KINGDOM OF SAUDIA ARABIA
THE SAUDI FUND FOR DEVELOPMENT (SFD)

PROJECT NAME

Reconstruction and repair works of more than 150 effected houses for non-refugees and Rehabilitation and Furniture for field playgrounds and a culture center

Lot#12

Construction of spectator in Beit Lahia playground

DONATED BY

Kingdom of Saudi Arabia through the Saudi Fund for Development (SFD)

EMPLOYER

United Nations Releif and Works Agency (UNRWA)
Through United Nations Development Programme (UNDP/PAPP)

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1 –EXCAVATION, EARTH WORKS AND ROAD WORKS

1.1 GENERAL

The Contractor shall carry out all excavations, filling, backfilling and all other earthworks required in whatever material may be encountered.

The Works shall be executed accurately to the dimensions, levels, lines and profiles as indicated on the drawings or directed by the Engineer.

The Contractor shall reconstruct to the proper level and profile any filled areas which settle or spread during the execution of the work or during the maintenance period.

The Contractor shall drain and dewater the underground water to a level below the excavation by lowering the water table with a proper drainage and dewatering system approved by the Engineer.

1.2 SOIL INFORMATION

The Contractor shall be deemed to have visited the Site of Works and satisfied himself as to the nature of the ground and made him conversant with the local conditions to be encountered during the execution of the Contract. The contractor is requested to perform a soil test to determine the nature and bearing capacity of the soil surface if indicated clearly in the contract documents.

1.3 MATERIALS

1.3.1 Backfill and Fill

Backfill and fill shall be a structurally sound material such as; gravel or native soil free of rocks with size more than 5cm, lumps, vegetables and other organic materials obtained from suitable excavated material and/or from approved borrow pits.

1.3.2 Water

Water shall be clean potable water as specified under “Concrete Work”

1.3.3 Concrete

Concrete used as fill for making up the correct level areas of over-excavation shall be, where required by the Engineer of Class “B” as specified under “Concrete Work”.

1.3.4 Hardcore

Hard-core under floor paving, etc. (Where shown on the drawings or as directed by the Engineer) shall consist of tough, sound and durable rubble stones (maximum 150mm), free from coatings, clays, seems or flows of any character. Fine aggregate for blinding the interstices of hard-core bed shall be as described in “Concrete Work”.

1.3.5 Agricultural Soils, Gravel and Sand Fill

Agricultural soil shall be first choice top soil rich in organic materials and free from roots, stones and rubbish suitable for plantation and shall be obtained from an approved source. Gravel fill shall consist of graded gravel 50mm down to 20mm and blinded with clean coarse sand.

1.4 SITE PREPARATION

1.4.1 Existing Public Utilities

The Contractor shall ascertain the whereabouts of all existing public utilities on the site, both above and below ground. Such utilities shall be removed, sealed or rerouted in a manner prescribed by the Public Authorities concerned at the Contractor's own expense. The Contractor shall also be held responsible for all damages entailed on any of the public utilities adjacent to the Site resulting from the Works.

1.4.2 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 at the Contractor's expense.

1.4.3 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 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 as directed by the Engineer.

1.5 SETTING-OUT

The Contractor shall stakeout the work as shown on the Drawings and secures the Engineer's approval of his stakeout 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-up for further approval in accordance with the relevant Clause of the Conditions of Contract.

1.6 EXCAVATION

1.6.1 General

Excavation in any material whatsoever found including rock to reduce levels and to form foundations, bases, trenches, septic tanks, pools, pits and the like to depths shown on the drawings or as directed by the Engineer.

Completely remove all existing obstructions in the line of excavations such as wall, slabs, curbs, steps and the like.

When removing any trees and roots with diameter more than 80 mm, should be rooted out to a depth of up to 500 mm then re-filled with approved material in layers. Also when mass rocks and other obstacles are found, the same mechanism of rooting and backfilling should be carried out at the expense of the contractor.

Trimming the sides of excavations to the required profiles and levels as well removing all loose material should be executed prior to consecutive process.

Level and well ram and consolidate surface of ground and bottom of all excavations to receive concrete foundations, beds, etc.

Bottoms of excavations shall be approved by the Engineer's Representative before any concrete is laid.

Should the Contractor excavate deeper than is shown on the drawings or required by the Engineer's Representative, to obtain a solid bottom, he must fill up excavation to the proper level with concrete Class B at his own expense.

1.6.2 Excavation in Rocks

Rock shall be defined as boulders, exceeding 0.25m3 in volume or any kind of stone or rock formation which in the opinion of the Engineer's Representative requires for its removal drilling and blasting wedging, sledging or barring or breaking up with power-operated hard tool..

The definition shall exclude any soft or disintegrated rock which can be removed with a hard pick or mechanical excavator or shovel or loose, shaken or previously blasted rock or broken stone in rock fillings or elsewhere.

Blasting by explosives shall not be permitted without obtaining the written approval of the Engineer. If such approval is given the Contractor shall be solely responsible for:-

1. Obtaining permits, keeping record.
2. Storing permits, keeping record.
3. Taking all necessary precautions in compliance with the regulations pertinent to the use of Explosives.
4. Any damage that may occur due to the blasting operations where rock is encountered it shall be carefully excavated and the Contractor shall not be entitled to additional compensation unless otherwise specified in the Bills of Quantities.

1.7 PLANKING AND STRUTTING

The terms "planking and strutting" will be deemed to cover whatever methods the Contractor elects to adopt for shoring the sides of excavation and also for planking and strutting the excavations against the sides of adjoining buildings, public roadways, etc… The Contractor will be held responsible for shoring the sides of all excavations, adjoining building and the like and no claim for additional excavation, concrete or other material or workmanship will be considered in this respect.

In the event of any collapse of the excavations, the Contractor shall re-excavate and re-instate such excavations at his own expense. No additional excavations will be paid or should the Contractor batter the sides of the excavations.

1.8 KEEPING EXCAVATIONS FREE FROM WATER

All excavations shall be kept clear of water by pumping or bailing or by well-point dewatering, 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 the regulations of the Local Authorities.

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.

1.9 STORING OF SUITABLE EXCAVATED MATERIAL

During excavation, materials suitable for backfill and fill shall be stockpiled on the Site at sufficient distance from the sides of the excavation to avoid overloading and prevent caverns or mixing with the concrete during the construction of foundations.

1.10 DISPOSAL OF UNSUITABLE AND SURPLUS EXCAVATED MATERIAL

Upon the order of the Engineer, all unsuitable and surplus excavated 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.

1.11 EXCAVATION FOR FOUNDATIONS AND SUB-STRUCTURE

The Contractor shall excavate to reach a suitable strata accepted by the Engineer or as shown by the Drawings during excavation for foundations, the bottom layer of excavation of minimum 200mm in thickness, shall be left undisturbed and subsequently removed manually only when the concrete in blinding is about to be placed in order to avoid softening or deterioration of the surfaces of the excavation.

Bottom of all excavations shall be formed to correct levels as shown on the Drawings or as directed in writing

1.12 EXCAVATION FOR TRENCHES

1.12.1 General

The Contractor shall provide all forms and bracings, and excavate trenches necessary to install all drainage, sewer water supply, electrical and telephone cables to the lines and grades complete in strict conformity with these specifications, applicable drawings and/or as directed by the Engineer.

1.12.2 Grading

The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along its length, except for the portions of the pipe where it is necessary to excavate for bell-holes and for proper sealing of joints. Bell-holes and depressions for joints shall be dug after the trench has been graded.

Care shall be taken not to excavate below the depths indicated. Where rock shall be excavated to the required depth, uneven surface of the bottom trench shall be excavated 15mm deeper. Such depth, if in rock, shall be back-filled with concrete Class "B" as specified under "Concrete Work" and when in earth, shall be back-filled with approved sand at the Contractor's own expense.

Whenever unstable soil, which in the opinion of the Engineer, is incapable of properly supporting the pipe or duct is encountered in the bottom of the trench, such soil shall be removed to the depth required and the trench back-filled to the proper grade with sand, fine gravel or other suitable material approved by the Engineer.

The width of the trench for Drainage at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench wall shall be 20mm on each side of the pipe. The width of the trench above that level may be as wide as necessary for sheeting and bracing and the proper performance of the work.

Trench for Water Supply System shall be of a depth to provide minimum cover over the top of 300mm and avoid interference of water lines with other utilities. Width of trench shall be a maximum of 200mm on each side of the pipe.

The width of trenches for electrical and telephone cables shall be as specified in their relative section. Banks may be sloped or widened to facilitate placement of cables, but not to an extend that will cause interference with other utilities.

Excavation for appurtenant structures for manholes, septic tank, percolating pit and similar structures shall be sufficient to allow a minimum of 300mm of clear space between their outer surfaces shoring timbers which may be used to protect the banks.

1.13 BACKFILL AND FILL

Approved suitable excavated material as specified under "MATERIALS" shall be used in the backfilling and filling next to footings, foundations underground structures, under sub-floors, etc... and shall be laid in layers not exceeding 250mm and compacted with compaction equipment, as approved by the Engineer. Moisture content shall be adjusted as directed by the Engineer and 97% of dry weight compaction accordance to ASTM: D1557-70 shall be achieved.

At least one sample of core pit must be taken from each 100 m2 in buildings for each layer of backfill.
Heavy equipments should not work or pass through within the structural boundary of the building during the backfilling process.

Should the quantity of the excavated material be not sufficient for the process of backfill and fill, the Contractor shall obtain the quantity required of such backfill and fill from approved borrow pits and transport same to the Site of work at his own expense if not itemized in the

bills of quantities.

No backfill shall be executed until the footings, foundations, etc., have been inspected, measured and approved by the Engineer.

Trenches should be backfilled until all required tests are performed and until the Engineer has verified that the Utility systems have been installed in accordance with the Specifications and the Drawings. The backfill in the pipe zone must be placed and completed so as to provide and maintain adequate and even support around the pipe wall. If mechanical compaction equipment is need, care must be taken to prevent direct contact with the pipe.

1.14 BED OF HARDCORE

The bed of hardcore where shown on the Drawings or as directed by the Engineer shall be of an approved rubble stone as specified under "MATERIALS" and shall be laid under floor paving. The rubble stone for hardcore shall be hand-packed with sharp edge upward and wider (natural face) laid on the ground. The interstices of hardcore bed shall be filled with approved fines, wetted sufficiently and well consolidated. The thickness of the hardcore bed shall be as shown on the Drawings.

1.15 PLACING OF AGRICULTURAL SOIL, GRAVEL AND SAND

The agricultural sifted soil as specified under "MATERIALS" shall be spread in the flower boxes and beds to the thickness shown on the Drawings after thorough watering and on a bed of 100mm thick graded gravel blinded with clean coarse sand to the satisfaction of the Engineer.

1.16 EXCAVATIONS OF CUTTINGS IN CARRIAGE WAYS

1. Hauling of material from cuttings or borrow pits to the embankments or other areas of fill shall proceed only when sufficient compaction plant is operating at the place of disposition to ensure compliance with the requirements of specifications.

2. Any excess depth excavated below formation level tolerance shall be made good by back filling with suitable material of similar characteristics to that removed, compacted in accordance with specification.

3. The slopes of cuttings shall be cleared of rock fragments which move when prized by a crow bar.

4. Construction traffic shall not use the surface of the bottom of a cutting unless the cutting is in rock or the Contractor maintains the level of the bottom surface at least 30cm above formation level. Any damage to the sub-grade arising from such use of the surface shall be made of good by the Contractor at his own expense, with material having the same characteristics as the material which has been damaged.

1.17 FILLING AND FORMING OF EMBANKMENTS AND OTHER AREAS OF FILL

1. Embankments and other areas of fill shall be formed of material defined as “suitable material”

2. All earthworks material placed in or below embankments, below formation level in cuttings or else wherein the works shall be deposited and compacted as soon as practicable after excavation in layers of thickness appropriate to the compaction plant used or as a permitted departure therefore. Embankments shall be built up evenly over the full width and shall be maintained at all times with a sufficient camber and a surface sufficiently even to enable surface water to drain readily from them. During the construction of embankments, the Contractor shall control and direct constructional traffic uniformly over their full width. Damage to compacted layers by constructional traffic shall be made good by the Contractor.

3. In areas of shallow filling where after removal of topsoil the ground level is within 30cm of formation level constructional traffic shall not use the surface unless the Contractor brings up and maintains the surface level at least 30cm above formation level. Any damage to the sub-grade arising from such use shall be made good by the Contractor at his own expense with material having the same characteristics as the damaged materials.

1.18 COMPACTION OF EMBANKMENTS AND OTHER AREAS OF FILL

1 All materials used in embankments and as filling elsewhere shall be compacted as soon as practicable after deposition.

2 Variation from the method of compaction stated below or the use of plant not included therein will be permitted only if the Contractor demonstrates at site trials that a state of compaction is achieved by the alternative method equivalent to that obtained using the approved methods. This procedure shall be agreed and approved by the Engineer.

3 The Engineer may at any time carry out comparative field density tests determined in accordance with B. S. 1377 test No. 14 on material, which he considers has been, inadequately compacted. If the test results when compared with the results of similar tests made on adjacent approved work in similar materials carried out in accordance with specification, show the state of compaction to be inadequate and this held to be due to failure of the Contractor to comply with the requirements of the Contract, the Contractor shall carry out such further work as the Engineer may decide is required to comply with the terms of the Contract.

4 The Contractor shall not less than 24 hours before he proposes to carry out compaction processes during periods of overtime, apply in writing to the Engineer for permission to do so.

1.19 MEASUREMENTS

All measurement of cut, backfill and fill of different materials should be using the engineering calculations or otherwise mentioned in the other contract documents or as directed by the Engineer.

2 -CONCRETE WORKS

2.1 SCOPE

This section describes and specifies work required for plain and reinforced concrete, including formwork intended to be used for the Project under the Contract in accordance with the Drawings, Bills of Quantities and as directed by the Engineer.

At the beginning of each month, the Contractor shall submit to the Engineer his concreting programme for that month, stating the pouring dates, so that adequate checking and supervision can be provided before and during the pouring operation. No pouring shall be allowed unless the Engineer has been given a week-advanced notice of the intention to pour.

2.2 APPLICABLE TESTS AND CODES

Prior to commencement of concrete work, the Contractor shall submit samples to the Engineer before sending them to the laboratories for testing, to establish the probability of the materials passing tests for specified requirements.

After the Engineer is convinced that the samples with their sources are truly representative samples and sufficient materials are available on the Site for the completion of all concrete works under the Contract, the samples shall be approved and sent to the laboratories for testing. Upon the Engineer's request, the Contractor shall have the tests made, at his own expense in the laboratories approved by the Engineer.

All concrete aggregates, cement and water shall be sampled and tested as frequently as deemed necessary by the Engineer. All tests samples shall be obtained in accordance with the latest editions of the American Society for Testing and Material (ACI) Code or any equally approved standard.

2.3 MATERIALS

2.3.1 Cement

2.3.1.1 General

Cement shall be Portland Type originating from approved manufacturers in sealed and labeled bags, each 50 kgs. Not capacity, name and brand of the manufacturer shall plainly be identified thereon and delivered to the site in good condition. Cement delivered in bulk shall be accepted only if a central mixing plant is used. The Quality of cement shall conform to the Standard Specification for PORTLAND CEMENT of ASIM Designation: C150-74 Type I- for use in general concrete construction and Type V- for use when high sulphate resistance is desired.

2.3.1.2 Storage of Cement

All cement shall be stored in suitable weatherproof and approved storage sheds which will protect the
cement from dampness. Storage sheds shall be erected in locations approved by the Engineer.
Provision for storage shall be ample, and the consignment of cement as received shall be separately stored in such a manner as to provide easy access for the identification and

inspection of each consignment. Cement shall be used in the order of its delivery to site, new deliveries shall not be used unless the cement from earlier deliveries has be completely used. Stored cement shall meet the test requirements at any time after storage when a re-test is ordered by the Engineer all the expense of the Contractor.

The Contractor shall keep accurate records of the deliveries of cement and of its use in the work.
Copies of these records shall be supplied to the Engineer in such form as may be required.

2.3.1.3 Rejection

The Contractor shall notify the Engineer of dates of delivery so that there will be sufficient time for sampling the cement either at the mill or upon delivery.

The provisional acceptance of the cement at the mill shall not deprive the Engineer of the right to reject on a reset of soundness at the time of delivery of the cement to the site.

Package of cement varying by 5 percent or more from the specified weight shall be rejected and if the average weight of packages in any consignment, as shown by weighing 50 packages taken at random, is less than that specified, the entire consignment shall be rejected and the Contractor shall remove it forthwith from the Site at his own expense and replace it with cement of satisfactory quality.
Stale cement or cement reclaimed from cleaning bags shall not be used and cement which for any reason has become partially set, or contains lump or caked cement, shall be rejected.

2.3.2 Aggregates

2.3.2.1 General Requirements

All aggregates shall consist of tough, hard, durable uncoated particles. The Contractor shall be responsible for the processing of this material to meet the requirements of the Specifications. Approval of aggregate quality and/or gradation shall not waive the responsibility of the Contractor to provide concrete of having the minimum strength specified.

2.3.2.2 Storage

Coarse and fine aggregates shall be delivered and stored separately on site in such a manner as to prevent segregation and contamination or the admixture of foreign materials. Aggregate which has become segregated or contaminated with foreign matter during storage or handling will be rejected and shall be removed and replaced with material of acceptable quality at the Contractor's expense.
Aggregates of the quality and colour selected shall be stored in sufficient quantity to avoid interruption of concreting work at any time.

2.3.3 Fine Aggregate

2.3.3.1 General Requirements

All fine aggregate shall conform to Standard Specification for Concrete Aggregates of ASIM Designation: C-33 and also to the detailed requirements give in Table 2-1 (appended here below). It shall not contain harmful materials such as iron pyrites, coal, mica, and shale.

Alkali, coated grains, or similar laminated materials such as soft and flaky particles, or any material which may attack the reinforcement, in such a form and in sufficient quantity to affect adversely the strength and durability of the concrete. Fine Aggregate passing sieve No. 4 shall not contain any voided shells.
Fine aggregates shall be washed thoroughly with de-mineralized water to ensure compliance with the appropriate requirements and limitations of the specifications.

The Contractor shall provide and maintain for this proposes sand-washing plant and equipment.

Fine Aggregate from different sources of supply shall not be mixed or stored in one pile nor used alternately in the same class of construction or mix.

Table 2-1: Detailed requirements for Fine Aggregate

Sieve Analysis	
Grading Sieve	**Percent of Passing**
3/8	100
No. 4	95- 100
No. 8	80- 100
No. 16	50- 85
No. 30	25- 60
No. 50	10- 30
No. 100	2- 10
No. 200	0- 3
Fineness modulus	2.50- 2.15
Organic Impurities	The color shall have an intensity not darker than two-thirds the intensity of the standard color solution. (Not darker than Plate 2 as determined by the Standard Method of Test for Organic Impurities in Sands for Concrete of ASTM Designation C - 40
Chlorides soluble in dilute Nitric Acid	Not more than 0.10 percent by weight when expressed as sodium chloride (NACL).
Total Acid soluble sulphates	Not more than 0.50 percent by weight when expressed as sulpher trioxide(S03)
Silt	Not more than 2 percent
Mortar strength	Compression ration less than 95 percent
Soundless	Weighted average loss when subjected to 5 cycles of the soundless test using magnesium sulfate, not more than 10 percent

2.3.4 Coarse Aggregate

2.3.4.1 General Requirements

All coarse aggregate for concrete shall conform to Standard Specifications for Concrete Aggregates of ASTM Destination: C-33 Coarse aggregate shall consist of gravel, crushes gravel, or crushed stone, having hard, strong durable pieces, free from adherents. It shall not contain harmful materials such as iron pyrites, coal, mica, alkali, laminated materials, or any material which may attack the reinforcement, in such a for or in sufficient quantity to affect adversely the strength and durability of the Concrete. Coarse aggregates shall be washed thoroughly with de-mineralized water to ensure compliance with the appropriate requirements

and limitations of the specifications. The Contractor shall provide and maintain for this purpose approved washing plant and equipment.

2.3.4.2 Deleterious Substances

The amount of deleterious substances shall not exceed the following limits:

Max. Permissible Limit Percent by Wt.:	
Soft fragments	2.00
Coal and lignite	0.50
Clay lumps	0.25
Materials passing the No.200 sieve	1.00
Thin or clognated pieces (length greater than 5 times average thickness)	4.00
Other local deleterious substances	0.00
Chlorides soluble in dilute Nitric acid when expressed as Sodium Chloride (NaCL)	0.05
Total acid soluble sulphates when expressed as sulpher trioxide (S03)	0.50

2.3.4.3 Percentage of Wear

Coarse aggregate shall conform to the following requirements:
Percentage of wear, Los Angeles test, not more than (30)

2.3.4.4 Grading

Coarse aggregate, when tested according to the requirements of ASTM, shall meet the following gradation and shall be uniformly graded within the limits stated in Table 2-2 here below:

Table 2-2: Grading Analysis for Coarse Aggregate

ASTM	Percentage by Weight Passing		
	Grading (3/4" to No.4)	Grading (1" to No.4)	Grading (2" to No.4)
2 ½ inch	--	--	100
2 inch	--	--	95- 100
1 ½ inch	--	100	--
1 inch	100	95- 100	35- 70
¾ inch	95- 100	--	--
½ inch	--	25- 60	10- 30
3/8 inch	20- 55	--	--
No. 4	0- 10	0- 10	0- 5
No. 8	0- 5	0- 5	--
No. 200	0- 1	0- 1	0- 1

2.3.5 Combined Aggregate

Approved fine and coarse aggregate on each batch of concrete shall be combined in proportions as approved by the Engineer, according to test results giving the required compressive concrete stress as specified per type of Concrete.
The combined aggregate gradation using the ¾ in. to No. 4 gradation shall be used for concrete members with reinforcement to close or permit proper placement and consolidation

of the concrete. Change from one gradation to another shall not be made during the progress of the work unless approved by the Engineer. Such changes are admitted only after being proved by test results.

2.3.6 Aggregate for Mortar

2.3.6.1 General Requirements

Aggregate for motor shall conform to the Standard Specification for Aggregate for Masonry Mortar of ASTM Designation: C-144 and shall consist of hard, strong, durable uncoated mineral or rock particles, free from injurious amounts of organic or other deleterious substances.

2.3.6.2 Organic Impurities

Fine aggregate for mortar when subjected to the Calorimetric test for organic impurities and producing a color darker than the standard color shall be rejected.

2.3.7 Water

2.3.7.1 Quality of Water

Water for mixing of concrete shall be fresh, clean and free from injurious amounts of oil, acid, or any other deleterious mineral and/or organic matter. It shall not contain chlorides such as sodium chloride in excess of 700 ppm. It shall not contain any impurities in amount sufficient to cause a change in the time of setting of Portland cement of more than 10 percent, nor a reduction in compressive strength of mortar of more than 5 percent compared to results obtained with distilled water.

The PH of the water for mixing and curing of concrete shall not be less than PH 4.5 or more than PH 8.5.

2.3.7.2 Tests for Water

When required by the Engineer the quality of the mixing water shall be determined by the Standard Method of Test for quality of water to be used in concrete, as specified in B.S. 3148: 1959 Tests for Water for Making Concrete.
In sampling water for testing, care shall be taken to ensure the containers are clean and that samples are representative.

2.3.7.3 Admixtures

Admixtures in concrete shall be used only when approved by the Engineer and shall conform to the requirements of the ASTM Standard Specifications Designation c-494-68 for Water Reducing and Retarding Admixtures, and C-260-69 for Air entraining Admixtures for Concrete, and waterproofing and watertight.

The Contractor shall ensure that the admixture supplied for use in the work is equivalent in composition to the admixture subjected to test under this Specification. Tests shall be made whenever practicable using the cement, aggregates, admixtures proposed for specific work, because the specific effects produced by chemical admixtures may vary with the properties of

the other ingredients of the concrete.

The specific effects produced by chemical admixtures may vary with the properties of the other ingredients of the concrete.

Admixture that contains relatively large amounts of chloride shall accelerate corrosion of reinforcing steel and shall be the cause of rejection.

Water reducing and retarding admixtures shall comply with the physical requirements of ASTM tests and shall be approved in writing by the Engineer.

When the admixture is delivered in packages or containers, the proprietary name of the admixture, the type and the weight or volume shall be plainly marked thereon. Similar information shall be provided in the shipping advises accompanying packaged or bulk shipments of admixtures.

The admixture shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment, and in a suitable weather-tight store that will protect the admixture from dampness.

Costs of such admixtures, sampling and testing shall be at the Contractor's expense.

2.4 COMPOSITION OF CONCRETE

The cement content, coarse aggregate size, water content, consistency and the approximate weights of fine and coarse aggregate (saturated surface-dry basis) for the class of concrete shall be within the requirements of Table 2-3 (I) and Table 2-3 (II) Below.
The weight of fine and coarse aggregate given in Table 2-3 (II) below is based on the use of aggregates having bulk specific gravities, in a saturated surface-dry condition, 2.65-5%. For reasonably well graded materials of normal physical characteristics, the use of the below indicated proportions, together with specified water content to obtain the required consistency, will result in concrete of the specified cement content, plus or minus two (2) percent.

For aggregate having specified gravities outside the ranges indicated in the Table 2-3 (II) below, the weights shall be corrected by multiplying the weights shown in Table 2-3 (II)below by the ration of the specific gravity of the aggregate and 2.65.

The relative weights of fine and coarse aggregate per sack of cement given in Table 2-3 (II) below are based on the use of natural sand having a fineness modulus within the range of 2.70 and 2.90 and methods of placing which do not involve high frequency vibration. When sharp, angular manufactured sands, or extremely coarsely graded sands are used, the relative amount of fine aggregate should be increased. For finer sands the relative amount of fine aggregate should be decreased. In general, the least amount of sand which will insure concrete of the required workability for the placing conditions involved should always be compensated for by changing the weight of coarse aggregate in the opposite direction by a corresponding amount.

Table 2-3 (I): Requirements of concrete composition

Class of concrete	Compressive strength at 28 days (in Kg/cm^2) Cube	Minimum cement content (Kg)	Coarse aggregate size	Max. water content (Liter per Bag)	Consistency range in slump (mm)	
					vibrated	non vibrated
A	250	375	¾ inch or 1 inch- No. 4 as required by the Engineer	27	50- 100	75- 125
B	200	350	Ditto	27	50- 100	33- 125
C	150	250	2 inch- No. 4	30	25- 50	50- 75

Table 2-3 (II): Requirements of concrete composition- Continue

Class of concrete	Cylinder compressive strength at 28 days (kg/ cm^2)	Approximate Weight (Saturated Surface-Dry) of Fine and Coarse Aggregate per Sack (50Kgs) of Cement			
		Rounded coarse aggregate		Angular coarse aggregate	
		Fine (Kg)	Coarse (Kg)	Fine (Kg)	Coarse (Kg)
A	250	40	170	95	150
B	210	95	180	100	160
C	140	140	370	160	340

Table 2-3 (II) is given for indicative purposes and is not binding.

The total sodium chloride content of any materials used for making concrete shall be less than:

- For mass concrete..... 1.5 percent
- For reinforced concrete..... 0.7 percent

Expressed as a percentage, by weight of the cement.

In calculations made under the provisions of this clause, any chloride, other than sodium chloride in the materials shall be converted to the equivalent of sodium chloride and be added to the amount of sodium chloride. The sulphate content shall not exceed 0.03 percent by weight of the cement.

2.5 PROPORTIONS

2.5.1 General

After the materials provided by the Contractor have been accepted for the works, the proportions and equivalent batch weights shall be determined which will produce concrete having not less than the strength required.

2.5.2 Trial Mixes

The actual proportions shall be determined on the basis trial mixes made by the Contractor and conducted with the content being determined by means of yield test in accordance with American Society for Testing Material (ASTM) Designation (C-138). The proportions will be

such as to required (within a tolerance of plus or minus one (1) percent, the cement content shown in Table I as the minimum cement content, provided, however, that if the materials supplied by the Contractor are of such a nature or are so graded that proportions based on the minimum cement content cannot be used without exceeding the maximum allowable water content specified in Table I, the proportions will be adjusted so as to require the least amount of cement which will produce concrete of the required plasticity and workability without exceeding such maximum allowable water content. No additional compensation will be made for the increase in quantity of cement required.

