Emergency Water Supply and Rehabilitation Programme
PAL 10-00052737
"Construction Of Booster Pump Station in Tal El Sultan in Rafah"

General and Particular (Technical) Specifications
A) General Specifications

1. SCOPE OF THE WORK

These specifications cover the construction of two water booster pumping stations (PS-6 & PS-7) located at the site of Tal El-Sultan new water storage tank. The booster pump station (PS-6) is designed to boost excess supply to the existing storage tanks in Yebna (ST-16 & ST-17) and new water storage tanks (ST-18A & 18B) in Rafah Governorates.

The PS-6 is composed of two pumps (one in duty and other standby), designed to discharge 320 m$^3$/hr for each pump, at a total dynamic head of 88 m. Likewise, the booster pump station (PS-7) is designed to provide continuous supply for Tal El-Sultan area and part of Western Rafah districts (pressure zone 1).

The PS-7 is composed of three pumps (two in duty and one standby), designed to discharge 280 m$^3$/hr for each pump, at a total dynamic head of 38 m.

The two booster pumping stations are fed directly from Tal El-Sultan ground reservoir through 18” steel pipe.

The scope of this contract includes:

- Construction of the pumps room, service building, generator, fuel storage tank and all concrete works related to mechanical and electrical equipment.
- Supply and install the equipment and machinery including, pumps with electric motors, electric panels with required control devices, electric generator unit, fuel tank and piping, pipes and fittings, connecting the pipes to the existing systems.

A. DEFINITIONS

Wherever the words defined in this section or pronouns used in their stead occur in the Contract Documents, they shall have the meanings herein given.

Wherever in the Contract Documents, or on the Drawings, the words "as directed", "as described", "as ordered", "as requested", "as required", "as permitted", or words of like import are used, it shall be understood that the direction, description, order, request, requirements or permission of the Engineer is intended. Similarly, the words "approval", "description", "order", and "request".

2. TENDER DRAWINGS

A number of Contract Drawings available at the date of Tender is included in the list of Drawings attached to these Specifications. All work shall be performed in accordance with the Drawings furnished together with the Contract Documents and any such additional drawings as may be issued by the Engineer from time to time during the progress of the work. Additional drawings (if any) will be furnished to the Contractor in due time so as to enable him to perform the work shown thereon in proper sequence and for any advance planning that may be necessary for the efficient performance of such work. The Engineer will decide in such instance whether additional drawings are required for advance planning of the works and determine the time required for doing so.

3. SHOP DRAWINGS

If at any time before the commencement or during the progress of the work it appears to the Engineer that for the proper execution of a specific part of the Works, shop Drawings are necessary, these Drawings shall be prepared by the Contractor at his own expense and submitted to the Engineer for approval. On the other hand, the Engineer shall have authority to order at any time and the Contractor shall agree to provide at his own expense any number of shop Drawings which, in the opinion of the Engineer are necessary for the proper execution of a specified Work. The
Contractor shall not proceed with the above-mentioned work unless these shop Drawings are approved by the Engineer.

4. **AS-BUILT DRAWINGS**

All prints of the Drawings, where required, shall be corrected by the Contractor and submitted to the Engineer for approval as the Works proceed. Upon the completion of the Works, the Contractor shall prepare a completely new set of Drawings for the project as executed and submit same in duplicate to the Engineer for approval. When approved by the Engineer, the Contractor shall submit one digital on CD and three copies of all Drawings duly marked "As-Built". The final payment shall not be made except for the actual works that have been complete in accordance with the Specifications and have been duly presented on the "As-Built Drawings". The Contractor shall not be entitled to any extra payment or extension of time for the correction, preparation and supplying of the mentioned drawings.

5. **ABBREVIATIONS OF STANDARDS**

The following abbreviations covering the Standards used for the Works under the Contract shall have the significance set forth opposite each:

- **BS** British Standards Specifications
- **CP** British Standard Codes of Practice
- **ASTM** American Society for Testing and Materials
- **ACI** American Concrete Institute
- **ISO** International Organization for Specification
- **LS** Local Standards

6. **STANDARDS**

The Works have been designed to incorporate and utilize economically goods, materials and workmanship to various specifications which are detailed herein. Reference is commonly made to British Standards (BS) and Local Standard (LS) and to the American Society for Testing and Materials Standards (ASTM). Different national or international standards (DIN or ISO etc.) that correspond to the specified Standard may be used provided that their requirements are not less stringent, and provided that the Contractor presents copies of such Standards translated into English. If any redesign of the Works is necessitated by the adoption of such alternatives the costs incurred shall be born by the Contractor. Those references shall in every case be deemed to include the latest edition or issue of such Standards.

7. **APPROVED**

This word when applied by the Engineer to the Contractor's drawings or documents shall mean that the drawings or documents are satisfactory from the standpoint of interfacing with Contractor's furnished components of the installations, and/or that the Engineer has not observed any statement or feature that appears to deviate from the Specification's requirements. Except for the interfacing with the Contractor's furnished components, the Contractor shall retain the entire responsibility for complete conformance with all of the Specification’s requirements.

8. **INCONSISTENCY IN CONTRACT DOCUMENTS**
The Contractor shall execute the Works according to the provisions of the Contract Documents. Any work indicated in one of the documents but omitted and/or not stated in one or more of the other documents shall be treated as though it were included in all of them. If any two documents of the Contract conflict as to the quantity of the work to be carried out, the discrepancy shall be brought to the notice of the Engineer, who shall instruct the Contractor which of the two conflicting documents to regard as correct. If the Contractor shall discover that any work has been omitted and/or not indicated entirely or partially from all the documents, but that such work is essential to the safety or proper functioning of the works, he shall report the facts immediately to the Engineer. If the work is something which in the opinion of the Engineer could not have been foreseen by an experienced Contractor, the Engineer shall issue to the Contractor a variation order stipulating the details of the work to be done. No additional payment shall be made in respect of work carried out in connection with discrepancies between the various Contract Documents.

9. ERRORS IN COMPUTING CONTRACT DOCUMENTS

The Contractor shall be responsible for any error which he makes in computing any quantities of material and labor required or costs involved or through any lack of knowledge of the Site, or misunderstanding of anything shown or implied on the Drawings or in the Specifications and/or the Bills of Quantities.

The Contractor must refer any discrepancy in the Drawings or the Specifications to the Engineer before proceeding in any of the Works. The decision of the Engineer as to the interpretation of the discrepancy will be final.

Any item or items of work not specifically shown on the Drawings or referred to in the Specifications but which, would be necessary for the proper construction of the Works in accordance with the best practice is implied and must be included for as incidental to the Contract Price.

Any item for which the Contractor has not inserted a price in the Bills of Quantities shall be deemed to be covered by other prices of rates therein.

10. CONTRACTOR'S RESPONSIBILITY

The Contractor shall bear, at his own cost and expense the full and entire responsibility for the sufficiency of plant, center, scaffolding, false work timbering, machinery, tools labor, etc. and generally for all means used for the execution and fulfillment of this Contract whether such means may or may not be approved or recommended by the Engineer.

Notwithstanding any minimum requirements included in this specification regarding quantity, output and adequacy of plant or outline of methods, the attaining of the specified standards of quality of work shall be the sole responsibility of the Contractor.

11. TEMPORARY WORKS AND REINSTATEMENT

The Contractor shall provide and maintain all temporary access roads and tracks necessary for movement of plant and materials and clear same away at completion and make good all Works damaged or disturbed.

The Contractor shall submit drawings and full particulars of all Temporary Works to the Engineer before commencing same. The Engineer may require modifications to be made if he considers...
them to be insufficient and the Contractor shall give effect to such modifications but shall not be relieved of his responsibilities for the sufficiency thereof.
The Contractor shall provide and maintain weatherproof sheds for storage of materials pertinent to the Works both for his own use and for the use of the Employer and clear same away at the completion of the Works.
The Contractor shall divert as required, at his own cost and to the approval of the Engineer, all public utilities encountered during the progress of the Works, except those specially indicated on the Drawings as being included in the Contract.
Where diversions of services are not required in connection with the permanent Works, the Contractor shall uphold, maintain and keep the same in working order in existing locations.
The Contractor shall make good, at his own expense, all damage to telephone, telegraph and electric cables or wires, sewers, water, or other pipes, except where the Public Authority or Private Party owning or responsible for the same elects to make good the damage. The cost incurred in so doing shall be paid by the Contractor to the Public Authority or Private Party on demand.
All injury to the surface of the land, to the beds of watercourses, projecting banks, etc., where disturbed by the Works (other than where specifically ordered by the Engineer) shall be repaired by the Contractor or the Authorities concerned, at the Contractor’s expense. All such making good shall be to the approval of the Engineer.
The requirements detailed above shall be provided and maintained at the expense of the Contractor. The Employer shall not be liable for loss or injury to any Temporary Works.

12. EXISTING FACILITIES

The existing facilities must be kept in continuous operation throughout the construction period. No interruption will be permitted which adversely affects the degree of service provided. Provided permission is obtained from Employer via Engineer in advance, portions of the existing facilities may be taken out of service for short periods corresponding to periods of minimum service demands. Such permission will not relieve the Contractor of any of his responsibilities under this Contract.
The cost of work and materials required in the construction and subsequent removal of temporary crossings and bypasses of all existing Utilities roads, pipes, channels and cables and in the reinstatement of all such utilities shall be included by the contractor in the unit rates for the respective items of work for which such crossings are required.

13. RELOCATION OF ELECTRIC AND TELEPHONE POLES

The Contractor shall transfer interfering electric and telephone poles to the new required locations. Work shall include dismantling and re-fixing of the electric and telephone cables, supplying and installing any shortage of conductors or necessary fittings and accessories. The work shall be executed as directed by the Engineer or his representative and in full coordination with the proper authorities.

14. SUBSURFACE STRUCTURES AND ALL UTILITIES

Before beginning work operations, the Contractor shall contact the local municipalities and utilities and notify them of his intention to begin work operations.
The Drawings may show and Specifications may discuss certain structures or facilities believed to exist in the working area, the exact location of which may vary from the locations indicated. The Drawings may not show all water lines, underground electric conduits or aboveground electric facilities, underground telephone conduits or aboveground telephone facilities, underground
cesspools and other sanitary facilities, all of which are known to exist in the area. There may be certain other facilities and utilities in the Work area not listed above or not shown on the Drawings, including septic tanks and service connections that must remain in service.

It shall be the responsibility of the Contractor to determine the exact location of such pipelines, subsurface structures and/or utilities ahead of his work by exploratory excavation or other means and to take suitable precautions to prevent damage to them and to prevent interruption of the services which such facilities provide. If they are broken or damaged, they shall be restored by the Contractor or the appropriate utility at the Contractor’s expense.

When water lines, sewers drains, other pipelines, subsurface structures and/or utilities are in close proximity to the Work and they must be removed, relocated or altered in any way, the Work shall be in strict accordance with the requirements and specifications of the owner of said facilities.

In addition, the Contractor shall pay particular attention to poles, pole lines, overhead wires and all other facilities aboveground that may be in conflict with the Work. The Contractor shall follow the same procedures outlined herein for underground facilities.

15. SAFETY OF ADJOINING EXISTING BUILDINGS

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

The Contractor shall keep the Engineer informed as to the manner in which he intends to proceed with the execution of the excavations and obtain his approval, such approval if given shall not absolve the Contractor of his responsibility under this clause. The Contractor shall save harmless and indemnify the Employer in respect of all claims, demands, proceedings, damages, costs, charges and expense whatsoever arising out of or in relation to any such matters in so far as the Contractor is responsible under this clause.

16. WATCHING

The Contractor shall allow for all necessary watching for the security of the Works and the protection of the public, including shelter and fuel for any watchman as required.

17. WATER AND ELECTRICAL POWER FOR THE WORKS

The Contractor shall provide all necessary water and electrical power and lighting for the Works, with all temporary plumbing and storage, pay all charges, and alter, adapt and maintain temporary work as necessary and remove and make good at completion.

18. MEDICAL FACILITIES

The Contractor shall arrange for medical attention to be available when necessary and shall provide all adequate first aid equipment within easy access of each Works area on the site. The Contractor shall display in suitable places the names of his employees who are available from time to time to
render first aid. The Contractor shall provide for the transport of serious cases to the nearest hospital.

19. SPECIFIED MANUFACTURER’S PRODUCTS

Manufacturer’s name or catalogue number, if shown in the Specification or indicated on the Drawings, are given only for indicative purposes and for general reference only. It shall be understood that the actual material supplied shall meet the requirements of the Specifications, and if necessary, the material specified under such manufacturer’s name or catalogue indicated for reference, shall be modified under the direction of the Engineer.

20. ALTERNATIVE MATERIALS

Should the Contractor wish to offer alternative items or materials to those specified he shall supply details of such alternatives together with details of any reduction in the Contract Price should the alternative be allowed to be substitute for the specified items or materials. All offered alternatives shall comply fully in all respects with the Specifications of the particular items or materials. Acceptance or refusal of such alternatives will be entirely at the discretion of the Engineer.

If during the course of the Contract certain materials or items required for use in the Works should be unobtainable, despite the best effort of the Contractor, the Contractor may offer for the approval of the Engineer alternative materials or items, provided that they possess the minimum requirements of the originally specified material.

In the event of acceptance of any alternative materials or items a suitable price reduction shall be made in respect of any decrease in value but no price addition shall be made in respect of increase in value.

In the event of refusal of any alternative materials or items the Contractor shall not be relieved of any of his obligations under the Contract and shall be solely liable for any delay or loss occasioned by his failure to provide the material or items as specified.

21. IMPORTED MATERIALS

The Contractor is required to produce documentary evidence that all imported materials or items have been ordered shortly after the Site is handed over for the commencement of the Works. This means materials or items that have to be ordered from abroad. As soon as orders have been placed, copies or such orders shall be submitted to the Engineer.

Consequently, no claim will be considered for extension of the Contract Period due to non-availability of materials.

22. PERIODIC REPORTS

The Contractor must present to the Engineer’s Representative detailed reports and schedules as stipulated in the Conditions of Contract.

The Contractor shall prove to the Engineer’s Representative upon his request the correctness of the above mentioned reports without having the right to use such documents to support a claim for any extra payment or compensation whatsoever in regard or in relation to such reports.

23. SITE PROGRESS MEETINGS

During the course of the work, site progress meetings shall be held at regular intervals at least once every two weeks in the presence of the Engineer for the purpose of coordinating the Contractor’s Works and to ensure that full compliance with the various sequences of the contract are maintained.
Minutes of such site meetings will be recorded, copies will be distributed to all persons concerned and full effect shall be given to all instructions contained herein.

Prior to such meetings the contractor shall give to the Engineer’s Representative details in writing of that portion of the Works he proposes to construct during the coming two weeks with details of the plant and methods he proposes to employ. These proposals shall be discussed at the meeting and no work based on such proposal shall proceed without the approval of the Engineer’s representative.

The Contractor shall have no claim against the Employer for costs incurred by him in changing the method of working or in the provision and use of other additional plant.

24. CANCELLATION DUE TO SLOW PROGRESS

If the Engineer shall be of the opinion that having regard to the state of the Works at any time, the contractor will be unable to complete any section of the Works by the time specified or by such extension thereof as he may be entitled to under the Contract and the contractor has failed to carry out steps and to expedite the work in accordance with the conditions of Contract or, if the Engineer is of the opinion that such steps are inadequate, the Engineer may, by written order omit the whole or any part of the uncompleted work included in that section and the Employer shall be at liberty to execute such omitted work by his own workmen or by other contractors. If the cost of such omitted or uncompleted work shall exceed the sum which would have been payable to the contractor on due completion of the said work, then the Contractor shall, upon demand, pay to the Employer the amount of such excess and it shall be deemed a debt due by the contractor to the Employer and shall be recoverable accordingly.

25. CARE OF THE WORKS

The Contractor shall keep all persons (including those employed by sub-Contractors) under control and within the boundaries of the Site. He will be held responsible for the care of the existing premises and of the works generally until their completion, including all work executed and materials, goods and plant (including those of sub-Contractors and Suppliers) deposited on the Site; together with all risks arising from the weather, carelessness of work people, damage or loss by theft or any other cause; and he shall make good at his own expense all such damage and loss.

26. PROTECTION FROM WEATHER AND FLOODS

The Contractor shall keep the Works well drained until the Engineer certifies that the whole of the Works is substantially complete and shall ensure that so far as is practicable all Work is carried out in the dry. Excavated areas shall be kept well drained and free from standing water.

The Contractor shall construct, operate and maintain all temporary dams, watercourses and other works of all kinds including pumping and well point dewatering plant that may be necessary to exclude water from the Works while construction is in progress. Such temporary works and plant shall not be removed without the approval of the Engineer’s Representative.

Notwithstanding any approval by the Engineer of the Contractor’s arrangements for the exclusion of water, the Contractor shall be responsible for the sufficiency thereof and for keeping the Works safe at all times particularly during any floods and for making good at his own expense any damage to the Works including any that may be attributable to flood. Any loss of production or additional costs of any kind that may result from floods shall be at the Contractor’s own risk.
27. CLEARING AWAY

The Contractor shall take down and clear away all plant, temporary works, including sheds, mess room, sanitary conveniences, offices, latrines, sign-boards, and other temporary works, unless otherwise described, and make good.

The Contractor shall remove all existing rubbish and debris and surplus materials from the site as they accumulate and at completion; and clean all surfaces, including those of affected portions of the existing premises, internally and externally, remove stains and touch up paint work and polished work, and leave the works clean and to the satisfaction of the Engineer at completion.

28. ROADS TO BE KEPT CLEAN

The Contractor shall take great care and all reasonable precautions to ensure that roads and through fares used by him either for the construction of the Works or for the transport of plant, labor and materials are not dirtied as a result of such construction or transport and, in the event of their becoming thus dirtied in the opinion of the Engineer’s Representative the Contractor shall take all necessary and immediate steps to clean them.

29. PROJECT PLANNING AND SCHEDULING

The Contractor in accordance with the Conditions of Contract shall submit within 3 days of the acceptance of his Tender to the Engineer a detailed program of works showing the order of procedure and the method in which he proposes to carry out the Works. In preparing his program or work plan the Contractor shall pay due regard to the priority required by certain works. Should the Engineer require the Contractor to modify his program of work, the Contractor shall forthwith submit a modified program incorporating such changes. Should the Engineer during the progress of work require further modifications to the program of work, the Contractor shall likewise review the said program. The Contractor shall also whenever required by the Engineer or the Engineer’s Representative, submit particulars in writing of the Contractor’s arrangements for carrying out the works and of the Constructional Plant and Temporary Works which the Contractor intends to supply, use or construct as the case may be.

30. TESTING ON COMPLETION

The Engineer may before issuing the Certificate of Completion require any part of the Works to be tested for conformity with the Specification. Such tests shall be made at the Contractor’s expense.

31. INSPECTION

If work to be done away from the construction site is to be inspected on behalf of the Employer during its fabrication, manufacture, or testing, or before shipment the Contractor shall give notice to the Engineer of the place and time where such fabrication, manufacture, testing, or shipping is to be done. Such notice shall be in writing and delivered to the Engineer in ample time so that the necessary arrangements for the inspection can be made.

In respect of all items of equipment and materials to be imported for incorporation in the permanent works the Contractor shall submit to the Engineer’s Representative in the English language inspection and test reports issued in the country of origin and certified by and independent inspector or inspection firm of international repute approved in advance by the Engineer. The reports shall certify that all such items are in full compliance with the Contract requirements and
specifications and shall be accompanied by full details of sampling, inspection and test results. Each such report shall be submitted prior to the shipment of the related items to the Site.

No extension of time on account of delays due to inspection shall be granted as such time as is needed for inspection shall be considered in the schedule of the Works.

Material and equipment procured within the country for incorporation in the permanent works shall be inspected at the place of origin by competent and experienced specialized personnel appointed by the Contractor and approved by the Engineer. Inspection and test reports certifying that the related item is in full compliance with the Contract requirements and specification shall be submitted prior to its incorporation in the works.

The certification herein prescribed shall be submitted whether or not the Engineer or his Representative has exercised the right to witness tests or make inspections at the point of origin. The Engineer shall be entitled to apply the Conditions of Contract in respect of items not so certified. Certification shall be furnished at the Contractor’s expense. It shall not relieve the Contractor of the obligation to ensure that all material and workmanship incorporated in the works shall be in full compliance with the Contract requirements and Specification at the time of final handing over of the completed works.

32. SUPPRESSION OF NOISE AND POLLUTION

The Contractor shall make every reasonable endeavor both by means of temporary works and by the use of particular plant or silencing devices to ensure that the level of noise or pollution resulting from the execution of the Works does not constitute a nuisance.

The Contractor shall take all such precautions as may be necessary in the conduct of the work to avoid water pollution, air pollution, noise pollution harmful to health, spreading of plant diseases and pests, or damage to natural resources or the environment, all as is consistent with good practice and as required by applicable laws, ordinances, and regulations or lawful orders of authority having jurisdiction.

33. PROTECTIVE EQUIPMENT AND CLOTHING

The Contractor shall provide and maintain all necessary protective and safety equipment and clothing for the operative and Site Staff.

34. DELAYS AND NON-PRODUCTIVE TIME

The Contractor shall be deemed to have allowed for all delay caused by difficulty in obtaining labor and materials or by suspension of part or the whole of the Works due to adverse and inclement weather conditions.

The Contractor shall allow for all costs incurred by non-productive time.

35. CLEANING UP

During its progress the work and the adjacent areas affected thereby shall be kept cleaned up and all rubbish, surplus materials and unneeded equipment shall be removed, and all damage repaired so that the public and property owners will be inconvenienced as little as possible.
Where material or debris has washed or flowed into or been placed in existing watercourses, ditches, gutters, drains, pipes, structures, work done under this contract, or elsewhere during the course of the Contractor’s operations, such materials or debris shall be entirely removed and satisfactorily disposed of during the progress of the work, and ditches, channels, drains, pipes, structures, and work, etc., shall, upon completion of the work, be left in a clean and neat condition.

The Contractor shall restore or replace, when and as directed, any public or private property damaged by his work, equipment, or employees, to condition at least equal to that existing immediately prior to the beginning of operations. To this end the Contractor shall do as required all necessary highway or driveway, sidewalk, and landscaping work. Suitable materials, equipment, and methods shall be used for such restoration.

The Contractor shall thoroughly clean all materials and equipment installed by him and his sub-Contractors, and on completion of the work shall deliver it undamaged and in fresh and new-appearing condition. All mechanical equipment shall be left fully charged with lubricant and ready for operation.

36. PERMITS, LICENSES AND FEES

Unless otherwise indicated in these Contract Documents, the Contractor shall obtain and pay for all construction permits and licenses. Employer shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work. The Contractor shall also pay all charges of utility service companies for connections to the Work.

37. ASSISTANCE TO THE ENGINEER’S REPRESENTATIVE

The Contractor shall render such assistance and supply such labor as may be required by the Engineer’s Representative in connection with the Contract and when required.

Such labor shall be retained in the employ of the Contractor, but shall operate and perform their duties under the direction of the Engineer’s Representative.

38. OFFICES FOR THE ENGINEER'S REPRESENTATIVE

The Contractor shall provide suitable site offices for the use of the Engineer's Representative and his assistants, throughout the period of construction. The site offices shall be constructed in a location approved by the Engineer's Representative during the mobilisation period. The offices shall be of fixed type and shall have walls, ceiling and partitions lined with Mansonite hardboard or similar material. All rooms shall have glazed windows complete with fly screens. Adequate fitted hardware, electrical switches, sockets, lighting, and plumbing fittings, sanitary ware and fittings and fixtures etc., shall be provided as necessary for the different areas.

The site offices shall be equipped, serviced and maintained in a clean, weatherproof and sanitary condition. Each operational site shall be provided with one office.

The electrical installation shall provide for simultaneous use of all electrical appliances.

The Contractor shall arrange for a temporary power supply to the offices and provide and maintain adequate diesel generator sets. All electricity bills shall be paid by the Contractor.

The Contractor may either arrange for a temporary main water supply or alternatively provide tankered water supply.
Throughout the duration of the Contract, the Contractor shall ensure an uninterrupted supply of water and electricity to the offices.

The offices shall be completed and all the equipment provided by the Commencement of the Permanent Works.

The Contractor shall provide all items listed in the attached Schedules.

Specific Requirements

1. The Contractor shall be responsible for making all arrangements and payments in respects of any land required for the site of the office building.
2. The Contractor shall be responsible for the security of the building and its contents at all times, cover all the operation and maintenance costs for the building and equipment provided and shall employ watchmen for this purpose.
3. The building shall become the property of the Contractor after the completion of the Works.
4. All offices furniture shall remain the property of the Contractor and will be returned to the contractor after the completion of the works.

SCHEDULE OF OFFICES

The requirements of the site offices on this contract are as follows:

<table>
<thead>
<tr>
<th>Room No.</th>
<th>Description</th>
<th>Size Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inspector</td>
<td>4m x 3m</td>
</tr>
<tr>
<td>2</td>
<td>Toilet</td>
<td>1.5m x 2m</td>
</tr>
<tr>
<td>3</td>
<td>Kitchen</td>
<td>2m x 1.5m</td>
</tr>
</tbody>
</table>

SCHEDULE OF Furniture

The Furniture required under this contract for the site offices indicated in the schedule of offices shall be to the Engineer’s approval and are as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Desk with two locking drawers and chair</td>
<td>1</td>
</tr>
<tr>
<td>b</td>
<td>Chair plastic covered, padded steel frame</td>
<td>4</td>
</tr>
<tr>
<td>c</td>
<td>Samples cupboard</td>
<td>1</td>
</tr>
<tr>
<td>d</td>
<td>Four drawers steel filing cabinet</td>
<td>1</td>
</tr>
<tr>
<td>e</td>
<td>In/out tray</td>
<td>1</td>
</tr>
<tr>
<td>f</td>
<td>Waste paper basket</td>
<td>1</td>
</tr>
<tr>
<td>g</td>
<td>2 ring gas burner</td>
<td>1</td>
</tr>
<tr>
<td>h</td>
<td>Fan</td>
<td>1</td>
</tr>
</tbody>
</table>
* The Contractor shall be responsible for all fees, costs and telephone charges incurred by the Engineer’s representatives until the completion of the works.

**The costs for these items shall be included in the contractor’s unit prices.**

### 39. SIGNBOARDS AND BOARDS

The contractor shall erect signboards and boards in prominent positions adjacent to the work to the satisfaction of the engineer as per the attached sketch.

The materials of construction shall consist of the following:

<table>
<thead>
<tr>
<th>Material</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posts and Struts</td>
<td>Timber or Galvanised steel tubes coated in extruded grey PVC</td>
</tr>
<tr>
<td>Foundations</td>
<td>Concrete</td>
</tr>
<tr>
<td>Backboards</td>
<td>Timber or ply, painted white wood</td>
</tr>
<tr>
<td>Signboards</td>
<td>Plastic or other approved</td>
</tr>
<tr>
<td>Fixings</td>
<td>By the Contractor</td>
</tr>
</tbody>
</table>

The Contractor shall be responsible for the structural design of all posts, struts, fixings and foundations.

All the text and logo shall be dark blue on a white background

The number of main signboards to be supplied is 1.

The Contractor shall allow for all associated costs in providing, erecting and relocation of this number of signboards when entering an amount in the unit prices provided in the Bill of Quantities.

In addition to the main signboards mentioned above, the contractor shall supply and install portable two signboards 100x70 cm size and shall indicate names of (project, client, consultant, contractor and Municipality). The price of these signboards shall be included in the contractor’s unit prices.

### 40. COMPUTER

The Contractor shall provide one computer and one laser printer as described below for the use of the Engineer’s Representative and his assistants, throughout the period of construction

Computer should meet the following specifications (will be the property of the contractor once the project finishes):

- HP Compaq dc 7600 small form factor
- Microsoft®, Window®, XP Professional –SP2
- Intel ® Pentium ® 4650 (3.4/800/2M)
- 1GB PC2-4200(DDR2-533)
- 1.44MB, Floppy Drive SFF
- 80GB SATA 3.0 Gb/s HARD Drive
- 16X DVD+/- RW Drive (LS/DL/DF)
- ATI RNX300SE, 128 MB PCIE DVI
- Integrated Broadcom Gigabit NIC
- HP standard keyboard PS/2
- HP USB optical mouse (cbl/slvr)
- 3/3/3(parts/labor/on-site)
• 17” Flat panel screen.
• HP USB 2-Button optional scroll mouse (Carbonated/ silver)
• HP USB 04 Standard Keyboard.

