



**YEMEN INTEGRATED URBAN SERVICES EMERGENCY PROJECT
(YIUSEP II AF)**

**TECHNICAL SPECIFICATION
FOR THE CONSTRUCTION OF
250 m3
ELEVATED WATER TANK**

**ELEVATED WATER TANK STRUCTURAL AND BUILDING
WORK**

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ELEVATED WATER TANK STRUCTURAL AND BUILDING WORK

1.1 Site Work

1.1.1 Geotechnical Study

1.1.1.1 Scope of Work

This clause covers the specification of conducting the soil investigation on site including the method of boring, sampling and the field and laboratory tests required.

1.1.1.2 Specifications

(i) Boring

For the pipelines, borings shall be achieved by mechanical rigs that use drilling fluid. All borings shall have a minimum diameter of 4 inch (100 mm). The boring includes field logging and recording of the soil stratification and groundwater table between ground surface and end of boring.

(ii) Sampling

1. For all borings disturbed samples shall be obtained at one meter intervals and at change of soil layer. The extracted samples shall be inspected and visually described on site in accordance with ASTM D2488. The samples shall be properly preserved, labeled and transported to the laboratory.
2. Additionally, in cohesive layers thin wall tube undisturbed samples shall be collected at 2.00 m depth intervals and at change of soil stratification. Thin wall tube sampling shall be carried out in accordance with ASTM D1587. The undisturbed samples shall be properly preserved with indications of upper and lower depths, properly labeled and transported to the laboratory.
3. In locations where dry drilling will be used, undisturbed samples shall be collected at 2.00 m depth intervals and at change of soil stratification. In test pits, the samples shall be of the bulk type with at least one cubic foot volume. For air-cooled drilling, thin wall tube sampling shall be used. The undisturbed samples shall be properly preserved with indications of upper and lower depths, properly labeled and transported to the laboratory. The undisturbed samples from the cohesionless layers shall be tested in the laboratory for collapse potential.
4. Groundwater samples (where exists) shall be collected from each borehole in accordance with ASTM D5903-96 (2001), properly preserved, labeled and transported to the laboratory for subsequent chemical analysis.

(iii) Standard Penetration Test (SPT)

Standard Penetration Tests (SPT) shall be carried out in cohesionless soils at 1.50 m depth intervals and at change of soil stratification. The test shall be carried out in accordance with ASTM D1586-99. The extracted samples from the split barrel shall be inspected and visually described on site in accordance with ASTM D2488. The samples shall be properly preserved, labeled and transported to the laboratory. However, in locations where dry boring technique will be used, the test will be carried at 2.00 m depth intervals such that it alternates with undisturbed soil sampling.

(iv) Field Vane Test

Field Vane Tests (FVT) shall be carried out in cohesive soils at 2.00 m depth intervals and at change of soil stratification. The FVT shall alternate with the thin wall tube sampling described in item 2-2 above. The FVT shall be carried out in accordance with ASTM D2573.

(v) Laboratory Testing

All laboratory testing shall be carried out in accordance with ASTM specifications. Specifically, the following shall be adhered to:

- Moisture content in accordance with ASTM D2216
- Grain size distribution tests in accordance with ASTM D422
- Liquid Limits and Plastic Limits in accordance with ASTM D4318
- Soil classification in accordance with ASTM 2487
- Specific Gravity Tests in accordance with ASTM D854
- Consolidation tests in accordance with ASTM D2435 Method B
- Collapse Potential of Unsaturated Soils in accordance with ASTM D5333-92 (1996)
- Standard Proctor Tests in accordance with ASTM D698 – Method A
- Chemical analysis of soil samples shall be carried out for samples collected from the top 3.0 m of the boreholes on condition that they are located above the groundwater table.

(vi) Soil Investigation Report

The results of the soil investigation shall be reported in accordance with the ASTM specifications and shall include the recommendation for the level and the type of foundations of the different elements of the Works.

1.1.2 Site Preparation

General

1.1.2.1 Scope of Work

This section covers the requirements for site preparation and shall include the necessary clearing, grubbing, stripping, demolishing and disposal of all debris.

Execution

1.1.2.2 Clearing

- Clearing includes the Cut and remove all timber, trees, stumps, brush, roots, grass, weeds rubbish and any other objectionable material resting on or protruding through the surface of the ground.
- Preserve and protect trees and other vegetation designated on the drawings or directed by the Engineer to remain as specified.
- Where required, depressions caused by the removal of boulders, trees or other obstacles shall be filled with adequate soil and compacted at no extra cost. Burning of removed materials will not be permitted on the site. All unsalvageable materials shall be disposed of by removing them from the site at the Contractor's expense.

1.1.2.3 Grubbing

- Grub and remove all stumps, roots in excess of 35 mm in diameter, matted roots, brush, timber, logs, concrete rubble and other debris encountered to a depth of 450 mm below original grading or 450 mm beneath the bottom of foundations whichever is deeper.
- Refill all grubbing holes and depressions excavated below the original ground surface with suitable materials and compact to a density conforming to the surrounding ground surface.

1.1.2.4 Stripping

- Strip topsoil from all areas to be occupied by buildings, structures, and roadways and all areas to be excavated or filled.
- Topsoil shall be free from brush, trash, large stones and other extraneous material. Avoid mixing topsoil with subsoil.
- Stockpile and protect topsoil until it is used in landscaping operations. Dispose of surplus topsoil after all work is completed in a manner approved by the Engineer.

1.1.2.5 Demolishing

Existing structures on site which the Engineer may order to be demolished or may require to be removed for the construction of the permanent work, shall be demolished to the extent necessary to construct the various units or to a depth of 0.5 meter below the finished ground level.

Before commencing demolishing work on any unit the Contractor shall ensure that all services to that unit have been disconnected.

1.1.2.6 Disposal

- Dispose of material and debris from site preparation operations by hauling such materials and debris to an approved offsite disposal area or to be defined by the Engineer. No rubbish or debris of any kind shall be buried on the site.
 - Burying of cleared and grubbed materials, or other for any reason will not be permitted.
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1.1.2.7 Protection

- Trees and other vegetation designated on the drawings or directed by the Engineer to remain shall be protected from damage by all construction operations by erecting suitable barriers, guards and enclosures, or by other approved means.
- Maintain protection until all work in the vicinity of the work being protected has been completed.
- Restrict construction activities to those areas within the limits of construction designed on the drawings, and within easements provided by the Employer. Adjacent properties and improvements thereon, public or private, which become damaged by construction operations shall be promptly restored to their original condition, to the full satisfaction of the property owner.

1.1.3 Excavation

1.1.3.1 Scope

This section covers excavation work and shall include the handling, storage, transportation, and disposal of not usable excavated material; all necessary sheeting, shoring, and protection work; preparation of subgrade; pumping and dewatering as necessary or required, protection of adjacent property.

Excavations shall be accurately cut to the lines and levels shown on the drawings and approved by the Engineer. Any formation which becomes waterlogged or otherwise spoilt shall be cleaned out and reformed to the original level at the expense of the Contractor and to the satisfaction of the Engineer before any further material is placed.

Excavation shall be deposited clear of all footpaths, roads, paved areas and lines of services.

1.1.3.2 Nature of Ground

Information as to the nature of the ground, where given, is believed to be correct but not guaranteed so and the Contractor must visit the Site and assess for himself the Site conditions and the exact nature of the ground to be excavated as failure to do so will not be admitted as the basis for any claims

1.1.3.3 Over Excavation

Over excavation by the Contractor shall be made good by him at his own expense by replacement with plain concrete (140 kg/cm²) or, if so directed by the Engineer, with hard-core or gravel suitably compacted

1.1.3.4 Governing Standards

Soil tests, when required, shall be governed by the British Standards (BS) or standards of the American Society for Testing and Materials (ASTM) and the American Association of State Highway and Transportation Officials (AASHTO).

Maximum density for cohesive compacted materials placed under this section shall be determined in accordance with ASTM D1557, as specified. The terms "maximum density" and "optimum moisture content" shall be as defined in ASTM D1557.

Relative density for noncohesive compacted materials placed under this section shall be determined in accordance with ASTM D4253 and D4254. The term "relative density" shall be as defined in ASTM D4253 and D4254.

1.1.3.5 Soil Classifications

References in these specifications to soil classification types and standards shall be as set forth in BS 1377 or in ASTM D2487 and as described in the soils report.

Particle size analysis of soils and aggregates will be performed using ASTM D422.

Determination of sand equivalent value will be performed using ASTM D2419.

1.1.3.6 Excavation in Rock

Rock in excavation shall be considered only when geological strata found only in ledges or masses not less than 1.0 m³ in volume which in the opinion of the Engineer would normally have to be broken up and removed by the use of rock quarrying methods. Samples from rock in the shape of cubes 15 x 15 x 15 cm are tested for crushing strength which should not be less than 70 kg/cm² in dry state and 40 kg/cm² for wet samples.

1.1.3.7 Blasting

Blasting or use of explosives shall not be permitted unless the contractor gets all the necessary permissions from the concerned local authorities.

1.1.3.8 Temporary Fencing

The Contractor shall have particular regard to the safety of persons and livestock and shall ensure that all open excavations, access routes and steep or loose slopes arising from the Contractor's operations are adequately fenced and protected.

1.1.3.9 Maintaining and Supporting Other Services and Structures

The Contractor shall be responsible for maintaining all water courses, sewers, drains, gas pipes, water pipes, electricity and telecommunication cables, other services and structures encountered during the construction of the Works and for any remedial measures necessary to make good any damage arising out of the construction of the Works. He shall temporarily support or divert and subsequently reinstate all such services and structures to the satisfaction of the Engineer and the appropriate authority.

As soon as an existing service is encountered in the excavation, the Contractor shall forthwith call the attention of the Engineer and the appropriate utilities service authority thereto.

Where permanent diversion or support is rendered necessary as the unavoidable result of the construction of the Works in accordance with the contract or where in the opinion of the Engineer the position of existing services warrants temporary diversion or support, the Engineer will instruct the Contractor accordingly.

Notwithstanding any relevant information furnished by the Employer or the Engineer, the Contractor shall be responsible for ascertaining, from his own inspection of the site and from the respective supply authorities and other public bodies and by excavating trial pits, the position of all mains, pipes and cables whether underground or overhead, within or near the site

The Contractor shall locate, protect, brace support and maintain all existing underground pipes, conducts, drains and other underground construction which may be uncovered or otherwise be affected by the work.

1.1.3.10 Excavation to be Kept Free from Water

The Contractor shall keep all excavations free from water whether caused by floods, storms or otherwise so that the Works shall be constructed in dry conditions.

The Contractor shall keep the sub-soil or accumulated water at a level lower than the bottom of the permanent work for such a period as required by the provisions of this specification and the Contractor's method of construction.

No water shall be discharged into any watercourse without the Contractor having first obtained all necessary consents from the concerned local authorities and the permission in writing of the Engineer and such permission shall not be granted unless the Contractor shall have provided to the satisfaction of the Engineer an efficient settling basin or sand trap through which all such water shall pass before discharge into the said watercourse.

1.1.3.11 Levels to be Recorded

Before the surface of any part of the site is disturbed or the Works thereon are begun, the Contractor shall take and record levels and dimensions of any such part. The Contractor shall also take and record such other levels and dimensions as are necessary during the progress of excavation.

All levels and dimensions shall be taken and recorded in the manner specified, or as agreed with the Engineer, in the presence of the Engineer.

1.1.3.12 Boreholes and Trial Pits (Trial Holes)

Trial holes shall be excavated well ahead of other excavation to such dimensions and depths as the Contractor shall deem necessary to determine information required by him.

Trial holes needed to determine the position of underground services, sub-soil drains or for any other reason shall be excavated and shall afterwards be reinstated immediately after the required information is obtained. The reinstatement of trial holes shall be carried out to the approval of the Engineer.

Precautions

1.1.3.13 Supporting Excavations

The Contractor shall support the sides and ends of all excavations to prevent any fall or run from any portion of the ground outside the excavation and to prevent settlement or damage to structures adjacent to the excavation.

The Contractor shall provide install and maintain all materials necessary to provide such support.

If, for any reason, any portion of the bottoms, sides or ends of any excavations shall give way, the Contractor shall take all necessary remedial measures including the excavation and removal of all the ground thereby disturbed both inside and outside the nominal limits of excavations.

Where the Contractor proposes to perform excavations with sloping faces (other than sloping excavations shown on his drawings or required as permanent features of the work) and without shoring, the excavated faces shall be to stable slopes and heights. Full details shall be submitted to the Engineer for approval.

1.1.3.14 Slips and Falls and Excess Excavation

In the event of slips or falls occurring or in the event of excavation being made in excess of the minimum necessary or practicable for the construction of the Works the voids so formed shall be filled. In all cases

where the voids so formed may, in the opinion of the Engineer affect the stability of the ground for the support of the permanent work or of adjacent structures and services then such voids shall be filled solid with concrete. In all other cases the voids shall be packed with selected excavated material thoroughly compacted.

Preparation for Foundations

1.1.3.15 Trimming Excavations

When excavating to specified levels for the foundations of any structures or to specified limits for the face of any structure required to abut undisturbed ground, the Contractor shall not excavate the last 150 mm until immediately before commencing the constructional work, except where the Engineer shall permit otherwise. Should the Contractor have excavated to within 150 mm above these specified levels or to within 150 mm of these specified limits before he is ready or able to commence the constructional work he shall, where required by the Engineer, excavate further so as to remove not less than 150 mm of material immediately before commencing the constructional work.

Before commencement of any constructional work all shattered and loose material shall be removed from the excavations by hand so as to ensure that the work rests on a sound and clean foundation or where appropriate abuts against undisturbed ground.

1.1.3.16 Inspection by the Engineer

When the specified levels or limits of excavation are reached the Contractor shall notify the Engineer that work is ready for inspection. The Engineer will inspect the ground exposed, and if he considers that any part of the ground is by its nature unsuitable he may direct the Contractor to excavate further. Such further excavation shall be refilled to the specified levels or limits with concrete or selected imported material as directed by the Engineer.

Should the material forming the bottom of any excavation, whilst acceptable to the Engineer at the time of his inspection, subsequently become unacceptable to him due to exposure to weather conditions or due to flooding or have become puddle, soft or loose during the progress of the Works, the Contractor shall remove such damaged, softened or loosened material and excavate further by hand.

The omission by the Engineer to give an instruction under this clause shall not relieve the Contractor from any responsibility for defects in the Works due to the construction being placed upon an unsuitable formation.

1.1.3.17 Concrete Blinding

Immediately upon completion of the excavation and where shown on the Contractor's drawings or ordered by the Engineer a blinding layer of concrete "20/20" not less than 75 millimetres thick or to the depth ordered shall be placed to prevent deterioration of the formation and to form a clean working surface for the structure.

Disposal of Material

1.1.3.18 Disposal of Excavated Material

Subject to any specific requirements of the Contract the disposition of excavated material shall be at the Contractor's discretion but shall be so arranged as to suit the overall requirements for the construction of the works.

The Contractor shall ensure that no excavated material which is suitable for and is required for re-use in the Works is disposed of outside the site.

The term "excavation" shall be deemed to include for disposing of excavated material within the site in any of the following ways:

- Backfilling to excavations and completed structures (except where such backfilling is specified as special filling) using suitable excavated material and including placing in temporary spoil tips and any double handling required all as specified hereafter, or
- Transporting and placing (approved) excavated material in permanent spoil tips, including the shaping and drainage of such tips all as specified hereafter; or
- Transporting selected excavated material to locations within the site where embankments are to be constructed or where filling around structures is specified to be constructed as embankment including tipping ready for spreading and compacting. or
- Transporting excavated material off the site all as specified hereafter.

1.1.3.19 Spoil Tips on Site

Only material which is approved by the Engineer shall be placed in the various spoil tips. No tree trunks, stumps, roots, branches or rubbish of any kind shall be placed in spoil tips.

Temporary spoil tips may be used to store excavated material as required and shall be arranged by the Contractor subject to the Engineer's approval having regard to any particular requirements of the Contract. Temporary spoil tips shall be so shaped as to maintain stability and good drainage at all times. Topsoil stripped from the site shall be stored in separate spoil tips for use in reinstatement or landscaping.

1.1.3.20 Disposal of Excavated Materials Off Site

Excavated material which is not required for or is unsuitable for re-use in the Works shall be disposed of offsite as directed by the Engineer.

Material ordered to be disposed of shall become the property of the Contractor and he shall be entirely responsible for its removal from the site and ultimate disposal.

1.1.3.21 Disposal of Materials

The disposal by the Contractor of materials arising from site clearance or from excavations shall be undertaken as work progresses so that the site is kept free from unnecessary obstruction.