2.5.3 Contents

The mixes required will be designated in kilograms of fine and coarse aggregate exclusive of free water, per sack (50 Kilograms) of cement and in liters of total mixing water per sack of cement on the basis of the required amount of cement per cubic meter of concrete.

2.5.4 Batch Weights

Since the proportions are designated in terms of aggregate in surface-dry condition, the equivalent batch weights to be used in the work shall be corrected periodically to take into account the actual moisture content of the aggregates at the time of use.

2.6 CONCRETE COMPRESSION AND SLUMP TESTS

2.6.1 Cubical Test

The Compression Strength of Concrete shall be obtained according to cubical tests locally done. Test cubes made in the field shall have a dimension of 15cm, At least 3 separate batches of concrete shall be made for trial and these shall be tested for compliance with the requirements of the table below, at least 3 test cubes being made from each batch of concrete. Once a mix is approved no substantial change in the materials or proportions of materials being used shall be made without the approval of the director of works who may then require further trial mixes to be produced. The compressive strength of the concrete will be taken as the arithmetic mean of the strength of all the cubes tested.
The following table 2-4 will be used to compare test results:

Table 2-4: Compressive Strength results of samples of concrete at 28 days. (Mixed by Weight)

Kind of Concrete	Mean value At 28 days Kg / cm^2	Minimum Individual Value at 28 days Kg / cm^2	Mean value At 28 days Kg / cm^2	Minimum Individual Value at 28 days Kg / cm^2
	In case of 3-4 samples taken		In case of 5 samples or more	
B - 150	185	130	175	130
B - 200	240	170	230	170
B - 250	300	215	290	215
B - 300	360	255	345	255
B - 350	420	300	405	300

Test at 7 days must not be less than 75% of the required strength at 28 days

2.6.2 Slump Tests

Slump tests shall be carried out periodically to ensure the appropriate water cement ratio in accordance with the Standard Method of Test of Slump of Portland Cement Concrete of the ASTM Designation: C-143.

2.6.3 Test of Hardened Concrete in the Structure

Where the results of specimens indicate that the concrete does not meet specification requirements, core boring tests conforming to the current issue of ASTM Designation: C-42 shall be performed, as directed by the Engineer, all at the Contractor's expense.

1. Hardened concrete is identical to specifications if the results of specimens test follow the conditions:
   - At least the average compressive strength of samples testing coincides the required design strength for the concrete.
   - No compressive strength of any of the sample specimens deviates from the required design strength for the concrete by (85%).
   - Cubes are standard size (150 × 150 × 150) mm and age (28) days mainly to the requirements of comparing strength. The nominal compressive strength is the minimum value of all the values of the testing samples, which does not allow the existence of values lower than more than (5) percent of the number of sample tests.
   - The contractor to submit to the supervisor written reports from an authorized laboratory for all of the tests carried out according to specifications and within period of not more than (24) hours of the implementation of the testing.

2. If the cube tests fail to pass the above; Core Specimens must be carried out at (3) specimens for each sample of hardened concrete which had not achieved the conditions of the sub-item mentioned above. Note that taking the specimens, water treatment and testing are in accordance with the requirements of American Standard (ASTM -C 42), this is coincided to the concrete specifications if the test results match following conditions:
   - At least the average compressive strength of the specimens of a sample is (85%) of the strength provided by the design.
   - At least the compressive strength of an individual specimen from a sample is (75%) of the strength provided by the design.

3. If test results fail to pass the condition stated in item (B) of this section, found not conform to these specifications, and must then be completely removed from the site at the expense of the contractor, as the same contractor bears full responsibility for any damage that might be caused to the sound elements as a result of the demolition and removal.

4. As exception to what is stated in paragraph (C) of this section, for the slabs and beams only, if the average value of compressive strength of the samples equivalent to the standard cubes (150 * 150 * 150) mm is not less than (150Kg/cm2); loading test might be carried out only upon the client request and at the contractor's expense to ensure the ability of the concrete elements to bear loads according to engineer and the designer. If the elements pass the load test, then the slabs and beams are considered structurally accepted.

5. Loading Test
   - Load test must be carried out at the site for the slabs and beams of reinforced concrete that are under the age of (56) days by authorized and experienced laboratory in that field.
     The loads must be equivalent to that part of the actual dead loads and shall be placed on the slabs and beams prior to loading the total loads by (48) hours and remain until the end of the test.
   - The slabs and beams must be loaded by a total of (0.85) multiplied by (1.4 Dead Load + 1.7 Live Load) Less Dead Load actually performing (48) hours before. Special devices should be placed at the bottom of slabs and beams to measure deflection. These devices should be installed on fixed frames to ensure the stability of these devices, and the preliminary readings to be taken prior to process of loading. The loads must be placed gradually and systematically for (24) hours, without causing any vibrations or shocks and batches of not less than (4) equal installments, and then taking the readings , which identifies the maximum deflection; that is the difference between this reading and reading pre-loading. Then the loads are lifted and left unloaded for two (24) hours, the readings are taken for the final deflection which determines the value of self-retrieval as the difference between this reading, and reading pre-lift.

6. Passing the test
   - The structural elements could succeed in passing the test, if not exceed the maximum deflection (D) in mm as per the formula:

     D = (50 L2) / h

     Where:
     L = Span loaded in meters of the following values: the distance between the centers of supports or clear span loaded plus the height of the structural element which is smaller.
     h = height of the structural element (mm)
   - The slabs and beams fail to pass the test if wide cracks appear or signs of failure during the test, or if they do not achieve the value of deflection (D).

2.7 MEASUREMENT OF MATERIALS

Materials shall be measured by weight, except as otherwise specified or where other methods are specifically authorized by the Engineer. The apparatus provided for weighing the aggregates and cement shall be suitably designed and constructed for this purpose. Each size of an aggregate and the cement shall be weighed separately. The accuracy of all weighing devices shall be such that successive quantities can be measured to within 1% of the desired amount. Cement in standard packages (sack) need not be weighed. The mixing water shall be measured by a measuring device susceptible of control accurate to plus or minus half percent of the capacity of the tank but not exceeding 2 liters. All measuring devices shall be subject to the Engineer's approval.

Where volumetric measurements are exceptionally authorized by the Engineer for projects where the amount of concrete is small, the weight proportions shall be converted to equivalent volumetric proportions. In such cases, suitable allowance shall be made for variations in the moisture condition of the aggregates, including the bulking effect in the fine aggregate.

2.8 MIXING OF CONCRETE

2.8.1 General

Unless otherwise authorized by the Engineer, concrete shall be machine mixed.

The mixing of concrete or mortar shall not be permitted when the temperature is above 40 C or when the temperature is below 5 C.

2.8.2 Mixing on Site

Concrete shall be thoroughly mixed in a batch mixer conforming to the requirements of B.S. 1305 Batch type concrete mixers which will ensure a uniform distribution of the materials throughout the mass.

The mixer shall be equipped with adequate storage and a device for accurately measuring and automatically controlling the amount of water used on each batch. Preferably mechanical means shall be provided for recording the number of revolutions for each batch and automatically preventing the discharge of the mixer until the materials have been mixed within the specified minimum time.
The entire contents of the mixer shall be removed from the drum before materials for a succeeding batch are placed therein.

All concrete shall be mixed for a period of not less than 1 ½ minutes after all materials, including water, are in the mixer. During the period of the mixing the mixer shall operate at the speed for which it has been designed, but this speed shall be not less than 14 nor more than 20 revolutions per minute.

The first batch of concrete material placed in the mixer shall contain sufficient excess of cement, sand and water to coat the inside of the drum without reducing the required mortar content of the mix. Upon the cessation of mixing for a considerable period, the mixer shall be thoroughly cleaned.

2.8.3 Truck Mixing

Truck mixers, unless otherwise authorized by the Engineer, shall be of the revolving drum type, watertight, and so constructed that the concrete can be mixed to ensure a uniform distribution of materials throughout the mass. All solid materials for the concrete shall be accurately measured in accordance with Section C.7 and charged into the drum at the proportioning plant.
Except as subsequently provided, the truck mixer shall be equipped with a tank for carrying mixing water. Only the prescribed amount of water shall be placed in the tank unless the tank id equipped with a device by which the quantity of water added can be readily verified. Truck mixers may be required to be provided with means by which the mixing time can be readily verified by the Engineer.

The maximum size of batch in truck mixers shall not exceed the maximum rated capacity of the mixer as stated by the manufacturer and stamped in metal on the mixer. Truck mixing shall be continued for not less than 50 revolutions after all ingredients including the water, are in the drum. The speed shall not be less than 4 r.p.m., nor more than a speed resulting in a

peripheral velocity of the drum of 70 meters per minute.
Nor more than 100 revolutions of mixing shall be at speed in excess of 6 r.p.m. Mixing shall begin within 30 minutes after the cement has been added either to the water or aggregate. When cement is charged into a mixer drum containing water or surface-wet aggregate and when the temperature is above (33 C) is used this limit shall be reduced to 1245 minutes; the limitation on time between the introduction of the cement to the aggregates and the beginning of the mixing may be waived when, in the judgment of the Engineer, the aggregates are sufficiently free from moisture, so that there will be no
harmful effects on the cement.

2.8.4 Partial mixing at the Central Plant

When a truck mixer provided with adequate mixing blades is used for transpiration, the mixing time at the mixing plant may be reduced to 30 seconds and the mixing completed in the truck mixer. The mixing time in the truck mixer shall be as specified under the Section C.8.3 for truck mixing.

2.8.5 Plant Mix

Mixing at a central plant shall conform to the requirements for mixing at the Site and shall conform to
the applicable requirements of the Standard Specification for Ready-Mixed Concrete of ASTM Designation: C-94.

2.8.6 Time of Hauling and Placing Concrete

If the distance from the mixing plant to the construction Site is so great that between the time of mixing and pouring the concrete, the temperature is below 40 C and the traveling time is more than 30 minutes, truck mixers must be employed.

When truck mixers are used, concrete shall be discharged and placed in its final position in the forms within thirty (30) minutes after water is first added to the mix.

2.8.7 Delivery

The rate of delivery of concrete during concreting operations shall be such as to provide for the proper handling, placing and finishing of the concrete. The rate shall be such that the interval between batches shall not exceed 20 minutes. The methods of delivering and handling the concrete shall be such as will facilitate placing with the minimum of re-handling and without damage to the structure of the concrete.

2.8.8 Re-tempering

The concrete shall be mixed only in such quantities as are required for immediate use and any concrete which has developed initial setting shall not be used. Concrete which has partially hardened shall not be re-tempered or remixed.

2.9 HANDLING AND PLACING CONCRETE

2.9.1 General

Prior to pouring concrete in any structure, the Contractor shall secure a written order to commence from the Engineer. In preparation for the placing of concrete all sawdust, chips, and other construction debris and extraneous matters shall be removed from the interior of forms, struts, stays and braces, serving temporarily to hold the forms in correct shape and alignment, pending the placing of concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the firms and not buried in the concrete. Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. The use of long troughs, chutes and pipes for conveying concrete from the mixer to the forms shall not be permitted unless the authorization in writing of the Engineer is obtained. In case an interior quality of concrete is produced by the use of such conveyers, the Engineer may order discontinuance of their use and the substitution of a satisfactory method of placing. Open troughs and chutes shall be of metal lined and shall be of rounded cross section to avoid the accumulation of concrete in corners. The chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement. The slope shall be steep enough (1 vertical to 2 or 2 ½ horizontal) to permit flow requiring a slump greater than specified or required for placement.
All chutes, troughs and pipes shall be kept clean and free from coating of hardened concrete by thoroughly flushing with water after each run. Water used for flushing shall be discharged clear of the structure. When placing operations would involve dropping the concrete more than 1.50 meter, it shall be deposited through sheet metal or other approved pipes. As far as practicable, the pipes shall be kept full of concrete during placing and their lower ends shall be kept buried in the newly placed concrete. After initial setting of concrete, the forms shall not be jarred and no strain shall be placed on the ends of reinforcement bars which project.

2.9.2 Hot Weather Concreting

The temperature of concrete when placed shall not exceed 27 °C when the relative humidity is 50 percent or less and shall not exceed 32 ° C for values of relative humidity between 50 percent and 70 percent, the max temperature of concrete shall be found by interpolation.
In lieu of above, the temperature of concrete when placed shall not exceed 32 ° C, regardless of the relative humidity.
The Contractor shall comply with the above requirements by the following procedures:-

- Cooling the mixing water and/or replacing 50% of the mixing water by crushed ice. When crushed ice is used it shall be stored at a temperature that will prevent formation of lumps. The ice shall be completely melted by the time mixing is completed.
- Shading aggregate stockpiles and/or keeping moist by sprinkling then with water.
- Cement shall not be used if its temperature exceeds 77 °C.
- Painting the mixer drum white and spraying it with cool water or shading the mixer from direct sunrays.
- Maintaining the mixing time and delivery time to the minimum acceptable.
- Sprinkling of forms sub-grade and reinforcement with cool water prior to placement of concrete.

Water reducing and retarding admixture shall be used in all concrete work when the temperature of concrete exceeds 27 ° C. The water cement ratio inclusive of free surface moisture on aggregates and any admixtures shall be kept to a minimum.

2.9.3 Vibrating Concrete

Concrete, during and immediately after depositing, shall be thoroughly compacted. The compaction shall be done by mechanical vibration subject to the following provisions:

- Vibration shall be internal unless special authorization of other methods is given by the Engineer or as provided herein.
- Vibration shall be of a type and design approved by the Engineer. They shall be capable of transmitting vibration to the concrete at frequencies of not less than 4500 impulses per minute.
- The intensity of vibration shall be such as to visibly affect mass concrete of 25mm slump.
- Contractor shall provide a sufficient number of the vibrators to properly compact each batch immediately after it is placed in the forms.
- Vibration shall be manipulated so as to thoroughly work the concrete around the reinforcement and embedded fixtures, and into the corners and angles of the forms.
- Vibration shall be applied only by experienced operators under close supervision, at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued so as to cause segregation. Vibration shall not be continued at any point to the extent that localized areas of grout are formed.
- Application of vibration shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.
- Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibrations. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the forms.
- Vibrator shall be supplement by such spading as it necessary to ensure smooth surface and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.
- The use of implements such as compressors which are likely to disturb or disarrange reinforcement or formwork shall not be permitted.

Concrete shall be placed in horizontal layers not more than 300mm thick as hereinafter provided. When less than a complete layer is placed in one operation, it shall be terminated in

a vertical bulkhead. Each layer shall be placed and compacted before the preceding batch has taken initial set to prevent injury to the green concrete and avoid surfaces of separation between the batches. Each layer shall be compacted so as to avoid the formation of a construction joint with preceding layer which has taken initial set.

When the placing of concrete is temporarily discontinued, the concrete after be coming firm enough to retain its form, shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete. To avoid visible points as far as possible upon exposed faces, the top surface of the concrete adjacent to the forms shall be smoothed with a trowel.
Immediately following an approved discontinuance of placing concrete all accumulations of mortar splashed upon the reinforcement bars and the surfaces of forms shall be removed. Dried mortar chips and dust shall not be puddle into the unset concrete. If the accumulations are not removed prior to the concrete becoming set, care shall be exercised not to injure or break the concrete steel bond at and near the surface of the concrete while cleaning the reinforcement bars.

2.9.4 Joints

Expansion joints shall be formed in the positions indicated and to the details shown on the Drawings or otherwise ordered by the Engineer. The expansion joints shall be filled with bitumen impregnated fiberboard to its full depth and width. The filling will be permitted to be used as permanent formwork only for the second casting. Where the fiberboard is exposed, it shall be cut back for a depth of at least 1cm. from the chamfered edges, filled and pointed with a resilient liquid poly sulphide polymer sealant. Whenever the placing of the concrete is discontinued other than at the expansion faces, this discontinuity shall form a construction joint. Construction joints are to be made only along a horizontal or vertical plane except that in the case of inclined or curved members they shall be at right angles to the principal axis. Care shall be taken to prevent offsetting of the joint and to ensure water tightness. The joints shall in every way satisfy the requirements of the Engineer, and be in accordance with the Drawings.

Unless otherwise shown on the Drawings, construction joints will not be allowed in the supported portion slabs, beams and beam like members. At construction joints the laminate film and porous layer of the already set concrete shall be removed and the surface keyed by hacking and then wire-brushed and thoroughly cleaned. Immediately before adding the new concrete, the surface it to be thoroughly wetted and a 1-cm thick coating of a fresh cement/sand mortar (having the same proportion of cement/sand as concrete in the mix) applied to the surface. The new concrete is then to be well compacted into the old.

The number of construction joints should be kept as few as possible consistent with reasonable precautions against shrinkage. Concreting should be carried out continuously up to construction joints.
Where it is necessary to introduce construction joints, careful consideration should be given to their exact location, which should be indicated on the drawings.

2.10 PRECAST HOLLOW CONCRETE BLOCKS [HOURDIS] FOR RIBBED SLABS:

2.10.1 Material and Manufacture

Aggregate shall be so sized, graded, proportioned and thoroughly mixed in a batch with such proportions of cement and clean water as to produce a homogeneous concrete mixture. However, in no case shall the proportion of cement in the mixture be less than five (5) standard [each weighing 50 Kgs] per cubic meter of concrete.
Pre-cast hollow concrete blocks (hourdis) for a ribbed slab shall be manufactured in approved vibrated, machine.
If for any reason the strength requirement is not achieved, cement shall be increased at the Contractor's own expense. The blocks shall be cured for twelve (12) consecutive days and shall be at least twenty-one (21) days old before incorporation in the Works. The blocks shall be of an approved pattern of withstanding a compressive force applied at the ends of 30 kgs/cm2 based on the gross sectional area of the block obtained without deducting voids.

The blocks shall be hard, sound, durable, sharp, clean with well defined arises, free from cracks and flaws or other defects and of the dimensions shown on the Structural Drawings. The blocks shall be obtained from an approved local factory.

2.10.2 Workmanship

Pre-cast hollow concrete blocks (hourdis) shall be laid exactly in a line with the cells on the long dimensions.
Close edge blocks shall be used at the end; the dimensions of the ribs and size of reinforcing bards shall be exactly according to the Structural Drawings, In narrow width specially made half blocks shall be used and full block shall not be used along their length (with the calls along the long dimensions of the rib.)

The blocks are to be laid on adequate forms. All blocks shall be cleaned and thoroughly wetted with clean water before the concrete is poured and labourers shall not be allowed to walk on them. Any block found to be defective or damaged during concreting operations shall be removed and replaced before pouring the concrete, all at the contractor's expense.

2.11 FORMWORK

2.11.1 General

The Contractor shall be responsible for the design and stability of the formwork. The contractor shall submit a full program of work indicating the various phases for the erection and removal of forms and the manner in which he intends to execute all concrete works.

2.11.2 Material

All forms shall be of wrought lumber and shall be built mortar tight and of sufficient, rigidity to prevent distortion due to the pressure of the concrete and other loads incident to the construction operations. Forms shall be constructed and maintained so as to prevent warping and the opening of joints due to shrinkage of the lumber.

The forms shall be substantial and unyielding and shall be so designed that the finished

concrete will conform to the proper dimensions and contours. The Contractor shall take into consideration the effect of vibration on the formwork, and shall be responsible for any damage or default resulting thereof.

2.11.3 Workmanship

Forms shall be inspected by the Engineer prior to installation of reinforcement
The number of spacing of the form struts and braces shall be such that the forms will be braced rigidly and uniformly lock joints between form sections shall be free from play or movement.

The shape, strength rigidity, water tightness and surface smoothness of re-used forms shall be maintained at all times. Any warped or bulged lumber must be resized before being re-used. Forms which are unsatisfactory in any respect shall not be re-used.

Metal tie rods or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 40mm from the face within injury to the concrete. In case ordinary wire ties are permitted, all wires, upon removal of the forms, shall be cut back at least 10mm.

From the face of the concrete with chisels or nippers for green concrete, nippers are necessary. All fittings for metal ties shall be of such design that the cavities produced upon their removal are the smallest possible.

The cavities shall be filled with non-shrinkage material mortar and the surface left sound, smooth, even and uniform in colour.

All forms shall be treated with special approved oil and saturated with water immediately before placing the concrete. For members with exposed faces, the forms shall be treated with approval material to prevent the adherence of concrete.

Any material which will adhere to or discolour the concrete shall not be used.

The contractor shall provide means for accurately measuring the settlement of the forms during placement of the concrete and shall make all necessary corrections as directed by the Engineer way release the contractor of his responsibility for the correctness of these schedules.

All reinforcement shall be placed strictly in accordance with the drawings and as instructed in writing by the Engineer. Nothing shall be allowed to interfere with the required disposition of the reinforcement, and the Contractor shall ensure that all parts of reinforcement are placed correctly in position and are temporarily fixed where necessary to prevent displacement before or during the process of tamping and ramming the concrete in place. The ties, links or stirrups connecting the bars shall be taut so that the bars are properly braced the inside of their curved part small be in actual contact with the bars, around which they are intended to fit.
Placed correctly in position and are temporarily fixed where necessary to prevent displacement before or during the process of tamping and ramming the concrete in place.

The ties, links or stirrups connecting the bars shall be taut so that the bars are properly braced the inside of their curved part small be in actual contact with the bars, around which they are intended to fit.

2.11.4 Removal of Form-work

In the determining of the time for removal of forms, consideration shall be given to the location and character of the structure, the weather and other conditions influencing the setting of the concrete and the materials used in the mix. In general, the forms of any positions of the structure shall not be removed until the concrete is strong enough to prevent injury to the concrete when the forms are removed. Unless otherwise directed by the Engineer forms shall remain in place for the following specified period of time:

- Centering under beams : 21 days
- Floor slabs : 21 days
- Walls, columns, sides of beams and other vertically formed surfaces : 3 days

Method of form removal likely to cause overstressing of the concrete shall not be used. In general, the forms shall be removed from the bottom upwards. Forms and their supports shall not be removed without the written approval of the Engineer. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight.

Centers shall be gradually and uniformly lowered in such a manner as to avoid injurious stresses in any part of the structure.
The Contractor shall include in his prices for any formwork which may have to be left in position due to the impossibility of removal of same.

2.12 REINFORCEMENT

2.12.1 General

The contractor shall prepare for his own use bar bending schedules from the information given on the drawings and in these specifications. These schedules shall be submitted to the Engineer for approval which shall in no way release the contractor of his responsibility for the correctness of these schedules.

All reinforcement shall be placed strictly in accordance with the drawings and as instructed in writing by the Engineer. Nothing shall be allowed to interfere with the required disposition of the reinforcement, and the contractor shall ensure that all parts of reinforcement are placed correctly in position and are temporarily fixed where necessary to prevent displacement before or during the process of tamping and ramming the concrete in place. The ties, links or stirrups connecting the bars shall be taut so that the bars are properly braced the inside of their curved part small be in actual contact with the bars, around which they are intended to fit. Placed correctly in position and are temporarily fixed where necessary to prevent displacement before or during the process of tamping and ramming the concrete in place.

The ties, links or stirrups connecting the bars shall be taut so that the bars are properly braced the inside of their curved part small be in actual contact with the bars, around which they are intended to fit.

2.12.2 Type and Quality of Steel Reinforcement

1. Hot-Rolled Steel Plain Rods and Bars

Hot rolled steel plain rods and bars shall conform to the strength requirements and minimum elongation of the Standard Specification for Deformed Billet-Steel Bars of Grade 40 with minimum yield strength 2400Kg/cms (35000 psi) for concrete Reinforcement of ASTM Designation (A-615) or equivalent.

2. Deformed Steel Rod and Bars

Deformed steel and bars shall conform to the requirements of the Standard Specification for Deformed Billet-Steel Bars of grade 60 with minimum yield strength 4200 kg/cm2 (60000 psi) for concrete reinforcement of ASTM Designation (A-615) or equivalent.

2.12.3 Wire

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

2.12.4 Order Lists

Before ordering material, all order lists and bending diagrams detailed in accordance with the latest revision of AGI Building Code shall be furnished by the contractor for the approval of the Engineer, and no material shall be ordered until such lists and steel bending diagrams have been approved. The approval of order lists and bending diagrams by the Engineer shall in no way relieve the contractor of his responsibility for the correctness of such lists and diagrams. Any expenses incurred to the revision of material furnished in accordance with such lists and diagrams to make and comply with the design drawings including cut and waste shall be borne by the contractor.

2.12.5 Protection of Material

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

2.12.6 Fabrication

Bar reinforcement shall be bent to the shapes shown on the Drawings and Steel Bending (Diagrams), bending dimensions and scheduling of bars for the reinforcement of concrete. All bars shall be bent cold, unless otherwise permitted by the Engineer. No bars partially embedded in concrete shall be bent except as shown on the plans or specifically permitted by the Engineer.

2.12.7 Placing and Fastening

All steel reinforcement shall be accurately placed in the position shown on the drawings and firmly held during the placing and setting of concrete. Bars shall be tied at all intersections except where spacing 300mm in each direction, in which case alternate intersections shall be tied.

Distance from the forms shall be maintained by means of stays, blocks ties, hangers, or other approved supports. Blocks for holding reinforcement from contract with the forms shall be pre-cast mortar blocks of approved shapes and dimensions or approved metal or plastic chairs. Metal chairs which are in contact with the exterior surface of the concrete shall be galvanized. Layers of bars shall be separated by pre-cast mortar blocks or by other equally suitable devices. The use of pebbles, pieces of broken stone or brick, metal pipe and wooden blocks

shall not be permitted. Reinforcement in any member shall be placed and then inspected and approved by the Engineer before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and its removal is required.

2.12.8 Splicing

All reinforcement shall be furnished in the full lengths indicated on the drawings. Splicing bars, except where shown on the drawing, will not be permitted without the written approval of the Engineer. Splices shall be staggered as far as possible.
Additional splices, other than those shown on the drawings; and allowed by the Engineer, shall be at the contractor's own expense.
The cost of all supports for holding reinforcement bars shall be borne by the Contractor.

2.13 CURING AND PROTECTION

2.13.1 Water Curing

All concrete shall be cured for a period of time required to obtain the full-specified strength but not less than seven (7) consecutive days. Unformed surfaces shall be covered with sand burlap, or other approved fabric mats kept continually wet. If the forms are removed before the end of the curing period, curing shall be continued as on the uniformed surfaces. When burlap, sand or other approved fabric materials are used, they shall not cause any undesirable finish such as rough surface and discoloring where exposed to light. Unhardened concrete shall be protected from heavy rains or flowing mechanical
injury and the Contractor shall submit for the Engineer's approval his construction procedure which is designed to avoid such an eventually. No fire or excessive heat shall be permitted near or in direct contact with concrete at any time. Water for curing shall conform to Section 2.3.6.

2.13.2 Curing with Curing Media

Curing medium shall meet all requirements of the specifications for Liquid Membrane-Forming Compounds for Curing Concrete of ASTM Designation: C-309 and test for water retention by concrete curing materials of ASTM Designation: C-156.
The compound shall be applied to the concrete surface by means of a sprayer, roller or lamb's wool applicator and shall be sprayed on. Ample time shall be allowed for the concrete surface to harden and to prevent any damage. The compound shall give a drying time not to exceed thirty minutes, and shall be applied undiluted directly from the manufacturer's labeled container in accordance with the manufacturer's directions and to the satisfaction of the Engineer.

The compound shall be completely compatible with adhesives, joint sealants and cement grout.

2.13.3 Payment

No separate payment shall be made for curing with water or with curing media. The cost of such curing shall be deemed to be included in the Unit Prices of "CONCRETE WORK".

2.14 CONCRETE [FAIR FACE] EXPOSED SURFACES

2.14.1 Formwork

Formwork for exposed concrete surface shall conform to the applicable requirements of Section C 14, in addition to those Specifications.
All concrete surfaces that are to be left exposed to view as a finished surface except for pre-cast concrete units, shall be produced by vertical metal shuttering.

