

CIVIL WORK  
SPECIFICATION

Technical Requirements

**1. SITE PREPARATION****1.1 Description**

Site preparation work consists of site clearance, survey, cutting, imported fill, embankment and construction of ditches for drainage. Work of this section includes all measurement and materials required to complete the supply, execution and construction of site preparation.

**1.2 Site Clearance**

The contractor shall clear, from all areas planned for the work, all buildings, materials, debris, etc, prior to the cutting and filling work taking all necessary precautions to prevent damage to the existing road structures and buildings or other facilities, in the area, which shall not be demolished.

**1.3 Survey**

Prior to commencement of the work, the contractor shall check the existing bench marks and reference points located on or out of the site as indicated. The contractor shall establish newly standard bench marks and points for the works within the site with the agreement of the Engineer.

**a. Traversing**

Prior to execution of the works the contractor shall check the existing reference points, and the results shall be submitted to the Engineer for approval.

**b. Principal points**

Principal points shall be established taking advantage of the existing reference points.

Individual principal point posts shall be of wood, 15cm x 15 cm size, with an indicating nail on the top, the surface of the post above the ground shall be painted white.

**c. Bench marks**

When establishing bench marks within the site, a minimum of one (1) back and forth leveling operation shall be carried out. Establishment of temporary bench marks shall be determined and performed by the contractor. Temporary bench mark posts shall be of wood, 12cm x 12cm x 100cm in size, with an indicating nail on the top, the surface of the post above ground shall be painted.

**d. Other survey**

Setting out for survey shall be done with the agreement of the Engineer.

The Engineer may issue instructions or orders for surveys to supplement those listed above or for different surveys with which the contractor shall promptly comply and carry at this own expense.

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**1.4 Protection from Water**

In case of rain, the day's works shall be stopped so as to confine damage due to rainfall to a minimum. According to the site conditions, temporary drainage ditches shall be provided. In cases where ditches, damage ditches etc. become blocked with sand, earth, etc, such shall be immediately removed. Broken slopes shall be immediately repaired. In case where swamps, pools etc. which are not shown on the Drawings are found, such shall be drained.

**1.5 Cutting**

Cutting refers to excavation of the natural ground of cut sections. preparatory drainage and disposition of ditches at the cutting sections f temporary disposition, loading, hauling , unloading and spreading of the cut soil at embankment sections , and other temporary works necessary. such excavation shall be carried out in accordance With the Drawings and specifications and as directed by the Engineer.

**1.6 Surface Finish**

The finished cutting and embankment shall be roughly leveled, a deviation, of approx. 5cm from the proposed height shall be allowed. Slopes shall be protected from damage due to weather during the execution. Final surface finish shall be executed after completion of building work it shall cover the depth after settling to that the levels indicated in the Drawings and specifications are met.

**2. EARTH WORK****2.1 Scope of Work**

Earth work consists of excavation, back filling and disposal of surplus Material. Work of this section includes all measures and materials required to complete the design supply, support, use, construction, removal of earth work.

**2.2 Excavation**

The ground shall be excavated to the lengths, widths and exact depths required for the construction of the works. The contractor shall examine any unsuitable or weak ground material, standards of which are given below and shall report the situation in writing to the Engineer before executing concrete or any other Works.

if the surface of a subgrade is found to be unstable or to include any type of refuse subject to removal in the opinion of the Engineer, the contractor shall excavate and remove such unsuitable Material to the width and depth

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required by the Engineer. Any excavation to a level lower than that indicated on the drawings shall be compensated for filling with concrete mix (1:4:8) or with other material as directed by the Engineer at the contractor's expense.

Due weather to negligence or error on the part of the contractor or at the request of the Engineer owing to an unstable sub grade, the contract price shall be deemed to cover the whole cost of all excavation, inclusive of replacement with suitable Material, necessary in what so ever typo of earth or ground conditions encountered, e.g. earth With boulders, hard pan , rock, old concrete foundation, roadways, paved areas, etc.

All excavation works shall be kept dry and clean in order that work may not be affected or interfered with by water entering the excavation. The contractor shall pump out all water which may occur or be brought into the excavation employing such equipment as engines, pumps pipe work, chutes and other necessary devices to keep the water level below the bottom of the permanent works during the period required by the Engineer, Raised water shall be conveyed away in such manner as not to cause any nuisance or injury to the occupants of adjacent properties or sites. If pumping is required f it shall be carried out continuously and my not be stopped without the permission of the Engineer .

Excavated material, approved by the Engineer for re-use for filling shall be selected, loaded and hauled to the specified location for temporary stockpiling. Excavation materials containing brushy roots or other vegetable materials shall be classified as unsuitable for fill.

The sides of excavation shall be supported as necessary to Maintain a vertical face and to prevent fall or slip of any nature at any - time during the duration of excavation and back filling works. The contractor shall be responsible for the design, supply, fixing and removal of the shoring, sheet piling or any works required to support the side of the excavation.

It is also the contractors responsibility to protect existing structures and utilities from damage or interruption of services due to excavation work .

## **2.3 Disposal of Surplus**

The contractor shall be responsible for all surplus soil of excavated material not suitable for re-use . The Engineer my require the contractor to transport such surplus to a disposal area and /or my instruct the contractor to dispose of the surplus to a disposal area to be procured by the contractor himself - This shall all be carried out by the contractor at no extra expense to the employer.

## **2.4 Filling**

### **2.4.1 Backfilling**

Excavation shall not be backfilled until such structures and properties as drainage, insulation pipes, construction details, and water tightness have  
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been inspected, tested and approved by the Engineer .

All available precaution shall be taken during back filling to ensure that the pipes, insulation and construction details are not damaged. All backfill material shall be approved and free from vegetable or organic material, mud, refuse, boulders, rock , stones of over 15 cm and other materials which, in the opinion of the Engineer, are unsuitable.

Filling shall be carried out in such away and to such a generous depth as to ensure that the final surfaces after settlement and compaction conform to the levels indicated in the Drawings and specifications .

#### **2. 4. 2 Compaction**

Compaction of fill (under ground pipes and those buildings or structures where concrete fill is not c quir required).

All soil fill material used shall be thoroughly compacted by mechanical means until the specified degree of compaction is obtained. The filling Material shall be approved by the Engineer and placed in even layers of a depth not greater than 30cm . A power driven roller of least 10 tons shall make at least 10 trips for each layer unless otherwise specified.

Every effort shall be made to compact the fill material at its optimum moisture content for compaction. In any case, the dry density of compacted soil shall not be less than 95% of the value obtained in a standard laboratory test. When spade will not permit the use of rollers, other types of approved equipment shall be used to achieve the same degree of degree of compaction specified. Filling and compacting around pipes, cables and conduits shall be done by hand using selected Materials to depth of the least 50cm above such pipes, cables and conduit .

#### **2. 5 Hard Core**

Where indicated on the drawings or directed by the Engineer, broken brick, hard stone or gravel free from vegetable matter and lump of clay shall be laid on the compacted subgrade to a thickness of 80mm.

#### **2.6 Protection Against Termites**

Selected appropriate anti-termite method approved by the Engineer shall be executed in accordance with the local procedures and Manufacturers instruction on the excavation bottom surface and the materials used for filling or backfilling and to the sores.

### **3. PILE WORK**

#### **3. 1 Preamble**

##### **3.1.1 Scope of work**

The work comprises supplying of labor, materials, plants, equipment, temporary huts and all other items necessary for the design and installation of the piles as shown on the drawings and described in these specification.

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The work is to be executed in accordance with specification and contract documents and to the satisfaction of the Engineer. All tenders shall therefore furnish information about the type of piles they specialize in and other relevant details of design, execution, equipment, testing, etc, complete, in support of their capabilities.

The whole of the work and materials shall conform to the current edition of relevant British standards and codes of practice.

### **3. 1. 2 Responsibility for design and workmanship**

The piling contractor will be responsible for designing and installing the piles to satisfy the performance requirements and minimum design criteria laid down in these specification lie shall provide all necessary details and information to satisfy the Engineer who designed the foundations that his proposals will meet the specification. It will also be his responsibility to produce standard workmanships in the best possible manner, to effect the design in the actual conditions encountered on the ground or below . In particular he shall make whatever day to day minor modifications to the agreed proposals that may be found to be necessary to cater for minor variations in ground conditions. Any variations from the agreed principle shall be in accordance with the Engineer's approval.

### **3. 1. 3 Site conditions**

The piling contractor will be deemed to have visited and inspected the site and surroundings before preparing his tender and to have made himself thoroughly acquainted with all details of the site, including those not specifically mentioned herein or on the drawings,

### **3. 1. 4 Existing services and Adjacent Buildings**

The piling contractor will be responsible for any claims arising from damage to services or to adjacent structures or property, at the time of executing the work.

### **3. 1. 5 Pile length for purpose of payment**

The length of each pile for purposes of payment shall be measured in accordance with the standard method of measurement for building and civil engineering work.

### **3. 1. 6 Records**

The piling contractor shall keep on site a complete record of the changes in the nature of the strata through which each passes. Such records shall be made available for inspection by the Engineer during the progress of the piling contract and copy shall be supplied to the Engineer at the completion of piling work .

## **3. 2 Design**

The pile is designed to carry as its part of the total support of the foundation loading. Specified in the drawings.

**3. 2. 1 Responsibility**

As stated in 3 .1.2, the piling contractor will be responsible for designing the piles and producing a piling that can carry safely the loads indicated on the foundation plans.

**3. 2. 2 Approval of Design**

Before accepting the piling contractor's tender, the Engineer will be required to satisfy himself that design proposals are sound and reasonable\* To this end the piling contractor shall submit any calculations or supporting evidence which the Engineer may call for after receipt of tender .

**3. 3 Concreting Materials and Workmanship****3. 3. 1 Materials**

cement, aggregate and water to be used shall be in accordance with the requirement of section ( 4-2 ) "concrete work". The piling contractor shall submit details of reinforcements included in his design and tender. All reinforcements used in the piles shall be as per the approval of the Engineer and in accordance with section ( 4- 2 ) .

**3. 3. 2 Concrete**

The concrete mix shall be designed by the piling contractor to suit the piling system adopted and shall be dry as possible consistent with that system , and the method of compaction. However, the minimum cylinder strength at 28 days shall be 211 kg/cm<sup>2</sup>.

**3.3.3 Placing and compacting**

The concrete shall be placed in its final position as soon as possible and in any case not later than half an hour after mixing. Ready mix concrete must be placed immediately it leaves the mixing truck. The method of placing shall be such as to ensure that the concrete in its final position shall be dense and homogeneous. Concrete shall not be ordinarily placed under water. If water is present within the pile-shell a sealing group of approved quality shall be placed in the bottom of the shell for 1 to 1-2 m depth, the water shall then be pumped from the pile and concrete placed in the dry. Adequate precautions shall be taken to ensure that water leaking out of concrete shall not build up on top of it during the pouring of Concrete in pile shaft, and any such water shall be removed before more concrete is placed in the shaft, The pile shall be concreted in one continuous operation. If the continuity of placing the concrete is interrupted no further concrete shall be placed without the prior approval of the Engineer. The method of compaction shall be proposed by the contractor and approved by the Engineer before placing concrete .

**3.3.4 Transporting concrete**

Concrete shall be transported from the mixer to the position of the pile in such a manner that segregation of the mix shall not occur .

### **3.4 Piling Workmanship**

#### **3.4.1 Setting out**

The main contractor will provide the piling contractor with all necessary layouts and take responsibility for their accuracy and check that the piling contractor executes the work in accordance with these layouts. The piling contractor shall set out the position of each pile.

#### **3.4.2 Tolerances**

The maximum permissible positional deviation of the center of each finished pile from the correct center point shown on the setting out drawing is 75 mm in any direction. The maximum permissible deviation from the specified inclination of any finished pile is 2-2.5 % .

The piling contractor shall bear the cost of any additional work which, in the opinion of the Engineer, may be necessary due to any pile being installed in apposition not within these tolerances.

#### **3.4.3 Temporary lining**

Adequate precaution shall be taken including the use of a temporary lining tube, water bearing or unstable strata, to prevent the ingress of water, to maintain any pile excavation to its full dimensions and to ensure that the pile shaft shall be formed to its full cross-sectional area, where there is a temporary lining it must be removed in the line of the pile in such a manner that no defect or damage will be sustained by the pile.

The depth to the average levels of the concrete surface of the pile shall be checked before and after any temporary linings are with draw. These measurements shall be recorded.

#### **3.4.5 Drilling Mud**

Drilling Mud may be allowed only with prior permission of the Engineer and subject to the piling contractor providing satisfactory evidence that its disposal will not foul or contaminate any part of the site or surrounding areas or services.

#### **3.4.6 Cleaning the Excavation**

Upon completion of any boring, the excavation shall be cleaned of all losses, disturbed and remolded soil to expose a dry base of undisturbed Material.

#### **3.4.7 Inspection**

After the tube has been installed in its final position, the Engineer will inspect the tube for proper plumb, location and other conditions. Only after his approval can the contractor proceed further in placing reinforcement and concreting the pile.

#### **3.4.8 Jetting and pre-boring**

Jetting and pre-boring may be used only with the prior permission of the

Engineer.

#### **3.4.9 Backfilling empty boring**

Where trimmed level of any pile is more than 600mm below the starting level of the piles, empty boring shall be backfilled as soon as possible with sand of colour which contrasts with the surrounding natural soil .

#### **3.4.10 Cleaning the site**

The piling contractor shall remove from the site at intervals during the operation of the work, and on completion, all unnecessary plant, rubbish, water and debris resulting from his activities.

### **3.5 Pile Testing**

Tests of completed piles shall conform to British standards CP 2004

#### **3.5.1 Notice of commencement**

The Engineer shall be given at least 40 hours notice before the commencement of each test .

#### **3.5.2 Supervision of pile tests**

The piling contractor shall Keep the tests under continuous and competent supervision to the satisfaction of the Engineer, All necessary facilities shall be provided to enable the Engineer to check reading during the progress of the tests.

#### **3.5.3 Testing assembly**

The piling contractor shall submit complete details of the testing assembly and all details of the proposed arrangement and procedure for test loading for approval of the Engineer before the installation of tension piles. The details shall include a complete list of all equipment being used in the test, including manufacturer's name and the reference number of the equipment.

#### **3.5.4 Test report**

At the conclusion of work each day the piling contractor shall send to the Engineer a copy of his daily record sheet . The piling contractor shall also send to the Engineer within one week of the completion of each test, two copies of all record graphs and results of laboratory and in-situ tests conducted on the installation and testing of all trial piles. This information shall include a load Settlement, diagram plotted to scales .

#### **3.5.5 Failure of contract test piles**

In the event of a contract the failing to satisfy the test requirements the piling contractor will be instructed to test additional piles.

The piling contractor shall bear the cost of all additional and consequential work as the Engineer may consider necessary due to the failure on one or more piles, to satisfy the requirements of the loading test .