1.1.4 Backfilling General

1.1.4.1 Scope

This section covers the work necessary for the construction of fills.

1.1.4.2 Governing Standards

Soil tests, when required, shall be governed by the British Standards or standards of the American Society for Testing and Materials (ASTM) and the American Association of State Highway and Transportation Officials (AASHTO).

Maximum density for compacted materials placed under this section shall be determined in accordance with ASTM D1557. In place dry density of compacted fill shall be determined in accordance with ASTM D 1 5 5 6 or D2922.

The quantitative determination of particle size analysis of soils shall be determined in accordance with ASTM D422.

The test method for the determination of the liquid limit, the plastic limit, and the plasticity index values of materials placed under this Contract shall be determined in accordance with ASTM D4318.

1.1.4.3 Preliminary Testing

All tests required for preliminary review of materials shall be made by an approved testing laboratory at the expense of the Contractor. Two initial gradation tests shall be made for each type of embedment and fill material. In addition, sulphate and chloride test results shall be submitted for each borrow material source.

Two Laboratory Modified Proctor Tests in accordance with ASTM-1557 (method D) shall be taken for each source of filling and each type of filling material.

1.1.4.4 Settlement

The Contractor shall be responsible for all settlement of backfilling which may occur within the Defects Liability Period stipulated in the Conditions of Contract.

The Contractor shall make, all repairs or replacements made necessary by settlement within 28 days after notice from the Engineer.

1.1.4.5 Materials

The material for backfilling shall consist of suitable soil with CBR $\geq 10\%$ meeting the required standards. Gravel, cobbles, and rock fragments shall not exceed 75mm in maximum dimension. Fill material after placement shall be free from segregation of material or pockets of material differing in gradation from the surrounding materials. Gravel, cobbles, and rock fragments not containing adequate amounts of finer material to fill the voids shall not be permitted. The material shall be free from brush, stumps, logs, roots, debris, and organic or other deleterious materials.

1.1.4.6 Site Preparation

All sites to be occupied by fill shall be cleared of all logs, trees, roots, brush, tree trimmings, and other objectionable materials and debris. All stumps shall be grubbed. Subgrades for backfilling shall be cleaned and stripped of all surface vegetation, sod, organic topsoil and satisfy CBR $\geq 10\%$. All waste materials shall be removed from the site and disposed of by and at the expense of the Contractor.

After removal of all soft and unsuitable materials such as organic and large rocks, the foundation beneath backfilling shall be prepared by leveling and rolling by several passes of an acceptable roller so that the surface materials of the subgrade will be compact and stable. All soft or loose zones detected by the proof rolling effort shall be removed and replaced with compacted fill in accordance with the requirements for placement and compaction.

Any excavation performed by the Contractor for his own convenience in the foundation preparations shall be replaced by material having qualities of impermeability and density at least equivalent to the original foundation material.

1.1.4.7 Dewatering

Dewatering shall be provided in accordance with the instruction of the Engineer if needed.

At all areas on the site, the fill shall be placed in dry and totally dewatered areas.

1.1.4.8 Embankment Construction Requirements

No material shall be placed in backfilling until the foundation has been dewatered and suitably prepared. Prior to placement of fill material in any portion of the backfilling, all surfaces shall have standing water removed from all depressions and shall be properly moistened and sufficiently clean to obtain a suitable bond with the fill.

1.1.4.9 Embankment and Fill Construction

Backfilling (soil with CBR $> 10\%$) shall be constructed to the lines and grades indicated on the drawings and as required to increase such elevations to allow for subsequent shrinkage or settlement. General requirements, the order of the excavation, the sources of material, and the deposit and compaction of all

excavation materials shall be as specified. Compaction shall reach 95% or more of maximum dry density obtained from modified proctor test.

To the maximum extent available, excess suitable material ($\text{CBR} \geq 10\%$) obtained from site excavations and structure and trench excavation shall be used for the construction of backfilling unless otherwise indicated. Additional material shall be imported. The sulphate and chloride content of the imported material shall not exceed the sulphate and chloride content of the site soils.

Where new material abuts old material, either original ground or backfilling, the old material shall be cut or broken by machine or hand methods accepted by the Engineer until it shows the characteristic color of undried materials. Both materials shall then be worked to bond them together.

1.1.4.10 Control Tests

The determination of the required field density of the compacted fill and structure backfill material shall be determined by performing laboratory tests.

1.1.4.11 Placing and Compacting of Materials

Permanent backfilling shall be constructed in horizontal layers not exceeding 350 mm in uncompacted thickness. Each layer shall be compacted to not less than the maximum dry density determined from laboratory testing. The moisture content shall be adjusted as required to achieve the required compaction.

Motor graders and bulldozers shall be used on each lift to remove mounds and ridges caused by the dumping operation and to obtain uniform thickness prior to compacting, as well as to assure a reasonably smooth riding surface for equipment. After each layer has been properly spread, it shall be sprinkled or wetted, if necessary, to provide the required amount of water for proper compaction, following which the layer shall be compacted to the required density before the next layer is placed thereon. Combined excavation, hauling, and placing operation shall be such that the materials, when compacted in the embankment, will be blended sufficiently to secure the best practicable degree of compaction.

Prior to and during the compacting operations, the material in each layer of the embankments shall have the specified moisture content necessary to achieve the required compaction density. The moisture content shall be uniform throughout the layer. To obtain the specified moisture content, the Contractor will be required to perform such operations as are considered necessary by the Engineer. Supplementary water, as required, shall be added to the material by sprinkling on the fill. If the fill material contains an excess of moisture, the Contractor will be required to perform such work as may be necessary to reduce the moisture content of the material and to produce the required uniformity of water content.

The compacting operation shall commence immediately after the layer has been brought to the uniform moisture content required, and shall continue, with or without additional sprinkling, until each layer has been uniformly compacted by rolling or other method accepted by the Engineer to the required degree of compaction. Which is not less than 95% of maximum dry density obtained from modified proctor test.

1.1.4.12 Imported Soil

Suitable material with $\text{CBR} \geq 10\%$ necessary to complete backfilling may be imported from offsite and hauled to the site of the work. Materials specified herein shall be furnished by the Contractor from his own offsite sources.

The source of any imported soil shall be approved by the Engineer. The sulphate and chloride content of the borrow material shall not exceed the sulphate and chloride content of the site soils.

1.1.4.13 Free Draining Fill, Filters and Slope Protection

Free draining fill material and filters shall be formed of hard durable particles and shall be free from clay, silt, soluble or organic matter.

The particle size distribution of free draining fill materials and filters shall be calculated in accordance with the filter rules so as to form a filter which will prevent migration of fines from the base material.

Material for draining fill shall be provided by the Contractor from an approved source. The Contractor may use material from excavations having first processed it so that it complies with the specification for free draining materials.

Rock used for slope protection (Rip-rap) shall be hard, durable and free from cracks, fissures and planes of weakness. The stones shall be of limits specified. The stones shall be rough hammer dressed so that they fit reasonably closely together. They shall be laid to a true and even surface, the spaces between the stones being filled with small broken stones.

Rock shall also not be liable to deteriorate on exposure to weather, water or wave action. Weight of rock when taken from the quarry shall not be less than 1900 kg/m³ and absorption of water after 24 hours shall not exceed 1.0% from its dry weight. Rip-rap shall conform to grading criteria approved by the Engineer.

The Contractor shall submit full details of the proposed source, certified test results and samples for the approval of the Engineer.

- With respect to rock used in the foot under water level:

Size of rock shall not exceed 40 cm and not less than 20 cm and graded as follows:

- 70% of volume of supplied rocks shall be graded between sizes 30 cm and 40 cm.
- 30% of volume of supplied rocks shall be graded between sizes 20 cm and 30 cm.

- With respect to rock pitching - either dry or with mortar - over water level shall be as follows:

Size of rock shall not exceed 30 cm and not less than 10 cm and graded as follows.

- 80% of volume of supplied rocks shall be graded between sizes 20 cm and 30 cm.
- 20% of volume of supplied rods shall be graded between sizes 10 cm and 20 cm to fill the voids between large rocks/

- With respect to the filter layer:

This layer shall be 30 cm thick divided to a layer of 15 cm thick of coarse clean sand spread on the slopes followed by second layer formed of broken rock or graded aggregate with a thickness of 15 cm and size between 2 cm and 4 cm,

1.1.4.14 Filling Adjacent to Completed Structures

The Contractor shall arrange the timing and rate of placing of fill material around or upon any completed or partially completed structure in such a way that no part of the Works is overstressed, weakened, damaged or endangered. The layers of fill material shall be so placed as to maintain adequate drainage and to prevent accumulation of water.

In particular, the placing of fill materials around the walls of basements and tanks shall commence only after the walls and floor have been completed and have attained their full specified strength. Fill around the walls of reservoirs shall not commence until after satisfactory completion of testing. Fill material behind walls fixed at the top to the roof shall not be placed until the roof has been completed and, if made of concrete, has attained its full specified strength and has the temporary supports removed. The materials shall be placed so as to exert a uniform pressure around the walls of a structure, and each layer shall be placed with a fall to prevent the accumulation of water.

Where not otherwise specified, cohesive soil shall be compacted by sufficient passes of a tamping roller to a density of 95% of maximum dry density determined by BS 1377 Test 12 or as specified in ASTM-D 1557 cohesionless soil shall be compacted by vibrating roller to a relative density of not less than 75%.

Special measures must be taken in compacting material laid immediately adjacent to a concrete wall to ensure that the material is well compacted. Hand operated vibrating plate compactors vibro-tampers or power rammers are to be used. In other cases compaction will be carried out by vibrating compactors smooth wheel or pneumatic type rollers of types approved by the Engineer.

1.1.4.15 Embankments

Embankments shall be of approved material, placed in layers of specified thickness and compacted in the specified manner to the specified lines and levels. Where not other-wise specified, cohesive soil shall be placed in layers not exceeding 200 mm in compacted thickness, cohesionless soil shall be placed in layers not exceeding 400 mm in compacted thickness.

Where not otherwise specified, cohesive soil shall be compacted by sufficient passes of a tamping roller to a density of 95% of maximum dry density determined by BS 1377 Test 12 or as specified in ASTM-D 1557 cohesionless soil shall be compacted by vibrating roller to a relative density of not less than 75%.

Additional material shall be placed above the specified levels to allow for subsequent settlement as calculated or, where not calculated, as specified by the Engineer, so that the final levels after settlement shall not be lower than the specified levels.

Adjusting

1.1.4.16 Final Grading

After work has been finished on backfilling, all areas which are to be graded shall be brought to grade at the indicated elevations, and contours.

Use of tracked power equipment will be permitted for final grading and dressing of backfilling, provided the result is uniform and equivalent to hand work. All surfaces shall be graded to secure effective drainage.

Final grading and surfacing shall be smooth, even, and free from clods and stones larger than 25 mm in greatest dimension, weeds, brush, and other debris.

Cleanup

1.1.4.17 Disposal of Excess Excavated Materials

Insofar as needed, suitable excavated materials shall be used in fills. All unused suitable excess excavated materials, except clay soils, together with all debris, stones, logs, stumps, roots, and other unsuitable materials shall be removed from the site and disposed of by, and at the expense of, the Contractor and in accordance with the instructions of the Engineer. Removal and disposal of this material from the site shall be the responsibility of the Contractor. In order to avoid unauthorized disposal, the Contractor shall arrange for each driver employed for the disposal of excavated materials to be given written instructions as to the acceptable place where each load is to be tipped. Copies of instructions, together with a list of approved places to be used, shall be available for inspection at any time by the Engineer. The Employer shall be indemnified against any claims arising from unauthorized disposal of such materials.

1.2 Concrete

1.2.1 General Requirements

This section covers the supply of materials for concrete, design of concrete mixes, quality control of concrete, mixing, transporting, placing, curing and testing of concrete.

1.2.1.1 References, Standards and Codes

The following publications, references, codes and standards are referred to in this Section with their latest amendments:

American Concrete Institute (ACI-318-2019):

The technical specifications for concrete works in an elevated tank project based on ACI 318-19.

1. Concrete Materials:

- Cement: The specification should require Type I/II Portland cement conforming to ASTM C150. This is the most common cement type used for general concrete construction.
- Aggregates: Fine and coarse aggregates should meet the grading and quality requirements of ASTM C33. Aggregates should be hard, durable, and free of deleterious substances.
- Water: The water used for mixing and curing concrete should be potable or meet the chemical limits specified in ACI 318-19 Section 26.4.1.3.
- Admixtures: Any chemical admixtures, such as water reducers, air-entrainers, or accelerators, should conform to ASTM C494 and be compatible with the cement.

2. Concrete Mixture Design:

- The concrete mixture proportions should be designed in accordance with ACI 318-19 Section 26.4.3. This includes determining the appropriate cementitious materials content, water-cementitious materials ratio, and aggregate proportions to achieve the target compressive strength (f'_c).
- The specification should require a minimum compressive strength (f'_c) based on the structural requirements of the elevated tank, typically in the range of 4,000 to 6,000 psi.
- The maximum water-cementitious materials ratio should be specified, usually around 0.45 to 0.50, to ensure durability and minimize shrinkage.
- An appropriate air content, typically 4-7%, should be specified to provide freeze-thaw resistance for outdoor exposed concrete.

3. Concrete Placement and Finishing:

- The specification should detail the requirements for concrete placement, including transportation, handling, and consolidation methods to ensure proper compaction and minimize segregation.
- Concrete curing procedures should be specified to maintain moisture and temperature conditions for the required curing period, as per ACI 318-19 Section 26.5.
- Concrete finishing requirements, such as smooth, broom, or trowel finishes, should be clearly defined based on the intended use and exposure conditions of the concrete surfaces.

4. Reinforcement:

- The reinforcing steel should conform to ASTM A615 Grade 60 or an equivalent high-strength deformed bar.
- Welded wire reinforcement, if used, should meet the requirements of ASTM A1064.
- The specification should include details on the placement, lap splicing, and anchorage of the reinforcement, following the provisions of ACI 318-19 Chapter 25.

5. Formwork and Embedded Items:

- The formwork design and construction should comply with the requirements of ACI 318-19 Section 26.11, ensuring that the formwork is sufficiently rigid and supported to maintain the desired concrete shape and dimensions.
-

- The placement of embedded items, such as anchor bolts, sleeves, and other accessories, should be specified in accordance with ACI 318-19 Section 26.6.

6. Inspection and Testing:

- The specification should outline the concrete sampling and testing procedures, including the frequency and acceptance criteria for compressive strength, slump, and air content, as per ACI 318-19 Chapter 26.
- Any other required testing, such as for reinforcement, should also be included in the specification.

7. Tolerances:

- The construction tolerances for the elevated tank concrete elements should be specified in alignment with the requirements of ACI 117 Standard Specifications for Tolerances for Concrete Construction and Materials.

American Society for Testing and Materials:

- ASTM C39 Standard test method for compressive strength of cylindrical concrete specimens (AASHTO T22).
- ASTM C88 Standard test method for soundness of aggregates by use of sodium sulfate or magnesium sulfate.
- ASTM C94 REV A Ready mixed concrete.
- ASTM C109 Standard test method for compressive strength of hydraulic cement mortars.
- ASTM C260 Air entraining admixtures for concrete.
- ASTM C494 Standard specification for chemical and mixtures for concrete.
- ASTM C618 Fly ash and raw or calcined natural pozzolans for use as a mineral admixture in portland cement concrete.
- ASTM D512 Standard test method for chloride ion in mixing water.
- ASTM D516 Standard test method for sulphate ion in mixing water.
- ASTM D1411 Standard test method for water-soluble chlorides present as admixes in graded aggregate.

American Concrete Institute Standards:

- ACI 305 Recommended Practice for hot weather concreting.

Other standards may be used subject to the Engineer's approval.

1.2.1.2 CONCRETE FORMWORK INCLUDES:

- Formwork for cast-in-place concrete structures
 - Openings for Other Work
 - Form Accessories
 - Form Stripping
-

1.2.1.3 DESIGN REQUIREMENTS

- Design and construction of formwork is the responsibility of the CONTRACTOR.
- Design formwork for vertical loads and lateral pressures in accordance with ACI 301, and ACI 347.
- Design formwork system which is adequately braced and has adequate strength and stability to ensure finished concrete within the specified tolerances.
- When necessary to maintain the specified tolerances, design camber into the formwork to compensate for an anticipated deflection and creep due to the weight and pressure of the fresh concrete and construction loads.

1.2.1.4 QUALITY ASSURANCE

- Perform work in accordance with ACI 301, 318, and 347.