41. Minimum Contractor Staff and Salaries
Beside labours and technicians, the minimum contractor’s staff should be as follows
• Project Manager  1
• Site Engineer       1
• Surveyor             1
• Office boy           1

The minimum salaries of the contractor’s staff should be as follows
• Project Manager  25 US$
• Site Engineer       20 US$
• Surveyor             15 US$
• Office boy           12 US$
• Technician           15 US$
• Labour                 12 US$

B) Particular (Technical) Specifications

EARTHWORKS

1. SCOPE OF WORK

This section covers excavation and backfilling work and shall include the necessary clearing, grubbing and preparation of the site; removal and disposal of all debris; excavation as required; the handling, storage, transportation and disposal of all excavated material; all necessary sheeting, shoring and protection work; preparation of sub-grades; pumping and dewatering as necessary or
required; protection of adjacent property; backfilling; surfacing and grading; and other related works.
No classification of excavated materials will be made. Excavation work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the work, regardless of the type, character, composition or condition thereof.

2. SITE INVESTIGATION

The Contractor shall be deemed to have visited the site of Works and satisfied himself as to the nature of the ground and made himself conversant with the local conditions to be encountered during the execution of the Contract.

3. MATERIALS

Construction materials supplied by the Contractor shall include but not be limited to the following:

Backfill

Backfill and fill shall be structurally sound material such as sand or native soil free of rocks, lumps, vegetable and other organic materials, obtained from suitable excavated material and/or from approved borrow pits. The backfill shall be appropriate for the existing road or paving construction to be reinstated as required.

Water shall be clean potable water free from injurious amounts of oil, acid or any other deleterious mineral and/or organic matter.

Concrete for thrust blocks, chambers, cover slabs or used as fill for making up to correct level and areas of over-excavation, shall have a characteristic strength as stipulated hereinafter.

4. SITE PREPARATION

Prior to commencing any excavation work, the Contractor shall establish a horizontal and vertical survey network, record existing ground elevations and stake the location to be excavated.

The Contractor shall prepare the site for construction by clearing, removing and disposing of all items not indicated on the Drawings to remain or so defined by the Engineer.

The Contractor shall obtain relevant excavation permits as required before commencing work.

Existing Utilities

The Contractor shall ascertain the whereabouts of all existing utilities on the site both, above and below ground.

The Contractor shall be held responsible for all damages entailed on any of the utilities adjacent to the site resulting from the Works.

All proposed or existing utilities, including buried pipes, sewers, ducts, culverts, cesspits, chambers and the like, in the vicinity of the work site, are to be determined by the Contractor and the location of them is to be shown on the as-built drawings.

Prior to commencement of excavation, the Contractor shall establish the number and location of underground utilities and chambers in the immediate proximity of the work.
Where necessary, the Contractor shall use hand tools to excavate test pits prior to excavation to
determine the exact locations of existing utilities. It shall be the responsibility of the Contractor to
make such explorations sufficiently in advance of construction to enable the engineer to approve
modifications, if any, to be made to the pipeline, structure or conflicting utility. The Contractor
shall obtain the permission of the Engineer before commencing any test pits and shall fence, mark
and protect them, as required by the Engineer. Test pits shall be refilled by hand as soon as
practicable after the necessary information has been obtained.

As the excavation approach sewers conduits, cables or other underground facilities, the excavation
shall be continued with care by means of hand tools. Where necessary, the Contractor shall provide
temporary support for the existing utilities to prevent damage during his operations. Notwithstanding these provisions, if damage to existing utilities results from the Contractor's
operations, such damage shall be repaired without delay by the Contractor to the Utility owner’s
satisfaction.

If damage to existing utilities causes disruption to Contractor's schedule of work by delaying work
in the area of such damage, the Contractor shall re-adjust his programme, methods of working and
resources so that critical dates in the schedule for the completion of the Contract are not affected.
This shall not be deemed to be an instructed acceleration.

Removal of Existing Structures and Other Obstructions

This work shall include, but not be limited to, the removal of existing structures and other
obstructions interfering with the Works. The salvaging of any of these materials for the use of the
Employer shall be as directed by the Engineer and unwanted materials shall be disposed off the Site
in a satisfactory manner as directed by the Engineer.

Cleaning and Grubbing

The Contractor shall perform the clearing and grubbing (if any), of top soil consisting mainly of
loose soil, vegetable and organic matters, drift sand, unsuitable soil and rubbish by scarifying the
areas to be excavated and sidewalks to a minimum depth of 300mm from the natural ground level.
All materials resulting from the above operations shall be removed from the site, loaded and
transported and off loaded, spread and leveled to approved dumps.

5. SETTING-OUT

The Contractor shall stake-out the work as shown on the Drawings and secure the Engineer's approval
of his stake-out before proceeding with construction. If, in the opinion of the Engineer, modification
of the line or grade is advisable before or after stake-out, the Engineer will issue detailed instructions
in writing to the Contractor for such modification and the Contractor shall revise the stake-out for
further approval in accordance with the relevant Clause of the Conditions of Contract.

6. EXCAVATION

The Contractor shall perform all excavation true to line, width and depths shown on the Drawings
or to such further lines, depths or dimensions or to reach suitable bearing strata as may be directed
by the Engineer.

Keeping Excavations Free from Water

All excavations shall be kept clear of water by pumping or bailing or by well-point de-watering,
but the latter system shall not be employed if any danger exists of withdrawing water from the
foundations of the adjoining buildings and such water shall be discharged clear of the Works and
the method adopted shall in no way contravene with regulations of the Municipalities.

The system or systems to be employed shall be approved by the Engineer. Such approval if given, shall not waive the Contractor's responsibilities and liabilities under the Contract.

Particular attention shall be paid to the installation of sheeting and shoring as may be necessary for the protection of the work and for the safety of personnel and public.

**Storing of Suitable Excavated Material**

During excavation, materials suitable for backfill shall be stockpiled on the site at adequate distance from the sides of the excavation to avoid over-loading and prevent collapse of the trench walls.

**Disposal of Unsuitable and Surplus Excavated Material**

Upon the order of the Engineer, all unsuitable and surplus materials shall be immediately removed, loaded and transported off the site area by the Contractor to approved dumps and he shall abide by the relevant local regulations.

7. **SHEETING, SHORING AND BRACING**

Except where banks are cut back on a stable slope, excavation shall be sheeted, braced and shored as necessary to prevent collapse of the excavations. The Contractor shall furnish, put in place, and maintain such sheeting, bracing, etc, as may be necessary to support the sides of the excavation and to prevent any movement of earth which could in any way diminish the width of the excavation to less than that necessary for proper construction, or could otherwise injure or delay the work, or endanger adjacent structures. If the Engineer's Representative is of the opinion that at any point sufficient proper supports have not been provided, he may order additional supports.

The Engineer may direct that sheeting and bracing be cut off at any specified elevation.

All sheeting and bracing not to be left in place shall be carefully removed in such manner as not to endanger the construction or other structures. All voids left or caused by the withdrawal of sheeting shall be backfilled immediately with approved material and compacted by ramming with tools especially adapted to that purpose, by watering or by other means as may be directed.

8. **EXCAVATION FOR STRUCTURES AND MANHOLES**

Excavation for the structures and manholes shall be carried out to the dimensions, lines and grades shown on the Drawings or required by the Engineer.

Should it appear that the bottom of the excavation does not provide a solid base for the chamber, the Contractor shall be required to consolidate the bottom using hand tampers and increasing the moisture content, if required, all as directed by the Engineer.

Any over-excavation at the bottom of the structure and manholes shall be restored to the proper grade by filling the over-excavation with suitable material or shall be filled with concrete. In the case of over-excavation in the walls, whether caused by careless work or by the necessity to prevent slides by excavating to a slope or for any other reason, the Contractor shall remove all loose material from the excavation, construct the walls of the structure to the dimensions shown on the Drawings and fill the spaces between the structures and the sides of the excavation with compacted backfill in layers of 15cm thickness. The material of the backfill shall be moistened if necessary and compacted to the level of the adjacent natural soil.
9. **UNAUTHORIZED EXCAVATION**

If the bottom of any excavation is taken out beyond the limits indicated or prescribed, the resulting void shall be backfilled at the Contractor's expense with thoroughly compacted, selected screened gravel or sand fill as directed by the engineer if the excavation was for a pipeline, or with concrete if the excavation was for a structure or a manhole.

10. **ELIMINATION OF UNSUITABLE MATERIAL**

Suitable material shall comprise all material that is acceptable in accordance with the Contract for use in the Works. Suitable material for earthworks shall be approved soil with a plasticity index not exceeding 6% obtained from excavations within the Works approved by the Engineer. It shall not contain an excess of fines.

Unsuitable material shall be deemed to be:

- Rock particles exceeding 75mm in size.
- Organic material, stumps and other perishable material.
- Material susceptible to spontaneous combustion.
- Soils of liquid limit exceeding 40% and/or plasticity index exceeding 6%.
- Any other material which the Engineer may deem to be unsuitable for earthwork.

If material unsuitable for foundation (in the opinion of the Engineer's Representative) is found at or below the grade to which excavation would normally be carried in accordance with the Drawings and/or structure, the Contractor shall remove such material to the required width and depth and replace it with compacted, selected screened gravel, sand fill or concrete as directed by the Engineer or his Representative.

11. **DISPOSAL OF SURPLUS EXCAVATION MATERIALS**

All surplus excavated materials shall be disposed of by the Contractor, except as otherwise directed or approved by the Engineer.

12. **BACKFILL**

**Backfill around Structures**

The materials to be used for backfill around structures, shall be approved granular backfill material obtained either from excavation for the structure and appurtenant Works, if it is approved by the Engineer or his representative, or from borrow pits cleaned and free of clay and stones as directed and specified hereinafter. The material used for backfill, the amount thereof, and the manner of placing shall be subject to direction of the Engineer or his representative. The backfill shall be carried out to the lines and grades shown on the Drawings. The backfill material shall completely and firmly fill the spaces between the excavation lines and the structure without leaving any voids and shall be compacted to the density of the adjacent natural or compacted earth or to 95% density using modified Proctor, whichever is greater. The backfill material shall be placed in horizontal layers not exceeding 15 cm in thickness after compaction.

The sides and bottom of the excavation shall be wetted before backfilling and so shall the backfill material, in order to obtain the moisture content necessary for the required compaction. Every layer shall be compacted by hand-operated and/or pneumatic tampers approved by the Engineer or his representative for every specific case as suitable.
Backfill against foundation walls shall not be placed until obtaining the approval of the Engineer or his representative. The backfill shall be performed in a manner that will not create unbalanced pressure that could damage completed Work.

Backfill material may be placed in either a dry or a wet condition. Any material, which is in the “bulking” range of the moisture content of the material, shall be saturated before compaction. No backfill material shall be placed when free water is standing on the surface of the area where the backfill is to be placed. No compaction of backfill will be permitted with free water on any portion of the backfill to be compacted. Any backfill containing organic materials or other unacceptable material previously described shall be removed and replaced with approved backfill material prior to compaction.

Compaction of backfill shall be performed as specified, with equipment suitable for the type of backfill material being placed. The Contractor shall select equipment capable of providing the minimum density required by these Specifications or in cases where the compaction equipment is specified, this specified equipment shall be used, and he shall submit information pertaining to the equipment to the Engineer or his representative for approval. Equipment shall be capable of compacting in restricted areas next to structures and around piping without damaging same.

Each lift of backfill material shall be compacted by at least two coverage of all portions of the surface of each lift by approved compaction equipment. One coverage is defined as the condition obtained when all portions of the surface of the backfill material have been subjected to the direct contact of the compacting surface of the compactor. The minimum density to be obtained in compacting select backfill shall be 95 percent of maximum density obtained in the laboratory in accordance with ASTM D 1557. This percentage is of standard Proctor density. Compaction tests, soil analyses and any other laboratory tests necessary in the opinion of the Engineer or his representative for proper completion of the work shall be performed by the Contractor.

The water content of the fill shall be controlled during placement within the range necessary to obtain the compaction specified. In general, the moisture content of backfill soils shall be within 3 percent of the optimum moisture content for compaction as determined by laboratory tests. All laboratory tests necessary to establish that the water content of the backfill is suitable for placement shall be performed by the Engineer or his representative. The Contractor shall perform all necessary work to adjust the water content of the backfill material to be within the range necessary to permit the compaction specified. This shall include, but not be limited to, spreading, scarifying and mixing to permit drying to reduce natural water contents to an acceptable range or adding water to increase the water content to an acceptable level.

The Contractor shall perform whatever tests he deems necessary to provide data for his selection of backfill material and control of water content. Copies of a test results shall be furnished to the Engineer or his representative for his review.

If the field and laboratory tests indicate unsatisfactory compaction, the Contractor shall provide the additional compaction necessary to obtain the specified degree of compaction. All additional compaction work shall be performed and paid for by the Contractor until the specified compactions is obtained.

If the specified densities are not being obtained because of the Contractor's improper control of placement or compaction procedures or because of improperly functioning compaction equipment, the Contractor shall perform whatever work is required to provide the specified densities. This work shall include complete removal of unacceptable backfill areas and replacement and re-compaction until acceptable backfill is provided. All additional work to provide acceptable backfill shall be performed and paid for by the Contractor. In-place density determinations shall be made by an approved laboratory using a sand density cone or equivalent method as specified by ASTM D1556.
Fill and Backfill under Structures

Unless otherwise indicated or specified, all fill and backfill under structures shall be compacted. The percentage of compacting for backfill shall be 98% of maximum density at optimum moisture content.

Tamping

Suitable material shall be deposited and spread in uniform, parallel layers not exceeding 15 cm thick before compacting. Before the next layer is placed, each layer shall be tamped as required so as to obtain a thoroughly compacted mass. The Contractor shall furnish and use an adequate number of power-driven tampers, each weighing at least 10kg for this purpose. Care shall be taken that the material close to the bank, as well as in all other portions of the trench, is thoroughly compacted.

To ensure proper compacting by tamping, the material shall first be wet by sprinkling. However no compacting by tamping shall be done when the material is too wet either from rain or too great an application of water to be compacted properly; at such times the work shall be suspended until the previously placed and new materials have dried out sufficiently to permit proper compacting or such other precautions shall be taken as may be necessary to obtain proper compacting.

No superficial load shall be placed on the exposed surface of the trench unless the backfill, if of non-cohesive sand is vibrated or tamped in layers not exceeding 15 cm in depth until the Engineer's Representative is satisfied that sufficient settlement has occurred to alleviate live or impact loads.

Backfilling for Pipelines

Backfilling of pipe trenches if any shall be done as practicable after the pipes have been satisfactorily laid in position and jointed. The first stage of the backfill, from the bedding surface and up to 30 cm above the top of the pipe, shall consist of granular material as specified in the subsection of Granular Backfill obtained from trench excavation or from borrow areas, free from, stones, clods, and organic matter. This backfill shall be hand-tamped under and around the pipe in layers not exceeding 15 cm in thickness after compaction, to a density not less than that required for the subsequent backfill (at least 95% of modified Proctor).

The remainder of the pipe trench (second stage backfill from 30 cm above the pipe to the top of the trench) shall be backfilled with selected excavated material or imported material as specified in the subsection of Select Backfill, and shall be placed in layers not exceeding 20 cm thickness after compaction, wetted as necessary and compacted to a density not less than that of the adjacent material or compacted soil (at least 95% of modified Proctor).

Granular Backfill

The material shall consist of natural silica sand subject to approval of the Engineer or his representative, other inert materials with similar characteristics having durable particles. Materials from different sources of supply shall not be mixed or stored in the same pile nor used alternately in the same class of construction without permission from the Engineer or his representative. The granular material shall be uniformly graded and shall meet the following gradation requirements.

<table>
<thead>
<tr>
<th>Sieve designation</th>
<th>Passing square-Mesh Sieves Percentages by Weight</th>
</tr>
</thead>
</table>

20
### AASHOT Test Method

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>100</td>
</tr>
<tr>
<td>No.4</td>
<td>0-40</td>
</tr>
<tr>
<td>No.200</td>
<td>0-10</td>
</tr>
</tbody>
</table>

No material containing pieces of wood or other organic matters or having lumps, pockets or concentrations of silt or clay will be accepted. Samples of proposed backfill material should be submitted to the Engineer or his representative for testing and approval prior to using the backfill. The contractor shall certify that for samples submitted, sufficient similar material is available to complete the Works. No backfill shall be placed at the site without approval by the Engineer or his representative. The Engineer or his representative shall be permitted to access borrow pits at all times for purposes of inspection.

Prior to placement of select backfill, the surface of the subgrade shall be leveled and shall be compacted with two complete coverages using equipment approved for backfill placement. The Engineer or his representative shall approve the subgrade prior to backfill placement. All backfill shall be placed in horizontal loose lifts not exceeding the thickness specified in previous section and shall be mixed and spread in a manner assuring uniform lift thickness after placing. Each layer of backfill shall be properly compacted as specified herein before placement of the following lift.

### Gravel or Crushed Stone Backfill
Gravel or crushed stone backfill shall consist of gravel, crushed stone, crushed rock, material sands, manufactured sands or combination thereof, and shall conform to the following gradation requirements:

<table>
<thead>
<tr>
<th>Screening size</th>
<th>Percentage passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot;</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>30-100</td>
</tr>
<tr>
<td>No. 40</td>
<td>0-30</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-5</td>
</tr>
</tbody>
</table>

The portion of the backfill passing the No.4 screen shall have a sand equivalent of not less than 60 percent.

Gravel or crushed stone backfill shall be placed as shown specified or where directed by the Engineer or his representative.

Gravel or crushed stone shall be spread in layers of uniform thickness not exceeding 20 cm and shall be thoroughly compacted with suitable power driven tampers or other power driven equipment. The placing, compacting and testing of gravel or crushed stone shall conform to applicable requirements for select backfill as specified herein except as noted above.

The Contractor shall submit to the Engineer or his representative samples of proposed gravel or crushed stone backfill. The proposed material must receive the approval of the Engineer or his representative prior to using of it on the project. The Contractor will be permitted to use excess materials from the trench provided that they conform to the above requirements.

**Miscellaneous Requirements**

Whatever method of compacting backfill is used, care shall be taken that stones and lumps shall not become nested and that all voids between stones shall be completely filled with fine material. The Contractor shall, as part of the work done under the items involving earth excavation and rock excavation as appropriate, furnish and place all other necessary backfill material.

All voids left by the removal of sheeting shall be completely backfilled with suitable materials thoroughly compacted.

When required, excavated material which is acceptable to the Engineer for surfacing or pavement sub-base shall be placed at the top of the backfill to such depths as may be specified elsewhere or as directed. The surface shall be brought to the required grade and stones raked out and removed.

**Measurements and Payments**

The payments for excavation for structures shall be in cubic meters. The volume of the excavation to be paid to the contractor shall be calculated based on the actual dimensions of the structure plus 2ms from each side if excavation depth is more than 3ms from GL. For structures with excavation depth less than 3ms from GL, the volume of excavation shall be the actual dimension of the structure plus 1m from each side.

The calculation of backfill volume shall be the same as the excavation minus the volume of the structure.

The payment for excavation and backfilling of pipes and manholes shall be included in the unit rates of pipes and manholes.
CONCRETE WORKS

1. GENERAL

Concrete work shall consist of furnishing all materials and constructing structures of the forms, shapes and dimensions shown on the Drawings or as directed, using Portland Cement Concrete, in accordance with the details shown on the Drawings and these Specifications.

Portland cement concrete shall consist of a mixture of Portland Cement, fine aggregate, coarse aggregate, water and additives when required. The mixture shall be proportioned, mixed, placed and cured in accordance with the requirements of B.S. 8110 Part 1:1985 Sections 6 and 7 specification. Where an additional clause conflicts or is inconsistent with the requirements of B.S. 8110, the additional clause shall always prevail. The concrete mixes shall be designed mixes for special or ordinary concrete as defined in B.S. 8110 Clause 6.3, the design requirements of which are laid down in this Specification.

2. MATERIALS

General Requirements

The classes of concrete and their respective minimum cement content, consistencies and the minimum required compressive strengths shall be as shown:

<table>
<thead>
<tr>
<th>Class</th>
<th>Comp. Strength (N/mm)</th>
<th>Slump (mm)</th>
<th>Min. Cement Content (kg/m)</th>
<th>Max. Free w/c Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (30/20/SRC)</td>
<td>20</td>
<td>25 - 75</td>
<td>350</td>
<td>0.55</td>
</tr>
<tr>
<td>B (25/20/SRC)</td>
<td>17</td>
<td>25 - 75</td>
<td>300</td>
<td>0.6</td>
</tr>
<tr>
<td>C (15/20/SRC)</td>
<td>10</td>
<td>25 - 100</td>
<td>200</td>
<td>0.7</td>
</tr>
</tbody>
</table>

3. FINE AGGREGATE FOR CONCRETE AND MORTAR

Fine aggregate for concrete shall consist of natural screened and washed sand or crushed sand having hard and durable particles, or of other inert materials with similar characteristics. It shall not contain harmful material such as clay lumps, tree roots, shale, iron pyrites, coal, mica, organic matter or any deleterious matter which may attack the reinforcement, in such a form or in sufficient quantity to affect adversely the strength and durability of the concrete. If necessary the aggregate shall be washed and sieved to remove the deleterious substances.

The fine aggregate shall comply in all respects with the requirements of B.S. 882.

Fine aggregate of fine grading (BS 882) shall not be used. In addition to the above, fine concrete aggregate shall meet the following requirements:

- Fineness Modulus, - Max. +/- 0.2 variance from test sample
- Sodium Sulphate Soundness, - Max. 10%
- Clay and Friable Particles, - Max. 1% by weight
- Test for Organic Impurities, - Lighter than standard
- Material Passing 0.075 mm sieve, - Max. 3%
- Chlorides (Cl), BS 812, part 117 - Max. 0.06% by weight of fine (acid soluble) aggregate
- Sulphate (SO3), BS 812, part 118 - Max. 0.3% by weight of fine (acid soluble) aggregate
- Sand Equivalent, - Min. 75

Fine concrete aggregate shall conform to one of the following grading (reproduced from BS882):
4. **COARSE AGGREGATE FOR CONCRETE**

Coarse aggregate for concrete shall consist of natural gravel, crushed gravel, or crushed stone, free from coating of clay or other deleterious substances. It shall not contain harmful materials such as pyrites, coal, mica, laminated materials, tree roots, shale, or any materials which may attack the reinforcement, in such a form or in sufficient quantity to affect adversely the strength and durability of the concrete. If necessary, coarse aggregate shall be washed to remove deleterious substances.

The aggregate shall comply in all respects with the requirements of B.S. 882. The aggregate shall also fulfil the following requirements:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flakiness Index (37.5 mm)</td>
<td>B.S. 812</td>
</tr>
<tr>
<td>Flakiness Index (20 mm)</td>
<td>B.S. 812</td>
</tr>
<tr>
<td>Elongation Index (20 mm)</td>
<td>B.S. 812</td>
</tr>
</tbody>
</table>

In addition to the above, coarse concrete aggregate shall meet the following requirements:

- Sodium Sulphate Soundness: Max. 10% loss
- Abrasion: Max. 40% loss
- Clay lumps and Friable Particles: Max. 0.25% by weight
- Soft Fragments and Shale: Max. 3% by weight B.S. 812
- Passing 0.075 mm: Max. 1%
- Chlorides (Cl) BS 812, Part 117: Max. 0.02% by weight (acid soluble) Coarse Aggregate
- Sulphates (SO₃) BS 812, Part 118: Max. 0.3% by weight (acid soluble) Coarse Aggregate
- Water Absorption: Max. 2%

The coarse aggregate shall conform to the following grading in accordance with the nominal size of aggregate specified (reproduced from BS 882).

<table>
<thead>
<tr>
<th>BS 410 Test Sieve</th>
<th>Percentage by Weight Passing BS Sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve (mm)</td>
<td>Coarse</td>
</tr>
<tr>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>2.36</td>
<td>60-100</td>
</tr>
<tr>
<td>1.18</td>
<td>30-90</td>
</tr>
<tr>
<td>0.6</td>
<td>15-54</td>
</tr>
<tr>
<td>0.3</td>
<td>5-40</td>
</tr>
<tr>
<td>0.15</td>
<td>0-15</td>
</tr>
</tbody>
</table>

Combined Aggregate - Approved coarse aggregate and fine concrete aggregate in each batch of concrete shall be combined in proportions as specified in BS.882 and as approved by the Engineer. However, in no case shall materials passing the 0.075 mm sieve exceed three (3) percent by weight of the combined aggregate.
For the overall concrete mix the following controls of salts contents of aggregates shall be adopted:
Chlorides (Cl)       Max. 0.3% by weight of cement
Sulphates (SO₃)     Max. 4% by weight of cement

The combined concrete aggregate gradation used in the work shall be as specified, except when otherwise approved or directed by the Engineer. Changes from one gradation to another shall not be made during the progress of the work unless approved by the Engineer.

Naturally occurring sand/gravel mixtures (all in aggregates) shall not be used unless otherwise directed by the Engineer.

5. WATER

Water for washing aggregate and for mixing of concrete shall be fresh, clean and substantially free from oil, acids, alkali, sewage, deleterious mineral or organic matter. It shall not contain chlorides such as sodium chloride in excess of 600 ppm nor sulphites such as sodium sulphate in excess of 500 ppm. It shall comply in all respects with B.S. 3148.

Water for curing concrete shall not have a pH lower than 5 or more than 7.5 nor contain impurities in sufficient amounts to cause discoloration of the concrete. Sources of water shall be maintained at such depth and the water shall be withdrawn in such a manner as to exclude silt, mud, grass and other foreign matter.

Approval of Source - All sources of water for use with cement shall be approved by the Engineer.

If at any time during construction the water from an approved source becomes unsatisfactory, the Contractor will be required to provide satisfactory water from some other source.

6. CEMENT

General

The cement shall be of approved manufacture and shall be delivered in bags with seals unbroken, or delivered in bulk, it shall be delivered in approved containers. Test certificates from the manufacturers or suppliers shall be submitted for each consignment and shall indicate the results of the tests for compressive strength, setting time, soundness and fineness carried out in accordance with the requirements of the relevant ASTM or British Standards. Further tests may be required by the Engineer after the cement is delivered and stored on the Site. The failure of any sample to satisfy the B.S. or ASTM requirements shall entitle the Engineer to reject the entire consignment from which it was taken. Cement should be stored on the site such a way to keep it away from water at all times. Sulphate Resisting Cement shall be used unless otherwise directed.

Portland Cement

Normal and rapid hardening cement shall comply with B.S.12.
Sulphate Resisting Cement
Sulphate resisting cement shall comply with B.S. 4027.

Admixtures

Air entraining agents, plasticizers, water proofing agents, retarders, and other similar admixtures shall comply with British Standard Specifications (5075, 8110, 1014, 3587, 3892) and shall be used in accordance with the manufacturer’s recommendations and B.S. Samples of proposed admixtures shall, if required, be submitted to an approved testing authority by the Contractor in order to ascertain its suitability for use in the Works. Use of any admixtures must be approved beforehand by the Engineer.
The cost of such admixtures shall be included in the cost of concrete and no extra payment shall be made if they are used. The proportions of cement, fine aggregate and water shall be determined by the Contractor before concreting commences and submitted together with such test results as may be required to the Engineer for approval and the Contractor shall not commence concreting before such approval is given nor shall he alter or vary in any way the proportion of mix unless he submits fresh test results and mix proportions to the Engineer for approval.

The approval by the Engineer of such mix designs does not in any way absolve the Contractor of any of the requirements of the Specifications.