The quantity of the surface of concrete exposed to view shall be consistent throughout the project and the following methods shall be adopted to obtain the required finish.

Metal forms of an approved type for pre-cast units

The Contractor may submit alternative proposals for the Engineer's approval if he so desires.

The Contractor is to submit to the Engineer for his approval shuttering details and sequence of operation relating to fair face concrete work. Sample panels shall be constructed for all their face concrete finishes and following the Engineer's approval the panels will remain on site and constitute a standard which must be maintained throughout the duration of the Contract.

2.14.2 Coating Forms with Mineral Oil

In addition to the above forms or linings, the forms shall be coated before placing reinforcement with an
approved colourless mineral oil free of kerosene.
All surplus oil on form surfaces and any oil on reinforcing steel shall be removed.

2.14.3 Samples and Workmanship

The Contractor shall submit for approval a sample panel not less than 600x1200mm to demonstrate the quantity of the exposed concrete produced by forms at his own expense.
The quantity of the finished work shall be measured against the quality of the approved sample panel and the work of inferior quality shall be repaired or replaced as directed by the Engineer without any additional cost.

The quality of the finished surfaces shall be uniform in colour and consistency, whether in colour or in texture, in any of the finished surfaces, the Engineer may order the repair or the demolition of the portion of concrete work and the reconstruction of same at the expense of the contractor and the contractor shall have no right to claim for any expenses or time delay incurred.

Alternatively the Engineer may order the contractor to plaster all exposed surfaces and bush-hammer the entire area of, concrete in the project so as to render all exposed surfaces of concrete consistent throughout the project at the contractor's own expense.

2.15 MONOLITHIC SMOOTH FINISH SURFACES

All concrete surfaces which are not in acceptance condition and which are required to be surface-finished as designated herein, shall be rubbed to a smooth and uniform texture with a carborundum brick and clear water as soon as the forms are removed and the concrete is ready to hone. The loose material formed on the surface shall be removed as soon as it dries by rubbing the surface with burlap or other approval material. A cement wash shall not be used.
Concrete surface shall be free from honeycombing, air holes, fins and projections arising from defective mixings, placing or formwork. When the formwork has been stuck off, the surface of concrete shall be left untouched until inspected by the Engineer. Any defective concrete work shall at the discretion of the Engineer be demolished completely and rebuilt or cut out and made good with concrete of the same proportions as the original. Such rectifications shall be to the satisfaction of the Engineer and at the Contractor’s own expense.

3 -BLOCK WORKS

3.1 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.

3.2 MATERIALS

3.2.1 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.

3.2.2 Aggregates

Aggregate for solid and hollow concrete blocks and mortar shall conform to the requirements for fine aggregates in the following Table 3-1:

Table 3-1: Aggregate Percentage Passing for Blocks

Sizes BS sieve No.	Sieve Opening (inch)	Sieve opening (mm)	% Passing
1/8	0.125	3.00	95-100
7	0.095	2.40	80-100
14	0.047	1.20	60-100
25	0.024	0.60	30-100
52	0.012	0.30	0.5- 100
100	0.006	0.15	0.0- 0.1

Note: The above figures represent the limits of percentages (by weight) passing sieves of the sizes mentioned.

3.2.3 Water

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

3.2.4 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.

3.3 MANUFACTURE OF CONCRETE BLOCKS

1. 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 165 kg per cubic meter of concrete.

2. Pre-cast concrete blocks shall be manufactured in approved vibrated machines. If for any reason the strength requirements are 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.

3. 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.

4. 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.

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

   Height = 200 mm + 1 % Tolerance
   Length = 400 mm + 1 % Tolerance
   Width = As required + 1 % Tolerance
   Web thickness = not less than 20 mm for block (40*20*10)/ or
   not less than 25 mm for block (40*20*15)/ or
   not less than 30 mm for block (40*20*20)

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

6. Hollow concrete blocks shall comply with the following requirements: -
   Compressive Strength at Twenty Eight (28) Days Over Gross-Sectional Area: -

   Solid Blocks:
   60 kgs/cm^2 average of 12 blocks
   50 kgs/cm^2 minimum for any block

   Hollow Blocks:
   35 kgs/cm^2 average of 12 blocks
   30 kgs/cm^2 minimum for any block

7. Water Absorption
   20% or less of dry weight

8. The contractor shall supply minimum 12 blocks from each supplying quantity up to 20,000 blocks or in case of change the manufacturer for testing the blocks before starting the masonry works. The all needed tests shall be on the contractor expenses.

9. 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 20mm. 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.

10. Concrete blocks for ribbed slabs shall be of the following dimensions:-

Length L (mm)	Height H (mm)	Width B (mm)	Minimum web thickness (mm)	
			For 3 eyes	For 2 eyes
400 Or 500	140	200- 300	20	----
	150	200- 300	20	22
	170	200- 300	20	22
	200	200- 300	20	22
400	250	200	22	22
500	350	200	25	----
+3 mm	+1 mm	+5 mm for one consignment	----	----

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

11. Weight of concrete blocks for ribbed slabs are specified as follows:-

Length L (mm)	Height H (mm)	Width B (mm)	Max Specific Weight (kg/m3)	
			For 3 eyes	For 2 eyes
400 Or 500	140	200- 300	1100	---
	150	200- 300	1100	---
	170	200- 300	1000	850
	200	200- 300	1000	850
400	250	200	1000	850
500	350	200	950	---

12. blocks for ribbed slabs shall comply with the following requirements: -
    Flexural Strength at Twenty Eight (28) Days Over Gross-Sectional Area: -

P (N) =2B minimum average of 6 blocks
P (N) =1.8B minimum for any block
Which;
P is the concentrated flexural load (N)
B is the width of the block (mm)

3.4 MORTAR

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

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

3. 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.

4. 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.

5. 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.

6. 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 form the site.

3.5 WORKMANSHIP

1. Block test results and approval from the engineer must be taken before starting the block work.
2. 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.

3. 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.

4. 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 1.20 m above in one day, and wall of partition necessarily left at different levels, must be racked back. All perpendiculars, quoins, internal and external angles, etc. properly bonded together and leveled round. All block work shall be plumbed vertically.

5. The surface of the walls and partitions prepared for plastering shall have the joints raked out 50 mm into the face of the wall to form key for the plaster.

- 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.
-

The accepted verticality tolerance must be within the following:

For every 3m height	+ 6 mm Tolerance
For every floor up to 6m height	+ 11 mm Tolerance
For 12 m height and more	+13 mm Tolerance
For boundary wall, expansion joint and decoration	+ 6 mm Tolerance

3.6 Concrete infill

Block work shall be bonded to concrete columns, wall and the like with concrete infill B250. block must be stopped in graded shape (10-15 cm from the concrete face) one 8 mm bar must cast in columns during casting with total length 40 cm fixed every 42 cm horizontally, in addition to two vertical 10 mm bars.

The prices inserted in the Bills of Quantities for the masonry works 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, concrete infill and transporting, placing compacting, curing, surface finishing, protection, construction and expansion joints and all labors and materials and tests.

4 -PLASTER WORK

4.1 GENERAL

This section of the specifications covers plaster work related with the drawings, bill of quantities, and as directed by the 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 through out 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 made, 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, and galvanized wire mesh.

4.2 Gypsum Plaster

4.2.1 MATERIALS

The cement and water used for plastering shall comply with BS specifications. The sand for plastering shall be clean, fine sand and shall be chemically and structurally stable. The sand shall be sieved and graded in accordance with the Table of Grading given below "table 4-1":

Table 4-1: Aggregate Percentage Passing for Plastering

BS Sieve No.	SIZE Inches	Approximate Millimeters	% PASSING	
			Undercoat	Finish Coat
7	0.095	2.4	95-100	100
14	0.047	1.2	80-95	95-100
25	0.024	.6	30-55	30-85
52	0.012	.3	5-50	5-50
100	0.006	.15	0-10	0-10

Note: The above figures represent the limits of percentages (by weight) passing sieves of the sizes mentioned.

The gypsum plaster shall be of the hemi-hydrate type with a controlled setting time. The resultant plaster shall be chemically inert when set, be capable of being toweled to a smooth surface and shall be highly resistant to cracking and crazing. Imported lime shall be of the hydrate type.

4.2.2 Mixing

The mixing shall be done mechanically. With regard to the lime mortars gauged with cement, the addition, just before use of the cement to small quantities of the lime/sand mix shall preferably take place in a mechanical mixing shall continue for such time as will ensure uniform distribution of materials and uniform color and consistency. It is important to note that

the quantity of water used shall be carefully controlled. Gypsum plaster shall be mixed in a clean pail or other approved vessel. The required amount of water shall be placed in the pail and the plaster added gradually and allowed to soak for 5 minutes. It shall then be stirred to a uniform consistency free from lumps and no more material shall be mixed than can be used in half an hour.

4.2.3 Workmanship

All plastering shall be executed in a neat workman like manner. All races except circular work shall be true and flat and angles shall be straight and level or plumb. Plastering shall be neatly made good up to metal or wood frames and skirting and around pipes or fittings. Angles shall be rounded to 5-mm radius. Surfaces of undercoats shall be well scratched to provide a key for finishing coats. Screed marks or making good on under-coats shall not show through the finishing coats. Surfaces described as trawled smooth shall be finished with a steel or celluloid trowel to a smooth flat surface free from trowel marks. Surfaces described as floated shall be finished with a wood or felt float to a flat surface free from trowel marks.

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

4.2.4 Internal & External Plaster

4.2.4.1 Samples

The contractor shall provide samples for all plaster layers before starting work within appropriate time to get approval by the engineer.

4.2.4.2 Preparation of Surfaces

All surfaces, to be plastered, shall be clean and free from dust, loose 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.

All small openings in walls resulted from electrical and plumping establishments shall be closed using (1:3 cement: sand) mortar.

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.

Where cement plaster is to be applied to surfaces shall first be dashed with a mixture of Portland cement and sand (1:1) mix to form a key. All surfaces shall he thoroughly sprayed with water and this shall be allowed to thoroughly dry out before the next coat is applied.

Before plastering is commenced all junctions between differing materials shall be reinforced. This shall apply where walls join columns, where brick walls join block walls 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

40cm 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 cubic meter of sand shall be applied and allowed to dry before rendering is commenced.

The contractor can use either (hyrib) or (expanded metal) type. The (hyrib) shall fix using overlapping and compressing method, but the expanded metal shall fix using strong nails.

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.

4.2.4.3 Application of Internal Coats

The internal plaster consists of 3-coats which are:

- First layer: (Key Coat)

This layer "Key Coat" is not less than 3 mm with (1:1) cement: sand mortar. This layer must be done by force throw out the mortar to all surfaces. It must be curing for minimum 3-days to keep it moist.

- Second layer: Base-Coat (Rendering)

Base coat shall be done for one wall in same time by using vertically ruler with 10cm width, starting from floor to roof.
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 thickness shall not less than 13mm, with (1:3:0.25) cement: sand mortar: lime.
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 minimum 3 days and then allowed to dry out.

- Third layer: 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.
Finishing coat thickness is about 3mm with (1:4:0.50) cement: sand mortar: lime.
The used sand shall consist of about 50% of soft sand (selisi sand).
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 skirting and around fittings and pipes. Angles shall be rounded to a 5mm radius.

4.2.4.4 Application of External Coats

The external plaster consists of 4-coats which are typically specify as same as internal plaster except that the second layer is the concrete coat. Concrete coat thickness is 5mm, with (1:2) cement: sand mortar and shall be kept moist with a fog spray for minimum 2 days and then allowed to dry out. Then base coat and finishing coat are same as in internal plaster.

4.2.4.5 Proportions for Internal and External Plaster

Screeds shall be laid and ruled as necessary to allow for a total thickness of 13-15mm for internal and external plaster and the rendering shall be applied to the required thickness.

4.2.4.6 Tyrolean Plaster (Fine Grain)

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

The contractor shall set up samples of different degrees of fineness for the engineer's approval prior to commencement of Tyrolean work. The engineer may choose different degrees of fineness for different parts of the works and the contractor shall allow for this in his rates.

4.2.4.6.1 Mixing

Cement and aggregate for each batch shall be accurately measured and mixed dry until evenly distributed and the mass is uniform in color. 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.

4.2.4.6.2 Proportions

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

1 part of white Portland cement
3 parts fine selected aggregate (Quartz)

4.2.4.6.3 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 5mm. thick

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

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 fog spraying. 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.

4.2.4.6.4 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.

4.2.4.6.5 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 color to the satisfaction of the engineer.

4.3 False ceiling from galvanized mesh and plastering

1. Fixing the approved galvanized mesh as temple from metal rods with diameter 8mm every 25cm in both sides which must weld with each other by electrical weld.
2. Check up the fixing mesh to ensure it's horizontally is good. Then covering it by 3-coats of rough plaster with 1cm thickness for each coat. Each coat shall be lightly scratched in both directions and wait until it dry to start with the second coat. The third coat is fine plaster coat with thickness 0.5cm. The final thickness for 3-coats is 3.5cm.
3. The used mortar for all 3-coats shall consist of (1:3) cement: sand mortar with adding laxative approved material.

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 splicer, hangers, clips and wall mounting next to walls. The system shall be installed complete in accordance with the manufacturer's instructions.

5 -TILING WORKS

5.1 Materials

Portland cement, fine aggregate and water shall be as previously specified in section 3, concrete works.

The colour pigments shall be of an approved manufacture, lime-proof and non-fading and complying with British Standard No. 1014: 1942.
The marble chipping shall be of an approved quality in irregular pieces varying for 0.047″ to 3/8″ in size defending on the effect required. The pieces should preferably be roughly cubical in shape and flaky shaped pieces shall not be used.
The granite chipping shall be of an approved quality graded from ½″ down with not more than 5% fine material passing a No. 100 sieve.

Marble and granite aggregates shall comply generally with table and granite aggregates shall comply generally with table of grading. In connection with marble aggregates, the percentages are approximate only. The actual grading should be selected to produce the surface effects required as shown in table 5-1.

Table 5-1: Aggregate Percentage of Passing for Tiles

B.S. Sieve No.	Sieve opining		Percentage of Passing	
	inch	mm		
-	½	13	100	-
-	3/8	10	59-100	59-100
-	3/16	5	30-60	25-60
7	0.095		20-50	5-30
14	0.047	1.2	15-40	0-10
25	2.40	0.6	10-30	-
52	0.012	0.15	5-50	-
100	0.006	0.3	0-5	-

Note: The above figures represent the limits of percentages (by weight) passing sieves of the sizes mentioned.

5.2 Mixing

Materials for in-situ paving and locally manufactured tiles shall be measured separately in approved gauge boxes on a clean, dry, level surface.
Materials shall be mixed either by hand or machine as previously specified in Section 3, concrete works.

5.3 Proportions

The following mixing table 5-2 shall be strictly adhered to in all castrations will be permitted only when demanded by the particular Specification for individual works or prior written consent of the Engineer.

Table 5-2: Mixing of Tiles composites

Nominal mix	Cement Kilos	Fine Aggregates Cu.M.
1:1	1442	1.00
1:2	721	1.00
1:2 ½	577	1.00
1:3	476	1.00
1:4	361	1.00
1:5	289	1.00

5.4 Granolithic Paving

These shall consist of a (1:2) mix-one part Portland cement to two and half parts of granolith aggregate mixed with sufficient water to give a suitable plasticity for laying. The paving shall be laid immediately following the concrete sub-base. If these paving are laid on a matured concrete sub-see the concrete shall first well cleaned wetted and brushed with a Portland cement grant.

To produce a wearing the granolithic mixture shall be tamped in with a wood float and trawled twice with a steel trowel to produce a smooth finish.
The paving shall be laid in alternate bays not exceeding 9 square meters in area and the bays shall be separated by expansion strips of brass or other approved material.
Covering them with Hussein wet for seven days shall cure granolithic paving.

5.5 Cement and sand paving

These shall consist of a (1:3) mix-one part of Portland cement to three parts of sand mixed with sufficient water to give a suitable plasticity for laying. The paving shall be laid immediately following the concrete sub-base. If laid on a matured concrete sub-base the same precautions should be taken as described for granolithic paving above.
The paving shall be laid in bays as prescribed above for granolithic paving.
Cement and sand paving intended as a wearing surface shall be troweled twice with a mechanical steel trowel to produce a smooth finish. Two coats of sodium silicate solution shall be brushed on.
Cement- sand paving shall be cured as described above for granolithic paving.

5.6 Cement and sand tiles

These shall be formed with a (1:2) mix of white or colored cement, or in white cement with a colour pigment added, and sand applied as a facing not less than 7 ½ mm thick to a Portland cement and sand (1:5) mix backing. The tiles shall be cast in heavy metal moulds under pressure to the proportions and sizes shown in the following table 5-3.

Table 5-3: Grinding of Granite and Marble Chipping

B.S. Sieve No.	Sizes of sieve		Percentage passing by Weight	
	mm	Inches	Granite Chipping	Marble Chipping
-	13	½	100	-
-	10	3/8	95-100	95-100
-	5	3/16	30-60	25-60
7	2.4	0.095	20-50	5-30
14	1.2	0.47	15-40	0-10
25	0.6	0.24	10-30	-
52	0.3	0.12	5-50	-
100	0.15	0.006	0-5	-

It is essential that closer grading limits be selected for the marble chipping if a consistent and uniform surface texture is desired.
Coloured cement and sand skirting to match tiles, 7cm or 10cm with chamfered top edges shall be produced in the same way as the tiles using the same mixes.
All cement and sand tiles shall be cured by totally immersing them, after the initial set has taken place, in a tank of clean water for at least 24 hours.
Cement and sand tiles shall be laid and bedded direct on to a concrete sub-floor on a cement and sand 1:4 mix screed. This screed shall be laid and bedded direct on to a concrete sub-floor on a cement and sand 1:4 mix screed. This screed shall be 2 ½ cm thick in the castoff 2 ½ cm tiles and 3cm thick in the case of 2cm tiles. The total thickness of cement and sand screed and tiles shall not exceed 5 cm. All tiles shall be laid with square joints.
All cement and sand tiles shall be cured by totally immersing them after the initial set has taken place I a tank of clean water for at least 24 hours.
All tiling shall be grouted up on completion immediately, care being taken to fill all joints completely. The grout shall consist of net cement of a color to match the tiling. Any surplus grout shall be cleaned off the face of tiling and surrounding surfaces immediately and all tiling shall be carefully cleaned off.

5.7 Terrazzo Tiles

These shall be formed with a (1:2 ½) mix of white or colored cement or white cement with a colour pigment added and granular marble chipping applied as a facing not less than 10 mm thick to a Portland cement and sand 1:5 mix backing.
The tiles shall be cast in heavy metal moulds under pressure to the proportions and sizes shown in the following table 5-4.

Table 5-4: Terrazzo Tile Dimensions

Size (cm)	Min Wear Surface(mm)	Size tolerances (mm)	Total Thickness (mm)
20x20	10	±0.5	20
25x25	12	±0.5	25
30x30	15	±1.0	30
40x40	15	±1.0	30
Skirting	6	±0.5	10

Tiles shall be cured as for cement and sand tiles and then ground, filled and polished before distribution to Site. Grinding shall be done wet by means of a No. 80 carborundum stone. Filling shall be carried out with neat cement grout of the same colour as the facing mix and this

shall be worked into the surface with a wooden shaper to fill all voids and air holes. Surplus grout shall be removed with a dry cloth. After a minimum period of 24 hours polishing shall be carried out wet by means of a No. 140 carborundum stone.
Terrazzo skirting 7cm, 10 cm or 20 cm high with chamfered top edge shall be produced in the same way as for tiles using the same mixes.
The contractor has to clean the place prior to starting the tiling works and get the approval from the engineer to laying clean sand 5 cm
Terrazzo tiles shall be laid and bedded on a cement and sand (1:4) mix screed. This screed shall be 2 ½cm thick in the case of 2 ½ tiles and 3cm thick in the case of 2cm tiles. The total thickness of the cement and sand screed and tiles shall not exceed 5cm. All tiles are laid with square joints.
Terrazzo tiles shall be laid only if it's age more than 28 days from that the date of manufacture.
The tiles shall be laid dry and tamped into the slurry to form a level surface. Joints shall be even and not more 3 mm wide in both directions.
All tilling shall be grouted up on completion immediately, care binge taken to fill all joints completely. The grout shall consist of neat cement of a colour to match the tilling. Any surplus surfaces immediately and all tilling shall be carefully cleaned off.
All terrazzo surfaces shall be polished on completion. Large areas such as floors shall be wet polished by means of approved machines using No. 140 carborundum wheel. Any surface too small for convenient machine polishing may be polished by hand using a No. 140 carborundum stone and water. Care must be taken during any polishing operation not to damage any angles or arises.
Terrazzo covering to items such as sills, treads and risers to steps, skirting etc., shall generally be applied in accordance with the foregoing specification except that the thickness of the facing shall be at least 12mm thick as the following table 5-5:

Table 5-5: In-Situ Terrazzo Dimensions

Item	Min Wear Surface(mm)	Total Thickness (mm)
Stair Tread	20	50
Stair Riser	12	20
Stair Skirting	12	20
Sill	20	50
Threshold	12	30

Terrazzo stair treads should be reinforced with at least 2 longitudinal bars Ø6mm and 3 transversal bars for each and glass joints will be installed along the cast in situ terrazzo.

5.8 Marble Paving

Marble paving shall generally be 2-3 cm thick the size, type and pattern that be as stated in the particular specification, BOQ and/or shown on the drawings.
The marble slabs shall be fixed solid on a bed of cement and sand 1:4 mix 3cm thick tight joints grouted in lime putty. Protective slurry of putty at least 3mm thick shall be applied to the marble paving and subsequently cleaned off.

Treads to stairs shall be 3cm thick fixed solid on a bed of cement and sand 1:4 mix 3cm thick 5 cm width of the treads need to be roughened. Risers to stairs shall be 2cm thick fixed solid on a backing of cement and sand 1:4 mix 3cm thick. Window sills shall be 3cm thick fixed solid on a bed of cement and sand 1:4 mix 3cm thick. Skirting shall be 1cm thick in lengths equal to the tile length, fixed solid on a backing of cemented sand 1:4 mix 2cm thick. Joints in skirting

shall be arranged to coincide with joints in adjacent paving. Rounded arises, noising and moldings shall be adequately protected by means of timber casing or lime putty ceilings. Treads, risers, skirting and windows sills shall be grouted and protected in a manner similar to paving.
The exposed faces and edges of all marble shall be polished smooth and be free from scratches or other defects.

5.9 Marble linings

Marble linings to walls, columns and the like shall generally be 2cm thick and the size, type and pattern shall be as stated in the particular specification, BOQ and/or as shown on the drawings. The marble slabs shall be cut square/rectangular and true and shall be uniform in shape and thickness. Patterns and moldings shall be accurately formed in accordance with the Drawings.
The marble slabs shall be fixed with copper or galvanized steel cramps and hooks and plaster raps leaving an air space of 12mm behind the slabs to prevent transfer of soluble salts from the backing materials. The cramps shall be 2 1/2cm x 5mm x 10mm girth one end and turned down and grouted into mortise in marble and the other and built into wall set 45cm apart in each bed. Mortises shall be accurately and carefully cut and all joints shall be thoroughly grouted.
Exposed edges and molding shall be protected by means of timber casings or lime putty coatings.
The exposed edges and faces of all marble shall be polished smooth and shall be free from scratches or other defects.

5.10 Generally

All paving shall be protected from damage during subsequent operations and shall be well washed and thoroughly cleaned before handing over.

5.11 Terrazzo Tiles Testing

The test sample should be randomly selected so that 0.5 per one thousand but not less than 6 tiles per 500 m^2. Each sample of 12 tile will be tested 6 tiles for flexural strength, 3 tiles for Water absorption and 3 tiles for Wear resistance .In case two tiles or more of the sample don't match the specification, then the whole shipment is rejected. But if one tile failed, then replication of the test should be proceeded.
The Terrazzo tiles, steps and cast in situ Terrazzo must be tested according to the international standards and as follows: -

- Specific Gravity: not less than 2.5
- Water Absorption: Absorption should not be more than 8% by weight for each sample.
- Flexural Strength: It should not be less than 5 N/mm2 for each sample.
- Wear Resistance: Rate of wear resistance should not be more 2mm on average for 3 samples of each batch. However, each sample should not have wear resistance over 2.5 mm.

5.12 Tiles and Cladding

All the tiling & cladding works will be executed according to the drawings and instructions and will be tested to control the quality of the materials as mentioned in the general specifications. *Unless otherwise said in the BOQ and drawings, the tiling will be:*

Terrazzo tiles (local production):

- Terrazzo (marble chips) floor tiles size 25x25x2.5cm.
- Terrazzo (marble chips) skirting 1x7cm.

Marble Works:

- Local marble (Class A) 3cm thick will be used for WC doors entrances, main entrances and any other places indicated in the contract documents.
- Local marble (Class A) copings 3cm thick will be used for staircases and roof parapets.
- Local or imported marble 30x60x2cm tiles or any size requested by the engineer will be used for flooring.
- Colored marble or granite 2.0cm thick with sizes as requested by the engineer.
- Windows sills will be local marble 3 cm thick (Class A).

The kitchen cabinets :

- Local marble 2cm thick (Class A) will be used for shelves, floor and back of the kitchen cabinets and 3cm thick for vertical dividers and the worktop will be from approved marble or granite, the cupboard leaves will be of colored aluminum.

West Bank stone: -

- West Bank stone of Class A will be used as shown in the drawings, specifications of stone works and the engineer's instructions.

5.13 Marble and Granite

The test sample should be randomly selected so that not less than one tile per 100 tiles.
The marble and granite must be tested according to the international standards and as follows: -

- Specific Gravity: not less than 2.5
- Water Absorption: Absorption should not be more than 0.75% by weight for each sample.

5.14 Ceramic, Glazed and Quarry Tiling.

Samples of tiles shall be submitted to Engineer for approval of quality and color prior to order.
Clay floor quarries and fitting shall be in accordance with BS 1286 Type A and the thickness and size shall be as stated in the Drawing, BOQ or as per the engineer approval.
Ceramic floor tiles and fitting shall be in accordance with BS 1286 Type B and the thickness and size shall be as stated in the Drawing, BOQ or as per the engineer approval.

Glazed ceramic floor tiling shall be of the type, thickness and size as stated in the Drawing, BOQ or as per the engineer approval.

The tiles shall be true to shape, flat, free from flaws, cracks and crazing, and keyed on the reverse side and shall be a manufacture approved by the engineer.

Semi-dry cement and sand (1:4) mortar shall be spread not less than 4 cm thick as tiles bedding.
Cement and sand mortar bed (1:3) not more than 2 cm shall be laid. Any admixture to the

mortar must be approved before used.
The contractor shall ensure that when fixing tiles with thin bed adhesive, the base to receive tiles is clean level and dry, no loose and friable areas and surface dusting.
Tiles shall be firmly tamped into motor to form a level surface. Joints shall be even and not more 3 mm wide in both directions using spacer lug tiles or spacer pegs.
Joints shall be continuous and extended vertically.

The tiles shall be grouted up with white or colour cement motor worked well into joints when bed is sufficiently firm to prevent disturbances of the tiles; surplus grout shall be cleaned off from faces of tiles.
Where tiling abuts against wood or metal frames or other tiling at angles and round pipes etc., it shall be carefully cut and fitted to form a neat joints. Open irregular joint with cement and sand or plaster will not be permitted.
Tiles shall be cleaned off and polished once completion.

5.15 Glazed Ceramic Wall Tiling

Walls tiles shall be in accordance with BS 1281 first quality and a minimum thickness of 6mm.
The tiles shall be true to shape, flat and free from flaws, cracks and crazing and keyed on the reverse side and shall be of a manufacture approved by the engineer.