1.2.1.5 QUALIFICATIONS

- Design formwork under direct supervision of a Structural Engineer experienced in design of this work.

1.2.1.6 DELIVERY, STORAGE AND HANDLING

- Deliver, store, protect and handle products to site.
- Store off ground in ventilated and protected manner to prevent deterioration from moisture.

1.2.1.7 COORDINATION

- Coordinate this Section with other Sections of work which require attachment of components to formwork.
- Prior to installing formwork, ensure that the long radius bends, required for concrete reinforcement will allow for correct placement of other rebar, anchor bolts and other embeds as well as providing the required concrete cover for the reinforcement.

FRAMING LUMBER

All framing lumber shall be stress graded. Lumber in direct contact with concrete shall be dressed on at least the contact side, with dressed or tongue and groove edges; other lumber may be dressed or rough.

BOARDS

Tongue and groove, Commercial Standard Douglas Fir or Number 2 common or better lumber, uniform 25mm thickness, to provide tight forms and of such moisture content as to prevent free absorption of moisture.

PLYWOOD FORMS

- Exposed Surfaces in Finished Work: 16mm or 19mm thick, high density overlay Plyform, Class 1 or Class II Exterior, DFPA grade trademarked, edge sealed, complying with PS-1.
- Concealed Concrete Surfaces: 16mm or 19mm thick, BB Plywood, Class 1 Exterior, DFPA grade trademark, complying with PS-1.

FIBERGLASS, PLASTIC AND METAL FORMS

May be used, subject to approval by the ENGINEER, if they produce the required concrete surfaces.

HARDBOARD

Tempered, S1S, not less than 5mm thick, in compliance with ANSI A135.4.

FORM TIES

Furnish ties designed for a minimum working strength, when fully assembled, of at least 11,000 N. Ties shall not be fitted with lugs, cones, washers or other devices which will leave a void in the concrete. Snap or wire ties are not acceptable. Use water seal ties in concrete exposed to hydrostatic pressure.

- Concealed Work: Use tie type with adjustable length which will not leave holes or depression larger than 22mm in diameter in face of concrete when removed.
- Exposed Exterior and Interior Work: Use a threaded, disconnecting type tie without cones.

FORM RELEASE AGENT

Non-staining liquid product which imparts waterproof film to prevent adhesion of concrete and will not leave paint impeding coating on face of concrete surfaces scheduled to be painted or act as a bond breaker to surfaces scheduled to be tiled.

JOINT DEVICES AND FILLER MATERIALS

- i) Premolded joint filler shall comply with ASTM D1752. Type I: Sponge Rubber, Type II: Cork, or Type III; Self-expanding cork.
- ii) Construction Joint Devices: Integral galvanized steel.
- iii) Sealant and Primer: Refer to Section 07920

WATERSTOPS

Polyvinyl chloride, minimum 12 Mpa tensile strength, minimum 46 degrees C to plus 79 degrees C working temperature range, maximum possible lengths, ribbed profile, preformed corner sections, heat welded jointing.

SCREED CHAIRS

Galvanized steel chairs shall be used. Wood shall not be used.

CHAMFER STRIPS

25mm angle chamfer strips of material same as forms shall be placed at all edges and corners of beams and pedestals which will be exposed in the finished work.

EXAMINATION

Verify lines, levels, and centers before proceeding with formwork. Ensure dimensions agree with Contract Drawings.

EARTH FORMS

Hand trim sides and bottom of earth forms. Remove loose soil prior to placing concrete.

ERECTION - FORMWORK

- Installation and removal of formwork shall comply with the recommendations of ACI 318, Chapter 6, and ACI 347.
- Construct adequately braced formwork so resulting concrete surfaces conform to specified tolerances.
- Brace forms adequately to retain forms in position during concrete placement and curing.
- Provide mortar-tight forms which conform to shapes, lines and dimensions shown and produce smooth surface without fins and projections.
- Provide form liners at locations and surfaces as indicated on Architectural Contract Drawings and as specified herein.
- All external edges of exposed concrete shall be chamfered by inserting 25mm angle strips in the form, unless otherwise noted on the Contract Drawings.

APPLICATION - FORM RELEASE AGENT

- A.** Apply form release agent on formwork in accordance with manufacturer's recommendations.
- B.** Coat forms with form release agent prior to placement of reinforcing steel. Do not allow excess coating material to stand in puddles in forms nor to come into contact with concrete against which fresh concrete is to be placed.
- C.** Do not apply form release agent where concrete surfaces will receive special finishes which are effected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

INSERTS, EMBEDDED PARTS, AND OPENINGS

- A.** Conduits and pipes shall be embedded in accordance with ACI 318 (Section 6.3). All embedded items shall be coated in accordance with ASTM A153.
 - B.** Ensure items to be embedded in concrete are free from oil and foreign matter that would weaken bond of concrete to such items.
 - C.** Install inserts, anchors, sleeves, reveals and other items specified elsewhere. Close ends of conduits, and piping and sleeves embedded in concrete with caps or plugs. Ensure that anchor bolts do not come in contact with reinforcing steel.
 - D.** Install waterstops continuous without displacing reinforcement at construction joints as shown on Contract Drawings and in accordance with manufacturer's instructions.
-

- E.** Complete test on piping and other items before starting concrete placement.
- F.** Before depositing concrete, check location and support of piping, electrical conduits and other items which are to be wholly or partially embedded.
- G.** Provide openings and recesses where required. Furnish and install sleeves.

JOINTS

- A.** Unless otherwise directed, make contraction, expansion and construction joints only where shown. All construction joints shall be wetted and standing water removed before new concrete is poured.

Locate construction joints perpendicular to the main reinforcement. All reinforcement to continue across joints. Arrange construction joints in a manner that will allow the concrete to be placed in one continuous operation. Immediately prior to placing adjacent concrete, thoroughly clean and wet the joint surface. After wetting, apply a uniform coat of neat cement grout. Install joints in a manner that will least impair the structures. Contractor shall provide drawings showing location of all construction and control joints.

- B.** Form keyways as shown on Contract Drawings.
- C.** Continue reinforcing steel and wire fabric across joints unless they are shown as being free to move.
- D.** Provide control joints in floor slabs except where covering occurs, e.g., with tiles. Make maximum distance between transverse contraction joints 5.0 meters as shown on Contract Drawings.
- E.** Install premolded joint filler at locations shown. Extend filler from bottom of concrete to flush with finished concrete surface or hold down below finish surface as shown on Contract Drawings.
- F.** Make splices in premolded filler in manner to preclude penetration of concrete between joint faces.
- G.** Where premolded joint filler is held below finish concrete face, install insert in the form to leave a proper size slot to receive sealant compound specified in Section 07920.

FORM CLEANING

- Clean forms as erection proceeds, to remove foreign matter such as sticks, boards, loose rocks, sand, debris, etc. within forms.
- Prior to placing concrete, forms shall be sprayed with contaminant free water to prevent loss of moisture from the concrete. Do not permit water to puddle.
- In tall narrow forms, "Window" shall be provided on the bottom for cleaning out the forms.

FORMWORK TOLERANCES

- Construct formwork to maintain tolerances required by ACI 301.

FIELD QUALITY CONTROL

- Inspect erected formwork, shoring, and bracing to ensure work is in accordance with formwork design, and supports, fastenings, wedges, ties, and items are secure prior to placement of concrete.

REMOVAL OF FORMS AND SHORES

- Forms and shores shall not be removed until concrete has attained sufficient strength to support its own weight and the imposed loads. Forms shall be removed when safety and serviceability are not impaired.
- Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

CONCRETE REINFORCEMENT

SECTION INCLUDES

- A. Reinforcement, wire fabric and accessories for concrete structures.

RELATED SECTIONS

- A. Concrete Formwork
- B. Cast-in-place Concrete
- C. Insulated Unit Masonry System

REFERENCE

- A. American Concrete Institute (ACI)
- 315 - Details and Detailing of Concrete Reinforcement
- 315R - Manual of Engineering and Placing Drawings for Reinforced Concrete Structures. 318 - Building Code Requirements for Reinforced Concrete.
- B. American Society for Testing and Material (ASTM)
- A82 - Cold-Drawn Steel Wire for Concrete Reinforcement A185 - Welded Steel Wire for Concrete Reinforcement
- A616 - Rail Steel Deformed and Plain Bars for Concrete Reinforcement A775/A775M-89 - Epoxy Coated Reinforcing Steel Bars
- A884 - Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.
- C. Concrete Reinforcing Steel Institute (CRSI) CRSI Manual of Standard Practice
- D. American Welding Society
- AWS D12-1- Recommended practice, for welding reinforcing steel, metal inserts and connections in reinforced concrete construction.

SUBMITTALS

- A. Shop Drawings - Submit Bar Bending Schedules and Bar placement detailed drawings.
- B. Certificates - Submit manufacturer's certification that materials meet specification requirements.
- C. Mill Test Reports - Submit mill test reports showing chemical and physical analyses performed in accordance with ASTM A616 as modified by ACI 318.

COORDINATION

- A. Coordinate work under provisions of project coordination.
-

- B. Coordinate with placement of formwork, formed openings and other work.

DELIVERY AND IDENTIFICATION

- A. Shipping - Ship reinforcing steel in bundles limited to one size and length. Equipment for handling bars shall have protected contact areas. Bundles of bars shall be lifted at multiple pick-up points to minimize bar to bar abrasion from sags in the bundles. Bars shall not be dropped or dragged. Bars shall be stored on protective cribbing.
- B. Identification - Tag each bundle at mill with waterproof tag showing name of mill, heat number, grade and size of bars and identifying number and shop drawing number. Tags shall not removed till reinforcement is in place.

1.3 REINFORCEMENT

- A. Reinforcing Bars , 420 Mpa yield grade. Use deformed bars, unless otherwise indicated on the Contract Drawings. Deformed rebars shall be used for all foundations, columns, grade beams, walls, roof and all elements in contact with soil & water.
- B. Welded Wire Fabric - ASTM A185, and SASO Specification SSA 224-1981.

ACCESSORY MATERIALS

- C. Tie Wire - 1.5 mm minimum, carbon steel soft temper, nylon, epoxy or plastic coated.
- D. Support for Reinforcement - As recommended by CRSI Manual of Standard Practice. All chairs, bolsters, bar supports, and spacers shall be coated or made of corrosion resistant material. Where concrete surfaces will be exposed to public view in finished structure use supports with plastic- protected legs or stainless steel legs.

FABRICATION

In accordance with the CRSI Manual of Standard Practice, and the following:

Reinforcing bars shall be cut and cold bent in accordance with ACI 315 and ACI 318 to shapes and dimensions specified in the approved Bar Bending Schedules and then placed as shown on the detailed drawings. Do not bend or straighten bars so as to damage or weaken material. The Contractor shall review all bending details prior to fabrication to verify that concrete cover and anchor bolt clearances can be maintained.

- **PART 3 EXECUTION**

INSPECTION

- Inspection and repair of reinforcement shall be done as per manufacturer's recommendations. The Contractor shall be responsible for repairing all damaged rebar. No concrete shall be placed until all rebars have been inspected and approved by the ENGINEER.

BAR SUPPORT AND SPACERS

- Support bars by means of bolsters or chairs with no less than minimum required by ACI 315R.

PLACING AND FASTENING

- Arrange and place reinforcing steel as shown on Approved Drawings. Welded wire fabric shall be rolled out flat in longest practical lengths. Lap joints one mesh plus 50mm. or 150mm minimum. Offset and laps of adjacent widths to prevent continuous lap. Fasten ends and sides of mesh at 400mm O.C. with tie wire.
- Secure reinforcement positively against displacement during placing of concrete.
- Wire or clip bars together as recommended in CRSI Recommended Practice for Placing Reinforcing Bars. Splices shall be tied with two wires.
- Maintain reinforcing steel accurately in locations shown.
- Before placement, ensure that reinforcement is free from dirt, mill scale, rust scale, oil, grease and other foreign matter.
- Reinforcement in formed concrete shall be fixed in position by means specified in paragraph 3.02 A above so that the necessary clearances from the surface of the concrete are maintained.

SPLICING

Lap splice bars as shown on contract drawings. Welded or mechanical splices, when approved shall develop not less than 125 percent of minimum yield strength of bar.

Avoid splicing at points of maximum stress. The minimum lap for a lapped splice shall be in accordance with ACI 318-89.

FIELD QUALITY CONTROL

- Field inspection shall be performed under quality control approved plan.
-

CAST –IN-PLACE CONCRETE

SECTION INCLUDES

- A. Portland cement cast-in-place concrete.
- B. Dry pack bedding mortar.
- C. Concrete Accessories

RELATED SECTIONS

- Concrete Formwork
- Concrete Reinforcement
- Concrete Finishing
- Concrete Curing
- Bituminous Damp-proofing.

REFERENCES

A. American Concrete Institute (ACI)

211.1 Standard Practice for Selecting Proportions for Normal, Heavy weight and Mass Concrete

301 Specifications for Structural Concrete for Buildings 303R Guide to Cast-in-Place Architectural Concrete

304 Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete. 305R Hot Weather Concreting

309 Standard Practice for Consolidation of Concrete

311 Recommended Practice for Concrete Inspection

318 Building Code Requirements for Reinforced Concrete

B. American Society for Testing and Materials (ASTM)

C31 Making and Curing Concrete Test Specimens in the Field C33 Concrete Aggregates

C39 Compressive Strength of Cylindrical Concrete Specimens C94 Ready-Mixed Concrete

C143 Slump of Portland Cement Concrete C150 Portland Cement

C172 Sampling Freshly Mixed Concrete

C231 Air Content of Freshly Mixed Concrete by the Pressure Method C260 Air-Entraining Admixtures for Concrete

C494 Chemical Admixtures for Concrete

C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

E329 Inspection and Testing Agencies for Concrete, Steel, and Bituminous Material as Used in Construction

D1752 Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

SUBMITTALS

- A. Submit under provisions of project general conditions.
- B. Design Mix.
 - Prior to placing concrete, submit design mixes for each class and type of concrete, certifying that proposed concrete ingredients and proportions will result in concrete mix meeting specified requirements. Include the following data:
 - Minimum sacks of cement per cubic meter;
 - Maximum water content per sack of cement;
 - Percent of air-entrained - by volume;
 - Maximum nominal coarse aggregate size;
 - Weights of aggregate in saturated surface-dry condition;
 - Design slump; and
 - Admixture type and gram per cubic meter.
 - Include for each class and type of concrete as many mix designs as there are combinations of different ingredients or types of ingredients anticipated to cover requirements of the work.
 - Test Reports: Submit test reports of concrete compression, air content, and slump tests within twenty four hours after completion of each test.
 - Certificates: Submit:
 - ✓ Manufacturer's certification that materials meet specification requirements.
 - ✓ Ready-mix delivery tickets.

PROJECT RECORD DOCUMENTS

- C. Submit under provisions of project general conditions.
- D. Accurately record actual locations of embedded utilities and components which are concealed from view.

QUALITY ASSURANCE

- E. Perform work in accordance with ACI 301 except as modified by ACI-318M.
- F. Conform to ACI 305R when concreting during hot weather.
- G. All testing, including requests and reports, are the responsibility of the Contractor.
- H. Failure to detect defective work or materials during testing will neither prevent rejection later when such defects are discovered, nor will it obligate the OWNER to make final acceptance.

FIELD SAMPLES

- ✓ Provide under project conditions and as per ENGINEER instructions.
-

COORDINATION

- I.** Coordinate work under project provisions..
- J.** Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.

CONCRETE MATERIALS

- A.** Cement: For all concrete below grade, and for structures containing liquids use Portland Cement, ASTM C150, Type V including the optional chemical requirements of Table 1-A and optional physical requirements of Table 2A.

For concrete above grade Type I cement shall be used. All bagged cement shall be clearly marked with name of manufacturer. Any bag varying more than 3% shall be rejected.

- B.** Aggregates: Conform to SASO SSA 278/1982 and the following:

- 1. Fine: ASTM C33. Sand shall be clean, hard, durable, uncoated grains, free from deleterious substances.
- 2. Coarse: ASTM C33. Aggregate shall be crushed stone, gravel or other aproved inert material having clean, hard, durable, uncoated particles. Maximum size aggregate shall be as follows:
 - ✓ Footings, Slabs on ground and unreinforced concrete: ASTM C33, Gradation 467 (37.5 mm to 4.75 mm).
 - ✓ Other concrete: ASTM C33, Gradation 57 (25 mm to 4.75 mm).
 - ✓ Water: Potable.

