walls, columns, desks and internal corners of steps continuously and flatly. For laying carpets, carpet expanders of an approved type and capacity shall be used in accordance with instructions of the carpet manufacturer.

Edges of the carpets shall be turned down into gaps between gripper and wall. Jointing of the carpets shall be executed in close conformity with the carpet manufacturer's instructions to produce strong and neat joints.

The Contractor shall keep the carpets protected, and shall clean at all times until acceptance of the work by the Employer in a manner approved by the Engineer.

SECTION 11

FURNISHINGS AND SPECIALITIES

1. SCOPE

This section shall apply to installation of furnishings and specialities.

2. LABO COUNTERS AND KITCHEN CABINETS

Labo counters and kitchen cabinets indicated on the drawings as "Ready-Made" shall be of factory made standard products and not of locally made.

Catalogues, cuts and technical literatures shall be submitted to the Engineer for his approval. Dimensions, finishes and functions shall be as indicated on the drawings.

Small variation of dimensions may be accepted.

Kitchen cabinets shall conform to the requirements of BS 1195 part 2 and BS 1244 part 2.

3. SHELVES AND CLOSETS

Shelves and closets shown on the drawings need not to be of factory-made and may be of locally made of the design, dimensions, and finishes shown on the drawings. Materials, finishes and workmanship shall be as specified under Section: CARPENTRY AND JOINERY, PAINT and DOORS AND WINDOWS. Shop drawings shall be submitted for approval.

4. TOILET BOOTHS

Toilet booths shown on the drawings shall be pre-fabricated as shown. Panel and door construction and materials shall be plywood surfaced hollow core flush panel construction and shall be of as specified under Section: DOORS AND WINDOWS.

All ironmongers and panel fixing metals shall be of stainless steel and samples shall be submitted to the Engineer for his approval. Samples of metal items and shop drawings of panel and door construction shall be submitted for approval.

Paint applied to panels and doors shall conform to the specification of Section: PAINT.

5. CHALKBOARD

Chalkboard used for lecture room shall be of the size shown. Chalkboard shall be of an standard factory-made product of an approved manufacture.

Core shall be honey comb or such alike homogeneous hollow core surfaced both sides with water-resistant plywoods.

Top surface shall be finished with more than 0.4 mm thick steel sheet painted with more than 3 coats of special paints for chalkboard purpose. Edge of the board shall be trimmed with extruded aluminium. Catalogue, cuts and technical literatures shall be submitted for approval. Colour of board surface shall be selected from standard colour of the manufacturer by the Engineer.

6. PROJECTION SCREEN

Projection screen used for lecture room shall be of the size shown and of an standard factory-made product of an approved manufacturer. The screen shall be of such that, when not used, screen is rolled up by spring action in the screen box prepared in the ceiling and when used, screen is manually rolled down to the pre-determined position.

Materials and finishes of the screen shall be of specially made suitable for the purpose of film projection.

7. PC DESKS

PC desks used for lecture room shall be of pre-cast fair faced reinforced concrete.

Materials, mixes and workmanship for reinforced concrete shall be as specified under Section: CONCRETE WORK.

Forms to be used shall be un-used virgin plywood.

Shop drawings shall be submitted for approval.

Precast concrete factory and pre-casting method shall be approved by the Engineer.

Dimension and shape of the desks shall be as shown.

Installation shall be accurate in position, plumb, level and in alignment as directed on the drawings. Anchoring to concrete slabs shall be rigid and stable to the satisfaction of the Engineer.

SECTION 12

AQUA TANKS

1. SCOPE

This section shall apply to the installation and the fixing of acryl resin clear plate view windows for aqua tanks of the aquarium building and also to caulking and sealing of the windows and epoxy lining for the water-proofing of the tanks.

2. MANUFACTURER

Installation and fixing of the view windows, caulking and sealing to the windows and epoxy lining to concrete tanks shall be executed by a single approved manufacturer of the window material who is experienced and notable for such work alike as Mitsubishi Rayon Co., Ltd., Telex: 222-2885 MRCTOK J, International phone: +81-3-272-4321. The manufacturer shall be also the installer of the windows.

The Contractor shall submit catalogues, shop drawings and successful past evidence for such works to the Engineer for his approval before ordering.

3. SHOP DRAWINGS

Shop drawings shall indicate details of construction, fixing, sealing and lining, and dimensions.

The Contractor shall also submit with shop drawings, calculation sheets verifying structural stiffness against water pressure of aqua tanks.

4. MATERIALS

Materials of acrylic resin plate shall conform to relevant ASTM and its average physical properties shall be more than as follows:

	ASTM TEST
Gravity	1.19
Light transmittance	92% (parallel)
Tensile strength	760 kg/cm ² (rupture)
Flexual strength	1,050 kg/cm ² (rupture)
Compressive strength	1,260 kg/cm ² (yield)
Shear strength	630 kg/cm ²
Water absorption	0.3% (weight gain on immersion for 24 hours)
Soluble matter lost after immersion	0.0%

Acrylic resin plate shall be of fully transparent and the surfaces of which shall be flat and parallel so that the surfaces provide clear undistorted vision and reflection.

Caulking and sealing required on the drawings for the aqua tanks shall be silicones sealant specified under Section: CAULKING AND SEALING as No.3 Sealant.

Metal accessories to fix acrylic resin plates shall be of 18-8 stainless steel (18% chromium, 8% nickel of steel alloy).

Neoprene rubber backing, one coat of epoxy lining and non shrinkage mortar shall be of the type recommended by the manufacturer of the acrylic plate.

5. GUARANTEE

The Contractor shall guarantee for the water-tightness of the aqua tanks for five years. If the Contractor might not be able to succeed to make water-tight, the Contractor shall make good or replace the fault at his own expense at the direction of the Engineer or the Employer.

6. WORKMANSHIP

The work shall be constructed as directed on the drawings. Acrylic plates shall be stored horizontal on the suitable decks so that the plates do not distorted and protected against all damages caused by other works.

Before installation of acrylic plates, aqua tank surfaces of concrete and water proofed cement mortar shall be painted with one coat of epoxy paint. Paint shall have even thickness and form an unbroken film.

After epoxy lining has dried, acrylic plates shall be set on setting blocks of acryl and fixed by fixing accessories at top using neoprene cushion spacers. Gaps of bottom shall be grouted with non shrinkage mortar up to a little lower level of concrete and water proofed cement mortar edge as shown.

All gaps for caulking shall be filled with silicone sealant with gun. All gaps where might cause water leakage shall also sealed with silicone sealant.

7. CLEANING AND PROTECTION

Acrylic surfaces shall be cleaned as specified under Section: GLASS AND GLAZING. All cares shall be taken to protect from damage. Damaged tanks prior to completion and acceptance shall be restored and replaced, as directed, at the Contractor's expense.

SECTION 13A

CIVIL WORK

1. STANDARDS OF WORKMANSHIP AND MATERIAL

All materials, plant, labour and workmanship connected with the execution of the work shall be to a standard not less than that required by the codes and standards specified in these Specifications, or their equivalent when approved in advance by the Engineer.

2. APPROVAL OF SOURCES AND TYPES OF MATERIAL, ETC.

The sources of materials shall be selected and representative samples submitted to the Engineer for testing prior to use in the Work. No material shall be used which is not secured from a source approved by the Engineer. Approval of a source does not mean that all material in the source is approved.