#### **3.5.6 Rejection of piles**

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The Engineer reserves the right to reject any pile which in his opinion is not structurally sound, or is not in a proper position and alignment. The contractor shall be bound to pull out same and re-drive a new pile in its place , or leave the defective piles install at the contractor's cost one or more additional pile as per the directions of the Engineer in writing.

### **3.6 Other Pile Types**

#### **3.6.1 Steel piles**

The work covered by this clause consists of furnishing all materials, labor and equipment and performing all operations for driving and completing steel piles as indicated on the drawings, in addition to driving and testing the test piles, all in accordance with the specification and as directed by the Engineer.

#### **3.6.2 Materials**

Steel piles shall be of the type and weights shown on the drawings and shall be manufactured from steel conforming v to ASTM-A36. All piles shall be straight and true to section and any pile which in the opinion of the Engineer, is defective in any way, shall be rejected and shall be replaced by the contractor.

#### **3.6.3 Driving steel piles**

Steel piles shall be driven vertically or inclined to true position and secured against lateral movement by leads or other suitable means approved by the Engineer, All piles driven out of line, but of plumb, with incorrect inclination, or twisted, broken or bent, otherwise damaged in driving shall be withdrawal and replaced with other piles, properly driven to the true position and alignment required and to the satisfaction of the Engineer. All piles shall be cut off at the levels indicated on the drawings . A steam hammer shall be used to drive the piles unless other equipment is permitted by the Engineer. Piles may be driven by a hammer and water jets or by water jets alone. An ample supply of water at adequate pressure shall provided. Piles shall be driven by hammer alone for the last 1.5 m of penetration, piles shall be driven to depths or to penetration per blow as directed by the Engineer. Accurate records of the penetration per blow for the last 30 cm shall be kept for the guidance of the Engineer in determining allowable loads on the pile.

If proper resistance to driving is not attained at the predetermined length of pile, or when the length of piling required is in excess of the largest continuous length that can be supplied, an additional length of piling shall be added by butt welding. The joint details shall be as shown or as directed and fulfilling the requirements of AISC standards.

The contractor shall take all the necessary precautions to prevent any damage to the existing properties due to the piling work.

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**4. CONCRETE WORK****4.1 Description**

Concrete work shall consist of mixing, conveying, placing of concrete , for work and reinforcement Work, (it is inclusive of all measures and materials required removal of concrete forms and reinforcement).

**4.2 Material**

All materials used in the work shall be the best of their kind and shall conform in quality and treatment to the conditions herein specified. The contractor shall submit to the Engineer when required and at his own expense, samples of all materials to be used in the works. The quality of the samples so provided being representative of the Bulk of such materials. The construction of all concrete and reinforced concrete work shall commence at points approved by Engineer and shall be continued and completed in accordance with the programme of work to be submitted to the Engineer for approval before the concrete work is commenced.

Any work considered by the Engineer to be of inferior workman ship and therefore , to present a potential point of weakness in any part of the work shall be demolished and rebuilt at the expense of the contractor.

**4.2.1 Cement**

Portland cement for all structural concrete shall conform to ASTM C 150, for all concrete construction below ground level and water-retaining structures, sulphate resisting Portland cement Type II of ASTM C 150 or equivalent shall be used and for above ground level Type I shall be used The contractor shall provide appropriate dry, well ventilated weather and water proof sheds of capacity sufficient to store cement so that the cement can be stored in such a manner as to prevent deterioration or intrusion of foreign matter. Floors of the sheds shall be at least 30 cm above ground. The cement while being conveyed to the site in trucks or other vehicles shall be adequately from the weather. The cement shall be used as soon as possible after delivery. Any cement that has deteriorated or has been contaminated shall not be used for concrete.

**4. 2. 2 Aggregates****a. General**

All aggregates shall conform to the requirements of J3.S 882 or equivalent and be locally available. Aggregates failing to meet above mentioned specifications but which have been shown by special test or to actual service to produce concrete of adequate strength and durability may be used when authorized by the engineer. The aggregates shall be dense, hard durable and free from harmful amount of reactive minerals and other chemical compounds and shall conform to the above mentioned standards. Samples of aggregates used in the work shall so provided from the same aggregate sources stockpile at the site, and be submitted to the laboratory authorized by the employer and the written approval of the authorized laboratory shall be given to

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the engineer for his approval.

**b. Grading of aggregate**

The grading of the fine and coarse aggregate shall be such that when they are mixed in the proportions decided for each class of concrete, the grading of the combined aggregate shall be suitable for making a dense concrete of appropriate workability with the proportions of cement and water with which the aggregate is to be used. The quantity of flaky aggregate shall be limited as much as possible.

When tested by means of laboratory sieve the fine and coarse aggregate shall conform to the requirements of D.S. 002 for graded aggregate. The contractor shall be responsible for mixing the aggregate in the proportions approved by the Engineer for each class of concrete and each section of the work. It shall submit samples of the re-graded material to the Engineer well in advance before commencing any concrete works, 20 mm size shall apply to all concrete having 200mm or less in thickness, for heavier wall, footing and mass concrete 25 mm size may be used, provided that the space between the reinforcing bars therein is one and half times greater than the maximum aggregate size.

**4. 2. 3 Water**

Water use in mixing concrete shall be clean and free from injurious amounts of oil, acids, alkalis, salts, organic material or other substance which may be deleterious to concrete or reinforcement. The temperature of water use for making concrete in hot weather shall be low enough to attain the proper mixing temperature of concrete, and in any case shall be Lower than 30 degree centigrade. The contractor shall store on the site an adequate supply of fresh water to meet all needs . The contractor must indicate the origin . of the water he intends to use.

**4.2.4 Steel reinforcing bars**

Reinforcing bar should be deformed bars for all reinforced concrete work, and should have minimum yield strength of 414 N/mm<sup>2</sup> ( 60000 psi) in accordance to ( ASTM A 184 and A 185) . Representative samples of all steel reinforcement that the contractor proposes to use in the Works together with manufacture's certificate stating clearly for each sample, the place of manufacture expected date and size of deliveries to site, and all relevant details as regards composition manufacture, strength and other qualities of the steel shall be submitted to the Engineer for written approval.

**4.2.5 Formwork**

luan ply wood, 5-ply, 12 mm thick, or wood boards shall be used . Wood boards or ply wood for shuttering shall be such as not to damage the placed concrete owing to its containing imparities and shall be able to withstand loading occurring during placing of concrete.

**4.2.6 Prefomed expansion joint sealer and filler**

Bitumen Impregnated fiber board to be used for joint filler, shall be robust,

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durable, waterproof, rat-proof , non- staining, made from selected hard and soft wood fibers impregnated with bitumen emulsion, preformed expansion joint seals shall consist of synthetic resin cover , hard PVC cap, steel anchors and elastic filler as shown on the drawings .

### **4.3 Concrete Mixes**

Concrete shall be proportioned to have the following specified compressive strengths, as determined by the specified testing and test evaluation procedure, specified compressive strength ( fc) shall be as indicated on the drawings.

### **4.4 Water-cement ratio**

Water-cement ratio shall be determine so as to achieve the required workability and to obtain the specified concrete strength, which shall be subject to the approval of the Engineer.

### **4.5 Test of Concrete**

Work cylinder test ( cubes in case B.S. is to be applied) shall be made on concrete sampled during the works. Samples shall be taken for each new grade concrete, from each 100 m<sup>3</sup> of concrete when the same grade is being used continuously, except for lean concrete and other non load bearing concrete. The number of specimens taken shall not less than 3 for each compressive strength test, All tests shall be performed in accordance with ASTM C. 39, B.S, 1881. and shall be carried out in an authorized laboratory at the contractor's own expense. If the results of the 28 days test are unsatisfactory, all concrete work shall be stopped at contractor's expense and shall not proceed further without the written permission of the Engineer. Should the test prove that the concrete is not satisfactory or the Engineer Judge any section to be defective , the condemned concrete shall be cut out, removed and replaced by the contractor.

### **4.6 Mixing and placing concrete**

#### **4.6.1 Mechanical Mixing, batching .**

All concrete shall be Machine Mixed. The location for the batching and minding plant shall be agreed by the Engineer, and the contractor must submit to the Engineer for approval before erection of any mixing plant his proposed arrangements for the storage of aggregate and batching and mixing of concrete. The contractor must also submit details on the type or types of mixers and machines to be used and proposals for the moans of conveying nixed concrete from the miser to the points of deposition.

All concrete shall be batched by weight and the weight-batching machines used shall be of a type approved by the Engineer and shall be kept

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accurate and in good condition while in use at the works. Checks shall be made as required by the engineer to determine whether the weighting devices are registering correctly. Each mixer shall be fitted with a water measuring device. If aggregate batching by volume is allowed, the cement shall be batched by weight and the water by weight or volume.

Any deposit of old concrete in the mixer drum shall be cleaned out by rotating clean aggregate and water in the drum before any fresh concrete is mixed.

#### **4. 6. 2 Placing and compacting**

Immediately after Mixing, the concrete shall be transported to the place of final deposit- by method which prevent separation , loss contamination of any of the ingredients.. Any method involving the use of pipes or chutes for transporting concrete shall not be permitted, except with the written approval of the Engineer.

Transport of concrete from the mixers must be as rapid. as possible and the contractor shall always be responsible to place and compact the concrete.

Before any concrete is poured, the formwork must be thoroughly cleaned of all dirt, shavings, loose stones, etc, and the wood form which will come in contact with the concrete shall be soaked well with an approved mould oil. The concrete shall be placed gently in position and shall normally not have a free fall of more than one meter. To convey, the concrete as near as possible to its final position, rubber or metal drop chutes shall be used for small sections, and bottom opening buckets or other suitable vessels for large sections. The concrete shall be placed in such a manner so as to prevent water from collecting at the ends, corner or along the faces of the forms, and it shall not be placed in large quantities at a given point and allowed to run or b be worked over a long distance in the form . All concrete shall be placed and compacted in even layers with each batch adjoining the previous one. The thickness of the layers shall be between 15-30 cm for reinforced concrete and up to 45 cm for un-reinforced concrete in relation to the width of the forms.

The concrete shall be carefully and continuously compacted and worked around the reinforcement and into the corners of the formwork so that it will be in close contact with the reinforcement and free from honeycombing. Over-vibration causing segregation shall be carefully avoided and the redistribution of concrete in the formwork by means of vibrators shall not be permitted.

The concrete shall be compacted by mechanical or electro-mechanical vibrators of a type approved by the Engineer. The plunger type vibrators shall have a diameter compatible with the spacing of the reinforcement., and sufficiently high frequency.

All vibration, compaction and finishing operations shall be completed immediately after placing of the concrete in its final position, workers shall

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not be permitted to walk over freshly placed concrete until it has hardened sufficiently to carry their weight without distortion, and great care shall be taken to ensure that reinforcement projecting from recently placed concrete is not shaken or disturbed so as not to destroy or damage the initial set of the concrete in contact with it.

Concreting in any one part or section of the work shall be carried out in one continuous operation and no interruption of concreting work shall be allowed without the approval of the Engineer .

#### **4.7 Concreting in Hot weather**

The recommendations set out in (( Recommended practice for hot weather concreting) ( ACI- 305-72) . The temperature of the mixed concrete shall not exceed 35 before placing in hot weather. In ambient temperatures coarse aggregates shall be sprayed with clean water for cooling. In order to keep the temperature of mixed concrete below the specified temperature, the contractor may use cooling equipment. Fresh concrete shall be protected from premature drying. Concrete in transit shall be shaded from direct sunlight and special care shall be taken to maintain the correct water/ cement ratio. The formwork and reinforcement in and around which the concrete is to be placed shall be sprayed with water to cool the surfaces and prevent excessive absorption from the concrete when placed. Generally all concrete shall be shaded from direct sunlight and drying winds and from excessive ambient temperature during placement.

#### **4.8 Concreting in cold weather**

No concrete shall be made with frozen aggregates or placed up on frozen surfaces. In cold weather, the contractor shall take special precautions, such as heating aggregates and mixing water to ensure that the temperature of the concrete when placed is not less than 4C .

#### **4.9 Curing**

Curing shall start as soon as practical after placing or finishing . concrete shall be cured with water unless membrane curing is employed.

The surface of placed concrete shall be covered with damp mats or other approved materials for a suffocation period taking into consideration weather conditions during the period. Horizontal surfaces shall be covered by a suitable method so as to avoid the effect of sunshine, drying wind and other harmful effects, vertical surfaces such as walls and column sides shall be wetted for a sufficient period by sprinkling water to forms, or other suitable methods.

#### **4.10 Reinforcement**

This article shall apply to the fabrication and erection of reinforcing steel bars. The materials to be used shall be specified in section 4.2.4 of this specification.

#### 4.10.1 Bending and anchorage

Bending specifications shall be drawn up as applicable in accordance with the approved codes, and each reinforcement bar shall be bent to the exact dimensions specified in the relevant specification. All bars shall be bent cold. Bars shall not be welded without the approval of the Engineer. No splices shall be made in the reinforcement except where approved by the Engineer, and all splices or overlaps shall comply entirely with the requirements of proved.

#### 4.10.2 Fixing of reinforcement

The steel reinforcement shall be assembled to the exact shapes and dimensions as approved by the Engineer. The rods shall have the approved cross-sectional area and shall be fixed accurately in the moulds. The ends of all tying wires shall be turned into the main body of the concrete and shall not be allowed to project towards the surface. Spacing blocks shall be used to ensure accurate cover to the reinforcement, where necessary, and these blocks shall be of precast concrete of a strength at least equal to that of the concrete being placed. They shall be as small as possible in view of practicality and shall be securely fixed in position by means of wires to be cast into them.

No temporary supports for the reinforcement shall be allowed to be incorporated into the finished concrete. At the time of concreting all reinforcement shall have been thoroughly cleaned and made free

of all loss rust (crude oil or any other coatings that might destroy or reduce the bond).

Unless otherwise specified or shown on the drawings, minimum cover shall be determined in accordance with ACI 318- 77 as indicated on the following table:

Description		Min. cover thickness
Cast against and permanently exposed to earth		75 mm
Exposed to earth and weather	D16 and smaller	40 mm
	D19 - D 25	50 mm
Not Exposed to weather and	Slabs and walls	D25 and smaller
		20 mm

not in contact with earth	Beams, girder, columns	main bars , ties, stirrups	40 mm
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**4.11 Form work**

This section covers the fabrication, erection and removal of forms and other necessary work thereof, including material and design of forms. All works, covered by this section shall conform to ACI 347 or relevant B.S. standards unless otherwise specified herein.