The tiles shall be immersed in water for 6 hours or until saturation tightly together to drain with end tiles turned.
Key layer cement and sand (1:2) then scratched screed (1:4 mix) should be applied preceding to tiles 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.
The render coat shall be wetted sufficiently to prevent it absorbing water from the bedding coats.
Thickness of finished bedding shall be not less than 6 mm nor more than 12 mm.
Each tiles shall be buttered evenly with motor and tapped firmly into position so that the bed is solid throughout.
Joints shall be even and not more than 3 mm wide using spacer lug tiles or spacer pegs.
Joints shall be continuous both horizontally and vertically.
Tiles shall be fixed to a finished surface that is plumb and true to +/- 2mm in any 2 m.
Tiles shall be neatly cut and fitted around pipes and other obstructions.
Tiles shall be grouted up to not less than 24 hours after fixing tiles to porous surfaces and not less than 3 days after fixing to impervious surfaces.
Tiles shall be cleaned off and polished upon completion.

5.16 Ceramic Tiles Testing

The test sample should be randomly selected so that 6 per one thousand or less but not more than 15 tiles for every delivery. In case two tiles or more of the sample do not match the specification, then the whole shipment is rejected. However, if one tile failed, then replication of the test should be preceded.

- Water Absorption: Absorption should not be more than 4% and 0.3 by weight for semi glazed and full glazed ceramic respectively.
- Flexural Strength: It should not be less than 5 N/mm^2 and 6.5 N/mm^2 for semi glazed and full glazed ceramic respectively.
- Wear Resistance: Rate of wear resistance should not be more 2.5mg/mm^2 and 1mg/mm^2 on average for 4 samples of each batch for semi glazed and full glazed ceramic respectively.

6 -METAL WORKS

6.1 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.

The contractor shall ensure of all dimensions on the site and clear them in detailed shop drawings for approval by the Engineer.

The contractor should provide the engineer with detailed shopdrawings for aluminum works that will be installed, in addition to providing samples of profiles, method of statement, accessories and hardware in order to have a written approval prior to starting.

6.2 Materials

6.2.1 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).

6.2.2 Aluminum

The Aluminum used should be approved type by the Palestinian Standards Institute, as indicated in the specifications and Bill of Quantities.

6.2.3 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.

6.2.4 Galvanized Steel Pipes

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

6.2.5 Paint

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

6.3 Description of Steel

Steel to be used for all the works must be new and have never used before and must be free of rust and crusts. The steel bar or plate should not be welded pieces but one unit.
The steel profiles and tubes used should be sound and free of defects like buckling, bending, and cracking or other. The tolerances in sections of steel shall not more than 0.30 mm for thickness and 0.50 mm for other dimensions.

6.4 Description of Aluminum

All of aluminum profiles should be according to the drawings and not be less than the following:

1. The thickness of aluminum profiles used for frames of windows and sliding doors shall not be less than (1.4 mm ± 0.05).
2. The thickness of aluminum profiles used for hinged windows and doors shall not be less than (1.4 mm) and not more 1.8mm.
3. The thickness of aluminum profiles used for leafs of windows and sliding doors shall not be less than (1.3 mm ± 0.05).
4. The thickness of aluminum profiles used for rail of louvers windows and toilet doors shall not be less than (1.3 mm ± 0.05) for Aluminum type 1088.
5. The thickness of aluminum for hollow sections with area of 3200 mm or above shall not be less than 1.4mm meanwhile the thickness for areas of 2200mm shall not less than 1.3mmm.
6. The thickness of aluminum profiles used for balustrade and protection for windows shall not be (2.05mm±0.1).
7. The thickness of decoration and architrave profiles should not less than 1.2 mm.
8. The thickness of anodizing coat at profiles should not less than 15 micron at least.
9. The thickness of powder coating at profile should not less than 60 micron at least.

6.5 Manufacturing and fixing of steel works:

6.5.1 General

The Contractor shall be responsible for the correctness and accuracy of the dimensions of the finished items. He shall therefore carefully check the dimensions indicated on the Drawings, verify any change and ascertain the sizes on the 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 take place after the contractor obtains, in writing, the approval of the Engineer for the above drawings.

6.5.2 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 steel sheet 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. 8 No. anchors, one end welded to frame and the other end dove-tailed to the masonry or concrete.

6.5.3 Hollow Metal Door Frames

Hollow metal door's frames shall be made of the profiles and sizes shown on the drawings and obtained from an approved manufacturer. The door frames shall be with minimum 2.0 mm thick, twice laminated steel sections and be delivered to site complete with a factory applied anti-corrosive plastic coating., ties cast 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.

6.6 Workmanship

6.6.1 Aluminum elements

The glass used should be transparent glass with a thickness of 4 mm or if stated otherwise.

The Aluminum used is coated with hot dipped polyester powder (paint thickness should not less than 60 microns).

Aluminum should be colored type and color choice as instructed by supervisor Engineer.

The used flay screen for the aluminum windows is manufactured of fiberglass as specified in drawings and bill of quantities.

Installing of aluminum frames to sills, lintels, and opening sides should be by using wedges manufactured of Polymerized Propylene or using screws made of aluminum or anti rust steel. Those screws should have enough size and length to fix the frames strongly as required and the approval of supervisor Engineer.

The hardware and accessories should be made of aluminum (Allen key corners, rails, locks, handles... etc.) of the same type of profiles required and shall be of solid hardware durable and shaped.
The used wheel rollers should be spherical ball bearing.
The locks should be secured and from approved type by the manufacturer or supervisor engineer.
The closing kit and tapes used to prevent water and air leakage should be manufactured from polymer vinyl chloride (PVC) or neoprene.

The engineer approval should be obtained for the color and appearance of the coating surface of aluminum before industrialization and supplying materials.

Selection of aluminum forms and profiles used to allow the tight closure of the doors and windows by installing tapes anti-air and weather influences, and providing the frames of sliding doors and windows with holes to permit disposing rainwater.

Aluminum works should not be installed before the completion of plastering and painting finishing.

Gap spaces between aluminum and architectural openings for doors and windows should be packed with a silicon paste injected from both sides to ensure full closure. The color of silicon must be fit to the color of aluminum.

Contact between the surfaces of aluminum and any metal surfaces contrast to the stainless steel, zinc-coated nickel or the bronze nickel is prohibited but only after addressing those surfaces using one coat of poly-zinc chromate primer and two coats of oil painting.

The contractor is responsible for all works of aluminum during and after installation until

handing over the project.

Installation of glass must be using strip of rubber between aluminum and glass from inside and outside.
The manufacturer must maintain the corners of aluminum works at right angles and gapless.

6.6.2 Steel elements

All steel works should be done with professional manner and welding must be hidden, not appeared on the face and polished.

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

No allowable showing any signs of knocks or any type of cavity in steel and should be all contact links arbitrator well without leaving any vacuum or clear signals welding redundant on the face.
Forging shall be sharp and true curbs and intersections, members of the same size shall halve together.

All items found in the railway premises in the building by rail to be commensurate with a solid and well.
It must be to work of all holes in block walls, concrete walls, tiles or stairs and where necessary to install steel works strictly by private machineries without causing any damages to the building. Costs of making holes well done and recovered are responsible of contractor with his own costs.

Manufacturing windows and doors as a full specifications and details shown on the drawings, taking into account that fixing 2 hinges for each window's shutter. However, if the height of shutter exceeds 1.5 meters, fix at least 3 Hinges for each shutter. For each door's shutter, fix 3 Hinges, 100 mm length unless otherwise specified in drawings or special specifications.

All steel members in contact with the soil shall paint 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

Making doors and windows accurately and proficiently duly taking into account that are made all welding by professionals and skilled labors with expertise in this area, and automatically clean all welded links and to get a smooth surface without protrusions
Stored all produced parts prior to installation in a dry place and the process of being transfer without scratches.

The contractor shall provide samples of any section for approval by Engineer before.

Fix door's frames in the wall by steel angles (3mm- thickness, 50 mm- wide, 200 mm- length), and be stationed in the form of right angles by welded one side of angel with steel frame and fix other side of angel with block by cement mortar.
Fix glass to window's frame using metallic clips and rubber or putty.

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
Welding work is along the flat welding (stitching along the line of welding)

6.6.3 Welding

Welding surfaces shall be clean, free cobalt, rust and other materials that will have the opposite effect on the welding by skilled professionals with expertise in this area.
Prohibits a welding operations in the up-normal weather conditions such rain, strong winds, or when temperatures fall to zero (0 ºc), unless action was taken to ensure that the impact of these conditions on welding operations, and the approval of Engineer
The intensity of electricity used in welding operations shall be located within the established range of welding rods, and then welding process is the movement of fluctuations consecutive start of the first welding and so close, and being removed from the slag welding operations abreast so that each layer of the welding layers completely clean before the following class action.
Prohibits any subsequent operations for one welding process unless after the disclosure of welding by engineer and approval, and is not being disclosed mentioned before passing 72 hours after the end of operations
Must provide workers with masks, protective glasses and gloves, and necessary to safe them during welding operations
Welding work is along the flat welding (stitching along the line of welding).

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.

6.7 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 submit to the Engineer for approval before ordering the materials.

6.8 Iron Steps

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

6.9 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.

6.10 Steel hand railing & 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 wherever possible shall be horizontal and circular. Horizontal and side palm plates shall be secured (I) by not less than 3 bolts of not less than 12mm diameter and 75mm length. Hand railing, base and palm plates shall be (I) painted after erection. Painting shall deem to including in the Contract rates for hand railing.

6.11 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 support 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 carry out after all welding and fabrication is complete.

6.12 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 supply complete with the fixing supports, which must be galvanized steel pipes, 2" diameter.

6.13 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).

7 -CARPENTRY WORKS

7.1 General

Carpentry work should be executed as shown on drawings and/or described in the contract documents in a proper manner and in accordance with the specification.
The carpenter is to clean out all shavings, cut ends and other timber waste from work places in the building and remove it from the site, all according to the satisfaction of the engineer.
All timber shall be softwood unless otherwise specified.
The contractor shall verify all sizes on the site by measuring all openings in order to cut wood with exact dimensions.

7.2 Description of Work

The extent of carpentry work is as shown on the drawings. The work includes, but is not necessarily limited to, wood grounds, blocking, nails and the like.

7.3 Quality Assurance

Codes and Standards: Comply with the applicable requirements of following codes and standards:

APA - American Plywood Association.
AWPB – American Wood Preservers Bureau.
U.L – Underwriter's Laboratories.

7.4 Particular

Timber for carpentry work shall be of species and quality suitable for the purpose for which it is to be used.
Samples of every type of timber which the contractor proposes to use in the work shall be sent to the engineer for approval. Each sample shall be labeled and the label shall state the species of the timber and the purpose for which it is to be used.
Timber shall be square, straight, true and shall be free from the following defects:

- Splits, ring checks and soft pitch.
- Hair cracks exceeding 0.25mm wide.
- Checks exceeding 30cm long.
- Checks more than half the thickness of the timber in depth.
- Knots exceeding 1cm mean diameter and/or exceeding 1m distance between their.
- Any size of knots in small timber species.
- Knots exceeding half the width of the surface.
- Decayed dead knots.
- Pitch pockets.
- Loose knots or knot holes.
- Decay and insect attack.
- Moist timber.
- Oil squeezer in timber which is still moist.

The soft wood generally shall have a moisture content limit of 15%. The hardwood shall have a

moisture content limit of 10% and shall have been kiln dried unless otherwise specified. The whole of the timber for joinery work shall be properly stacked and protected from rain and ground moisture.

Where preservation treatment is specified in the contract:
The moisture content of the timber immediately prior to treatment shall not exceed 28% and the timber shall be free from surface moisture and dirt. Treatment is to take place after all cutting and shaping is complete, and care must be taken not to damage surfaces of treated timber. If surface damage or cutting after treatment is unavoidable a liberal coating of preservative is to be made to such areas.
The preservative treatment shall be either:
Creosote applied by vacuum/pressure to BS 144 and 913, or
Copper/ chrome/ arsenic slats applied by vacuum/pressure to BS 4072.

7.5 Submittals

1- Submit shop drawings show full dimensions of each member. Show details of connections, connectors and other accessories. Indicates species and stress grade and other variables in required work.
2- Wood Treatment Data: Submit chemical treatment applied and manufacturer's instructions for proper use of each type of treated material.
3- Pressure Treatment: For each type specified, includE certification by treating plant stating chemicals and process used, net amount of salts retained and conformance with applicable standards.
4- For water-borne preservatives: include statement that moisture content of treated material was reduced to maximum of 15% prior to shipment to the project site.
5- Fire-Retardant Treatment: Include certification by treating plant that treatment material complies with governing regulations and that treatment will not bleed through finished surfaces.

7.6 Product Delivery, Storage and Handling

1- Keep carpentry materials dry during delivery, storage and handling. Store lumber and plywood in stacks with provision for air circulation within stacks. Protect bottom of stacks against contact with damp surfaces. Protect exposed materials against weather.
2- Do not store dressed or treated lumber or plywood out-doors.

7.7 Materials

7.7.1 Timber

1- General: Timber for framing, blocking etc., shall be sound, well conditioned, properly seasoned to suite the particular use and free from defects or combination of defects rendering it unsuitable for the purpose intended. Unless otherwise indicated, timber shall be No.1 yellow pine or No.1 fir.
2- Moisture Content: 15% maximum.

7.7.2 Plywood

1- Concealed Plywood shall be Exterior Type, C-C Grade.

2- Exposed Plywood shall be Exterior Type with medium density overlay on exposed faces.
3- Electrical Panels: If required for backing panels of electrical and communication equipment, provide Interior type plywood with exterior glue, fire-retardant treated.

7.7.3 Anchorage and Fastening Materials

Provide approved type, size, material and finish for each application.

7.7.4 Plywood Covered With Veneer

These sheets are formed of odd layers where each one is perpendicular to the underlying layer and should be ex-factory made with minimum total thickness 4mm unless otherwise specified.
In case of 3-layers for plywood sheet; it is not permitted to exceed the thickness of middle layer than 60% of total thickness of plywood sheet.
But if the plywood sheet consists of more than 3-layers, the total thickness of the two faces and those enclosed layers in which its fibers are in the same direction of faces' fibers; is ranged between 40% and 60% of the total thickness of sheet.
The contractor shall get the approval of the engineer for the source of the plywood sheets.
It is not permitted to combine plywood sheets with thickness less than the specified thickness by any means in order to get the required thickness.
The plywood sheet shall be free from any defects.
The faces of plywood sheet shall be of hard or smooth veneer as per specifications and bills of quantities.

7.7.5 Adhesive material

It is recommended to use highly adhesive material with approval of the engineer.

7.7.6 Plastic Sheets (Formica)

Use fire and moist proof sheets with approved color either shining or mutt. The used sheets shall be approved Britain made or equivalent like (Formica, Arborybe, Upper stop, etc.).

7.7.7 Nails and screws

1- Use nails with appropriate section and length for the work, and do not use weak or bend nails.
2- Use Rawl Plug or Rawl Plastic with nails to fix the wood as recommended by the manufacturer.
3- Soft wood is not permitted for plugs and wedges, only hard wood should be used.
4- Use copper, or chrome nails in case of visible nails, and do not use steel nails in this case.

7.8 Job conditions

1- Time delivery and installation of carpentry work to avoid delaying other activities which is dependent on or affected by the carpentry work and to comply with protection and storage requirements.
2- Framing, furring, nailing, blocking, grounds and similar supports should be performed so that the work will comply with design requirements.

7.9 Wood Preservative Treatments

1- General: treatment of lumber and plywood, where required or indicated as "Treated", is to comply with the applicable requirements of the American Wood Preservers Bureau (AWPB), available form AWPI.
2- Pressure treat the following items with waterborne preservatives for above-ground use, should comply with AWPB LP-2:

- Wood cants, nailing, blocking, stripping and similar members in connection with roofing, flashing, vapor barriers and waterproofing.
- Wood blocking, furring, stripping and similar concealed members in contact with masonry or concrete.
- Kiln-dry wood to a maximum moisture content of 15% after treatment with water-borne preservatives.
- Pressure treat wood members placed in the ground with below-round water-borne preservatives, complying with AWPB LP-22.

7.10 Fire Retardant Treated Wood

- Where fire-retardant treated plywood is specified, comply with AWPB standards for pressure impregnation with fire-retardant chemicals to achieve a flame spread rating of not more than 25 when tested in accordance with UL Test 723, ASTME 84, or National Fire Protection Association (NFPA) Test 355.

  Where transparent or paint finish is shown or scheduled for treated wood, use a fire-retardant treatment which will not bled through or adversely affect bond or finish.
- Complete fabrication prior to treatment, wherever possible, to minimize cutting and jointing after treatment. Coat surfaces cut after treatment with a heavy brush coat of the same fire-retardant chemical.
- Kiln-dry lumber and plywood to a maximum content of 15% after treatment.
- Inspect each piece of plywood after drying; do not use twisted, warped, bowed or otherwise damaged or defective pieces.
- Provide UL label or other equivalent on each piece of fire- retardant treated wood.

7.11 Inspection

The contractor shall examine the substrates and the conditions under which carpentry work shall be carried out and correct any unsatisfactory conditions.
Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

7.12 Workmanship

Timber shall be cut and blocked early by enough time to let the wood dries prior to forming.
Sections of timber used in the carpentry work are the net dimensions after cutting, scraping and rubbing the timber.
Make connections with Mortise and Tenon (dove & tail) way and use approved adhesive material to fix them with appropriate wooden nail if necessary.

Through assembling the door components including door frame; use Mortise and Tenon not less than 20mm in length.
Wooden parts should be painted with two coats of primer prior to installation.
Fix wooden frame to the wall using galvanized steel angels (120mm length, 30mm width & 4mm thick) by fixing the angel in the frame using screws and in the wall using cement mortar.
In case of fixing the wooden frame in concrete member; use expandable screws (Philips) with 100mm length and 5mm thick. The screws shall be sunk in the frame and the holes shall be filled with glue mixed with sawdust.
The minimum thickness of frame is 45mm. The frame shall exceed the wall width by not less than 15mm from both sides of wall to fit with plaster work, or 20mm in case of fixing ceramic wall tiling.
Use white cold bitumen coat for maximum 100mm height from bottom of frame legs as well as the back of frame as for moisture protection.
All framing shall be jointed as shown on the drawings, as specified by specification or approval by the engineer.
Hinges shall be designed and fixed so that they will transmit the loads and resist the stresses to which they will be subjected.
Unless otherwise stated; hinges shall be secured with a sufficient number of nails of an approved type.
Use 3-hinges with minimum 100mm length to fix the door with frame. The hinges should be made of brass metal.
All connections exposed to the weather shall be thickly primed except where adhesive materials are used.
No nails, screws, or bolts shall be placed in an end split. If splitting is likely to occur, holes for nails are to be pre-bored at diameters not exceeding 4/5 of the diameter of the nail.
Members of structural units shall be clamped and spiked together before drilling bolt holes. Holes for bolts shall be bored from both sides. A tolerance of 1mm will be allowed in positioning bolt holes.
Timber connectors, where specified, shall be 2 single sides toothed plates for demountable joints and one double sides toothed plate for permanent joint.
Timber shown on the drawings to be plugged shall be properly and securely fixed by means of splayed or expansion bolts.
Timber shall not be built into walls or floors unless this is shown on the drawings. When required, it shall be coated with a wood preservative material suitable for the position in which the member is to be incorporated.

7.13 Installation

1-General: Discard units of material which are unsound, warped, bowed, twisted, improperly treated, not adequately seasoned or too small to fabricate the work with a minimum of joints or the optimum jointing arrangement.
2-Shop Drawings: Comply with details shown on approved shop drawings. Provide lumber and plywood of dimensions not less than those shown.
3- Fit carpentry work to other work. Scribe and cope as required for accurate fit.
4- Set carpentry work accurately to required levels and lines with members plumb and true.
5- Securely attach carpentry work to substrates by anchoring and fastening as shown and as required by recognized standards.

- Provide washers under bolt heads and nuts in contacts with wood.
- Nail plywood to comply with recommendations of the American Plywood Association.
- Countersink nail heads on exposed carpentry work and fill holes.

6- Fasteners:

- Use common wire nails, except as otherwise shown or specified herein. Use finishing nails for exposed work. Do not wax or lubricate fasteners that depend on friction for holding power. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members.
- Install fasteners without splitting of wood, predrilled as required. Do not drive threaded friction type fasteners; turn into place. Tighten bolts and lag screws at installation and retighten as required for tight connections prior to closing or at completion of work.

7.14 Wood Grounds, Nailing, Framing and Blocking:

1- Provide wherever shown and where required for screeding or attachment of other work. Form to shapes as shown and cut as required for true line and level of work to be attached or screeded.
2- Coordinate location with other work; refer to shop drawings of such work, if any.
3- Attach to substrates securely with anchor bolts or other attachment devices as shown and as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise indicated. Build into masonry as work progresses, cutting to fit masonry unit size involved. Anchor to formwork before concrete placement.
4- Provide grounds of dressed dey-beveled lumber not less than 38mm wide and the thickness required to bring face of ground to exact thickness of finish material involved. Remove temporary grounds when no longer required. Where indicted as permanent grounds, provide treated lumber.

7.15 Wooden door

Make the wooden door according to approved shop drawings.
In case of flush compressed doors, make the internal fillers from white wood with 3cm maximum distance between fillers, and 3cm minimum width for each one. Make the architraves using hard wood unless otherwise specified.
Forming fillers as specified in the drawings and make a tongue through the longitudinal part of the frame with minimum 1cm length.
Doors which their connections include gaps, shall be rejected.

7.15.1 Wooden doorframe

Use class (1) wood to make the frames with appropriate width and 4.5cm thick with appropriate architraves from both sides of the frame.
Fix the frame with 10cm minimum length under the tiling level.
Coat the frame with primer coat then two coats of white cold bitumen for the back and buried part before fixation.

7.15.2 Metal accessories

Use high quality accessories for doors made of brass or chrome, approved by engineer.
Use first class, approved quality locks and handles according to the type specified in the particular specifications.

8 PAINTING WORKS

8.1 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 and bill 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 of finish coats.
All painting works shall be applied by skilled workmen experienced in this work.

8.2 MATERIALS

8.2.1 Materials in General

The materials to be used shall be of the best quality and of approved types, obtained from an approved manufacturers *and these material approved from "**the ministry of Public works and population**"*.
All paints shall comply with the following requirements:

- The product shall be thoroughly mixed.
- The color of the paint shall match the approved sample.
- Paint shall show no evidence of cracking, chipping of flaking.
- Paint in the containers during and after application shall not be abnormally pungent, offensive or disagreeable.
- 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.
- Paint shall dry to a uniform, smooth, flat or Semi-gloss finish under ordinary conditions or illumination and wearing. There shall be no laps, skips, high-lighted spot or brush marks. Tinted paints shall dry to a uniform color.
- Recoating of a previous painted surface shall produce no lighting softening or other film irregularities.
- Paint materials should be tested by an authorized and approved laboratory in compliance with the B.S or Palestinian Standard.

8.2.2 Flint-coat Protective Coating:

Flint-coat protective coating on fire escape staircase floors shall be colored, "Decorate". The product of "Flint-coat" or approved equivalent shall be especially compound acrylic resin latex color coating, heavy bodied, flexible and abrasive resistant.

8.2.3 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.

8.2.4 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.

8.2.5 Fillers

Shall be "Polyfilla " or approved equal.

8.2.6 Stopping

Shall be hard stopping composed of white load paste, and other fillers obtained from an approved supplier.

8.2.7 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.

8.2.8 Thinners

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

8.2.9 Stain

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

8.2.10 Color

Shall be pure tiny color that will easily dissolved and mix with the various coatings and shall conform to the requirements of B.S. 1014: 1961 “Pigments for cement, magnesium oxy-chloride and concrete”.

8.2.11 Primers

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

- Interior or exterior plastered surfaces: Alkali resistant primer as recommended by the manufacture.
- Ferrous Surfaces: Lead based or zinc Chromate and Calcium Plum bate as recommended by the Manufacturer.
- Non-ferrous surfaces: Mordant solution of an approved brand and rust inhibiting primer.

- Woodwork Surfaces: Leadless grey primer in accordance with B.S. 2524 latest edition.

8.2.12 Undercoating Paints

For exterior or interior shall be as follows:

- One coat of whitewash or color-wash as shown on the Schedule of Finishes and the Drawings.
- White lead bases undercoating in accordance with B.S. 2525, Colors shall be similar to the finishing paint.
- Other undercoating paints to be applied as recommended by the manufacturers of the finishing paint.

8.2.13 Finishing Paints

Shall be as follows unless otherwise indicated on the Drawings:

- Interior plastered surfaces and exposed concrete surfaces as shown on the Schedule of finishes and the drawings:
  Float enamel paint or approved emulsion paint for interior use of an approved color and supplier.
- Exterior exposed and plastered surfaces as shown on the Drawings:
  Approved emulsion paint for exterior use of the color indicated on the Drawings.
- Interior woodwork surfaces other than hardwood:
  Oil paint semi-gloss finish of an approved manufacturer.
- Hardwood surfaces:
  Approve oil stain and ducco spray, or flat enamel paint.

8.3 WORKMANSHIP STATIONARY

8.3.1 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. As the materials are in 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 judgment is necessary by the Engineer the paint samples may be tested in a laboratory designated by the Engineer at the contractor's expense, complete color 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 produced 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 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 surfaces, 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 from 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 station to insure that they receive an 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 sandpapered smooth.

8.3.2 Plastered Surfaces with 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 re-appear in which case it shall be brushed of 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.
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 sandpaper until smooth surface is

achieved.
A minimum of two 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.

8.3.3 Ferrous Surfaces:

Surfaces shall be thoroughly cleaned to remove and dirt, wire brushed and scraped to remove scale and rust. One coat of approval putty shall be applied on the surfaces and left to dry for 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 "Galvanized" primer or other approved equal shall be 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 surfaces 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 reprimand 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 undercoat 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.

8.3.4 Non-Ferrous Surfaces

Galvanized steel surfaces to be painted shall be solvent-cleaned or painted with mordant solution and shall be primed with Poly-zinc before the application of paints as described above for ferrous surfaces.

8.3.5 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 exist shall be removed by washing, rubbing down and burning off as necessary. Oil 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 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.
Wood surfaces specified as stained shall only be rubbed down with fine abrasive paper and two coats of oil stain deco sprayed to the satisfaction of the Engineer.
Wood surfaces specified as varnished shall be thoroughly cleaned down of all dirt, oil, grease, etc… and rubbed to a smooth finish, knots shall be treated with knotting and 2 coats of approved oil varnish applied.

8.3.6 Flint coat Protective Coating

Two coats of flint coat Decorate colored coatings should be applied at normal dilution i.e.: two (2) volumes Decorate and one (1) volume water, using no primer. The first coat should be allowed to dry before applying the second one.

8.3.7 Oil Stain Finish to Woodwork

The stain finish to woodwork shall be an approved manufacturer’s oil stain system applied strictly in accordance with the manufacturer’s instructions.
All surfaces are to be thoroughly dry and cleaned and sanded down and all nail holes or similar defects shall be filled and leveled up with approved hard stopping
The finish shall be applied in two coats. The first coat shall be pigmented stain wax brush applied. The surface shall be allowed to dry for 2-10 minutes and then rubbed with a cloth in rotary motion to remove excess stain and produce an even surface.
The first coat shall be allowed to dry completely before application of the second coat.
The second coat shall be natural (clear) stain wax and buffed.
The Engineer shall select the stain color and the contractor shall allow for preparing sample panels for the Engineer’s approval and these sample panels will provide the standard for the work.

9 -ROOFING, WATERPROOFING AND THERMAL INSULATION

9.1 SCOPE

These specifications cover, waterproofing, roofing and thermal insulation 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.

9.2 Preparation

All surfaces must be clean sound, and free from oil, grease and all loosely adherent materials. Wire brush, sand blast or grit blasting may be used to remove any surplus adhered to concrete and steel. The contractor must submit a request for all materials for Engineer approval.

9.3 MATERIALS

9.3.1 Damp proofing

All substructures, floors of ground floor of kitchens, toilet and bathrooms have to be painted with a waterproofing liquid.
Before application of primer and bituminous layers, angle fillets of concrete should be constructed at the wall boundary of the bathroom, toilet and kitchen with dimension of 7 cm* 7 cm and working mix cement & sand by 1:3. Thresholds of the same mix must be implemented at the bathroom, toilet and kitchen doors.