The Contractor shall, before placing any order for materials, manufactured articles, equipment or machinery for incorporation in the Works, submit for the approval of the Engineer the names of the firms from whom the Contractor proposes to obtain such materials, etc., together with a list of the materials, manufactured articles, equipment or machinery which the Contractor proposes that the firms should supply; and no materials, etc. shall be ordered or obtained from any firm which the Engineer shall not have previously approved in writing.

The Contractor shall, when required, supply in writing full information regarding the localities in which the materials are being obtained and in which the work is to be prepared. No permanent work, except superficial operations, shall be carried out without the consent in writing of the Engineer. Full and complete notice, in writing, shall be given sufficiently in advance of the time of the production or manufacture in order to make such arrangements as deemed necessary for inspection.

Before the beginning of each phase of the work the Contractor must submit to the Engineer a complete description, with supporting execution drawings and catalogues, to describe his method of execution. The Contractor must obtain the Engineer's approval before proceeding with each phase of the work.

SECTION 13B

EXCAVATION AND FILLING WORKS

1. FILLING LOW LEVEL AREAS WITH EARTH OBTAINED FROM EXCAVATIONS

The Contractor shall, prior to commencing filling works, carry out necessary levelling in order to control the thickness of the layer to be scarified to a depth of not less than 15 cms. (fifteen centimetres) and not exceeding 20 cms. (twenty centimetres).

Then water shall be added, the earth shall be raked and compaction shall be carried out, then earth obtained from excavations in high level areas of the road or surplus excavated material from excavations to stormwater drainage or sewerage installations shall be brought after obtaining prior approval of the Engineer regarding its suitability for filling. Such earth shall be spread, levelled and compacted in layers not exceeding 15 cms. (fifteen centimetres) - after compaction - and all necessary work shall be carried out as indicated in the Specifications.

2. FILLING LOW LEVEL AREAS WITH EARTH OBTAINED FROM BORROW PITS

In the event of insufficient of earth obtained from excavation in high level areas in the road or from surplus excavation material from stormwater drainage or sewerage excavations, the Contractor shall obtain prior approval of the Engineer in respect of borrow pits from which the earth shall be imported and the Contractor shall be required to give all the necessary facilities for obtaining the samples for forwarding them to the AUTHORITATIVE LABORATORY with a view to determining suitability of such earth for filling.

3. FILLING AROUND AND ON CULVERTS, STORMWATER DRAINAGE AND SEWERAGE INSTALLATIONS

The Contractor shall carry out filling around and on culverts and stormwater and sewer pipes and installations in layers not exceeding 15 cms. (fifteen centimetres) thick each after compaction, and shall consolidate the said well by using heavy hand or mechanical rollers or any other plant approved by the Engineer to ensure good compaction of earth without disturbing the works already constructed. It should be taken into consideration that the require quantity of water should be added in order to make the density of the soil corresponding to other densities in the body of the road. The earths to be used in such filling shall be either obtained from excavations or borrow pits after obtaining the approval of the Engineer in respect of their suitability for filling.

4. EXCAVATION OF SOFT SOIL

Should it transpire during the progress of the work that the soil does not have a bearing capacity conforming to the A.A.S.H.O. Specifications or the A.S.T.M. Specifications shall be requested with a view to estimating the extent of bearing suitability of this earth by means of obtaining specimens therefrom and conducting necessary testing thereon. Thereafter, and in the light of such results, the necessary measures shall be decided as whether to excavate and cart away such earths as indicated or taking any other measure.

5. EXCAVATION IN AREAS HIGHER THAN DESIGN LEVELS

The Contractor shall excavate high level areas down to the level of the road sub-grade as indicated.

SECTION 13C

EARTH COMPACTION

1. DEFINING OPTIMUM MOISTURE CONTENT

The Contractor shall define the optimum moisture content for all types of soils which he is required to compact and he shall not be allowed to embark on compaction except after acquainting himself with such content. These tests shall be conducted in accordance with the A.A.S.H.O. specifications or the A.S.T.M. specifications.

2. STAGES OF EXECUTION OF EARTH COMPACTION

Grading and levelling shall be carried out to the full width of the road surface for parts required to be filled or parts already executed down to the road foundations. This work shall be carried out before commencing earth compaction.

3. The road surface shall be scarified, in parts excavated, down to a sufficient and suitable depth so that the thickness of the compacted layer shall not be less than 15 cms. (fifteen centimetres) and not exceeding 20 cms. (twenty centimetres). Soil shall be pulveried and compaction shall be carried out and the specified quantity of water shall be added in order to reach a degree of compaction not less than 95% of Maximum Dry-Density to a depth not less than 25 cms. below finished sub-grade level, all to be carried out as indicated in these Specifications.

4. As for parts to be filled, the original surfaces of the road shall be scarified to a thickness of 10 cms, and the necessary eaths shall be added for the first layer and shall be mixed well and pulverised and the specified quantity of water shall be added so that the thickness of this layer shall not be in excess of 15 cms, after compaction in order to reach a degree of compaction not less than 95% of Maximum Dry-Density not such that the compacted layers will be less than 35 cms. below finished sub-grade, all to be carried out as indicated in these specifications.

In the event of filling in areas flooded or permeated with water and which have not been stipulated in these Specifications that such water should necessarily be pumped out and the site dried, filling shall be carried out on top of the water surface up to the level permitting the use of necessary rollers for compaction as per the instructions of the Engineer.

5. The necessary amount of water shall be added in lots by means of vehicles equipped with special mechanical sprinklers which ensure control of water distribution so that water will spout out evenly and under adequate pressure helping the water to permeate the pulverised soil in the quantity required to be added at one time to the approval of the Engineer.
6. The earth shall be turned over well after adding each lot of water so as to mix well with the pulverized soil in all the thickness of the layer. The water shall be evenly distributed.
7. When optimum moisture content is reached in the pulverized earth according to Laboratory testings, or is not in excess of 2% - 4% of optimum moisture content - determined by obtaining specimens for defining the moisture content in the Laboratory - the earth shall be primarily levelled by means of motorgraders.
8. Compaction operations shall be commenced after the primary levelling referred to above, by means of pneumatic rollers or by other rollers approved by the Engineer, depending on the type of soil being compacted in order to obtain the required density.

The compaction shall be by passing the roller several times regularly and always in the direction of the road axis, back and forth until the soil reaches the compaction degree required. Rolling shall start from both edges of the road in the direction of the axis; but if the road is inclined in one direction, so far as the cross-section is concerned, rolling shall be started from the low level to the high level and extra quantities of water shall be added, if necessary, in order to compensate for the amount of water lost in evaporation in the course of compaction.

The road surface shall be levelled longways and crossways by using motorgraders so that if a 4 metre long configurated screed unit is placed on the road surface covering half the width of the road, there will be no differences or rises or depressions exceeding 1 cm. The road surface shall be compacted and formed in its final shape by means of steel rollers weighing 5 - 8 tons or any other rollers approved by the Engineer.

9. Traffic shall not be allowed to pass on the compacted layer until soil compaction has been carried out ahead of the sub-base by more than 30,000 square metres in respect of roads outside residential areas and 15,000 square metres in respect of roads within the residential areas. The Contractor shall carry out maintenance work to the compacted layers where the road filling required several layers to reach the required levels.