ADMIXTURES

- C.** Air-entraining: ASTM C260
- D.** Water Reducing: ASTM C494, Type B (retarding), D (water reducing and retarding) or G (water reducing, high range and retarding) depending upon the temperature, humidity and wind conditions oat time of placement.
- E.** Calcium Chloride or Admixtures containing chloride salts shall not be used.
- F.** Administering of the Admixtures shall be by means of automatic weighing at batching plants only.

ACCESSORIES

- G.** Epoxy Bonding Agent: For bonding new concrete to existing concrete use Sika's Sikador Hi-Mod; Adhesive Engineering Company's Concrevice 1001-LPL or 1170; Master Builder's Brutem 17, or approved equal.
 - H.** Vapor Barrier: A minimum thickness of 0.15mm (6 Mils) polyethylene sheet.
 - I.** Dry-pack Mortar: Dry pack mortar shall be composed of one part Portland Cement, two parts sand with sufficient water that a mass of mortar tightly squeezed in the hand will retain its shape but will crumble when distributed.
 - J.** All structural concrete shall have a minimum compressive strength of 27.58 Mpa (4000 psi) at 28 days. Lean Concrete beneath foundation, where specified on Contract Drawings, shall have a minimum compressive strength of 13.8 MPa (2000 PSI) at 28 days.
-

- K. Inserts: As shown in Contract Drawings and shall be hot dipped galvanized.
- L. Dovetail Anchors Slots: Self securing 20 gauge galvanized metal packed with readily removable material.
- M. Protection of concrete below grade: Comply with the requirements of section 07160.

CONCRETE MIX

- N. Mix and deliver concrete of the required strength & workability at the site. Addition of water to the concrete at site will not be allowed.
- O. Provide concrete to the criteria given on Contract Drawings.
- P. Chemical Admixture: Quantity, preparation and mixing shall comply with the manufacturer's directions for use at temperatures when concrete will be placed. Calcium chloride shall not be used.
- Q. Air Entrainment: Determine air content in accordance with ACI 301, Chapter 3, Table 3.4.1.
- R. Consolidation: Comply with ACI 309.
- S. Hot Weather Concreting: Comply with ACI 305R.
- T. Joints: Comply with ACI 301, Chapter 6.

- **PART 3 EXECUTION**

EXAMINATION

- A. Verify site condition under provisions of Section 01040.
- B. Verify requirements for concrete cover over reinforcement.
- C. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete. Use wooden templates for accurately positioning anchor bolts, if required.

PREPARATION

- D. Bonding New Concrete to Existing Concrete: Thoroughly clean and roughen existing concrete to a full amplitude of 6mm by sand blasting or other mechanical methods. Apply an approved epoxy bonding agent to the contact surface in accordance with the manufacturer's recommendations. Do not apply when the air temperature is less than 5 degrees C.
- E. Thoroughly compact the sub-grade.

PLACING CONCRETE

- F. Place concrete in accordance with ACI 301 and 304.
 - G. Place vapor barrier as noted on Contract Drawing. Repair vapor barrier damaged during placement of reinforcement. Repair with vapor barrier material. Lap over damaged areas minimum 150 mm and seal watertight. Wet the surface of mud slab beneath foundations just prior to concrete placement where lean concrete is specified on Contract Drawings.
 - H. Install joint devices in accordance with manufacturer's instructions.
 - I. Place concrete continuously between predetermined expansion, control, and construction joints.
-

- J. Consolidate concrete in accordance with ACI-301, and 309.
- K. Place floor slabs in saw cut pattern. Monolithic pours shall not exceed 110 sq. meters and shall be as nearly square as feasible. Construction joints shall be located accordingly.
- L. Provide vertical V-notch type contraction joints on the outside face of retaining walls spaced no more than 9 meters (30 ft.) apart horizontally. Locate per architectural Contract Drawings.
- M. Backfill shall be completed both in front and behind the retaining wall to the same finished level before additional material is placed behind the wall.
- N. Just prior to the placement of concrete, forms shall be cleaned of all debris, sand and standing water. In tall or narrow forms, windows shall be provided on the side of forms.
- O. Concrete shall be deposited at or near its final position, eliminating the tendency to segregate when it has flowed laterally into place. Concrete will be moved by shovel method only. No rakes will be used in concrete placement.
- P. On sloping surfaces, concrete placement shall start at the lower portion of the slope and progress upward.
- Q. No concrete that has partially hardened or been contaminated by foreign material shall be placed in the forms.
- R. Concrete shall not be dropped freely from a height of more than 1 m (3 ft.) and shall be distributed in uniform layers not to exceed 600 mm (2 ft.) in height, avoiding inclined layers and cold joints.
- S. Slabs and beam stems shall be placed in one operation.
- T. Concreting once started, shall be continuous until a section is completed. When stoppage occurs, construction joints shall be placed horizontally or vertically. As needed, provide keys and dowels.
- U. All concrete shall be thoroughly consolidated by vibrators, working concrete around reinforcement and embedded fixtures and into corners of the forms. Vibrators shall be adequately sized as per ACI-309, Table 5.1.4.
- V. Vibrators shall not be used to move concrete laterally. Vibrators should be inserted and withdrawn vertically at intervals of five to twenty seconds duration and at points 460 mm to 750 mm (18 in to 30 in) apart, penetrating previously placed fresh concrete. Do not over-vibrate.

SURFACE TOLERANCES

Comply with the recommendations of ACI 301, Chapter 11 for class A, B, or C tolerances.

CONCRETE FINISHING

- W. Concrete Floor Finishing - Refer to FINISHING section.
 - X. Formed Surface: Finishes shall be produced by complying with the requirements of ACI 301, Chapter 10.
 - Y. Horizontal Surface: Finishes shall be produced by complying with the requirements of ACI 301, Chapter 11.
 - Z. Equipment Pads or Bases: Surfaces shall be steel trowelled unless otherwise noted on Contract Drawings. Provide a Class A horizontal surface and finish the visible edges using a 12mm radius edger.
 - AA. Wood float surfaces which will receive tiles with full bed setting system.
-

BB. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drain at 10mm per meter unless otherwise noted on Contract Drawing.

CURING AND PROTECTION

Refer to Section 03370.

FIELD QUALITY CONTROL

CC. Field inspection and testing will be performed in accordance with ACI 301 and under provisions of Section 01400.

DD. Qualifications of Testing Agency: Testing agency shall meet the requirements of ASTM E329.

EE. Tests:

- 1) Compression and strength tests: Each test shall consist of four standard 150mm by 300mm cylinders; two cylinders to be tested at the age of seven days and two cylinders at the age of 28 days. Specimens made to check the adequacy of the design for strength of concrete, or as a basis for acceptance of concrete, shall be made and laboratory-cured in accordance with ASTM C31. Additional tests of specimens cured entirely under field conditions may be utilized to check the adequacy of curing and protection of the concrete. Strength tests shall be in accordance with ASTM C39.
- 2) Slump tests: Tests for slump shall be made at the place of deposit and in accordance with ASTM C143. Tests shall be made on the first batch of each day's delivery, whenever cylinders are made, after a change in mix proportions and as often as necessary to control slump required. If failure to meet specifications is indicated, a check on another portion of same sample shall be made immediately. If the second check also indicates failure, the batch shall be rejected. Slump should be as follows:

	<u>Max</u>	<u>Min</u>
Foundation,	130mm	50mm
Walls and Footings	100mm	50mm
Building Beams, Walls and Columns		
Slabs on Grade	75mm	50mm

- 3) Air entrainment tests: At least one test shall be made at the place of deposit for each day's placing and as often as a change in consistency of the concrete mix is noted. For normal weight (stone) concrete the tests shall be made in accordance with ASTM C231.

FF. Corrective action: When a cylinder falls below the specified strength for the location of concrete specified, the design mix and water content shall be adjusted to produce the specified strength for concrete that is subsequently placed. In addition, additional curing or replacement may be required for that portion of the structure where the questionable concrete has been placed.

6.3.02 PATCHING

A. General: Surface defects, including tie holes, unless otherwise indicated shall be repaired immediately after form removal. Honeycombed and other defective concrete shall be removed down to sound concrete. If chipping is necessary the edges shall be perpendicular to the surface or slightly undercut. No feathered edges are acceptable. The area to be patched and an area at least 150mm wide surrounding the patch shall be dampened to prevent absorption of water from the patching mortar.

B. Application:

- 1) A bonding grout shall be prepared using a mix of approximately one part Portland Cement to one part fine sand passing a 0.6 mm (No. 30) mesh sieve, mixed to the consistency of thick cream.

The patching mixture shall be produced using the same materials and of the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than one part Portland Cement to 2.5 parts sand by damp loose volume. White Portland Cement shall be substituted for a part of the gray Portland Cement on exposed concrete in order to

produce a color matching the color of the surrounding concrete, as determined by a trial patch. The quantity of mixing water shall be no more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.

- 2) After surface water has evaporated from the area to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to lose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, the mortar shall be left undisturbed for at least 1 hour before being finally finished.
- 3) The patched area shall be kept damp for seven days. Metal tools shall not be used in finishing a patch in a formed wall which will be exposed.

C. The holes shall be filled solid with patching mortar.

6.3.03 DEFECTIVE CONCRETE

- A. Concrete will be considered defective unless it is structurally sound, watertight, properly finished and within specified tolerances.
 - B. Concrete in place that is deemed structurally defective will be checked at the direction of the ENGINEER by drilled core specimens or other acceptable means. If testing of core specimens shows that strength is less than 85 percent of specified strength, the concrete will be considered defective.
 - C. Defective concrete shall be replaced unless other corrective action is approved by the ENGINEER.
 - D. Costs incurred in replacement and taking and testing of core specimens shall be borne by the Contractor.
-

1.4 Formwork and Joints

1.4.1 General Requirements

This section covers the supply, erection, removal of formwork, the finishes to be attained and the remedial action to be taken to the finished concrete after removal of formwork.

1.4.1.1 References, Standards and Codes

The following publications, references, codes and standards are referred to in this Section.

British Standards Institution (BSI)

BS 3809 1993 Wood wool permanent formwork and infill units for reinforced concrete floors and roofs.

American Concrete Institute Standard (ACI)

ACI 347 Formwork for concrete, fifth edition.

American Association of State Highways and Transportation Officials AASHTO)

AASHTO M33 Standard Specification for preformed expansion joint filler for concrete (bituminous type) (ASTM D994-71 - R 1982).

Other standards may be used subject to the Engineer's approval.

1.4.1.2 Submissions

When required by the Engineer, the Contractor shall submit calculations and designs for formwork including layout of panels, before fabrication is commenced.

1.4.2 Formwork

1.4.2.1 Materials

Formwork shall be constructed of timber, sheet metal or other approved material. The Contractor shall also furnish all struts, braces and ties to withstand the placing and vibrating of concrete and the effects of weather.

Form ties shall be the rod and cone or other approved type. They shall be designed so that no part remaining embedded in the concrete after the formwork has been removed shall be nearer than 50mm from the surface in the case of reinforced concrete and 150mm in the case of unreinforced concrete.

Form ties for use in water retaining structures shall incorporate a diaphragm not less than 50mm diameter welded to the mid point of the tie, designed to prevent water passing along the tie.

1.4.2.2 Design and Detailing

The Contractor shall be responsible for the adequacy and safety of formwork.

On formwork to external faces which will be permanently exposed, all horizontal and vertical formwork joints shall be so arranged that joint lines shall form a uniform pattern on the face of the concrete.

Where the Contractor proposes to make up the formwork from standard sized manufactured formwork panels, the size of such panels shall be approved by the Engineer before they are used in the construction of the Works. The finished appearance of the entire elevation of the structure and adjoining structures shall be considered when planning the pattern of joint lines caused by formwork and by construction joints to ensure continuity of horizontal and vertical lines.

1.4.2.3 Erection of Formwork

All formwork shall be soundly constructed, firmly supported, adequately struted, braced and tied to withstand the placing and vibrating of concrete and the effects of weather. Formwork shall not be tied to or supported by reinforcement.

Faces of formwork in contact with concrete shall be free from adhering foreign matter, projecting nails and the like, splits or other defects, and all formwork shall be clean and free from standing water, dirt, shavings, chippings or other foreign matter. Joints shall be sufficiently watertight to prevent the escape of mortar or the formation of fins or other blemishes on the face of the concrete.

All exposed exterior angles on the finished concrete of ninety (90) degrees or less shall be given 20mm by 20mm chamfers.

Formwork shall be provided for the top surfaces of sloping work where the slope exceeds fifteen (15) degrees from the horizontal (except where such top surface is specified as spade finish) and shall be anchored to enable the concrete to be properly compacted and to prevent air being trapped.

Formwork in contact with the concrete shall be treated with a suitable non staining mould oil prior to reinforcement and concrete placement, to prevent adherence of the concrete except where the surface is subsequently to be rendered. Care shall be taken to prevent the oil from coming in contact with reinforcement or with concrete at construction joints. Surface retarding agents shall not be used unless specified.

Where ties are built into the concrete for the purpose of supporting formwork, the whole or part of any such supports shall be capable of removal so that no part remaining embedded in the concrete shall be nearer than 50mm from the surface in the case of reinforced concrete and 150mm in the case of unreinforced concrete. Holes left after removal of such supports shall be neatly filled with well rammed dry pack mortar.

Openings for inspection of the inside of the formwork, for the removal of water used for washing down and for placing concrete shall be provided and so formed as to be easily closed before or during placing concrete. Before placing concrete all bolts, pipes or conduits or any other fixtures which are to be built in shall be held fast by fixing to the formwork or otherwise. Holes shall not be cut in any concrete without prior approval of the Engineer.

1.4.2.4 Removal of Formwork

Formwork shall be so designed so as to permit easy removal without resorting to hammering or levering against the surface of the concrete.

The periods of time elapsing between the placing of the concrete and the striking of the formwork shall be as approved by the Engineer after consideration of the loads likely to be imposed on the concrete and shall in any case be not less than the periods shown below.

Where soffit formwork is constructed in a manner that allows the removal of the majority of the formwork and the retention during and after such removal of a sufficient number of adequate supporting props in an undisturbed condition, the Contractor may with the agreement of the Engineer, remove the formwork at the earlier times listed below provided that the props are left in position and are not disturbed during removal of the majority of the formwork.

Minimum Period Before striking Formwork:

Type of Formwork	Minimum Period Before Striking Formwork
Vertical formwork to columns, walls and large beams	18 hours
Soffit form work to slabs (props left under)	3 days
Props to slabs	11 days
Soffit form work to beams (props left under)	8 days
Props to beams	15 days

Notwithstanding the foregoing, the Contractor shall be held responsible for any damage arising from removal of formwork before the structure is capable of carrying its own weight and any incidental loading.

1.4.2.5 Building in Plant

The Contractor shall erect all formwork, struts and other temporary work to enable the plant to be built in, and such formwork shall be designed to allow placing of the concrete, mortar or grout so as to fill the voids completely, and to enable the air to escape from any cavities during filling. The formwork shall be sealed against pipework and other items of the plant to prevent leakage of grout. Formwork shall be supported independently of all plant and pipework. The Contractor shall use such templates and moulds as necessary to achieve the accurate positioning of such items as penstocks and access covers.

1.4.2.6 Defects in Formed Surfaces

Workmanship in formwork and concreting shall be such that concrete, surfaces are perfectly compacted and smooth.

Any minor surface blemishes shall be repaired by the Contractor, at his expense, to the satisfaction of the Engineer immediately after removal of formwork. Any remedial treatment to concrete surfaces shall be agreed upon with the Engineer.

No rendering of finished surfaces shall be allowed.

Any concrete, the surface of which is found to have been treated before inspection by the Engineer shall be rejected.

Remedial measures may include, but shall not be limited to, the following:

- (i) Holes left by formwork supports shall be thoroughly cleaned out to remove all loose material and the sides shall be roughened, if necessary, to ensure a satisfactory bond they shall then be filled with an approved epoxy resin mortar or with dry pack mortar.
- (ii) Fins, pinhole bubbles, surface discoloration and minor defects may be rubbed down with sacking and cement immediately after the formwork is removed.
- (iii) Abrupt and gradual irregularities may be rubbed down with carborundum and water after the concrete has been fully cured.
- (iv) Small defects and minor honeycombing shall be chipped out normal to the face of the concrete to a depth of at least 25mm and filled with an approved epoxy resin mortar or with dry pack mortar.

Where deeper or more extensive defects occur, the Contractor shall obtain the approval of the Engineer to the methods of repair proposed which may include, but shall not be limited to, cutting out to a depth of 25mm with a diamond saw to give a regular edge to the repair and further chipping to form a hole with dovetail shape to sound concrete; or to a total depth of 75mm whichever is greater.