7. MIXING AND TESTING

Samples of Aggregates

Samples of both fine and coarse aggregates are to be submitted to the Engineer for testing at least one week before commencing deliveries. No deliveries in bulk are to be commenced until such samples are approved by the Engineer as complying with this Specification.

Trial Mixes

Following the engineer’s approval of the materials for each class of concrete, the Contractor shall prepare a trial mix of each grade of concrete in the presence of the Engineer’s Representative. Each trial mix shall comprise not less than 1/3 of a cubic meter of concrete and shall be mixed in an approved type of concrete mixer similar to that which the Contractor propose to employ on the Works. The quantities of all ingredients of trial mix including water shall be carefully determined by weight according to the approved mix design. Each trial mix shall show no tendency to segregate when handled and compacted by the methods by which the Contractor proposes to handle and compact the grade of concrete in the Works and it shall be capable of adequate compaction by such methods.

Water/Cement Ratio

The quantity of water to be added to the cement and aggregates during mixing shall be just sufficient to produce a workable mix to enable it to be well compacted and worked into corners of formwork and around reinforcement. All mixes shall be designed in respect of the proportioning of water so that the Slump Test as carried out according to B.S.1881 shall be in accordance with the slump specification. Measurement of water on the site shall take into account the moisture present in the aggregates, and Slump Tests shall be taken sufficiently frequently to ensure that variations in the moisture content of the aggregate are fully taken into account in determining the amount of water to be added.

Measurement of Ingredients

The aggregates for the concrete shall be measured by weight but measurement by volume may be allowed in special circumstances with approval of the Engineer.

When the aggregates are to be measured by weight the weight batching machines shall be of a type approved by the Engineer’s Representative. They shall be kept clean and in good condition and adjustment. At intervals as the Engineer’s Representative may require, the Contractor shall check the accuracy of each weight-batching machine.

When the aggregates are to be measured by volume, the proportions of fine and coarse aggregates shall be measured in well constructed gauge boxes, of dimensions approved by the Engineer’s Representative to guarantee that whole multiples of such gauge boxes will ensure the use of one or
more whole bags or containers of cement and the capacity of the concrete mixer shall be such as to ensure that no splitting of cement bags or containers is required. Gauge boxes shall be properly filled and struck off level, addition of fine aggregates to allow for bulking due to moisture content being made as required.

An efficient water measuring device shall be fitted to each concrete mixer. Any cement container shall be such as to contain an accurately weighed amount of cement.

**Mixing Concrete**

The concrete shall be mixed in a power driven machine of the batch type, no hand mixing shall be permitted. Mixing shall continue until the mass of concrete batch is uniform in consistency and colour. The method of discharge shall be such as to cause no segregation of the concrete materials. Concrete which has commenced to set before placement shall not be re-mixed and shall be rejected and in no case used in the works.

**Concrete Testing - Compressive Crushing Strength**

One set of three test cubes (15cm x 15cm x 15 cm) shall be taken from each 6 cubic metre batch or one set of three test cubes for each individual concrete member (anchor block) if the concrete is batched individually. The cubes shall be cured in water at ambient air temperature. One cube shall be tested at 7 days and the other two at 28 days. The compressive strength shall be deemed to be the average strength value obtained from the two cubes crushed at 28 days. The result of the 7-day cube compressive strength shall act as an early warning indicator that the 28 day strength may not be achieved. Where the specified 28-day strength is not achieved the Contractor shall replace the defective concrete member at his own cost.

**Concrete Testing - Workability**

The contractor shall carry out slump tests on each separate concrete batch or delivery and additional slump tests every one hour on the same batch or delivery if the time for placing concrete exceeds one hour. The cost of slump tests is deemed to be included in the cost for providing and placing concrete.

**Concrete Testing - Materials**

The Contractor shall also obtain and furnish the Engineer with current Material Test Certificates from the concrete supplier or otherwise for the following parameters;

- Grading, fine and coarse aggregate
- Flakiness and Elongation Index
- Compacting Factor Test
- Co-efficient of expansion for the aggregates
- Absorption Index
- Mix Design.

**8. TRANSPORTING CONCRETE**

Concrete shall be taken from the place of mixing to the place of deposition by methods which shall prevent the segregation or loss of the ingredients and which are sufficiently rapid to ensure that the concrete does not commence to set before it is compacted in position. The concrete shall be deposited as near as possible to its final position in the works and shall not be allowed to flow laterally into position. Deposition of the concrete through shutes shall not be permitted nor dropped
freely from a height exceeding 1.50m.

9. PLACING CONCRETE - GENERAL

Concrete shall not be placed without the Engineers approval. The approval shall be given on satisfactory completion of checking by the Contractor and the Engineers Representative, which shall include the following:

- Extent of the foundation and preparation,
- Character of the bearing surface preparation,
- Correct alignment, placing and cover to reinforcement,
- Overall cleanliness.

The concrete shall be placed in its final position as soon as possible after it has been mixed, and in any case before the initial set has taken place. The Contractor shall ensure that concrete, which has already been placed in position and has commenced to set is not disturbed by the placing and compaction of further concrete nearby. All concrete shall be carefully worked around and between reinforcement and all other embedded fittings without such reinforcement or fittings being disturbed. Concrete is to be worked well up against whatever surface it joins.

Suitable measures shall be taken by the Contractor to ensure that concrete placed in hot weather conditions shall not impair the quality or strength of the final installed concrete. Due regard shall be paid to ambient and mix temperatures. Surfaces and forms prepared to receive the concrete shall be shaded wherever practicable and moistened with water to prevent drying out of the concrete coming into contact with hot surfaces or reinforcement.

10. COMPACTING CONCRETE

Tamping

All concrete shall be thoroughly compacted to the maximum with approved tampers without any segregation in its final position before it commences to set. Care shall be taken to avoid the use of spade type tampers, which may cause segregation. Initial compaction shall be with tampers and compaction with screed boards shall be limited to final shape and finish. During the placing and compaction of reinforced concrete, a competent steel fixer shall be in attendance to adjust and correct if necessary the position of the reinforcement.

Vibrating

Concrete shall be compacted by vibrating with an approved vibrator. The vibrators shall not be attached to any reinforcement or embedded fittings and where immersion type vibrators are used, care shall be taken to ensure that they do not come into contact with the reinforcement or embedded fittings. Freshly placed concrete shall not be vibrated in a manner likely to cause damage to concrete, which has already begun its initial set. Concrete shall not be vibrated excessively where segregation would result. Shutter type vibrators shall not be used. Nor shall immersion type vibrators come into contact with the formwork.

11. CURING OF CONCRETE

All concrete shall be protected from the harmful effects of sunshine, drying winds, rain, flowing water, or other adverse effects. For at least 7 days after placing, the concrete shall be prevented from drying out by being sprayed with water and covered with hessian, clean sand or other approved material, which shall be kept wet.
Membrane curing of concrete with an approved liquid may be used as an alternative to curing with water except that membrane curing liquid shall not be applied to surfaces of concrete from which the shuttering has been struck, until the concrete surface and finish has been inspected and approved by the Engineer.

Concrete curing compound shall be readily distinguishable upon the concrete surface for at least four hours after the application. The colour, if any, shall be inconspicuous on exposed surfaces within seven days after application.

The contractor shall ensure that the concrete is adequately protected against inclement weather until properly set and shall if necessary provide additional protection to that specified above.

12. INSPECTION OF CONCRETE

The condition of formed surfaces shall be inspected immediately on striking the shuttering by the Contractor and Engineers Representative, for the presence of defects. Any remedial action approved by the Engineers Representative, such as application of cement slurry or mortar to superficial defects, shall be carried out immediately while the concrete surface is still moist and before any curing membrane is applied.

13. DEFECTIVE CONCRETE

The Contractor shall on the written instruction of the Engineer’s Representative remove and reconstruct any portion of the work which in the opinion of the Engineer’s Representative is unsatisfactory as regards the quality of concrete, incorrect dimension or position of the cast concrete, badly placed or insufficient reinforcement, honeycombing or other such cause as to render the construction defective or non compliant with the specification or which may prejudicially affect the strength or durability of the construction.

14. REPAIRS TO CONCRETE

The method of repairing and replacing defective concrete, which the contractor proposes to adopt, shall be submitted to the Engineer’s Representative for prior approval and the repair shall be carried out in such manner as he may direct or approve.

15. SUPERVISION OF CONCRETE WORK

Throughout the progress of the concrete work the Contractor shall employ and provide such supervision as is necessary to ensure the following:

- The day to day control of the quality of the concrete;
- The mixing, transporting, placing, compacting, curing and protection of the concrete;
- The testing of concrete and material constituents specified;
- Investigation of defects as required by the Engineer; and
- Preparation of all concreting records and reports as required by the Engineer.

16. FINISHING OF CONCRETE

All concrete surfaces not formed by shuttering shall be trawled to a smooth dense surface with the minimum of cement and fine particles being brought to the surface and shall be free from irregularities.

Shuttered surfaces of concrete may be formed by casting against sawn timber. All other exposed concrete including precast concrete shall be cast against steel, plywood or planed timber formwork.
and shall be carefully rubbed down with carborundum to remove all imperfections and irregularities.

17. DESIGN AND CONSTRUCTION OF FORMWORK

Formwork shall in every respect be adapted to the structure and the required surface finish of the concrete. It shall include all temporary moulds for forming the concrete to the required shape and finish for the support of such moulds. It shall be fixed in true alignment and securely wedged and braced so as to be able to withstand, without displacement, deflection or movement of any kind, the weight of the construction and the movement of persons, materials and plant. Joints shall be close enough to prevent the leakage of liquid and fine materials from the concrete.

The Engineer’s Representative may require at the prior submission for approval of the Contractor’s proposals for the design and construction of formwork including supports. The formwork shall be constructed so as to permit its removal without damage to the concrete.

18. SPACING BLOCKS AND TEMPORARY TIES

Internal spacing blocks and construction ties shall be avoided as far as possible and practicable. Where it is intended that these shall be removed whether before or after the concrete has set, the making good of the concrete shall be subject to the Engineer’s Representative’s approval. The removal of the blocks or internal ties must not jeopardise the stability of the construction. If, with the approval of the Engineer’s Representative, these are allowed to remain in the concrete then they shall be of a material and quality that they do not prejudice the strength of the work. Concrete spacing blocks shall be made of concrete at least equal in quality to the main concrete. Metal ties shall be positioned such that they do not come into contact with any of the reinforcement or fittings and no part of the tie shall be permanently embedded in the concrete nearer than 5 cm to the exterior surface of the concrete.

All holes resulting on the concrete surface from their removal shall be in-filled with 1:2 cement mortars.

19. PREPARATION FOR CONCRETING

Immediately before the concrete is deposited, the formwork, shall be thoroughly cleaned out and freed from sawdust, shavings, wire cuttings, dust, sand, soil and all other deleterious and extraneous materials. Temporary openings shall be provided in the formwork to facilitate this work. The internal surfaces of the formwork shall, immediately prior to final erection, be coated with mould oil. The mould oil shall be of approved type and shall be applied uniformly and the quantities used shall be the minimum consistent with its purposes. The contractor shall ensure that all steel reinforcement and adjoining concrete surfaces are kept free of mould oil.

20. APPROVAL BEFORE CONCRETING

The Contractor shall in all cases request the approval of the formwork by the Engineer’s Representative in sufficient time to allow an inspection to be made and shall not commence concreting until such approval is obtained. The period between the Contractor’s request for approval and his intention to commence concreting shall be not less than 24 hours.

Such approval shall not absolve the Contractor of his responsibilities under the Contract.
21. **REMOVAL OF FORMWORK**

All formwork shall be struck without jarring the concrete or subjecting the concrete to sudden shock. Before striking any formwork the Contractor shall demonstrate to the Engineer’s Representative that the concrete has attained adequate strength.

Removal of shutter as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Time for Removal (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Vertical sides of beams, columns and slabs</td>
<td></td>
</tr>
<tr>
<td>- Less than 1.2 m high</td>
<td>1</td>
</tr>
<tr>
<td>- More than 1.2 m high</td>
<td>2</td>
</tr>
<tr>
<td>2- Concrete Walls</td>
<td>4</td>
</tr>
<tr>
<td>3- Beam and main slabs removal of props in summer</td>
<td>14</td>
</tr>
<tr>
<td>4- Beams and main slabs removal of props in winter</td>
<td>18</td>
</tr>
</tbody>
</table>

22. **BLINDING CONCRETE**

Prior to placing any structural concrete on natural surfaces, a blinding layer of class C concrete shall be laid to a minimum of 75mm thickness. This blinding layer shall be suitably cured prior to subsequent concrete placement. The blinding shall be clean and free from any dust and impurities prior to subsequent concrete placement.

23. **CONCRETE BELOW GROUND**

All concrete placed below ground level shall be painted with two coats of hot bituminous paint membrane plus one undercoat.

24. **REINFORCED CONCRETE DESIGN**

All reinforced concrete shall be designed to BS 8110 or similar approved by the Engineer.

25. **CEMENT MORTAR AND GROUT**

Mortars and grout shall be composed of Portland cement and sand in the following proportions;

<table>
<thead>
<tr>
<th>Quality</th>
<th>Portland cement</th>
<th>Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>G2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>G3</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

The amount of water added shall be sufficient to make the mortar or grout workable, consistent with its purpose.

26. **READY MIXED CONCRETE**

The use of concrete delivered to the site in a plastic condition ready for placing in its final position shall be permitted provided that the constituent materials and the concrete mix shall comply with the requirements of this specification and subject to the following conditions:

- Water shall only be added to the mix under the control of the central batching plant,
- No further addition of water shall be permitted,
- Dry batching with water added on site shall not be permitted,
- The Contractor shall submit details of his proposed supplier to the Engineer for approval including copies of all specified current materials test certificates plus copies of batching plant and dosing meter calibration certificates,

The Concrete shall be placed in its final position within 1-hour maximum of the time of adding cement to the wetted aggregates.

The contractor shall provide one copy of the delivery ticket number together with a record of the slump test on site, times of placing, completion time of placing, position of placing plus the works test cube reference number. If necessary the site test cubes results should be capable of being compared with the central batching plant cube results.

27. REINFORCEMENT STEEL

The Contractor shall be responsible for the provision of reinforcement steel in sufficient quantity and of the specified steel grade, diameter, length and shape as shown on the drawings. All reinforcing steel shall be high yield deformed reinforcing steel bars with a yield strength of 400 N/mm². Mild steel where otherwise specified shall be either deformed or plain bars to BS 4449. Tying wire shall be No. 16 gauge soft annealed iron wire.

28. REINFORCEMENT STEEL FIXING

Prior to concreting the Contractor shall ensure that all reinforcement bars are entirely free from loose mill scale, loose rust, oil, grease, paint, mould oil, and all other deleterious and extraneous material. All hooks, bends and shape codes for bar bending schedules shall be to BS 1478, or equivalent to be approved by the Engineer. Bars shall be bent to the correct radius around proprietary mandrels of the requisite diameter.

All bars to be fixed shall be so positioned to provide the specified cover of concrete. The steel reinforcement bars shall be fixed with tying wire to form a rigid cage. Reinforcement projecting from the framework for continuation shall be adequately supported throughout concreting and shall not be sent out of position.

The Contractor shall in all cases request the approval of the steel fixing by the Engineer’s Representative in sufficient time to allow an inspection to be made and shall not commence concreting until such approval is obtained. The period between the Contractor’s request for approval and his intention to commence concreting shall be not less than 24 hours. Such approval shall not absolve the contractor of his responsibilities under the Contract.

29. CONCRETE SPACING BLOCKS SHALL BE USED TO ENSURE CORRECT PLACING AND COVER OF THE BARS

1. Concrete spacing blocks shall be used to ensure correct placing and cover of the bars.
2. The cover to reinforcement between the outside of the bars and the concrete face shall be 50mm if concrete face is in contact with soil or sewage. Where concrete face is in contact with air, the cover shall be 25mm. With straw rope covered by hessian cloth and secured in place by binding wire which shall be carried under the flange of the gland.

1. All plain ends shall be adequately protected by straw rope secured in place by binding wire or strap. None of the packing will be returnable. The cost of packing shall be included for in the schedule rates.
2. The materials supplied shall be of the appropriate grade and quality and shall be adequately protected against the climatic conditions in the Middle East. All plastic materials shall be protected from direct sunlight and appropriate coverings supplied for use at the delivery and storage areas.

30 MEASUREMENT AND PAYMENTS

The prices inserted in the B.O.Q for concrete and payment thereof shall be based on net finished specified dimensions of the work and shall include the cost of all testing, mix design, trial mixes, construction and subsequent removal to tip of trial panels, mixing, transporting, placing, compacting, curing, surface finishing, protection, construction of expansion joints, repairs to concrete, formwork and all labor and materials and tests.

CONCRETE STRUCTURES

1. GENERAL

All concrete structures shall be supplied by the Contractor.

2. PRECAST CONCRETE MEMBERS

The Contractor shall cast and install precast concrete beams, slabs and manholes according to details shown on the Drawings. The Contractor shall complete casting of the precast elements in due time, so as to avoid delays to the execution of other Works. The Contractor may either bring to the Site ready-made precast concrete members cast elsewhere or cast them on the Site of Works. In any case casting shall be carried out under the Engineer supervision and the Contractor shall be obliged to obtain the Engineer or his representative approval to the casting methods prior to commencement of Work.

Precast members shall be of concrete class as shown on the Drawings or mentioned in the Specifications and shall pass the required tests.

During casting, concrete shall be well consolidated and vibrated by mechanical vibrators, so as to produce members free of voids or stone pockets.

All precast concrete elements shall conform to the Drawings as to shape and dimensions, all concrete faces shall be straight and leveled, unless otherwise shown on the Drawings. Installation of precast elements on the Site shall be carried out by placing them in position according to details shown on the Drawings. Surfaces resulting from installation of precast elements shall be straight and accurately leveled unless otherwise directed.

Any precast concrete elements damaged during casting or fixing or from any other cause will be rejected by the Engineer or his representative, and the Contractor shall forthwith remove such rejected elements from the Site of Works, and shall provide new elements to replace those rejected, all at the Contractor's expense.

3. EMBEDDED METAL PARTS

Parts of metal Work, such as pipes fixtures for wall brackets, hooks and similar parts are to be embedded in the concrete and shall be attached to the forms in their proper position prior to placing of the concrete. All expense for and in connection with the installation of such metal parts shall be included in the unit prices for the concrete in which they are to be embedded.

4. OPENING AND HOLES IN CONCRETE

Where it is impracticable, as determined by the Engineer or his representative, to install metal parts in the forms as required under subsection 7.2.3.3, suitable holes or recesses shall be formed in the concrete structure into which the metal parts can be placed and grouted in. The shape and dimensions of such holes shall be as shown on the Drawings or as determined by the Engineer or
his representative, and they shall be formed with wooden core boxes, fabricated in such a manner
that they can be completely withdrawn or broken up and removed after the concrete has set. All
such core boxes shall be set with great accuracy with the aid of templates and securely fixed to
prevent displacement during concreting. The supply and installation of all such core boxes and
their removal when the concrete has hardened sufficiently is deemed to be included in unit rates for
concrete.
Where the holes or openings have not been formed in the concrete during placement, the Engineer
or his representative may either order the tearing down and rebuilding of the structure or the part
thereof concerned, or permit such holes or openings being cut in the hardened concrete to the
dimensions shown on the Drawings or as directed by the Engineer or, his representative. Such
cutting shall be kept to the minimum necessary dimensions and shall be done by drilling. Chiseling
or the use of a power tool, all as approved by the Engineer or his representative and in such a
manner as not to cause any damage to the concrete structure.

Reinforcement bars passing through such holes or openings shall not be cut without the express
written permission of the Engineer or his representative.

Where the forming of the opening or holes has been omitted by the Contractor's neglect, all tearing
down and rebuilding or cutting of holes and openings in the hardened concrete as aforesaid shall be
done by the Contractor at his own expense, in all other cases the cost thereof shall be born by the
Employer and shall be paid for as extra Work.

5. BITUMEN COATING OF CONCRETE SURFACES

Bitumen coating of concrete surface where required shall be carried out according to B.S. or Israeli
Standards. When bitumen protection is required to the floor of the structure, it shall be applied to
the lean concrete layer on which the floor shall be cast. In this case the glass mat fabric of the
coating shall be left projecting some 15 cm on every side, and after the floor and wall have been
cast it shall be folded upward and fixed to the wall with hot bitumen, and only then shall coating of
the outer surface of walls, as specified above, be continued.

The corner formed between the layer of lean concrete and the bottom of the wall shall be filled with
bitumen.
Care should be taken to cover properly the vertical edges of the structure by folding over the glass
fabric from one wall to the other and sticking it on with hot bitumen.

6. WATERSTOPS

General

Rubber water stops or PVC water stops shall be provided in the joints in concrete where shown on
the Drawings. If not shown on the drawings the minimum width of the water stop shall be 200mm.

The Contractor shall submit with his Tender a detailed description of the water stop he intends to
use, accompanied by a drawing showing the shape and size of the water stop, the name of the
manufacture, and the methods to be installing and splicing the water stop, which shall be in
accordance with the requirements detailed below.
The Contractor shall also furnish all labor and materials for making field splices in all waterstops. The Contractor shall take suitable precaution to support and protect the waterstops during the progress of the work and shall repair or replace any damaged waterstop.

All waterstops shall be stored in as cool a place as practicable, preferably at 21 °C or less. Waterstops shall not be stored in the open or where they will be exposed to the direct rays of the sun. All waterstops shall be protected form oil or grease.

**Rubber Waterstops**

The rubber waterstop shall be fabricated from a high-grade, tread-type compound. The basic polymer shall be natural rubber or a synthetic rubber. The material shall be compounded and cured to have the following physical characteristics: yield strength 10.2 N/mm², elasticity of 400% at braking strain.

**Installation**

The waterstop shall be installed with approximately one-half of the width of the material embedded in the concrete on each side of the joint. Care shall be exercised in placing and vibrating the concrete about the waterstop to insure complete filling of the concrete forms under and about the waterstop, and to obtain a continuous bond between the concrete and the waterstop at all points around the periphery of the waterstop. In the event the waterstop is installed in the concrete on one side of a joint more than one month prior to the scheduled in date of placing the concrete on the other side of the joint, the exposed waterstop shall be covered or shaded to protect it from the direct rays of the sun during the exposure. Before placing the concrete on the other side of the joint the projecting half of the waterstop shall be carefully cleaned.

The contractor shall take suitable precaution to support and protect the waterstops during of the work and shall replace at this own cost all damaged or deteriorated waterstops.

7. **CONCRETE MANHOLES**

Concrete manholes shall be constructed at the locations shown on the Drawings, and elsewhere as directed by the Engineer or his representative. Their shape and dimensions shall conform to those shown on the typical Drawings and the inner dimensions, if not specified otherwise, will be after plastering or otherwise finished surfaces.

**Construction Of Manholes And Valve Chambers**

All manholes shall have reinforced-concrete bases. The Contractor shall construct all manholes, and special structures including transition chambers and outfall structures as indicated on the Drawings and herein specified.

Manhole cover slabs shall be either precast or cast in place reinforced-concrete as marked on the Drawings. The cast iron frames and covers for manholes shall be brought to grade by the number of courses of concrete blocks shown on the Drawings and a reinforced concrete frame into which the cast iron frame is embedded. Concrete B300 shall be cast to a minimum thickness of 150mm around the concrete blocks for rigidity.

Manhole walls (rings) shall be either precast or cast in place reinforced-concrete. In pre-cast construction rubber o-rings are to be placed in all joints except for the joint between the cast in place roof slab and the top wall ring. In below the manhole cover slab shall have removable plus or minus 30cm high concrete ring.

The inverts shall conform accurately to the size of the adjoining pipe. Side inverts shall be curved and main inverts (where direction changes) shall be laid out in smooth curves of the longest
possible which is tangent, within the manhole to the center lines of adjoining pipelines all as indicated on the drawings and approved by the engineer.

**Cast-In Situ Reinforced Concrete Manhole**

This type consists of a reinforced concrete (B300) base slab cast on firm ground foundations (so as to prevent any differential settlement), reinforced concrete (B300) walls cast on the base at least 24 hours later with the required openings for installation of pipes in one time or more according to the manhole depth, and reinforced concrete roof slab with the appropriate cover. Reinforcement and dimensions shall be as shown on the Drawings. The forms used shall be tight, proper and smooth. Waterstop RX type or equivalent shall be placed when the concrete cast on stages.

**Precast Concrete Manhole**

This type consists of a cast-in situ or precast reinforced concrete (B300) base with the required openings for installation of pipes installed on a firm ground foundations (so as to prevent any differential settlement), precast concrete (B300) rings of 1 m height or as specified on the Drawings of tongue and groove type for the walls fixed on the base and precast reinforced concrete roof slab with the appropriate cover. Reinforcement and dimensions shall be as shown on the Drawings. The forms used shall be tight, proper and smooth.

Joints between the slabs, rings and bases of manholes shall have natural or synthetic rubber ring maintained in place in such manner as to ensure watertight joints during the specified tests and the subsequent life of the installed manholes. The rubber ring shall be highly resistant to deterioration in contact with sewage and shall be seamless and MAGNUFLEX type or equivalent.

**Plastering**

Where shown on the Drawings or otherwise required, internal surfaces (e.g., cast-in situ manholes) shall be lined or plastered with 1 cm thick cement sand mortar in the proportions of 1: 1 1/2 and steel trowel finished.

The inside plastering may be omitted if steel forms are used and the inside surface of the wall is as smooth as the cement plaster finish or otherwise directed by the Engineer or his representative

**Coating**

Coating material of 100% Solid Coal Tar Epoxy or equivalent shall be applied to the internal surface of the walls and the roof of Sewerage manholes as shown on the Drawings or otherwise directed by the Engineer or his representative.

**Deep Manholes**

The upper ring where the depth of manhole is more than 2.0 m or as directed by the Engineer or his representative should be of a cone shape. Concrete encasement for manhole cover shall be constructed according to the Drawings and as directed by the Engineer or his representative. Encasement should be applied where manhole laid in natural ground surface or in the gradient of 1.5% or more in paved area, the manhole neck should be encased as shown on the Drawings with reinforced concrete B300.

**Manhole Cover And Grating**

The contractor shall furnish all cast-iron frames and covers conforming to the details shown on the drawings, or as herein before specified. As described in the general specifications, the contractor shall submit for approval, detailed shop and working drawings of all casting before fabrication.
The castings shall be of good quality, strong, tough, even grained cast iron, smooth, free from scale, lumps, blisters, sand holes, and defects of every nature which would render them unfit for service for which they are intended. All castings shall be thoroughly cleaned and subject to a careful hammer inspection.

Manhole covers shall be circular, made of cast iron with cast iron frames, the dimensions and type conforming to B.S 497 or to I.S 489, as shown on the Drawings or requested by the Engineer or his representative. Manhole frames shall be set firmly in cement mortar so that the covers are 1 cm below the final surface. All manhole covers shall be non-ventilated and none rocking. After completion of the Work, cast iron parts of the covers and the frames shall be painted with bitumen paint. Grease shall be placed between the frame and the cover. All water manholes covers shall have the word (WATER) in Arabic and English. Cast iron grating with frame shall be supplied and or manufactured in accordance with details shown on the Drawings and in accordance with the instructions of the Engineer or his representative. Frame shall be embedded in the concrete of the roof of storm water inlet and Catch basin and depressed 3cm below the final surface. After completion of the Works, cast iron parts of the gratings and frames shall be painted with bitumen paint.

**Manholes Steps**

Cast iron steps or steel rungs, complying with B.S. 1247 shall be installed by the contractor at manholes up to the depth of 5.0 meters. Ladders shall be installed at all manholes with depths exceeding 5.0 meters. All step irons and ladders shall be coated with glass fabric as shown on the drawings or as directed by the engineer.

### 8. INTERLOCK BLOCK PAVERS

**General**

The work shall consist of the construction of Interlock Block Pavers in accordance with Specifications, Drawings and the Engineer or his representative Instructions. Precast Interlock Block Pavers shall be formed by homogeneous elements 6 cm thickness to be used in sidewalk and 8 cm thickness to be used in drive way.