10. COMPACTION TESTS

Compaction tests shall be carried out in accordance with the A.A.S.H.O. T16 Specifications or the A.S.T.M.O. 1527 Specifications by using the Modified Proctor Test. It is also necessary that the plant and machinery used be of the types and weights which will enable the required degree of density to be reached in accordance with the Laboratory tests, and the dry density to which the soil in the road shall be compacted must not be less than 95% of the Maximum Dry Density according to Laboratory test and as indicated in the A.A.S.H.O. 59 - 55 Specifications.

The thickness of the compacted layer shall be ascertained by obtaining a specimen from the soil within 24 hours after completing compaction in accordance with the A.A.S.H.O. Specifications, at the rate of one specimen per 100 metre run of the road and from any spot in the road width selected by the Engineer provided that such spot is not less than half a metre distance from the edge of the road. In case this specimen does not conform with the required density and thickness, three other specimens will be tested, and in case these specimens do not conform, the Contractor shall grade and pulverize the layer again and, if necessary, add new filling at his own expense according to the specifications until the required result is obtained.

11. SIDEWALKS AND ROAD SHOULDERS

1) Sidewalks

All excavations and filling to sidewalks to the level of asphalt adjacent to the curbstones shall be subject to all these same Specifications dealing with earth works and Compaction.

If sidewalks are not paved, it is permissible - as indicated in these Specifications and according to the instructions of the Engineer - to carry out filling with clean earth which is not suitable for filling in the areas hereinbefore defined, as from the asphalt surface until the level of the curbstone.

The Contractor shall complete all the works prior to commencing asphaltting, but shall thereafter carry out mechanical final levelling to side walks, if possible, or hand levelling including sprinkling with water and rolling as necessary so that the level of sidewalks shall be flush with the tops of curbstones and sloping in accordance with the drawings - in the case of sidewalks - and true to level in the case of islands.

2) Road Shoulders

It should be observed that all excavations and filling until the level of asphalt are subject to all the stipulations indicated in the Specifications treating of earth works and compaction, to the width specified in the Specifications and drawings pertaining to

each operation. It should also be taken into consideration that an outward slope of 2% must be provided. If it has been specified that road shoulders are to be stabilized, this shall be carried out in the width shown in the drawings and as specified in the Particular Specification in respect of each separate operation.

12. TESTING TO BE CONDUCTED

Testings to be carried out are as follows:

- 1) Proctor Test for defining the Maximum Dry Density and corresponding moisture contents
- 2) Modified Proctor Test for defining the Maximum Dry Density and corresponding moisture contents.
- 3) Test for defining Soil Liquid Limit
- 4) Test for defining Soil Plastic Limit
- 5) Test for defining Soil Shrinkage
- 6) Test for defining Soil Specific Weight
- 7) Test for defining mechanical analysis of soil
- 8) Test for defining Ratio in weight passing Sieve No. 200
- 9) Test for defining Field Soil Dry Density after compaction on site

An adequate number of such tests should be conducted to ensure that the work is well controlled and conforming to the A.A.S.H.O. Specification, unless the Specifications specify omitting or adding some tests.

SECTION 13D

ROAD AND PAVEMENTS

1. TYPES OF BASE COURSES

Base Courses

This Section contains the Specification for Base Courses to be generally used in U.A.E. roads, apart from other types of base courses incorporated under 13D.2 of these Specifications and any types stipulated in the Particular Specification.

2. SOURCES OF MATERIALS

In all cases the Engineer shall approve the sources of material and shall conduct necessary testings on specimens in order to ensure their compliance with the Specifications allowing for a sufficient period of time before embarking on supplying such material to the site. This, of course, shall not prevent acceptance or rejection of material supplied by the Contractor, according to their conformity to the Specification or otherwise.

The Contractor shall always be responsible in respect of such material as indicated elsewhere in the Documents.

3. SANDY SOIL USED IN BASE COURSES

- 1) The sandy soil shall be fine aggregates passing the No. 10 Sieve (2.0 mm.) and consisting of natural sands or sand produced by crushers in addition to fine aggregates passing the No. 200 Sieve.
- 2) The ratio of fine aggregates passing the No. 200 Sieve shall not exceed $\frac{2}{3}$ of the proportion passing the No. 40 Sieve and this fine aggregate may consist of lime-sand-earth or natural fine aggregates or any other suitable material.
- 3) The liquid limit in respect of material passing the No. 40 Sieve should not exceed 25 and the plasticity index should not exceed 6.
- 4) The sandy soil shall be clean and free from organic matter silt and other extraneous and detrimental materials.
- 5) The sand equivalent should not be less than 30 in accordance with the A.A.S.H.O. T.176 test.

- 6) The gradation of the sandy soil should fall within the gradation limit (a) shown in Schedule No. 1 incorporated in Clause 5, of this part.
- 7) If the fine aggregates in the sand to be used in base courses are not sufficient and it is necessary to add an additional quantity thereof, whether to obtain the general gradation required or to change the characteristics of the material passing the No. 40 Sieve to comply with what is indicated (under item 3 of this Clause), such material shall be added in a manner which will ensure obtaining completely and totally homogenous sand and approved by the Engineer.
- 8) Control of materials and checking their confirmity to the Conditions and Specifications shall be as indicated under 19... of this Section.

4. SHINGLE USED IN BASE COURSES

- 1) Shingle consists of coarse aggregate not passing the No. 10 Sieve.
- 2) The shingle used in base courses shall be hard and durable and free from organic matter, dirt and other detrimental matter with a low ratio of flattened particles.
- 3) All sizes of shingle shall be homogeneous with respect to composition, physical and chemical characteristics.
- 4) The percentage of abrasion shall not exceed 50% when conducting the Los Angeles Test on a specimen of shingle supplied in accordance with the A.A.S.H.O. T.96 Specification.
- 5) The absorption coefficient shall not exceed 0.015 as indicated in Clause 21. of this Section.
- 6) The porosity percentage shall not exceed 3% as indicated in Clause 22 of this Section.
- 7) The shingle used in base courses shall be graded in such a manner that when mixed with sand in the proportions indicated in the Particular Specification for each operation separately, the gradation of the shingle and sand mix shall fall within the General Gradation (B) or (C) shown in Schedule No. 1 incorporated in 5 of this Section and as indicated in the Particular Specifications.
- 8) Control of materials and checking their confirmity to the General Conditions and Specifications shall be as indicated under this Section 13D.

5. GENERAL GRADATION

The general and total gradation including fine aggregates and bonding materials shall conform to one of the gradation types (A) or (B) or (C) as indicated below.

Schedule No. 1
indicating the General Gradation Limits for Base Course Materials

<u>No. of size of square mesh sieve in inches</u>	<u>Gradation A</u>	<u>Gradation B</u>	<u>Gradation C</u>
2"	100	100	100
1"	100	100	75 - 95
3/3"	100	60 - 100	40 - 75
No. 4	70 - 100	50 - 85	30 - 60
No. 10	55 - 100	40 - 70	20 - 45
No. 40	30 - 70	25 - 45	15 - 30
No. 200	5 - 15	3 - 15	3 - 15

This Schedule of general and total gradation of materials to be used in the base courses indicates the limit within which the materials can be accepted. The general gradation of materials used shall be gradual so that it would not vary from the minimum limit passing a certain sieve to the maximum limit passing the next sieve or vice versa. Selection of one of the gradations shown in the above Schedule shall be subject to the Particular Specification.