If reinforcing steel is exposed, the concrete shall be removed to a depth of 25mm beyond the reinforcement. Steel mesh reinforcement shall then be sprung into the dovetail. The void shall be refilled with concrete or suitable approved epoxy resin mortar.

The Contractor shall thoroughly clean any hole or defective area that is to be filled and where the surface has been damaged, the Contractor shall break out any loose, broken or cracked concrete or aggregate.

Where remedial work is to be carried out using concrete, the concrete surrounding the hole shall be thoroughly soaked after which the surface shall be dried so as to leave a small amount of free water on the surface. The surface shall then be dusted lightly with cement by means of a small dry brush until the whole surface that will come into contact with the dry pack mortar has been covered and darkened by absorption of the free water by cement. Any dry cement in the hole shall be removed.

The concrete mix shall be approved by the Engineer and shall be placed and compacted into the hole, using formwork as necessary.

Where remedial work is to be carried out using epoxy resin mortar or other special material, the surface of the cleaned hole shall be prepared and primed and the repair material placed, compacted and finished in accordance with the manufacturer's instructions.

Where in the opinion of the Engineer, the defect is too extensive to permit satisfactory repair, either from the point of view of structural integrity or appearance, the concrete containing the defect shall be broken out and replaced.

1.4.2.7 Inspection and Testing

Before concrete is placed against any formwork, the formwork shall be inspected and approved by the Contractor and offered for inspection by the Engineer.

If a "Pour-card" system is in operation, the card shall be signed by the Contractor and submitted to the Engineer with the request for inspection of the formwork.

1.4.3 Joints

1.4.3.1 Construction Joints

Construction joints shall be of the types indicated on the drawings and shall be constructed wherever and only in such places as are indicated on the Drawings or otherwise directed or approved.

Construction joints shall be formed at the Contractor's expense. Should the Contractor desire any addition or reduction in the number of joints he shall submit his proposals to the Engineer for his approval before the preparation of the formwork. In the event of such approval being withheld, the Contractor shall not be entitled to any additional payment.

In all construction joints the face of the previously placed concrete shall be thoroughly roughened by mechanical means so as to expose the aggregate. The surface thus exposed shall, immediately before concreting is started, be thoroughly cleaned with compressed air and washed and saturated with water.

Where construction joints are required in slabs or beams, these shall be made with vertical faces and located at a distance of 1/4 to 1/3 of the total length of the span measured from one of the supports, unless the Engineer should approve otherwise.

Construction joints in watertight structures shall be related as described above and shall further be provided with a P.V.C. water stop or similar. Should the Contractor desire to adopt other measures to ensure the watertightness of construction joints, he is at liberty to submit proposals to the Engineer for his consideration. Should the Engineer approve such proposal, the cost of the materials required and of any extra work involved shall be at the Contractor's expense as shall be the costs of any remedial measures necessary to make good any joints which may prove to be non-watertight, regardless to whether the Engineer shall have approved or not approved any of the proposals the Contractor may have made in respect of that joint.

If during the course of the Contract, it should become apparent that the Contractor's methods of forming construction joints are not proving effective, the Engineer may order the Contractor to execute at the latter's expense such preventive measures as the Engineer may consider necessary to ensure the watertightness of construction joints in further work.

1.4.3.2 Movement Joints

Movement joints are defined as all joints intended to accommodate relative movement between adjoining parts of a structure, special provision being made where necessary for maintaining the watertightness of the joint. The Contractor shall comply with instructions of manufacturers or

jointing materials and shall, if required by the Engineer demonstrate that the joining materials can be applied satisfactorily.

The Contractor shall submit to the Engineer for his approval, as soon as practicable after the acceptance of his Tender and not less than three weeks before the commencement of concreting, details of his proposals of the installation of water stops. These shall show where joints are to be located and details of the intersections and changes of direction to a scale that shows the position of any joint or shape of any moulded section.

As far as possible jointing on site shall be confined to the making of butt joints in straight runs of water stops. Where it is agreed with the Engineer that it is necessary to make an intersection or change of direction or any joint, other than a butt joint in a straight run, on site a preliminary joint, intersection or change of direction piece shall be made and submitted to such tests as the Engineer may have required.

Flexible water stops shall be fully supported in the formwork, free of nails and clear of reinforcement and other fixtures. Damaged water stops shall be replaced and during concreting care shall be taken to place the concrete so that water stops do not bend or distort.

The surface of set concrete in a movement joint shall, where specified on the drawings, be painted with two coats of bituminous paint and new concrete shall be placed against it only when the paint is dry. Expansion joints shall be formed by a separating strip of approved preformed joint filler manufactured from graded and selected cork granule bound with high grade bitumen and encased between layers of tough asphalt paper. Joint filler shall be of thickness and width as indicated on the drawings.

Caulking grooves shall be provided as shown on the Drawings. Immediately prior to caulking, the groove shall be wire brushed and loose material removed and blown out by compressed air. After the groove has dried it shall be primed and caulked with approved jointing sealing compound applied in accordance with the manufacturer's instructions. At all caulked joints, the face of the caulking strip and 50 mm width of concrete on either side shall be painted with two coats of paint having the same base as the caulking compound.

1.4.3.3 Sliding Planes and Joints

Sliding planes on the concrete formation carpet shall consist of a bitumen sand mixture one (1) to four (4) by volume spread evenly 3mm thick over the carpet coat or of building paper either of which shall be applied immediately before the structural floor is concreted and shall be at all times suitably protected. Where building paper is used the concrete formation carpet shall be finished with a wood trowel to give a smooth surface.

Sliding joints shall consist of one layer of bituminous felt of weight 1.36 kilograms per square meter (1.36 kg/m²), to each of the complementary contact surfaces. Alternatively, and subject to the approval of the Engineer sliding joints may comprise two (2) layers of purpose made preformed plastic membrane which when in contact shall give a coefficient of friction of not more than 0.2 when subjected to a load of 270 kN/m². Where formed in concrete structures the lower joint bedding surface shall be steel float finished to a smooth true surface.

1.5 Building Work

1.5.1 General Requirements

This section covers the requirements for building work, insulation, timber, aluminum work, glazing, plumbing and finishing work including accessories and associated furniture.

1.5.1.1 References, Standards and Codes

The following publications, references, codes and standards with their latest amendments are referred to in this Section.

British Standards Institution (BSI)

BS 12	Specification for ordinary and rapid-hardening Portland cement (AMD 5860 - 1988).
BS 459	Matchboarded wooden door leaves for external use.
BS 544	Linseed oil putty for use in wooden frames.
BS 729	Hot dip galvanized coatings on iron and steel articles.
BS 743	Materials for damp proof courses (AMD 6579 - 1991).
BS 812	Methods for sampling and testing of mineral aggregates, sands and fillers.
BS 864	Capillary and compression fittings for copper tubes and polyethylene pipes.
BS 882	Aggregates from natural sources for concrete.
BS 890	Building limes.
BS 952	Glass for glazing (Part 1 & 2).
BS 970	Wrought steels for mechanical and allied engineering purposes.
BS 1010	Draw-off taps and stop valves for water services (screw down pattern). Part 2.
BS 1014	Pigments for Portland cement and Portland cement products.
BS 1125	WC flushing cisterns (including dual flush cisterns and flush pipes).
BS 1186	Quality of timber and workmanship in joinery (Parts 1, 2 & 3).
BS 1199	Building sands from natural sources.
BS 1200	Building sands from natural sources.
BS 1203	Specification for synthetic resin adhesives (phenolic and aminoplastic) for plywood (AMD 6284) 1990.
BS 1212	Specification for float operated valves (excluding floats) (Parts 1, 2, 3 & 4).
BS 1243	Specification for metal ties for cavity wall construction.
BS 1254	Specification for WC seats (plastics).
BS 1449	Steel plate, sheet and strip (Sec. 1.1).
BS 1470	Wrought aluminum and aluminum alloys for general engineering purposes - plate, sheet and strip (AMD 6032) 1989.
BS 1471	Wrought aluminum and aluminum alloys for general engineering purposes - drawn tube (AMD 2).

BS 1474	Wrought aluminum and aluminum alloys for general engineering purposes - bars, extruded round tubes and sections.
BS 1494	Fixing accessories for building purposes (AMD 1) Part 1.
BS 1579	Connectors for timber.
BS 1615	Anodic oxidation coatings on aluminum.
BS 1968	Floats for ball valves (copper) (AMD 2).
BS 2499	Hot-applied joint sealant system for concrete pavement.
BS 2871	Copper and copper alloys - Tubes for water, gas and sanitation (Part 1).
BS 2879	Draining taps (screw down pattern) (AMD 3) 1980
BS 3148	Water for making concrete (including notes on the suitability of the water).
BS 3444	Blockboard and laminboard.
BS 3505	Unplasticized poly vinyl chloride (PVC) pressure pipes for cold potable water (AMD 6130).
BS 3921	Clay bricks.
BS 4027	Sulphate-resisting Portland cement.
BS 4255	Rubber used in preformed gaskets for weather exclusion from buildings (Part 1 - non-cellular gaskets).
BS 4449	Carbon steel bars for the reinforcement of concrete.
BS 4483	Steel fabric for the reinforcement of concrete.
BS 5215	AMD 1, one-part gun-grade polysulphide based sealants.
BS 4514	Unplasticized PVC soil and ventilating pipes, fittings and accessories.
BS 5154	Copper alloy globe, globe stop and check, check and gate valves.
BS 5254	Polypropylene waste pipe and fittings.
BS 5255	Thermoplastics waste pipe and fittings.
BS 5262	Code of practice. External rendered finishes.
BS 5305	Tile flooring and slab flooring.
BS 5325	Installation of textile floor coverings.
BS 5385	Wall and floor tiling (Parts 1, 2, 3, 4 & 5).
BS 5493	Code of practice for protective coating of iron and steel structures against corrosion (AMD 7898) 1993.
BS 5503	Vitreous china washdown WC pans with horizontal outlet (Parts 1, 2 & 3).
BS 5520	Specification for vitreous china bown urinals. Rimless type.
BS 5628	Code of practice for use of masonry (Parts 1, 2, & 3).
BS 6073	Precast concrete masonry units (Parts 1 & 2).

BS 6150	Code of practice for painting of buildings.
BS 6431	Ceramic floor and wall tiles (Part 1 & 2).
BS 6566	Plywood (Part 1).
BS 7263	Precast concrete flags (Part 1).
BS 7372	Specification for Industrial wire mesh (Part 1 & 2).
BS 8203	Code of practice for installation of sheet and tile flooring.
BS CP 144	Roof coverings (Part 3 & 4).
BS CP 204	In-situ floor finishes (AMD 6968) 1992.

American Society for Testing and Materials

ASTM (A36/A36 M)	REV.A Standard specification for structural steel.
ASTM (D1751)	Standard specification for preformed expansion joint filler for concrete paving and structural construction.

Other standards may be used subject to the engineer's approval

1.5.1.2 Submissions

The following submissions are required under this section:-

- (i) Samples of bricks and blocks to be used in the work.
- (ii) Samples of thermal insulation boards and damp proof sheets with its technical data.
- (iii) Samples of glazed tiles for walls and floors.
- (iv) Samples of plumbing fittings and valves, and catalogues for appliances showing dimensions and weight for each.
- (v) Detailed shop drawings for internal plumbing works.
- (vi) Samples of ironmongery for timberworks and aluminum works.
- (vii) Detailed shop drawings for steel doors and gates.

1.5.2 Brickwork and Blockwork

1.5.2.1 Bricks and Blocks

Concrete blocks shall be in accordance with BS 6073. The overall requirements for salt content in blockwork, aggregates, mixing and curing water shall be as stated for concrete.

Cement for solid or hollow concrete blocks and mortar shall be ordinary Portland cement for use above ground surface and sulphate resisting cement for use below ground surface, as specified herein.

Fine aggregate for solid or hollow concrete blocks shall conform to the requirements for aggregates of concrete.

Water to be used in blockwork shall conform to the requirements specified for concreting. Aggregate shall be so sized, graded, proportioned and thoroughly mixed in a batch mixer with such proportions of cement and water as to produce a homogeneous concrete mixture.

Concrete blocks shall be obtained from an approved local factory and shall be press molded in approved molds and vibrating pressure machines.

Blocks shall be cured in the shade, by being kept thoroughly moist with water applied by sprinklers or other approved means for a period of at least seven (7) days, starting immediately after casting as practicable and in any case no longer than will allow any drying of the blocks to occur. The blocks shall be stacked on a clean and levelled platform free from earth, or other impurities during the curing process and shall be stacked in honeycomb fashion after curing. The blocks shall not be used prior to one month after the date of manufacture, nor shall any blocks be used that have not been inspected and approved by the Engineer. Blocks with broken arrises or corners will be rejected.

Samples from blocks shall be tested according to Specification.

Dimensions of blocks shall be as follows :-

Length	Width	Height
mm	mm	mm
400	200	200
400	200	150
400	200	100

The allowed tolerance in any of the actual dimensions of the blocks shall be within ± 4 mm.

The compressive strength calculated for the total area including the holes shall not be less than the limits shown in the following Table.

Minimum Compressive Strength for the Individual Block		Minimum Average of the Compressive Strength	
N/mm ²	(kg/cm ²)	N/mm ²	(kg/cm ²)
2.5	(25)	3.0	(30)

Several samples of each type of block specified for the works shall be submitted for approval by the Engineer before the blocks are ordered.

The Contractor shall allow for taking samples at delivery of blocks on the site at any stage of the works and submitting them to the Engineer for his approval.

1.5.2.2 Blockwork Workmanship

All blockwork shall be set out and built to the respective dimensions, thickness and heights, shown on the drawings and/or as instructed in writing by the Engineer.

All external and internal walls, partitions and screen walls shown on the drawings shall be built in hollow concrete blocks unless otherwise directed by the Engineer in writing.

Solid blocks shall always be used around openings of windows and doors and in the first two courses of blocks built on reinforced concrete ground beams and beams. Blocks are to be kept carefully and neatly stacked clear of the ground.

The concrete foundations or concrete floors shall be cleaned from earth, dust, debris and wetted before blocks are laid.

All joints shall be well flushed up at every course with full beds of mortar and the vertical joints completely filled.

Perpendes shall be maintained and quoins, reveals and jambs shall be plumb and true.

No portion of the walls shall be raised more than 1 m above any other part at one time without the consent of the Engineer. Where temporary changes of level occur, the work shall be raked back.

All blocks, where left exposed, shall be finished to an even true fair face and pointed with a near half round recessed joint as the work proceeds.

The top of walls left off shall be wetted before work is recommenced. A layer of mortar shall be spread on top before the blocks are laid, and all joints shall be thoroughly flushed up as the work proceeds. All joints shall be uniform and shall not exceed 12 mm. All perpendes, quoins, internal and external angles shall be kept strictly true and square and the whole properly bonded together and levelled round. All blockwork shall be plumbed vertically.

The surface of the walls and partitions prepared for plastering or rendering shall have the joints raked out 15 mm from face of the wall to form key for the plaster.

Blockwork walls shall be tied to columns and concrete walls by horizontal galvanized mild steel cramps at distance not exceeding 40 mm and projecting from face of concrete columns or walls by 30 cm.

Partitions shall be bonded to main walls by toothing every second course into main walls to a depth of not less than 100 mm.

Reinforcing of course will be done by laying a continuous strips of steel wire mesh bedded in the mortar every fourth coarse.

All walls and partitions shall be properly cured by sprinkling water for a period of not less than three (3) days after completion of laying. No hollow blocks shall abut any built-in fixtures, e.g. door and window frames, apertures, louvers, .. etc.

The Engineer's instructions shall be obtained and followed with regard to the height of courses, but in general course height shall be 200 mm and mortar joints 10 mm thick. The courses shall be set out so that bed joints occur in line with lintels and other features and cut courses shall be avoided as far as possible. Course height shall not vary throughout the building and each course shall be leveled throughout the building.

1.5.2.3 Fixing Frames of Windows and Doors

The Contractor shall fix after completion of the blockwork the frames of windows and doors, with 3 mm clearance all round, including adjusting and building in approved hard wood dove-tailed plugs and screwing the frames to those plugs, making good, filling solid between the frames and openings in cement mortar and raking out and pointing exposed edges with an approved mixture of patent compound.

1.5.2.4 Mortar

Materials, mixing and application of mortars shall generally comply with the requirements of the specification. Cement for use above damp proof course shall be ordinary Portland cement in slow setting quality complying with BS 12. Cement for use below damp proof course or where in contact with the ground shall be sulphate resisting to BS 4027.