The maximum dimension deviations from the stated work sizes for Interlock Block Pavers as follows:

- **Length**+ 2mm.
- **Width** + 2mm.
- **Thickness** + 3 mm.

The finished product shall be of solid appearance with clean face, be free of segregation, honeycombing and no evidence of internal rendering.

**Material**

Material shall be conform to the requirements specified in BS 6717 as specified herein.

The aggregate shall conform to the appropriate British Standard. In composite paving blocks, the surface layer shall be formed as an integral part of block and shall not be less than 5 mm thick. Retarding, color and any admixtures shall not have adverse effect on properties of Interlock Block Pavers.

Interlock Block Pavers shall be made using one or more of binders conforming to the appropriate British standards.

The Contractor shall submit samples of various types of Interlock Block Paver for approval of color and shape by the Engineer or his representative prior to commencing the Work.

**Compressive Strength Test**
Test shall be carried out on Interlock Block Pavers according to BS 6717 to ascertain the strength. Before laying -Interlock Block Pavers, 16 samples collected, each 2 sample shall represent 5000 blocks. All samples stored for $(24 \pm 4)$ h in water maintained at temperature of $(20 \pm 5)$ °C. The average compressive strength of 16 samples shall be not less than 490 kg/cm² and crushing strength of any individual block shall not be less than 400 kg/cm².

**Abrasion Test**
Test shall be carried out to a certain surface requirement using Bohme machine according to DIN 52108 with natural abrasion material or artificial corundum. The average Abrasion of 16 samples shall not exceed 5 mm and not exceed 6mm for each individual sample after 440 revolution of abrasion machine.

**Absorption Test**
Absorption should not be more than 8% by weight of each sample.

**Construction**
Interlock Block Pavers shall be set on to locations and grades shown on the Drawings and shall be laid directly on a granular material. Granular material shall be placed on the top of a crushed aggregate base course layer to adjust the final level of the Interlock Bloc Pavers and to fill the joints between the Blocks.
All Interlock Block Pavers shall be thoroughly cleaned of all extraneous material prior to approval. All Interlock Block Pavers shall be laid within a tolerance of plus or minus three (3) mm, at, each end of an element, to the lines and grades given on the Drawings. All Interlock Block Pavers shall be compacted by a compactor plate to the satisfaction of the Engineer or his representative.

**BLOCK WORKS**

1. **SCOPE**
These specifications cover the supply of materials manufacture and workmanship of concrete blocks intended to be used for the construction of block wall, partitions, facings, etc., required for the project in accordance with the Drawings, Bills of Quantities and as directed in writing by Engineer.

2. **MATERIALS**

**Cement**
Cement for solid or hollow blocks and mortar shall be Ordinary Portland Cement ASTM Designation C 150-74 and white cement ASTM: C 91-71.

**Aggregates**
Aggregate for solid and hollow concrete blocks and mortar shall conform to the requirements for fine aggregates in the “Concrete Work” Section.

**Water**
Water to be used in block work shall conform to the requirements specified for water in the “Concrete Work” Section.

**Lime**
Lime shall be non-hydraulic lime compiling in all respects with B.S. 890, and shall be prepared in accordance with the appropriate requirements of British Standard Code of Practice 121: Part 1: 1973, latest revision. The contractor must satisfy himself by analysis or otherwise that the ground lime is not adulterated or air-slaked. Factory-produced, dry, hydrated, non-hydraulic or semi-hydraulic lime ready for use, shall be mixed with sand and made into coarse mix or be soaked to putty by mixing with water and allowing to stand not less than (16) sixteen hours before use.
The lump or ground non-hydraulic or quick-lime shall be slaked, run to putty and matured for not less than two (2) weeks.

3. MANUFACTURE OF CONCRETE BLOCKS

Aggregate shall be so sized, graded, proportioned and thoroughly mixed in a batch mixer with such proportions of cement and water as to produce homogeneous concrete mixture. However, in no case shall the proportion of cement in the mixture be less than five (5) standard bags (each weighing 50 kgs) per cubic meter of concrete.

Precast concrete blocks shall be manufactured in approved vibrated machines. If for any reason the strength requirements is not achieved, the cement shall be increased at the contractor’s own expense. The water used in the mix shall be clean and of a sufficient quantity to allow complete hydration of the cement without providing an excess when molding.

Concrete blocks shall be hard, sound, durable, sharp, rectangular shape, clean with well define arises free from racks and flaws or other defects. Concrete blocks shall be either obtained from an approved local factory or manufactured on the site. If manufactured on site, the blocks shall be press molded in approved molds and vibrating press wire machines with a minimum of 2800 cycles per minute.

Blocks manufactured on the site shall be cured in the shade by being kept thoroughly moist with water applied by sprinklers or other approved means for a period of at least seven (7) days. The blocks shall be stocked on a clean and level platform free from earth or other impurities during the curing process, and shall be stocked in honey-comb fashion after curing. The blocks shall not be used prior to one (1) month after the date of manufacture.

Concrete blocks (solid or hollow) shall be of the following dimensions: -

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>200 mm + 1 % Tolerance</td>
</tr>
<tr>
<td>Length</td>
<td>400 mm + 1 % Tolerance</td>
</tr>
<tr>
<td>Width</td>
<td>As required + 1 % Tolerance</td>
</tr>
</tbody>
</table>

The nominal width of blocks shall be as indicated on the Drawings and as directed by the Engineer.

Hollow concrete blocks shall be as indicated on the following requirements: -

Compressive Strength at Twenty Eight (28) Days Over Cross-Sectional Area: -

a) Load-Bearing Walls
   - 60 kgs/cm² average of 12 blocks
   - 50 kgs/cm² minimum for any block

b) Non-Load-Bearing Walls
   - 30 kgs/cm² average of 12 blocks
   - 25 kgs/cm² minimum for any block

Water Absorption
- 20% or less of dry weight

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 nowhere less than 40mm. 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.
4. MORTAR
Mortar shall be prepared in the following proportions with the addition of the minimum quantity of clean water for workability:

Cement and sand mortar (1:3) mix, shall be composed of one part cement to three parts of sand by volume.

Hydrated lime up to 1/4 (one quarter) by volume of the dry cement may be added for bedding blocks, upon the approval of the Engineer, to improve workability without appreciably reducing the strength.

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

In the cast of cement-lime mortar, the sand and lime shall be mixed first and the cement added. It shall be assumed that the lime has not increased the bulk of the sand.

Cement mortars shall be used within thirty (30) minutes after mixing. Hardened mortars shall not be used in the work and shall, upon the request of the Engineer, be immediately removed from the site.

5. WORKMANSHIP
All block work shall be set out and built to the respective dimensions, thickness and heights shown on the Drawings and/or instructed in writing by The Engineer.

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 in writing by The Engineer.

The blocks shall be well buttered with mortar before being laid and all joints shall be in uniform manner and shall not exceed soaked before being used and the tops of wall left off shall be wetted before work is recommenced. All blocks shall, no one portion being raised more than 1.00 m above another at one time, and wall of partition necessarily left at different levels, must be racked back. All perpends, quoins, internal and external angles, etc. properly bonded together and leveled round. All block work shall be plumbed vertically.

The surface of the walls and partitions prepared for plastering, shall have the joints raked out 10 mm into the face of the wall to form key for the plaster.

All block walls shall be bonded to reinforced concrete columns by means of wall ties, complying in all respects with B.S. 1243 latest edition. The ties shall be minimum 200 mm long of which 100 mm shall be embedded in the reinforced concrete column and the remainder set into the block wall at the rate of two (2) ties per meter. Partitions shall be bonded to main wall by toothing at every fourth course into main wall to a depth of not less than 100 mm.

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 course.

Walls and partitions terminating against soffits of beams or slabs shall be lightly wedged with metal wedges after mortar in bed joints has attained its initial set, and the joint packed with mortar.

Cut and fit block work next to reinforced concrete door, window, jambs and sills, and form chases for the ends of the door and window lintels. No hollow blocks shall abut any built-in fixtures e.g. door and window frames, apertures, louvers, etc.
The cavity between skins of block work shall be 100 mm (nominal) wide and kept clear throughout the construction of the hollow walls. The skins of hollow walls are to be tied together with butterfly twist type galvanized steel wire to the approval of The Engineer and built into each skin one meter apart horizontally and every alternate coarse, staggered.

FLOOR, WALL, AND CEILING FINISHES

1. GENERAL
This section of the specifications covers plaster works and other floor, wall and ceiling finishes intended for the works all in accordance with the drawings, bill of quantities, and as directed by Engineer.

The Contractor shall attend upon other trades and protect all work specified under this section from damage during subsequent operations, make good any defects, clean away debris upon completion and throughout leave all work in perfect condition to Engineer’s satisfaction.

Damaged or defective materials shall not be used in the works.

Any defective materials or materials damaged during or after installation shall be removed and replaced at the Contractor’s expense.

All materials shall be of approved makes, and samples shall be submitted for Engineer’s approval. These materials shall include but not be limited to all kinds of cements, sand, additives, metal lath, galvanized plaster beads, precast terrazzo tiles, ceramic tiles, and aluminum profiles.

2. PLASTERWORK

Mixing of Ingredients
Except where hand-mixing of small batches is approved by the Engineer, mechanical mixers of an approved type shall be used for the mixing of plaster.

Frozen, caked or lumped materials shall not be used. Mechanical mixers, mixing boxes and tools shall be cleaned after the mixing of each batch and kept free of plaster from previous mixes. Plaster shall be thoroughly mixed with the proper amount of water until uniform in colour and consistency. Retempering will not be permitted and all plaster which has begun to stiffen shall be discarded.

All plastering shall be executed in a neat workmanlike manner and internal and external angles shall be true, straight and plumb. Plaster shall be made good adjacent to wood or metal frames, skirtings and around pipes or other fittings.

All tools, implements, vessels and surfaces shall at all times be kept scrupulously clean and strict precautions shall be taken to avoid the plaster or other materials becoming contaminated by pieces of partially set material which would tend to retard or accelerate the setting time.

Preparation of Surfaces
All surfaces to be plastered shall be clean and free from dust, grease, loose or projecting mortar and all traces of salts are to be thoroughly sprayed with water, but all free water shall be allowed to dry and disappear from the surface before the plaster is applied.

Plastering shall not be commenced until the background has been suitably prepared. Block work joints shall be deeply raked out, efflorescence brushed off and all dust and foreign matter removed.
Before plastering is commenced all junctions between differing materials shall be reinforced. This shall apply where walls join columns and beams, particularly where flush, and similar situations where cracks are likely to develop and as directed by the Engineer. The reinforcement shall consist of strip of galvanized wire mesh (10 to 15mm hexagonal mesh) 15cm wide which shall be plugged, nailed or stapled as required at intervals of not exceeding 45cm at both edges. On all external surfaces and on all smooth internal surfaces spatter dash of cement and sand which shall contain 500 kgs of cement per one meter cube of sand shall be applied and allowed to dry before rendering is commenced. All surfaces of walls shall be wetted immediately prior to applying the first coat of rendering and this shall be allowed to thoroughly dry out before the next coat is applied.

The Contractor shall form vertical guide screeds 5cm wide.

The spacing shall not exceed 1.50 meters.

The screeds shall be plumb and in the same plane with each other. The sides of the screed shall be left rough to bond with plaster, the surface shall be smooth.

The finished surface shall be true and shape and angle even in all directions, with straight arises free of cracks and trowel marks and to the entire satisfaction of the Engineer.

Application of Coats

Base-Coat (Rendering)

After the application of the spatterdash "Rasheh" the base coat shall be applied after the spatterdash coat has set but in no case earlier than 24 hours after the application of the spatterdash coat.

When applied to masonry or to concrete surfaces the base coat shall be applied with sufficient force to prevent air pockets and to secure a good bond.

The base coat shall be lightly scratched in both directions to provide a key for the finishing coat and shall be kept moist with a fog spray for 2 days and then allowed to dry out.

Finishing Coat

Shall not be applied until the rendering or base coat has seasoned for seven days, just before the application of the finish coat, the rendering or base coat shall be wetted evenly with a fog spray. Where cement plaster with a smooth troweled finish is specified or indicated on the Drawings, the finish coat shall be first floated to a true even surface, then troweled in a manner that will force the sand particles down into the plaster and with the final troweling, leave the surface finished smooth and free from, rough areas, trowel marks, checks or other blemishes.

Cement plaster in all other spaces, where a smooth finish is not specified or noted on the Drawings, shall be given a sand float finish or a uniform texture, as approved by the Engineer. The finish coat shall be kept moist with a fog spray for at least two days, and thereafter shall be protected against rapid drying until properly and thoroughly cured. Plaster shall be made good up to frames and skirtings and around fittings and pipes. Angles shall be rounded to a 6mm radius.

Proportions for Internal and External Plaster

Internal and external plaster shall be composed of 400kg of cement per one cubic meter of salt free sand.

Plastering shall be applied in two (2) coats unless otherwise specified or indicated on the Drawings.

Finishing coat shall have a reasonably uniform thickness of approximately 5mm.

Screeds shall be laid and ruled as necessary to allow for a total thickness of 15mm for external and internal plaster and the rendering shall be applied to the required thickness.
The metal grid system shall be a patent system suitable for use with in-situ plaster and expanded metal lathing and shall have flat metal hangers to suit suspended ceilings depths as shown on the Drawings and described in the Bill of Quantities. The system shall include all main and cross runners, necessary splicers, hangers, clips and wall mounting next to walls. The system shall be installed complete in accordance with the manufacturer's instructions.

The metal grid suspension system shall be concealed and shall allow for the whole of the ceiling to be demountable.

All concealed ferrous metal members such as channel runners, Z-bars, clips and splines shall have an approved corrosive-resistant finish.

**Metal Lath**
At all junctions of dissimilar materials (i.e. concrete and block work or steel elements) the joint shall be covered by metal lath strips not less than 200mm in width securely fixed to the surface.

**Tyrolean Plaster (Fine Grain)**

**General**

The Tyrolean plaster shall be executed to the extent shown on the Drawings and as directed by the Engineer.

The contractor shall provide sample(s) of Tyrolean plaster for the approval of the Engineer prior to commencement of Tyrolean work.

**Mixing**

Cement and aggregate for each batch shall be accurately measured and mixed dry until evenly distributed and the mass is uniform in colour. All batches shall be of such size that they can be entirely used within half an hour. Mechanical mixers of an approved type shall be used for mixing Tyrolean plaster, except when hand mixing of small batches is specifically approved by the Engineer. Mechanical mixers, mixing boxes and tools shall be cleaned after mixing each batch and kept free of Tyrolean mortar from previous mixes. Water content shall be maintained at a minimum. Mixing shall be continued until plasticity is obtained.

**Proportions**

Proportions of materials for Tyrolean, by volume shall be as follows:

1. **Scratch Coat**
   
   1 part Ordinary Portland Cement  
   3 parts fine aggregate

2. **Finish Coat**

   1 part of white Portland cement  
   3 parts fine selected aggregate

No lime shall be allowed in either scratch or finishing coat, scratch coat shall be set on spatterdash.

**Application of Tyrolean**

1. Workmanship:
Surface to receive Tyrolean shall be clean, free from dust, dirt, oil, or other particles that might interfere with a satisfactory bond. Surface to receive Tyrolean shall be evenly dampened (not soaked) with a fog spray before Tyrolean is applied. If surfaces become dry in spots, the dry areas shall be dampened again to restore uniform section. Tyrolean coats shall be applied continuously in one general direction without allowing mortar to dry at edges. Edges to be jointed shall be dampened slightly to produce a smooth confluence. Tyrolean unless otherwise shown or specified shall be two coats work not less than 20mm. thick (i.e. spatterdash, cratch coat and one Tyrolean coat).

All exterior corners of Tyrolean shall be slightly rounded. Tyrolean on soft surfaces shall be pitched forward to form a drip

2. Scratch Coat:

Shall be approximately 14mm. thick and shall be applied under sufficient pressure to form goods keys and shall be brought to a plumb, true even surface. The scratch coat shall be damp-cured 48 hours before the finish coat is applied.

3. Finish Coat:

Shall be approximately 6mm. thick. Surface of the scratch coat shall be dampened several hours before the finish coat is to be applied. Additional dampening at time of application shall be by fogspraying. Dampening by brush will not be permitted. When measured with a 2 meter long, straight edge applied in all directions, the finish surface shall not vary from a true plane by more than 1.5mm. The finishing coat shall be applied by means of a proper spraying machine and the degree of the finishing coat shall be determined by the Engineer. The Contractor shall set up samples of different degrees of fineness for the Engineer's approval. The Engineer may choose different degrees of fineness for different parts of the works and the Contractor shall allow for this in his rates.

4. Curing:

As soon as the finish coat has taken its initial set, the tyrolean shall be protected against direct rays of the sun or rapid drying for at least 10 days. During this time tyrolean shall be kept moist by frequent fog, spraying. Care shall be taken to prevent staining of the tyrolean.

5. Acceptance and Repairing:

Tyrolean with cracks, blisters, pits, checks or discoloration will not be accepted. Tyrolean shall be clean and sound and in accordance with the requirements of the Specifications. After all other related work has been completed, pointing around trim and set work and repairing of damaged portions shall be performed to the satisfaction of the Engineer. Repairs shall match existing tyrolean in texture and colour to the satisfaction of the Engineer.

3. TERRAZZO TILING

Materials

Precast terrazzo units shall be formed with A 1:2.5 mix of white or tinted cement and granular marble chipping for the topping (wearing layer) set on a cement and sand backing of 1:3 mix, and shall be obtained from an approved manufacturer and shall be in accordance with the requirements of BS 4131 or 4357.

These units (tiles) shall be cast in heavy steel molds under pressure to form the dimensions and patterns as stated in the bill, grinding shall be done wet by means of a no. 80 carborundum stone.
Filling shall be carried out with a neat cement grout of the same color as the facing mix in order to fill all voids & air holes. 24 hours later, wet polishing by means of a no. 140 carborundum stone shall be carried out, and all units cured by immersion in clean water for 24 hours. Samples shall be subject to Engineer’s approval prior to work.

**Installation**
Terrazzo units shall be laid on a bed of sand with a 1:3 mix of cement and sand mortar with a lime admixture.

Grouting shall be done neatly using a matching color or cement, and all tiling, surrounding surfaces, and surplus cement shall be cleaned off carefully.

Upon completion all terrazzo surfaces shall be wet polished using a no. 140 carborundum stone.

All units shall be well shaped with straight edges perfectly flat and free from defects, which effect appearance and serviceability.

Chipped units or units with cracks or defects will not be accepted and shall be replaced at the Contractor’s expense and to the satisfaction of Engineer.

4. **CERAMIC AND WALL TILING**

**Materials**
Ceramic floor tiles shall be first quality Spanish Type 20x20cm vitreous clay non-slip tiles with keyed backs, and a minimum thickness of 8mm or of the sizes indicated on the drawings. Samples of tiles shall be submitted to Engineer for approval of quality and color prior to order. For walls tiles shall be first quality Spanish type 20x20cm and a minimum thickness of 6mm. Glazed samples shall be submitted to the Engineer for approval.

**Installation**
Ceramic floor tiles shall be soaked and bedded in cement and sand mortar (1:3 mix) with addition of an approved plasticizer.

Tiling shall be carried out to the levels indicated on the drawings in a first class workmanship.

All joints shall be as close as possible and shall in no case exceed 0.5 mm in width on face. Tiles shall be neatly cut and fitted around pipes and other obstructions.

The surface of the floor and wall shall be very gently rubbed with a wood block to bring the tile surface to true planes. Excess slurry shall be removed, and the floor shall be rubbed with burlap to clean the tiles and finish the joints to the satisfaction of Engineer.

5. **MARBLE FLOOR TILING**
Marble slabs for flooring, skirtings and the like shall be first quality local marble obtained from an approved supplier.

The marble slabs shall be of the dimensions and thickness shown on the drawings and in the Bills of Quantities and shall be uniform in colour and texture, smooth and free from voids, earth veins, lamination and the like, and shall be of an approved colour and to the pattern and sizes shown on the drawings.

Samples of marble slabs shall be submitted to the Engineer for approval prior to order. Marble slabs shall be cut square, true and shall be uniform in shape in thickness. Mortises shall be carefully cut without causing any damage to marble, and rebates shall be carefully formed by special machines to the width and depth required to the satisfaction of the Engineer.

Marble slabs for floor finish and marble treads shall be laid on a bed of sand with cement and
sand mortar (1:3) mix.

All marble slabs shall be backed with stain proofing in accordance with the manufacturer's instructions.

Marble skirttings and rises shall be bedded with same mix as for floor marble but without the bed of sand.

All joints shall be thoroughly grouted with unstained cement and cleaned well before it sets hard.

All exposed faces and edges of marble shall be polished, smooth, free from scratches or other defects and properly protected from damage by means of timber casings. All workmanship shall be of the best of its kind and shall be carried out in a manner satisfactory to the Engineer.

**Marble Thresholds And Window Sills**

Unless otherwise shown on the drawings or stated in the Bills of Quantities, marble thresholds and window sills shall be first quality local marble obtained from an approved manufacturer. Thresholds and window sills shall be of the thickness and widths shown, of one piece and full length of the opening, leveled on both sides with hone finish on all exposed surface. Ends of thresholds shall be fitted accurately to jambs.

**Protection And Cleaning Marble**

Great care shall be taken to protect delivered and erected marble from chipping and staining during the course of the work. Delivered marble shall be stored in a water free area on raised platforms and shall be covered with tarpaulins or similar material until required for use.

Erected work shall be protected at corners, etc., with non-staining wood formwork, boards, etc. Floors shall be protected with suitable boarding, etc., after laying. Any work damaged or stained at the time of handing over shall be replaced or cleaned as required by the Engineer.

After completion of setting, all marble work shall be thoroughly cleaned by scrubbing with fibber brushes and mild alkaline solution that contains no caustic or harsh fillers. The use of wire brush or acid solution will not be permitted. Cleaning shall begin at the top of the building and proceed downwards. Upon completion all marble shall be left clean and free from stains or traces of cleaning fluid and with all joints pointed and to the entire satisfaction of the Engineer.

**Floor Dressing**

The granular abrasive powder shall be troweled into the finishing surfaces of the screed applied as desired hereinabove; working out of the dressing shall strictly conform to the method of application recommended by the manufacturer of material.

Marble Works shall be of the following specifications:

- Local marble (Yatta) 3cm thick will be used for doors entrances WCs, main entrances, staircases and roof parapets and Window sills.

**METALWORK**

1. **SCOPE**

These specifications cover ferrous and non-ferrous works intended to be used in the Project all in accordance with the Drawings and as directed by the Engineer.

2. **MATERIALS**
Steel
Steel plates, and structural steel shaped sections shall conform to the requirements of B.S. 4 latest edition for structural sections, Part 1 Hot-rolled sections and Part 2 Hot-rolled hollow sections (Metric Series).

Bolts, Nuts and Washers
Bolts and nuts shall conform to the requirements of B.S. 4190: I.S.O. metric black hexagon bolts, screws and nuts. Plain washers shall be made of steel. Taper or other specially shaped washers shall be made of steel or malleable cast iron and shall conform to the requirements of B.S. 4320. Metal washers for general engineering purposes.

Galvanized Steel Pipes
Galvanized steel pipes shall conform to the requirements of B.S. 1287 - I.S.O. "Medium Series".

Paint
Paint for Metalworker shall comply with the applicable requirements as specified under "PAINTING".

Aluminum
All aluminum elements shall be manufactured of extruded sections of aluminum alloy, mechanically jointed. Fittings shall be aluminum alloy in accordance with B.S. 1331 the latest edition.

All parts and members shall be of aluminum commercial quality like (Al-Mg-Si) heat-treated, free from defects impairing its strength and durability and containing not more than 0.4% copper. All exposed surfaces shall be polished to a mirror-like surface, free from defects, and shall be as shown on Drawings and as directed in writing by the Engineer. Aluminum shall be treated to comply with B.S. 1615 and B.S. 3987. All aluminum sections shall present clear straight and sharply defined lines and shall be free from defects and imperfections that may impair their strength.

All screws, bolts and other necessary accessories shall be of aluminum or other non-corrodible material and shall match in colour and consistency the finish of the approved aluminum.

Aluminum elastic glazing beads shall be provided to all windows and doors which are assembled by pressure to fit with the relevant groove in the profile.

The glazing bars shall be threaded or interlaced at points of intersections and machine tenonned to frame.

Stainless Steel
Stainless steel sections, sheets and strips shall be of authentic non-magnetic steels, 18/10/3 chromium nickel-molybdenum group as explained in publication PD 6290 New designation system for stainless steel issued by the British Standard Institution.

3. MANUFACTURE

General
The Contractor shall be responsible for the correctness and accuracy of the dimensions of the finished articles.

He shall therefore carefully check the dimensions indicated on the Drawings, verify any change ascertain the sizes at Site which will enable him to prepare Final working Drawings for fabrication
and erection purpose. Such Drawings shall be submitted to the Engineer for his verification and approval.

Fabrication orders can only be placed after the Contractor has obtained in writing the approval of the Engineer on the above Drawings.

The steel sections where specified to be factory rust-proof shall be rust-proofed by hot dip galvanized, metalizing or sheradizing process. The rust-proofed shall be sufficient to withstand the 72 hours salt-spray test as provided for in B.S. 1391. If the rustproof coating shall be damaged during the progress of work, the damaged part shall be recoated to minimum the original thickness to the satisfaction of the Engineer.

Flush Steel Door and Frame
Flush steel door shall be fabricated of hot-rolled steel sections for framed skeleton with diagonal bracings and lined both faces with sheet steel of thickness as shown on Drawings or stated in the Bills of Quantities, riveted to framed skeleton as shown on the Drawings. The frame shall be made of hot-rolled steel sections and shall be provided with No.8 anchors, one end welded to frame and other end dovetailed.

Hollow Metal Door Frames
Hollow metal door frames shall be purpose made to the profiles and sizes shown on the drawings and obtained from an approved manufacturer. The door frames shall be from 2.5mm thick, twice laminated steel sections and be delivered to site complete with a factory applied anti-corrosive plastic coating, ties cast on to backs of frames for building in and rubber silencers on the locking stile.

The frames shall be stored in a clean, dry place, off the ground and protected from the weather.

The frames shall be free of all dents, bumps, splits, and cracks and any defective frames shall be made good or replaced at the Contractor's own expense.

Aluminum Windows, Doors
The aluminum windows and doors etc. with all necessary accessories and fittings shall be of the pattern, design, dimensions and thickness shown on the Drawings and obtained from an approved manufacturer.

Prints of shop Drawings for aluminum windows, doors, frames etc. showing the dimensions, sizes, thickness, materials, finishes, joining, attachments, fasteners and the relation of this section to adjoining work, shall be submitted to the Engineer for approval before ordering any material. All work shall be fabricated and erected in accordance with the approved Drawings.

All aluminum windows, doors, frames, etc. shall be factory assembled and reinforced to the Drawings, complete with hinges, glazing gaskets and anchors. The only Site work allowed on Aluminum units is fixing in position and glazing. The finished surfaces shall present a clear surface free from alloy defects, scratches, or other surface blemishes.

4. WORKMANSHIP

Steel Elements
All steel parts shall be accurately set out, cut, framed, assembled and executed using proper bolts or welding electrodes. All cut parts shall be sawn cut, no oxygen burning shall be permitted except for pipe supports. All welding shall be electrical welding, clean and of proper workmanship. All cut parts and welded sections shall be ground, even and filed smooth with rounded edges.
All steel members in contact with the soil shall be painted with two (2) coats of protective asphalt paint. All doors frames staircases, etc. shall be given at least one (1) coat of approved rust inhibiting primer before delivery to Site.

Frames for doors and windows shall be provided with not less than (3) adjustable type anchors on each jamb, maximum distance between anchors shall be eight hundred (800) mm.

All joints shall be machined to a close fit and all pins and screws shall be countersunk and dressed flush after assembly.

Forging shall be sharp and true curbs and intersections, members of the same size shall be halved together.

The plain surfaces shall be smooth, free from wrap or buckle. Moulded members and mitres shall be clean, cut, straight and true. Construction joints shall be welded their full length and cleaned off flush on exposed surfaces.