6. FINISHED SUB-GRADE LEVELS

Prior to commencing the construction of the base courses it is necessary to make sure that the sub-grade courses conform to the Specifications and to compact them to Maximum Dry Density as indicated in 14 of this Section and that the surface thereof conforms to the levels and slopes indicated in the longitudinal and cross-sections and in the drawings.

7. MIXING OF MATERIALS

If the materials necessary for the sub-bases require mixing of various materials or adding fine bonding material in order to obtain the required general gradation, they may be mixed wither in central mixing plant or by mobile mixing machine on the road. Mixing shall continue until it is ascertained that all materials have become homogeneous and conforming to the required general gradation. The

Contractor may use any plant or machinery for carrying out the mixing of material provided approval of the Engineer is obtained in respect of the method of mixing and the type of equipment, and the Contractor shall ensure homogeneity of materials after mixing and spreading and that they are conforming to the Specifications in respect of type and gradation.

8. MATERIALS DEEMED SUITABLE WITHOUT MIXING

If the material as supplied on the road surface is considered in accordance with the Specifications so far as the required gradation and the physical and mechanical characteristics are concerned, such material could be used by spreading and levelling machines directly upon delivery to the road surface. Such material could be obtained in this manner either directly from their original sources or from the Central Mixing Plant or from quantities stored up on site so that this material will not need mixing thereafter.

9. DEFINING THE OPTIMUM MOISTURE CONTENT

Specimens shall be obtained from materials after fully making sure that they conform to the Specifications. Thereafter the Modified Proctor test is carried out with a view to defining the optimum moisture content in order to obtain the Maximum Dry Density. The specimen obtained should fully represent the material to be spread on the road surface, and specimens will be taken repeatedly and the Modified Proctor Test conducted whenever discrepancy in the type or gradation of the supplied materials occurs.

10. NATURAL MOISTURE CONTENT

The natural moisture content in materials constituting the sub-base shall be defined. Should it be less than the optimum moisture content to be added, a quantity of water equivalent to the shortage in the required moisture content shall be sprinkled allowing for the quantity to be lost by evaporation in the process of raking, levelling and compacting, which depends on atmospheric temperature, quantity of material and the equipment and plant to be used in this operation, provided that the layer shall be compacted when the moisture content therein is exactly equivalent to the optimum moisture content in order to obtain Maximum Dry Density.

If the natural moisture content in materials exceeds the Optimum Moisture Content, then it is necessary in such a case to air the materials in order to reach the moisture content required for operation as stated above. Approval of the Engineer shall be obtained regarding the moisture content to be reached in respect of materials before compaction is carried out and the Engineer shall

have the right to request increasing or decreasing this moisture content as he deems fit. And in general the object is to obtain Maximum Dry Density in materials after being fully compacted.

11. ENSURING CONTINUITY OF WORK

After completing testing of materials and defining the various moisture contents as previously mentioned in 10; it should be ascertained that the materials have been supplied in accordance with the Specifications by any of the means previously described, and in the quantities necessary for constructing a layer not more than 15 cms. thick after being fully compacted. Such quantities shall be sufficient for ensuring continuity of works in constructing the sub-bases according to the approved Work Programme.

12. SPREADING

Materials shall be spread thereafter on the road surface either by special Spreader Boxes equipped to ensure spreading of materials to a regular thickness or by means of a motorgrader. The quantity of water previously determined shall then be added and the motorgrader shall be operated whilst adding the water, and the materials shall continue to be raked with the water added until it is fully ascertained that the materials have become homogeneous following mixing and raking, and that the moisture content is uniform in all parts of the section where the work is being carried out and in the various depths of the layer thickness.

13. DISTRIBUTION

Thereafter the motorgrader shall be passed to ensure that the material has been evenly spread and in the scheduled thicknesses and widths, and the surface shall be made according to the levels and slopes indicated in the standard profiles and sections. Approval of the Engineer must be secured prior to embarking on compacting the sub-bases.

14. COMPACTION

The sub-base layer shall be compacted after complete spreading, mixing, and raking, provided that compaction shall start immediately by means of pneumatic and steel rollers or vibrating rollers and in accordance with the instructions of the Engineer.

Compaction shall start with rollers from extreme sides proceeding gradually towards the road axis. Under no circumstances should compaction be started from the middle of the road before the sides.

Rolling shall continue until all the lower surface has been compacted and the voids reduced to the minimum possible limit and until the relative density is not less than 95% of the Maximum Dry Density. This is determined by laboratory tests using the Modified Proctor Tests.

15. LEVELLING

Work in levelling the lower surface shall continue by motorgrader and rollers until the layer becomes true to level as required and conforming to the Specifications and Drawings. The final surface of the sub-base shall be tested by means of a 5-metre long screed unit, and no rises or depressions in excess of 1 cm. shall appear in the surface, otherwise such areas of the sub-base shall be stripped, corrected and recompacted.

16. PROTECTION OF SURFACE

The Contractor shall protect with all available means the sub-base so that it would be maintained sound during work progress, after its completion and prior to receiving the bituminous layers or prior to laying the surface overlay thereon. Any damage caused to the layer if exposed to traffic or natural conditions resulting in the disintegration of its surface should be made good at the expense of the Contractor.

17. MULTI-LAYERS

During all mixing and turning over of base course materials, complete care must be practised so that base layers already compacted under the layer being executed are not affected, or that the finished sub-grade surface is also not affected. This aspect must be given special attention in places where equipment makes turns in going back and forth and any such damage resulting in mixing the various layers constituting the subgrades and base courses shall be carefully made good by the Contractor and at his expense.

If more than one base course is required for reaching the required thickness separately described in the Specifications for each operation, each such course shall be constructed as hereinbefore described regarding care in execution and the degree of conformity to true level.

18. BITUMINOUS OVERLAY AND TACK COAT

If a surface course is desired to be made after completing the base course or if it is stipulated in the particular Conditions that the

surface shall receive a binder course, then it will be necessary to make a bituminous tack coat in the first instance, and a thin bituminous overlay in the second instance, in order to protect the base course and have it open for traffic until the wearing course is applied. This work shall be carried out in accordance with the Specifications indicated in 27 of this Section.

Prior to making preparations for the bituminous overlay or tack coat, the base course should be left to dry so that the moisture content in the entire thickness of the course shall be less than 80% of the Optimum Moisture Content, provided that the bituminous layer is sprayed before the surface of the base course is completely dry so that the fine bonding material will not be wafted away from the surface.

19. SIEVE ANALYSIS

Sieve Analysis shall be conducted for both sand and shingle or for defining total gradation of mix as stipulated in the American Specification A.A.S.H.O. T₁₁ T₂₇.

20. DEFINING SAND EQUIVALENT

The Los Angeles test for defining sand equivalent shall be carried out in accordance with A.A.S.H.O. T.176.