**4.11.1 Design of forms**

- a. Forms shall be constructed complete with centering, sleeves and molds to conform to the shape, form, line and grade required and shall be maintained rigid to prevent deformation under load where required forms shall provide for adequate protection of the precast units placed within the forms, before pouring concrete.
- b. Joints shall be leak proof and arranged vertically or horizontally to conform to the design pattern. Forms shall be placed on successive units for continuous surfaces and fitted to accurate alignment to secure smooth completed surfaces free from irregularities, In long span, where intermediate supports are not possible, the form deflection due to fresh concrete shall be compensated for. Members shall have true surfaces in accordance with desired lines, planes and elevations. If adequate foundation for shores can not be secured, trussed supports shall be provided.
- c. Form-ties; in general, shall be (snap-tie) type which beak predetermined points at least 2.5 mm, behind the finish surface of the concrete, or type which can be wholly with drawn. Where form ties, bolts, or rods are to be completely removed, they shall be coated with grease, In no event, either in interior, exterior, or below\_ grade applications, shall any parts of metal ties be allowed to remain within 2.5cm, of the finished concrete
- d. Form surfaces shall be coated before placing of reinforcement, when oil is used , surplus oil shall be removed from form surfaces. All oil stains shall be cleaned from reinforcing steel before pouring of concrete,
- e. Forms shall not be removed without the approval of Engineer. This approval shall not relieve the contractor of responsibility for the safety of the work, the minimum period of time that must elapse between the pouring of the concrete and the slackening of the form work shall be as follows:

Type of Formwork	Minimum period before removal
	Surface temperature of concrete

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	more than 16 C°	7- 16 C
Slabs, beams , girders columns, walls	14 days	21 days
	24 hours	24 hours

The removal of form works shall in all cases be supervised by an experienced foreman. All form works shall be removed without such shock or vibration as would damage the concrete, and before the form works and props are removed the concrete surface should be exposed, where necessary, in order to ascertain that the concrete has hardened sufficiently, Any work showing signs of damage due to premature loading is to be removed and entirely reconstructed at the contractor's expense.

**4.12 Expansion joints**

Expansion Joints shall be formed in walls, Floors, roofs, beams and foundations where indicated on drawings. Where specified or shown on the drawings, expansion Joint in Floor shall be covered with specified metal covers, Reinforcement, or their embedded items bonded to the concrete ( except dowels in floors bonded on only one side of joints), shall not be permitted to extend completely through any expansion joint, Expansion joints in water retaining structures shall incorporate at raid\_depth of the concrete a pressure resisting PVC water stop and joint fillers shall be installed as shown on the drawing.

**4. 13 Construction Joint**

Unless otherwise specified here in , construction joint shall be formed and treated in accordance with ( specification for structural concrete for Building), ( ACI 301 \_ 72). The position of construction joints shall be arranged to minimise the affect of shrinkage and construction. The following Special requirements apply to the position of construction joints:

**a. In beams and slab .**

Construction Joints, other than in cantilevers, shall be located at approximate quarter span points from the center line of supports. Construction joints shall not be made in cantilevers, and where it is practicable to do so, the whole of the internal span from which the cantilever springs shall be cast at the same time as the cantilever.

**b. In flat slab.**

Construction Joints shall be formed at the center of supporting span approximately.

**c. In foundation**

As far as possible construction joints shall be located midway between the footing or pile cap for column and walls. In isolated footings or pile taps ,

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the construction joint shall not be allowed.

At each construction joint, the surface of the existing concrete shall be thoroughly roughened to remove all laitance and other injurious materials and wetted before any further concrete is placed.

All concrete between construction joints shall be placed continuously. In the event of unavoidable delay during concreting, the engineer may require a construction joint to be made, or other appropriate action taken.

Horizontal and vertical joints shall be thoroughly wetted and covered with allayer of mortar immediately before placing new concrete.

## **4. 14 Finishing**

### **4. 14. 1 General**

The finishes described, below must not cause any deviation out sid the specified allowable deviation from plumb or level or from alignment, profile grades or dimensions specified in the paragraph on tolerance. Offsets caused by displaced or misplaced sheathing, lining or form sections, or by knots in forms or by other wise defective items shall be checked by direct measurement.

All other irregularities can be checked by use of straight edges or by use of templates. Surfaces shall be corrected so as to meet the requirements specified in the paragraph or tolerances.

### **4.14. 2 Formed surfaces**

Formed surfaces to be hidden by backfill, plaster or other finish material shall not require treatment after form removal except for patching defective concrete, the filling of holes and the specified curing, correction of surface irregularities shall be required for depression exceeding a limit not affecting the subsequent finish. Formed surfaces for exposed walls, water conduit, parapets, curbs, stair faces and other areas shall be smooth and regular when completed. Ridges or lips on exposed concrete shall be removed by tooling , grinding or rubbing.

### **4.14.3 Fair faced concrete**

This type of finish is for surfaces which are permanently exposed to view. Forms to provide this finish shall be faced with wrought tongued and grooved boards or plywood or metal panels , arranged in a uniform approved pattern, free from defects likely to detract from the general appearance of the finished surface. This finished shall be such as to require no general filling of surface pitting, but fins, surface discoloration and other minor defects shall be remedied by methods approved by the Engineer without extra cost to the contract.

All forms shall be removed without damages to the concrete. The use of non- staining mould oil or other material to facilitate this shall not have a deleterious effect on either the strength or appearance of the concrete and

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shall be subject to the approval of the Engineer.

#### **4.14.4 Unformed Surfaces**

Unformed screeded finish surfaces to be covered by backfill or concrete and surfaces of sub-floors to be covered by concrete floor topping: Finishing operations shall include sufficient leveling and screeding to produce flat uniform surfaces.

Unformed floated finish surfaces not permanently concealed by backfill or concrete and for which other finishes are not specified, including concrete to be permanently exposed to view such as outside decks, floor of sumps, tops of walls, surfaces of gutters, sidewalks and outside entrance slabs, when trowelled finishes are needed, floating shall be continued until a small amount of mortar without excess water is brought to the surface, permitting effective trowelling.

Surfaces to receive mastic water proofing or asphalt water proofing shall not have any prominence likely to cause damage or other harmful irregularity. Surface irregularities shall be reduced or eliminated by grinding, after concrete has hardened.

#### **4.14.5 Chemical Surface hardening**

When shown on the drawings, a cement mortar trowelled finish or concrete trowelled finish surface shall be treated with chemical hardener, it shall be applied to slabs after they are at least 28 days cured, cleaned and free from dust, oil, grease and other foreign matter, and dry chemical hardener shall be applied in accordance with the manufacturer's instructions.

### **5. PRECAST CONCRETE**

#### **5.1 General**

##### **5.1.1 Scope of Work**

Provide precast concrete panels, materials, equipments, and , labors, complete, in place, as shown on the drawings, specified herein, and as evidently required for a complete and proper installation of precast concrete work .

##### **5.1.2 Related work Described**

Elsewhere

- a. Cast in place concrete
- b. Concrete reinforcement

##### **5.1.3 Quality Assurance**

The manufacturer should demonstrate the ability to provide the required quality as specified on the drawings or as directed by the Engineer.

The installers must not have less than two years successful experience in

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erecting similar items to those required in this work.

## 5.2 Submittals

### 5.2.1 Manufacturing Data

The Contractor, prior to any work shall submit to the Engineer the following items :

- a. Complete material list with their specifications of all items proposed to be furnished and installed for this work.
- b. Specifications and instructions for all manufactured materials and products going to be used in this work.
- c. Laboratory test reports as required by the Engineer.
- d. Shop Drawings showing complete information for the fabrication and installation of all required work, which is also supposed to include the following information:
  - i. Member dimensions and cross section, location, size, and type of reinforcement and lifting devices use for handling and erection.
  - ii. Details inserts, connections, and joints, including all accessories.
  - iii. Location and details of anchorage devices that are to be embedded in other construction,
  - iv. Welded connections by AWS standards,
  - v. Erection procedure, sequence of erection, and method for temporary bracing and staging .

### 5.2.2 Samples

- a. Precast samples approximately 300x300x50mm. cast from the mix specified illustrating equality color and texture of the proposed surface finish.
- b. Submit samples of cast-in gaskets, anchorages, and other attachments and accessories if required by the Engineer.
- c. Prior to start of installation, one full-size sample of **each** required precast concrete unit shall be submitted to the job site for approval by the Engineer, Acceptable samples may be incorporated in the construction,
- d. The Engineer inspect color, texture, and general condition only . Compliance with all other requirements is the exclusive responsibility of the contractor.

## 5.3 Delivery and Storage

- a. Deliver the work of this section to the job site in such quantities and at such times as to assure the continuity of the installation.
- b. Storing and delivering of the units shall be in a manner to prevent cracking , distortion , warping, staining, and other physical damages,

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and in a manner to keep all marking visible.

- c. Lift and support the units at the designed lift points as shown on the approved shop Drawings.
- d. At no time shall units be permitted to rest on earth or other staining materials.
- e. Units shall be separated one from another with non-staining wood strips.
- f. Thin or flat elements shall be maintained in a vertical position.

#### **5.4 Protection and Replacements**

Use all means necessary to protect, the units from damages and staining before, during, and after installation. In the event of damage to the units or any materials of all other trades, immediately make all repairs necessary to the satisfaction of the Engineer. Where corrective measures are considered un-practicable or unsatisfactory, the faulty work shall be replaced by new units at no additional cost to the Employer.

### **5.5 Products**

#### **5.5.1 General**

- a. Concreting materials as referred to in section ( 4\_2). " Concrete Work ".
- b. Provide all reinforcement, necessary, and connection materials required in accordance with the final design as approved "by the Engineer,
- c. All anchors, bolts, dowels, fittings and attachment members shall be of types indicated on the drawings and as approved by the Engineer.
- d. All the materials provided under this Article shall meet or exceed the quality specified for similar materials in other sections of these specifications\*
- e. Those materials not specified in those sections, but required for a complete and proper installation, shall be new, first quality of their respective kinds, and selected by the contractor subject to the approval of the Engineer.

#### **5.5.2 Design**

- a. Provide complete design, calculations, and drawings prepared and signed by an engineer properly licensed to perform such services.
- b. Make all necessary provision in the design to accommodate all stresses to be encountered.

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Design in accordance with all pertinent recommendations contained in:

1. ACI 301
2. ACI 304
3. ACI 311
4. ACI 310
5. ACI 347
6. Concrete Reinforcing Steel Institute " Manual of standard Practice" .
7. Prestressed Concrete Institute MILL116 " Manual for Plants and Production of precast concrete products.

Comply with building code requirements which are more stringent than above. In the event of conflict, the more stringent provisions shall govern.

- c. Engineer's review of calculation does not relieve the manufacturer of design responsibility .
- d. Design modifications may be made as necessary to meet field conditions and to ensure proper fitting of work.

Maintain the general design concept as shown without increasing sizes of members or altering profile and alignments, and as acceptable to the Engineer.

#### **5.5.4 Concrete mixes**

- a. Prepare design mixes for each type of concrete required, and secure the Engineer's approval of the proposed design. Design mixes may be prepared by an independent plant, at precast manufacturers option.
- b. Design the mix and proportion of the concrete to attain a minimum compressive strength of 201 Kg / cm<sup>2</sup> when cured and tested at 20 days in accordance with ASTM C39 with minimum cement content of 305Kg/m<sup>3</sup>
- c. Submit written reports to the Engineer of proposed mix at least 14 days prior to start of precast unit production.
- d. Mix design adjustments may be requested when characteristics of materials, job conditions weather, test results, or other circumstances .

warrant laboratory test data for revised mix designs and strength results must be submitted to and accepted by the Engineer before using in the work.

#### **5. 6. Equipments**

- a. forms shall be constructed of steel, with smooth contact surfaces and free from any staining effect confirming the exact design dimension and shapes.

They shall have sufficient strength to withstand high frequency vibration and to prevent deformation under applied loads. The form's surfaces shall be coated with a bond breaking compound before reinforcement is placed.

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The coat shall not adversely affect concrete properties of appearance.

- b. Vibrating table shall be of design and construction to provide frequency vibration as required to produce units of the strength, aggregate distribution, and finish specified and defined by the approved samples and test specimens.
- c. Mixers shall be of type to maintain even distribution of fine and coarse aggregate,
- d. Lifting of precast units shall be done using power equipment of a type approved by the Engineer.

## **5.7 Fabrication**

### **5.7.1 General**

- a. mix Materials for concrete in an acceptable drum type batch machine mixer and as explained in section(4\_6) provide a batch ticket for each batch discharge and used in work, indicating project ; Identification name and number, date, mix type, mix time, quantity, and amount of water introduced .
- b. Ready mix concrete shall be comply with requirements of ASTM C94, and as herein specified.
  - i. Addition of water to batch will not be permitted.
  - ii. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing and delivery time than that specified in ASTM C94 may be required.
- c. Place and secure all anchors , clips, inserts, reglets, lifting devices, stud bolts , shear ties, and other devices required for handling and installing the precast units, and for attachment of subsequent items as indicated or specified.
- d. Finish units shall be straight , true to size and shape and within the specified casting tolerances. Exposed edges shall be sharp, straight , and Square.
- e. Dimensional tolerances shall be  $^{+}$  ;\_ 3mm and for lintels shall be  $^{+}$  ;\_ 6mm. Variation from position in plan  $^{+}$  ;\_ 13mm maximum at any locations. Offsets in alignment of adjacent members at any joint shall be 1,5 in any 3000mm run and 6mm maximum .

### **5.7.2 Curing**

Form cure for a minimum of 20 hours. Keep Wet continuously for not less than seven days after being removed from the forms. Following this curing period, allowing this curing period, allow the units to air dry for at least four days before being erected.

### **5.7.3 Surface Finish**

Appearance of the precast units is of primary importance and special attention shall be paid to uniformity color, and texture

- a. Finish of formed surfaces Normal plant\_run finish produced by forms that impart a smooth finish to the concrete. Small surfaces holes caused by air bubbles, normal form joint marks, and minor chips and spalls will be tolerated, but no major unsightly imperfections, honeycomb, or structural defects will be

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permitted.

- b. Finish of unformed surfaces .

Apply trowel finish to unformed surfaces unless otherwise indicated , consolidate concrete, bring to proper level with a straightedge, float and trowel to a smooth, uniform finish. Apply scratch finish to precast units which will receive concrete topping after installation .

## **5.8 Execution**

### **5.8.1 Inspection**

Examine the areas and conditions under which work of this section will be installed.

Correct conditions detrimental to proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

### **5.3.2 Installations**

#### **5.8.2.1 General**

Install the work of this section in strict accordance with the approved shop Drawings, and all pertinent codes and regulations. All cutting, drilling and welding required for installation shall be provided.

#### **5.3.2.2 Bracing**

Bracing shall be adequate to resist any dimensional changes and resist wind load. They shall be left in place until final connections to the structural frames have been made.

#### **5.8.2.3 Bearing Pads**

Install flexible bearing pads where indicated on the approved shop Drawing, set pads on level and uniform bearing surface, maintain in correct position until precast units are in place.

#### **5.8.2.4 Welding**

Perform all welding in compliance with the approved drawings. All unsatisfactory connections shall be replaced or corrected according to the instructions of the Engineer,

#### **5.8.2.5 Grouting**

- a. After precast units have been placed and secured, grout open spaces at connections and joints.

At all times exercise extreme care to prevent staining of exposed panel surfaces.