Sand for mortars shall be either crushed stone or pit sand obtained from an approved source or a mixture of the two. It shall be clean and well graded and shall comply with table (1) in BS 1199 and BS 1200.

Water used for mortars shall be as specified for concrete.

Non-hydraulic or semi hydraulic lime shall be as described in BS 890. Hydraulic lime shall be either ground quick lime or hydraulic lime as described in CP 121: Part 1. The lime shall be prepared in accordance with the appropriate requirements or CP 121: Part 1.

Colouring agents or plasticizer where used as directed shall be of approved manufacture.

Plaster shall be manufactured from gypsum rock crushed and ground to a fine powder. Approximately 75% of the combined moisture shall be driven off during manufacture and the finished product must include the necessary aggregates and additives to produce the desired properties and setting time of the plaster without the need for further additions other than water.

Cement-sand mortar shall be a mixture of the various ingredient in the proportions shown in the following Table.

Mortar mix	Proportions by Volume	
	Cement	Sand
A	350kg	1m ³
B	450kg	1m ³

Mortar Mix (C) is composed of two (2) parts of lime and three (3) parts of sand with the addition of 150 kg. cement to each cubic meter of this mix.

Epoxy mortar shall be a mixture of silica aggregates and epoxy resin, free from any solvent and acid resistant.

The epoxy mortar shall be supplied by an approved manufacturer and shall be supplied in sealed containers which shall be marked at the factory with date of manufacture of the contents. Any material that has exceeded the recommended shelf life shall not be used.

The epoxy mortar shall be handled, stored and used in strict accordance with the manufacturer's instructions and to the satisfaction of the Engineer.

The finished exposed surfaces of the epoxy mortar shall be completely smooth and free from all blemishes and defects.

1.5.3 Damp Proofing and Thermal Insulation Work

General

Materials for tanking, damp proofing, protection or insulation purposes shall be resistant to all weather and high temperature variations without being subject to any damage, and must have perfect adherence to all surfaces.

Materials used must have special properties which shall allow to provide complete protection against water infiltration. Materials must provide an effective shield against water and will not creep even under ambient high temperature. It must have perfect resistance to erosion and the action of aggressive water and soil, and must be designed for outstanding durability.

Materials for thermal insulation must have very good mechanical properties, together with efficient performance and high thermal resistance.

The Contractor shall submit samples of materials, which he shall use, to the Engineer for approval before order.

1.5.3.1 Horizontal Damp Proofing Courses

Horizontal damp proof courses shall be of two (2) layers, of sheets cross in direction, with minimum thickness of 1.5 mm for each layer. They shall be made of tar-based product with synthetic resins and reinforced with strong inert fibrous mat. They shall be laid under floor slabs inside buildings and under reinforced concrete slabs and footings of foundations. They also are laid on roofs of buildings and around parapets. Primer coat is applied before laying sheets. Suitable adhesive material is used according to manufacturer's instructions.

Care shall be taken to ensure that all surfaces are dry, smooth and clean before primer is applied to them.

Distance of overlap shall be not less than 15 cm and joints shall be staggered.

1.5.3.2 Vertical Damp Proofing

Vertical damp proofing for tanking of concrete walls shall be single ply with minimum thickness of 1.5 mm made either as specified in Item 4.5.3.1 or may consist of flexible PVC sheet, black in colour and at least 0.3 mm thick to which is laminated a flexible self-adhesive rubber bitumen compound at least 1.5 mm thick.

Materials for priming the background surface shall be compatible with the damp proofing membrane used and according to manufacturer's instructions.

1.5.3.3 Damp Proof Course on Walls Built With Concrete Blocks

A damp proof course is laid on walls at places and levels shown on the drawings and is made as described after:

- (i) A layer of cement sand mortar mix (A) 10 mm thick. is laid on wall to form an even bed.
- (ii) Damp proof course as specified in clause (4.5.3.1) is laid in continuous strips with 150 mm laps. The leading edge of flexible damp proof courses shall be kept 10mm back from the face of back wall.

External faces of walls adjacent to backfill shall be damp insulated as specified in clause (4.5.3.5).

1.5.3.4 Elastic Polyethylene Membrane for Protection of Foundations

Aggressive soils on which plain concrete is to be laid for foundation shall be covered with black elastic polyethylene membrane sheets 500 micron thick. The sheets shall extend 250 mm beyond the edge of concrete and the spare sheets shall be folded up against the outer face of concrete before filling is carried out. Sheets are laid over soil after grading and compaction and before placing concrete.

Membranes shall be laid loose, in strips not less than 1.20 m wide with a minimum lap width of 150 mm.

1.5.3.5 Bituminous Emulsion Coating

This paint shall be tar based with bitumen content not less than 50% by weight, and it shall be used as a protective shield for foundations and concrete structures against aggressive ground water and soils. The paint is applied cold either by brush or spray. The surface is covered with bituminous material in three layers each of 200 g/m².

The material shall be brought to site in sealed containers and applied according to manufacturer's instructions after applying a primer coat to seal cavities and voids.

1.5.3.6 Waterproof and Anti-Acid Paint for Internal Surfaces of Water and Sewage Holding Structures

Internal faces of water and sewage holding structures may be required to be painted by a waterproof non-toxic paint based on cementous material which also has the property of sealing voids and protecting concrete from any corrosive action.

This material is applied as a paint by brush or as a spray under pressure in two coats other than the primer coat applied to seal any hair cracks or voids in concrete face, after the remedy of any defect.

The paint shall be of quality approved by the Engineer before supply, and shall be applied to surfaces after applying the primer coat according to manufacturer's instructions.

1.5.3.7 Plastic P.V.C. Water Stop

This material is used to ensure water tightness in water and sewage holding structures. It is placed at horizontal and vertical construction joints and at junctions between walls and floors of reservoirs and at contraction and expansion joints. Different types of water stop material shall not be used together in any complete installation.

The PVC materials shall be high grade virgin polyvinyl chloride containing no filler, reclaimed or scrap material. It shall comply with the requirements of BS 2571 for type M3 or E3.

Water stops shall be of the heavy duty type and of the shape and size indicated on the drawings and shall have the physical properties given below:-

- | | | |
|---------------------------------|------|--------------------|
| - Tensile strength (min) at 70° | 12.5 | N/sq.mm |
| - Elongation at break (min) | 350% | |
| - E-module | 50 | kg/cm ² |
| - Shear strength | 75 | kg/cm ² |
| - Density (min) | 1300 | kg/cm ² |

Water stop shall be carefully maintained in the position shown on the Drawings and shall be fastened properly by special clips to steel reinforcement or to the formwork shutters to avoid movement or displacement of water stop during casting of fresh concrete.

Junction pieces for joints intersections and transition pieces shall be supplied and samples of all the materials have to be submitted to the Engineer before work for approval.

Site jointing of water stop shall be carried out strictly in accordance with the manufacturer's instructions.

The Contractor shall supply the manufacturer's test certificates for each consignment of waterstop delivered to Site and shall if requested supply to the Engineer sufficient samples of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate standard test procedure.

1.5.3.8 Thermal Insulation for Roofs

Material used as thermal insulation must be of an approved high efficient quality and must not deteriorate at prevailing climatic conditions.

Material for thermal insulation will be extruded polystyrene rigid foam boards 5 cm thick. The boards shall be fully bonded to the primed surface of the screed or directly on the concrete slabs as specified.

Bonding shall be done either by hot bitumen or any other approved bonding agent recommended by the manufacturer. Above polystyrene rigid boards shall comply with the following:-

- | | | |
|-------------------------------|---|----------------------------|
| - Thickness | : | 5 cm |
| - Thermal conductivity at 10° | | |
| - mean temperature. | : | K = 0.028 W/m deg. C. |
| - Density | : | 32.35 kg/m ³ |
| - Capillarity | : | None |
| - Compressive strength at | | |
| - 5% compression. | : | = 0.245 M/N/M ² |

There shall be no air between screed or concrete slab and the polystyrene board.

The Contractor shall submit a sample of the material used to the Engineer for approval before order.

1.5.3.9 Water Proof Joint Filler

Joint filler shall be water proof, rot-proof, and will not absorb moisture.

It must have the property of compression to a certain extent and the immediate recovery. It must be sufficiently robust to resist deformation under the weight of poured concrete.

The Contractor shall supply and fix premoulded joint fillers in all expansion joints and where shown on the Drawings. The joint filler shall be high density closed cell polyethylene filler, bonded cork. Material shall be obtained from manufacturers approved by the Engineer and shall be stored and fixed in accordance with the manufacturer's instructions. The joint filler of the material and thickness specified shall be cut to shape and fixed to fill the whole space between the concrete faces to the joint not otherwise filled by waterstop and joint sealer. Abutting pieces shall be placed in close contact and the joints covered on each side to prevent the passage of cement grout.

The Contractor shall supply the manufacturer's tests certificate for each consignment of each type of joint filler delivered to Site and shall if requested supply to the Engineer sufficient samples of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate standard test procedure.

The filler shall comply with the following American Society for Testing and Materials Specifications:

- | | | |
|----|--|------------------------|
| a. | High Density Closed Cell Polyethylene Filler | ASTM D 3575 |
| b. | Resin Bonded Cork Filler | ASTM D 1752-84 Type II |
| c. | Low Density Closed Cell Polyethylene Filler | ASTM D 3575 |
| d. | Bitumen Bonded Cork and Impregnated Fiberboard | ASTM D 1751-83 |

Joint filler shall be either cork joint filler or cellular joint filler.

- (i) Cork joint filler shall be waterproof and rotproof, and shall not extrude as a result of compression. Cork joint filler shall compress to less than 50% of its original thickness with immediate recovery to 80% or more of its original thickness.
- (ii) Cellular joint filler shall be a performed low compression joint filler made from foam rubber. Cellular joint filler shall recover to its original thickness after each loading and unloading.

Joint filler for use in potable water service reservoirs shall be of granulated cork bound with insoluble synthetic resin. For other structures including pavements the joint filler shall be of granulated cork bound with bitumen.

The joint filler shall be fixed to the required dimensions of the joint cross section and shall provide a firm base for the joint sealer. Where the depth of the joint between the concrete surface and the water stop does not exceed 500mm a filler shall be placed in single depth sections.

1.5.3.10 Joint Sealer

The Contractor shall construct recesses at all joints and on both faces of the concrete work except on the underside of ground slabs. The recesses shall be accurately formed to the lines and dimensions shown on the Drawings or as agreed with the Engineer.

The Contractor shall prepare the surfaces of the recess and shall supply a joint sealer and fill or cork the recess completely with it.

Joint sealing shall be not commenced without the approval of the Engineer. In reservoir joints the sealer shall be poured after the construction of the reservoir roof.

All joint sealers shall be from an approved manufacturer. The Contractor shall supply the manufacturer's test certificates for each consignment of each type of joint sealant delivered to the Site.

Joint sealer shall be non-degradable for its particular application and shall be suitable for use in hot climates. Joint sealer shall be elastoplastic and shall possess a movement accommodation factor of at least \pm twelve and a half percent (12.5%).

For movement joints in water retaining structures, the physical properties of the sealer shall not be inferior to those of polysulphide based sealers complying with BS 4254 and the sealer shall have a minimum life expectancy of fifteen (15) years.

For horizontal joints in non-water-retaining structures or pavements unless otherwise shown on the Drawings, the sealer shall be type (A1) rubberized bituminous compound to BS 2499, and shall have a minimum life expectancy of ten (10) years.

In other situations the sealer shall be synthetic rubber based on poly-sulphide to BS 5215 or based on polyurethane or silicon to the approval of the Engineer and shall have a minimum life expectancy of fifteen (15) years.

Where the joint sealer is to be in contact with a protective coating, the Contractor shall satisfy the Engineer that the sealer and the protective coating are compatible.

The sealer shall be stored in accordance with the manufacturer's instructions and no sealer shall be used after its shelf life has elapsed.

To ensure non adhesion to the back of the joint cavity, a bond breaker shall be fixed where this is specified by the manufacturer of the sealer.

Primer shall be obtained from the same manufacturer as the sealer.

Sealing of movement joints shall be carried out only when adjacent concrete surfaces are perfectly dry.

Immediately before the application of the joint sealer, the groove protection batten shall be removed in such lengths as it represents a single day work for sealing the joints. The joint grooves shall be thoroughly cleaned out to remove all traces of dust, dirt, and must be completely dry. Primer shall then be applied to joints and allowed to dry before application. Joints shall be filled with approved sealer, strictly in accordance with the manufacturer's instructions.

On permanently exposed areas of structures, joint sealing shall be carried out with the aid of masking tape to form neatly defined surface limits to the sealer.

1.5.3.11 Slip Membrane for Sliding Joints

Slip membrane material used for sliding joints shall consist of two thicknesses of low friction plastic material which shall be non-toxic and suitable for use with potable water, compatible with any other materials used in conjunction with them, non-extruding and durable. The coefficient of friction between the two strips shall not exceed 0.20 when subjected to a load of 220 kN/sq.m. The maximum bearing pressure for the material shall not exceed 250 kN/sq.m.

The two layers shall be together to prevent ingress of mortar, and the lower fixed to the concrete surface using a purpose-made adhesive supplied by the manufacturer of the slip membrane. This concrete to which the slip membrane is to be bonded shall be Type U3 and shall be clean and dry before application of the adhesive.

1.5.4 Plastering, Rendering and Wall Facing

1.5.4.1 General

Internal plastering shall comply with BS 5492-1990 external rendering shall comply with BS 5262-1991

The Contractor shall furnish all materials, labour and equipment to complete the plaster work or wall and ceiling facings as shown on the drawings, as specified in these specifications.

1.5.4.2 Materials

- **Cement:** shall be Portland cement, from an approved source and should apply with the requirements of B.S. 12 : 1958 – “Portland Cement, Ordinary or Rapid Hardening”. All cement delivered to the site shall be stored on a boarded platform and thoroughly protected from weather.
- **Lime:** for undercoats, lime shall comply with BS. 890 : 1960, Class B for quick lime or Hydrated, Lime, for finishing coat, be slaked in a manner appropriate to their type. Non-hydraulic and semi-hydraulic quick lime shall be run to putty and maturated for two weeks before use.
- **Gypsum:** Gypsum building plaster shall comply with appropriate clauses in BS. 1191 : 1967 – “Gypsum Building Plaster” retarded semi-hydraulic gypsum plaster shall be used with sand for undercoats at the rate of one part sand per six parts gypsum, and neat for finishing coats. A hydrous gypsum plaster shall be used neat for finishing coats.
- **Sand:** for plastering shall be natural sand conforming with BS. 1198 – 1200 : 1955 – “Building Sands from natural sources”. It shall be hard, clean and free from adherent coatings, and shall not contain any appreciable amount of clay, it shall be free from deleterious matter likely to affect adversely the hardening, strength durability or appearance of the plaster.
- **Water:** shall be clean, free from deleterious materials, injurious amount of organic impurities, alkaline and from any unusual proportion of dissolved salts.

All branded materials shall be delivered on the site in their original package, bearing the trade name of materials concerned. Manufacturer’s certificate of compliance shall be submitted with each shipment.

- **Lathing:** shall comply with BS. 1369 : 111947 – “Metal lathing (steel) for plastering”. The minimum weight shall be not less than 1.25 kg/m² and with the required openings.
- **Corner Beads:** Metal beads are provided at all external corners to be plastered and at sides and jambs of windows and other openings without frames occurring in plastered walls, fabricated from zinc-coated steel, not lighter than 26 – gauge (0.45 mm) thick metal.

- **Expansion Beads:** Metal expansion beads are provided in plaster ceilings and walls at the location and spacing indicated on drawings or directed by the Engineer, of the same previous type.

- **Plaster Thickness:**

Plaster shall be of 15 mm minimum and 25 mm maximum thickness when measured from the face of the plaster base to the face of the finished plaster surfaces.

1.5.4.3 Preparation

All plastering shall be executed in a neat workmanlike manner. All metal grounds, corner beads, screeds, ... etc., shall be carefully examined to see that they are straight, plumb level, or true to the required angles before the plaster is applied.

Plaster shall not be applied to masonry or concrete surfaces that have been coated with a bituminous compound or other waterproofing agents.

Masonry surfaces shall be evenly dampened to provide proper suction prior to plastering.

Plastering shall be neatly made good up to metal or wood frames and skirtings and around pipes or fittings. Angles shall be rounded to 5 mm radius. Surfaces of undercoats shall be well scratched to provide a key for finishing coats.

Concrete surfaces to receive bond plaster shall be cleaned of all dust, loose particles and other foreign matter concrete surfaces shall have sufficient roughness to provide a proper bond. Before application of plaster, the surface shall be evenly dampened.