21. ABSORPTION COEFFICIENT

Absorption coefficient for coarse aggregates shall be defined by preparing five specimens, spherical in shape as much as possible and weighing around 30 grms. to be dried by keeping them under a temperature of 110°C. for 24 hours. Thereafter they will be accurately weighed, submerged in distilled water and left for the period necessary for saturation, i.e. when the increase in weight stops. They they are accurately weighed after drying the water adhering to the surface by a dry piece of cloth. The absorption coefficient is the arithmetical mean of the increase of the specimen weight, after being submerged, over its weight when dry.

22. POROSITY

The porosity ratio of the solid and coarse aggregates shall be defined as follows:

The coarse shingle is crushed so that it would all pass the No. 50 Sieve. A specimen weighing 20 - 50 grms. will be taken, dried under

a temperature of 110°C for not less than 15 hours and then the density flask and distilled water will be used for calculating the actual specific weight of the specimen.

Thereafter the apparent specific weight will be defined by preparing four samples of shingle weighing approximately 30 grms. and of almost cubic shape. They are dried for 24 hours under a temperature of 110°C, weighed accurately and their size determined by Amsler Gauge or any other approved method. The apparent specific weight is the resultant weight of the specimen divided by its size and taking the arithmetical average of the four specimens. The porosity percentage of shingle is:

$$\frac{\text{Actual specific weight} - \text{The apparent specific weight} \times 100}{\text{Actual specific weight}}$$

23. LIQUID LIMIT

The liquid limit test shall be carried out in accordance with A.S.T.M. 423-61T for material passing the No. 40 Sieve.

24. PLASTIC LIMIT

The Plastic Limit test shall be carried out in accordance with A.S.T.M. 421-59T.

25. PROCTOR

The Modified Proctor Test shall be carried out on material passing the 3/4" Sieve and by compensating for the weight of the material retained on the 3/4" Sieve by material equivalent thereto in weight of that passing the 3/4" Sieve and retained on the No. 4 Sieve in accordance with A.S.T.M. D.1527.

26. ABRASION

The Los Angeles Abrasion test for solid aggregates shall be conducted as per A.A.S.H.O. T-96.

27. ASPHALT SURFACE COURSE MATERIALS

- 1) The Specifications of the materials used shall correspond to the latest edition of the A.A.S.H.O. and the A.S.T.M. Specifications unless such specifications for the materials used are stipulated in this Specification or in the Particular Specification.

- 2) In all cases the Engineer shall approve the sources of materials and conduct the necessary tests on specimens therefrom with a view to ascertaining their compliance to the Specifications, before embarking on supplying the materials on the road by sufficient time in order to determine whether they comply with specifications or otherwise and the Contractor shall be always responsible therefore for supplying said materials for testing in time.
- 3) The Contractor shall be responsible for securing all the materials so far as quantity and type are concerned.

28. SAND

Sand is defined as granular material passing the No. 10 Sieve (2 mm.) and not passing the No. 200 Sieve (0.075 mm.)

Sand may be natural or crushed (resulting from the crushing of stones and shingle) or a mixture of both according to the specifications required and, in general, particles exceeding 2 mm. in size shall not be allowed to be in excess of 20% in weight of this sand.

Moreover, sand shall be of the coarse type, sharp, clean and free from dust and material likely to change in size in case the moisture content is changed and shall be free from hard clay lumps when dry, and the sand equivalent shall not be less than 50 according to the test.

29. CRUSHED SHINGLE

Crushed shingle is defined as material resulting from crushed natural stones and gravel in sizes ranging from 2 cm. to 25 cm. when tested by Square Mesh Sieves. It shall also be clean and free from extraneous material, sand and dust, and shall be sharp-edged with all its grains crushed in a cubic and not in a flat shape. The shingle used in asphalt mixes shall prove to have a high degree of adhesion to bitumen to be defined by the Laboratory in accordance with the resultant Stripping Phenomenon Test described in A.S.T.M.

In the event of failure of said test, additives shall be required to be added to the bitumen in order to secure that bonding characteristics are successful in the necessary proportion.

30. FILLER

Filler shall be the material passing the No. 200 Sieve (0.075 mm.) and may consist of pulverised limestone or sands plus slaked lime powder which is used in constructional works in as much as the conditions specified are concerned. The filler shall be free from

organic material and hard clay lumps and the proportion not passing the No. 200 Sieve shall not be in excess of 25% in weight the quantity of which shall be considered as part of the sand to be added thereto in calculating the proportions of the asphalt mix constituents.

31. HARD BITUMEN

- 1) The following specification shall include bitumen resulting from refining of crude oil and the bitumen used shall be conforming to these specifications when tested in the light of the A.A.S.H.O. Specifications.
- 2) Each bitumen consignment weighing 50 tons or less shall be accompanied by an analysis certificate showing all the specifications according to the testing results indicated in item 3), issued by the Plant from which the bitumen has been purchased.
- 3) Prerequisites for acceptance of asphalt cement shall be as follows:

Description	A.A.S.H.O.	A.S.T.M.	Penetration at 25°C	
	Test Method	Test Method	60/70	80/100
1) Softening Point (°C) Ring and Ball Method	T53	D36	45/55	40/50
2) Ductility at 25°C (Minimum limit in cm)	T51	D113	100	100
3) Flash Point COG (Minimum limit in °C)	T48	D92	250	250
4) Heat Loss (%): Maximum at 163°C (5 hrs)	T47	D6	1.0	1.0
5) Thin Film Oven Test: Penetration after heat loss test (Minimum as a percentage of the original penetration degree) 25°C 10009, 5 sec	T49	D5	47	45
6) Ductility at 25°C (Minimum in cm)	T51		50	75
7) Solubility in CS ₂ or CCL ₃ (Minimum percentage)	T44-641	D2042	99.5	99.5

General Requirements: The asphalt shall be prepared by the refining of petroleum. It shall be uniform in character, free from water and shall not foam when heated to 175°C.

32. LIQUID BITUMEN

- 1) These specifications include rapid curing and medium curing liquid bitumen.
- 2) The bitumen shall be in accordance with the following specifications when subjected to the appropriate A.A.S.H.O. or A.S.T.M. tests.
- 3) Each bitumen consignment weighing 50 tons or less shall be accompanied by an analysis certificate showing all its specifications according to the results of the test indicated in item 4), issued by the plant from which the bitumen has been purchased.
- 4) Prerequisites for Acceptance of Liquid Bitumen - These shall be as follows:

Liquid Asphalt Specifications

Characteristics	A.A.S.H.O.	A.S.T.M.	Grades			
	Test Method	Test Method	Tack Coat R.C.-1	Tack Coat R.C.-2	Prime Coat M.C.-0	Prime Coat M.C.-1
1) Flash Point (°C) (Tagliabue open cup)	T79	D1310	-	27 +	38 +	38 +
2) Kinematic Viscosity: at 60°C secs.	T201	D2170	70-140	250-500	30-60	70-140
3) Distillation Test (% of total distillate to 360°C):	T78	D402				
To 190°C			10 +	-	-	-
To 225°C			50 +	35 +	25 -	20 -
To 260°C			70 +	60 +	40-70	20-60
To 315°C			85 +	80 +	75-93	65-90
Residue from Distillation, to 360°C, % by volume			55 +	65 +	50 +	55 +
4) Test on residue from distillation at 360°C						
a) Penetration: 25°-100 gr	T49	D5	80-120	80-120	120-250	120-250
b) Ductility at 25°C (cms)	T51	D113	100 +	100 +	100 +	100 +
c) Solubility in CCL ₃ (%)	T44-641	D2042	99.5 +	99.5 +	99.5 +	99.5 +
5) Water, %	T55	D95	0.2 -	0.2 -	0.2 -	0.2 -

General Requirement: The material should not foam when heated to application temperature recommended by the Asphalt Institute.