- b. Use only grout systems recommended by the manufacturer of the precast units and approved by the Engineer.
- c. Provide any acceptable method to retain the grout in place until it is sufficiently hard to support itself.
- d. Pack spaces with stiff grout materials, tamping voids completely full. place the grout in a manner to finish smooth } plumb and leved with adjacent concrete surfaces,

e. Keep grouted surfaces damp for not less than 24 hours after grout has taken its initial set .

Promptly remove all grout material from exposed surfaces before it hardens.

### **5.9 Cleaning**

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Upon completion of installation and patching , all exposed work of this section shall be washed clean with clean water. All excess materials shall be removed and the site left in a clean and acceptable condition.

### **5.10 Plant Quality control Evaluations**

- a, The manufacturer shall provide samples of materials and concrete mixes as may be requested for additional testing and evaluation.
- b . The strength of precast concrete units will be consider potentially deficient if they fail to comply with any of the requirements which may affect the strength including the following conditions:
  1. Failure to meet compressive strength tests requirements.
  2. Reinforcement not conforming to specified fabrication requirements.
  3. Precast units damaged during handling erection. When there is evidence that the strength of precast concrete units does not meet specification requirements, cores shall be drilled for compressive strength determination complying with ASTM G42.
- c. Where core test results are satisfactory and precast units are acceptable for use, fill core holes solid with patching mortar, and finish to match adjacent concrete surfaces.
- d. Defective units which do not conform to the specified requirements shall be replaced with suitable units and corrections shall also be made for any other work affected by this correction without any additional cost.

## **6. BRICK AND CONCRETE BLOCK WORK**

### **6.1 Scope of work**

Furnish all labour, material and equipment for the complete building of brick and concrete block work as shown on the drawings, as specified herein and as evidently necessary to complete the work.

### **6.2 Submittals**

Before starting the work the contractor shall submit the following to the Engineer and receive his written approval.

#### **6.2.1 Manufacturer and sample blocks**

Before precasting concrete block, the name and official address of the concrete block manufacturer, if the contractor intends to use a sub, contractor, sample block and sources of cement and aggregate making up the concrete block shall be submitted to the Engineer for his written approval.

report

Test required and as specified here in after shall be executed by the contractor and test results shall be submitted to the Engineer for his written approval.

**6.3 Materials****6.3.1 Masonry brick**

Brick shall be locally available products conforming to D.S. 3921 or equivalent and be hard, well baked and shall have a uniform and sufficient compressive strength appropriate to the use. The shape of the bricks shall be rectangular. Brick used in foundation shall be misakhraj brick or equivalent.

**6.3.2 Concrete blocks**

All concrete blocks shall conform to ASTM C129, B.S 2028 or equivalent unless otherwise specified as follows:

- a. Concrete block shall be manufactured in accordance with the specification stated herein,
- b. block shall be manufactured of Portland cement and locally available aggregate by mixing and compacting using an electric machine,
- c. block shall be reasonably uniform in compressive strength and in all dimensions and shall be straight and free from cracks, chips or other defects.

Specification of the materials shall be in accordance with section ( 4\_2), " Concrete work "

**6.3.3 Joint mortar materials****a. cement**

cement shall be specified in section 4\_2\_1 ( concrete work)

**b. Sand**

Sand shall be clean sharp, coarse, well \_ graded and shall conform to ASTM C-144 ( Aggregate for Mrrary jortar ) or B»S. 1200 ( Building sand from Natural aourcec)

**c. additive**

water proofing additive shall conform to B.S 3826 or equivalent, other admixtures, such as a type which reduces early water loss from the masonry units and produces an expansion action in the plastic grout sufficient to off\_set initial shrinkage and promote bonding of the grout , may be used when approved by the Engineer.

**6.4 Workmanship**

**6.4.1** The contractor shall provide a masonry foreman who is thoroughly experience, competent and skilled in masonry construction .

The foremen shall personally supervise the mixing and placing of all mortar. Masonry reinforcing and anchoring must be done in strict accordance with the drawing and specifications.

**6.4.2 Scaffolding and Equipment**

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The contractor shall furnish, erect and maintain as long as necessary and remove when no longer required, safe and adequate scaffolding and other equipment required for the proper execution of the work. All equipment for the mixing, transportation and handling of mortar shall be clean and kept clear of set mortar, dirt or other foreign matter. Etoffaluiag or other objects shall not bump or rub against masonry.

#### **6.4.3 Mixing of joint Mortar**

a. Standard proportion of mortar mix for the joint of bricks and blocks shall be: cement to sand = 1:3, or as directed by the Engineer, sulphate resisting cement shall be used in mortars below damp proof course

b. Mixing

i. Mix mortar by mechanical mixer or by hand on a clean level board.

ii. mix thoroughly so that all individual constituents are incorporated evenly but do not over-mix mortars containing plasticizers.

iii. Keep mixer clean at all times.

iv. Use mortar within one hour of discharge from mixer at normal temperature. In no case shall mortar be used after the initial set has taken place. Reconstitution of mortar will not be permitted.

#### **6.4.4 Laying units**

All work shall be laid true to dimensions and be plumb, square in bond and properly anchored with vertical and horizontal straight joints that are in line, plumb, horizontal and true. Brick laying for protective lining for waterproofing membrane shall be laid in running bond with standard 2\_3mm joints horizontally and vertically. All surfaces of waterproof membrane to receive brick laying shall be thoroughly domed masonry mortar shall be spread over the entire surface of joints. Laying out of the bricks shall be arranged so that vertical joints are staggered. Half bricks or other shapes shall be used where required, All hollow block shall be laid cells vertical and with full mortar coverage on all top and side faces, horizontally and vertically. Cells of hollow blocks to be grouted with concrete or mortar are those carrying the horizontal and vertical reinforcement and also abutting cells, with or without reinforcing, cells of hollow block forming the corner, of entrances and doorways and cantilevered fins of walls and those so indicated on the drawings or so required by the Engineer.

In laying concrete solid blocks, pounding of corners and jambs after units have been set in position shall be avoided, where an adjustment must be made after the mortar has started to set, the mortar shall be removed and replaced with fresh mortar, corners of unfinished ends shall not be exposed, Bond all intersecting masonry walls together as indicated or as approved by the Engineer, When necessary to cut masonry units, preference must be given to the use of power equipment. Cutting shall be kept to a minimum.

A protective covering of mortar shall be formed around the reinforcing bars at a minimum depth of 20 mm, laying for brick work shall be as shown on the drawings. when it is not specified on the drawings, the contractor shall follow the instruction of the Engineer.

#### **6.4.5 Joints in brick and concrete block work.**

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Joints, both vertical and horizontal, shall be 1 cm thick and not staggered. Mortar shall be flushed with the correct tool where plaster is to be applied.

Joints of masonry units which will be exposed or painted, form a concave joint section.

Joints which are not to be visible in the finished work to be struck off with the trowel as the work proceeds.

Joints on the surfaces of fair-faced work shall be finished to provide a smooth surface flush with the brick and or block

face or a keyed joint of approved profile as the work proceeded

All holes in composed masonry shall be repaired, and the walls pointed. Defective joints shall be trowelled out and repointed with mortar.

## **7. ROOFING WORK**

### **7.1 Scope of work**

furnish all labour materials and equipment for the complete installation of roofing works with insulation as indicated on the drawing and specified herein.

### **7.2 Materials**

#### **7.2.1 Asphalt felt**

Asphalt felt shall be asphalt saturated felt conforming to the requirement either of 1313-1 D226, B,S 747 or Iraqi standard specifications-Felt shall be 3Pty Felt consisting of bituminous substance reinforced with fiber glass and two layers of building papers with fine aggregate,,

#### **7.2.2 Asphalt primer**

Asphalt primer shall conform to the requirements of ASTM D41 of local standards specifications using natural asphalt flux with petroleum asphalt, and let down with selected solvent, to produce maximum adhesion to prime surface and subsequently-applied coatings.

#### **7.2.3. mastic waterproofing material**

mastic water proofing materials shall be specific emulsion type mastic water proofing materials, such as flintkote or equivalent to be approved by the Engineer.

#### **7.2.4 Earth filling**

The materials used for roof earth fills should be free from lump, stones and of an approved quality. Filling materials should be free from foreign matter, such as, nymphs of insect, rubbish of any kind, gravel and soluble salts. Earth fills shall be compacted very well and shall be of 100mm average thickness to form the slopes to drain water.

#### **7.2.5 Precast concrete tiles**

The precast tiles shall be 300x800mm by 40mm thick and have a flexure strength

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not less than 600lb/in<sup>2</sup>, well vibrated smooth finish and shall be bedded directly on the clean earth filling that is laid to slope. The joints should be thoroughly cleaned and then carefully filled with approved mastic. The mastic should be applied with headed tools and pressure. A blow lamp is then run over the joint which is then smoothed with a heated jointing tool\*. For the skirting the size of precast tile shall be 150x150x100mm as a right angle shape, the vertical and horizontal joints for skirting shall be cleaned, primed and filled with mastic as described above.

### 7.2.6 Styropor

Styropor for insulation of the roof shall have a thickness of 40mm, with thermal conductivity at 90 F° as ( 0.2 BTu /FT-HR,F°)

## 7.3 Built \_ up Bituminous roofing system.

7.3.1 Hoofing system shall consist of the following layers:

- a. Asphalt primer ( not less than 0.3L/m<sup>2</sup> )
- b. Asphalt ( thickness must be not less than 12mm).
- c. Two layers 3Ply of asphalt felt.
- d. Insulation ( styropor)of 40 mm thickness
- e. Clean earth filling of 100mm average thickness
- f. Precast concrete tiles of 300 x 800 x 40mm and 20.0x150x80Qnra for skirting with mastic jointing.

7.3.2 All surface receiving built \_ up bituminous roofing must be clean free from dirt, dust, oil, grease, mortar spatter and other foreign matters and must be completely dried out before roofing is applied.

7.3.3 all sharp edge projecting from surface shall be chipped and ground smooth. All in - and - out corners and angles of deck and a butting walls or vertical surfaces shall be trowelled with cement mortar with radius of approximately 50mm.

7.3.4 First, asphalt primer apply a uniform coating of asphalt followed by layer of 3ply asphalt felt over entire roof and another layer in opposite direction. Each asphalt felt shall be laid free from wrinkles and buckles and lapped over preceding layer with a minimum length of 150mm.

7.3.5 Felt shall be applied to the vertical surface of parapet continuously from the horizontal surface if practical, or separate felt shall be applied over lapping a minimum of 200 mm with horizontal felt layers.

## 8. FINISHING WORKS

### 8.1 Scope of work

Furnish all labour, materials and equipment for the completion of work as shown on the drawing and specified herein,

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**8.2 Plastering Work****8.2.1 materials****8.2.1.1 Juss**

Juss shall be locally produced natural gypsup in Iraq, and shall be fresh, completely dry and well ground material and shall not leave residuals on 56 mesh/cm sieve, and shall be free from extraneous which may be affected by spontaneous slating. Juss shall be kept in a dry area, covered and protected from moisture, juss shall be the best grade obtainable from an approved source and complying with relevant Iraqi standards.

**8.2.1.2 Sand**

Sand for finish coats shall be clean and well graded from coarse fine as specified in concrete work

**8.2.1.3 Cement**

Cement shall be specified in section 4-2-1 (concrete work)

**8.2.2 Plastering accessories**

All plastering accessories shall be approved on samples by the Engineer before starting plastering work. Such accessories, including corner beads, casing beads, lath and other materials, shall be used where and necessary for workmanlike plastering work.

**8.2.3.1 Working environment**

Maintain uniform ventilation and a temperature of not lower than 5°C until plastered surface are dry.

Excessively rapid drying shall be prevented.

**8.2.3.2 Surface preparation**

Dust, Oil, grease and other undesirable substances that might hinder the forming of a good bond with plaster bases on concrete or masonry shall be removed immediately prior to plastering.

**8.2.3.3 Moistening underbed**

Immediately before applying plastering work, brick and concrete surfaces shall be wet-down sufficiently to reduce suction but shall not be excessively wet.

**8.2.4 Application**

All plastering shall be executed in a workmanlike manner leaving all finished plaster surfaces free from waves or imperfections.

**8.2.4.1 Nixing**

Plaster materials shall be thoroughly mixed with the correct amount of water, in accordance with the specific requirements of the work,

**8.2.4.2 Number of coatings**

All work shall be not less than two-coats.

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**8.2.4.3 Standard mixing proportions**

portland cement plaster on walls

- a. First coat : 1 part portland cement, 2.5 parts sand by volume.
- b. Finish coat : 1 part portland cement, 3 parts sand by volume.

**8.2.4.4 Grouting**

permeiers of door and window frames, pipes and ducts shall be grouted with cement mortar of part of cement and 3 parts sand by volume.

**8.2.5 Juss Plaster**

Juss plaster shall be mixed and applied in accordance with local practice . Juss plaster shall be plastered in 2 coats, each coast shall not exceed 15mm thickness. Metal lath shall be used at all corners and angles and stops.

**8.2.6 Cement mortar plastering**

All plastering shall be done in two coats. The first coat shall be applied as thinly as possible and in a manner obtaining plan faces, with all angles arrises and reveals perfectly plumb and square. This coat should be well scratched to provide a key for the final coat. After completion, the plaster shall be cured for at least 24 hours by being continuously wet.

**8.3 Terrazzo****8.3.1 Materials**

The terrazzo tile shall be machine made tile, composed of natural aggregate of potland cement and marble chips, formed by hydraulic press. Terrazzo floor tile shall be 300\*300\*25mm thick and of selected colour and pattern and it shall be complete with all necessary special shapes and corners.

Cement motar for setting the floor tile shall be approximately 25mm thick and shall be composed of 1 part Portland cement and 3 parts sand by volum. Grout for terrazzo tile floor joint consist of 1 part white cement and 2 parts clean sharp sand by volume and the width shall be 5mm .

**8.3.2 Installation**

The concrete floor shall be dry, firm, clean, free of grease or wax, proper adhesion shall" ber assured between the mortar and all tiles and the finished floor surfaces shall be smooth.

Joints shall be arranged at regular intervals with due consideration to the axis of the room, joint filling shall be executed so as not to leave any unfavorable space . All joints shall be closed joints. No traffic of any kind or any shook shall be permitted during the 48 hours following installation of the tiles. Mortar and grout on the tile surfaces shall be cleaned away. Tiles that are cracked or show broken corners shall be removed and replaced with sound tiles at the contractor's expense.

**8.4 In situe cast Terrazzo**

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**8.4.1 Materials****8.4.1.1 Cement**

Portland cement shall be type 1, white cement shall be used for the surface layer of the terrazzo, the balance of the balance of the cement shall be gray colored.

**8.4.1.2 aggregate**

marble aggregates shall be crushed marble, hard and round, not flaky, free from dust or other impurities.

sizes of marble aggregates shall be as follows .

- i. All particles shall pass through a 24mm sieve
- ii. 40% to 60% of the particles shall pass through a 12mm sieve.
- iii. No particle shall pass through a 6mm sieve

Dividing strip or edging strips shall be of brass not less than 4.5mm thick and 12mm high. Brass shall conform with DS 2074 or Other equivalent standards.