All work shall be erected plumb and true to lines and rigidly secured to walls, floors or ceilings as shown on Drawings and to the satisfaction of the Engineer.

Hardware for steel doors, etc. shall be as specified in the B.O.Q.

**Aluminum Windows and Doors**

The Contractor shall furnish and install all aluminum units as indicated on the Drawings. Workmanship and installation shall be in accordance with recommended standard of First Class Aluminum Manufacturers.

All aluminum work shall be performed in a shop where grade of metalwork is of recognized quality acceptable to the Engineer. All items shall be installed plumb, straight, square, level and in proper elevation, plane location and alignment with other work. All work shall be designed for adjustment to field variations, fitted with proper joints and intersections, adequately anchored in place, strictly in accordance with best practice. Where aluminum surfaces come in contact with metals other than stainless steel, zinc, white bronze or small areas of other metals compatible with aluminum surfaces they shall be kept from direct contact with such parts by painting the dissimilar metal with a prime coat of zinc-chromate primer or other suitable primer, followed by one or two coats of aluminum metal-and-masonry paint or other suitable protective coating, excluding those containing lead pigments or a non-absorptive tape or gasket shall be placed between aluminum and dissimilar metals. Steel anchors and connecting members shall be hot dip galvanized or zinc plated after fabrication.

Aluminum surfaces in contact with lime mortar, concrete, plaster or other masonry materials, shall be painted with alkaline-resistant coating such as heavy-bodied bituminous paint or waterwhite methacrylate lacquer.

Aluminum in contact with wood or absorptive materials which may become repeatedly wet shall be painted with two coats of aluminum metal-and-masonry paint or a coat of heavy-bodies bituminous paint. Alternately paint the wood or other absorptive material with two coats of aluminum house paint and seal joints with a good quality of caulking compound.

Where aluminum is in contact with treated wood, wood shall be treated with pentachlorophenol, 5% minimum concentration or approved equal, followed with the protective measures described for aluminum in contact with wood or other absorptive materials.
The aluminum work shall be designed and anchored to that the work will not be distorted nor the fasteners overstressed form the expansion and contraction of the metal.

Before shipment from the factory, aluminum surfaces requiring protection shall be given a coating which will protect the metal during construction in areas where appearance of the finish on Aluminum items is important, a coating of methacrylate type lacquer shall be applied as specified hereinafter.

Apply two sprayed coats of water-white methacrylate lacquer having a total minimum thickness of 0.015 mm, which when applied to the aluminum surface shall be capable of withstanding the action of lime mortar for a period of at least one week in an atmosphere of 100% relative humidity at 40°C, the action of 10% (by weight) muriatic acid for a period of six hours at 20°C, and the action of atmospheric weathering for a period of 12 months. The coating shall be applied in the manufacturer's plant to the exposed surfaces of all aluminum components subject to staining from alkaline mortar and plaster, abrasion and other construction abuses. Before application of lacquer, the manufacturers shall remove all fabrication compounds, moisture, dirt accumulations and other foreign materials to ensure proper lacquer adhesion.

Upon completion, the Contractor shall clean all aluminum work as required by removing protective tape or other coating, using mild soap or detergents and clear petroleum spirits.

Acids, caustics and abrasives shall not be used. Where cleaners are used to remove excess sealings compounds care shall be exercised to prevent damage to seals or staining or damage to adjacent work.

The Contractor shall be responsible for the protection of all aluminum work until the completion of the works, and only units in perfect working order and in perfect conditions shall be accepted.

**Hollow Metal Door Frames**

Hollow metal door frames shall be fixed and shown on the drawings all in accordance with the manufacturer's printed instructions and flushed up solid with plain concrete or cement mortar.

The rates for hollow metal door frames are to include for the supply and assembly of the complete unit including all necessary holes for hinges and lock, cutting of torsion threshold bar if necessary and fixing in walls in accordance with the manufacturer's printed instructions and plain concrete or mortar filling as shown on the drawings.

5. **VENTILATION LOUVERS**

Steel ventilation louvers, shall be made to the sizes, dimensions and designs shown on the drawings and fixed to concrete as indicated on the Drawings. Shop drawings shall be prepared to detail fixing and samples shall be submitted to the Engineer for approval before ordering the materials.

6. **IRON STEPS**

The Contractor shall supply and fix galvanized malleable steel iron steps of general purpose pattern conforming with B.S. 1247, and having a 117mm tail. They shall be built into walls truly level and in vertical lines as shown on the Drawings or directed by the Engineer.

7. **LADDERS**

Steel ladders shall consist of galvanized mild steel coated with fiberglass or as specified in the B.O.Q and supplied complete with suitable bottom and top brackets and intermediate support brackets at centers not exceeding 20cm.
8. STEEL HANDRAILING AND BALUSTRADES

Unless otherwise specified hand railing and balustrades shall consist of handrails and standards of galvanized mild steel. Handrails shall be flush jointed with an internal screwed nipple joint. Removable hand railing shall be half lap jointed.

Handrails shall be not less than 45mm outside diameter and to rails shall be set not less than 1.05m above adjacent floor or platform level, unless shown otherwise on the Drawings.

Standards shall be tubular and not less than 45mm outside diameter and shall be of the double ball type with balls at approximately equal spacing above adjacent floor or platform level.

Base plates shall wherever possible be horizontal and circular. Horizontal and side palm plates shall be secured by not less than three bolts of not less than 12mm diameter and 75mm length. Handrailing, base and palm plates shall be I painted after erection. Painting shall be deemed to be included in the Contract rates for handrailing.

9. GALVANIZED STEEL COVERS

Galvanized steel covers shall be galvanized mild steel with raised threads of Durbar pattern or similar approved by the Engineer. The plate shall be sufficient thickness to support. A distributed load of 5KN/square meter or shall be as detailed on the Drawings.

The covers shall be supported on galvanized mild steel frames. The frames shall have mitered and welded corners, with welded fishtail anchors at not greater than 1m centers, all galvanized after fabrications.

Galvanized mild steel lifting handles shall be welded onto the covers where shown on the Drawings. Locking devices to manhole covers shall be of galvanized mild steel and as shown on the Drawings. Galvanizing to all covers shall be carried out after all welding and fabrication is complete.

10. PERMANENT FENCING

Permanent fencing if requested shall be installed over the boundary wall and shall be 0.5m overall height consisting of 4 strands of barbed wire. All steel parts shall be galvanized. The fencing should be supplied complete with the fixing supports which must be galvanized steel pipes, 2” diameter.

11. MONORAIL HOIST

Monorail hoist shall be furnished and installed to the dimensions shown on the drawings. "I" beam shall be used, in accordance to BS 449:Part 2 1969 (Specifications for the use of structural street in building. Part 2: Metric Units).

12. MEASUREMENT OF STEELWORK AND METALWORK

Unless otherwise specified, the cost of preparation for and application of protective systems and paint to steelwork and metalwork shall be included in the Contract Rates for the various items of steelwork and metalwork.

The forming of all necessary holes and recesses in concrete work to receive steelwork and metalwork shall be deemed to be included in the Contract Rates for the relevant steelwork and metalwork.
The Contract Rates for structural steelwork shall include for designing, detailing, supply, preparation, painting and erection of structural steelwork complete all as specified. Structural steelwork will be measured by weight and for this purpose the weight will be calculated from the length of each section required when fixed in the permanent structure and the weight per unit length of that section as listed in British Standards or if not so listed then as given in the steel manufacturer's tables. No allowance will be made for any rolling margin and no measurement will be made of any nuts, bolts, paint, welding materials or the like, but no deduction will be made in respect of any bolt hole.

The Contract Rates for miscellaneous metalwork shall include for supply, preparation and painting or galvanizing, fixing and building in complete with all necessary fixings, nuts and washers. Miscellaneous metalwork including iron steps, galvanized steel cover metalwork, ladders and others will be measured as supplied and fixed as specified. Contract Rates for galvanized steel covers shall include for supplying and fixing complete with frame hinges, locking hatch and lifting handles as specified on the Drawings.

Fencing will be measured as the length supplied and fixed as specified. The Contract rates shall include for supplying and installing complete with all hinges, ties, plunger bars, as specified on the Drawings including all excavation, backfilling and concrete work as necessary.

**PAINTING**

1. **SCOPE**
   The Specifications cover paint work to exposed concrete and plastered surfaces, wood work, ferrous and non-ferrous surfaces in accordance with the Schedule of Finishes, Drawings, Bills of Quantities and as directed in writing by the Engineer.

   The term "paint" as used herein includes emulsions, enamels, lacquers sealers and other coatings, organic or inorganic, whether used as prime intermediate or finish coats.

   All painting works shall be applied by skilled workmen experienced in this work.

2. **MATERIALS**

   **Materials in General**
   The materials to be used shall be of the best quality and of approved types, obtained from an approved manufacturer.

   All paints shall comply with the following requirements:

   a. The product shall be thoroughly mixed and ground.
   b. The color of the paint shall match the approved samples.
   c. Paint shall show no evidence of cracking, chipping of flaking.
   d. Paint in the containers during and after application shall not be abnormally pungent, offensive or disagreeable.
   e. Paint shall show easy brushing, good flowing and spreading and leveling properties. These properties shall be demonstrated on test specimens at the request of the Engineer. Coats that have any noticeable pull under a large brush and that show poor spreading and flowing properties will not be acceptable.
   f. Paint shall dry to a uniform, smooth, flat or semigloss finish under ordinary conditions or illumination and wearing. There shall be no laps, skips, highlighted spot or brush marks. Tinted paints shall dry to a uniform color.
   g. Re-coating of a previous painted surface shall produce no lighting softening or other film irregularities.
Knotting
Shall be composed of dissolving shellac or other resin remains unaffected by the resinous materials in the timber leaching into the paint film and causing discoloration or defective drying shall be in accordance with B.S. 1336 latest edition.

Mordant Solution
Shall be composed of a solution slightly acidic in nature and containing solvents, for applying to new smooth metallic surface to remove grease, organic soaps and provide a physical key and shall be obtained from an approved supplier.

Fillers
Shall be "Polyfilla", "Alabastine" or approved equal.

Stopping
Shall be hard stopping composed of white lead paste, gold size (oleo resinous medium) and other fillers obtained from an approved supplier.

Putty Filler
Shall be composed of white lead and dry filler mixed with pure linseed oil, the content of the white lead shall be not less than ten percent (10%) of the mixture by volume and shall be obtained from an approved supplier.

Thinners
Shall be an approved turpentine or white spirit, except where the paints are specified to be water thinned, fresh water shall be used.

Pigments
Shall be pure tint colours that will easily dissolve and mix with the various coatings and shall conform to the requirements of B.S. 1014: 1961 "Pigments for cement, magnesium oxychloride and concrete".

Rust Inhibitor
Shall be "Galvafroid" primer, manufactured by "Seconrastic Ltd". Brackwell, Berks, England" or Crown Chorinated Rubber Zinc Rick Primer-Product Data Sheet No.56, manufactured by the Walpmur co. Ltd., Darwen Lancs" or approved equivalent.

Primers
Primers applied to surface of different materials shall be as follows:

a. Interior or exterior plastered surfaces:
   Alkali resistant primer as recommended by the manufacturer.

b. Ferrous Surface:
   Lead based or zinc Chromate and Calcium Plumbate as recommended by the Manufacturer.

c. Non-ferrous surface:
   Mordant solution of an approved brand and rust inhibiting primer.

d. Woodwork Surface:
   Leadless grey primer in accordance with B.S. 2524 latest edition.

Undercoating Paints
For exterior or interior shall be as follows:
a. 2 coats of whitewash or color wash as shown on the Schedule of Finishes and the Drawings.

b. White lead bases undercoating in accordance with B.S. 2525: Colours shall be similar to the finishing paint.

c. Other undercoating paints to be applied as recommended by the manufacturers of the finishing paint.

**Finishing Paints**

Shall be as follows unless otherwise indicated on the Drawings:

a. Interior plastered surfaces and exposed concrete surfaces as shown on the Drawings: Float enamel paint or approved emulsion paint for interior use of an approved colour and supplier.

b. Exterior exposed and plastered surfaces as shown on the Drawings: Approved emulsion paint for exterior use of the colour indicated on the Drawings.

c. Interior or exterior ferrous and nonferrous surfaces, ditto:

d. Interior woodwork surfaces: Oil paint semi-gloss finish of an approved manufacturer.

3. **WORKMANSHIP**

**General**

The Contractor shall submit to the Engineer for approval the brand and quality of the paints he proposes to use.

If approval is given to a brand of paint the Contractor shall use the primers, undercoats etc... manufactured or recommended by the manufacturers of that brand.

All paints to be used under this contract shall be delivered and stored on the Site in sealed, labeled containers, a minimum of 30 days prior to application by the Contractor that the material is at the Site, samples of each material shall be obtained at random from sealed container by the Engineer in the presence of an authorized representative of the Contractor.

Samples shall be clearly identified by commercial name, type of paint and intended use. If judged necessary by the Engineer the paint samples may be tested a laboratory designated by the Engineer at the Contractor's expense.

Complete colour charts for the paints to be used shall be submitted to the Engineer for approval.

Pigmented paints shall be furnished in containers not larger than 25 kgs. All paints shall be products that have a minimum of 2 years satisfactory field services.

Mixing and application of paint shall be in accordance with the Specifications of the manufacturers concerned and to the approval of the Engineer.

The mixing of paints etc... of different brands before or during application will not be permitted. No dilution of painting materials shall be allowed except strictly as detailed by the manufacturers and as approved by the Engineer.

Hardware, hardware accessories, machine surface, plates., lighting fixtures and similar items in place prior to cleaning and painting, which are not intended to be painted, shall be removed or protected prior to painting operations and repositioned upon completion of painting work as directed by the Engineer.
Equipment adjacent or against walls shall be disconnected by workmen skilled in these trades and moved to permit the wall surfaces to be painted, and following completion of painting shall be replaced and reconnected.

Cleaning solvents shall be of low toxicity. Cleaning and painting shall be so programmed that dust and other contaminants form the cleaning process will not fall on wet or newly painted surfaces.

Brushes, pails, Kettles, etc. used in carrying out the work shall be clean and free from foreign matter. They shall be thoroughly cleaned before being used for different types or classes of material.

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

Painting shall preferably be shaded from direct sun light to avoid blistering and wrinkling. Wherever possible, painting of exterior surfaces shall "follow" the sun such that it is carried out in shadow.

Edges, corners, crevices, welds and rivets shall receive special attention to insure that they receive adequate thickness of paint.

All cracks and holes shall be cut out properly square and made good with suitable hard plaster or cement sand mix as appropriate such repaired portions being allowed to dry out and sand papered smooth.

**Plastered Surfaces Emulsion or Enamel Paint**

Such works shall be allowed to dry out completely before carrying out the painting operation. Plaster applied in the winter season shall be at least five weeks old and that applied in the summer shall be at least two weeks old before commencing painting operations.

Preparation of surfaces shall consist of vigorous brushing and rubbing down to remove loose surface material and dust.

Surfaces shall then be left for a week to determine whether efflorescence reappears in which case it shall be brushed off dry and a further waiting period of one week allowed.

Alternatively, the surfaces may be neutralized by brushing on a solution of 3 percent phosphoric acid and 2 percent zinc chloride and removing all loose particles after drying. No painting shall be carried out until the Engineer is satisfied that no efflorescence is occurring.

Where required by the Engineer one or two coats of "alkali resistant" primer shall be applied, sufficiently thinned to penetrate the surface. All plastered and concrete surfaces shall be twice stopped with approved putty filler. The first coat of stopping shall be applied after the primer coat dried out completely and the second coat after the first undercoat application. Each coat of stopping shall be allowed to dry and harden thoroughly and shall then be rubbed by sand paper until smooth surface is achieved.

A minimum of two (2) approved undercoats recommended by the manufacturers of finishing coat shall be applied by brushing well into the surface. Each coat shall be allowed to dry and harden thoroughly before the next coat is applied.

The finishing coat of paint shall be applied after the completion and testing of the mechanical and electrical works.
3.3 Ferrous Surfaces:
Surfaces shall be thoroughly cleaned to remove and dirt, wire brushed and scraped to remove scale and rust. One coat of approved putty shall be applied on the surface and left to dry at least twenty four (24) hours, surfaces shall then be rubbed by sandpaper or other approved means before primer is applied.

One coat of rust inhibiting "Galvafroid" primer or other approved equal shall be applied by brushing well into the surface and shall be allowed to dry and harden thoroughly before the application of subsequent coats.

If ferrous works delivered primed, the surface shall be examined to ascertain that the primer coat is hard. If not satisfactory the primer coat shall be removed and the surfaces cleaned to remove grease and dirt and re-primed as described above for ferrous. Abraded spots on shop-coated surfaces shall be wire-coated surfaces shall be wire-brushed and touched up with same materials as the shop-coat.

The under-coat and finishing coat shall be chlorinated rubber paint interior or exterior grades and used all in accordance with the directions of the approved manufacturer.

Chlorinated rubber paint, interior or exterior grades, shall not be applied in damp, foggy or freezing weather or to any surface which is not perfectly dry. Ferrous surfaces shall be thoroughly cleaned free of all rust, scale, dirt, oil and grease, etc.
Brush application is recommended although this material may be sprayed if desired, only special thinners produced by the approved manufacturer may be added to achieve the spraying consistency required.

Special approved thinners may be used for cleaning brushes after use.
Ferrous works such as frames, covers to expansion joints, etc. which are to be built into walls shall be primed before installation.

Non-Ferrous Surfaces
Galvanized steel surfaces to be painted shall be solvent- cleaned or painted with mordant solution before the application of paints as described above for ferrous surfaces.

Wood Surfaces
Wood surfaces except surfaces to be given natural finish or other finish specified shall be primed, undercoated twice with undercoating paint as recommended by the manufacturer of finishing coat and final coat with semi-gloss enamel paint of approved manufacturer.

Wood surfaces shall be scrubbed with abrasive paper to obtain a smooth surface. Surface mould where present shall be removed by washing, rubbing down and burning off as necessary. Oily wood shall be swabbed with white spirit. Resinous exudation and large knots shall be removed and replaced by approved filler or knot sealer and the surface shall be primed.

Parts of wood to be enclosed in walls shall be primed unless already impregnated with creosote or other preservative. Priming shall be brushed on and a minimum of two coats applied to end grain. After the primer coat is hard, all cracks, holes, open joints, etc. shall be made good with hard stopping and rubbed with fine abrasive paper. If the first process of stopping found to be unsatisfactory it shall be repeated after the first undercoating is applied and well dried.

Priming of joinery shall be applied only on the site after the Engineer has approved such joinery and before it is fixed. The two undercoat paints shall be applied on wood doors, panels, etc... before they are fixed, to ensure that the bottom and top edge and sides are thoroughly painted. The finishing coat of paint to such wood doors, panels etc. shall be applied after fixing in position and as directed by the Engineer.
SANITARY INSTALLATIONS

1. GENERAL

Scope of work
The Contractor shall furnish all labor, materials, equipment tools, appurtenances, services and temporary work, to provide complete the several plumbing and drainage systems all in perfect working order. This work shall include but not be limited to the following:

a. Sanitary fixtures.
b. Water supply systems including: cold water and hot water services.
c. Waste disposal system.
d. Rain water services.
e. External gravity sewer network.
f. Fire protection system.
g. Testing of all piping systems and equipment and other devices to demonstrate that the entire installations are in perfect working order.

All fixtures and materials shall be brand new bearing stamped ratings as required and must be approved by the Engineer prior to their use.

The foregoing sub-paragraphs are not intended to itemize all works required by this section of the Specifications and are only for the purpose of outlining the extent of work for the guidance of Tenderers.

General Description of the work
The sanitary works in the building shall consist of all water supply to and water discharge from all the sanitary fixtures.

Water distribution to all floors is effected from a roof tank of 1000 liters capacity fed from the main city network.

Drainage of the ground floor is discharged by gravity from individual points to a system of manholes which will be later discharged to any close outlet. Fire protection in the building is achieved by a wet riser system and in certain locations by portable fire extinguishers as shown. Rain water is collected from roof and discharged to any nearby outlet.

2. SANITARY FIXTURES

General
All sanitary fittings shall be of an approved quality obtained from an approved manufacturer. Sanitary fittings and their connections, services, wastes, etc., shall be located as shown on the Drawings and shall be designed and installed to the satisfaction of the Engineer. Unless otherwise required by the Particular Specification or shown on the Drawings, the quality and sizes of the fittings shall be according to B.S. Standards as follows:
**Sinks** shall be either white glazed fire clay complying with B.S. 1206 or stainless steel complying with B.S. 1244 fitted with chromium plated hot and cold water mixer, combined overflow and trapped waste, plug and chain. Sinks shall be fixed on pair of cantilever brackets built into wall or on frame and supports of 1.0 inch diameter galvanized steel pipe or on block work piers as detailed on the drawings, or directed by the Engineer.

**Kitchen Sinks** is manufactured from a single piece of high grade 18/10 stainless steel, as a result of this process no welding is necessary, and a much stranger produced. Sink with one bowel or two bowels fitted with chromium plated hot and cold water mixer, combined overflow and trapped waste, plug and chain will be considered as shown in the drawing & as mentioned in B.O.Q.

**Baths** shall be white porcelain enameled cast iron complying with B.S. 1189, with rectangular tops and Side and end panels were required, fitted with two 3/4 in diameter chromium plated pillar valves, overflow and 2 in diameter trapped waste, plug and chain. Where baths are fitted with a shower this shall be of either the overhead type or the telephone type. In all cases the shower hose and exposed piping shall be chromium plated and the connections to such showers shall be through chromium plated mixing valve. The baths and showers shall be fixed as detailed on the Drawings or directed by the Engineer. The recommended type is Colored Porcelain wash basin without pedestal (Bracket type-Italian Made).

**Asiatic-Water close:** Suites shall be sea-water resistant and shall comprise white -glazed fire clay squatting Slab, pan, "s" or "p" trap with 3 1/2 inch bore outlet, two gallon capacity high or low level white enameled cast iron or white glazed fire clay or plastic flushing cistern fixed to walls with cantilever brackets or concealed fixing, 1 1/4 in. (high level) or 1 1/2 in (low level) diameter flush pipes, non-corroding valves siphon, 1/2 inch low-pressure ball valve and union, 3/4 in overflow and union, and either flushing handle or pull and chain. A flush valve may be installed instead of the flushing arrangement described above if required.

**European Water Closet** Suites shall comprise white glazed fire clay pan complying with B.S. 1213, weighing approximately 20 kg and having 'S' or 'P' trap with 3 1/2 in bore outlet, Two-gallon capacity high or low level white enameled cast iron or white -glazed flushing cistern fixed to walls with cantilever brackets or concealed fixing 1 1/4 in (high level) or 1 1/2 in (low level) diameter flush pipe, non-corroding valves siphon, 1/2 in low-pressure ball valve and union, 3/4 in overflow and union either flushing handle or pull and chain, and with double flap solid section plastic ring seat complying with B.S. 1254.

Paper holder for all toilets should be provided.

The recommended type is Colored Porcelain WC closet with plastic cistern.

Ample application of petroleum jelly shall be applied to all surfaces of exposed chromium plated piping, valves and fittings and stainless steel fixtures immediately after installation. Concealed brackets, hangers and plates shall have a shop coat of paint.

The location and disposition of all items shall be as indicated on the relevant drawings.

**PIPES:** The pipes shall be un-plasticized polyvinyl chloride (U.P.V.C) pipes, as shown on Drawings or as detailed. Pipes shall be laid in position by means of a leveling instrument. Supporting wedges will not be permitted. Where necessary, cutting of, pipes shall be carried out. Special attention is directed with regard of turning down the cut ends to the correct outside diameters.
3.  DOMESTIC HOT AND COLD WATER

Domestic Hot Water Tank
Tank shall be of the double cylinder storage type for vertical mounting. Tank shall be constructed of welded sheet steel galvanized after fabrication and tested at 12 atmospheres and a working pressure of 6 atmospheres.

Storage Tanks
Water tank used is PVC local made / Rotoplase or approved equivalent with lockable cover. The tank capacities will be as mentioned in the bills of quantities and as shown in the drawings. The installation of the water tank must be carried out according to the manufacturer's instructions i.e. (Tank foundations, Mechanical float valve, fittings, vent pipe, overflow, drain, connections, tank foundation and the required accessories).

Electric Hot Water Heaters
Enamelled series or approved equivalent water heaters are recommended 80 litters capacity. The boiler, made with thick steel tested at 16 atm and provided with safety valves. It's protected with exclusive glass lining and the magnesium anode. The boiler shall be of a large plane flange which makes inspections extremely easy. The insulation consists of a thickness of 2.5cm of expanded polyurethane, thus reducing heat dispersion to minimum values.

Water Distribution Networks
All the materials used in the main water distribution lines are galvanized steel pipes. All the internal cold water pipes will be galvanized steel pipes schedule 40. Hot water pipes will be steel pipes schedule 40. All under ground pipes shall be galvanized steel coated with bitumen.

4.  TESTING

General
The Contractor shall submit to the Engineer prior to the date of commencement of the tests his proposed test procedure. The procedure method and points of measurement and the method of calculation, shall be approved by the Engineer before any test is carried out.

The Contractor shall supply skilled staff and all necessary instruments and carry out any test of any kind on a piece of equipment, apparatus, part of a system or on a complete system if the Engineer requests such a test for determining specified or guaranteed data, as given in the Specifications.

Any damage resulting from the tests shall be repaired and/ or damage material replaced, all to the satisfaction of the Engineer.

In the event of any repair or any adjustment having to be made other than normal running adjustment, the tests shall be void and shall be recommenced after the adjustment or repairs have been completed.

The test shall not be made void due to circumstances beyond the contractor's control. All testing, balancing and final adjustment shall be in accordance with the provision of the applicable BS, Code of Practice.

Water Supply Systems
All water supply piping shall be tested under hydrostatic pressure of not less than 1.5 times working pressure p. s . i maintained for four hours. This test should be applied to separate lengths of pipe work before final connection of equipment and appliances but after all piping is completed. Systems shall also be flushed.
Test shall be completed and approved before pipes, valves and fittings have been concealed.

**Drainage and Waste Systems**

These systems shall be subject to a water test prior to being covered and also tested for water tightness after backfilling.

On any section of the pipe under test the head of water applied shall not be less than 3.00 meters and not greater than 6.00 meters. Tests shall be maintained for 20 minutes, and any defects shall be rectified and the test reapplied to the complete satisfaction of the Engineer.

**Final Testing**

In addition to the above, final tests shall be carried out as directed by the Engineer just before final completion of the Works and during the maintenance period.

**Working Drawings and Ordering**

Immediately the Contractor has been awarded the Contract shall prepare detailed working drawings showing exact position of all sanitary fixtures and position and size of all water pipe work, drainage, and piping clearly indicating fittings proposed. These drawings, when approved by the Engineer, shall be used for ordering purposes.

**PROOFING AND WATERPROOFING**

1. **SCOPE**

These specifications cover, waterproofing and roofing systems intended to be used for underground structures floors and roof decks required for the Works in accordance with the Drawings, Bills of Quantities and as directed in writing by the Engineer.

2. **MATERIALS**

**Primer**

The material used as a primer shall conform to ASTM Specifications D41, for primer for use with Asphalt in Damproofing and waterproofing below or above ground level for application to concrete and masonry surfaces.

**Bitumen**

The bitumen for Damproofing and waterproofing shall be a soft, adhesive Self-healing" asphalt which flows easily under the mop and which is suitable for use below ground level on horizontal and vertical surface under uniformly moderate temperature conditions both during the process of installation and during service.

The bitumen shall be homogeneous and free from water and shall conform to the requirements of ASTM Specifications D449-73 "Type A.


**Mastic Asphalt**

Mastic asphalt for damp proofing and waterproofing shall comply with B.S. 1097, B.S. 1418 and with B.S. Code of Practice C.P. 102-Protection of buildings against water from the ground. Mastic asphalt for roofing purposes shall comply with B.S. 988 B.S. 1162 Code of Practice C.P. 144, Part 4-Mastic Asphalt.