Asphalt Mix	Scope of Use	Paving Course		Marshall Test Specifications
		Thickness (cm)	Average Weight Kg/M ²	

33. FINE ASPHALTIC CONCRETE MIX 0/5 MM. Number of Compaction Blows each end of specimen: 50

- Composition: 2 - 4 50 - 70

Crushed shingle 20-35% by weight, 2/5 mm.
 Filler less than 0.075 mm 7-12% by weight and the remainder sand 0.075/2 mm

a. As a thin surface layer when paving roads within residential areas requiring a fine surface.

- Granular Gradation of mix formed as per Type 2
 - % of bitumen by weight ranging from 6.5 - 8.5 on total mineral aggregates

b. Routine maintenance works for main roads surfaces outside residential areas.

Stability Coefficient (Kgr) 500 at least.

Flow Coefficient (0.1 mm) 10 - 40

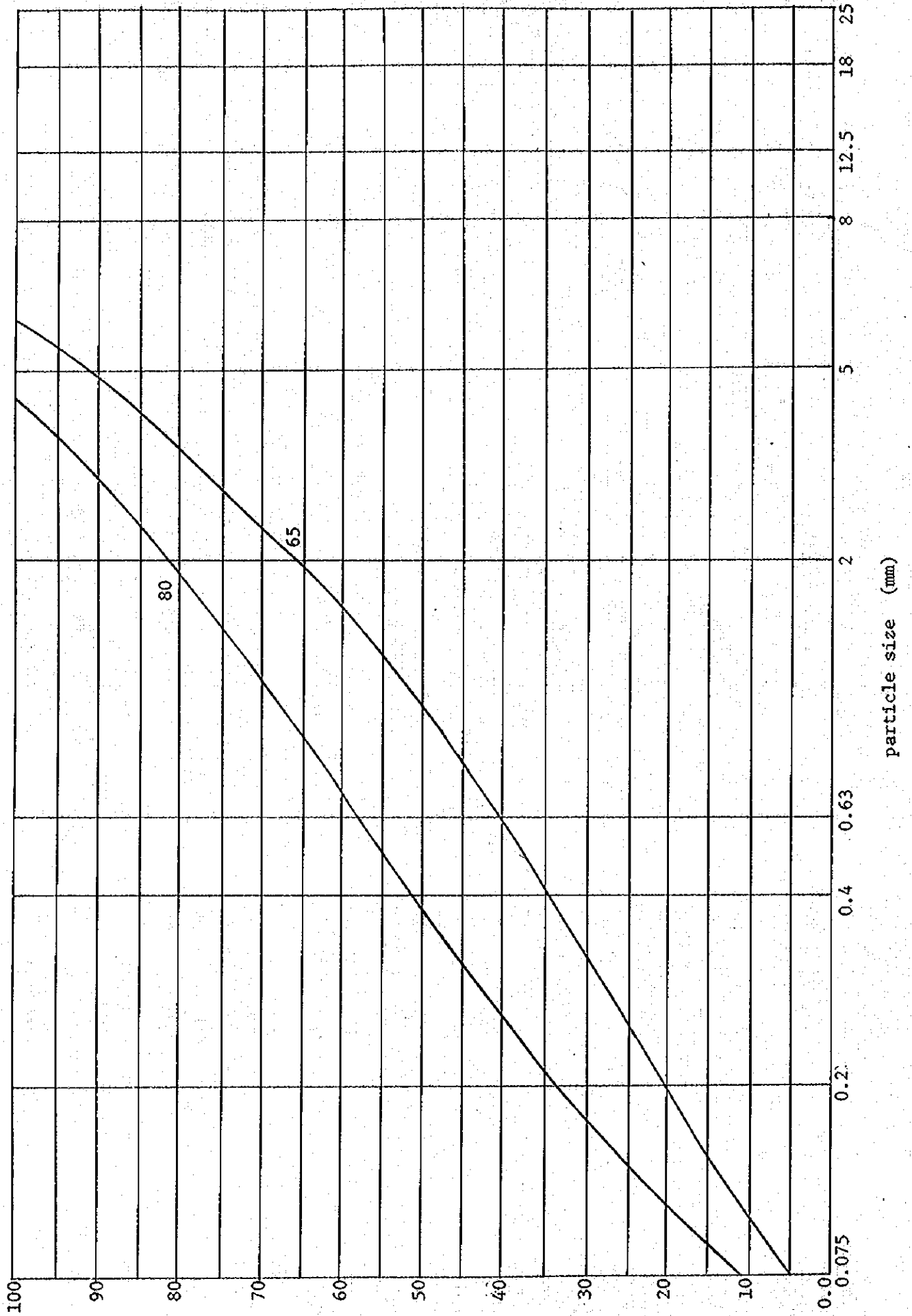
- The sand shall contain at least 20% by weight of crushed sand (from Crushing Plant)

Asphalt Mix	Scope of Use	Paving Course		Marshall Test Specifications
		Thickness (cm)	Average Weight Kg/M ²	

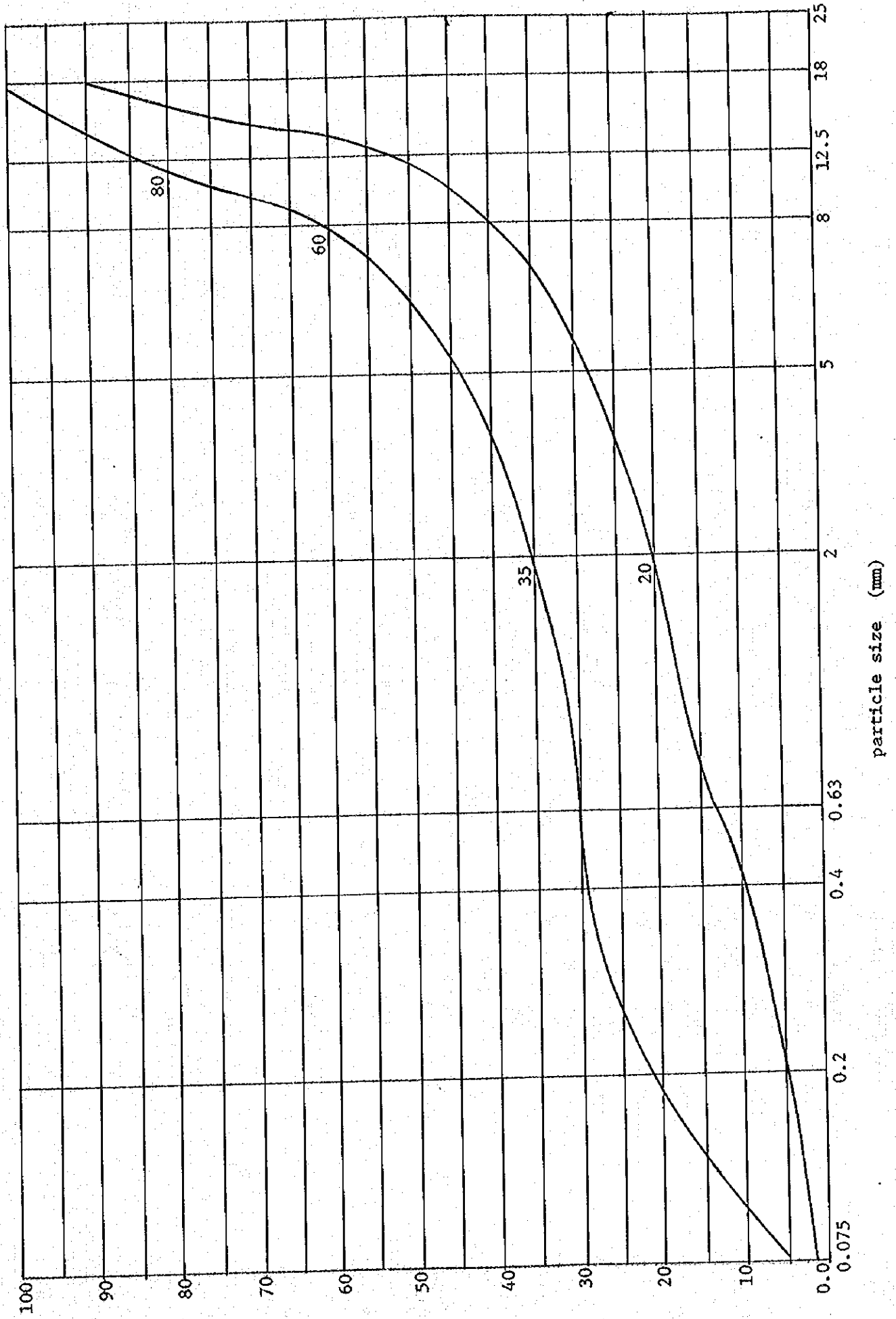
34. COARSE ASPHALTIC CONCRETE MIX 0/18 MM
 Number of Compaction Blows each end of specimen: 50