9.3.2 Waterproofing of exterior walls

This will be added to the exterior plastering of walls. It's an integral concrete waterproofing compound that will reduce moisture absorption in the plastering mixture.

In case of buried masonry, the joints between courses should be ranked out to 0.5cm, and then the walls to be plastered with rich cement mortar 0.5cm thick by 1:1 cement –sand ratio.
The bitumen primer should be applied after the plastering is totally dried and left enough time as per instructions of the manufacturer. Two coats of hot bitumen 75/25 should be applied perpendicular to each other, unless otherwise indicated, so that any holes, cracks or any defects are not been noticed.
In case of concrete walls; any loose particles and steel ties should be removed and accordingly patched with special cementeous material prior to application of the primer and bituminous coats as previously described.

9.3.3 Waterproofing of the roof

9.3.3.1 Lightweight Concrete

A sloping screed consisting of lightweight concrete screed shall conform to B.S.3797:

lightweight aggregate for concrete. The lightweight aggregate shall be such a 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 bags stacked not more than 3.00 meters high.
Process of damp-proofing layers should not be started at least four days after curing of concrete screed finished and dried.
Cement angle fillets 10cm * 10 cm must to be executed at the boundary of roof parapet with cement & sand mix by 1:3

9.3.3.1.1 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 light- weight aggregate and the following mixing table 9-1 shall be strictly observed.

Table 9-1: Mixing of light- weight aggregate

Nominal Mix	Lightweight Aggregate	Cement Contents	Water
8:1	1:00 Cubic Meter	150 kgs.	200 Liters

As overall, the maximum bulk dried density of the lightweight concrete should not exceed in anyhow 1200kg/m2.

9.3.3.1.2Mixing 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 tamped, 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 light weight 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 7 days then left for 4 days drying 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.

9.3.4 Waterproofing

An application of Plastomeric Bitumen-Polymer waterproofing sheets (APP) with splayed chips must be carried out after application of corresponding primer as instructed by the manufacturer. Membranes should not be less than 4mm in thickness or 4.5kg/m2.
Application process of the membranes must be done by torching them to the specified temperature prior to adhering to the roof deck. The pricing will include overlapping 10cm between sheets, upstands up to 15cm, dressing into storm water traps, etc.
Measurement of the membrane and underlay screeds will be for the horizontal projection of the deck unless otherwise described

9.3.4.1 Workmanship

Prior to the beginning of the roofing works, the Engineer and the roofing superintendent shall proceed to the inspection and approval of the receiving surfaces, the upstands at roof edges, the drains, vent pipes and other venting devices, the construction joints etc.

The contractor will be notified in writing of all defects of the flat surfaces or details and work shall not be preceded until such defects have been corrected.

One coat of primer is painted over the entire surface. Installation of the bituminous layers shall be carried out in conformity with the manufacturer’s specifications and using propane torch welding only.
Asphalt coatings shall be softened but not melted as to avoid superheating using a single-

nozzle torch of adequate size. Rolls shall overlap 75mm on sides and 150mm at ends. All inadequately welded seams will be refused. All superheated areas or parts will be refused and will require adequate repair in accordance with the degree of deterioration of the membrane.

Air blisters, wrinkles impact and tearing marks and protective granules pounding marks are not admissible. Should these defects occur, roofing works shall be carried out again.

9.3.4.2 Bituminous Flashings

A plain underlay bonded to the support with previously applied primer coating or welded to it with propane torch. This underlay shall be unrolled parallel to the upstanding element in one meter width extending 150mm onto the current surface underlay.

Apply the current surface-finishing layer onto the flashing underlay and then recover with the flashing-finishing layer extending 200mm onto the current finished surface.
This layer shall be welded with propane torch in full adherence that no air is entrapped between layers. Side and end laps shall be staggered over underlay seams and 75mm wide.

9.4 WATERSTOPS

9.4.1 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 water-stops. The Contractor shall take suitable precaution to support and protect the water-stops during the progress of the work and shall repair or replace any damaged water-stop.

All water-stops shall be stored in as cool a place as practicable, preferably at 21 C^0 or less. Water-stops shall not be stored in the open or where they will be exposed to the direct rays of the sun. All water-stops shall be protected form oil or grease.

9.4.2 Rubber Water-stops

The rubber water-stop 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.

9.4.3 Installation

The water-stop 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 water-stop to insure complete filling of the concrete forms under and about the water-stop, and to obtain a continuous bond between the concrete and the water-stop at all points around the periphery of the water-stop. In the event the water-stop 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 water-stop 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 water-stop shall be carefully cleaned.

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

9.5 THERMAL INSULATION

Criteria, design aspects, implementation methodology and relevant materials of the thermal insulation must be according to the Palestinian Code for Energy Efficient Building and using the supplementary Guidelines.

10 -STONE WORKS

10.1 Introduction

The masonry stone is one of the oldest building materials known in the history of construction that had strongly influenced the architectural style and construction system in the Middle East.
By given the unique quality of the masonry stone, it is considered as one of the most prevailing and essential items in the building construction until the twentieth century as introduced other materials.
Natural masonry stone has several sources in the world especially in the Middle East including Jordan, Palestine, Saudi Arabia, Morocco and other.
The masonry stone specifications cover all the stone works intended to be used for external walls including the decorations at elevations, architectural openings, arches, and copings covering the parapet of the roof.
All these required works should be in accordance with the drawings, bills of Quantities and as directed in writing by the supervisor Engineer.

10.2 Categories of stone in Palestine

10.2.1 According to the classification of compounds, which contains:

- Stones contain wire mainly stone such as quartz
- Stones containing silicate minerals and other silicate minerals that contain Feldspar which is aluminum silicate with lime and potassium with color red or pink, or containing aluminum silicate with iron then the color becomes brown black.
- Calcareous stones contain minerals which are either calcite (calcium carbonate) or dolomite with a calcium magnesium carbonate.

10.2.2 Classification by region of stone:

- Al Shoyokh stone, this type of stone is extracted from Hebron, which is more common in Gaza Strip.
- Kabatia stone, this type of stone is extracted from Jenien.
- Anjasa stone, this type of stone is extracted from Hebron, which is most common in the Gaza Strip.
- Jamma'in stone, this type of stone is extracted from Nablus, which is a high price stone, and hard formation with a high quality).
- Yatta stone, this type of stone is extracted from Hebron.

10.2.3 Classification by engraving formats:

The masonry stone is craved in multiple formats including:

10.2.3.1 Stippled stone (Milattash) format

This type of stone format is achieved by engraving all over the stone surface using a pointed carving chisel distributed regularly as possible.
The depth of Stippling groove should not be more than 3 mm in stone class A, and 5 mm in stone class B and C.

10.2.3.2 (Misamsam) stone format

This type of stone format is achieved by engraving the stone surface using a fork head chisel equal and parallel lines horizontally or vertically or at angle of 45 degrees.
The depth of groove should not be more than 3 mm in stone class A, and 5 mm in stone class B and C.

10.2.3.3 Rough stone (Tobzeh) format

This type of stone format is achieved by keeping the stone in its original rough surface, but refining works should be done around the edges of the stone.
The depth of refining works should be more than 90 mm from the edges and not less than 50 in stone class A, and 40 in stone class B and 30 in stone class C.

10.2.3.4 (Tabbih) stone Format

This type of stone formats is achieved by engraving intensively as required on the stone surface using a spiky-head hammer grade 10, 12, or 14 to keep it free of cavities, or other stone defects.

10.3 Advantages of natural stone

1. Color consistency and not influenced by natural erosion agents
2. Thermal insulation and firmness and durability
3. Maintain the natural form and flair.
4. Lack of need for maintenance.
5. Relevance for all weather conditions.

10.4 Defects in stone

1. Holes: in the form of pockets within the stone make it a weak over time.
2. Impurities: in the form of pockets within the stone filled with shells.
3. Seams: a shakes within the stone filled with materials mainly crystallized calcium carbonate.
4. Races: the pockets filled with lime which distorts the stone and makes it weak as well.
5. Irregularities of colors: the regular color of stone is very important advantage in terms of architectural appearance and durability of stone, that determining the acceptance of stone or not.

10.5 Stone Industry

The stone industry process is going through several stages.

1. Extracting of natural stone from stone quarries in the form of blocks that go through cutting process to the required sizes and volumes.
2. Stone carving using different kinds of chisels. The stone surface should be chipped manually to be fitted with the required formats.
3. If a saw is used in the Stone cutting process, the inner edges of stone should bi-chipped to increase the contact between the stone and the backfilling concrete.

10.6 Materials

10.6.1 Technical Specifications for masonry stone

1. The masonry stone in its different shapes and formats that intended to be used in walls construction should be of high quality and free of defects such as holes, impurities, seams and shakes, races, irregularities of colors, structural weaknesses and other defects that would tend to increase unduly the deteriorations from natural causes.
2. Should be regular in color, and remains constant through the time.
3. Samples of stone materials and dressing shall be submitted for the Engineer's approval 30 days before delivery of any such material to the Site.
4. All stones shall be selected well in advance of the time required and passing through the physical and laboratory test as the following table:

Table 10.1 : Illustrates the Test Parameters and Values for the Masonry Stones

TEST	STANDARD	TEST TIME (DAY)	CLASS A	CLASS B	CLASS C
Dry density g/cm2	ASTM C97	3	2.56	2.45	2.16
Compression Resistance kg/m2	ASTM C170	2	800	700	600
Flexural Resistance kg/cm2	ASTM C99	3	55	47	28
Sear Resistance kg/cm2	ASTM C97	3	6.9	5.2	3.4
Erosion & abrasion	ASTM C241	3	≤1%	≤1%	≤1%
Water absorption	ASTM C97	3	3%	4.3%	7.5%

5. Stone Dimensions
   - The height of mason stone is 25 cm or 12.5 cm and other sizes can be selected depending on the nature of the project.
   - The masonry stone length should be between 35 – 70cm, while the length of small pieces that used to complete the facade should not be less than 1.5 stone height.
6. Stone thickness: The thickness of masonry stone according to the Jordanian specifications should be between 5 - 7 cm of the stone used in the facades building and 3 cm of the stone used in the facades cladding or tiling.

10.6.2 Backfilling Concrete:

The backfilling concrete used for the Stone construction should be concrete (B-150) where the design compressive strength of the concrete should not be less than (185 kg / cm 2) and the quantity of cement at a minimum of (260 kg / m 3).

10.6.3 Wire meshes reinforcement

Wire mesh reinforcement of spacing 20cm*20cm and ø8 mm should be fixed to the façade concrete block by anchors with distance does not exceed 60 cm in two directions.

10.7 Workmanship

The contractor should provide stone samples for the engineer approval and the approved stones

to be kept with the engineer during of the implementation of the work until completion, and should set up mockup of the stone facade for the Engineer's approval before executing any pointing.
The total thickness of stone building and concrete backing shall be as shown on the approved shop drawings.
All stones shall be cleaned and thoroughly wetted before setting up.
The back surface of the stone should be chipped well in terms of increasing the contact between stone and concrete.
All stone courses should be hand placed, carried up in a uniform manner. Not more than 2 courses are allowed to rise above one another at the same time .The joints must be solidly bedded with full mortar and fully squeezed out.
The mortar for bedding will consist of mixture of cement, fine aggregate size (1.18mm), and clean sand with ratio 1:2:1 respectively.
The period of time allowable for using the mortar in masonry stone works should not be more half an hour
The vertical overlapping between stone courses should not be less than 25cm unless otherwise mentioned.
The horizontal and vertical joints between stone courses should be 5mm in width, and to ensure even and regular width of beds and joints when setting up stones. The Contractor shall use hardwood wedges to ensure close and regular gaps between beds and joints.
The horizontal and vertical joints should be straight and perpendicular to each other and should be cleaned and grooved in depth of not less than 1.5 cm.
All stone courses, stone arches, and any architectural decorations should be well supported by convenient shuttering works according to the engineer's instructions and under the contractor's responsibility for any damage occurred of any kind.
A holes of 2.5cm depth (2 holes at least) on the upper surface of each stone , then a galvanized wire of ø 4mm, Z-shape should be fixed in the holes with adhesive paste and tied to the wire mesh reinforcement.
Care should be exercised when casting the backfilling concrete behind the stone courses, that should gradually with layers' doesn't exceed 20cm thickness for each layer and in a period of time between layers of 1 hour at least.
Backfilling concrete for masonry stone should be from 5 - 8 cm thickness, unless otherwise mentioned.
Detailed shop drawings for all stone works and installations should be submitted and approved by the supervisor engineer, clarifying the method of installations, dimensions and sizes, types, formats, width of joints, etc.

10.8 Stone cleaning and Joints grouting (TAKHEEL)

After completion of the installation of stone, hardwood wedges should be removed, then the stones are cleaned from the suspended dirt by one of two ways either by sand blasting or by grinder machine with wire brush.

The mortar used for grouting works should be consists of mixture of white cement, fine aggregate size (1.18mm), and clean sand with ratio 1:1:1 respectively, while the coloring of the mortar should according to engineer's instruction.
Types of grouting (TAKHEEL).

1. flush: the grouting should be flat with the face of the stone and polished well.
2. Grooved: the grouting concavity should be half circular with diameter (5 mm) and depth (3 mm) of the surface of the stone.
3. Recessed: the grouting depth and width should be according to instructions and

specifications, where the recessed grouting width should not be less than (4mm) of the depth of the joints.

10.9 Quantity measurements for mason stone works

All stone works quantities should be measured by square meter for all kinds, types, stone arches, architectural openings, and façade decorations unless otherwise mentioned, taking in consideration that the price includes the installation of scaffolding duration of the implementation, wire mesh reinforcements works, backfilling concrete works, Stone cleaning and Joints grouting and all needed works according to engineer's instructions .

11 -PLUMPING AND SANITARY INSTALLATIONS

11.1 Scope of work

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

- Excavating, backfilling, breaking in wall, concrete encasement and reinstatement works.
- Plumping fixtures.
- Water supply systems including cold and hot water services.
- Waste disposal system.
- Rainwater services.
- External gravity sewer network.
- Fire fighting system.
- Gas system.
- Water tanks and water pump.
- 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 Tendering.

11.2 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 fed from the main city network.
Hot water is generated by means of water heater or solar system and stored in hot water storage tank.
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.
All riser branches must be provided by elbows, Tees or nipples with gate at the point of connecting with branches.
Clean out opening must be provided where shown on drawings and where required.
Slope of drain pipes to be 1cm/mr unless otherwise indicated.
Vent for sewage pipes to be 1 meter above finished roof and including galvanized wire dome grating.
Where vent pipe penetrates the roof slab; roof finishes and waterproofing material must be carried up around the pipe and must be closed with vent cap to prevent water penetration, all to the approval of the Engineer.
Fire fighting in the building is achieved by a wet riser system and in certain locations by portable fire extinguishers as shown in approved shop drawing.
Rain water is collected from roof and discharged to any nearby outlet as shown on approved shop drawing.

11.2.1 Drainage and Drain system

The external pipes shall be made of un-plasticized polyvinyl chloride (U.P.V.C.) from approved made unless otherwise noted according to the approved shop drawings.
The internal pipes shall be made of polyvinyl chloride (P.V.C.) or propylene (P.P) from approved made unless otherwise noted according to the approved shop drawings. Pipes shall be laid in position by means of leveling instrument.

11.2.2 Water Distribution Networks

All the materials used in the main water distribution lines are galvanized steel pipes, grade B and approved made unless otherwise specified. All the internal cold and hot water pipes will be galvanized steel grade B or Polyethylene pipes (Golani system) as indicated in the drawings and bill of quantities, all per specifications and engineer's approval.
All the under ground pipes shall be galvanized steel coated with bitumen and wrapped with insulation tape as directed by the engineer unless otherwise specified.
Where pipes emerge through walls, floors or ceilings; they should be passing through sleeves and insulated with tape over bitumen coats.
Wherever galvanized steel pipes are used for hot water, approved heat insulator should cover the pipes in addition to bitumen coats.
Fire fighting pipes will be galvanized steel pipes and as in the approved shop drawings.

11.3 Pipe Installation

All piping shall be properly supported or suspended on stands, clamps, hangers, etc. of approved made. Supports shall be designated to permit free expansion and contraction while minimizing vibration. Pipes shall be anchored as directed by means of steel clamps securely fastened to the pipe and rigidly attached to the building structure. Screw threads shall be cut clean and true and joints made tight without caulking. Reducing fittings shall be used to change pipe size, and reductions to be made with eccentric reducers. Short radius fittings shall not be used.
Pipe work shall confirm fully of the following requirements:

- Piping shall be properly graded to secure easy circulations and prevent noise and water hammer. As much pitch as space conditions allow must be given. Capped dirt pockets to be installed at all riser heels, low points, and other places where dirt may accumulate. Allowance must be made for proper provision for expansion and contraction in all portions of pipe work to prevent undue strain in piping. Expansion joints to be installed as directed by the Engineer.
- All fittings such as elbows, tees, bushes, etc. shall be of best quality, foreign made or approved made [Class A] according to local standard with smooth interior surfaces. Approved screw unions or spherical joints shall be installed at trapped instruments, etc. and where else directed to permit easy connection and disconnection. Final connection to all equipment and fixtures shall be made in a manner that will permit the complete removal of any fixture or any piece of equipment without cutting of pipeline. If after the plant is in operation any system do not circulate quickly and noiselessly [due to trapped or air bound connections]. The Contractor shall make proper alternations in these defective connections. If connections are concealed in furring floors or ceilings, the contractor shall bear all expenses of tearing up and rebuilding construction and finish.
- All mains shall have a slope of not less than 5mm in 3 meters in direction of flow. All

branches shall have a slope of not less than 1mm in 3 meters towards the main. All branches from mains shall be connected at the angle of 45 if possible. Each piece of pipe and each fitting shall be carefully inspected on the inside to see that there is not defective workmanship on the pipe or obstructions in the pipes or fittings. Joints in all threaded piping shall be jointed using red oxide lead and boiled in.

- Straight elbows, bushing, long screws or bull head tees shall not be installed, and all offsets shall be made with fittings. Pipes shall not be bended at any time.
- Pipe work shall be installed in manner to allow for ease of air escape and system draining. It shall be endeavored to obtain this naturally by gravity. However, where conditions don't permit it an automatic air vent shall be installed at all air pocket locations and drain gate valves shall be supplied and installed at all low points and risers legs or as shown on drawings.

Before turning the project over to owner, system shall be thoroughly flushed of all dirt and foreign matter and the contractor shall thoroughly disinfect the entire water system including underground mains.

Pipes material is galvanized steel "blue sign" local made "class A".
All pipe fittings such as elbow, tee, reducer, union, etc. shall be galvanized forged steel of the same quality of the pipe. Pipes and fittings shall be suitable for threaded connections

The Contractor shall provide suitable and substantial hangers and supports for all piping works. Piping shall be carried by pipe hangers supported by concrete insets. In general supports for pipes shall be not more than 2.5m apart for 2" and smaller pipes according to the conditions of the job and directions of the engineer. Copper piping shall have hanger every 1.5 meter.

All vertical piping will be supported by heavy pipe clamps resting on the building structure. No piping shall be hung with other piping and all hangers shall be of heavy construction suitable for the size of supported pipes. All horizontal pipes shall be supported by split ring hangers of malleable iron provided with solid rod and nuts to maintain adjustable height.
All vertical pipe line passing up through the building shall be hung from each floor of the building. Malleable iron clamps of suitable size and bolted around the pipes shall be used for these supports.
These pipes shall be secured midway between the floor and the ceiling of each story by means of malleable iron, solid hangers around the pipe and fastened to adjacent walls by means of inverted bolts cast in concrete walls. Anchors shall be separated and independent from all hangers and supports.

11.4 Valves

Hand valves, float valves and check valves shall be of an approved made and shall be furnished and installed as shown on the drawings or as directed during construction.
The Contractor shall include for the finishing; the required valve tag and a schedule of valves with a schematic drawing showing position of each. The drawing shall be glazed, framed and hung in the machine room.

11.5 Floor Drain

Floor drain shall be obtained from an approved made P.V.C. 4"/2" minimum water seal, complete with chrome plated duty strainer tightly sealed to drain body. All 2" P.V.C. drain pipes are connected to floor trap by rubber sealed record fittings.

11.6 Roof Drain

Each roof drain shall be of P.V.C. constructed with built in trap, having and integral flange and wire dome type strainer, fixed by screwing into the drain body. Rain drain shall be installed as shown on drawings.

11.7 Storage Tanks

Water tank used is P.E approved made class A 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 drawings, manufacturer's instructions i.e. (tank foundation, mechanical float valve, valves, fittings, vent pipe, overflow, drain, connections and the required accessories) and as supervisor engineer instructions.

11.8 Manholes and Chambers

11.8.1 General

All chambers and manholes will be supplied by the Contractor according to drawings, specifications, bills of quantities and Engineer's instructions.
Work shall include excavation, backfilling, concrete base, hard-core installation, reinforced concrete cover slab, benching, internal rendering, external bituminous insulation, internal epoxy protection paining if notified in the bills of quantities, etc.

11.8.2 Construction of Manholes and valve Chambers

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

Manholes, chambers, and special structures shall conform in shape, size, dimensions, materials, and other respects to the details indicated on the Drawings or as ordered by the Engineer.

Manhole and chamber cover slabs shall be either pre-cast or cast in place reinforced-concrete as marked on the Drawings. The cast iron frames and covers for manholes and chambers shall be brought with grade so that to sustain the indicated load.

Manhole walls (rings) and cover slabs shall be either pre-cast 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 general, the top level of manhole cover slab shall not be in any how lower than the level of cast iron cover by 30cm.

Benching of manholes must be smoothly curved and semi circular of diameter equivalent to inlet and outlet pipes. Benching should be rendered and plastered perfectly smooth, inclined in the manhole to 2cm minimum.

Manholes over 1m deep shall be supplied with Cast Iron steps well anchored to the concrete walls at a spacing of 30cm.

Drop manholes must be constructed if the difference in depth between the inlet and outlet pipes exceeds 60cm.

11.8.3 Formwork of Valve Chambers

The Contractor shall be responsible for the design and stability of the formwork of the chambers. The Contractor shall submit a full program of work and safety indicating the various phases for the erection and removal of forms and the manner in which he intends to execute.
The contractor shall take the safety measures in order to avoid any corresponding incident and he shall hold the responsibility of pit protection during the construction of the chamber.

11.8.4 Cleaning

All manholes and valve chambers specified under this section shall be cleaned of any accumulation of silt, mortar, debris or any other foreign matter of any kind and shall be free of any such accumulations at the time of final inspection.

11.9 TESTING

11.9.1 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 voided 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 technical practice.

11.9.2 Water Supply Systems

All water supply piping shall be tested under hydrostatic pressure of not less than working pressure for 24 or hydrostatic pressure of not less than 1.5 working pressure for one hour as directed by the supervisor engineer. 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.

11.9.3 Gas Network

A - Copper Pipes Used for Gas:
1 - The pipes should be round and smooth, completely clean, free of defects and surface

oxidation and to be trimmed off vertically so that the roundness of the cross section does not be affected.
2 – The supplied pipes should be of brand name and clearly showing the manufacturer brand, Standard No. in addition to the type and size of such pipes.
3 - The contractor has to provide a certificate issued by recognized laboratory proving that the pipes comply with the specifications, otherwise the engineer is entitled to take samples from the supplied pipes for testing at the expense of the contractor.

B - Pressure to Cut Copper Pipes:
1 – Fittings should be suitable for connections of copper pipes and comply with the British Standard (BS 864 PART2).
2 - Fittings should be made of copper or copper alloys which resist chemical corrosion.
3 - Fittings must pass the hydraulic pressure test equal to 2.1 N/mm2 with no leakage.
4 - Fittings must pass must pass the porosity test according to British Standard (BS 864 PART2).

C – Connection of Copper Pipes by Welding:
1 – Both ends of the two pipes should be cleaned properly with steel wool or glass paper, wiped from any particles and painted with welding agent (FLUX) before the welding process.
2 - The process of welding should be performed either by silver ring or welding tin according to the special specifications. If is not explicitly specified which method to be followed, the contractor has the right to choose the appropriate one of those methods.

*** Silver Ring Method:**

This method is used to joint a pipe with a fitting so that the pipe end as well the fitting are heated till the silver ring inside the fitting melts and flow to fill the gap between the pipe and the fitting.
*** Welding Tin Method:**

This method is used to joint a pipe with a fitting or a pipe to pipe so that the ends of the two pipes are heated, then make the welding rod touches the area of welding till it fills the gap between the pipes.

11.9.4 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.

11.9.5 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.

11.10 PLUMBING FIXTURES

The following fixtures shall be supplied with cold and hot water by pipes not less than 1/2".

1. Supply and installation of wash basin, porcelain approved made class "A", with chrome plated cold and hot water mixer or faucet, size ½" of approved manufacturer such as including PVC trap connected with over flow and with the floor trap by plastic P.V.C. pipe 2". The work shall include supply and install soap holder, chain and rubber plug, angle valves, hoses and all needed accessories . Height of basin is 80 cm from the finish floor level.

2. Supply and installation of porcelain W.C. including internal S or P Siphon approved made class "A". The price includes plastic flushing cistern tank, plastic W.C. seat cover of heavy duty, porcelain toilet paper holder, chrome plated angle valve ½", chrome plated flexible hoses ½", flushing spray hose, and all needed accessories. The W.C. should be connected with the 4 inch P.V.C. main sewage pipes and the flushing tank to be connected to the main water line by ½" galvanized pipe or otherwise specified. European W.C. bowels shall be fixed to floor by cadmium screws and tightly grouted.

3. Supply and installation of stainless steel kitchen or fire clay porcelain including the supply and fixation of chrome plated mixer of approved quality connected to cold and hot water mainline by ½" galvanized steel pipes or otherwise specified including PVC trap connected with over flow and with the floor trap by plastic P.V.C. pipe 2". The work shall include supply and install chain and rubber plug, angle valves, hoses and all needed accessories.

11.11 Working Drawings and Ordering

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

12 -ELECTRICAL WORKS

12.1 GENERAL REQUIREMENT

12.1.1 Prerequisite Conditions

All applicable sections of the general Specifications are included by reference to the work required by this division of the specifications.

12.1.2 Extend of Work

The work shall include all necessary labour, materials, plant services machinery and appliances and alike at the Contractor's own risk and expense to deliver, construct, install and complete the electrical installation in good working condition in accordance with the drawings, specifications and bills of quantities. All materials and workmanship shall, except where otherwise directed, comply with the requirements and regulations of the appropriate local Electrical Authority, and I.E.E. and shall be subject to the approval of the Engineer.

Work shall also include:

- The procurement of and payment for all permits and licenses required for the performance of the work.
- All hoists, scaffolds, staging, runways and equipment required for the performance of the work.
- All job measurements and shop layouts required for the proper installation of material and equipment included in the work.
- All lights, guards and signs as required by safety regulations applicable to the work.
- The removal of all dirt and refused materials resulting from the performance of the work from the premises, as it accumulates,.
- All equipment under this heading shall be installed under complete supervisory service finished by the Contractor and where necessary, this shall include the services of special erection and operation engineers.

12.1.3 Miscellaneous Conditions

1. All installed material and equipment shall be new, with best quality and design, and free from defects and imperfections.
2. All the installation and adjustment of material and equipment shall be done by experienced electricians, has proper trade and all workmanship shall be first class.
3. Installed material and equipment included in the work shall be protected from dirt and damage and maintained in a clean condition during the performance of the work.
4. Apparatus, equipment and material required for the performance of the work shall be stored under requirements of applicable regulations and of direction from the Architect.
5. The Contractor shall cooperate with all other Contractors on the project, be responsible for prompt delivery of all materials and equipments and for the installation of all works under this division at a time and in a manner so that there will be no delay in the construction schedule.