**Roofing Felt**
The roofing felt for built-up roofing shall comply with B.S. 747: Part 2: 1970 (Metric units) Roofing felt, class 1A and as described in B.S. C.P. 144: Part 3: 1968.

**Aggregate Lightweight Concrete Screed**
The aggregate for lightweight concrete screed shall conform to B.S. 3797: 1964 lightweight aggregates for concrete. The lightweight aggregate shall be such as Vermiculite, 'Alveolite, etc... aggregate of an exfoliated micaceous mineral aggregate incombustible and chemically inert, obtained from an approved manufacturer, graded and mixed in accordance with the manufacturer's instructions.

The lightweight aggregate shall be delivered to the Site in the manufacturer's sealed and branded containers which shall be clearly marked to show the grade of lightweight aggregate contained therein. They shall be stored in a covered shed with floor raised off the ground and the bats stacked not more than 3.00 meters high.

**Fine Aggregate, Cement and Water**
The fine aggregate (maximum size 10mm), ordinary Portland Cement and water, for use in topping screed for lightweight concrete screed, shall be as specified under "CONCRETE WORK" and floor, wall and ceiling finishing.

3. **WORKMANSHIP**

**Damproofing and Waterproofing**

*Primer and Asphalt*

The primer and asphalt, as specified under "Materials" shall be used as a damproof and waterproof course to accessible underground surfaces of reinforced concrete structures to the extent shown on the Drawings, and shall consist of one coat of primer and two coats of asphalt.

All surfaces to be damproofed and waterproofed shall be properly prepared by brushing, cleaning and leaving the surfaces free from dirt, dust, grease, loose or projecting particles of mortar or concrete, all traces of salt shall be thoroughly sprayed with water and allowed to dry and disappear from the surfaces before the application of the priming coat.

Asphalt shall be applied hot in two coats for both horizontal and vertical work. Each coat of asphalt shall be allowed to dry for a period of at least 24 hours before the second coat is applied. Warm, clean and properly make good injunctions between horizontal and vertical asphalt, with two coats angle fillets at all internal angles.

**Lightweight Concrete and Topping Screed**

*General*

The work shall consist of laying and finishing the lightweight concrete screed to the thickness and falls shown on the Drawings and as described in the Bills of Quantities to the entire satisfaction of the Engineer.

All roof decks shall be graded to drain water freely into rainwater outlets. Rainwater connections shall be set up to permit smooth flow of water.

*Mixing Proportions*

The lightweight concrete screeds shall be measured, mixed applied and cured in accordance with the manufacturer's instructions and to the satisfaction of the Engineer.
Gauges boxes shall be used for the measurement of lightweight aggregate and the following mixing table shall be strictly observed.

<table>
<thead>
<tr>
<th>NOMINAL MIX</th>
<th>LIGHTWEIGHT AGGREGATE</th>
<th>METER CEMENT CONTENTS</th>
<th>WATER</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:1</td>
<td>1:00</td>
<td>CUBE</td>
<td>150 kgs.</td>
</tr>
</tbody>
</table>

**Mixing Methods**

Mixing may be carried out by hand or by approved machine in accordance with the following procedures:

**By Hand:**

The measured quantity of lightweight aggregate shall be poured out onto a clean dry level surface and sufficient water added -only to give workability. Mixing shall be carried out until the water has been distributed amongst the lightweight aggregate. The cement shall be added and further mixing shall take place until all materials are uniformly distributed.

**By Machine:**

The machine used for mixing shall be an approved countercurrent rotating paddle type mixer operating at the speed recommended by the manufacturer. The water shall be placed in the mixer followed by the lightweight aggregate and mixing shall continue until the water has been distributed amongst the lightweight aggregate.

The cement shall then be added and further mixing shall take place until all the materials are uniformly distributed.

It is extremely important to ensure that the mixing period is kept as short as possible in order to prevent compression of the lightweight aggregate. For this reason ordinary concrete mixer of the revolving drum type are unsuitable and shall not be used.

If an approved mixing machine is not available then the mixing shall be carried out by hand.

It is also important that the water content be kept to the minimum possible to allow for the proper hydration of the cement. Sloppy mixes shall not be used. An even consistency free from lumps and excess water is required. As a Site test for consistency, a handful of the mix when firmly gripped should just release water.

Placing of the lightweight concrete mix shall take place immediately after mixing. The lightweight concrete screed shall be laid to falls in alternate bays not exceeding 16.00 square meters in area to a minimum depth of 50mm. The lightweight concrete mix shall be carefully spread by means of a rake to a depth 12.5% greater than the finished thickness required and shall then be lightly troweled down to its finished thickness. The mix shall not be tambed, vibrated or compressed with heavy implements.

The lightweight concrete screed shall be cured by covering with damp hessian for a period of seven days and during this time the screed shall not be subjected to traffic to any kind.

After curing the lightweight concrete screed shall be protected by a layer of cement and sand (1:4) mix. This topping shall be well troweled in to ensure proper adhesion with the lightweight concrete screed and shall have a minimum finished thickness above the lightweight concrete screed of 30mm and shall be finished flat and true with a steel trowel.
The screed and topping shall be water cured with damp hessian for a period of 28 days before receiving waterproofing system. Alternatively the cement and sand topping may, with the approval of the Engineer be applied immediately after troweling the lightweight concrete screed. Lightweight concrete screed, cement and sand topping shall not be laid during rain.

**Built-Up Roof**

**General Requirements**

All roof decks shall be graded to drain water freely into downpouts, and shall be smooth, firm, thoroughly set, and dry.

**Storage and Handling for Materials**

Rolls of felt and containers of bitumens shall be stored on end. Rolls of felt shall be properly covered and all materials shall be kept clean and dry. In cold weather plied felts shall not be thrown or dropped since the shock of impact can fracture adhesive between plies causing them to separate. Such a condition, often considered a factory defect, more frequently is cause by rough handling.

**Preparation of Materials**

Bitumen shall be placed in kettles, melted and frequently stirred to prevent burning. Cutting back, adulterating or fluxing of bitumen with any other material shall not be allowed.

Felts shall be unrolled, turned over, piled up and permitted to flatten. Then they shall be re-rolled in the opposite direction before application.

**Application of Materials**

Before work is started all rubbish shall be removed and, during the work, the deck shall be maintained clean and free of loose or foreign materials and obstructions other than tools and appliances of the roofer.

Decks that are scaling or that are covered with dust shall not be primed until thoroughly cleaned. Leaky containers for bitumen shall not be used since splashes seldom can be removed entirely.

A sufficient quantity of bitumen shall be used so that it will flood ahead of the roll in an unbroken line so that the felt will be completely embedded.

The felts shall be rolled closely behind the mop so that at no time shall the mopping be more than one meter brommed in while the bitumen is still hot. The stable type of broom or suitable squeegee shall be used for this purpose.

In applying felts on built-up roofs it is important that they be laid so that the flow of water is over or parallel to (never against) the laps of the finishing felts. Care shall be taken to ensure that all surfaces upon which felt is to be laid are dry, smooth and clean.

Felts shall be applied in three layers of the felt lapping each felt 600mm over the preceding one. Mop the full width under each felt with the asphalt.

The felt shall be dressed and bonded into months of rainwater outlets and well fitted and sealed around openings.
When roofing abuts against vertical surfaces such as walls or parapets, it shall be carried up for a minimum height of 150mm and 150mm back off the walls or parapets forming triangular fillets as a skirting or base continuous with the root membranes.

Pipes and other structures piercing the roof shall be primed with a bitumen solution and shall have a collar of hot bitumen formed up to them at 45°C. The roofing felt shall be dressed up and capping layer of flashing felt shall be dressed over the collar, bonded to the pipe and secured with four turns of stout copper wire.

At angles or other obstacles wherever felt needs cutting, a mastic joint or seal shall be used to ensure the continuation of the waterproofing membrane.

All roof finishes shall be carefully worked or fitted around pipes or openings. On completion all roofs are to be left sound and water tight and in a neat and clean condition.

**Minimum Materials**

Minimum materials required per 9 square meters of roof area for built-up roof:

<table>
<thead>
<tr>
<th>Material</th>
<th>Specification</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime coat</td>
<td>As recommended by the asphalt manufacturer.</td>
<td>approximately</td>
</tr>
<tr>
<td>Felts</td>
<td>3 layers of saturated asphalt left</td>
<td>20 kgs.</td>
</tr>
<tr>
<td>Bitumen</td>
<td>Mastic asphalt for mopping each layer of felt</td>
<td>10 kgs.</td>
</tr>
<tr>
<td></td>
<td>For flood coat to receive</td>
<td>136 kgs.  Chippings</td>
</tr>
</tbody>
</table>

They shall include all enclosure fittings. Wooden strips shall be as specified under JOINERY AND IRONMONGREY.

Care shall be taken during installation not to cause any damage to the waterproofing material laid on roof deck.

**4. PROTECTION AND CLEANING**

Roof coverings and finished shall be protected from damage until the completion of the Works. Should any damage be caused it shall be made good to the satisfaction of the Engineer at the Contractor's expense.
MECHANICAL WORK AND PIPING

This section covers: centrifugal pumping units and piping.

Each pumping unit shall be complete with an electric motor and all other appurtenances specified or otherwise required for proper operation of the equipment.

Other equipment furnished under this section shall be fabricated and assembled in proper operating conditions in full conformity with drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer unless exceptions are noted by the Engineer.

1. PUMPING UNITS

Pumps:
The pumps shall be horizontal, single end suction or multi-stage centrifugal pumps of standard construction for clear drinking water. Each pump of booster station PS-6 shall be capable to pump 320 cubic meter per hour of clear drinking water at a total dynamic head of 88 meters with a hydraulic efficiency not less than 77% at the duty point as produced by LOWARA or equivalent. Likewise, each pump of booster station PS-7 shall be capable to pump 280 cubic meter per hour of clear drinking water at a total dynamic head of 38 meters with a hydraulic efficiency not less than 78% at the duty point as produced by LOWARA or equivalent

Each pumping unit shall include the pump, the electric motor, the flexible coupling and guard, and the base plate.

The characteristic curves of the pumps for quantity, versus total dynamic head, efficiency, horsepower, net positive suction head required shall be submitted with the tender. The two booster stations, PS-6 & PS-7 shall draw water from a nearby Tal El-Sultan ground reservoir through 18” steel pipe. PS-6 pumps the water into new 12” steel discharge pipe connecting the existing 10” steel trunk line to boost excess supply to the existing storage tanks in Yebna (ST-16 & ST-17) and new water storage tanks (ST-18A & 18B) in Rafah Governorate. PS-7 pumps the water into new 14” steel discharge pipe connecting the main water distribution network of Tal El-Sultan to provide continuous supply for Tal El-Sultan area and part of Western Rafah districts (pressure zone 1). The pump operating point of PS-6 and PS-7 shall fall as near as possible to the best efficiency point as obtained from the manufacturer’s published data. For each pumping unit the pump shall be connected to the motor by a flexible coupling protected by a suitable guard. The pump, the electric motor and the coupling shall be connected together in perfect alignment on a rigid base plate, which shall be installed on a concrete foundation using anchoring bolts. The un-witnessed performance test shall be submitted to the Engineer for approval. No materials or equipment shall be ordered and no work carried out until shop drawings has been made and approved by the Engineer.

The pumping units of booster station **PS-6** shall be designed for the following operating conditions and requirements:

- Electric pump from LOWARA Model FHBF 125-270/1320 or equivalent.
- With flexible coupling, base and standard motor compliance with EN 733- (DN 24255)
- Rated total dynamic head, meters 88
- Capacity at rated head, m³ / hour 320
- Maximum speed 2950 rpm
- Maximum power capacity 132 KW
- Bronze impeller
- Cast iron body
- Silicon Carbide mechanical seal
The pumping units of booster station **PS-7** shall be designed for the following operating conditions and requirements:

- Electric pump from LOWARA Model FHBS 100-200/370 or equivalent.
- With stub shaft and standard motor
- Rated total dynamic head, meters 38
- Capacity at rated head, m³/hour 280
- Maximum speed 2950 rpm
- Maximum power capacity 37 KW
- Bronze impeller
- Cast iron body
- Silicon Carbide mechanical seal
- NBR O-ring seal
- Stainless steel shaft
- Insulation class F
- Enclosure class IP 55

Pump performance shall be stable and free from cavitation and noise throughout all of the specified operating range of the pump.

The rotating parts shall be statically and dynamically balanced.

**Electrical Motors:**
The motors shall be totally enclosed squirrel-cage, fan-cooled, induction type, class F insulation with weather protection according to IP 55.

Power supply 3 phase, 380v, 50HZ.

Synchronous speed 3,000 r.p.m.

Motor winding shall incorporate thermal switches as to safeguard against overheating. The thermal switches shall be connected in the control circuit of the starter.

Motors shall be weatherproof with roded screens suitable for outdoor use. The motor windings shall be insulated, and motors shall operate continuously at rate voltage and frequency with a temperature rise not to exceed 40°C above ambient when operating at 115 percent of the rate power. The motors shall be rated for a minimum of 45 KW and shall be capable to drive the pump without over-loading through the full operating range of the pump from maximum capacity to shut off head. The motors shall have a full-load power factor of not less than 75 percent. The locked rotor torque shall be not less than 100 percent of full-load torque. The breakdown torque shall be not less than 200 percent of full-load torque. All motor bearings shall be of the antifriction type suited for a 10-year minimum life.

**Drawings And Data**
Complete fabrication, assembly and installation Drawings, together with detailed Specifications and data covering materials used, parts, devices and other accessories forming a part of the equipment furnished, shall be submitted with the tender. The data and Specifications for each unit shall include, but shall not be limited to, the following:

Pumps:
- Name of Manufacture;
- Type and Model;
- Rotative Speed;
- Size of Suction Inlet;
- Size of Discharge Outlet;
- Net Weight of Pump;
- Complete Performance Curves Showing Capacity Versus Total Dynamic Head, NPSH Required, Horsepower and Overall Efficiency;
- Data on Shop Painting;
- Flexible Coupling Make and Type;
- Sectional Drawings and Dimensions;
- Operation and Maintenance Manuals;
- Spare Parts Manual.

Motors:
- Name of Manufacturer;
- Type and Model;
- Type of Bearings and Lubrication;
- Rated Size of Motor, hp;
- Net Weight of Motor;
- Temperature Rating;
- Full Load Rotative Speed;
- Efficiency and Power Factor at Full Load, 3/4 Load and 1/2 Load;
- Locked Rotor Current;
- Rated Current and Voltage;
- Sectional Drawings and Dimensions;
- Operation and Maintenance Manuals;
- Spare Parts Manual.

2. LEVEL CONTROL
Low water pump cutoff and high level alarm have to be provided. The low level cutoff is required to prevent the pumps from running dry, and the high level alarm serves to notify the operator in the event the pump should fail to operate. Description of sequence of operation of pump drive system under normal automatic mode, normal manual mode, emergency-automatic mode and manual operation mode shall be provided.

3. FLOW METERS
A flow meter shall be installed on the outlet line of the header line as shown on the drawings or otherwise specified by the engineer. The capacity of the meter shall be related to the flow of the pumps as specified in BOQ. The flow meter shall be of the interchangeable type where the internal mechanism can be replaced without disturbing the body and the pipeline. The meter shall have the following specification:

The water meters shall be for cold water of ABB type Helix 4000:
- Fully in accordance with ISO 4064/1 with short body length on flanges,
- The rotor shall be parallel to the direction of flow,
- Shall have EC (or equivalent) approval of accuracy for class B as specified in ISO 4064/1,
- The accuracy shall be guaranteed if the meter is installed with any inclination,
- Shall be of cast iron with internal and external epoxy coating,
- The flanges shall be drilled in accordance to DIN 2532/3 or BS 4662 PN16,
- The coupling between the wet and the dry (recording mechanism) part shall be magnetic and fully tamperproof against external non-destructive action,
- The housing of the dry mechanism shall be of copper with solid glass window which shall be fully condensation-free and waterproof under 2 m water pressure,
- The measuring mechanism shall be equipped to enable telemetric (pulse) connection without destruction of the seal and/or requirement for the meter parts removing,
- The complete measuring mechanism shall be removable and interchangeable without any effect on the meter accuracy in the range of +/- 2%
- The meter shall provide possibility for two pulse rates: 100 litters and 1 m³ with possibility to use both outputs simultaneously,
- The meter shall be able to function in continuous and intermittent supply conditions, without exceeding the maximum permissible errors (+/- 2%).

Admissible metering errors

- Highest range of measurement: between maximum flow rate \( M_{ax} \) and transitional flow rate \( Q_t \): +/- 2%
- Lowest range of measurement: between transitional flow rate \( Q_t \) and minimal flow rate \( M_{min} \): +/- 5%

6. PIPES, FITTINGS AND PIPELAYING

Steel Pipes
Except as otherwise specified, steel pipes shall meet the requirements of S.I. 530 for the grade and wall thickness shown on the Drawings. In some special cases, other materials (stainless steel) will be used. Pipes shall be either with plain ends for butt welding or with a bell on one end for fillet welded lap joints. Pipes shall normally be supplied with a cement mortar lining on the inside. Pipes for installation below ground shall be supplied with an external extruded polyethylene coating. Pipes for installation above ground shall be painted from outside with three epoxy coats. The finish coat shall have colors approved by the Engineer.

Pipes passing through walls of structures retaining water or solution shall have puddle flanges or flanged anchoring sleeves. They shall be connected to the adjoining pipe-work by flanged joints or dismantling joints.

Adequate provision shall be made to anchor, support, drain, vent, pressure test, dismantle and clean all pipe-work. Valves, meters, strainers and the like shall be supported independently of the pipes to which they are connected.

Pipe-work systems shall be designed to withstand the maximum internal and external forces which could occur in service and under hydraulic test pressures.

The configuration and method of support shall be such as to minimize bending stresses.

Dimensions
The pipes shall be supplied with minimum wall thickness of 3/16” for diameters of 10”-24” and with minimum wall thickness of 5/32” for diameters of 8”, 6” and 4” pipes.
**Tolerances**

The tolerance on the specified wall thickness is +12% and -5% (except on weld areas where maximum height of weld reinforcement shall be 3mm) with a minimum of +/-0.5 mm.

The tolerance on the outside diameter is +/-0.75 or +/-10mm.

**Coating, Lining, Painting**

- **Polyethylene Coating**

  Pipes intended for below ground laying shall be protected externally by polyethylene coating according to AWWA C214 in three layers
  - Primer (first layer)
  - Corrosion Protection Layer (inner layer)
  - Mechanical Protection layer (outer layer)

  Coating works in the field shall consist of coating weld joints and repairing damaged or defective existing coating.

- **Cement-Mortar Lining**

  All pipes, except the galvanized pipes shall be supplied with a cement-mortar lining applied centrifugally at the pipe factory. Lining work in the field consists of repair of damaged lining, especially at pipe ends and lining short unlined sections or fabricated fittings.

  The cement lining shall consist of a mixture of sand with a gradation varying between 0.16 mm and 5mm and with a 96% purity index, potable water and Portland or blast furnace cements with low water solubility. The cement lining shall be carried out in the mill by means of centrifugation and shall have a smooth surface coat consisting of fine grains of sand and cement.

  The specific gravity of the mortar used shall be not less than 2.2 after centrifugation.

  The thickness of cement lining shall be as per AWWA C205-85 stipulations.

- **Painting of Pipes**

  Pipes and fittings in valve chambers shall receive a cover paint consisting of 2 coats of bituminous varnish such as "Askar 120" or equivalent.

  Pipes above ground exposed so the atmosphere shall receive a top coat of epoxy paint.

**Inspection and Repair**

Surface of lining shall be checked on 100 percent of production; the Contractor shall submit to the Engineer manufacturer's certificates to this effect. All over-sanded areas, blisters, cracks as a result of impacts and unsatisfactory thin spots shall be cut to the minimum permitted length.

Temperature and shrinkage cracks less than 1 mm width need not be repaired. Wider cracks have to be repaired if they do not heal under continuous soaking in water. When cement lining is damaged locally, protection of the bare zone shall be ensured by either applying a bituminous primer Endolac or similar followed by a coat of mastic bitumen or another product recommended by the pipe manufacturer, or by cutting out and replacing by hand to the full required thickness of the cement lining. Which method of repair to be used will be decided by the Engineer.

**Pipe Welding**
Square cuts shall be in a plane perpendicular to the pipe axis. Oblique cuts shall be done accurately to the required angle in such a manner that the cut edge is in one plane. Pipe ends for butt welding shall be bevelled to an angle of 30° with the plane of the edge, with a permissible variation of +5° or -0°.

All cutting shall be done with a mechanical tool, or by oxy-acetylene torch using a special cutting device, or Arc-air (carbon electrode with air jet). Flame cut surfaces shall be perfectly clean, and if this is not achieved by cutting, the cut surfaces shall be filled smooth. Cutting of mortar-lined pipes shall always be done with Arc-air cutting equipment. After the metal has been cut through to the mortar lining, the latter shall be carefully broken along the cut and the pipe edge prepared for welding.

**Fitting-Up of Pipes for Welding**

1. **Butt Joints**

The root opening between the pipes shall be such as will ensure full penetration without burn-through. When aligning pipes, the offset between pipe ends about to be joined shall be reduced to a minimum. External line-up clamps shall be used to centre pipes. Internal clamps may be used when approved by the Engineer.

The external line-up clamp may be removed only after 50% of the root bead has already been welded, in segments equally distributed around the pipe, not shorter than 7cm each; their quality and thickness shall not be inferior to those required for root welding.

The internal clamp may be removed only after the whole of the root bead has been welded.

2. **Lap Joints**

In lap joints the plain end of one pipe shall be shoved in until it abuts against the shoulder of the bell, so that the gap between the mortar lining of the two pipes is reduced to a minimum.

**Welding Of Pipes**

1. **General**

All welds shall be made by the manual shielded metal-arc method by welders having passed the welders' qualification test in accordance with S.I.127. Welds will be either butt welds for plain-ended pipe joints or fillet welds for lap joints (bell and spigot).

Electrodes used for welding shall generally be "Universal 6010" or "Zika Z 21P"- or equivalent. The electrodes proposed by the Contractor shall be subject to the Engineer's approval prior to their use.

Electrodes that have been damaged, become moist or otherwise deteriorated shall be rejected.

Pipe ends to be welded together shall be thoroughly cleaned of any dirt, oil, residues of paint and asphalt, and any other foreign matter that may adversely affect the quality of the weld.

2. **Welding of Joints**

The number of beads in each weld seam shall not be less than two, and their thickness shall not exceed 3.0 mm each.

In butt welds, the thickness and number of the beads shall be so adjusted that the height of the weld reinforcement shall be not less than 0.8 mm and not more than 1.5 mm above the pipe surface. The width of the cover bead shall be approximately 3.0mm more than the width of the groove before welding. In fillet welds, the thickness of the throat shall be at least (0.707) of the pipe wall thickness. Cutting back of the edge of the bell shall be kept to a minimum. All weld metal shall be thoroughly fused to the parent metal and to the previously placed weld metal.
After the completion of each bead, the weld shall be thoroughly cleaned of all scale, slag, or dirt. All spots on the weld where electrodes are changed shall also be cleaned. A penning hammer and steel brush may be used for cleaning, provided it is done to sound the bright metal. The finished seam shall be thoroughly cleaned by means of steel brushes.

3. Welding Mortar-Lined Pipes

Butt Joints
When butt-welding mortar-lined pipes the continuity of the lining at the joints shall be ensured by the use of the special compound called "X-pando". This compound, which is supplied in powder form, shall be mixed with water to a plastic (not liquid) consistency. The quantity of mixture prepared at a time shall not exceed that required for half an hour's work. The end faces of the existing mortar lining shall be wetted and buttered with X-pando paste to a thickness of about 2mm, small defects and depressions in the existing lining being filled in the process. Weld surfaces shall be kept clean of X-pando and where necessary wiped clean with a dry rag. Immediately after the application of the X-pando to the ends of pipes, the pipe ends shall be firmly pressed together and tack-welded. Before continuing with the root weld, any paste that may have entered the weld groove shall be removed, and weld surfaces cleaned as specified above. The weld shall then be completed as specified. The Contractor shall use X-pando subject to the approval of the Engineer.

Lap Joints
In pipes not accessible from the inside, a sufficient quantity of mortar shall be placed in the bell just before the new pipes are shoved in. After the new pipe is laid in place, excess mortar shall be removed and the inside of the joint finished by pulling a rubber ball or equivalent through the joint. Where the inside of the pipe is accessible, the mortar lining at the joint shall be completed by plastering on with a good bond to the existing lining and trowelling smooth and flush with the adjacent mortar lining.

4. Welding of Flanges
The welding of flanges to pipes shall be of the same quality as that specified for pipe welds. Slip-on flanges shall receive an interior weld inside the flange opening, in addition to the external weld. Weld neck flanges shall be attached to pipe ends as specified above for the welding together of pipes, care being taken to ensure a perfect concentric alignment between pipe and flange.

When welding on flanges, care shall be taken that the face of the flanges is perpendicular to the pipe axis. Flange faces shall be kept free from weld material or other defects such as splutter, dirt, etc. All defects in the flange faces that may interfere with the proper sealing of flanges shall be repaired.

5. Repair of Weld Defects
The Engineer may permit repairs of defects in the root or filler beads to be made, but any weld that shows evidence of repair work having been done without such permission may be rejected. Pinholes and undercuts in the final bead may be repaired, but such repairs shall be subject to the Engineer's approval. Undercuts not exceeding 1.0 mm in depth will not be considered as defects.

Before repairs are made, the defective areas shall be removed by chipping, grinding, or flame gouging. All slag and scale shall be removed by wire brushing. When cracks are found, the entire seam shall be cut and re-welded.

Welded Bends and Elbows
Welded bends and elbows shall consist of suitable obliquely cut pieces of pipe ("mitres") welded together. These mitres shall be cut to the exact dimensions shown on the Drawings and accurately fitted together so that after welding the completed bend or elbow will have the exact shape and
dimensions shown on the Drawings. The ends of the mitres shall be bevelled for welding as specified above.

In all bends and elbows having a diameter of more than 10" the seams between miters shall also receive an internal weld pass, which shall be made after the weld root has been thoroughly cleaned.

**Fabrication of Branch Outlets**
Fabricated T and Y branch connections shall be produced by cutting the branch pipe to the correct intersection shape to fit the curvature of the main pipe, cutting the required opening in the main pipe and welding the branch pipe to the main pipe.

The quality of the welds shall be as specified for pipe connections. The inside of the pipe intersection shall be cleaned and smoothed to ensure unobstructed flow in the pipe. Where shown on the Drawings or instructed by the Engineer, the Contractor shall install and weld reinforcement saddles to fabricated T and Y branches specified above. The saddle shall be cut and bent to the required shape and slipped over the branch, its outside edges shall be welded to the main pipe while the edge of its opening shall be welded to the branch pipe. Quality of welds shall be as specified above for welding of pipes.

**Fabrication of Pipe Reducers**
The Contractor shall fabricate the reducers from steel plate properly cut, rolled and welded or by cutting out wedge-shaped pieces from a length of pipe the diameter of which shall be equal to the larger diameter of the required reducer, squeezing the pipe together to the shape of the reducer and welding along the cut edges, which shall be straight and bevelled for welding, the gap between them being of uniform width over the whole length. On pipes having a diameter of more than 10" an internal pass shall be added to each weld, which shall not protrude more than 1.5 mm into the inside of the pipe. The ends of the pipe reducer shall have edges in parallel placed perpendicular to the pipe axis and shall be bevelled for butt welding.

**Prefabri cated Fittings**
Prefabr icated elbows, tees and reducers shall be jointed to pipe by square butt weld or by lap weld.

5. **WELD INSPECTION AND TESTS**

**Inspection and Tests - General**
The Engineer, himself or by his authorized representative, will exercise a continuous control of the welding work and will inspect the quality of the welds. In addition to routine supervision and visual inspection of the completed welds, the Engineer will have the right to request samples to be cut from the welds for destructive tests. If so required by the Engineer, welds shall also be tested by radiography.