Before plastering is commenced all junctions between differing walls and columns, where cracks are likely to develop and as directed by the Engineer, reinforcement wire mesh (10 to 15 mm hexagonal) 15 cm wide which shall be plugged, nailed or stapled as required at intervals of not exceeding 50 cm at both edges.

1.5.4.4 Mixing

Cement and sand for each batch shall be accurately measured and mixed dry until evenly distributed and until the mass is uniform in colour. No caked lumpy materials shall be used. All batches shall be in such size that they can be entirely used within 30 minutes.

Water content shall be maintained at a minimum. Mixing shall be continued until plasticity is obtained, mortar that has begun to set shall not be used. Retempering will not be permitted.

1.5.4.5 Application

Surfaces to receive plaster shall be clean from dust, dirt, or other particles that might interface with a satisfactory bond.

Stone, wood or metal installations including flashings that adjoin or occur in connection with plaster, shall be in place, plumb, straight and true before beginning any plaster work.

Masonry joints shall be emptied to a depth not less than 1.5 cm, surfaces shall be evenly dampened (not soaked) with a fog spray before plaster is applied, rubbed with brush if necessary to clean up surplus mortar which may be adjoining. If surfaces become dry in spots, the dry areas shall be dampened again to restore uniform suction.

Plaster coats shall be applied continuously in one general direction without allowing mortar to dry at edges.

Edges to be joined shall be dampened slightly to produce a smooth confluence.

A groove 1-2 cm width to 1 cm depth, shall be made in all walls below the ceiling level or below the beams level or as directed by the Engineer. The rates of plaster shall include these grooves.

1.5.4.6 Plaster Coats

Plaster, unless otherwise shown or specified, shall be “three coats” work and not less than 15 mm thick. All exterior corners of plaster shall be slightly rounded.

- **Scratch-Coat:** (first coat) shall be about 3 mm thick, (450 kg cement/m³ sand mix), applied with sufficient pressure to form good full keys, left rough in texture. This coat shall be damp-cured three days, before applying screeds and grounds to ensure levelling of plaster surfaces. Grounds shall be made of lime cement mortar and traces of gypsum, they are spots made to undercoat thickness at spaces of 1.00m so as their surface in same horizontal level for ceilings by means of float and spirit level, and in same vertical level for walls by means of plumb-line, then fill between grounds with the same mortar of proposed plaster to make vertical screeds for walls and longitudinal for ceilings, with faces at same level with grounds. All meeting surfaces should be in right angle. These grounds and screeds shall be checked by the Engineer representatively before beginning plastering the undercoat. It will be used as guide for plastering. After finishing the undercoat these marks should be removed and replaced by same mortar as the under coat.
- **Undercoat:** (second coat) shall be applied after one week of the scratch-coat is applied, and after this coat has set firm and hard. The undercoat shall be brought out to grounds, using a double-back application if required, straightened to a true surface with rod and derby, without application of water and cross raked or scratched with spaces not exceeding 5 cm to provide a mechanically key for reception of finish-coat. This coat shall be damped cured two days before the finish-coat is applied. It shall be made in accordance with specifications of each type of plaster with average thickness of 1.5 cm and shall be applied after evenly dampening the walls with water thoroughly floated to a true level, then trowelled. Undercoat shall be applied before skirtings and similars, and floorings.
- **Finish-Coat:** (third coat) shall be then applied according to specifications of each type of plaster with thickness not less than 5 mm, after fixing doors and windows frames, plugs, but before fixing architraves, skirtings, wooden cornices and similar. All inside angles resulting from meetings of ceilings, wells, also buttresses and openings shall be rounded.

Finishing shall be applied to a partially dry base coat or to a thoroughly dry base coat which has been evenly wetted. The use of excessive water shall be avoided in the application of all types of finish-coat plastering.

1.5.4.7 Proportioning of Plaster

(i) **Cement Plaster:**

- a. Scratch coat: 450 kg cement to one cubic meter sand.
- b. Under and finish coats: 300 kg cement to one cubic meter sand, and 0.10 m³ lime putty or chemical plasticiser.

(ii) **Hard Surface Plaster:**

- a. Scratch coat: 450 kg cement to one cubic meter sand.
- b. Under and finish coats: 250 kg cement to one cubic meter sand, and 0.10 m³ lime putty or chemical plasticiser.
- c. Finish-coat: stone power (5 pars), white cement (1 part) with thickness not less than 5 mms.

(iii) **Waterproof Cement Plaster:**

- a. Scratch coat: 450 kg cement to one cubic meter sand.
- b. Under and finish coat: 400 kg cement to one cubic meter sand with the addition of waterproofing material as sika, pudlo, or other approved materials in accordance with the Manufacturer's specifications.

(iv) **Rendering for External Use to Facades**

Rendering may be finished smooth, textured or rough-cast. Smooth rendering is either steel troweled or wood floated made with mortar composed of stone powder, white cement, sand and lime putty. Coloured oxide is added for the required colour.

(v) **Plaster of Exterior Walls: (Tyroline Plaster)**

- a. Scratch coat: 450 kg cement to one cubic meter of fine sand.
- b. Under-coat: 300 kg cement to one cubic meter sand or 2 parts of clean lime (by volume) 3 parts of sand (by volume) and 150 kg cement per one cubic meter of the mixture.
- c. Finish-coat: Consists of marble powder, lime, fine sand and white or coloured cement mixed together at the rate directed by the Engineer to give texture and colours needed. It will be applied with the tyroline.

The price includes making any grooves shown on elevations drawings.

(vi) **Textured Rendering:**

Textured rendering may be made in variety of ways and in many different designs.

Mainly textured rendering is obtained by throwing on to the under coat a wet mix of fine aggregate and cement material by the use of hand-operated or power driven machine giving a rough finish which shall be applied by wood float to remove surface peaks leaving an overall thickness of 5 mm.

In case of rough-cast finish the thrown mix with the required proportions and size of aggregate shall be left as thrown.

(vii) **Artificial Stone Plaster:**

- a. Scratch coat: 450 kg cement to one cubic meter fine sand.
- b. Under-coat: 250 kg cement to one cubic meter sand. The surface has to be trued and scratched to form good bonding.
- c. Finish-coat: Five parts of hard lime stone chips, three parts clean lime powder, 1.5 parts white cement and the required colour oxides. This coat shall be not less than 8mm thick and shall be allowed to dry. The surfaces shall be rubbed or tooled to produce the required finish.

1.5.5 Base Screeds

1.5.5.1 Materials

Materials for base screeds shall be in accordance with BS CP 204, Part 2, Section 1 and as set out below:

- (i) Cement shall be Portland cement complying with BS 12.
- (ii) Sand shall comply with BS 1199.
- (iii) Water shall be clean and free from harmful matter in suspension and solution. Where doubt exists, the water shall be tested in accordance with BS 3148.
- (iv) Lime shall comply with BS 890.
- (v) Plaster shall be pre-mixed plaster of approved manufacture.

Mix proportions for base screeds shall be 1 : 4 by volume cement-sand, unless under thin floor coverings (vinyl tiles, fitted carpets, ... etc.) when they shall be 1 : 3 by volume cement-sand.

Screed reinforcement shall be steel fabric reinforcement to BS 4483 (3mm diameter 200mm² mesh).

1.5.5.2 Preparation

Base concrete to receive floor screeds shall be prepared as follows:

- (i) For screeds, separately laid within three (3) to twelve (12) hours of the base concrete being placed: the loose aggregates on the surface of the base concrete shall be removed by light or mist spraying with watering and brushing. Any excess water shall be removed prior to laying screed.
- (ii) For screeds separately laid more than twelve (12) hours after the base concrete has been placed: the loose aggregates on surface of the base concrete shall be completely removed by hacking to expose clean aggregate particles. All loose concrete, dust and dirt shall be removed by thorough washing with water. Any excess water shall be removed prior to applying the cement slurry.
- (iii) For screeds laid "unbound": no special preparation is necessary, except to remove all projecting nibs and sweep the concrete surface clean prior to laying the separating layer.

1.5.5.3 Workmanship

Materials for screeds shall be thoroughly and efficiently mixed dry by mechanical means until a uniform distribution is obtained, and then water is added. The water content shall be kept as low as necessary to allow sufficient workability for laying and compacting. No extra water and/or other material shall be added after the mixture is out of the mixer. Where only small quantities are required, mixing may be carried out by hand on a clean watertight surface.

Floor screeds shall be laid to the thickness, levels and falls to the approval of the Engineer or as shown on the Drawings.

Thick floor screeds shall be laid in bays of maximum size 20 m². Bays shall be laid alternately. Floor screeds for thin floor coverings shall be laid in strips not larger than 3 m wide.

Side forms shall be fixed rigidly and supported throughout their length so that they will not be disturbed by the spreading and compacting of the floor screeds. Forms shall be set true to line within ± 3 mm, and to level within ± 3 mm, and shall be checked for level immediately before Works starts.

The screed mix shall be placed between the forms, worked around the penetrations, duct covers, manhole covers, gutters, balustrade standards, pipes and other obstructions, and shall be fully compacted by means of a screed board, or other suitable compacting equipment in such a way that an excess of latency is not brought to the surface.

All edge joints of floor screeds shall be simple butt joints without filler. Screeds laid over construction joints in concrete shall be separated by 10mm impregnated hardwood strips or the like.

As soon as a floor screed has hardened sufficiently to prevent damage to the surface, it shall be cured for a minimum period of seven (7) days, by means of either wet canvas, straw mats, sand, polytene/or sheeting laid on the surface and kept continuously damp and in position for the full curing period.

Floor screeds shall not be laid in areas exposed to high temperatures, strong sunlight, strong draughts and/or winds, unless protected from such conditions.

1.5.5.4 Surface Finish

Screed base course (1 : 4 nominal mix) shall generally be finished with wood float to give an even texture. The sprinkling of cement into the surface and trolling to absorb water will not be permitted.

1.5.5.5 Tolerances and Defects

The finished surface of base course screeds shall not depart more than 3mm from the edge of a 3 m straight edge placed anywhere on the surface.

Variations in the surface level of a floor screed shall have a tolerance within ± 3 mm from the floor datum. Floor screeds shall be free of all defects and any Works, which shows signs of bond failure, hollow patches, crazing, cracking and/or any other defects, which will not be accepted, and shall be removed and replaced with acceptable Works by the Contractor.

The extent of the Works to be removed and the method to be used in the removal and replacement of this Works shall be to the approval of the Engineer.

1.5.6 In-situ Toppings

1.5.6.1 General

In-situ topping and wearing courses shall be of the following kinds and as specified or shown on the Drawings:-

- (i) Cement-screed wearing course;

1.5.6.2 Cement - Screed

Cement - screed for toppings shall be in accordance with the requirements for base-course screed except for the following:-

Screed wearing course (1 : 3 nominal mix) shall be tamped with a wood float and trowelled twice with a steel trowel to produce a smooth finish. Matured sub-base shall first be well cleaned, wetted and brushed with a Portland cement grout before topping is laid. Finishing screeds shall be made as specified around gullies and any penetrations through the floor surface.

Abrupt irregularities caused by differences of levels between adjacent bays shall not exceed ± 1 mm, and where thin flexible floor coverings are to be laid, it shall not exceed ± 5 mm. All surfaces shall be approved by the Engineer before further Works is carried out.

1.5.7 Paving

1.5.7.1 Materials for Paving

Concrete paving slabs shall be 50 mm thick, hydraulically pressed precast concrete slabs to BS 7263 (Part 1) to approved sizes.

Marble shall be of the best quality Karara white marble for floors and walls, free of defects, cut square, true and shall be uniform in shape and thickness. Sizes, types, patterns and finishes shall be as required and approved by the Engineer.

1.5.7.2 Workmanship

Precast concrete slabs shall be laid and bedded by the following method:-

On a well compacted layer of sand having a loose thickness of 50 mm, and cement sand mortar (1 : 4 mix.) of 20 mm.

All precast concrete slabs shall be laid in bays not exceeding 10m in length, the bays being separated by an expansion joint 10mm wide.

Marble treads and risers for stairs and door openings shall be cut to fit exactly the required dimensions to the approval of Engineer. Marble slabs for topping the roof parapet shall be formed with two bottom grooves along the slab for rain water drip and the top surface shall be slightly, but equally to all slabs, sloping to outside.

Marble paving shall be laid by the "semi-dry" method on a mortar bedding not less than 25 mm thick on a base screed of 35 mm minimum thickness.

The mortar bed shall first be applied over the base screed to a minimum thickness of 25 mm. The mortar after having been trowel-finished or treated with a screed to eliminate any rough particles of sand, shall be allowed to reach a semi-dry consistency during its curing period at which it will support the tiles firmly.

The slabs shall then be laid and set using a cement paste of the consistency of putty. The surface shall be cleaned thoroughly. The joints shall be filled with grout the next day and the tile surfaces shall again be cleaned.

Joint strips of suitable approved material shall be provided at not more than 8 m centers to form Contraction joints. Joints shall also be provided around the perimeter of the paving and around all plinths and mountings.

No acid, alkalis or any hard means of wiping shall be used for the cleaning the Works.

1.5.8 Tiling and Floor Covering

1.5.8.1 Materials

Tiles shall be supplied as follows:-

- **Glazed ceramic tiles** for walls shall be either white or coloured, true to shape, flat and free from flaws, cracks and crazing, uniform in colour, keyed on the back and shall comply with BS 6431. The tiles shall be of a suitable type, size and colour.
- **Ceramic floor tiles** shall be true to shape, flat free from flaws, cracks, uniform in colour and of an approved type, make and colour. Dimensions and tolerances shall comply with BS 6431.
- **Precast mosaic floor and skirting tiles** shall be true to shape, flat, free from flaws, cracks and pittings. They shall also be of smooth surface and of an approved type, make, colour, and square. The facing shall consist of cement and marble or granite chippings (1 : 2 : 5 nominal mix) using either white cement with or without pigment added, or coloured cement to be non-fading to BS 1014. The facing is to be wear resistant and of a finished thickness not less than 10 mm. Backing shall consist of plain cement and sand 1 : 5 mix. with min. thickness 15mm.

Mosaic tiles shall be supplied polished. They shall be cured by total immersion after initial set in clean water for at least twenty four (24) hours. This is to be done before grinding, filling and polishing.

- **Precast cement/sand tiles** of 20 mm thickness shall be formed of minimum 10mm facing of 1 : 3 white cement to sand by volume, set on a backing of sulphate resisting cement mortar with minimum cement content of 350 kg to each cubic meter of sand. A sample should be approved by the Engineer before ordering.

- **Marble Floor Tiles**

Marble tile flooring and skirting shall be from national product and of high quality as shown in drawings, free from defects, metallic veins and cracks. The selected marble tiles shall have sharp edges, correctly cut and rubbed to produce the required aesthetic finish. Tiles and skirtings shall be with the required dimensions and 20 mm thick.

Marble tiles are laid on clean sand bed 2 cm thick, and cement sand mortar mix (1:3). Joints between tiles are not more than 1 mm and grouted with white cement slurry.

- **Marble Steps**

The required marble shall be of best quality, free from defects, metallic veins and cracks. Treads and rises shall be with thickness as shown in drawings. Steps shall be bedded in cement mortar mix (1:3).

- **Granite Tile**

Granite tiles shall have sharp edges, correctly cut or ribbed to produce the required aesthetic finish the exposed surface finish shall be either glass polished, eggshell, matt, fine punched or rough punched.

1.5.8.2 Preparation

Floor tiles which are to be laid in cement mortar, shall be soaked in clean water for fifteen to thirty (15 - 30) minutes before fixing, and allowed to drain for ten to fifteen (10 - 15) minutes. Any surplus water shall be removed from the backs before laying.

Tiles to be fixed with adhesives shall not be soaked or wetted prior to laying.

Each floor area shall be set out to avoid the use of small cut pieces as far as possible. Floor tiling shall be set to the levels and falls required. Wall tiling shall be set to true horizontal lines.

Tiles shall be laid so that the key patterns on the back of the tiles lie in the same direction.

All cutting of tiles shall be fair cutting using a tile cutter.

Before the commencement of work, backgrounds shall be inspected and tested to ensure that their cleanliness, moisture content, alkalinity and sulphate content, ... etc., are such that they will not adversely affect the work.

1.5.8.3 Workmanship

Workmanship and construction for ceramic or glazed tiles to floors and walls shall be in accordance with BS 5385 (Part 3 & 5).

Tiling shall be free of all defects and any Works which shows signs of bond failure, hollow patches, misalignment, cracking and/or any other defect will not be accepted, and shall be removed and replaced with acceptable work.