6. Acceptance of the work shall be subject to the condition that all installed systems, equipment, apparatus and appliances included in the work shall operate and perform as designed and as selected with respect to efficiency capacity and quietness and shall operate and perform without producing objectionable noise within occupied area of the building.
7. Acceptance of the work shall be subject to the conditions that any time within one year after date of final approval, any defective part of the work resulting from the supply of faulty workmanship or material shall be immediately amended, repaired or replaced as a part of the contract work without any cost to the owner.

12.1.4 Power Supply

The system of distribution will be fed from a 230/400 volts 3-phase, 4 wire 50 Hz.

12.1.5 System of Distribution

The system of distribution to be used for lighting and power is to be the radial type, including branch circuits and ring circuits system where shown in drawings.

12.1.6 Drawings and Specifications

All electrical drawings are intended to cover the layout and design of the work, but are not to be scaled for exact measurements. Where special detail and dimensions are not shown on the drawings, the Contractor shall take measurements and make electrical layouts as required for the proper installation of electrical work so that interference with all other work will be avoided.

All drawings and specifications on the project are complementary, each set to all other sets, and they shall be used in combination for the execution of the work. Electrical work shown on any set drawings, including all architectural drawings for general work and equipment, and electrical work called for under any section of the project specifications, shall be considered as included in the work unless specifically excluded by inclusion in some other part of the work. The work shall include roughing in for fixtures and equipment as called for or inferred. The Contractor shall check all drawings and specifications for the project and shall be responsible for the installation of all electrical work.

12.1.7 Inspection of the Site

Contractor shall inspect the Site, study existing conditions, check with the drawings and specification and be fully informed as to the work required by the Contract.

12.1.8 Operation and Maintenance Instructions

The Contractor shall furnish all services and personnel to the Owner’s operating and maintenance as required for adequate verbal and written instructions. Two complete copies of a service manual in hard back binders shall be furnished at the end of the project and shall include printed operating and maintenance instructions for systems specified under this heading, all approved shop drawings and all manufacturers’ printed instructions for operation and maintenance of the equipment.
When the work is completed and at a time designed by the Owner, the Contractor shall furnish

the services of a qualified instructor to train the Owner's personnel in the operation and maintenance of the systems & equipment.

12.1.9 Record Drawings

Contractor shall be required to keep a day to day record of changes in location of all equipment, conduit, and devices on one or more sets of contract drawings, underground utilities or other readily identifiable feature.

The Contractor shall record such changes in red ink on black line prints. The record prints shall be submitted to the Engineer for approval prior to final payment.

12.1.10 Cutting and Patching

Any cutting of new construction which is required for the installation of electrical work after the construction of walls and floor slabs shall be done by the Contractor.
Cutting shall be done with extreme care so that the strength of the structure will not be endangered.
Adequate protection shall be provided to prevent damage to adjacent areas. Patching and finishing of opening shall be the responsibility of the Contractor.

12.1.11 Existing Equipment

All existing equipment that indicated to be removed shall remain the property of the Owner if he so desires. Such equipment shall be removed by the Contractor and delivered to a point on the project site as designated by the Owner. Any equipment that the Owner does not desire to retain shall be promptly removed from the Site by the Contractor.

Any existing equipment or material that is to remain in service and is damaged by the Contractor during the course of the Contract shall be repaired and refinished or replaced to the satisfaction of the Owner, at his discretion.

12.1.12 Conduct of Work

All work under this Contract which may interfere with the operation of the Owner's utilities, shall be done in such a manner and at such time as may be satisfactory to the Owner. Make temporary alternations and connections as required to execute work so that all services in the building are maintained with the minimum possible interruption. Temporary shutdowns shall be segregated and shall be of the shortest possible duration. All services shall be kept on continuous operation unless permissions are otherwise granted by the Owner. All temporary wiring shall be the responsibility of the Contractor at no additional cost of the Owner.

12.1.13 Omissions

If anything necessary to the proper installation or operation of the electric system is omitted from the drawings or specifications, or bill of quantities, or indicated incorrectly, the Contractor shall call the attention of the Engineer to these omissions or inaccuracy immediately before work proceeds. Should the Contractor fall to do so, he shall be herder responsible and shall make good such errors or any damage caused at his own expense.

12.1.14 Samples

Samples of the following shall be submitted to Engineer by the Contractor before the work commences:

Section of conduit, section of wires and cables, junction boxes, switches and plates, outlet box isolating switches, lamp holders, ceiling roses ,distribution boxes, circuits breakers, earth leakage relays, any fixtures to be supplied by the Contractor and other materials to be incorporated in the installation. The work done by the Contractor shall not vary in any manner from the samples submitted and approved without written permission from the Engineer.

12.1.15 Layout

Before the Contractor commences the installation he shall discuss the exact timing and the whole layout in detail with the Engineer, in order to determinate the exact position of distribution boards, fittings and accessories, the runs of cable and conduits, etc.

12.1.16 Drawings

The design of the accompanied drawings and the quantities in the attached schedules are not definite and are subject to any variations made by the Engineer during constructions. No variations or amendments in the drawings and the specifications shall be instructed to the Contractor except as directed in writing by the Engineer who has the right to refuse all the materials and works which don't match with the drawings and specifications.

12.1.17 Testing

The Contractor shall make tests for perfect operation of installations, insulation and earth resistance and continuity at his own expense and in the presence of the Engineer

12.1.18 Tenderers

Tenderers for the electrical work shall have previous experience in this field of work and an official license of three-phase installations from the local Electrical Authority.

12.1.19 Risks insurance policy

The Contractor should provide on his own expense and all risks insurance policy for his workers during all the period of his work.

12.1.20 Director of works

The Contractor or his representatives should be on the Site daily for taking any instructions from the director of works (Engineer).

12.1.21 Owner reserves

The Owner reserves the right to accept any tender, either as regards the whole of the work indicated therein, or any one or, more parts so included. The Owner does not bind himself to accept the lowest of any tender.

12.2 MISCELLANEOUS WORK

12.2.1 Equipment Identification and Labels

All electrical equipments, such as disconnect switches, motor starters, controls, push buttons, panel boards, and other similar items shall be adequately identified with labels. Labels shall clearly designate name and use of equipment and be made of embossed plastic tape except where engraved plates are called for elsewhere in the specification or on the drawings.

12.2.2 Grounding

1. Grounding shall be in accordance with the local Electrical Authority requirements and regulations, and with the I.E.E. regulations.

2. All branch circuit conduit wiring shall include an insulated copper wire for grounding of all non-current carrying conductive surfaces of electrical equipment subject to person contact, and for every electrical outlet.

3. Earthing conductivity test should be conducted so that the resistance not exceeding 2 Ohm.

4. Earth electrode must be provided which consists of 3 driven copper rods 1,5 meter long of standard type, and must be installed as near as possible to the main board. The earth wire has to be copper conductor as specified making loop connection between the rods and the earth (ground) bus bar, the distance between each rod and the other have to be at least 7 meters with a checking manhole at least 60cm depth.

5. Other similar P.V.C. copper conductor has to be bonded to the main water supply pipe from the earth bus bar.

12.2.3 Adjusting, Aligning and Testing

1. All-electrical equipment furnished under this heading and all electrical equipment furnished by others shall be adjusted and tested by the Contractor.

2. Mechanism of all electrical equipment shall be checked for alignment with drive and adjusted as required. Protective devices and parts shall be checked and tested for specified and required application and adjusted as required. Adjustable parts of all lighting fixtures and electrical equipment shall be checked, tested and adjusted as required to produce the intended performance.

3. Complete wiring system shall be free from short circuits and after completion, the Contractor shall perform tests for insulation resistance in accordance with the requirements of the I.E.E.

4. The Contractor shall hold responsibility of the operation, service and maintenance of all new electrical equipment furnished by him during construction and prior to acceptance by the Owner. All electrical equipments shall be maintained in the best operating condition including proper lubrication. Operational failure caused by defective material and/or

labour will be recovered by the contractor.

12.2.4 Motor and other Control Equipment

The Contractor shall install and mount miscellaneous disconnection switches and motor controls in accordance with the instructions, wiring diagrams and approved shop drawings, also he shall be responsible for the operation of such devices only to the extend of proper mounting and wiring. Work shall include mountings and supporting as required for all equipments including angle frames, steel plates, bars, bolts, etc. The Contractor shall furnish and install all conduit, wire, etc., as required to connect all equipment furnished by him including motors, disconnect switches, starters, controls, push buttons, etc.

The Contractor shall perform all work required to rough in and connect to all equipment required electrical connections, except equipment that is furnished by the Owner which shall be roughed in only. This work shall be as indicated on drawings, approved equipment shop drawings and by direction on the job.

The Contractor shall connect feeders to control and motors as shown on drawings, make connections and install wire to all mechanical components. The Contractor shall coordinate with other traders involved in the proper coil voltages for control of magnetic starters and contactors.

12.2.5 Opening and Setting of Conduit

Work shall include all required cutting and afterward patching for the installation of material and equipment included in the work.

Any cutting and/or patching of new construction which is required for the installation of Electrical work after new walls and floors have been constructed, shall be the responsibility of the Contractor if the cutting and patching is due to errors or omissions on the part of the Contractors.

12.2.6 Excavation and Backfilling

The Contractor shall excavate as required for the installation of all underground work under this heading. Surplus material not needed for backfilling shall be deposited or distributed in the premises as directed. Trenches shall be of sufficient width and shall be cribbed or braced to prevent cave-in or settlement. Trenches close to walls and columns shall not be excavated without prior consultation with the Engineer, otherwise it will be his representative. Pumping equipment shall be furnished to keep trenches free of water. Dry earth shall be rammed into place at the sides of conduits and leaving joints and top of conduits exposed until approved.

After approval, all trenches for work installed by the Contractor shall be backfilled by him in 15cm layers of well-tamped dry sand in a manner to prevent future settlement. Rocks debris, bricks, and like material shall not be used for backfilling. Where direct burial cable is installed, the trenches shall have 5cm of dry sand on the bottom of trench.

Any trenches improperly backfilled or where settlement occurs, they shall be reopened to a depth required for the proper compaction, then refilled and compacted with the surface restored to the required grade.

As a part of this Contract, all roads, streets, and sidewalks damaged by the installation of building services or other work under this heading shall be furnished to the satisfaction of the authorities and regulations having jurisdiction.

12.3 GENERAL CONDITION OF THE DIFFERENT PARTS OF INSTALLATIONS

12.3.1 CONDUITS

1. Conduit shall be installed for all wires and cables except where otherwise stated or directed. The conduits shall be P.V.C. pipe of the thinner type or similar under plaster.
2. Fireproof plastic type should be used whenever exposed installations are used. In addition, conduits shall be securely fastened in place with approved straps.
3. Steel conduit should be used in the boiler, and where else directed by the Engineer.
4. No conduits should have an internal diameter less that 13mm. The Conductors area within the conduit should not exceed 50% of the area of the conduit.
5. The conduit has to be away from heat and mechanical pressure.
6. The contractor shall be responsible for ensuring that the conduits are laid so that water cannot infiltrate or accumulate at any point.
7. The Contractor shall be responsible to ensure that placing of the conduit is done prior to pouring of concrete without delaying the concrete work.
8. The Contractor should make all his effort to run all the conduit pipes in horizontal or vertical lines and not to be inclined and to be at the same level from the floor in all rooms.
9. The conduits should have cover at least of 2cm of plaster or concrete.
10. Separate conduits have to be used for separate systems of different voltage.
11. Conduits between any two connection boxes have to be of one piece with no connection in the pipes.
12. Where finish wall surfaces are to be plastered, the Electrical Contractor shall cooperate with the General Contractor during construction of these walls and use care in the installation of all conduits and boxes so that wall surfaces will have a finished appearance
13. Conduit shall be installed to requirements of structure and to requirements of all other work on the project. Conduits shall be installed so that to divert from all openings, depressions, pipes, ducts, reinforcing steel, etc., and conduits set in the forms of concrete structure shall be installed in a manner that installation will not affect the strength of the structure.
14. All electrical work shall be protected against damages during construction and any work damaged or moved out of line after roughing-in shall be repaired and re-set to the approval of the Engineer, without additional cost to the owner.
15. All conduits have to match the local standard.

12.3.2 PULL BOXES AND CONNECTION BOXES

1. The contractor has to make his best to use the minimum number of these boxes.
2. All boxes should be of the same material as that of the conduits.
3. Boxes should be wide enough to contain all connections of cables easily.
4. Pull boxes and connection boxes should be installed all at the same level from ceiling.
5. All boxes should be covered.
6. All the connections for installed connectors should be done inside the boxes.
7. Cables of different voltage should not be drawn or connected in the same connection box.

12.3.3 OUTLET BOXES

1. Suitable outlet boxes shall be installed for all electrical service outlets, including plug receptacles, lighting fixtures, switches, etc.
2. Location of outlets on drawings is approximate and except where dimensions are shown, exact location of outlets shall be taken from plans and details on general drawings or as directed by the Engineer.
3. Outlets shall be located generally from column centers and finished wall lines or to center of acoustical and decorative ceiling panels and to centers or joints of wall panels.
4. Outlets shall be installed in an accessible location.

12.3.4 SWITCHES

1. Outlet boxes for switches are to be fixed 140cm above finished floor level and 12cm horizontally from the outside edge of the nearest door.
2. Switches should be of 10 amp with different signs for emergency switches if used.
3. Switches should be of waterproof type for the bathrooms and where else shown.
4. All switches should be installed flush.
5. Switches shall be wired in the phase lines only.
6. The neutral conductors shall not be broken.
7. Switches panels shall have a similar assembly to switches and should be group-mounted in a common box if possible, and if it is without pilot lamp, otherwise it has to be group-mounted in aluminum or stainless steel cover to the approval of the Engineer.

12.3.5 SOCKETS

1. Boxes for sockets outlets are to be installed 60cm or, as shown in the drawings above finished floor level.
2. Socket should be of 13 amp or 16 amp for the power socket with different color for socket and non-emergency.
3. Sockets should be of all-installed rockers flush.
4. Sockets in the boiler room should be industrial heavy duty.
5. Sockets in the bathrooms and where else shown shall be waterproof.
6. All sockets shall be wired in the same manner with the phase always connected to the same pole [right pole].

12.3.6 WIRES, WIRING

1. All wires and cables, except where otherwise stated are to have a soft copper core, refined and tinned, with an electric conductivity of not less than 98%. The core shall be insulated with rubber with braid for 600 volley service.
2. Samples of cabling and wiring proposed by the contractor, are to be submitted prior to commencement of the work. These must comply with the requirements of the I.E.E., and local standard to ensure a constant voltage in every part of the building.
3. All wires are to be standard. [for lighting and power, the neutral wire shall be different in color from the phase wires].
4. All wires shall be run through conduits and shall be continuous between outlets and boxes. At least 20cm of wire to be left outside the outlet for fixture connection.
5. Where wire size is shown on drawings or specified, it shall be the same size throughout the circuit.
6. Wiring inside panel boards shall be neat and well arranged, using appropriate lugs for

termination and connection of conductors.

7. Joints in the cables or wires are not allowed to be made inside conduits.
8. Wires are to be fixed to boards with an appliance ensuring perfect electrical contact, to the approval of the Engineer.
9. When drawing wires through conduits, no lubricant is permitted.
10. Cable shoes have to be used for wires of 6 sq. mm. or above.
11. All boxes and distribution boards have to be carefully cleaned from plaster and other foreign material before drawing any electrical wires or cables.
12. Colours of the cables should be as follows:

- Single phase circuits:

Brown	for the phase
Black	for the neutral
Green & Yellow or White	for the earth
Blue	for direct [switch Wires].

- 3 Phase circuits:

Brown, Yellow & Blue	for the three phase.
Black	for the neutral
Green & Yellow or white	for the earth

12.3.7 Cables

1. All the cables should be of the following type NYY, 5 or 4 cores, 11000 volt, plain annealed high conductivity copper wire conductors P.V.C. sheathed. Under Ground cables should be of type NYBY or XLPE.
2. Colours of cores in the cable should be red, yellow, blue & black. Colours of sheathes shall be black.
3. Cables terminations should be through brass cable glands. Glands should be complete with brass earth tags and steel locknuts.
4. Cable connection at both ends should be through cable shoes.
5. Cables should be covered with soft sand, concrete slabs and special warning tape in 3 languages.

12.3.8 Wire Size

1. Sizes of wires should be 1.5mm2 for lighting and 2.5mm2 for socket outlets and local ring main circuit unless otherwise indicated in the contract documents or instructed by the engineer.
2. The size of the earth cable for any circuit should be the same size as that of the phase or as shown on the drawings.
3. The size of the wire for the bells, loud speakers and sound outlets should not be less than 0.6sq.mm

12.3.9 Electrical Boards

1. All boards should be manufactured by a qualified factory who has a wide experience in this field.
2. The Contractor should supply detailed drawings for each board which show the electrical and mechanical design of the board with dimensions. Therefore, the contractor shall get the approval of the Engineer before he commences with the manufacturing of these boards.
3. Electrical boards should be erected complete with all conduits terminated to it before

installation of any cable in the conduit.

Body of Electrical Boards

1. Electrical boards and panels shall be ready made otherwise it should be manufactured from 2mm galvanized steel sheet with all angles and channels needed for supporting and mounting the equipments and it should be full finished steel with electrostatic painting with beige colour.
2. All screws, nuts and washers should be galvanized.
3. Boards to be designed with removable front plates for easy access to the interior for cabling up and maintenance.
4. A special compartment with separate cover shall be made for terminals, neutral and earth bars.
5. All panel boards shall be with doors.
6. All doors which have equipments mounted on them shall be shielded from inside with isolation sheets.
7. Distribution Boards in wet areas should be of waterproof type.
8. All electrical boards shall have spare space of at least 25% of their space.

12.3.10 Bus - Bars

1. All bus-bars shall be of hard drawn electrolytic copper.
2. Bus bars shall be supported by suitable bus-bar insulator to protect the bars from any electrical, mechanical and dynamic stresses.
3. Bus-bars shall be rated at a max. of 2 amps/sq. mm.

12.3.11 Neutral and Earth Bars

Suitable bars for neutral and earth shall be mounted on the top compartment of each board, for terminating the outgoing circuits on them. A bolt with suitable size shall be welded on the body of each board for earthing.

12.3.12 Labels

All circuits shall be labeled in English language and to be of the black sandwich type and engraved.

12.3.13 Main C.B.S

These C.Bs shall be air insulated, adjustable, with magnetic and thermal protection, and have a main rupturing capacity of 25 K.A.
These C.Bs shall be of the best quality and preferably of the Siemens or NZM-type K.L.M made. in Germany or equivalent.

12.3.14 Miniature C.BS, Automatic Change Over Switch, [Mechanical Interlock] and E.L.Rs.

These M.C.Bs shall be of the air insulated type with magnetic and thermal protection and fixed adjustment, the main rupturing capacity of these M.C.Bs shall not be less than 15 K.A. The M.C.Bs type N and E.L.R. shall be of the best quality and preferably Siemens or NZM-type

K.L.M made. in Germany or equivalent. All E.L.R. shall be 4-pole with 0,03 amp sensitivity.

12.3.15 On - OFF Swtches

All these switches shall be hand operated, air insulated and able to withstand any load and fault conditions.
These switches shall be Gewiss type or K.L.M. made or equivalent.

12.3.16 Instruments

All the measuring instruments shall be very accurate which have dimensions of 120x100 mm. and mounted on the boards.
All ampere and volt meters shall be with selector switches to measure the voltage between phases and between phases and the neutral.

12.3.17 Connectors

All outgoing connectors shall be terminated and mounted on the upper compartment of the boards or otherwise shown in the drawings.
Connectors must have a copper strip between the wire and the screws. All connectors shall have special paper fixed on them for writing the names of the circuits. Connectors shall be of or best quality.

12.3.18 Telephones

1. 1” conduit should be installed from each telephone box to the main telephone box in the floor where shown in drawings with galvanized rope to be installed within for the telephone company.
2. The telephone box should be 1 meter high from floor level unless otherwise indicated.
3. Main conduits from the floor boxes and the operator have to be shown in drawings with a galvanized rope.
4. Telephone cables for the main boxes and the telephone outlet should be drawn with the presence of the telephone department.

12.3.19 Fire Alarm Installations

1. MICC/PVC sheathed cable only shall be used for the wiring of the fire alarm, smoke detectors, etc., associated with the installation.
2. Where interconnections are to be made between buildings for control panel displays, PVC/SWA/PVC cables may be used.
3. Size of wire for Fire Alarm should be at least 1.5 sq. mm.
4. Fire alarm system shall include the following:
   - Smoke detectors
   - Heat detectors
   - Addressable break glass call point
   - Short circuit isolators
   - End of line resistors
   - 6” diameter ,24V internal fire bells (sounder)
   - Addressable repeater FACP (X-zone)
   - Voice evacuation and emergency telephone system (auto dialer)

5. The FACP shall indicate :
   - Zone leds main fire
   - Fault and pre-alarm leds
   - Power tests, system fault, alarm fault, remote signal and activated sound and silence alarm leds
   - The duration of the FACP will be 24 hours standby

12.3.20 Lightening System

1- Lightening system should be implemented in compliance to drawings and American Standard NFPA78.
2- The Contractor has to submit samples of the lightening system components to the Engineer for approval.
3- Electrodes and strips should be made of copper type 11000C according to ASTM-B187 or equivalent.
4- After installation of the lightening system to be completed, the contractor has to make earth leakage and resistance tests for the system according to the American Standard and under supervision of the Engineer.

12.3.21 Lighting Fixtures Schedule

Type of lamp	Description	Manufacturer
A	Single Fluorescent Fixture on ceiling or wall	GAASH or equivalent Fl. 1x36 W
B	Double Fluorescent Fixture on ceiling or wall	GAASH or equivalent Fl. 2x36 W
C	Globe on ceiling or wall with Incandescent lamp	GAASH or equivalent Fl. 1x75 W
D	Recessed spotlight (Recessed spotlight with reflector lamp and white colour).	GAASH or equivalent Fl. 1x60 W

13 -SUB BASE AND BASE COURSES

13.1 General

Locating sources and manufacturers of materials are the responsibility of the contractor.

Prior to starting quarry or borrow pit operations, the contractor shall obtain written permission from the Authorities or Owner concerned.

The contractor shall submit to the Engineer, 10 days prior to the scheduled beginning of crushing and screening, a statement of origin of all stone and/or gravel aggregates and granular materials.

The contractor shall submit for testing and approval, representative samples of all materials needed. Samples shall be taken by the contractor in the presence of the Engineer. Approval of specific sources of materials shall not be considered as final approval.

The contractor may conduct necessary tests in the Field Laboratory in the presence of the Engineer and the contractor's Materials Engineer.

Samples shall satisfy all specified test requirements. The contractor shall furnish all necessary labor, transport, tools and equipment required by the Engineer.

13.2 Granular Material for Sub-Base

Granular material for use in sub-base courses shall be naturally occurring gravel, blended as necessary with fine or coarse material and screened to produce the specified gradation. Crushing of natural granular material shall not normally be required, unless for the purpose of meeting the gradation requirements, or when shown on the Drawings (to produce a higher quality sub-base with improved mechanical stability).

Gravel shall consist of hard, durable and sound stones, free from deleterious substances not mentioned below.

Other requirements are:

Crystalline gypsum (expressed as SO3)	5% max.
Clay lumps and friable particles	10% max.

Flakey and elongated particles

Crushed rock	40% max. Each
Crushed gravel	45% max. Each
Natural gravel	50% max. Each

Determined in accordance with BS812 Section 105.1: 1985 and BS812 Part 1 1975)

Maximum dry density

Minimum dry density is **2.05gm/cm^3**.

Chart content (determined by percentage by weight insoluble in hydrochloric acid) should be specified in

special technical specification.

Granular materials delivered to the road site shall meet the requirement of class A or B as shown in Table 3.1, when tested in accordance with AASHTO T-27 after dry mixing and just before spreading and compacting. The Class of granular material to be used shall be as shown on the Drawings or otherwise as selected by the Engineer. The actual gradation shall, in all cases, be continuous ad smooth within the specified limits for each Class. If gradation is tested after compaction, a tolerance of 3% is allowed in the upper limit for the percentage of material passing sieve no. 200.

Gradation of Granular Material by Class, shown table 13-1

Table 13-1: Gradation of Granular Material by class

Sieve Designation (Square openings)	Percent by weight passing	
	Class A	Class B
63 mm (2-1/2 in.)	100	
50 mm (2 in.)	80-100	100
37.5 mm (1-1/2 in.)	70-95	80-100
25 mm (1 in.)	55-90	60-95
12.5 mm (1/2 in.)	45-75	47-80
4.75 mm (No.4)	30-60	30-60
2.00 mm (No. 10)	22-48	22-45
0.425 mm (No.40)	10-30	10-30
0.075 mm (No. 200)	5-12	5-12

Sand equivalent

The material shall contain a minimum of **25%** sand equivalent at any stage of construction.
Shrinkage limit less than 3%

Loss weight of granular material

The loss weight of granular material shall not exceed **45%** after 500 revolution, when tested in accordance with AASHTO T 96 (Los Angelos Abrasion Test).

$$\text{The ratio of wear loss} = \frac{Abrasion\ after\ 100\ \text{Re}v.}{Abrasion\ after\ 500\ \text{Re}v.}$$

Should not be more than twenty percent of the maximum allowed abrasion after 500 revelations.

Soaked CBR

The granular material shall have a 4-day soaked CBR of not **less than 30 when** compacted at 100% of modified proctor AASHTO (T 180-D) and tested in accordance with AASHTO T 193.

Soundness

When tested for soundness in accordance with AASHTO T 104, the material shall not show signs of disintegration and the percentage loss in weight after 5 cycles shall not exceed 12% in the case of the sodium sulphate test and 18% in the case of the magnesium sulphate test.

Portion of granular material

The portion of granular material, including any blended material, passing the 0.425 mm (No. 40) mesh sieve shall have a liquid limit **(L.L) of not more than 27** and a plasticity index **(P.I.) not grater than 6** when tested in accordance with AASHTO T 89 and T 90.
Non-Plastic condition might be accepted if crushed limestone is used provided that angularity test (R) value shall not be less than 8.

Additional fine material

If additional fine material is required to correct the gradation of the granular material, or for adjusting the L.L. or P.I. of the fraction passing 0.425 mm (No. 40) sieve, it shall be uniformly blended and mixed with the granular material. Additional fine material for these purposes shall be obtained from the crushing of stone, gravel, or slag, if naturally occurring fine materials not available.

13.3 Aggregate for Base Courses:

Aggregate for use in base course construction shall be crushed stone, and may be washed, if directed, to remove excessive quantities of clay, silty clay or salts.

It shall consist of hard durable and sound particles or fragments of stone, free from other substance. Other requirements are gypsum, or flaky particles.

Other requirements

Gypsum content (expressed as SO_3) 2 % max.
Clay lumps and friable particles 8 % max.
Elongated and flakey particles for crushed rock (Determined in accordance with BS 812 Part 1: 1975)
Granit and Basalt 40 % max each.
Lime stone 35 % max
Minimum dry density (g/cm3) 2.15 % min
Linear shrinkage not exceed 3%
Gradation of Base course Aggregate by class, shown in table 13-2.

Table 13-2: Gradation of Base course Aggregate by class

Sieve Designation	Percent by weight passing	
	Class A	Class B
50 mm (2 in)		100
37.5 mm (1.5 in)	100	70-100
25 mm (1 in)	75-100	55-85
19 mm (3/4 in)	60-90	50-80
12.5 mm (1/2 in)	45-80	
9.5 mm (3/8 in)	40-70	40-70
4.75 mm (No 4)	30-65	30-60
2 mm (No 10)	20-40	20-50
0.425 mm (No 40)	8-20	10-30
0.075 mm (No 200)	5-10	5-15

The material shall contain a minimum of 40% sand equivalent at any stage of construction.

The loss weight shall not exceed 40 % after 500 revolutions, when tested in accordance with AASHTO T96 (Los Angeles Abrasion Test).

The ratio of wear loss should not be more than twenty percent of maximum allowed abrasion after 500 revolutions.

The crushed aggregate base course material shall have a 4-day soaked CBR of not less than 80 when compacted at 100 % of modified proctor AASHTO (T 180-D) and tested in accordance with AASHTO T 193.