- Composition:
 - Crushed shingle 65 - 80% weight 2/18 mm.
 - As a bonding layer to be spread underneath the surface course for mixture in types 1, 2 and 3.
 - Filler less than 0.075 mm 3 - 6 by weight
 - Remainder sand 0.075/2 mm
 - 4 - 8 110 - 175 Air voids % 3 - 6
- Granular gradation shall be according to Type 4.
- % of bitumen by weight ranging from 4 - 5.5 on total Mineral Aggregate
- Coefficient (Kg) 500 at least
- Flow Coefficient 0.1 (mm) 10 - 40

Type 1 Fine Asphalt Concrete 0 - 5 mm



Type 2 Coarse Asphalt Concrete 0 - 18 mm



35. GENERAL CONDITIONS FOR DESIGNING THE ASPHALT MIX

- 1) Bitumen of 60/70 penetration shall be used provided that its liquidity characteristics are tested by the Ring and Ball Method before being used and after extracting it from the asphalt mix. It is stipulated that the liquidity limit after its extraction shall not exceed 8° over the maximum value thereof before use.
- 2) The ratio of the mix composed from granular material and filler shall be defined so that it would fall within the scope allowed in the attached types. Then the Optimum Bitumen Ratio is defined in the light of the Marshall Test which gives highest stability value and the stability value as defined after submerging the mix in water for three days and is compared with the original stability value, provided that this ratio under no circumstances be less than 70%, otherwise reconsideration shall be given to the testing of quality of material constituting the mix.
- 3) The values pertaining to the minimum Marshall Stability value mentioned in these Specifications shall be considered as guidance values for the purpose of designing the mix proportions only and shall not be taken into consideration when judging conformity of the characteristics of the mix to its respective specifications.
- 4) The granular gradation of the mix shall be tested by means of sieves of the hereunder mentioned capacities and variation in weight proportions after designing the mix composition shall not exceed (Job Mix Formula) the following:

Sieve Capacity in mm.	Percentage by weight of allowable Tolerances after defining the Mix Proportions
25	± 5
18	± 5
8	± 5
5	± 4
2	± 4
0.63	± 3
0.2	± 3
0.075	± 1

36. BITUMINOUS PRIME COAT DESCRIPTION OF WORK

This operation consists of covering the road surface soil, road surface, base course surface or macadam road surface or others with a prime coat of liquid bitumen in accordance with these Specifications and in the quantities indicated in the conditions and drawings pertaining to each operation.

37. LIQUID BITUMEN MATERIALS

Liquid Bitumen utilized shall be one of the medium curing types (M.C.-0 and M.C.-1) and shall be free from water and conforming to the respective specifications of these types as shown in Clause No.406 of this Specification. Selection of any of these types for utilization shall be as stipulated in the Particular Conditions.

38. MACHINERY AND TOOLS

Machinery for cleaning the road surface, heating, distributing and sprinkling of liquid bitumen shall be of the types and specification suitable for the particular operation.

39. PROPERTING THE ROAD SURFACE

Before spreading the bituminous asphalt, the road shall be well cleaned from loose material and earth by using mechanical and manual brushes or air hoses and repairing any ruts in the surface by using a suitable material so that the surface will be true to level and free from loose material and earth and in accordance with the specification in both long-way and cross-way directions.

40. METHOD OF OPERATION AND EXECUTION

After preparing the road surface as indicated in Clause 39, the liquid bitumen shall be spread after heating to a temperature of 35 - 90°C depending on the type of bitumen used, taking into consideration the type of bitumen utilized and providing that the road surface is dried to such an extent that permits the surface to be saturated with bitumen, and provided that the atmospheric temperature is not below 10°C.

Liquid Bitumen shall be spread by mechanical pressure spreaders and at the rate defined in the Particular Specifications for this operation. In general this proportion shall be altered in the light of the coarseness or softness extent of the surface, atmospheric temperature, and type of bitumen to be used. It should be observed that the proportion is defined in each case so that the road surface is fully saturated with bitumen after a lapse of 24 hours following spreading.

It is permitted to spread the bituminous course to 1/3 or 1/2 of the road width according to the instructions of the Engineer in charge; and it should be observed in order to prevent overlapping of the bituminous course at transverse joints, that thick paper is used each time at the end of the area receiving the course, or any other method approved by the Engineer in charge and serving this purpose.

Hand sprayers are allowed to be used for areas where it is not practical to use mechanical pressure spreaders subject to the approval of the Engineer in charge.

41. DESCRIPTION OF WORK FOR TACK COAT

This operation shall consist of applying a prime coat of liquid bitumen to the road surface, whether a base course surface or old macadam road surface or other surface, directly before spreading a bituminous surface course thereon to secure bonding of said course to road surface, in accordance with this Specification.

42. MATERIALS

Liquid Bitumen - Liquid Bitumen utilized shall be rapid curing (R.C. 1) or (R.C. 2) type and shall be free from water and conforming to the specifications for this type of bitumen as indicated in Clause 32 of this Specification.

43. MACHINERY AND PLANT

The machinery for cleaning the road surface and heating, distributing and spraying the liquid bitumen shall be of the type and specifications suitable for the particular operation.

44. PREPARING ROAD SURFACE

Prior to spreading the bituminous tack coat the road surface shall be well cleaned from loose material, slit and earth by using mechanical and manual brushes or air hoses.