**8.4.1.4** Pig ment shall be a lime - proof, non – fading mineral pigment the same as the pigment used in Engineer approved samples and shall comply with BS 1014 or other equivalent standards.

**8.4.2 Workmanship****8.4.2.1 Working environment**

- i. In case of cold weather all precaution shall be exercised to avoid adverse weather, such as ambient temperature below 48 .
- ii. In case of hot weather, ensure that full compaction is not premature stiffening or drying out of mix after compaction, not prevent excessively quick drying out.
- iii. In case of wet weather, protect terrazzo work from rain or snow.

**8.4.2.2. Surface preparation**

surface to receive terrazzo shall be thoroughly cleaned free from dust, dirt , oil and other deleterious items.

**8.4.2.3 13ond Breaker**

polyethylene sheet having a minimum 0.08mm thickness with minimum lapping 150mm shall be laid for separation over entire underbed surfaces

**8.4.2.4 Dividing or edging strips**

Dividing or edging brass strips shall be fixed in a minimum 7000x7000mm grid with metal anchor and mortar according to layout plans, underneath each brass strip, a wooden dividing strip shall be added to complete the joining.

**8.4.2.5 unbonded cement screed**

mortar for unbonded shall be 1 part cement and 3 parts sand by volume with the least amount of water required. Lay screed in two courses on hand breaker layer. The lower course shall be thicker than the upper and placed to the level about 15mm lower than the top of brass dividing strips. The top the undered shall be slightly lower

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along dividing strips in order to have slightly thicker finishing course.

### **8.5 Flooring of marble and Granite**

All marbles and granites must be carefully selected from the best quarry beds, and utmost care must be exercised to ensure that the maximum amount of adjacent marble matches accurately. All stone shall be free from cracks, holes, scratches and other blemishes. No stooping will be allowed.

All stones shall be free from cracks, holes, scratches and other blemishes. All stones shall be of the highest quality, durable with resistance to atmospheric agents and shall pass, all the strength test ( Compressive strength ) and shall have adequate tensile strength.

The contractor will be required immediately to produce representative samples of all the stones intended to be supplied for the employer's representative's approval, and the whole of the supply shall correspond with the approved samples. No other quality of stone will be accepted and the contractor will be required to guarantee that the qualities will comply in all respect with specification and the samples approved by the employer's representative.

Mocked up sample panels of stone work to indicate the range of color and texture . matching of vein, workmanship, etc. shall also presented for the approval of the Employer's representative.

All stonework is to be accurately worked, deadsquare and ture and accurately placed in the definite position with due respect to levels, alignments and verticality and perfectly jointed and fitted against adjoining members . All visible edges will have to be rectified and gauged with a maximum tolerance of 0,5mm on the gauging thickness ( and shall be finished to the same degree of that of adjoining finished surfaces of trfcone). And <sup>+</sup> ;\_1.5mm in the thickness of slab in general. The tolerance allowed in the cut of the slab, for out of joint and precision of size and squareness shall not exceed 0.5m per 500mm.

All Exposed faces of marble are to be finished to the degree indicated on drawings and described thereon. The whole of the work will be inspected at the factory during working and upon arrival at the site and the Employer's representative will reject any material or workmanship which does not conform to the conditions and will require replacment to be made at the contractor's expense.

### **8.6 Quarry tiles**

Quarry tile shall be unglazed semi - vitreous tile made from natural clay conforming to BS 1236 or other relevent standards in terms of water absorption, resistance to abrasion and chemical attack, flexural strength and so forth.

Size of tile shall be 90 \* 90 \* 10 mm thickness and bottom surface shall have grooved Keys to increase bonding to underbed three different colours shall be selected subject to the approval of the Engineer,

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**8.7 Sportflooring****8.7.1 Description of work**

Furnish and install Sportflooring and accessories as specified herein, shown on the drawings, and retired by the Engineer.

**8.7.2 Quality Assurance**

- a. Supplier shall be an established firm, experienced in the field.
- b. The installer shall have completed at least three projects of similar magnitude and complexity,
- c. Level flooring to a tolerance of  $\pm 3$  mm from the true plane

**8.7.3 Submittals**

- a. Submit manufacturer's recommendations for the correct preparation, finishing and testing of concrete subfloor surface to receive the sportflooring.
- b. Submit manufacturer's specifications for installation handling, protection and jointance.
- c. Submit 3 sets of samples of each type, color, and finish of flooring and accessory required. Sample submittals will be reviewed for color, texture and pattern only.

**8.7.4 Delivery, storage and Handling**

protect flooring materials and accessories from any kind of damages during delivery, storage and handling. store in a dry place with adequate air circulation. Do not deliver flooring materials to building until all masonry, painting, plastering, tile work, overhead mechanical work, and lighting are completed.

**8.7.5 Job conditions**

- a. Keep the areas which receive flooring to the temperature required by the manufacturer's instructions for at least 48 hours prior to installation.

Maintain this temperature during and after installation as recommended by flooring manufacturer,

- b. Do not install floor system until concrete has been cured for (30) days and other requirements are obtained as specified.

**8.7.6 Materials****8.7.6.1 General**

- a. Uniform in thickness and size.
- b. Edges cut accurately and square.
- c. Uniform color.

**8.7.6.2 Sport flooring Materials**

Shall be monoflex or indoor flex or any other equal quality approved by the Engineer. The length and width determined by dimensions of area to be installed and

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as approved by the Engineer. The physical properties shall be as follow:

Color stability ---- good,

abrasion resistance ---- excellent,

resistance to cigarette ---- burns

sound isolation ---- maximum acoustic absorption.

**8.7.6.3** Adhesives materials as recommended by the flooring manufacturer to suit flooring materials and substrate conditions. No substitutions.

**8.7.6.4** Game line paint shall be compatible with the floor finish surface and the same color required by the game and as approved by the Engineer.

### **8.7.7 Execution**

#### **8.7.7.1 inspection**

Examine the areas and conditions under which the flooring work is shown to be installed and remedy any conditions detrimental to the proper and timely completion of the work.

Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable for installation.

#### **8.7.7.2 Preparation**

Prior to laying flooring, broom, clean or vacuum surfaces to be covered and inspect sub floor. Use leveling compound as recommended by the flooring manufacturer for filling small cracks and depressions in sub floors. Start of flooring installation indicates acceptance of sub floor conditions and full responsibility for completed work,

#### **8.7.7.3 Installation and finishing**

##### **a. Flooring surface**

1. Unroll, perfectly fit, cut and leave unrolled to relax.

2. Apply adhesive materials according to manufacturers directions. Use 3mm notched trowel to spread adhesive. Do not soil walls or adjacent areas with adhesives.

3. Unroll into freshly applied adhesive.

End seams shall be single cut, edge seams overlapped, then snapped into place to insure tight seam, The flooring shall be laid tight, even and straight,

4. Roll the entire surface with medium-size roller to remove any entrapped air.

Wipe away any adhesive that oozes between seams.

5. All seams shall be weighted in place.

Leave weight in place a minimum of twelve(12) hours.

b. Game line painting shall be done as specified by the manufacturer of the sport flooring.

Protect all the lines with plastic plates and make sure of avoiding any damages to

them,

- c. Finishing shall be in accordance with manufacturer current procedure, using approved materials.
- d. After sportflooring surface is installed and game lines painted , area is to be kept locked by contractor to allow curing time for paint and adhesive. No other trades are to be allowed on the floor until it is accepted by the Engineer.
- e. Clean up all unused materials and debris and remove same from the premises.

## **8.8 Ceramic tile**

### **8.8.1 Materials**

Glazed ceramic wall tile shall be square edge, matte finish, glazed natural clay tile . Tile shall be free from defects which affect appearance or serviceability , will not be acceptable.

Tile shall be free from a dark spots over 0-16mm ( interior or 0.3mm exterior) in diameter, fractures in the glaze, heavy accumulations of glaze , spots in sufficiently glazed , frosted crystalline appearance and rough spots, ceramic tile shall be first quality, size the drawing.

### **8.8.2 Installation**

a. Apply setting beds for tile directly to moistened concrete, concrete block, Portland cement plaster other bases, setting beds shall be composed by volume of one part Portland cement, to one half part hydrated lime to four parts dry sand, mixed with minimum amount of water necessary to produce a workable mass. Apply in sufficient quantity and with sufficient pressure to cover well the entire area and form a good key. Bring out flush with temporary screeds or guide strips so placed as to give a true, even surface at the proper distance from the finished face of tile. Setting beds shall not less than 1.25cm nor more than 1- 9cm thick.

b. Joints shall be straight, level, perpendicular, and of even width. Vertical joints shall be maintained plumb for the entire height of the tile work. Tile where called for on the drawings shall have staggered joints as shown.

Each tile shall be brought to a true level plane surface by uniformly applied pressure under a straightedge , Tiles that are improperly placed shall be removed and reset. Damaged or defective tile shall be replaced.

c. Before setting, tile shall be thoroughly soaked in clean water and drained so that no free moisture remains on the back of tile . Wall tile shall be set by trowelling a skin coat of neat portland cement on the setting bed or by applying a skin coat to the back of each tile unit and immediately floating the tile in to place. All tile special shapes, and trim pieces shall be solidly backed with mortar.

d. Grouting : Immediately after a suitable area of tile has set, grout joints full with plastic mix of neat, white Portland cement. If desired, the contractor may add fine, white grouting sand up to an amount equal in volume to the portland cement.

Wet joints before application of the grout. Force maximum grout in the joints by

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squeegee, brush or finger application. Tool joints slightly concave to the edge of the cushion, and wipe excess grout from face of tile, Allow no mortar from setting bed to show through the grout . Immediately roughen the replace grout at any depressions that appear along the face of pouted joint once the surface has been cleaned.

e. Cleaning : After grout is thoroughly set, sponge and wash tile thoroughly, diagonally across joints, and polish with clean, dry cloths.

Acid cleaners not allowed.

f. Curing : Keep joints continuously damp for a period of at least 72 hours after applying grout.

## **8.9 Glazed tile**

### **8.9.1 Material**

Glazed wall tile shall be used for; the interior surfaces of toilets, and be square in shape of 150x150mm and white colour.

### **8.9.2 Installation**

The Installation of glazed tile shall be accordance with section (8-8-2)

## **8.10 Suspended Ceilings**

The Mechanical suspension system should be of an approved type. The suspension system should be of type that will be installed by direct suspension from the structural ceiling by hangers. Hangers should be at intervals as shown on drawing and. they should be not smaller than 10mm mild steel rods.

All steel members of the suspension system should be painted .

The mechanical suspension system should be of an approved exposed grid system  
The exposed suspension member shall be in width and installed as shown on the drawings.

The suspended ceilings shall be made of ribbed metal lath designed for interior one side plastering. The metal lath should have an approved pattern and should be of email mesh that ensure good bend with the plaster and should be rigid and do not show any signs of sagging or bending when the

plaster is applied . Metal lath sheets should be lapped sufficiently. Prior to plastering the metal lath the whole surface of the lath should be treated with (1:1) cement sand slurry to form a complete coat under plaster, Whomever " Tile suspended ceiling" or " Acoustic Tile suspended ceiling" are specified on Drawings.or in the Bill of Quantities then the tiles that shall be used should be Termiteproof, Rot proof, odourless, durable, not sustaining vermin and of type approved by the Engineer, prior to delivery tile samples should

be submitted to the Engineer for approval. All tiles should comply with the requirements indicated on drawings and shall have a minimum thickness of 12mm . Tile should have dimensions approved by the Engineer.

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All the ceiling materials should be handled by experienced workers. False ceiling should be fixed horizontally at the indicated elevations.

The method of fixing the suspended ceilings should be according to the requirements of this specification and as shown on the drawings that will be furnished by the contractor with his bid.

## **8.11 Painting work**

### **8.11.1 Description of work**

This specification section covers the surface preparation, material, manufacture, delivery and application of painting.

All paints shall be of the first quality and/or standard products of reputable manufacturers.

### **8.11.2 Surface preparation**

a. Surface preparation for concrete, mortar and plaster unless otherwise specifically instructed in the specifications, the following procedures for preparation shall be adopted.

i. Surface shall be sufficiently dried before painting

ii. Dirt, dust and foreign matter shall be removed with care not to damage the surface.

iii. Interior mortar and plaster surfaces shall first be painted with emulsion sealer and then putty shall be applied to remedy the irregularities of surfaces, such as hair cracks, minute holes, etc. and immediately after application, excessive putty shall be skimmed off with a wooden or iron spatula, when the putty dries, the puttied surfaces shall be sanded with sandpaper prior to a paint application

IV. Exterior mortar surfaces shall first receive cement filler or the like with brush or their hair cracks minute holes, etc. Then the remedied surfaces shall be sanded with sandpaper followed by applications of solvent based sealer or that approved by the Engineer

V. Regarding the exterior concrete, major irregularities of the surfaces shall be corrected by filling the crevices, holes, etc. with cement filler or the like. The filler shall be applied with wooden or iron spatula as smoothly as possible. When the filler dries, solvent based sealer or that approved by the Engineer shall be applied before painting.

b. Surface preparation for wood

i. Wooden naps, dirt and foreign matter shall be removed by sandpaper with care not to damage the material.

ii. Gum shall be burnt by an electric heating coil or pared with wiped off with solvents.

iii. Knots shall then be sealed with two coats of shellac varnish.

IV. For opaque finishing, cracks, holes, crevices, cavities, etc. shall be filled with oil putty.

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V. For transparent finishing, wood grains shall be filled with polishing powder kneaded with boiled oil and solvent, preferred, or water.

Vi. In order to ensure smooth surfaces, all surfaces puttied and once filled with polishing powder shall be sanded with sandpaper.

c. Surface preparation for steel.

i. Oil and grease shall be wiped off with solvents,

ii. After blasting or cleaning with a power tool, dust on the surface shall be blown off with an air-blower.

d. Surface preparation for galvanized iron.

i. Oil and grease shall be wiped off with solvent.

ii. White rust shall be sanded off with sandpaper.

### 8.11.3 Materials

paints shall be factory manufactured and delivered to the job in unbroken container's which shall show the designated name, formula, color, Manufacturer's directions and name of manufacturer, all of which shall be plainly legible at the time of the use, the following paints, which conform to B.S specifications or their equivalent shall be used,

a. Oil paint ( on wood and metal surfaces) oil paint shall stand for long oil base alkyd paint for undercoat and finish coat conforming to B,S 2524 or equivalent standards,

b. Gloss emulsion paint ( on interior walls) Gloss emulsion paint shall stand for comparatively gloss rich vinyl emulsion paint.

c. Oil stain clear lacquer ( on wood )

Oil stain clear lacquer shall stand for acrylic resin type clear lacquer finish combined with colour.

d. Polyurethane clear lacquer ( on wood )

Polyurethane clear lacquer shall stand for Polyurethane resin type clear lacquer finish combined with colour toner.