When tested for soundness is accordance with AASHTO -104, the material shall not show signs of disintegration and the loss by weight shall not exceed 12 % in case of the sodium sulphate test, and 18 % in the case of the magnesium sulphate test.

The portion of aggregate, including any blended material passing the 0.425 mm (No. 40) sieve shall have a liquid limit (L.L.) of not more than 25 and plasticity index (P.I) of not more than 6, and not less than 3 when tested in accordance with AASHTO T 89 and T 90.

If additional fine material is required to correct the aggregate gradation or for adjusting the L.L or P.I. of fraction passing the 0.425 mm (No 40) sieve, it shall be uniformly blended and mixed with the aggregate material.

Elongated and flakiness not to exceed 35% for each.

13.4 GRANULAR SUB-BASE COURSES

13.4.1 Scope

These Works shall consist of furnishing granular sub-base material of the required Class, mixing, spreading on prepared sub-grade, compacting and finishing, all as and where shown on the Drawings.

13.4.2 Materials

All materials shall conform to the relevant requirements of Section "Materials", in respect of granular material Class A or Class B for sub-base construction.

13.4.3 Sub-grade Surface Preparation

The sub-grade shall have previously been constructed in accordance with the requirements of Section "Sub-grade Construction and Topping" and properly maintained and kept well drained thereafter.
At all special grade control points, such as at bridge structures, existing pavements, etc. The sub-grade shall be lowered to a depth sufficient to permit construction of the sub-base course to the specified elevations and thickness.

Transitions shall be of sufficient length to avoid abrupt change of grade and shall be within plus or minus 3% of the final design grade unless otherwise directed. Surplus material shall be removed and disposed of.

The sub grade shall be inspected and approved immediately prior to commencement of sub-

base construction. Any soft, yielding material shall be removed and replaced by approved topping material. Holes, depression and other irregularities shall be made good as directed and the sub-grade re-compacted as necessary and finished ready to receive the sub-base course.

13.4.4 Equipment

Equipment used to handle, place, spread, water, compact and finish sub-base shall conform to the requirements of Section “Contractor's Plant and Equipment" and with the Contractor's approved Work Program.

13.4.5 Construction

13.4.5.1 Stockpiling of Granular Material

Stockpiling procedures shall conform to the relevant requirements of Section "Materials".

Methods used for stockpiling granular material and removing it from stockpiles shall not result in significant degradation or segregation nor the introduction of significant amounts of foreign materials or extraneous matter.

Granular material adversely affected, in the opinion of the Engineer, by stockpiling or handling procedures shall be incorporated in the Works regardless of previous approval of such material, until the deficiencies have been rectified in an acceptable manner.

13.4.5.2 Mixing and Spreading

All components of sub-base course material shall be mixed thoroughly and uniformly with water in situ. The amount of water added, as approved by the Engineer, shall be such that the material will be uniform and within the specified moisture content range at the time of compaction. Wetting of granular material in stockpiles or in trucks before or during delivery to the Site will not be permitted. However, water shall be added to the material, if necessary, during placing and compaction of sub-base material.

The sub-base material shall be placed on the subgrade in a uniform two layers each 150 mm thickness (after compaction).

If approved, heavy duty vibratory compaction equipment is used, the sub base may be in one 300 mm layer (after compaction) provided compaction tests with appropriate testing equipment indicate that the specified compaction standard will be attained and uniform throughout the thickness.

The sub-base material shall be placed to the required width using a self-propelled spreader or motor grade equipped with blade extensions. Water shall be applied by approved spraying equipment and thoroughly mixed with the sub-base material.
The material shall not be bundled in such a way as to cause segregation. If the spreading equipment causes segregation in the material, or leaves ridges, or other objectionable marks on the surface which cannot be readily eliminated or prevented by adjustment of the equipment, the use of such equipment shall forthwith be discontinued and it shall be replaced by a spreader or grader capable or spreading the material in proper manner.

All segregated material shall be removed and replaced with well-graded material. "Skin"

patching will not be permitted. Only minor surface manipulation and watering to achieve the required surface tolerances will be permitted during the compaction process.

Neither hauling nor placement of material will be permitted when, in the judgment of the Engineer, the weather or surface conditions are such that hauling operations will cause cutting of the subgrade or cause contamination of the sub-base material.

13.4.5.3 Compaction

The Contractor shall plan the sequence of operations so that the least amount of water will be lost by evaporation from uncompleted surfaces, If the Contractor delays placing of succeeding layers of material to the extent that additional water is required to prevent raveling or excessive drying, the application of such water shall be carried out as directed and at the Contractor's expense.

The sub-base material shall be compacted by means of approved compaction equipment, progressing gradually from the outside towards the center, with each succeeding pass uniformly overlapping the previous pass.

Rolling shall continue until the entire thickness of each sub-base layer so thoroughly and uniformly to 100% AASHTO T 180 (Method D) maximum density. Final rolling of the completed course shall be by means of an approved self-propelled roller. Rolling shall be accompanied by sufficient blading, to insure a smooth surface, free from ruts or ridges and having the proper shape. When additional water is required, it shall be applied in an approved manner.

Any areas inaccessible to normal compaction shall be compacted by use of portable mechanical tampers until the required standard of compaction is achieved.

Each layer shall be completely compacted and approved prior to delivery of materials for the subsequent layer.

Prior to placing a subsequent layer, the existing surface shall be made sufficiently moist as directed, to ensure proper bond between the layers.

The edges and slopes of the sub-base course shall be bladed or otherwise dressed to conform to the lines and dimensions shown on the Drawings and to present straight, neat lines and slopes as free of loose material as practicable.

Material which has dried out prior to final compaction, or which has dried and compacted subsequent to final compaction, shall be watered and recompacted using approved equipment and procedure. If the Contractor is unable to return the material to its original or specified condition with respect to compaction, thickness and surface tolerances, the Contractor shall remove the material and reconstruct the sub-base course on a re-approved sub grade.

13.4.5.4 Tolerances

The fully compacted and completed sub-base course shall conform to the lines, grades and cross sections as shown on the Drawings.

The elevations of the finished sub-base course shall be checked by the Contractor in the

presence of the Engineer at maximum intervals of 10 m and at intermediate points as directed.

The tolerance on elevations of finished surface shall be plus 10 mm to minus 20 mm, minus tolerance shall be compensating by the proceeding layer.

When the finished surface is tested with a 3 m long straightedge, placed parallel to, or at right angles to the centerline, the maximum deviation of the surface from the testing edge between any 2 contact points shall not exceed 10 mm.

All areas which exceed the specified tolerances shall be corrected by removing the defective sections of sub-base and reconstructing them or, if approved, by adding new material mixing and re-compacting and finishing to the specified standard.

13.4.5.5 Maintenance of Completed Sub-base

Following completion and acceptance of the sub-base course, it shall be maintained by the Contractor at his own expense. The sub-base shall be bladed, broomed and otherwise maintained, keeping it free from raveling and other defects until such time as the base course is placed. Water shall be applied at such times and in such directed by the Engineer.

13.4.6 Testing

Every 500 linear meter of sub-base material or whenever there is a change in the material source shall be subject to a full set (3 points and one point extra will take around manholes if exist 1 sample / 20 manholes))of tests after mixing in situ and, if found satisfactory, shall be approved for compaction. This approval shall not deem to constitute acceptance of the sub-base course.

Sampling and testing shall conform to the relevant requirements of Section 1.05- "Control of Materials and Standards for Sampling and Testing".

Compaction shall be tested in accordance with AASHTO T 191 or AASHTO T 205. If there is a delay between the construction of any layer and the following layer, if necessary and required by the Engineer the compaction of the lower layer may be recertified to ensure that it has not loosened due to traffic, passage of construction equipment, adverse weather conditions or otherwise.

13.4.3 Measurement

1. The net area executed must be measured (without the area under the curb stone).
2. The area of manholes and gullies is to be deducted from measurement.

13.5 AGGREGATE BASE COURSES

13.5.1 Scope

These works shall consist of furnishing crushed aggregate base course material of class a, mixing, spreading, compacting and finishing, all as and where shown in the Drawings.

13.5.2 Surface Preparation

The sub-grade surface shall be inspected and approved prior to commencement of base construction, Holes, depressions and other irregularities shall be made good as directed an the

sub-grade re-compacted as necessary and finished ready to receive the base course layer.

13.5.3 Equipment

Equipment used to handle, place, spread, water, compact and finish base course in accordance with contractor's Work program approved by the Engineer.

13.5.4 Construction

13.5.4.1 Stockpiling of Base Course Material

Stockpiling method of aggregates and moving them from stockpiles shall not result in significant degradation or the introduction of significant amounts of foreign materials. Aggregate materials adversely affected, in the opinion of the Engineer, by stockpiling or handling procedures shall not be incorporated in the works regardless of previous approval of such material until the deficiencies have been rectified in an acceptable manner.

13.5.4.2 Mixing and Spreading

Base course material shall be mixed with water to reach the specified moisture content range at the time of compaction. The mixed material shall be handled and placed on subgrade in a uniform layer as to not cause segregation. All segregating material shall be removed and replaced with well-graded material, "Skin" patching will not be permitted and spread to the required width and shall be delivered such that it is ready for compaction without farther shaping.

13.5.4.3 Compaction

The contractor shall plan the sequence of operations so that the least amount of water will be lost by evaporation from uncompleted surfaces.
The base course material shall be compacted by means of approved compaction equipment, progressing gradually from the outside towards the center, with each succeeding pass uniformly overlapping the previous pass. Rolling shall continue until the entire thickness of each base layer is thoroughly and uniformly compacted to 100% AASHTO T 180 (Method D) maximum density:

The edges and edge slops of the base course shall be bladed or otherwise dressed to conform to the lines and dimension shown on the Drawings.

Materials which have dried out prior to final compaction, or which has dried and decompacted subsequent to final compaction, shall be watered and recompacted. If the contractor failed to return the material to its original or specified condition with respect to compaction, thickness and surface tolerance the contractor shall scarify the material and reconstruct the base course on a re-approved subgrade surface or to the satisfaction of the Engineer.

13.5.4.4 Tolerances

The dully-compacted base course shall conform to the lines, grades and cross sections as shown in the drawings.

The elevations of base course shall be checked at intervals of 10 m on straight and 5 m on curves, the tolerance on elevations of surface shall not exceed +10 mm or -05 mm, and not exceed 12 mm between any two contact points tested with a 4 m long straight edge placed parallel to, or at right angles to center line.

All areas which exceed the specified tolerances shall be scarified and corrected to specified standard.

13.5.4.5 Maintenance of Completed Base Course

Following completion and acceptance of base course, it shall be maintained by contractor at his own expense. The surface shall be broomed and rolled keeping it free from defects until such time as the following course is placed. Water shall be applied at such times and in such quantities as directed.

13.5.5 Testing

Sub base and base Course material shall be tested in accordance with the table shown below at stock pile and at the mixing plant for control on site tests, and if satisfactory shall be approved for use. This approval shall not be deemed to constitute acceptance of base course for full payment purposes.

Required Tests and Minimum Repetition for Base course material, shown in table 13-3.

Table 13-3: Required Tests and Minimum Repetition for Base course

Source of Materials		**Control on Site (The Road)**	
Required Test	**Repetition Required for all Test**	**Required Tests**	**Repetition Required for all Test**
1-Gradation of materials	* Test for each source	1. Proctor	* test for every 500 Lm for each layer * when materials changed
2- Plasticity Index	* for every 1000 m^3	2. Gradation of materials	
3- Abrasion	* When materials changed or every 1000 m^3	3. Plasticity Index	
4- C.B.R.		4. C.B.R.	
5- Sand equivalent		5. Abrasion	
6-Percentage of Fractured Grains		6. Sand equivalent 7. Clay Lumps & Friable particles 8. Field Density 9. Thickness	

Compaction test: for every layer at least 3 samples taken for one street or 1000 m^2 from layer area, or 200 linear meter of road which is smaller.

13.5.6 Measurement

3. The net area executed must be measured (without the area under the curb stone).
4. The area of manholes and gullies is to be deducted from measurement.

14 -BITUMINOUS CONSTRUCTION

14.1 Material

14.1.1 Scope

All material sources and the quality of materials proposed for use in the works shall be approved prior to procurement or processing material from such sources. Inspection, sampling, testing and re-testing as necessary, shall be at the contractors expense.

14.1.2 Sampling and Testing of Aggregate

In order to ascertain the properties of aggregate materials, the contractor shall submit for testing and approval, representative samples of all materials intended for corporation in the works, prior to starting quarry operations, the samples shall be taken by contractor in the presence of the Engineer.

Tests performed by the contractor shall utilize in assessing the locations, extent of deposits and quantities of materials which will conform to the specifications when properly processed. All testing as carried out by the contractor shall in no way obviate the need for further testing by Engineer.
Approval of specific sources of materials shall not be considered as final approval and acceptance of materials from such sources.

Unsatisfactory materials whether in place or not, shall be removed promptly from the site. The contractor shall furnish all necessary material, labor, tools, and equipment and transport required by the engineer for such inspections.

14.1.3 Aggregates for Bituminous Paving Mixes

1. Aggregate for use in bituminous, binder and wearing courses, shall consist of crushed stone.

2. Course aggregate shall be the fraction of crushed aggregate material retained on 4.75 mm (No. 4) sieve. Fine aggregate shall be the fraction of crushed aggregate material passing 4.75 mm (N0. 4) sieve. Mineral filler shall be added when the combined grading of course and fine aggregates is deficient in material passing 0.075 mm (No. 200) sieve.

3. The material from hot bins passing the number 40 sieve (0.425 mm) when tested in accordance with AASHTO T90 shall be non plastic.

4. Aggregate shall not contain gypsum more than 1% and the course fraction of the aggregate shall not contain more than:
   - 5% chert and flint for aggregate to be used in the Wearing course.
   - 5% chert and flint for aggregate to be used in the Binder course.

5. Aggregates shall be of uniform quality, free from decomposed stone, organic matter, shale.

6. The percentage by weight of friable particles, clay lumps, and other deleterious matter shall not exceed 1% as determined by AASHTO T112.

7. Aggregate particles shall be clean, hard, durable and sound. Crushing shall result in a product such that, for particles retained on 4.75 mm (No. 4) sieve, at least 90% by weight shall have 2 or more fractured faces.

8. The flakiness index and the elongation index test should be conducted in accordance with BS 812, the flakiness and elongation index must be less than 30.

9. Aggregates shall be washed if directed, to remove any clay lumps, organic matter, adherent dust or clay films or other extraneous or deleterious matter that may prevent or detract from proper adhesion of bitumen to the aggregate particles.

10. Material filler shall consist of finely divided mineral matter such as limestone dust if added separately; hydrated lime; other non-plastic mineral filler, free from clay and organic impurities; or Portland cement, conforming to AASHTO M17.

11. Combined course and fine aggregates for bituminous mixes, including mineral filler, when tested in accordance with AASHTO T27 and T11, shall conform to gradations shown in Table shown below (Table 14-1):-

Table 14-1: Gradation of Aggregates for Bituminous Mixes

Sieve Designation	Binder Course Percent Passing	Wearing Course Percent Passing
1″ (25.0mm)	-	-
3/4″ (19.0mm)	100	100
1/2 ″ (12.5mm)	82±9	89±9
3/8″ (9.5 mm)	72±9	82±9
No. 4 (4.75mm)	54±9	66±9
No. 8 (2.36mm)	41±9	53±9
No. 16 (1.18mm)	32±9	41±9
No. 30 (0.600mm)	24±9	31±9
No. 50 (0.300mm)	17±7	21±8
No. 80 (0.150mm)	12±5	13±6
No. 200 (0.75mm)	5±2	4.5±2.5

12. The loss in weight of aggregate after 500 revolutions, when tested in accordance with AASHTO T96, shall not exceed 35%.

    Ratio of wear loss = [ ] is less than or equal 25.

13. When tested for soundness in accordance with AASHTO T104 the course aggregate (retained on No. 4 sieve) shall not shown sings of disintegration and the loss by weight after 5 cycles shall not exceed 9% in the case of the sodium sulphate test and 12% in the case of the magnesium sulphate test.

14. When tested for resistance to stripping in accordance with the AASHTO T-182 at least 95% coated particles should be achieved. Scandinavian test shall be carried out and at last 60% of the coarse aggregate surfaces area shall remain coated with a bitumen film especially for exposed surfaces other wise anti stripping agent must be added to achieve the required coating.
15. The material shall contain minimum 50% sand equivalent. Test sample shall be taken from hot bins.

16. Minimum Dry Specific Gravity (g/cm3) 2.55 min

17. Water absorption not exceed 2%

14.1.4 Heating of Bitumen

1. Heating equipment shall be of an approved type. Any method of heating that introduces free steam or moisture into the bitumen will not be approved.

2. Bitumen shall not be heated more than 170degrees C. materials heated in excess of this temperature will be rejected and shall not be used in the works.

3. Heating of bitumen shall be uniform and under control at all times, to the specified temperature. The circulation system shall be of adequate size to insure proper and continuous circulation of bitumen during the entire operating period.

4. Thermometers of adequate range (calibrated in 2 degrees c increments) for accurately measuring the temperature of the bitumen, shall be located so as to be readily visible and shall be kept clean and working order at all times.

14.2 BITUMINOUS PRIME AND TACK COATS

14.2.1 Scope

This work shall consist of furnishing and applying and MC cutback bitumen prime coat to a previously constructed aggregate base course and applying tack coat on Asphalt or concrete surfaces all as and where shown on the Drawings.

14.2.2 Medium Curing Cutback Bitumen

1. MC cutback bitumen for prime coat shall be used as recommended by ASTM D2399-83 for open and tight surface, and RC should be used as tack coat.

2. All surfaces to receive either prime or tack coats shall conform to the specified tolerances and compaction requirements and shall be properly cleaned and finally approved before applying any bitumen material.

3. Application of prime and tack coats shall be performed only when the surface to be treated is sufficiently moist and atmospheric temperature is above 15 C. There should be no fog, rain, strong winds, dusty conditions, or dust storms.

4. The surface of all structures shall be protected in an approved manner during the

equipment operation. The contractor shall be responsible for making good any staining or damage of the structures to the satisfaction of the Engineer.

5. Traffic shall not be permitted to surfaces after they have been cleaned and prepared for prime coat application.

6. The contractor shall maintain prime or tack coats until it is covered by the subsequent pavement course.
7. Any area where the coats have been damaged shall be cleaned of all loose material and re-applied at the contractor's expense.

8. Applying temperature of MC- 70 shall be 45-80C.

9. Areas to be primed shall be including 200 mm widths outside the edge of the permanent line.

10. Application rate for prime coat shall be 1 lit/sq.m and tack coat application shall be 0.7 lit/sq.m.

11. Asphalt pavement shall not be placed on prime coat before 24 hours, and no traffic is allowed to pass on prime coat.

12. The minimum solid residue by evaporation by weight must exceed 50 % when tested according to ASTM D 1461-85.

13. The Ash content of residue by weight must not exceed 7 % when tested according to AASHTO T-83(2000).

14. The drying time for prime coat must not exceed 24 hour.

15. The density range from 990 to 1010 gm/l when tested according to ASTM D 70

14.3 BITUMINOUS COURSES

14.3.1 Scope

This work shall consist of the general requirements of furnishing materials, mixing at a central mixing plant, spreading and compacting bituminous courses.

14.3.2 Job Mix and Project Mixes

1. The contractor shall submit certificate of origin of all material used in the mix for approval of the engineer, the material must be of best kinds.

2. The contractor shall submit his proposed Job Mix Formula for approval, at least 30 days prior to beginning production so that the life of the submitted Job Mix should not exceed 6 months from the date of submittion for small size projects but to be furnished particularly for large size projects . Therefore, samples from materials use in the preparing mix design (aggregates and bitumen) shall be sent to specialized laboratories to be tested for final approval of mix design.

3. The Job Mix Formula is established by the contractor, under the supervision of the engineer, in the field laboratory mix design procedures shall conform to the Marshall method of mix design. All trial mixes shall be prepared and tested by the contractor in the presence of the Engineer.

4. The Job Mix Formula shall specify a combination of mineral aggregates including filler and bitumen in such proportions as to produce a Job Mix which is within the limits of the specified gradation and bitumen content ranges and which meets the Marshall Test requirements. It shall also stipulate the mixing temperature at discharge from the mixer which, unless otherwise directed, shall be 170 degrees C.

5. The Marshall Test procedure shall be used to determine the percentage of bitumen to be incorporated in the mix. The Job Mix Formula shall take into consideration the absorption of bitumen into the aggregates. Air voids shall be calculated in accordance with the procedure given in the Asphalt Institute Manual, MS-2.

6. When compacting specimens on accordance with the Marshall Test procedure, the number of blows applied with the compaction hammer shall be 75 on each side.

7. In order to meet the requirements, an approved additive such as Portland cement, hydrated lime or liquid antistrip agent, may be required in the Job Mix. Portland cement shall meet the requirements of ASTM M 85. Hydrated lime shall meet the requirements of ASTM C207, Type N. Cement or hydrated lime will normally be required in the approximate range of 2-3% by weight of the aggregates and shall be added at the cold feed in dry or slurry form as directed. Liquid antistriping agent, if needed will normally be required in the approximate range of 0.6-1.0% by weight of the bitumen, or according to the manufacturers specifications.

8. Upon receipt of approval of the Job Mix Formula, the Contractor shall adjust his mixing plant to proportion the individual aggregates, mineral filler and bitumen to produce a final project mix within the limits given in Table shown (14-2) with respect to the Job Mix gradation

Table 14-2: Maximum Variations of Project Mix from Approved Job Mix

Sieve Designation (square openings)	Specified Tolerances
9.5 mm (3/8 in.) and above	± 5.0%
4.75 mm (No. 4)	± 4.0%
2.36 mm (No. 8)	± 4.0%
1.18 mm (No. 16)	± 4.0%
0.600 mm (No. 30)	± 4.0%
0.300 mm (No. 50)	± 4.0%
0.150 mm (No. 100)	± 4.0%
0.75 mm (No. 200)	± 1.5%
Bitumen Content	± 0.3%
Temperature of Mix on discharge temperature	± 5 C of the specified mixing

9. Conformance to gradation requirements will be determined on the extracted aggregate in accordance with AASHTO T 30. The bitumen content shall be determined in accordance

with AASHTO T 164.

10. The participation of the Engineer in the preparation of the Job Mix Formula shall in no way relieve the Contractor of responsibility for producing project mixes meeting the specified requirements.

14.3.3 Spreading and Finishing Equipment

1. Bituminous course shall be spread and finished using approved type, self contained, power-propelled pavers of sufficient capacity. Pavers shall be provided with electronically controlled vibratory screed or strike-off assembly and shall be capable of spreading and finishing the course of bituminous mix to the proper thickness and in lane widths applicable to the typical cross sections shown on the Drawings.

2. The pavers shall employ mechanical devices such as equalizing runners, straightedge runners, evener arms or other compensating devices, to maintain trueness of grade and confine the edges of the mix to true lines without the use of stationary side forms. Joint leveling devices shall be provided for smoothing adjusting longitudinal joints between lanes.

3. The paver shall be equipped with receiving hopper having sufficient capacity for a uniform spreading operation. The hopper is equipped with a distribution system to place the mix uniformly in front of the full length of the screed.

4. The screed or strike-off assembly and extensions shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mix.

5. The paver shall be capable of being operated at forward speeds consistent with satisfactory laying of the mix. Speed shall be fully adjustable

6. The Contractor shall make available, for reference by the engineer, the manufacturer's instruction and operating manuals for each paver intended for use.

14.3.4 Surface Preparation

1. When the bituminous mix is to be placed on a base course, the surface shall be prepared to meet the appropriate specified compaction and surface tolerance requirements. The surface shall hen be primed as specified “Bituminous Prime Coat”. No bituminous mix shall be laid on a prime coat until it has been inspected and approved.

2. Broken, soft, or unstable areas of aggregate base course shall be removed and replaced. The areas shall be excavated to a depth as directed and refilled with the specified bituminous mix.

14.3.5 Delivery, Spreading and Finishing

14.3.5.1 Delivery of Mix to Site

1. A sufficient number of haul vehicles shall be provided so that adequate supplies of mix are delivered to ensure that continuous paving will be achieved.

2. Hauling equipment for aggregates and bituminous mixes shall consist of vehicles having dump bodies suitable for dumping materials in a windrow or in spreader boxes. The bodied shall be so constructed that their volume measurement can be accurately determined. They shall be constructed and maintained such that loss of materials during hauling operations will not occur.
3. Dump controls shall be capable of operation from the driver's seat.

4. Hauling equipment for hot bituminous mixes shall have tight, clean, smooth metal beds which are periodically thinly coated with a lime solution or other approved material to prevent adherence of the mix. All hauling units shall be equipped with a canvas or other approved type cover which shall be used to cover the hot material upon loading at the mixing plant and shall not be removed until the mix is discharged into the paver.

5. The dispatching of the hauling vehicles to the site shall be so scheduled that all material delivered is placed at least 90 minutes before sunset to allow sufficient time for compaction.
6. Delivery of material shall be at a uniform rate and in an amount well within the capacity of the paving and compacting equipment.

7. The mix delivered to site must have a temperature range from 139^{o} to 163^{o} .

8. Each haul vehicle shall be weighed after each loading at the mixing plant and accurate records shall be kept of the gross weight and net weight of each load, for each vehicle dates and time of loading.

14.3.5.2 Setting out Reference Line

1. The Contractor shall survey the centerline profile and crown of the existing surface or base and determine a reference grade line which will be submitted for approval. A reference line of wire or suitable cord shall be installed at a uniform grade parallel to the approved reference grade line such that conformance with the required geometrics, surface tolerance and minimum thickness requirements shall be ensured.

2. The reference line shall be maintained taut and free from sags at all times during spreading and initial compacting operations.

3. A wire or cord reference line shall be installed on both sides of the paver for the initial bituminous course being laid. Thereafter only one reference line will normally be required, if the paver is equipped with adequate automatic super elevation control.

14.3.5.3 Spreading and Finishing

1. Bituminous mixes shall be laid only when the air temperature is at least 5 degrees C or above when the existing surface is free from moisture, and when the weather is not foggy, rainy, dusty or excessively windy (particularly at low temperatures).

2. After completion of surface preparation, the bituminous mix shall be spread and finished true to crown and grade by approved automatically controlled bituminous pavers. The mix may be spread and finished by approved hand methods only where the engineer determines that machine methods are impracticable. Hand methods include heated hand tampers of at least 10 kg weight and approved type mechanical (vibratory) tampers.

3. The paver shall spread the bituminous mix without tearing the surface and shall strike a finish that is smooth, true to cross section, uniform in density and texture and free from hollows, transverse corrugations and other irregularities.

4. The paver shall be operated at a speed which gives the best results for the type of pavers being used and which coordinates satisfactorily with the rate of delivery of the mix to the paver. A uniform rate of placement shall be achieved without repeated intermittent operation of the paver.

5. The mix shall be delivered to the paver in time to permit completion of spreading, finishing and compaction of the mix during daylight hours.

6. If during laying, the paver is repeatedly delayed because of lack of mix or if the paver stands at one location for an extended period, resulting in the (unrolled) mat under and adjacent to the rear of the spreader falling below the minimum temperature for breakdown rolling, the affected portion of mat shall be cut out and discarded and a transverse joint shall be constructed. Paving shall not recommence until the engineer is satisfied that paving will proceed without interruptions.

7. Contact surfaces of curbing, gutters, manholes, and similar structures shall be painted with a thin, uniform coating of tack coat material. The bituminous mixture shall be placed uniformly high near the contact surfaces so that after compaction it will be 10 mm above the edge of such structure.

8. If during the paving operations, it is found that the spreading and finishing equipment in operation leaves in the pavement surface tracks or indented areas or other objectionable irregularities that are not satisfactorily corrected by the scheduled operations, the use of the equipment shall be discontinued, until faults are corrected to the approval of the engineer. If this is not possible, other satisfactory spreading and finishing equipment shall be provided by the contractor.