45. METHOD OF OPERATION AND EXECUTION

After preparation of road surface according to Clause 44 the work shall be executed as indicated in Clause 40 of this Specification, supplemented by the following:

- 1) Liquid bitumen shall be heated to a temperature of 35 - 90°C.
- 2) The average quantity of bitumen utilized shall range from 0.5 - 1.00 Kg. per Metre Super as described in the Particular Specification.

- 3) The bituminous tack coat shall not be ahead of the bituminous surface course spreading by more than 150 metres or less than 30 metres.

46. TRANSPORTING THE ASPHALT MIX

The asphalt mix shall be transported from mixing plant to the site of work to be spread directly on the road by means of clean tipper vehicles. The temperature of the mix shall depend on the type of bitumen used. In case of using bitumen of 60/70 penetration, the temperature of the mix, at the time of mixing in the mixing plant, shall not exceed 155°C, and shall not be less than 120°C, at the time of reaching the site. Asphalt mix shall be rejected if its temperature is in excess of or less than the said two temperature figures. In the event of long distances between the mixing plant and the site of work where the temperature of the asphalt mix may drop during haulage below the required temperature degree, or in the event of cold weather and presence of climatic changes, the Contractor shall cover and protect the asphalt during transportation and whilst waiting to unload.

47. SPREADING OF THE ASPHALT MIX

Spreading of the asphalt mix on the road shall be suspended if the temperature of the atmosphere drops below 8°C. or in the event of rainfall, following rainfall, or sand-storms.

All impurities shall be removed from the surface of the bonding asphalt course prior to spreading the surface course or spraying the tack coat. Also, it shall not be allowed to spread any asphalt course before ascertaining that the previously placed courses are in conformity with the Specifications in so far as density (rolling) and trueness of level are concerned.

The mix is normally spread by mechanical spreaders except in the case of small areas of paving or areas where the spreaders cannot pass, e.g. crossings, cut-throughs of islands, etc. as these could be spread by hand. In such a case, this course shall comply with all conditions regarding trueness of level, thickness and homogeneity of the mix as specified for mechanical spreaders.

When spreading the asphalt mix on a base course having a discrepancy in levels within the permissible tolerance limit, the asphalt course shall be constructed to proposed levels and shall be homogeneous and ultimately yielding an even surface free from undulations, rises or depressions within the permissible tolerance.

It should be noticed that transverse asphalt joints are out vertically and sprayed with liquid bitumen prior to commencing the work in completing the spreading of the asphalt course. When asphalt spreading work is suspended to an extent which allows the temperature of the asphalt mix to drop below the required degree, such spread part shall be removed, its edge cut vertically, heated and then sprayed with liquid bitumen before completing the spreading of the mix. The part shall be rolled with due care.

Longitudinal joints shall be straight and their edges cut vertically and the various lanes shall not overlap and the joints of each lane should be pushed back to a sufficient distance. All opening-covers in the road for water drainage etc. shall have their positions and levels determined before spreading the asphalt course.

48. ROLLING ASPHALT MIX

The rolling operation shall directly follow the spreader and before the mix temperature drops below 100°C. and rolling shall be carried out in three stages. The first stage for preliminary compaction, the second for basic compaction and the third for final compaction. Weights and types of rollers and the number of trips made by roller per stage shall be sufficient to reach the required density. Rolling shall be performed in the linear direction of the road, commencing from the low level side and working up to the high level side of the road section. As for parts not providing access to mechanical rollers, these could be compacted by hand by using suitable equipment. The speed of the roller shall be slow and shall not exceed 1.8 Km/hour. The roller shall not stand, change its direction or speed on the same spot.

49. ASPHALT PAVING TESTS

Number and Weights of Material Specimens for Laboratory Tests

Laboratory tests on paving material shall be conducted at the laboratory provided that the weights of the specimens taken shall be as follows:

- Filler	2 Kgs.
- Sand and fine aggregate, maximum size 8 mm	5 "
- Shingle, maximum size 25 mm	15 "
- Shingle, exceeding 25 mm in size	30 "
- Bitumen : Specimen composed of 3 separate parts, each weighing 2 kgs. per 100 tons of bitumen.	

Asphalt mix produced by asphalt mixing plants:

- Asphalt mix, maximum size 5 mm	3 Kgs.
- Ditto size 18 mm	8 "
- Ditto of sizes exceeding 18 mm	15 "

50. TESTS TO BE CARRIED OUT AT ASPHALT MIXING PLANT

The Contractor shall carry out the following tests at the Asphalt Mixing Plant:

- 1) Tests conducted at Mixing Plant on materials constituting the mix:
 - a) Visual inspection of granular material, sand, shingle and filler.
 - b) Sieve analysis of granular materials.
 - c) Routine tests on bituminous materials.
- 2) Mixing Plant Tests
 - a) Temperature degree of dry granular material.
 - b) Temperature degree of bitumen.
 - c) Temperature degree of asphalt mix produced at the Mixing Plant, and after its spreading on the road.
 - d) Controlling proportions of the mix constituents such as aggregate (fine and coarse), sand, fine material and bitumen by means of the standard scales of the mixer.
 - e) Checking the mix produced by the mixer by testing the proportions of the mix constituents by means of an apparatus for extracting the bitumen from the asphalt mix and the sieve analysis of the granular material mix.

51. TESTING EVENNESS OF SURFACE

The Engineer shall test the evenness of surface for each course of the various asphalt courses incorporated in the contract beginning with the natural ground level until the final asphalt course level to ascertain their conformity to the Specifications and Drawings in respect of

- 1) Levels and longitudinal falls of the road axes.
- 2) Falls to cross-sections of the road. Tolerances exceeding + 0.4 per cent shall not be allowed (i.e. in case it is necessary to provide crossways sloping of 2 per cent, tolerance in such sloping shall be allowed from 1.6 to 2.4%.

- 3) Checking evenness of the surface with a straight wooden screed unit 5 metre long, allowing for the following maximum tolerances:

Surface course	-	maximum tolerance of 5 mm
Bonding course	-	ditto 7 mm
Base course	-	ditto 10 mm
Sub-Grade surface	-	ditto 30 mm

52. TESTING DEGREE OF COMPACTION - THICKNESS AND BONDING OF COURSES

The Engineer shall test compaction of asphaltic courses - each course separately - to ascertain that rolling has been carried out correctly and that the density of the compacted asphalt mix, and ratio of voids and final thickness of the course after compaction and consolidation of the courses together are all in accordance with the Specifications.

Specimens of the paving courses on the road shall be obtained after rolling is completed in spaces the area of which shall not be less than 40 x 40 cm or in circular spaces of 150 mm or 101.6 mm diameter by means of mechanical cylindrical boring machines and at the rate of one specimen per 200 metre run of road or 2000 metre super of paving. The specimen shall be taken under the supervision of the Engineer and Contractor's representative. The said persons shall sign each sample and mark the location and the date thereon.

Thickness of paving course, density of the mix and ratio of voids shall be determined by an average of 3 specimens obtained from a space 600 metres in length on the road or from an area of 6000 metre super of paving.

Prerequisites for acceptance of mixed density after compaction shall be set on the basis that the mix density after compaction on the road (specimen), shall not be less than the following:

Surface Course	:	97% of laboratory density for Marshall specimen.
Asphalt Buxter Course	:	96% ditto
Asphalt Base Course	:	94% ditto