### 9.11.4 General rules

a. Inflammable paints shall be in an independent, isolated and well ventilated place and sheltered avoiding direct sunlight.

b. painting places shall be ensured of good ventilation to avoid poisoning by solvents as well as prevent to fire.

c. Special attention shall be paid to the preventing of fire.

Hazards fire shall be kept off from the painting places and paint stores to prevent occurrences of explosion, fire, etc, cloths and / or rugs used for wiping or soaked with paint may have a danger of spontaneous combustion, therefore, such materials shall be immediately disposed of.

d. Painting work shall be suspended under the following circumstances:

i. At Atmospheric temperature is below 5C° and relative humidity is more than

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80%.

- ii. During snow, rain, strong wind or days expected of such weather conditions.
  - iii. Untidy conditions of work where good work cannot be expected.
  - V. Painted surfaces can be damaged or hindered by other works.
  - Vi. Ventilation is not sufficient enough that proper drying of paint can be ensured.
- e. The proper application method shall be employed to meet nature of the paint, and paint applications shall be done evenly so as not to leave blemishes, saggings, runnings, wrinkles, bubbles, ect.
- f. paint for finish coating shall be, as a rule, prepared for special color and luster effects which shall be subject to approval of the Engineer.
- Color sample, color plates, ect, shall be submitted to him.
- g. Paint shall be delivered to the site sealed.
- h. Paint shall be in general, used as it is, however depending on the roughness / fineness of the surface, degree of absorption, atmospheric temperature, ect, it may be adjusted by use of thinner or solvent to ensure proper painting.
- i. Painted surfaces shall be well protected from contamination and damage until they are thoroughly dry and floors and other surfaces adjacent to areas to be painted shall be properly or protected otherwise from stains before painting work commences
- j. After blast or power tool cleaning of steel surfaces, primer shall be applied as soon as possible in order to avoid growth of rust.
- k. Manufacturer's instructions shall be strictly observed to ensure proper and good painting work.

## **9. METAL WORK**

### **Scope of Work**

Furnish all labour, material and equipment for complete erection of miscall metal work as shown on the drawings, specified herein and as evidently necessary to complete the work. All supplemental parts necessary to complete the work shall be included whether or not such parts are definitely shown or specified .

#### **9.1 Work includes, though is not limited, the followings:**

##### **9.1.1. Aluminum items such as:**

- a. Aluminum windows and frames.
- b. Aluminum doors and frames.
- c. Aluminum screens with doors.
- d. Expansion joint covers.

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**9.1.2 Steel items such**

- a. Steel floors and frames aixafcetwi .
- b. Hand railing

**9.2 Submittals**

The contractor shall submit the following to the Engineer for his written approval before starting the metalwork.

**9.2.1 Manufacturer**

Names and official addresses of the manufactures of the miscellaneous metal items with technical brochures there of for approval.

**9.2.2 Samples**

Samples of metal items in appropriate sizes to show materials, finishes, construction, etc. The contractor when he has submitted the actual piece as a sample.

**9.2.3 Test reports and certificates**

The contractor shall submit to the Engineer for his written approval, all test reports and certificates at the contractor's expense when so required by the Engineer.

**9.2.4 Spares and tools**

Such metal items which the contractor may recommend for maintenance purposes after acceptance of the building shall be listed with prices for each item, so that the owner may purchase all or any quantity of such, at his discretion and expense.

**9.3 Materials****9.3.1 General**

The basic materials to be used for the material work shall conform to following standards or other equivalent standards.

- B.S 4 : 1972 part 1 (( Hot Rolled sections ))
- B.S 4 : 1969 part 2 (( Hot Tolloed Hollow sections ))
- B.S 1940 : 1971 part 1 (( wrough steel pipe fittings ))
- B.S 4360 : 1972 (( Weldable structural steel ))
- B.S 729 : 1971 (( Hot dip galvanized coatings on iron and steel articles))
- B.S 1449 : 1956 (( steel plate, sheets and strips ))
- B.S 1970 : 1972 (( wrough aluminum and aluminum purposes plate steel and strip ))
- B.S 1161 : 1977 (( Aluminum alloy section for structural purposes ))

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B.S	1474	: 1972	(( wrought aluminum and aluminum alloy for general engineer purposes, bars, extruded round tubes and sections ))
B.S	1471		(( wrought aluminum and aluminum for general engineering purposes forging stock and forging))
B.S	1475		(( wrought aluminum and aluminum for general engineering purposes - wrie ))
B.S	1475		(( Anodic oxidation coating on aluminum ))

### 9.3.2 Aluminum

Aluminum for ornamental or miscall shall be corrosion resistant aluminum alloy and meet the requirements for B.S or other engineer approved standerd.

### 9.3.3 Steel

Steel for metal item shall be new, low carbon mild steel and shall meet the requirements of ASTM 36 or other standards applicable for the designated purposes.

### 9.3.4 Steel Tubing

Steel tubing shall be carbon steel for general structural purposes containing not more than 0.05% sulphur, manufactured by hot rolling or seam welding having heavy walls and rounded corners.

### 9.3.5 Stainless steel

Stainless steel for ornamental or miscall metal shall conform to the B.S standards and other equivalent standards

## 9.4 Products

### 9.4.1 General

- a. Refor to all relevant drawings and the doors and windows schedules for types, materials, locations, dimensions, operations, details and quantities of all metal doors, windows, louvres, and frames.
- b. All members shall be straighr or correctly curved, free from warp or distortion
- c. Anchors shall be provided along the frame at intervals not more than the specified distances so as to rigidly fix all metal doors, windows and louvres
- d, All metal surfaces shall be given corrosion protection treatment, expect, where embedded in concrete such treatment shall be galvanizing bonderizing or rust paint coating given after completely cleaning of rust and losse scale, and shall be of a type, worir and in colors suitable to the subsequent application of finish paint.
- e. Connection of all members shall be rigidly fixed and ground smooth where exposed.
- f. The doors, windows, louvres and relevant frames shall be stiffened internally to resist wind, self weight and operations and to rigidly accommodate finish hardware .

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g. All steel louvres, including exterior louvers and door louvers, shall be stationary unless otherwise indicated or specified and shall be provided with bird screen on rear side drawings.

#### **9.4.2 Aluminium**

a. Aluminium doors and screen shall comprise framing members transition member st ancors, aaaptors mountings, They shall be cut to size and shall be prepared for joints after corrections have been made for removing stress,

b. All screws, miscellaneous fastening devices and aluminium alloy or corrosion resistant materials of sufficient strength to perform the functions for which they are used.

#### **9.4.3 Aluminium**

a. Aluminum windows shall be designed to perform the functions for which they are required.

shall be securely attached to the window section,

b. All exposed screws shall be stainless steel or aluminum, concealed screws and fixing devices shall be aluminum or Kino plated.

c. There shall be no aluminium contact between aluminium members which are required to slide against one another, to avoid excessive wear.

#### **9.4.4 Steel doors and frames a. Shop a. Shop fabrication**

profiled steel door frames and flush doors shall be supplied completely. Namely t door height or ceiling height frames shall be supplied complete with hinges | lock strike, rubber shock absorbers basseties and fixing lugs.

Ready for building without any further cutting, Doors shall be mortised drilled and prepared for iron mongeny at the and shall be complete with hinges, handles or standard pattern lock set.

The faces shall be free from seams and joints. Flush doors shall be available in either single or duoble leaf sets. Door frames shall be thoroughly cleaned, treated and coated against corrosion as specified in the item (9-4-1 )

**9.4.5** Weather stripping, impact absorbers and air-tight strips weather stripping impact a bosorbers and air-tight strips shall be materials compatible with aluminium and other metal with which it comes in contact, without promoting corrosion and with sufficient resistance against deterioration by all weathering factors.

All profiles shall be in accordance with drawings and as required.

#### **9.4.5 Flyscreens and birdscreens**

a. All open lights of the windows shall have having 18 wires per inch.

b. All exterior steel louvres shall have birdscreens, having 4x2mm steelwires per inch,

c. Frames to fasten the screens shall be as shown on the drawings and shall Jiave sufficient regidity to prvctont sagging of the screens.

## **9.5 Steel handrails**

steel handrail shall be installed at various stairs and made of steel frame.

### **9.5.1 Materials**

Steel handrail shall be of pipes which conform to B.S, size shall be in accordance with that indicated in the drawings, and it shall be finished with paint

### **9.5.2 Installation**

Steel handrail shall be factory - welded as a rule. welding operators shall be ones who are well-skilled and experienced and have sufficient knowledge of the work, in case embedded anchors are used for anchoring the material, they shall three times more resistance against expected pressure.

Joints between the handrail and bulusters shall be welded . cut sections shall be covered with same materials used for the handrail by weldt.

## **9.6 Delivery, Storage and Handling**

All metal door, window and louvre materials shall be delivered to the job site and stored under protection against damage including scratches, bents, warps, corrosion, etc. and against moisture and contamination.

## **9.7 Installation**

**9.7.1** Metal doors, windows and louvres shall be set plumb square level and in exact alignment with surrounding work to the supporting structure by tight and rigid anchoring and grouting methods, as shown on drawings.

**9.7.2** All joints between interior metal and structure and between interior glass framing and mullion members shall be air-tightly fixed.

All materials shall be screwed in place using blocking, masonry plugs or anchor straps as required, where mouldings are jointed, they shall be accurately cut and fitted to result in a tightly closed joint.

**9.7.3** Installation of door , window and louvre frames shall be done in the following manner.

The frame shall be temporarily fixed in the proximity of the true location by supporting with temporary wooden wedges provided between the frame and the surrounding structure. The frame shall be positioned to the true level plumb and correct position by adjusting the wedges precisely .

Anchors shall be welded to the projecting steel from the surrounding structure so that the frame will not move 1:3 cement mortar shall be grouted tightly around the anchor followed with grouting of all spaces between the frame and surrounding structure. The wedge shall be removed after the grouting has set,

## **9.8 Protection and cleaning**

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**9.8.1** After installation all metal door, window and louvre work shall be cleaned carefully until the building is accepted by the Engineer,

**9.8.2** Solvent harmful to metal and finish of door, window and louvre work shall not be used for cleaning.

## **10. WOOD WORK**

### **10.1 Description of work**

Furnish and install wood doors according to the specifications listed herein, shown on the Drawings, and needed for a complete and proper installation.

Provide hardware and louvers for wood doors as specified under this section.

### **10.2 Submittals**

#### **10.2.1 Product Data**

a. Name and official address of wooden doors manufacturer shall be submitted to the Engineer for written approval before starting wooden floor.

b. Submit a copy of door manufacturer's specifications or product data which may show compliance with specified requirements.

c. Details of core and edge construction for each type of door.

d. Details of louvers and trim for openings in doors.

e. Location and extent of hardware blocking,

#### **10.2.2 Samples**

samples submitted will be reviewed for color and texture on 3y. Compliance with other requirements is the exclusive responsibility of the contractor. Submit samples for the following:

a. Cut - out sample of doors materials, core stile, rail, and finish of surface veneer.

b. Submit one sample of each exposed hardware unit if required by the Engineer. The remaining undamaged samples will be returned to the supplier after final check.

### **10.3 General Requirements**

a. Exposed face Materials: Provide same material on both faces of individual doors, unless otherwise indicated,

b. Transom and side panels: Wherever panels are retrofitted in same framing systems as wood doors, provide panels which match quality and appearance of associated wood doors in all respects, Imbricate matching panels with same construction, veneers and finish as specified for associated doors,

c. Openings : Light - opening shall be factory cut openings. Louvers shall be provided of type, size and profile to comply with the applicable requirements of the referenced standards for (s) of door required and as shown on the drawings and approved by the

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Engineer.

**10.3.1 Katorials**

a. Provide door construction for complying with referenced standards and as approved by the Engineer,

Core construction shall be of solid wood-block,

Face veneers shall comply with premium Grade and of the species and cut indicated .

i. All plywood facing shall conform to B.S. 3449, or other equivalent standards. The adhesive shall be of synthetic resin and of type suitable for designated use. Both faces shall be free from knots, overlaps, patches and all open defects, Both faces shall be suitably smooth for painting,

ii. All hardwood facing shall be sound, properly seasoned and free from sapwood , beetle infection or from any defect rendering it unsuitable for the purpose for which it is intended. The selected hardwood shall be Teak or approved equivalent .

b. Adhesives shall be type 1 waterproof bond.

c. Furnish all finish hardware with all necessary screws, bolts and any other fasteners of suitable size and type required in this section.

d. All units of each kind of hardware ( latch and lock sets, bill t closers,.... etc) shall be obtained from only one manufacturer which shall be of the best type and complies with the requirements of the door and door frame and approved by the Engineer.

e. Kick plates shall be gauge 10-0 Stainless steel. edges are to be beveled on three sides,

f. Provide matching finishes for all hardware units at each door or opening to the greatest extent possible.

**10.3.3 Prefitting and preparation for Hardware**

Pre-fit and pre-machine all wood doors at the factory. Comply with tolerance requirements for pre-fitting, Machine doors for all hardware requiring cutting of doors. Reinforce doors and frames for all finish hardware items,

**10.4 Execution****10.4.1 Inspection**

Examine floor frames and verify that frames are of the correct type and have been installed as required for proper hanging of corresponding doors. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to the installer,

**10.4.2 Installation**

a. Set doors level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation. Clearances shall be 3mm at Jamb and heads and 13mm from bottom of door to top of decorative floor finish or covering,

b, Hinges shall be located as follows :

i. Top Hinges: not over 290 mm from inside of frame rabbet at head to centre line of Mngc,

ii, Bottom Hinge : not over 330 mm above bottom of door frame to centre line of hinge.

iii. Center Hinge: Midway between top and bottom hinges,

c. Hardware units shall be installed as required by the manufacturer's instruction. Except as indicated or specified otherwise, use fasteners furnished with hardware to fasten hardware in place. Fasten hardware to wood surface with full- threaded wood screws or sheet metal screws. Use machine screws set in expansion shields for fastening hardware to solid concrete and masonry surfaces

d, For surfaces are later to be finished or painted, install each surface mounted items completely and then removed during- the finish application, after which re-install each item back to place.

#### **10.4.3 Quality control**

When required by the Engineer , cut apart one or two doors selected by random to determine compliance with the specified requirements, Evidence of non - compliance will result in rejection of the Acceptance doors so tested shall be replaced at the expense of the Owner,

#### **10.5 Delivery and storage**

a. Protect wood doors during transit , storage and handling to prevent any damages or deterioration. In

b.Coordinate delivery of wood doors to comply with the requirements of the painting sections.

c. Doors shall be stored out of the way of work in progress and not exposed to extreme changes of temperature,

d. Adjust and check each operating items of hardware and each door to ensure proper operation. Doors or hardware units damaged before acceptance of the work shall be refinish or replaced and as directed by the Engineer.

e. Clean and inspect operating items as necessary to proper function and finish of doors and hardware.

### **11. PAVEMENT WORK**

#### **11.1 Description of Work**

Furnish and install cement concrete pavement conforming to the requirements shown on the -Drawings, specified herein, or required by the Engineer.