**Destructive Tests**

**General**
Destructive tests will include all or part of the following, at the Engineer's discretion:
1. Break Test
2. Bend Test
3. Tensile Test (in special cases)

Both the Contractor and the Engineer will endeavor to ensure the proper execution of the welds, so as to avoid altogether or minimize the number of destructive tests.
**Frequency Of Tests**

Should one of the samples taken for destructive tests not meet the standards of acceptability set out below, the Contractor will be required to cut additional samples from the same weld or from other welds made by the same welder. If one of the new samples does not meet the requirements, the Contractor will be required to cut more samples until a clear picture of the extent of defective welds is obtained.

Should such additional tests show that the quality of the welds is unacceptable, as determined by the Engineer. The Engineer may require the Contractor to remove and re-weld all welds made by the welder concerned.

In the event of this test sample meeting the requirements of the specification, the cost of cutting the sample and preparing and testing the specimens, and that of patching the pipe where the sample has been cut out, will be borne by the Employer. Should the sample fail to meet the above requirements, all such cost, as well as the cost of all additional tests that may be required to determine the extent of the defective welds as aforesaid, shall be borne by the Contractor.

**Taking Samples For Bend Test, Break Test And Tensile Test**

Samples for Bend Test, Break Test and Tensile Test shall be cut from the pipe in the form of strips 5cm wide, perpendicular to the weld seam and extending 10cm on either side of the weld, so that the weld will be located in the centre of the sample.

The opening resulting from cutting the sample shall be closed by welding on a patch of steel plate having a thickness not less than that of the pipe wall.

The cost of patching up openings as herein described shall be included in the cost of taking samples as specified above.

**Bend Test**

The bend test samples shall be bent in a suitable jig in the field or in the shop. The bend shall be located exactly over the weld with the weld face on the convex side. The sample shall be considered as meeting the requirements if it will not break and no cracks larger than 3mm in any direction will appear on the convex side of the bend.

**Break Test**

The break test samples shall be hacksaw-notched on both edges across the centre of the weld to ensure breaking of the sample in the weld. The sample shall be supported on both sides of the weld and broken by a strong hammer blow. The required result is that the broken surface shall show full penetration of the weld and no burns or excessive slag inclusions. The break surface shall not show more than one gas pocket per square centimeter, provided that no gas pocket has a diameter of more than 1.5 mm.

**Tensile Test**

Samples for tensile strength and elongation tests shall be sent for testing to an authorized laboratory. These tests will serve as a control of the welding procedure and of the quality of the electrodes, but not to test the welder's ability. In this test the samples shall show a tensile strength not less than those required of the steel of which the pipes are made.

**Radiographic Tests - General**

Radiographic tests shall be performed at the rate of 10 (ten) percent of all weld seams. If these primary tests should not give satisfactory results, the Engineer will conduct additional radiographic tests to ascertain the quality of the welding work. All weld defects discovered by the tests shall be repaired as directed by the Engineer and all repaired welds shall be re-tested.
The routine radiographic tests (10 percent) will be carried out at the Employer's expense. Should, however, the Engineer think it necessary to conduct additional tests because of the defective quality of the welds, the cost of all such additional tests will be charged to the Contractor's account. The Contractor shall also bear the cost of repair of all welds found defective under test as well as the cost of re-testing such repaired welds.

**Standards Of Acceptability For Radiographic Welds Tests**

- Lack of Penetration and Lack of Fusion will be permitted subject to the following provisions:
  1. The length of any individual defect of this kind shall not exceed 25mm.
  2. The total length of all such defects in any 30cm length of weld shall not exceed 25mm.
  3. The total length of all such defects in any two consecutive 30cm length of weld shall not exceed 50mm.
  4. Individual defects shall be separated by at least 15cm of sound weld metal free from any defects whatsoever.

- Burn-through Areas shall be permitted subject to the following provisions:
  1. The length of any individual burn-through area shall not exceed 13mm.
  2. The total length of all burn-through areas in any 30cm length of weld shall not exceed 25mm.
  3. The total length of all burn-through areas in any two consecutive 30cm lengths of weld shall not exceed 50mm.
  4. Individual burn-through areas shall be separated by at least 15cm of sound weld metal free from any defects whatsoever.

- Elongated Slag Inclusions will be permitted subject to the following provisions:
  1. Any elongated slag inclusion shall not exceed 50mm in length or 1.5 mm in width.
  2. The total length of all elongated slag inclusions in any two consecutive 30cm lengths of weld shall not exceed 100mm.
  3. The total length of all elongated slag inclusions in any two consecutive 30cm lengths of weld shall not exceed 100mm.
  4. Adjacent elongated slag inclusions shall be separated by at least 15cm of sound weld metal free from any defects whatsoever.
  5. Parallel elongated slag inclusions shall be considered as separate defects if the width of either of them exceeds 0.8mm.

- Isolated Slag Inclusions will be permitted subject to the following provisions:
  1. The width of any isolated slag inclusion shall not exceed 3mm.
  2. The total length of all isolated slag inclusions in any 30cm length of weld shall not exceed 12mm.
  3. There shall be no more than 4 (four) isolated slag inclusions exceeding 3mm in width in any 30cm length of weld.
  4. The total length of all isolated slag inclusions in any 60cm length of weld shall not exceed 25mm.
  5. Adjacent isolated slag inclusions shall be separated by at least 50mm of sound weld metal free from any defects whatsoever.

- Porosity or Gas Pockets will be permitted subject to the following provisions:
1. The maximum dimension of any individual gas pocket shall not exceed 1.5mm.
2. The distance between any two gas pockets exceeding 1mm in size shall be at least 4 (four) times the wall thickness of the pipe.
3. The distance between any two gas pocket exceeding 0.5 mm and smaller or equal to 1.0mm shall be at least twice the wall thickness of the pipe.
4. Not more than two gas pockets smaller than 0.5mm in size shall occur in any 10mm length of weld; nor shall there be more than ten such gas pockets in any 100mm length of weld.

♦ Cracks

No crack whatsoever will be permitted in any weld.

♦ Accumulation of Discontinuities:

1. No accumulation of discontinuities or of any defects whatsoever having a total length of more than 50mm will be permitted in any 30cm length of weld.
2. No accumulation of discontinuities or of any defects whatsoever having a total length in excess of 10 percent of the total weld length will be permitted.

♦ Undercuts will be permitted subject to the following provisions:

1. Any undercut adjacent to the cover bead on the outside of the pipe shall not exceed 1mm in depth or 50mm in length.
2. Any undercut adjacent to the root bead in the inside of the pipe shall not exceed 0.5mm in depth or 50mm in length.

5. INSTALLING AND LAYING OF PIPES

Pipes Embedded in Concrete

The contractor shall prepare these pipe sections with their fittings where necessary, to the shape and dimension as shown in the drawings and shall fix them in their exact positions. Puddle flanges shall be welded to the pipe section to be embedded in concrete. Prior to installation the pipe surfaces shall be thoroughly cleaned of all dirt, paint residue, loose rust and mill scale, and of any other foreign matter detrimental to a good bond between the steel and concrete; light rust adhering to the metal may remain.

The Contractor shall not commence placing of concrete around the pipes until the Engineer has inspected the installed pipes and given his consent to start concreting.

Prior to casting concrete surround, the pipe surfaces shall first be covered with a rich, semi-dry mortar which shall be made to adhere to the steel. Concrete must then be cast while the mortar is still wet.

Underground Pipes

All jointing between pipes and between pipes and fittings shall be done by welding, except that where shown on the Drawings or directed by the Engineer, flanges or mechanical couplings shall be used.

Before lowering-in, the pipe coating shall be inspected and all defects repaired. Lowering of pipes into the trench shall be done by pipe layers or other equipment acceptable to the Engineer, so that no injury or deformation is caused to the pipes or the coating and lining. Welded pipes shall be laid on the finished trench bottom, so that each pipe is supported over its entire length. The interior of the pipes shall be kept clean and free from any dirt and foreign matter.
At the end of each working day and wherever work is discontinued for a considerable time, the ends of each welded section, whether in or alongside the trench, shall be closed by a suitable cover snapping onto the pipe end.

Lowering-in of pipes shall be done carefully to prevent damage to pipe coating or lining.

6. THRUST BLOCKS, ANCHORS AND CONCRETE SURROUNDING
If not otherwise instructed the Contractor shall provide thrust blocks at all bends, tees, branches and tapers and at blank ends for the pressure pipeline as specified by the pipe Manufacturers and the Engineer. Enlargements shall be excavated in sides and bottom of the trench to accommodate anchorage and thrust blocks. The back of supports and blocks shall abut on to undisturbed solid ground. All loose material shall be removed before concreting.

The thrust blocks shall be designed by the Contractor in accordance with the BS.8110-the structural use of concrete. The Contractor shall show that soil resistance is greater than or equal to 1.2 times the force exerted by the pipe when subjected to the test pressure. The soil resistance shall be calculated as the frictional resistance of the soil against the thrust block. The passive resistance of the soil shall not be considered in thrust block calculations.

Concrete shall extend to undisturbed ground on thrust faces of thrust blocks and on both faces of anchor blocks.

Where details are not shown on the drawings, the Contractor shall prepare proposals for thrust and anchor blocks and submit them to the Engineer’s Representative for approval. Such approval shall not relieve the Contractor of his responsibility for the adequacy of his proposals. Special details shall be shown on the drawings or instructed at site where environmental or ground conditions dictate.

All thrust blocks, anchors shall be constructed from concrete with minimum strength of 250 kg/cm².

7. VALVES - GENERAL
Valves shall be rated for a pressure of not less than 10 bar except where otherwise specified. Valve bodies shall withstand a test pressure 50% greater than the rated pressure.

Valve bodies shall give the following information:
Manufacturer's name
Rated pressure
Size of valve
Direction of flow "Arrow"

Each valve or its operating equipment shall bear an approved name plate stating its function.

The operating gear of valves shall be such that one man can open and close the valve against an unbalanced head 15% in excess of the maximum encountered in service.

All valves shall be provided with access to enable renewal of seating and gland packing without removal of the valve bodies from the pipelines.

All valves shall be fitted with cast iron indexed hand wheel clearly marked “open” and “closed” with an arrow to indicate the direction of rotation.

During installation no valve shall be closed without wiping the faces with a clean cloth dipped in clean oil. Valves and fittings shall be individually supported and their weight shall not be borne by the pipeline or the joints.
Valves 2” (50mm) diameter and smaller shall be of bronze construction with screwed end, rising stem conform to BS 5154.

**Finishes to Valves**
Internal un-machined surfaces of valves shall be coated with two coats of an approved epoxy paint, and machined surfaces liable to corrosion with an anti-corrosion composition. External surfaces for valves in chamber shall be coated with two coats of epoxy paint and valves to be in contact with the soil shall be supplied primed for wrapping.

**Flanged Joints**
Flanges shall comply with BS 4504 NP 12. Each flanged joint shall be supplied complete with rubber jointing rings, and steel bolts and nuts which shall include two washers per bolt.

**Types of Valves and Other Fittings**

*Sluice Gates*

APPLICATION: as watertight sluice gate in channels (suitable for channel mounting), sealing on three sides till the height of the door (blocking a stream till overflow happens)

For aggressive liquids (sewerage, seawater, water treatment etc.) the design shall be executed with stainless steel AISI 316 guides, cross bar and strengthening profiles.

DESCRIPTION: The sluice gate shall be provided with a vertical-moving door to close circular, square and/or rectangular shaped openings.

On seating tightening shall be effected without use of adjustable wedges by means of a special EPDM spherical/lip shaped rubber profile on 3 sides.

The rising stem (spindle) shall be provided with trapezium thread.

The sluice gate shall be watertight on one- or, on request, both sides withstanding a pressure which is equal to the maximum height of the door without any visible deformation.

To maintain free passage of flow the channel-mounted penstock shall be supplied with flush invert.

MATERIALS: The door shall be of HDPE (high-density polyethylene) with a minimum thickness of 30 mm and will be provided with: stainless steel AISI 316 strengthening profiles (running into the guides).

Strengthening profiles for stiffness are calculated on the basis of the E-module over 50 years in combination with a permanent water pressure equal to the height of the door.

The door shall be provided with a replaceable EPDM spherical/lip shaped rubber profile for sealing. The groove in which the sealing is placed, will be provided with teething to prevent easy removal of seal.

The frame or back plate shall be of HDPE with a thickness of 30 mm. The guides and the cross bar shall be of stainless steel AISI 316. The cross bar in stainless steel AISI 316 will be U or C-shaped to add extra strength and stiffness the frame.

The trapezium threaded stem (spindle) shall be from stainless steel AISI 316 executed with a thrust ring shrunk around it, with striking pen, without any welding. Depending on the size, the penstock shall be operated through one or two stems (spindles).

The stop at the underside shall be a stainless steel AISI 316 bearing ring with a minimum thickness of 8 mm.

The bearing(s) house shall be of a wear resistant polyacetal.

The nut block(s) shall be of wear resistant polyacetal or bronze minimum RG 7 according to DIN 1705 with low contents of zinc.
The tightening between wall and frame or back plate shall be of neoprene cell rubber tape to be stucked on the frame plate according to installation instructions.

INSTALLATION: The sluice gate shall be mounted free of tension. In case of no recesses in the channel walls, mounting shall take place by means of an additional frame of HDPE or stainless steel to be fixed to the channel bottom and walls with chemical anchors.

In case of recesses in the channel walls and bottom mounting shall by preference be done by means of HDPE wedges (penstock remains easily removable) or by grouting in the frame.

All construction bolts, nuts, studs and fixing anchors shall be manufactured from stainless steel AISI 316.

Stem or spindle extension shall be from stainless steel AISI 316 tube coupled by bolted connection. Adjustable stem guides (guide brackets) shall be constructed from PU/Stainless steel AISI 316.

♦ Air Valves

Air valves shall efficiently exhaust or ventilate the force main during filling and emptying and also release entrapped air while in service. It shall be of cast iron to BS 1452 Gr. 14 and fit to wastewater flows. The orifice and ball shall be of nylon or A.B.S. plastic and sealing surfaces of nitrite rubber. They shall be of small or large orifice or both as called for in the drawings but sizing of the orifice shall be as recommended by the manufacturer for each location, diameter of pipeline and maximum pressure.

25 mm diameter air valves shall have a 25 mm diameter screwed inlet ferrule with a stop cock of gun metal. Air valves of diameter 50 mm or greater shall have an appropriate diameter flanged outlet and an isolating device of the same diameter. The isolating device may be either a gate valve.

♦ Check Valves (Non Return Valves)

Check valves shall be of the swing type with an extended hinge pin extended from both sides and with counterweight lever arms. Check valves shall be used to prevent automatically reversing of flow. Check valves shall comply with BS 4090 with cast iron body, door and cover, gunmetal seats and stainless steel hinge pin. All materials shall be to appropriate British Standards.

♦ Pressure Switches

The pressure switches are required to initiate remote alarm signals of pressure fluctuations and shall be located in easily accessible locations as shown on drawings and directed by the Engineer. The pressure switches shall comprise of beryllium copper diaphragm, brass 15 mm B.S.P., pressure connection, die-cast zinc micro-switch housing and steel and top cover with neoprene gasket.

Pressure sensing elements shall be either Bourdon tube or diaphragm type converting pressure to a proportional 4 to 20 mA current signal 24 VDC.

♦ Pressure gauges

Pressure gauges shall be of Bourdon tube type with an 4” dial size equipped with a bronze three way cock for air release suitable for 1/2” piping. Pressure gauges shall comply with BS 1780. The dials shall be graduated in bars (0-10bar).

Installation of Valves and Accessories

General
Before being installed, the valves and accessories, and especially valve seats, shall be cleaned of any dirt that may have entered them. When installing the valves, their correct position shall be ensured by means of a spirit level. Fitting the valves to pipes shall be done accurately, but without using force. Fitting of valves by tightening bolts forcibly or by any other method that will cause internal stresses in the valve or flanges will not be permitted.

**Flanges**
Flanges shall be welded to the pipes in accordance with the requirements of sub-clause 2.4.4. Care shall be taken to weld the flange with the face perpendicular to the pipe axis and the bolt holes straddling the centre line. Flange faces shall be kept free from weld material, spatter, and any other foreign matter, and all defects that may prevent proper sealing of flanges shall be repaired.

**Bolts**
Only bolts of the correct diameter shall be used. All bolts used on a valve shall be of equal length, which shall be such that after the nut has been tightened not less than one thread and not more than three threads of the bolt will protrude from the nut. Bolts shall be tightened crosswise, gradually and uniformly.

**Gaskets**
Only one sealing gasket shall be used between each pair of flanges. Gaskets shall be of the ring type, i.e. their outer rim shall just touch the bolt holes and their inside diameter shall be equal to that of the corresponding pipe. Gasket material shall be either fabric-reinforced rubber or compressed asbestos sheets known as "Klingerit".

Gaskets shall be fabricated by cutting from sheets. Cutting the gaskets by hammering on the flange will be strictly prohibited. When being installed, the gaskets shall be absolutely clean. Each gasket shall be used only once.

**Gate Valves**
Before being installed, each valve shall be fully opened and cleaned on the inside with a clean rag soaked in kerosene. Then the valve shall be completely closed and the flange faces also cleaned with kerosene. After cleaning, the flange faces shall be protected with wooden or cardboard covers, which may be removed only immediately prior to installing the valve.

**Check Valves, Float Valves, etc.**
The operation of all such valves shall be checked before and after installation and their proper functioning when put to use must be ensured.

**Mechanical Couplings**
Mechanical couplings shall be of the "Dresser" or "Victaulic" type as shown on the Drawings. Ends of pipes to be joined by Victaulic couplings shall be fitted with accurately machined rings. Ends of pipes to be joined by Dresser couplings shall be cleaned of paint, coating or other foreign matter and shall be sufficiently round for at least 20 cm from the pipe edge so that joint rings and couplings shall slide freely onto pipes; no forcing-on of rings by hammer blows will be permitted. All joint components and pipe ends shall be cleaned and inspected before installation of joint. Rubber gaskets shall be kept in a clean and dry place and protected against sunshine until immediately before installation. Coupling bolts shall be tightened evenly and gradually with sufficient force to attain a tight joint, but without causing undue stresses in bolts or joint components.

8. **CLEANING AND TESTING OF PIPELINES**

**General**
The Contractor shall submit for the Engineer or his representative for approval details of his proposed methods and program for testing (including details of test equipment) and shall arrange for all tests to be witnessed by the Engineer or other persons appointed by the Engineer. Pipelines shall be properly completed and supported before being put under test.

Notwithstanding the foregoing the Contractor may at any stage of construction, carry out such other tests as he considers desirable to check materials and workmanship on the pipeline but this shall not relieve the Contractor of his obligations to achieve successful tests under the Contract.

All water required for testing and cleaning the pipelines shall be potable or any suitable water approved by the Engineer or his representative.

The Contractor shall provide the required number of pumps, plug ends, shop fabricated test blank flanges, pipes and connections and all approved leakage detection equipment and all other items necessary and suitable for the testing of all pipes as described herein. The Contractor shall also provide all necessary temporary Works and material required for the test and shall remove the same upon successful completion of these tests.

The Contractor shall also provide the services of specialized personnel to conduct the test operation together with all required labor.

All tests shall be done in the presence of the Engineer or his representative, and the results of such tests shall be signed by the Contractor and handed over to the Engineer or his representative on demand. The results of all tests specifying the section of pipe tested, and all relevant date of the testing shall be produced in the form of a report by the Contractor and submitted to the Engineer or his representative for approval. This report shall be signed by both the Contractor and the Engineer or his representative.

The Contractor shall bear all costs in providing all labor, water, end caps, blank flanges, test pumps, gauges, piping and other necessary apparatus required to carry out the tests, the whole -cost for testing shall "be on the Contractor's account, including any repairs, re-testing, re-excavation, replacement or any other costs as may arise.

Cleaning and Inspection Of Pipelines
During and until commissioning, the Contractor shall provide and maintain wooden plugs in all open ends of pipes, to prevent the ingress of silt and deleterious matter into the pipelines.

After backfilling pipe trenches and completing chambers, hatch boxes etc. and before the trench surfaces are reinstated, the interior of pipelines shall be cleaned of silt and debris by approved methods for inspection by the Engineer's Representative as follows:

All newly constructed pipelines of 500mm (nom.) internal diameter and smaller shall have a loose plug passed through them to show that they are clear of obstruction and free from deflection. The loose plug shall be dimensioned to suit the permissible minimum deflected diameter of the pipe.

Hydrostatic Pressure Testing Of Pressure Pipeline

- General

After pipe laying, casting of concrete structures on the pressure pipeline and partial backfill have been completed, the lines shall be tested over their entire length or, in the case of long lines, in sections. The pressure test shall only be performed in the presence of the Engineer’s Representative.

The test pressure shall be determined by the Engineer in each case. The required pressure shall be obtained by means of a special pressure pump or by connecting the line to a suitable source of
pressure.

**Preparation for Pressure Test**
The Contractor shall provide written notice to the Engineer of any test two days before the test is to be carried out. The Contractor shall maintain written records of the tests and provide copies of the records to the Engineer prior to the completion of the project.

Filling of the pipelines with water shall not begin until 7 days after the last concrete structures have been cast. Prior to filling the lines, all joints and structures shall be inspected and be in good condition and proper functioning of all valves shall be ascertained. When testing a section not ending in a valve, the open end shall be a bulkhead and securely anchored. The testing installation and the working of the pump shall also be examined. Prior to hydraulically testing the pipelines the Contractor shall provide adequate temporary thrust blocks at the ends of uncompleted sections, pipes shall be partially backfilled to about 500 mm above the crown of the pipe, in order to anchor the pipes during testing. Joints and fittings, however, shall remain uncovered until the pipeline has been tested satisfactorily.

The length of the section of pipeline to be tested may be determined by the contractor but shall not exceed 500 meters. Levels of the length of pipe under test shall be such that the minimum test pressure specified is achieved at all points whilst the maximum test pressure specified is nowhere exceeded.

**Filling the pipeline with Water**
The lines shall not be filled until the Engineer's written approval has been given. The lines shall be filled gradually and slowly in order to prevent water hammer or chattering in the pipes and to permit the escape of all air from the pipelines. The rate at which the lines are to be filled shall be determined by the availability of water. Consideration shall be given to filling mains at night, but always with the approval of the Municipality Engineer.

Before testing the line should be filled slowly and evenly with water through any convenient top or valve from the lowest end point. At every high point an automatic air release valve must be installed. After expelling all the entrapped air out of the test portion, all air release valves should be closed. If it is not possible to fill the line from the lowest point, an additional outlet should be added at the inlet point to release air at that point and this line/section should be kept filled for 24 hours before the pressure test.

At the commencement of filling, all blows out valves shall be open and each valve shall be closed after the water has flushed all dirt that may have accumulated in the pipes.

After the filling has been completed, but before the pressure is raised, all valves shall be inspected for water-tightness and all leaks in gaskets and stuffing boxes shall be stopped. Should this inspection show any leaks at the joints or defects in the valves that cannot be repaired while the lines are full of water, the lines shall be drained and the necessary repairs done. This inspection shall be repeated until all leaks are stopped.

Valves shall not be used to isolate sections forming the pipeline during testing operations.

**Pressure Test**
The pressure test shall be 1.5 times the maximum working pressure. The pressure shall be raised slowly to the specified test pressure and maintained at that pressure for a period long enough for the Engineer to examine the whole section under test. The pipeline shall be maintained under this pressure for a period of 24 hours, during which the pressure shall not be allowed to fall below 100% of the test pressure but shall be restored to the full test pressure by such pumping as may be necessary.
Should any inspection be unsatisfactory or any test fail, the Contractor shall replace defective pipes, leaking joints or otherwise re-execute defective work as instructed following which cleaning and testing will be repeated until the Engineer’s Representative certifies the pipeline to be satisfactory.

The pressure test shall also serve as a strength test for the concrete anchor and thrust blocks, thus these structures shall be designed by the Contractor accordingly. Any structures failing the test shall be replaced by the Contractor at his own expense.

**Electrical Works**

**Description of the work:**
The work in the water pump station comprises the followings:

1. Supplying and erecting flush type electrical wiring of the machines building.
2. Supplying and erecting electrical protection and control switchboards.
3. Supplying and erecting electrical network pipes and cables.
4. Supplying and erecting electrical security light network.
5. Supplying and erecting electrical generator with its control.
7. Supplying and erecting fire alarm system.
8. Supplying and erecting lightning protection system.
9. Supplying and erecting grounding system.

**GENERAL:**

1. All materials and equipment shall meet the requirements of the following standards, codes and regulations: B.S.S- British standard- Britain. V.D.E. and DIN - Germany. NEMA, UL, NEC. - USA
2. All supplied cables and conductors shall be NYY and/or XLPE copper, with 1000 Volt insulation for 400/230 Volt network.
3. Total impedance of the grounding system in accordance with ground total mass will not exceed 5 Ohms.
4. Metal parts shall be Hot galvanized not less than 110 Micron.
5. Metal switchboards shall be made of 2 mm thick galvanized steel sheets, painted with Epoxy.
6. All metal equipment and light fixtures shall be earthed with earth wire equal to the phase conductor.

**Electrical Wiring:**

1. All Electrical wiring for the machines and generator building will be flush type.
2. All conductors for internal wiring are PVC insulated PVC Sheathed copper and shall be insulated for 600 Volts, with standard colors (red, black, blue, yellow, green).
3. Electrical wires for internal lighting are 3 conductors, each 1.5 sq.mm cross-section inside 0.75 diameter PVC conduits.
4. Electrical wires for internal power sockets are 3 conductors, each 2.5 sq.mm cross-section inside 0.75 diameter PVC conduits.
5. Pulling of wires inside conduit may be carried out before the finishing works have been completed, unless otherwise instructed by the consulting engineer. However, connection to all devices and installations of the fixtures shall be carried out after the finishing works have been completed.
6. No lubricant, other than soapstone, shall be used to facilitate pulling of wires.
7. All taps and joints in conductors shall only be made in outlets, junction boxes and switchboards, no joints shall be made in joint boxes. Connectors and clamps shall be of approved design surrounded with plastic insulation. It is not allowed to use insulation tape when connecting two ends of conductors.

8. At each fixture a loop or end of wire not less than 20 cm long shall be left for connection to devices or fixtures. Soldered connections shall be used where conductors are under strain. Non-acid base flux shall be used for soldering.

9. Switches shall be wired in phase lines only. The neutral conductors shall not be broken. All outlets shall be wired in the same manner with the phase connected to the same pole (right pole when viewed from the rear or top pole).

10. PVC pipes (conduits) are of 1000 Volts insulation strength, cross-sections are 0.75", 1.0", 1.25", 1.5" and 2", 50% of the pipe cross-section shall be left empty for air circulation and cooling purposes.

11. Approved junction or outlet boxes shall be used at all branchings of conduit or outlets. A maximum run of 10 m with two 90 degrees bends, shall not be exceeded between one box and another on a single run of conduit.

12. Bends in conduits shall be made such that the inside radius of conduits not changed and bent angles shall not exceed 90 degrees.

13. All conduit ends left open during the course of the works shall be plugged to avoid filling with plaster, and the like.

Switches and Sockets:
1. Switches shall be of an approved European, American or Japanese brand names and types, 230 Volt, 10 Ampere.
2. Outlet boxes for switches shall be fixed 1.2 m above finished floor level, and 12 cm horizontally from the outside edge of the nearest door architrave.
3. Sockets shall be of an approved European, American or Japanese brand names and types (Greek type) for 3-pin plugs with safety shutters, 230 Volt, 16 Amperes, unless otherwise directed.
4. Outlet boxes for socket outlets shall be installed 40 cm above finished floor level.
5. Plates for switches and socket outlets shall be approved heavy duty white plastic, fitting flush against the plaster, attached to the outlet box by 2 screws.

Fluorescent Lighting Fittings:
1. Each fixture shall be complete, including 40 watt 120 cm long, or 20 watt 60 cm long day light discharge lamps, choke coils, starters, capacitors, and wiring.
2. The lamp shall have 7500 hours life time, and gives more than 2300 lumens after 100 hours. The choke coil shall have original brand name.
3. The light fixture is to be fitted direct under ceiling.