9. Transverse joints in succeeding layers shall be offset by at least 2 m. Longitudinal joints shall be offset at least 150 mm.

10. Bituminous mix shall be spread in one or more layers so that, after rolling, the nominal thickness of each layer of the compacted bituminous material does not exceed 2 to 3 times maximum size of aggregate. This maximum thickness may be increased slightly when such increase is more appropriate to total pavement thickness and provided the engineer determines that such increased thickness will not be detrimental to the quality of the finished bituminous course, and the contractor can show that the required density is attained throughout the layer thickness.

11. Transitions and structure approaches shall meet the design criteria for geometrics, the surface tolerance specifications, and shall not be visually discontinuous or abrupt in appearance.

14.3.5.4 Joints and Edges

1. All joints between old and new pavements or between successive days' work shall be as to ensure thorough and continuous bond between the old and new material.

2. Before placing fresh mix against previously laid, the contact surface shall be cut back to a near vertical face, and shall be sprayed or painted with a thin uniform coat of tack coat material. Longitudinal joints shall be made by overlapping the paver screed on the previously laid material (cut back as necessary) and depositing a sufficient amount of fresh mix so that the joint formed will be smooth and tight.

3. Unsupported edges of bituminous layers shall be rolled immediately following the rolling of the longitudinal joint. The material along the unsupported edge may, if approved, be raised slightly by hand methods, to ensure that the full weight of the roller will bear fully on the edge material

4. On completion, the longitudinal edges of bituminous pavement shall be true to the width and alignment as shown on the drawings. The edges shall be cut back if necessary prior to rolling, additional mix placed manually in a longitudinal strip adjoining each pavement edge, and the edge rolled down to a neat 3:1 (H:V) slope.

5. Transverse joints shall be carefully constructed and thoroughly compacted to provide a smooth riding surface. Joints shall be straight-edged and string-lined to assure smoothness and true alignment

14.3.5.5 Compaction

1. After spreading and strike-off, and as soon as the mix conditions permit the rolling to be performed without excessive shoving or tearing, the mixture shall be thoroughly and uniformly compacted, using approved types, sizes and number of rollers. Rolling shall not be prolonged to the point where cracks appear or shoving or displacement occurs.

2. All rollers shall be self-propelled vibratory steel wheel, 2-axle tandem steel-tired and pneumatic-tired types, in proper operating condition, capable of reversing without backlash or tearing of the surface, and shall be operated at numbers of rollers required is 3, of which one must be pneumatic type. The Contractor shall select a suitable method and pattern of rolling that will achieve the required compaction, to engineers approval.

3. Prior to use on site of pneumatic-tired rollers, the contractor shall furnish, for reference and retention by the engineer, manufacturers' charts or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of tire loadings for each type and size of compactor tire to be used. The contractor shall ensure that tire pressures are maintained at all times in conformity with such charts or tabulations. The maximum allowable tolerances shall be plus or minus 35 KN/sq.m (5 psi).

4. Rollers should move at a slow but uniform speed, generally with the drive roll or wheels nearest the paver.

5. Breakdown rolling shall be consist of 3 complete coverage unless otherwise directed. Rolling shall be longitudinal, and overlapping on successive trips by at least one half the width of the rear wheels.

6. To prevent adhesion of the mix to the rollers, the wheels shall be kept lightly moistened with water. Excessive use of water will not be permitted.

7. The initial or breakdown rolling shall be followed by intermediate rolling involving 3 coverage with pneumatic-tired rollers unless otherwise specified.

8. Finishing rolling shall then be carried out by means of tandem power steel rollers unless otherwise designated. If specified density is not achieved, changes shall be made in size and number of rollers being used to ensure the compaction requirements are met.

9. The compacted density shall be equal to or more than 97% and 98% for binder course and wearing course, respectively, of average Marshall bulk specific gravity for each day production unless otherwise directed by the engineer.

10. If after re-testing the density achieved is 0.5% or less below the specified density, the asphaltic layer will be accepted in the works subject to a 10% reduction to the billed rates. If on the other hand the density achieved is greater than 0.5% below the specified density the asphaltic material shall be removed and new materials laid to the specification at the contractor's cost.

14.3.5.6 Test for Bituminous Pavements

1. Minimum Tests Required as shown in table 14-3 below:

Table 14-3: Minimum Test Required for Bituminous

Work item	Tests at Source of material	Frequency of tests	Tests at road site	Frequency of tests
1- Materials used in Asphalt mix (at Batching plant)	1- Specific gravity and water absorption 2- Abrasion test 3- Chert content 4- Clay lumps and friable materials 5- Flaky and elongated particles 6- Soundness	- Test for each source - When materials quality changes - As requested		
2- Materials used in Asphalt mix (from hot bins)	1- Gradation 2- Specific gravity and water absorption 3- Plasticity index 4-Sand equivalent 5- Stripping with asphalt	- Test for each source - when materials quality changes - As requested		
3- Asphalt mix	1. Complete mix	-For each		

Work item	Tests at Source of material	Frequency of tests	Tests at road site	Frequency of tests
design (At batching plant)	design in accordance with American Asphalt Institute (MS2) 2. Loss of stability	project -When materials quality changes -When results are not consistent with the mix design results - As requested		
4- Asphalt	At Batching plant 1- Stability 2- Flow 3- Extraction (binder content and gradation) 4- Air voids 5- Voids in mineral aggregates 6- Daily Marshall density	- Test each 3 working days - Test for each batching plant - As requested	Behind spreader 1- Stability 2- Flow 3-Extraction (binder content and gradation 4-Air voids 5- Voids in mineral aggregates 6-Marshall density	-Test each working day - Test for each batch - As requested
	7-Loss of Stability	- Once a week - As requested	7- Road density and thickness (after final compaction	- Test each 200 lin.m. per lane - As requested
			8-Loss off stability	- Once a week - As requested

2. The Marshall Bulk specific gravity shall be determined in accordance with AASHTO T 166 or AASHTO T 275. The Marshall specimens shall be prepared from the same material used in construction, taken from samples of fresh bituminous mix at the mixing plant or from trucks delivering mix to the site. Oven heating for up to 30 minutes to maintain the heat of the sample is permissible.

3. The bulk specific gravity of the mix as placed and compacted in situ shall be determined from 100 mm nominal diameter core samples, or slab samples cut from compacted layer on the road at locations designated by the engineer who may require additional tests to determine limits of areas deficient in density, or for recheck.

4. Samples for in situ bulk specific gravity determinations shall be taken in sets of 2 from each pavement location. Minimum frequency of sampling for each bituminous layer shall be one set/lane/500 m, with a minimum of one set per day of placing bituminous layers.

5. The contractor shall, cut the samples with an approved core drill in the presence of the

engineer. The equipment shall be capable of cutting the mixture without shattering the edges or otherwise disturbing the density of the specimen. The contractor shall fill and compact all test holes at his own expense.

14.3.6 Surface Tolerances

1. The fully compacted and completed bituminous course shall conform to the lines, grades and cross sections as shown on the drawings.

2. The elevations of the finished course shall be checked by the contractor in the presence of the engineer at maximum intervals of 25 m and at intermediate points as directed.

3. When the finished surface is tested with a 4 m long straightedge, placed parallel to, or at right angles to the centerline, the maximum deviation of the surface from the test edge between any 2 contacts points shall not exceed the tolerances specified 6.0 mm.

4. All areas which exceed the specified tolerances shall be corrected by removing the defective sections of bituminous course and reconstructing them or, if approved, by adding new material and recompacting and finishing to the specified standard or increasing the thickness of the succeeding course.

5. The tolerances specified for evenness of finished surfaces for all types of bituminous course, shall not invalidate the tolerances specified for construction thickness and elevations of such courses.

14.3.7 Determination of Thickness of Course

1. Cylinder core samples shall be taken next day of pavement layer as specified gravity core samples.

2. Thickness of bituminous course shall be determined by average caliper measurement of cores, rounded upwards to the nearest mm.

3. Paved sections to be measured separately shall consist of each 200 lin.m section in each traffic lane. The last section in each traffic lane shall be 200 m plus the fractional part of 200 m remaining. Other areas such as intersections, entrances, etc. shall be measured as one section and the thickness of each shall be determined separately. Small irregular unit areas may be included as part of another section.

4. One core shall be taken from each section by the contractor at approved location and in the presence of the engineer. When the measurement of the core from any paved section is not deficient by more than 3 mm from the specified thickness, the core will be deemed to be off the specified thickness as shown on the drawings.

5. When the measurement of the core from any paved section is deficient by more than 3 mm but not more than 15% from specified thickness layer, 2 additional cores spaced at not less than 100 m shall be taken and used together with the first core to determine the average thickness of such section, if it failed again, 15% will reduction from unit price.

6. When the measurement of the core from any paved section is less than the specified

thickness by more than 15% from specified thickness layer, the average thickness of such section shall be determined by taking additional cores at not less than 5 m intervals parallel to the centerline in each direction from the affected location until, in each direction, a core is taken which is not deficient by more than 15% from specified thickness layer, Exploratory cores for deficient thickness will not be used in average thickness determinations, if it failed again, Asphalt layer will remove or replacement.

7. Any retest should be taken directly within a week from pavement layer.

8. Any deficiencies in the total thickness of bituminous courses shall be subject to a proportional reduction in the area of layer measured for payment. Alternatively, the contractor shall construct all at his own expense, a wearing course overlay, if practicable in the judgment of the engineer. Any such overlay shall be a minimum of 30 mm compacted thicknesses and to the specified standard of the course it is overlaying.

9. If the deficiency in total asphalt layers thickness is from 0 -3 mm, full payment will be made, on condition that deficiencies are not found in more than 10% of the total project.
   If deficiencies from 0 -3 mm more than 10% from total layer then Engineer shall be left to the substantial handing -over procedure.

10. Deficiencies exceeding 3 mm shall be rejected, removed and re-paved on his own expenses as per specification for the defected areas.

14.3.8 Measurement

1. Bituminous course shall be measured by sq.m for furnished, paved compacted, tested and approved areas placed according to drawing.
2. Any correction, tests, samples, etc. shall not be measured for direct payment.

14.4 BITUMINOUS BINDER AND WEARING COURSES

14.4.1 Scope

These works shall consist of furnishing materials, mixing at mixing plant, spreading and compacting bituminous binder and wearing course on an approved aggregate base course as and where shown in the drawings.

14.4.2 Materials

1. Materials shall conform to relevant requirements of section" Materials" mentioned before.

2. Unless otherwise shown on drawings, bitumen for binder and wearing course construction shall be 60/70 penetration graded bitumen.

14.4.3 Job Mix and Project Mix

1. The Job Mix formula shall be established by the contractor in accordance with the procedure and requirements of section "Bituminous Course" mentioned before.

2. The Job Mix for bituminous binder and wearing courses shall conform to the following

composition limits, as shown in Table 14-4: with Marshal density is more than 2.3 g/cm3

3.

Table 14-4: Job Mix Requirements to Bituminous Courses

Property Medium-Light		
	Binder	***Wearing***
Marshall Stability at 60c (kg)	900	900
Flow (mms)	2-4	2-4
Voids in Mineral aggregate %	13.5	14.5
Voids in total mix (%)	3-7	3-5
Stiffness (kg/mm)	500 (Min)	400 (Min)
* Loss of stability (%)	25(Max)	25(Max)
Asphalt Content (% in weight)	4.5-6	5-7

* This test to be carried out in accordance with AASHTO T 165-82.
* After the Job Mix Formula has been established and approved, all subsequent mixes shall conform to it within the allowable tolerances.

14.4.4 Equipment

Plant and equipment for mixing, hauling, placing and compacting bituminous binder course and wearing course materials, shall conform to the relevant requirements of section “Bituminous Course”.

14.4.5 Surface Preparation:

Preparation of surface upon which bituminous binder course and the bituminous wearing course mixes are to be laid, and the use of prime coat, shall be appropriate to type and condition of such surface and shall conform with the relevant requirements of section "Bituminous Courses".

14.4.6 Delivery, Spreading and Finishing

14.4.6.1 General

The delivery, spreading and finishing of bituminous mixes for binder and wearing courses shall conform with the relevant requirements of Section “Bituminous Course” and to the following particular requirements.

14.4.6.2 Rollers

1. Initial breakdown rolling shall be carried out by use of 2 dual-drum steel-wheeled rollers each of minimum weight 7,000 kg. These rollers shall be purpose made for compaction of hot bituminous courses.

2. Intermediate rolling shall be carried out by of at least 2 self-propelled, tandem pneumatic smooth-tired rollers each capable of exerting contact pressures of up to 690 kN/sq.m (100

psi) and ballast- adjustable to ensure uniform wheel loadings.

3. Final rolling shall be carried out by use 2, 2-axle tandem, steel-tired rollers each of minimum weight 10.000 kg, capable of exerting contract pressures of up to 65 kg/cm (350 Ib/in.)

14.4.6.3 Standard of Compaction

The compacted density of the bituminous wearing course shall be not less than 98% of the average Marshall Bulk density for each day's production.

14.4.7 Sampling and Testing

Sampling and testing shall conform to the relevant requirements of Section "Bituminous Course ".

14.4.8 Surface Tolerances

1. Surface tolerances shall conform with the relevant requirements of Section "Bituminous Course ", and to the following particular requirements.

2. The tolerances on elevations of the final bituminous wearing course surface shall not be greater than 10 mms.

3. When the finished wearing course surface is tested with a 3 m long straightedge, placed parallel to, or at right angles to the centerline, the maximum deviation of the surface from the testing edge between any 2 contact points shall not exceed 5.0 mm.

14.4.9 Determination of Thickness

1. Procedures for determining the average compacted thickness of bituminous binder and wearing course shall conform with the relevant requirements of Section " Bituminous Courses" and the following particular requirements.

2. Cores for thickness measurements of binder course shall be used to determine if changes are necessary in the constructed thickness of the wearing course to rectify and thickness deficiencies in the binder course.

14.4.10 Measurement

1. Bituminous binder course and bituminous wearing course shall be measured by sq.m. of mix finished, spread, compacted, completed and accepted; measurements shall be of the areas and thickness as shown on the drawings.

2. Deficiencies in thickness of wearing course shall, unless an overlay is constructed at contractor's expense, result in proportion only of the wearing course area being measured for payment. Proportions shall be determined in accordance with the thickness deficiencies and area proportions mentioned in section "Bituminous Course".

3. All other items shall not be measured for direct payment and their cost shall be included in bituminous binder course and bituminous wearing course price.

14.5 PAVEMENT MARKINGS FOR TRAFFIC

14.5.1 Scope

1. These Works shall consist of the furnishing and application, of the traffic markings and to highway pavements for the guidance, control and safety of vehicular and pedestrian traffic.

2. White (Class A) and yellow (Class B) painted markings shall include centerlines, lane lines, border (edge) lines, pedestrian crossing lines, stop lines, directional arrows, lettering and symbols using the following materials as appropriate and as on the Drawings.

14.5.2 PAINT AND THERMOPLASTIC MATERIALS

Reflective Paint (RP)

1. RP shall consist of a mixture of binder, white or yellow pigment and filler specifically compounded for cold application and adhesion to finished paved areas. Paint shall be reflective by adding reflective spheres before adhesion the film dries or sets.

2. White and yellow RP shall conform to AASHTO M248 Type III. The surface application glass spheres shall conform to AASHTO M247, Type I.

14.5.3 APPLICATION

14.5.3.1 Equipment for Pavement Marking

1. The equipment used for pavement marking shall consist of approved types of truck-mounted units, or motorized equipment, or manually operated equipment, depending on the type of marking required. The truck-mounted or motorized unit for centerlines, lines, and edge lines shall consist of a mobile, self-contained unit carrying its own material and capable of operating at a maximum speed of 10 km/h while applying paint. The hand applicator equipment shall be sufficiently maneuverable to install centerlines, lane lines; edge lines gore striping, run lines, crosswalks, stop lines, arrows, and legends

2. Spraying equipment shall be capable of satisfactorily applying the paint under pressure with a uniformity of feed through nozzles spraying directly on the pavement. Each paint tank shall be equipped with cut-off valves which will enable broken (skip) lines to be sprayed automatically. Each nozzle shall have a mechanical bed dispenser that will operate simultaneously with the spray muzzle and distribute the beads in a uniform pattern at the rate specified. Each nozzle shall also be equipped with suitable line guides and shall provide a method for cleaning the surface of dust just prior to paint application.

3. The spray machine for application of reflective paint lines and other markings shall have an attachment to accurately regulate the rate of application and a tachometer or other approved device to ensure uniform paint application at the designated rate. It shall be adjustable to enable the painting of 1 or 2 adjacent lines simultaneously along the centerline. The paint shall be properly agitated while in operation.

4. An automatic glass sphere dispenser with synchronized automatic cut-off shall be attached to

the applicator machine. The dispenser shall utilize pressure type spray guns which will embed the spheres into the surface to at least 0.5 times the sphere diameter. The dispenser shall also be equipped with an automatic cut-off synchronized with the cut-off of the thermoplastic material.

5. Hand equipment shall be used only for painted markings, including arrows, crosswalks, stop lines, symbols and legends, and it shall hold a minimum of 25kg and not more than 100kg of molten material unless otherwise agreed between the Engineer and the supplier.

14.5.3.2 Setting Out and Pavement Preparation

1. The Contractor shall set out all control points necessary for locating paint lines and markings. On irregular widths of roads, the locations of boarder (edge) lines shall be adjusted so as to fall continuously on the pavement.
   The locations of all painted markings shall be accurately established and shall be subject to approval before application commences. Markers shall not be located over longitudinal or transverse pavement joints.

2 The area of road surface on which marking is to take place shall be free of dirt, grease, oil, moisture, lose or unsound layers, and any other material which could adversely affect the bond. The areas shall be thoroughly cleaned to the satisfaction of the Engineer before proceeding with painting.

3. Pavement marking shall not proceed when there is moisture on the pavement surface or the air is misty; or the surface temperature of the pavement is below 10 degrees C; or when wind or other conditions may cause a film of dust to be deposited on the surface, or in other conditions that, in the opinion of the Engineer, could displace, damage, or adversely affect the bonding of the material to the pavement surface. Any markings damaged due to water or rain within 20 minutes after application, shall be removed and replaced at the Contractor's expense.

14.5.3.3 Painting and Adhesive Film Application

1. The use of Class A (white) paint or Class B (yellow) paint and the type of paint material shall be in accordance with the design standards and as shown on the drawings.

2. Application of the various categories of point to the pavement surface shall be carried out in accordance with the equipment manufacturer's recommendations and as shown on the drawings and directed by the engineer.

3. Painting applications may include centerlines, border (edge) lines, 'no passing' lines, intersection markings chevron striping (in gross areas), pedestrian crossings, letters, arrow, symbols and other special purpose pavement markings.

4. Preformed reflective thermoplastic film shall be utilized only where specified for markings such as intersection markings, lettering, arrows, symbols and other special purpose markings. Application shall be in accordance with the manufacturer's recommendations and shall be carried out in the presence of the Engineer.

14.5.3.4 Reflective Paint (RP) Application

1. Traffic paint shall be thoroughly mixed in the shipping container before placing in the machine tank. The paint machine tanks, connections, and spray nozzles shall be thoroughly cleaned each day with thinner before starting any spraying.

2. The minimum wet film thickness for all painted areas shall be 0.4 mm.
   The minimum rate of application for 100 mm width paint lines shall be as follows:
   a- Continuous (solid) paint lines: 40 ltr/km for smooth surfaces and 50 ltr/km for rough surfaces.
   b- Broken (skip) paint lines: 14 ltr/km for smooth surfaces and 17.5ltr/km for rough surfaces (assuming gap length is double the length of paint line).
   Rates shall be modified proportionately for other widths of traffic lines.

3. The measured application rate shall not vary from the approved rate by more than 5% in any 1/km. At any point where a check indicates a variation in exceeds of 5% painting shall be stopped and the equipment adjusted or replaced. Identifiable areas of deficiency shall be corrected as directed.

4. Immediately following the application of paint, a uniform application of glass beads shall be applied at the rate of 0.6-0.7 kg/ltr of paint.

14.5.3.5 Protection of Markings

1. Immediately following the application of paint lines and other markings on pavement open to traffic, traffic cones and other devices shall be placed alongside or over the paint at intervals not exceeding 10 m and shall remain on place until the paint has dried.

2. Traffic shall be prevented from crossing wet paint lines and the Contractor shall use sufficient numbers of flagmen, barricades, or other protection, particularly at crossings to prevent traffic from crossing wet paint. Section of paint which have been damaged by traffic before the paint has cured, shall be repaired and pavement outside the painted area cleaned at the contractor's expense.

14.5.4 Sampling and Testing

1. All material shall be shipped to the job site in undamaged, sealed, original packaging clearly identifying each material as to name, color, manufacturer, batch number, and date of manufacture. All material shall be accompanied by certified test results verifying compliance with all specified physical and chemical requirements.

2. All paint products and other materials designated by the engineer shall be sampled for testing. Sampling shall be performed by the contractor in the presence of the engineer. Materials shall be sampled in their original containers. All samples shall be packaged for shipment as approved by the engineer. Samples shall be transported to the mobile field laboratory or to an approved independent laboratory, as directed by the engineer. Paint materials shall not be used until approved by the employer.

14.5.5 Measurement

Painted pavement lines and painted pavement markings shall be deemed to be included in the price of the painted surfaces.

14.6 CONCRETE CURBS

14.6.1 Scope

This work shall consist of furnishing and constructing concrete curbs and concrete paving to sidewalks as and where shown in the Drawings.

14.6.2 Materials and Precast Manufacture

14.6.2.1 Concrete

Portland cement concrete shall be class B 300 for all in situ and precast concrete unless otherwise indicated.

14.6.2.2 Mortar

Mortar shall consist of cement and fine aggregate having the same proportions used in the concrete construction.

14.6.2.3 Precast Concrete Units

1. All precast units shall be manufactured to the dimension shown on the drawings. Manufacturing tolerances shall be 3mm in any one dimension. End and edge faces shall be perpendicular to the base.

2. For horizontal curves of radius less than 10m, curb units shall be manufactured to the radius shown and in such circumstances where straight elements or portions of straight elements shall not be used.

4. Precast units shall be cast upside down in approved steel molds under conditions of controlled temperature and humidity. The engineer's approval of the samples will not be considered final and the engineer may reject any precast units delivered to the site which do not meet the required standards.

14.6.3 Precast Concrete Curbs

1. The sub-grade shall be excavated to the dimensions as shown in the drawings, and the surface of sub-grade shall be leveled and compacted to at least 95% AASHTO T180 maximum density.

2. The Base Coarse under the curb is to be placed to the required level and compacted and tested according to the base course specifications.

3. Forms for the concrete base shall be approved wood or steel. All forms shall be sufficiently strong and rigid and securely staked and braced to obtain a finished product correct to the dimensions, lines and grade required. Forms shall be cleaned and oiled before each use.

4. Concrete shall be placed, compacted and shaped to the sections shown on the drawings taking in account expansion joints. Concrete shall be compacted with an approved internal

type vibrator or if approved, by hand spudding and tamping.
Edges shall be rounded if necessary by the use of wood molding or by the use of an edger as applicable. The concrete base shall be finished to a true and even surface with a wood float. Concrete shall be membrane or water cured for at least 7 days before precast units are placed thereon.

5. Precast units from approved factory shall be set accurately in position in mortar on the concrete base. Joints pattern precast units shall not be mortared unless otherwise shown on the drawings. Units shall be closely spaced and every 10 m run shall be provided with an expansion joint.

6. Where curbs or gutters are installed on existing concrete pavement and using epoxy resin adhesive, the installation procedures shall conform to those specified for raised pavement markers in Section "Pavement Markings for Traffic".

7. After curbs have been installed, forms shall be erected and concrete backing, shall be placed as shown on the drawings.
Pavement courses shall not be laid against curbs until the concrete backing has membrane or water cured for at least 14 days.

8. The tolerances on alignment of completed precast shall be as specified for in situ concrete construction.

3. The area adjacent to completed and accepted curbs shall be backfilled with approved material to the top edges of the curbs to 95 % AASHTO T180 maximum density.

10. The curb to be painted by white, red, and black colours according to traffic requirement, the paint must be after cleaning the curb, with one prime coat and two faces coloured approved road paints.

11. Test: 5 curbs must be tested for every 1000 curbs as British Standard Bs-Pn 1340/2003 Average flexural strength of the curb must not less than 5 N/mm2 but not less than 4 N/mm2 for any specimen of the sample.

14.7 INTERLOCKING TILES

The work includes supply, install and maintain of all forms, dimensions and colors of interlock tiles in accordance with the specifications and technical requirements of the contract and in accordance with the instructions of the Engineer. The Contractor shall comply with the following:

14.7.1 - Not to use broken or distorted tiles in any way, and the layers of tiles consist of: Upper layer: cement, basalt and coloring pigment mix (not less than 10 mm). Bottom layer: cement and aggregate mix.

14.7.2 - Not to fill the gaps between and around the tiles with concrete or cement mortar but in case of no way to install complete tile, mechanical or electrical cutter should be used. At the boundary of tiled area, ready made end pieces must be installed.

14.7.3 - Interlock tiles should be transported in palettes and using a crane mechanism or fork lift to upload and download tile packages.

14.7.4 - Installation of interlocking tiles might be carried out manually or automatically.

14.7.5 - Soiled or non homogenous tiles must be replaced by clean and unharmed ones.

14.7.6 - Manufacturer, type, dimensions, color must be approved prior to supply of the tiles to the site.

14.7.7 - Average compression strength of the interlocking tiles must not less than 49N/mm2 but not less than 40N/mm2 for any specimen of the sample.

14.7.8- Average abrasion resistance of interlocking tiles should not be more than 3mm but not more than 4mm for any specimen at 440 revolutions of carborundum stone.

14.7.9 - Water absorption of the interlocking tiles should not be not more than 2% after 10 minutes and not more than 5% after 24 hours.

14.7.10 Sample of interlocking tiles must be tested by an approved lab according to the international standards. Each sample contains at least 2 specimens per 1000 tiles. Each set consist of 12 tiles distributed as follows:
For Compressive & Dimensions: 6 tiles
For Abrasion: 3 tiles.
For Absorption: 3 tiles.

14.7.11 - Tolerance in dimensions should not exceed 2 mm in all directions.

14.7.12 - The price of the interlocking tiles work should include the following according to the technical specification and instructed by the Engineer :

I. Supply and spread of dry, clean and coarse sand layer with thickness 5 cm below the tiles. Sand must be graded by mechanical or manual long straight stick taking into consideration the required slopes.

II. Supply and install of tiles according to the required size and color. Finish level of tiles must be even and straightness must be maintained along the area boundary. Tiles should be compacted mechanically using a plate compactor with area 0.35 - 0.50 m 2 , power 16-24 kN and frequency 75-100 Hz taking necessary precautions to avoid any damage to the tiles during the process of compaction. In case of unconstrained edges, compaction should be carried out at a distance not less than one 1 m from edge.

III. The gaps between the interlocking tiles should not exceed 3 mm.

IV. When testing the surface using a straight stick length of 3 m should not excess ± 5 mm.

V. Evenness of two adjoining tiles should not exceed 2 mm.

VI. The implementation of the edge beams is set first and then closing the spaces with interlocking tiles.

VII. Finish level should not exceed the design level by ± 5 mm.
VIII. Prior to tiling work, the concrete backing level of curbstone should be adjusted so that not to obstruct with the tiles level.

14.7.13 - Concrete edge beam B250 (Size 20 × 40 cm) should be constructed at the beginnings and ends of the interlocking tiles (unless otherwise noted in drawings and bill of quantities), including the necessary excavation and cutting the existing asphalt using a special cutter, as well as the shuttering and reinforcement works.

14.7.14 - The Contractor shall submit a statement of work as well as performing mockup of implementation before the start of work. The contractor must obtain the Engineer's approval of this plan before starting work.

14.7.15 - The Contractor shall take into account using the readymade starters ½ or ¾ of the tile, depending on the proposed pattern.

14.7.16 - Measurement will be engineering quantities so that calculating the net area of tiles laid on the ground. Area of manholes, storm water gullies, etc are to be deducted from the gross area.