#### **11.2 Quality Assurance**

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work shall conform to AASHTO " American Association of state Highway and Transportation officials " requirements and any approved standards ,

**11.3 Related Iforic Described Elsewhere :**

- a. Excavation f filling, and grading
- b. Cost-in- place concrete
- c. Precast concrete

**11.4 Materials****11.4.1 General**

All materials used in this section shall be supplied from the sources satisfying the requirements given, here inf or elesswhere in this specifications and approved by the Engineer,

**11.4.2 Sub- Base Course Aggregate**

Provide a mixture of sand-gravel subbase of thickness specified on the Drawings complying with AASHTO T-27 and with modified CBE value of r.ot less than 20 when tested at 95% density of maximum dry density at optimum moisture ontent. The materials should be free from lumps or balls of clay , vegetable matter , objectionable coatings, or other foreign material-

The souroe of the materials to be Bead for. producing the sub-base aggregate shall be selected Tifell in advance of the tine they will be required in the work. The portion of material passing 0.4 ram screen shall have plasticity index ASTM DH24 of not more than 6 and liquid linitl ASTM DH23, of not more than 25 or as required by AASHTO T89-68 . The materials shall be obtained from one source which satisfying the requirements and approved by the Engineer.

Grading requirments shall comply with the sieve anaylsis given by AASHTO T-27 Type B, This gmdation represent the limit which shall determine suitability of aggregate and sources of supply. The final gradations decided on shall be well graded from coarse to fine ( as designated in the AASHT- T-27) and shall not very from the low limit on one sieve to theKigh limit on the adajacent sieves, or vice versa.

The materials shall be compacted to a density of not less then 95% of maximum dry density at opimum moisture as determined in accocdance with AASHTO T180 method " D". Approved materials for subbase shall be stock piled in the manner and at the locations designated by the Engineer, Materials obtained from different sources , Shall be stockpiled separately,

**11.4.2 Concrete Materials**

- a. Ordinary Protland Cement

The cement used shall conform to ASTM C150, AASHTO M85-74, or complying in all respect with B.S.12:1971 . The contractor shall provide appropriate dry , weather - proof sheds of sufficient capacity to store cement. The cement shall be used as soon as possible after delivery. Any cement that

has been stored for a period exceeding 3 months shall not be used until it has been tested for suitability.

Any deteriorated cement shall not be used for concrete

b. Fine Aggregate Fine aggregate shall be moderately sharp and free from soft particles, clay, shell, loam or any other deleterious materials. The soluble sulphate ( S03) content shall not exceed 0.5% when tested in accordance with B.S 1377 test No. 10. The amount of sulphate ( S03) in the concrete mass shall not exceed 4.5 % of weight of

Cement in the total concrete mass .

The sand shall comply with the following grading when tested in accordance with AASHTO T27- 74 or ASTM 33.

Sieve Size mm	Imperial	% Passing by Weight
9.5	3/8 in	100
4.75	No. 4	95 - 100
1.10	No. 16	45-80
0.30	No. 50	12-30
0.15	No, 100	2- 10
0.075	No. 200	0 -30

The grading from any source shall be reasonably uniform and not subject to the extreme percentages of grading specified above . The contractor shall execute a quality test on fine aggregate and each aggregate source , and the results shall be submitted to the Engineer for approval.

c. Coarse Aggregate

Coarse aggregate shall consist of either natural gravel, or crushed stone or crushed gravel. All coarse aggregate shall be produced, stockpiled and batched as a single-sized material complying with the grading limits of ASTM C33 or AASHTO ( T27 -74) . For convenience the ASTM C33 are produced as follows:

Sieve Size mm	Imperial	% Passing lty weight
50	2 in	100
37.5	1 $\frac{1}{2}$ in	90 -100
19,0	$\frac{3}{4}$ in	35 -70
9.5	$\frac{3}{8}$ in	10 -30
4.75	No.4	0-5

The aggregate shall be composed of sound, tough, durable particles free from clay balls, organic matter, and other deleterious materials , The aggregate shall not contain more than 8% by weight of flat or elongated pieces. Other physical requirements of the coarse aggregate shall be within the limits given below:

Physical Property		Maximum Permissible Limits (% by weight)
1	Soluble sulphate content $Sr_3$ ( B.S 1377, Test Ho. 10)	0.5
2	Sodium sulphate soundness ( AASII TO T104 -74	12
3	Wear L.A. Abrasion (AASHTO T96-74)	40
4	Friable Particles	3

5	Coal and Lignite (AA.SHTO T133-70)	0.25
6	Clay Lwrvps (AASHTO T112-74)	0.25
7	Ifeterial Passing1 the 0.075 mm (AASHTO T11-74)	1
8	KLengation Index ( BS 012)	15
9	Flalciness Jhdez ( BS 012)	35

The controctor shall execute a quality test on coarse aggregate and each aggregate source and the results shall be submitted to the Engineer for approval .

d. Admixture

1. Air Hitraining Adnixtures for concrete shall be in accordance with MSHTO M154.
2. Chemical Admixture for water rodnction f set retardation and set acceleration or their combinations shall be in accordance with AASHTO M194.

e. Mixing water

Mixng water shall be clean and free from oil, acids, alkalis , salts, organic material or subetance which may deleterious to concrete or reinforcement. The contractor shall store on the site an adequate supply of fresh water to meet all n.eeds. The water shall be tested as prescribed in MSHTO T26-72.

f. Reinforcement

Concrete reinforcement shall be of wire mesh as shown on the drawings. The wire mesh shall be of welded plain cold drawn steel wire fabric mats complying with ASTM A185 AASHTO M55 - 73 , or B.S 4483 ( 1969). The mesh shall be furnished in flat sheets, not rolls, unelas otherwise acceptable to the Engineer. Minimum yield strength 40Kgs/mm<sup>2</sup> .

The mesh shall be rectangular with clase spacing between langitudiioal bars and wider spacing1 between transverse.

g. Polythene sheeting

Polythene sheeting for placing immediately below concrete slabs shall be 0.065 mm thick made from polythene or other approved hydrocarbon thermoplastic resin.

#### 11.4.4 Joint Filler

1. Provide resilient and nan-estruding type premolded cork units or sponge Rubber joint filler or any other equivalent material approved by the Engineer.
2. Provude sizes, and shapes of units as recommended by the manufacturer for joint size and condition shown.

Where joint movement is a factor in the determination of size, consult with the

- 
- Engineer to determine nature and magnitude of anticipated joint movements for the temperature and condition of project at time of installation.
3. Specified hardness and compressibilities are intended to establish requirements for normal or average conditions of installation and use. Where a range of hardness or compressibility is available for a product, comply with manufacturer's recommendations for specific condition of use.
  4. The joint material shall not deteriorate under any weather conditions and is to be of such a character as not be permanently deformed or broken by moderate twisting) bending or other ordinary handling.
  5. Strips of the joint filler which do not conform to the specified dimensions within the tolerance  $0+2\text{mm}$  for thickness and  $^{+}$ ;  $-12\text{ mm}$  for depth are to be rejected. All damaged strips are to be rejected.
  6. Joint filler material shall be compatible with the substrate, sealants, and other materials in the joint system.

#### **11.4.5 Joint sealer**

1. The sealing material shall be impermeable, withstand all weather conditions and capable of adhering firmly to concrete without cracking, spalling or disintegrating and will not require an impracticable condition of dryness or cleanliness of concrete slabs. The preferable materials used as sealing compound shall be hot-poured rubber bitumen compounds material or synthetic rubber content or any other satisfactory materials approved by the Engineer.
2. The sealant material shall be compatible with joint surfaces, joint fillers and other materials in the joint system.

#### **11.4.6 Joint Dowel Bars and Tie Bars**

Dowel Bars shall be of mild plain steel bars complying with the requirements of ASTM A615 or BS 4449 (1969) and as shown on the drawings and table (I). Cut bars to true length with ends square and free of burrs. Dowel bars for contraction and expansion joints shall be of dimensions and spacing shown in Figs, (2, 3) and table (3).

Tie bars for the longitudinal joints are 12mm diameter mild steel 1m long centrally located over the joint centre line at mid-depth of the slab and spaced at 600mm centres.

As an alternative to mild steel, 10mm diameter high yield steel tie bars 750 mm long may be used

**11.4.7 Metal Expansion Caps** Furnish the end of the coated half of each dowel bar in expansion joints with a steel or cardboard cap about 100mm long. The end of the cap shall be filled with cotton waste or similar compressible material to allow for bar movement of not less than 25mm and as shown on the drawing unless otherwise indicated.

### **11.5 Sampling and Testing**

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All materials shall be approved by the Engineer prior to use in the work. Additional samples will be taken and tested by the Engineer during the progress of the work to check on the quality of the material being supplied and/or placed by the contractor.

The contractor should set up his own testing facilities or arrange the same from the private laboratory to assure that his materials and workmanship comply with the specifications,

## **11.6 Concrete Mix and Design**

### **11.6.1 Composition**

a. All concrete shall be proportioned by weighing and shall conform to the following strength and mix requirements.

1. compressive strength, 250 Kg/cm<sup>2</sup>, minimum at 28 days when tested in accordance with AASHTO T-22
2. Minimum cement content 300 Kg/m<sup>3</sup>.
3. Maximum slump ( 50mm) when tested in accordance with
4. Air content 4-7% when tested in accordance with AASHTO T 196

b. At least 28 days prior to the start of paving operations and after approval of all materials to be used in concrete the contractor shall submit for approval the mix design he intends to use based on proportioned weights of cement, air entrainment agent, saturated surface dry aggregate, and water. This mix design will be tested by the Engineer and approval will not be granted unless the average 28 days compressive strength exceeds the minimum strength requirements by at least 15%. The making, curing, and testing of the specimens for the compressive strength of the concrete shall be in accordance with AASHTO T 23-73.

c. The required consistency of the concrete mixture shall

be such that the mixture will be cohesive, uniform and plastic permitting proper handling and finishing when deposited, it shall not flow, but shall remain in a conical pile and shall be minimum segregation during the process of handling and finishing.

### **11.6.2 Batching and Mixing**

Concrete shall either be batched and mixed at a central batching and mixing plant, or batched at a central batching plant while mixing can be either by field mixers adjacent to the forms for slabs, or mixed in a truck mixer.

## **11.7 Forms**

Side forms shall be made of metal or any other approved material. They shall be of approved construction and provided with adequate devices for secure setting so that when in place they shall withstand the impact and vibration of the compacting and finishing equipment with settlement not exceeding 1.5mm/3m. Form sections shall be tightly joined by a locked joint free from play in any direction.

Bent, twisted or battered forms are to be removed from the site. Repaired forms are

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not to be used unless approved by the Engineer. Wooden forms may be used only for curves having a radius of less than 50m. They shall be made of two 2.5cm well seasoned surfaced planks fastened together and shall be attached securely to a wooden base 20cm in width. All wooden forms shall be braced at least every 60cm with steel pins of the size and length approved by the Engineer.

## **11.8 Elocution**

### **11.8.1 General**

The entire work shall be constructed to the exact position and elevation in conformity to the lines and grades shown on the Drawings or as directed by the Engineer. The contractor shall provide his own men and instruments for determining alignment, elevation and position of all construction between any points, subject to the check and correction by the Engineer,

### **11.8.2 Inspection**

Examine the areas and conditions under which paving is to be installed and remedy any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

### **11.8.3 Subgrade**

1. The formation level on embankments and in cuttings shall be the surface level of the underside of the subbase. The levels and tolerance or irregularity of surface shall be within the Unit specified. Any permitted deviation below the true levels shall be made up in sub-base material compacted as specified which shall not be measured for payments.
2. Materials for the subgrade shall not contain harmful amounts of water-soluble substances and shall be such that the strength and bearing capacity will not be adversely affected by the presence of water.
3. In the event of unsuitable material, the contractor shall remove such material to the depth indicated on the drawing or as directed by the Engineer and replaced with approved filling material compacted as specified herein.
4. The compaction shall be performed with suitable compacting equipment such as pneumatic-tired rollers or macadam rollers. If necessary, vibrating rollers and sheepfoot rollers may be used upon obtaining approval by the Engineer,

The subgrade shall be compacted to a density not less than 95% of the maximum dry density (as determined by AASHTO T180-74) at optimum moisture content. Compaction of the subgrades adjacent to structures shall be carefully performed by an approved method which does not cause any damage to the structures. Degree of compaction of the completed subgrades shall be tested as specified hereinafter.

6. Surface of the subgrades shall extend to at least beyond either edge of the pavement including the kerbs if any. The completed subgrades shall be protected from any damage.

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7. The following tests shall be performed in accordance with ASTM, AASHTO or BS or other approved standards:

(i) Classification Tests

- a. Specific gravity --- AASHTO (T1 60-74) or BS 1377 test 6 .
- b. Mechanical analysis ---- MSHTO (TOG-77) or BS 1377 Test 7
- c. Liquid limit. ---- AASHTO ( T09 -6G) or BS 1377 test 2
- d. Plastic limit ---- MSHTO (T90 -70) or BS 1377 test 3.
- e. Moisture content ---- BS 1377 test 1

These tests shall be made at a rate not less than one test for every 1000m<sup>2</sup> of the materials but not less than 3 tests in any case,

(ii) Compaction tests

Compaction and density tests on the subgrades shall be made at a rate not less than one test for every 300m<sup>2</sup> of the surface area of the subgrades

The tests shall be on a random basis and cover the entire width of the section. Testing of any layer of construction will be deemed acceptable providing 8 out of 10 consecutive tests are equal to or in excess of the minimum and the remaining 2 tests do not fall below the minimum by more than 20%.

#### **11.8.4 Sub-Base course**

1. Prior to construction of the subbase, the previously constructed subgrade surfaces shall be cleaned of all foreign substances . Any area of the subgrade having inadequate compaction or any deviation from the requirements specified shall be corrected by scarifying, removing and/or adding approved material, re - shaping and re - compacting to the required density and to the satisfaction of the Engineer.
2. Sub - base shall be constructed only when weather conditions do not detrimentally affect the quality of the finished formation.
3. The materials shall be transported with pneumatic-tired vehicles to the area where the subbase is to be constructed, and shall be mechanically spread in an appropriate thickness to obtain the required compacted thickness .
4. Where the subbase course thickness exceeds 20cm it may be constructed in two or more layers of equal thickness. No superimposed layer shall be placed before the previous layer has been approved by the Engineer.
5. Each layer shall be compacted to at least 95% of the maximum dry density at optimum moisture content as determined by MSHTO T180-74. Water shall be applied during the compaction in such an amount as necessary to obtain the specified density,
6. In all places not accessible to the rolling equipment, the materials shall be compacted thoroughly with approved mechanical or hand tampers to a density comparable to that obtained by rolling .
7. Surface of the finished subbase course at any point shall be properly shaped to a

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- smooth uniform surface and shall be not vary more than one (1) cm above or below the grade level shown on the drawing .
- 8, Tho subbase cours shall be constructed to the full width of the pavement inclusive of the foundation of kerbs in the above-mentioned thickness. Elevation for the foundation of the kerbs shall be carried out only after the full width of the base course, is compacted and approved by the Engineer,
  9. Grade and alignment central stakes shall be furnished set and maintained by the contractor, subject to checking by the Engineer . The work shall conform of the lines, grades and cross~ sections shown on the Drawings. The tolerance for level is +1 cm to 2 cm .
  10. The completed subbase course shall be maintained in an acceptable condition at all times prior to the construction of the concrete surfacing . Traffic will not be permitted on the subbase during the rainy season,
  11. The following tests shall be executed, on preselected samples approved by the Engineer in accordance with relevant AASHTO specifications.