Telephone and TV Sockets:
1. Telephone and TV sockets shall be of an approved name and type.
2. Outlet boxes for socket outlets shall be installed 40 cm above finished floor level.
3. 3mm diameter inductive coaxial TV cable shall be fixed to the TV socket direct from the TV connection box, and 75 ohm end of line resistor shall be used, series connection is used up to but no more than five sockets.
4. Telephone socket shall be connected to 3 pairs telephone cable, 0.5 sq.mm conductor and connected to telephone exchange (if any).

Electric bells:
1. Electric bell shall be of heavy duty approved type.
2. There are bells and serines connected to same control, and shall be operated simultaneously.
3. The conductor’s cross section is 2.5 sq.mm, 3 wires system.

Electrical switchboards and panel boards:
1. The framework of the switchboard material is mentioned in the bills of quantities.
2. The framework of the metal switchboard is to be constructed of galvanized steel sheet not less than 2 mm thickness.
3. It must have front access to switches, circuit breakers, and other equipments.
4. The framework must have doors that close tightly with original strong hinges and key lock system. Metal doors shall be earthed with earthing wires.
5. The metal framework is to be painted by electrostatic and insulating beige paint 90-100 microns or more in thickness.
6. All incoming and outgoing cables must be brought from the bottom and/or top through tight insulating flanges.
7. Conductors and busbars on a switchboard or panel board shall be so located as to be free from physical damage and shall be held firmly in place. Other than the required interconnections and control wiring, only those conductors that are intended for termination in vertical section of a switchboard shall be located in that section. Barriers shall be placed in all service switchboards that will isolate the service busbars and terminals from the remainder of the switchboard.
8. The arrangement of busbars and conductors shall be such as to avoid over-heating due to inductive effects.
9. Load terminals in switchboards and panel boards shall be so located that it will be unnecessary to reach across or beyond an ungrounded line bus in order to make load connections.
10. Unused openings in switchboards and panel boards shall be effectively closed to afford protection substantially equivalent to that of the wall of the cabinet.
11. Switchboard metal frames and structures supporting switching equipment shall be grounded.
12. Terminal blocks shall be rigidly fixed and shall be covered by effective insulting material or cover.
13. Obvious name plates shall be fixed by screws on the switchboard or panel board. The name plate shall carry the names of the lines, machines / equipment next to all corresponding cable terminals and switches or circuit breakers.

Earthing in foundation:
1. A hot galvanized sheet steel 3x30 mm cross section shall be welded to the steel reinforcement of the tie beams at the columns as shown in the drawings.
2. The earth resistance shall be 5 Ohms or less.
3. One or more grounding units shall be used if the earth resistance of the steel sheets is more than 5 Ohms, and this is to be done on the contractor expenses, no extra payment will be paid to the contractor when he fixes and connects the grounding units.

Grounding Unit:
1. A number of 17 mm diameter, 1.5 m long copper/lead bars, electrodes.
2. The electrodes shall be electrically connected.
3. Copper flat washers, nuts, bolts, clamps, etc.
4. The grounding wire is specified in the bill of quantities copper conductor connected to metal parts of the switchboards and/or the galvanized steel sheets in foundations.
5. Standard 60 cm diameter inspection chamber with its 5 tons cover.
6. The ground resistance shall be 5 ohms or less.
Circuit breakers:
Circuit breakers shall be an approved European, American or Japanese brand names and types, and shall have thermal and magnetic trip (release) mechanisms and/or control.

Short circuit (switching) capacity of miniature circuit breakers shall be not less than 10KA, at rated currents and nominal voltage 415V for three phase, and 240V for single phase. Number of operating cycles not less than 20000 (o.c).

Short circuit (switching) capacity of LV molded case circuit breakers shall be not less than 50KA, at rated currents and nominal voltage 415V for three phase. Number of operating cycles not less than 30000 (o.c). Remote tripping, solenoid coil, under voltage trip, auxiliary switches for alarm and signaling shall be provided if necessary and specified. Terminal covers shall be fixed for safety and protection.
Earth leakage circuit breakers sensitivity is 30 mA for residential and commercial applications, and 200 mA for industrial applications at nominal current and voltage. Number of operating cycles not less than 20000 (o.c).
Indication of: ON/OFF, Voltage and Ampere rating shall be clear in the front face of the circuit breaker. The insulation material shall be for 600V operation.
Technical manuals shall be provided for the approval of the engineer.

The Capacitors:
1. The capacitor shall have charging and discharging resistances as specified by the manufacturer and according to the control.
2. Protection covers shall be provided against faults, and explosion of the capacitors.
3. Special control of the capacitors shall be done as might be specified by the manufacturer of the motor/pumps.
4. Power factor correction shall be equipped with automatic controller to maintain suitable PF of 0.92 or as approved by the Engineer.

The Contactors:
1. The contactors shall have 3 or 4 (poles) main power supply contacts, in addition to any needed number of auxiliary contacts for power and control purposes.
2. The contacts ratings are specified as: 380-440 V ac, 50/60 Hz, Amperes and/or HP and/or KW load rating, at utilization category AC3.
3. The contactor coil is 220V ac, and/or 12-24 V dc, and/or as might be specified by the manufacturer and control of the PLC.

Programmable Logic Controller (PLC):
1. Temperature: -40 to 85 centigrade degree.
2. Humidity: 5% to 95%
3. Vibration: 0.2" 5-10Hz, 1G 10-200Hz.
4. AC power source: 120V - 240V ac.
5. Frequency: 47 - 53 Hz.
7. Back-up Battery: Lithium, long-life, 8-10 years no load, 1 year loaded.
8. Typical Scan Rate: 0.8 ms/1K of logic words.
9. Maximum Number of input/output points: 128 I/O.
10. K Bytes RAM memory (minimum).
11. Logic memory: CMOS RAM, PROM, EEPROM not less than 16K Bytes (8 K Words), and/or memory back not less than 16 K Bytes.
12. Internal Functions: 1024 internal coils,>300 timers/counters, 2048 data registers, analog 128 input, analog 64 output, 80 KHz high speed counters.
13. Programming: Relay ladder, Statement list, Hand Held Programmer, Workmaster or IBM compatible with all cables, interface ports, and software.
14. Instructions: not less 20 basic, 60 functions.

**Solid State Reduced Voltage Starter (RVS):**
1. The RVS shall be an approved brand names and types.
2. It has fully featured, Digital-Microprocessor based design.
5. Starting Conditions: Max ambient temp 50 C, Max starting current 400% FLA, Max start time 30 seconds adjustable, Max starts per hour 6 starts at max ratings up to 60 starts at light loads.
6. By-Pass Contactor: The RVS has by-pass contactor control to be operated in more severe conditions.
7. Additional Ventilation: RVS general purpose enclosures has a fan on air outlet.
8. Terminals, Auxiliary and Alarm Contacts: The RVS has:
   • control supply terminals to RVS, supply terminals to the fans.
   • Soft start, soft stop terminals, energy save/slow speed terminals.
   • End of acceleration terminals, alarm and external fault terminals, tacho-feedback terminals.
   • Power, common, and neutral terminals.
9. Digital display.
10. Control and programming facilities.

**The Relays:**
1. Time delay sensitive relay is connected to float output. Supply voltage is 220V ac and/or 12-24 V dc, it has N.O, and N.C output contacts, and two input terminals (for float signal). The delay time is controlled by switch range (5 - 15 seconds).
2. Humidity sensitive relay is connected to sensitive electrode inside the cooling oil chamber of the pump. the electrode gives the signal when there is moisture in the oil chamber due to insulation break down. The relay has N.O, and N.C. output contacts, and two input terminals (for oil electrode and earth conductors). The supply voltage is 220 V ac and or 12-24 V dc.

**The Floats:**
1. The Float shall be an approved brand names and types.
2. It has 10A, 220V, N.O. and N.C. electrical contacts.
3. The use of the float shall be specified for water wet well, pools and tanks. The material of the float and conductors and cables shall be protected from chemical materials and acids.
4. Special methods and care shall be used in fixing the floats and cables so that it is protected against mechanical shocks and easy to check and maintain.
5. The cable shall be, so long so, that it need not extra connection inside the water tank.
6. Junction boxes of an approved type shall be used to connect float cable to switchboards and control.

**Uninterruptible Power Supply (UPS):**
1. Watt rating, at least 2x12V/60A internal/external backup batteries, 50-60 Minutes discharging time at full load, 220 V ac sine wave output, less than 1 msec transfer time.
2. Indicators and buzzer: indication lights for on line output, overload/fault, low battery, on line and/or off line loading, with buzzer sound for fault, low battery, and off line.
3. Protection against mains malfunctions, short and overload, and circuits for filtering out voltage fluctuations.

**Alarm Electric Bell and Serine:**
1. It shall be specified in the manual its use for alarm in open areas and shall follow IP55 standards.
2. The working voltage shall be 220 V ac, and/or 12-24 V dc.
3. The serine has a flashing red or yellow light in addition to sound alarm.
4. The cables and conductors shall be according to manufacturer specifications.

**Security light fixture:**
1. The street light fixture shall be an approved brand names and types double insulated IP65 category.
2. The body is injected polyester, canopy is injected UV stabilized polypropylene, canopy clips are stainless steel, spigot entry is pressure die cast aluminum.
3. It has high degree of sealing against the ingress of dust and moisture (IP65), and electrical safety (insulated to class 2 double insulated) and one piece high purity aluminum reflector.
4. The lamp holder has to be adjustable on site. The lamp is 150W HPS.
5. The bowls are made of acrylic or polycarbonate, with gasket attached which beds into a deep protected channel with multi rib sealing face.
6. The bowl is hinged in two corners and two latches in the other two corners clamp the bowl security.
7. Installation/mounting: side and post top entries 34-42mm diameter, 60mm long with 20 degree inclination.
8. Detachable control gear tray with all necessary choke coil, starter ignitor and capacitor.

**DIESEL GENERATOR UNIT**
The Contractor shall supply and install an insulated diesel generator unit to be automatically operated in case of electricity failure.

The generator unit shall be of the following characteristics:

- Output at stand-by operation shall be not less than 180 KVA
- Voltage 230/400 with zero terminal, 3 phase, 50HZ, 1500 r.p.m.
- Alternator shall be of the brushless type equipped with an automatic self adjusting and exiting regulators.
- Winding shall be of the tropical type.

The diesel engine shall be multi-cylinder, two or four stroke, in-line, turbo-charged engine. The engine shall be equipped with water cooling system, including radiator and blower type fan, exhaust piping including residential muffler with an elastic conduit of sufficient length, electric starting system including heavy duty 200 ampere-hours batteries and automatic trickling charger for charging the batteries, instrument panel with all necessary gauges and controls. The engine and
alternator shall be mounted in perfect alignment on a common rigid steel frame. Alternator with single or two bearing supports are acceptable. The engine shall have automatic shut down devices in case of high cooling water temperature or no water in the radiator, low lubricating oil pressure and over-speed. The D.G. shall be equipped with additional manual starting push buttons.

The Contractor shall supply and install a 4000 liters above ground fuel tank as per drawings, with all piping and fittings from the storage fuel tank including return piping and fuel pump with float valve. Water proof concrete construction shall be built around the tank to prevent earth and aquifer pollution in case of leakage from the tank.

All rotating parts of machinery shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the vibration displacement (peak to peak) as measured at any point on the machine shall not exceed 4.0 mils.

At any operating speed, the ratio of rotative speed to the critical speed of a unit of components thereof shall not be less than 0.8 or more than 1.3.

Site Condition

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient Temperature</td>
<td>5-35°</td>
</tr>
<tr>
<td>Altitude</td>
<td>70 m. A.S.L.</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>65 %</td>
</tr>
</tbody>
</table>
ROADS AND PAVINGS

Unless otherwise instructed, all the roads and paving shall be fully reinstated to the existing roads and paving condition and this shall include the base course, asphalt layers and interlock tiles.

1. BASE
Description
This work shall consist of, watering mixing, spreading and compacting crushed stone base course in accordance with these Specifications and in conformity with the lines, grades, thickness, and typical cross sections as directed by the Engineer.

Applicable Publications
The following Specifications and Standards form an integral part of this Division of the Technical Specifications and are deemed to be fully applicable to tests carried out by the Contractor as and when directed by the Engineer or his representative.

American Society for Testing Materials

C 29 Test for Unit Weight of Aggregate
C 117 Test for Materials. Finer than No.200 Sieve in Mineral Aggregate by Washing
C 131 Test for Resistance to Abrasion of Small Size Course Aggregate by Use of Los Angeles Machine.
C 136 Test for Sieve or Screen Analysis of Fine and Coarse Aggregates
C 75 Sampling Stone, Slag, Gravel, Sand and stone Block for Use as Highway Materials
D 423 Test for Liquid Limit of Soils
D 424 Test for Plastic Limit and plasticity Index of Soils
D 854 Test for Specific Gravity of Soils
D 1556 Test for Density of Soil in Place by the Sand-Cone Method
D 1557 Test for Moisture-Density Relations of Soils Using 10-lb Hammer and 18-In. Drop
D 1883 Test for Bearing Ratio of laboratory-Compacted Soils
D 2167 Test for Density of Soil in Place by the Rubber Balloon Method

American Association of State Highway and Transportation Officials

T 176 Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test

Materials
The base course material shall consist of hard, durable particles or fragments of stone or gravel crushed to the required size by mechanical crusher, and a filler of sand or other finely divided mineral matter. The material shall be free from vegetable matter, clay lumps, and the deleterious substances.

General Requirements
The gradation of the crushed stone shall conform to the following grading requirements:

### Grading requirements

<table>
<thead>
<tr>
<th>SIEVE SIZE</th>
<th>PERCENT PASSING BY WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>INCHES MM A B</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>38.100</td>
</tr>
<tr>
<td>1</td>
<td>25.400</td>
</tr>
<tr>
<td>0.75</td>
<td>19.100</td>
</tr>
<tr>
<td>0.5</td>
<td>12.700</td>
</tr>
<tr>
<td>0.375</td>
<td>9.520</td>
</tr>
<tr>
<td>No. 4</td>
<td>9.760</td>
</tr>
<tr>
<td>No. 10</td>
<td>2.000</td>
</tr>
<tr>
<td>No. 40</td>
<td>0.420</td>
</tr>
<tr>
<td>No. 200</td>
<td>0.074</td>
</tr>
</tbody>
</table>

The portion of the material retained on a No. 4 sieve shall be known as coarse aggregate, and that portion passing a No. 4 sieve shall be known as fine aggregate.

Coarse aggregate shall have a percentage of wear of not more than 40% at 500 revolutions as determined by the AASHTO 96 Test method.

For all grading that portion passing a No. 40 sieve, including blending filler, shall have a liquid limit of not more than 25 and a plasticity index of not more than 6 as determined by AASHO T89 and T91 respectively.

The material must pass the ASTM soundness test so that the decrease after 5 cycles will be not more than 12 percent when sodium sulfate is used or not more than 18 percent when magnesium sulfate is used. CBR must not be less than 80 percent at maximum dry density and expansion when a compacted sample is soaked not to exceed 1 percent.

### Spreading

Crushed stone for base course shall be delivered to the roadbeds as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free from pockets of coarse or fine material.

The base course material shall be deposited on the prepared sub-base by approved mechanical method at a uniform quantity which will provide the required compacted thickness within the specified tolerances without resorting to spotting, picking-up or shifting the base material.

The base course material shall be spread and compacted in layers each 20 cm thick after compaction.

### Compacting

The base course material shall be watered and compacted to not less than 98 percent of maximum dry density (Modified AASHTO) as determined in the laboratory.

The surface of the finished base course at any point shall not vary more than 1.5 cm above or below the grade established by the Engineer's Representative.

If the above requirements are not complied with the base shall be reshaped reworked watered and thoroughly re-compacted to conform to the specified requirements.

### 2. BITUMINOUS PRIME COAT AND TACK COAT

90
Description
This work shall consist of furnishing and applying a bituminous prime coat and tack coat RC2 to the finished base course surface in accordance with these Specifications and as shown on the Drawings.

Applicable Specifications
The following Specifications and Standard form an integral part of this Division of the Technical Specifications and are deemed to be fully applicable to test to be carried out by the Contractor when and as directed by the Engineer or his representative.

American Society for Testing and Materials
D 140 Sampling Bituminous Materials
D 2028 Spec. for Cut-Back Asphalt (Rapid Curing Type)
D 2027 Spec. for Cut-back Asphalt (Medium Curing Type)
D 1250 ASTM-IP Petroleum Measurement Tables
D 2995 Recom. Practice for Determining Application Rate of Bituminous Distributors

Materials
The bituminous prime and tack coats as per this "Division of the Technical Specifications, shall consist of an application of asphalt material respectively on a previously prepared subbase and crushed stone base and bituminous base course.

Bituminous Material
The bituminous material to be used for the prime coat shall conform to the kind, grade and Specifications as follows:

Medium Curing Cut-Back Asphalt, grade MC- 70, conforming to the requirements of ASTM D 2027.

The bituminous materials to be used for the tack coat shall conform to the kind, grade and Specifications as follows:

Rapid Curing Cut-Back Asphalt, grade RC- 70, conforming to the requirements of ASTM D 2028.

Application temperature shall be as follows:
For MC- 70 and RC- 70, between 50°C and 80°C.

Depending on local condition and on the possibilities of obtaining bituminous materials, the Engineer or his representative may modify the type and graduation of the materials for the prime coat and the tack coat.

Quantities To Be Applied
Bituminous materials for the prime coat shall be applied in quantities of 1.0 liters per square meter. Bituminous material for the tack coat shall be applied in quantity 0.5 liters per square meter. The exact quantities, which may be varied to suit field conditions, will be determined by the Engineer or his representative following trials to be carried out by the Contractor.

Sampling and Testing
All samples of bituminous material, unless otherwise specified, shall be, taken in accordance with the requirements of ASTM D 140. All samples and tests shall be supplied and carried out by the Contractor at his own expense.

The source from which the bituminous material is to be obtained shall be selected in advance of the time when the material is required for use in the Work and suitably sized samples shall be submitted to the Engineer or his representative for approval not less than 45 days. Before commencing the Work. Additional samples of bituminous material may be required by the Engineer or his representative during construction.

Preparation of the Surface
Holes and depressions shall be repaired by removing all loose and defective material and replacing it with approved granular material as directed by the Engineer. All bumps, ridges, depressions, corrugations and waves shall be corrected by lightly grading the road surface with an autopatrol grader. If necessary and if ordered by the Engineer the surface may be reshaped and re-compacted. All loose material shall be swept from the surface prior to priming by means of a power broom. The surface of the road may be dampened slightly with water prior to priming if so ordered by the Engineer.

Application Of Bituminous Material
Prime and tack coats shall be applied as prescribed below

PRIME COAT
Following the preparation of the sub base or crushed stone base courses, the bituminous, material shall be applied by means of a bituminous distributor at the temperature specified. The bituminous material shall be applied at the pressure and in the amounts as directed by the Engineer or his representative. The priming material shall be so applied that uniform distribution is obtained at all points of the surface to be primed or treated. Unless the distributor is equipped so as to obtain satisfactory results at the junction of previous and subsequent applications, building paper shall be spread on the surface for a sufficient distance back from the ends of each application so that flow through the sprays may be started and stopped on the paper, and that all sprays will be operating at full force on the surface to be treated. Immediately after the application, the building paper shall be removed and destroyed. All spots unavoidably missed by the distributor shall be properly treated with bituminous material.
Following the application of prime material, the surface shall be allowed to dry for a period of not less than 48 hours without being disturbed of for such additional period of time as may be necessary to attain penetration into the soil-aggregate subbase or crushed stone base courses and the drying out or evaporation of the volatile from prime material, which period shall be determined by the Engineer or his representative.

TACK COAT
Following the preparation of the surface of bituminous base course, the bituminous material shall be applied by means of bituminous distributor at the temperature specified. The bituminous material shall be applied at the pressure and in the amount as directed by the Engineer or his representative. The coating material shall be so applied that uniform distribution is obtained at all points of the surface to be treated.

Unless the distributor is equipped so as to obtain satisfactory results at the junction of previous and subsequent application, building paper shall be spread on the surface for a sufficient distance back from the ends of each application so that flow through the sprays may be started and stopped on the paper, and that all sprays will be operating at full force on the surface to be treated. Immediately after the application, the building paper shall be removed and destroyed. All spots unavoidably missed by the distributor shall be properly treated with bituminous material.
The surface coated shall be allowed to dry until the volatile have dried out or evaporated from the tack materials and it is in a proper condition of tackiness receive the base or wearing courses respectively. The coat shall be applied only so far in advance of base and wearing courses as is necessary to obtain this proper condition of tackiness, which period shall be determined by the Engineer or his representative.

3. ASPHALTIC CONCRETE

Description
This work shall consist of furnishing and mixing aggregate and asphalt binder, and spreading and compacting the mixture, all as specified in these Specifications and in conformity with the lines, grades, thickness and typical cross section shown on the Drawings.

Materials
1. Mineral Aggregate

Mineral aggregate for asphaltic concrete shall consist of coarse aggregate, fine aggregate and filler if such is required to obtain the grading for the combined aggregate.

a. Coarse aggregate shall consist of clean crushed rock or crushed gravel. The aggregate shall be uniformly graded within the limits specified. The coarse aggregate shall pass the following:

Soundness Sodium Sulphate       10% Max. 
(5 cycles) ASTM C88
Magnesium Sulphate                12% Max.
Loss by Abrasion after 100 revolutions
ASTM or latest revision thereof    40% Max.
Thin and elongated pieces, by weight
pieces larger than 1” less than 1/5 of
the length.                        25% Max.
Soft fragments ASTM C235-57T or
latest revision thereof            25% Max.

The coarse aggregate shall have at least one mechanically fractured face on 80 percent of the particles retained on the No. 4 sieve. And when coated with asphalt shall pass the stripping test not less than 95% coated bituminous.

b. The fine aggregate shall consist of natural sands free from lumps of clay or silt or other deleterious material. The sizes of the particles shall be such as to provide the required specified graded aggregate when blended with the coarse aggregate. The fine aggregate may be produced with the coarse aggregate if the source of the paving aggregate is such that the processing requirements of the specifications.

c. Mineral filler shall be Portland Cement, rock dust, or natural filler from approved deposits. Such filler need only to be added to the aggregate to secure the specified grading of the combined aggregate. The mineral filler shall meet the following gradation requirements.

<table>
<thead>
<tr>
<th>U.S. STANDARD SIEVE</th>
<th>PERCENT PASSING BY DRY WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>#30</td>
<td>100</td>
</tr>
<tr>
<td>#100</td>
<td>95</td>
</tr>
<tr>
<td>#200</td>
<td>65</td>
</tr>
</tbody>
</table>
d. The intent of these Specifications is to have the Contractor supply a combined aggregate to the pugmill of the asphalt plant that meets the grading requirements as herein specified. The Contractor may supply to his asphalt plant a combined aggregate or he may choose to supply the various components of the final aggregate and deliver these to a set of cold feeders. In any case irrespective of the way the Contractor may select to deliver the aggregate to the plant, it shall be heated and following the heating and drying it shall be delivered to a set of screens to be separated into sizes as specified prior to delivery to the pugmill where it is mixed with the specified liquid asphalt. The addition of mineral filler may or may not be necessary but the grading requirements of the total aggregate must be met irrespective of the manner that the Contractor chooses to produce the specified aggregate.

The combined mineral aggregate shall meet the following physical requirements:

<table>
<thead>
<tr>
<th>Sand Equivalent</th>
<th>50 Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasticity index</td>
<td>6 maximum</td>
</tr>
</tbody>
</table>

2. Asphalt Cement
Unless otherwise specified the asphalt cement shall be the product produced by the latest specification for asphalt cement for use in road pavement construction and shall have a penetration at (25°C) 77°F of 60 to 70, when tested by means of the latest ASTM test method for measuring penetration.

Grading Requirements and Asphalt percent
The asphalt mixture shall conform to the requirements of this specification. The mineral aggregate, (that is the combination of the coarse aggregate, the fine aggregate and the filler) for the binder and wearing courses shall be within the following limits:

<table>
<thead>
<tr>
<th>ASTM SIEVE SIZE</th>
<th>MIX FORMULA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>1.5 inch</td>
<td>-</td>
</tr>
<tr>
<td>1.0 inch</td>
<td>-</td>
</tr>
<tr>
<td>0.75 inch</td>
<td>100%</td>
</tr>
<tr>
<td>0.5 inch</td>
<td>95-100%</td>
</tr>
<tr>
<td>0.95 inch</td>
<td>70-95%</td>
</tr>
<tr>
<td>No. 4</td>
<td>50-70%</td>
</tr>
<tr>
<td>No. 10</td>
<td>32-52%</td>
</tr>
<tr>
<td>No. 40</td>
<td>16-30%</td>
</tr>
<tr>
<td>No. 80</td>
<td>10-20%</td>
</tr>
<tr>
<td>No. 200</td>
<td>4-9%</td>
</tr>
</tbody>
</table>

The grading of the above aggregate shall be uniform within the limits specified above. Any addition or rejection of any size or sizes necessary to produce a uniform aggregate shall be the full and complete responsibility of the Contractor. Fines or mineral filler will only be added when the natural crushed material is short of such sizes and the addition is required to bring the combined aggregate within the limits specified above.

Preparation of the Asphalt Cement
The penetration of the asphalt cement shall be tested by the Engineer's Representative from time to time to ensure that it is maintained at a uniform consistency. The Engineer's Representative may test other physical properties of the asphalt to check on the quality of the material delivered and to ensure that it meets the required specification. For asphaltic concrete as herein specified the
asphalt shall be 60/70 penetration paving grade asphalt, unless otherwise specified in the special provisions of the Contract. The 60/70 asphalt shall be heated in an approved storage tank to a temperature of 325°F (163°C) prior to being mixed with the heated aggregates. The permissible range for heating and mixing is 149°C to 163°C when this grade of asphalt is used. The aggregates will be fed to the mixer at a uniform rate and at a temperature range identical to that of the asphalt cement.

**Laying the Asphaltic Concrete**
The paving shall be accomplished by means of a self-propelled paver of standard make and design, equipped with a vibratory screed, capable of laying the pavement true to line and grade.

The freshly laid mix shall be rolled by means of approved rollers. The breakdown roller shall be 3-5 tons and to back roller shall be 8 to 10 tons. In addition, there shall be one rubber tired roller. Rolling shall be done by commencing at the edge and progressing to the center with an overlap of half the width of the roller on each pass. The rollers shall be operated at a very slow speed as directed by Engineer’s Representative and shall not stop and reverse at the same point at each pass. Rolling shall be carried out as close behind the paver as possible. The rubber tired roller shall have smooth tires and shall be operated either in front or behind the back roller as may be required to obtain the required result.

Hand raking and handwork shall be kept to a minimum and the indiscriminate throwing of hot mix across the fresh pavement to correct surface deficiencies shall not be permitted. Where hand raking or hand finishing is necessary the large stones in the mix at the surface shall be raked out and thrown clear of the fresh pavement.

All joints in the pavement shall be vertical. Joints at the start of a day's run shall be cut vertical and the surplus of hardened material removed. The end joint shall be hand raked in such a manner to provide a finished surface free from any bump or depression and the rolling of the end joint shall be cross wise to the roadway with at least half of the roller on the previously laid mat. Likewise, the center joint shall be rolled in such a manner as to provide a smooth joint and the initial pass of the roller shall be such that at least half of the roller is on the hardened pavement adjoining the mat being paved. Where two or more layers of asphaltic mix are being laid the center joint and the construction joints shall not be placed in the same vertical plane.

**Density Requirements**
The density of the finished pavement shall be not less than 98 percent of the Marshall density obtained in the laboratory.

**Pavement Uniformity**
The finished pavement shall be of uniform thickness and texture and the thickness shall not vary more than 6mm from that specified. The surface tolerance of any paving course shall be such so as not to exceed 6mm when tested by means of a 4 meter straight edge longitudinally and 3mm when tested transversely. Any layer with deviations exceeding the foregoing limits shall be corrected or removed and replaced by the Contractor at his own expense, to the satisfaction of the Engineer's Representative.