**A. Tests for materials**

- a. Mechanical analysis
- b. LL, PL and PI
- c. Moisture - density relation
- d. Modified CUR

These tests shall be made at rate not less than one tests for every 1000 cubic meters of each material or when deemed necessary , but not less than 3 tests in any case, Any Materials found not to conform with the requirements, then or later, will be cause for rejection. Unacceptable materials shall be removed and exchanged with a suitable materials at no cost to the employer .

**B. Tests for compacted subbase**

Compaction and density tests on subbase shall be performed at a rate not less than one test for every 300 square meters of surface area of the finished subbase.

**11.8.5 Concrete Surfacing****11.8.5.1 Form Construction**

- a. The side forms shall be placed to true vertical alignment . They shall be laid on a continuous bed of cement or tar or lean concrete about 2 in thick. They shall be laid slightly high and brought to level by taping down.
- b. The forms shall be set to the required grades and lines, rigidly braced and secured . The forms shall have not vertical or horizontal movement in excess of 2mm when subjected to the load of the finishing machine, or from any other construction operation,
- c. Install sufficient quantity of forms to allow continuous progress of the work and so that forms can remain in place at least 24 hours after concrete placement.
- d. Check completed formwork for grade and alignment to the following tolerances:

1. Top of forms not more than 3mm in 3000 mm.
2. Vertical face on longitudinal axis, not more than 6mm in 3000mm.
- e. The forms shall be cleaned thoroughly and oiled with form release agent as often as required to ensure separation from concrete without damage
- f. Forms shall be laid at least one day ahead of Concreting

#### **11.8.5.2 Polythene sheeting**

Immediately before anjr concrete is placed, polythene sheeting as specified above shall be laid on the subbase over the entire area. The sheeting shall not torn or damaged when the concrete is placed thereon. The sheeting shall be lapped at least 30cm and any damaged sheeting shall be replaced at the contractor's

#### **11.8.5.3 Fixing reinforcement**

The number , size , form and pasition of all steel reinforcing bars and other parts shall be exact accordance with the drawings. They shall be kept in the correct positions of the forms without displacement during the process of working the concrete into place , The provision of spacer bars, supporting stools distance pieces if required shall be to the approval of the Engineer, but the responsibility for maintaining the reinforcement in the specified position during concreting

shall rest solely with the contractor. All steel reinforcement shall be cleard and free from all loose mill scale, dust, coating such as paint,cement , grout,.... etc , before the concrete is deposited

#### **11.8.5.4 Concrete placement :**

- 1, Comply with the requirements of chapter ( 4 ) section. ( 6 ) for mixing and placing concrete and as herein specified.
2. Do not place concrete until subbase and forms have been checked for line and grade.
3. When concreting operations are about to start, the polythene sheeting on the base shall be in a finished condition, free of all forign and -unsuitable materials, not muddy, free from dust and dry earth or any rucking
4. Trucks delivering concrete shall not run on polythene sheeting -nor shall they run on completed slabs until at least 14 days after placing the concrete.
5. The concrete shall be tipped on to a banker board either to the side or on the formation level, and the material shovelled into position by hand.
6. Place and compact concrete in two layers, strike-off the initial pour for the entire width of placement and to the required depth below the finished surface as shown on the Drawing . Care shall be taken to avoid damaging the polythene sheeting during the laying of the lower layer .
7. Great care shall be taken to ensure complete compaction. Fetrol-driven vibrators mounted on a wooden or steel bean can be used for compaction or any other compacting devices approved by the Engineer.
- 8, The surface of the lower layer, after compaction shall be rough, free from laitance and free from surplus water to eneure complete bond with the upper layer. The

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joining of the upper and the lower layers in no way creates a plane of weariness in the concrete pavement slab.

9. Steel fabric reinforcement shall, where it is required by the drawings, be placed on the surface of the lower layer of concrete with longitudinal and transverse overlaps not less than 40 times the diameter of the bars transverse to the overlapped edge of the sheet, or 15cm whichever is the greater. The mats shall be clean and free from excessive rust. Keep flat and free of distortions.
10. The upper layer of concrete shall be placed before initial set develops in the lower layer, lower layer concrete initially set before placing the upper layer shall be entirely replaced. The upper layer of concrete shall be deposited, spread and compacted, and finished to the required surface levels and finishes.
11. Spreading, compacting and finishing operations are to be completed without delay. Any concrete, which, has been in place too long before completion of these operations, is to be removed from the site.
12. Place concrete using methods which prevent segregation of the maximum t consolidate concrete along the face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Consolidate with care to prevent dislocation of reinforcements, dowels, and joint devices.
13. Deposit and spread concrete in a continuous operation between transverse joints, as far as possible. If interrupted for more than  $1\frac{1}{2}$  hour,
14. When adjacent pavement lanes are placed in separate operations, do not operate equipment on the until the pavement has attained sufficient strength to carry the loads without injury.
15. As soon as the side forms are removed the edges of the slab shall first be inspected by the Engineer. Any minor honeycombed areas shall then be filled in with mortar (1:2).

### 11.8.6 Joints

#### 11.8.6.1 General :

Construct expansion, weakened plane (contraction), and construction joints as indicated on drawings and in accordance with the required specifications. All joints shall be constructed true to-line with their faces perpendicular to surface of the pavement, unless otherwise indicated. Joints shall not vary more than 2cm from a true line or from their designated position. Transverse joints shall be at right angles to the centerline. When joining coasting structures, place transverse joints to align with previously placed joints, unless otherwise indicated,

#### 11.8.6.2 Contraction joint :

Provide weakened plane (contraction) joints, sectioning concrete into areas as shown on the Drawings. Construct weakened - plane joints for a depth equal to at least  $\frac{1}{4}$  concrete thickness. The type of the joint may be as follows:

- a. Tooled joints : Form weakened - plane joints in fresh concrete by grooving top

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portion with a recommended cutting tool and finishing edges with a jointer.

- b. Sawn joints : Form weakened - plane joints using powered saws equipped with shatterproof abrasive or diamondrimmed blades. Cut joints into hardened concrete as soon as surface will not be torn abraded, or otherwise damaged by cutting action.
- c. Inserts : Use embedded strips of metal or sealed wood to form weakened - plane joints.

Set strips into the plastic concrete and carefully remove strips after concrete has hardened.

#### **11.0.6.3 Expansion joints :**

shall be installed as indicated on the drawings. Provide provided joint filler for expansion joints, The expansion joints shall be located at distances not less than 30ft ( 97441x1) o.c, or as indicated on Drawings. Extend joint fillers full-width and depth of joint, and not less than 13mm or more than 25mm below finished surface where joint sealer is indicated. If no joint sealer, place top of joint filler flush with finished concrete surface. Joint fillers shall be furnished in one -piece lengths for the full width being placed, wherever possible. Where more than one length is required lace or clip joint filler sections together. The top edge of the joint filler shall be protected during concrete placement with a metal cap, wood strip, or other temporary material. Remove protection after concrete has been placed on both sides of joint. Concrete slab edge along the expansion joint shall be really finished with a slightly rounded edging tool.

#### **11.8.6.4 Dowel Bars:**

Dowel bars for expansion and contraction joints shall be placed on an axis parallel to the surface of the slab and to the centre line of the slab ( Parallel to the side form).

One —half the dowels must be coated with grease or asphalt to break the bond with the concrete so that the dowel may slide freely. The dowels shall be free from indentations or other deformation and have ends.

#### **11.8.6.5 Construction Joints**

Place construction joints at the end of all pours at locations where placement operations are stopped

for a period of more than  $\frac{1}{2}$  hour except where such pour terminate at expansion joints and as shown on the drawing. The day work should normally begin and end at an expansion or contraction joint, and construction joints should be regarded as emergency joints and avoided, whenever Possible tie deformed tiebars to hold the joint tightly closed If the construction joint replace a contraction joint , dowels may be installed so that one end of each dowel bar is free to move, as shown on the Drawings,

Construction joints shall not be placed nearer than 10ft to an expansion or contraction joint,

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**11.8.6.6 Longitudinal joints**

Place longitudinal joints between adjacent traffic lanes. Tiebars shall be used at mid-depth of the slab. The tiebars diameter, length, and spacing are shown on the Drawings.

A sealing groove filled with sealing compound should be provided. The groove is formed by securing a chip of wood of the required size to the form whether carting the first half width of the road. When the form is removed the strip of the Bread is left in position until the second half of the road has been completed, and it is then removed. To prevent the development of cracking, transverse joint on each side of a longitudinal joint should be in line with one another and not staggered. Transverse joints should always be at right angles to the slab edges to avoid sideways movements of the slabs and the formation of diagonal cracking at the acute corners.

**11.8.6.7 Joint Filler**

a. Suitable Materials for filling joints are soft knot — free timber; impregnated fibreboard, chipboard, cork and cellular rubber. Materials containing high proportion of bitumen should not be used. The material used shall comply with division 1.3.4.

b. The filler board shall be placed vertically - or perpendicular to the pavement surface on the line of the joint without any overlap. No gaps are allowed below it, between individual lengths or between it and the form, or previously laid concrete.

c. The filler board shall extend to the underside of the groove - forming strip of wood or metal in expansion joints. There shall be no gap between the filler and any such strip.

**11.8.6.8 Joint sealing**

a. Grooves for sealing construction joints shall be formed either by a strip of steel, hardwood or other approved material secured to the form. Grooves for contraction and expansion joints shall be formed by cutting the concrete after it has hardened sufficiently without risk of cracking or spalling.

All grooves shall have square corners and the outside edges of pavements shall be finished with a 6mm radius.

b. All joint grooves in the concrete pavement (excepting any joints incorporating synthetic rubber strip) shall be filled with a joint sealing compound as previously specified in division 1.3.5 and as shown on the drawings.

c. The grooves shall be continuous without blockage.

d. In the case of expansion joint, the filler material is to be exposed for the full length of the joint. Before filling all joint grooves are to be dry and free from dust, concrete fragments or other deposited materials and shall be inspected by the Engineer before they are filled.

e. The sealing compound is to be heated and poured in accordance with the procedure recommended by the manufacturer, particular care being taken not to exceed the maximum temperature specified by the manufacturer,

f. Pouring shall be done by any approved method so that the sealer will fill the prescribed space to levels required without spilling on exposed surfaces of the

concrete. Any excess sealer shall be removed immediately in a manner which does not discolour nor injure the concrete or the regaining sealer

- g. Allow sufficient time for the seal to harden before traffic is permitted on the pavement,
- h. Expansion joints shall be sealed 6,5 mm below surface level; contraction joints shall be sealed 10 mm below surface level; construction joints shall be sealed level with the surface .

#### 11.8.7 Concrete Finishing

- a. After striking-off and consolidation of concrete, smooth the surface by screeding and floating. Use hand methods
- b. Finishing shall be carried out continuously over as long a length of concrete as possible. The finishing pass shall be made down behind the compacting operation and the beam shall be tilted slightly so that the leading is about 3 mm higher than the trailing edge, to facilitate the striking off any small quantities of excess concrete. The mechanical finishers shall not be allowed to remain too long in one position, and too many passes shall not be made to avoid the formation of laitance on the surface of concrete.
- c. Use hand methods only where mechanical floating is not possible. Adjust the floating to compact the surface and produce a uniform texture.
- d. The foregoing work is to be carried out while the concrete is still plastic and workable and in such time sequence as to ensure the removal of water or laitance from the surface. Excess thin mortar, accumulating ahead of the finishing floats and straight - edges, shall be removed from the surface of the pavement, and shall not be used in filling depressions, Fresh concrete shall be used to correct and fill all depressions.
- e. After floating , test surface for flatness with 3m straightedge which shall be checked twice daily.
- f. Work edges of slabs , formed joints, and top edge of curb with an edging tool. Care shall be taken to eliminate any tool marks on concrete surface ,
- g. After completion of floating, complete surface finishing as follows :
  - 1. Brush finish , by drawing a fine - hair brush across concrete surface, perpendicular to a line of traffic. Repeat operation if required to provide a fine line texture acceptable to the Engineer.
  - 2. On inclined slab surface, provide a coarse non - slip finish by scoring surface with a stiff- bristled broom perpendicular to line of traffic.
- h. The time allowed to elapse between mixing the concrete in place shall not exceed 1 1/2 hours.
- i. Do not remove forms for 24 hours after concrete casting.

After removal , clean ends of joints and repair, any minor honeycombed areas.

**11.8.8 Accuracy of surface finish.**

- a. The finished surface of tie road shall be to H&v limits shown on the Drawings within a tolerance of  $\pm 1$  cm.
- b. The gap between the bottom of the strength edge and the surface of the pavement shall not be greater than 3mm in any position and direction on the surface of the road.
- c. There shall not be any deflection exceeding 1 cm from a straight line between any two prints 30 m apart longitudinally .

**11.9 Curing**

Immediately after the finishing operations have been completed, the entire surface of the newly placed concrete shall be cured in accordance with one of the following methods as approved by the Engineer :

- a. Burlap 1 mats or Damp fabric.

The surface shall be completely covered with fully Treated mats or Damp fabric throughout the curing period and as specified by the Engineer,

- b. Damp sand .

This cannot normally be applied until the day after the concrete has been laid and must be kept damp throughout the curing period . Before this some other curing process must be used, such as waterproof covering on light framework.

- c. Waterproof covering

The waterproof covering such as paper shall be lapped of least 45 cm and cover the whole surface and sides of the pavement for 7 days after the concrete has been placed.

- d. Impervious membrane method,

The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place, the curing compound shall not be applied during rainfall. Curing compound shall be applied by mechanical sprayers.

The curing compound shall be of such character that the film will harden within 30 minutes after application, It is very important that the rate of spread be uniform and the coverage in accordance with the manufacturer instructions.

**11.8.10 Repair and Protection**

- a. Repair or replace broken or defective concrete as directed by the Engineer.
- b. The thickness of the pavement shall be determined by average caliper measurement of cores tested in accordance with AASHTO T146.

Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy resin grout.

- c, protect concrete from damage until acceptance of work.

Exclude traffic from pavement for at least 14 days after placement.

d. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

e. Sweep concrete pavement and wash free of stains, discolorations, dirt and other foreign material gust prior to final inspection.

**11.8.11 Traffic Markings**

Traffic marking shall be done with approved manufacturer's recommended procedure and equipment. The width of traffic markings shall be 15cm and the painting shall be performed only when the existing surface is dry and clean, the temperature is above 5 °C and when the weather is not excessively windy, dusty or foggy.