Joint fillers, sealer and adhesives shall be mixed and used strictly in accordance with the manufacturer's instructions.

Additives shall not be used in rendered backings to receive wall tiling.

Thin tiles shall generally be adhesive fixed. Backgrounds shall be cleaned and primed according to the manufacturer's instructions, and the adhesive shall be applied by the notched trowel technique and trowelled over the area to be tiled at a thickness of 4 mm, then combed with a trowel having 4 x 4 mm notches at 16mm centers to form ribs. Tiles shall be pressed in as recommended by the Engineer.

Thick tiles shall be bedded in cement/sand mortar (1 : 4 mix) 6 to 8 mm thick to a true vertical or horizontal face with continuous horizontal and vertical joints and shall be pointed in neat white or coloured cement. Any surplus which adheres to the face of the tile shall be wiped off with a damp cloth before it sets hard.

The external angles, side and top edges of glazed wall tiling shall be formed with rounded edge (bullnose) tiles.

At intersections, returned rounded edge tiles shall be used.

The joints shall be either close tight joints or open joints not exceeding 2 mm wide. Joints in wall tiling shall match those of the floor tiling and special approved fittings shall be used at the intersections between wall tiles and horizontal surfaces.

Where tiling abuts against wood or metal frames or other tiling at angles and around pipes, ... etc, it shall be carefully cut and fitted to form a close neat joint. Open irregular joints filled with cement and sand and/or plaster will not be permitted.

Skirtings, coves, channels and other fittings shall be bedded as tiles.

Movement joints 6 to 10 mm wide shall be formed around the perimeter of the floors and generally at 4.6 m in both directions of surfaces for the full thickness of tile and bed. The joints shall be filled to not more than 6mm from the face of the tile with joint filler, and sealed with polysulphide sealant applied by gun and neatly smoothed off and pressed home.

The surface of the tiling shall be protected by the use of masking tape, which shall be removed before the sealant has set. Any sealant on the face of the tile shall be cleaned off.

Brass junction strip shall be fixed at the junction of tile and other floorings. It shall be set in position before the tiles are laid, and shall extend through the full thickness of the tiling and bed.

Grouting shall be carried out not less than fourteen (14) hours after the completion of the tiling. Where mastic adhesives are used, sufficient additional time shall be allowed for the adhesive to dry out. The grout shall be well worked into the joints with a shaped piece of wood so as to fill the whole joint. Surplus grouting shall be removed and the tile surface polished with clean dry cloths.

1.5.8.4 Tolerances

The surface of finished wall tiling shall not depart by more than 3mm from the edge of a 3m straight edge placed anywhere on the surface.

1.5.8.5 Protection of Finishes

General

The Contractor shall anticipate the possible sources of damage to finishing Works and shall take active and positive protective measures to the satisfaction of the Engineer, and the acceptance of responsibility for making good in the event of damage will not be adequate.

Protective devices shall protect the Works against damage arising from weather conditions, construction, warping, distortion, abrasion, sunlight, humidity and/or other condition, which would have an adverse effect on the Works.

The Contractor shall provide devices to protect his Works during loading, transportation and unloading at the site.

Protective devices shall be arranged so that wherever possible they can be maintained in position during storage, assembly and fixing and until the Works have been completed.

The Contractor shall, as necessary, provide, maintain, alter and adapt protective devices to protect his Works during construction, assembly and installation up to the time of completion.

1.5.8.6 Drying and Cleaning

Upon completion, the Contractor shall thoroughly brush and wipe down to remove dust, ...etc., and clean the finishing Works so that they are left in a condition to the satisfaction of the Engineer.

1.5.9 Timber and Timber Doors

General

The following shall apply to all carpentry and joinery incorporated in the Works by the Contractor.

Workmen employed in the manufacture and installation of the Permanent Works timber Works shall be experienced in the type of Works being undertaken.

1.5.9.1 Materials

Timber shall be of good quality, sound, in good condition, reasonably free from shakes and free from loose dead knots, insect attack, decay, twisting and warping. Timber shall be properly seasoned to suit the purpose for which it is intended as shown in BS 1186 (Part 1, 2 & 3).

Only knots with characteristics similar to those detailed in BS 1186: Part 1 will generally be allowed.

1.5.9.2 Softwood

Softwood shall be as follows:

- (i) Redwood, specially selected from the best unsorted and joinery quality.
- (ii) Douglas fir of selected merchantable quality or better.
- (iii) Any other approved by the Engineer.

1.5.9.3 Hardwood

Hardwood shall be selected and of the best quality, it shall be particularly checked for infestation by pinhole bores. Selected Iroko hardwood shall comply with BS 1186 : Part 1, Grade FAS.

1.5.9.4 Plywood and Face Veneers

All plywood shall be to the approval of the Engineer and shall comply with the requirements of BS 6566 and bonded to BS 1203:

Grade (1) where varnished

Grade (2) elsewhere

Plywood and face veneers shall be free from end joints (including joints in veneers), overlaps in core veneers, dead knots, patches and plugs, open defects, depressions due to defect in cure, insect attack, fungal attack, and from discoloration differing from that normally associated with species.

Face veneers shall be to the approval of the Engineer, shall be hard, durable and shall be capable of being finished to a smooth surface. Face veneers shall closely match the general joinery timber supplied and shall be applied to one or more sides as required.

1.5.9.5 Veneered Blockboard

Veneered blockboard shall be regular density board complying with BS 3444 produced in a factory by an approved process and faced with hardwood veneer (minimum 3mm thickness). Where Works has only one visible face, the rear (invisible) face shall have a balancing veneer. Veneers

shall be carefully chosen and applied so as to present a good appearance. Full sheets shall have edges lipped with matching 6mm thick hardwood, strips, the full thickness of the sheet.

1.5.9.6 Miscellaneous Material

Screws shall comply with BS 1494 (AMD 1) Part 1. Timber connectors where used shall be two single-sided toothed plate (round or square) for demountable joints or one double sided toothed plate (round or square) for permanent joints to BS 1579.

Fixings to walls and floors and ceilings shall be carried out by the following means:

- (i) Approved patent fibre or purpose made filling plugs fixed in accordance with the manufacturer's instructions.
- (ii) Approved parallel expanding anchors.
- (iii) Hardwood plugs cut on the twist, provided the structure is approved as sufficient to take the plugs. Softwood plugs shall not be used.

1.5.9.7 Ironmongery

(i) General

The Contractor shall provide all necessary ironmongery including matching screws, bolts, plugs and other fixings. The use of nails for fixing ironmongery will not be permitted.

Ironmongery shall be of the best quality and to the approval of the Engineer and unless otherwise specified shall be solid brass. The Contractor will be required to submit samples of all items of ironmongery (including hinges) for approval.

Ironmongery (door, window and furniture, ... etc.) shall not be fitted with the exception of hinges till all other finished are completed. All screws used for fixing ironmongery shall be of the correct type, material, finish, size and shape to the approval of the Engineer.

Items shall be surface mounted or housed into neatly cut recesses as appropriate. They shall be mounted square with the timber-work, neat in line, be pleasing in appearance and free of paint and varnish.

The hinges on which the doors, windows, fly screen doors ... etc., are hung, shall be carefully housed or let in to the door, window and flyscreen door, ... etc., and to the frames.

All fittings if already fixed shall be removed before starting any painting operations and shall be refixed in place after the painting Works are completed and approved by the Engineer.

All ironmongery shall be carefully wrapped and protected until the completion of the Works and any items or parts which are damaged or defaced shall be replaced before handing over.

Emergency doors to chlorination areas shall be provided with a full width panic bar operating a latch lock. It shall be possible to open the door from the outside using only a key.

On completion, the brass shall be polished and all locks, catches and similar items of ironmongery shall be properly cleaned, tested and oiled. Keys shall be clearly labelled with metal or hardboard tags of size approximately 50 mm x 20 mm securely fixed to the keys and handed over to the Engineer. Quadruplicate sets of keys shall be supplied.

(ii) Fittings for Carpentry Work

All fittings and hardware should be manufactured by reputed manufacturer and to the satisfaction of the Engineer.

The Contractor shall supply the following for lockset system:

Operating key set including two keys per lockset.

All keys shall be tagged, or otherwise marked, before delivery, with identification of the door for which the lockset is intended.

Each sash shall have three spike or ordinary hinges of brass, 110 mm length. Hinge leaf shall be fixed with three brass screws with sinking heads.

Cylinder mortise lock with latch bolt moves with lever handleless or key, dead bolt moves by two turns key, 5 pin tumblers, 50 mm backset.

Latch bolt shall move by one pair of lever handles, aluminum anodized 120 mm length. The handle works on a steel spindle square section 8 x 8 mm. The handle shall have anodized aluminum face 50 mm diameter, of two parts to cover fixing screws.

Door sash shall have a combined stop and holder of brass and nickel plated, 75 x 75 mm size, 4 mm thick, 4 screw holes. On surface shall be installed a quarter of a ball of solid brass and nickel plated, 35 mm diameter, fixed on its vertical surface a piece of tough rubber 8 mm thick by means of two sinking head screws. The holder shall be installed on floor by screwing in wooden plugs to the required shape.

In case of two sashes doors, only one sash shall have two mortise bolts of brass and nickel plated 20 cm length.

Sashes of toilet doors shall have a mortise lock with latch bolt working by lever handle from both sides, and dead bolt working from inside by a knob, anodized aluminum 90 mm length.

Corridor and service doors shall have two swinging hinges of brass and nickel plated 125 mm size, working in the two directions.

Swinging doors shall have cylinder mortise lock with roller bolt.

All sashes of all types of doors shall have a plinth, from inside and outside, of anodized aluminum, 3 mm thick, 200 mm height, with colour matches with the handles and as directed by the Engineer. The plinth shall be placed and fixed by 8-10 aluminum screws, with sinking head to the plinth colour.

1.5.9.8 Preservation of Softwood

All softwood incorporated in the Works or delivered to the site shall be treated with an organic solvent preservative by means of double vacuum impregnation after final machining, but before assembly. The treatment process shall be to the approval of the Engineer.

1.5.9.9 Moisture Content of Timber

All timber shall be seasoned. On arrival, timber shall be close-stacked on level bearers or suitable racks spaced to allow circulation of air and protection against water, dirt, decay, insect attack, soil and other deleterious matter. The Contractor shall take all necessary steps to preserve the timber in best quality condition.

1.5.9.10 Exposed Faces

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

1.5.9.11 Natural Finish

When natural finish or finish for staining, clear polishing or varnishing is required, the timber in adjacent pieces shall be matched, uniform and symmetrical in color and grain.

1.5.9.12 Shrinkage

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

1.5.9.13 Tolerance

Reasonable tolerance shall be provided at all connections between joinery Works and the building carcass, whether of masonry or frame construction, so that any irregularities settlements or other movements shall be adequately compensated.

1.5.9.14 Joints

Joints shall comply with BS 1186, Part 2.

Loose joints are to be used where provision must be made for shrinkage or other movements acting other than in the direction of stresses of fixing or loading.

Glued joints shall be used where provision need not be made for shrinkage or other movements in the connections and where sealed joints are required. All glued joints shall be cross-tongued or otherwise reinforced. All nails, sprigs, ...etc., shall be punched and puttied. Surfaces in contact shall have a good sawn or planed finish. All cutting edges of tools are to be sharp to avoid burnishing. The surface of plywood to be glued shall be lightly dressed with sand or glass paper. The sand or glass paper must not be allowed to clog and cause burnishing.

Members in construction to be joined by gluing are to be of similar size and shape. All surfaces to be glued shall be kept clean, free from dirt, sawdust, oil and any other contamination . Adequate pressure shall be applied to glued joints to ensure intimate contact and shall be maintained whilst the glue is setting.

All joints shall be flushed, without gaps or imperfections.

Mixing and setting conditions shall be in accordance with the glue maker's instructions

1.5.9.15 Scribing

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

1.5.9.16 Finishing

All wrought surfaces shall be appropriately prepared for decoration as required.

1.5.9.17 Hardwood Works Fixing

Fixings shall be by jointing or by gluing to other timber or by means of brass screws with countersunk heads using proprietary plugs. Where Works is face screwed, heads of screws shall finish not less than 6mm below the surface and be covered with round hardwood pellets of appropriate thickness. Pellets shall be chosen and fixed so as to match color and pattern of grain so far as is practical. Nailing will not be permitted. Sections shall be neatly and accurately cut with fine toothed saws.

1.5.9.18 Priming

All joinery which is to be painted shall be delivered to site unpainted and shall be primed on site immediately after inspection and acceptance by the Engineer and before fixing.

1.5.9.19 Defective Work

All defective timber that is defaced, split, shrunk or excessively warped shall be removed and replaced.

1.5.9.20 Framing

Where described as framed, all joinery shall be put together with well fitting mortise and tenon joints and be glued and wedged up solid. Final wedging up shall not be completed until fixing of joinery is commenced. All glued joints shall be cross-tongued and all hardwood joinery shall be secretly fixed. All joinery to be painted shall be knotted and primed with an approved primer before leaving the shop.

1.5.9.21 Flush doors

Generally flush doors shall have a minimum thickness of 40mm. They shall be of the hollow - core type and be faced both sides with veneered plywood.

Flush doors shall be to the approval of the Engineer and shall comply with the requirements of BS 459. All edges shall be bevelled and lipped with hardwood tongued into the edge of the door.

1.5.9.22 Frames

In general, frames, architraves and extension pieces shall be manufactured from red or whitewood timber in accordance with, the requirements of BS 1186 : Part 1 and shall include the use of finger-jointed material.

1.5.10 Glass and Glazing

1.5.10.1 Standards

The following standards and code of practice in their latest edition shall apply to works covered by this section.

BS 952	Glass for glazing.
BS 4255	Rubber used in preformed gaskets.
BS 544	Linseed oil putty
BS 6262	Code of practice for glazing for buildings.

1.5.10.2 Glass

Glass shall be in accordance with BS 952 with a density about 2560 kg/m³. Sheets shall be selected of such quality that surface deterioration will not develop after glazing.

The schedules define the thickness of the glass suitable for each application based on glass areas and estimated wind loading in accordance of BS CP 152. The minimum thickness shall be 4 mm.

- Wired reinforced glass shall be with a polished surface, 6mm thick with straight wires both ways to form 12.6 mm squares.
- Solar control glass shall be formed from two panes of glass bonded together with a lamination between them of thin metallic film.

- Double glazing units shall be formed from two panes of glass separated by a profiled aluminum spacer, the inner pane shall be clear float glass and the outer pane solar control glass.

All glass shall be of accurate size with clean undamaged edges, free from defects and with flat and parallel surfaces.

1.5.10.3 Glazing

Glazing shall comply generally with BS 6262.

Glazing gaskets shall be formed in continuous lengths or "frames" so that material at corners or joints cannot separate and allow air leaks. Gaskets shall be of proprietary manufacture and specially shaped for the window unit and glass with which they are to be used. They shall be of a thickness such that when in position they are compressed.

Rebates and grooves shall be true, rigid, dry and unobstructed and of adequate depth, from 16 mm to 32 mm, depending on the unit size, to allow for glazing tolerances, gaskets and mastic sealant.

Glass panes shall be accurately cut to size with square corners. Front and back face clearances shall be sufficient to allow for gaskets or sealants and edge clearance shall be 3 mm for panes of up to 4 m² and 6 mm for panes up to 8.4 m².

Panes of glass shall be centralized in the surround. Where mastic only is used in conjunction with beads the glass shall be rested on two unplasticized PVC setting blocks along the bottom edge and (in the case of horizontal sliding windows) two further blocks in each vertical edge. These shall be at the quarter points and not nearer to the corner than 75 mm. The setting blocks shall be 25 mm to 75 mm long and of the thickness necessary to hold the glass central. Where preformed glazing strips are used capable of serving the same purpose as spacing blocks the latter shall be dispensed with.

Beads shall have square cut corners for a perfect fit and the ends of the hollow sections shall be mastic filled before fixing. Beads shall be fixed by means of integral grooves extruded into the frame so that the full length is locked into position and with the sealing gaskets in position, the overall window sash forms a box section. For this reason the beads must be designed as part of the window assembly. Screws or studs at intervals along the sashes for fixing beads will not be accepted. Preformed gaskets shall be of a proprietary type, preformed for each specified window type which must have grooves to accept the gaskets.

Glazing compound of approved type and manufacture shall be used for bedding and sealing bead glazing.

External glazing shall be wind and watertight on completion.

1.5.11 Aluminum Work

1.5.11.1 Aluminum Fittings

The materials for fittings made of aluminum shall be in accordance with the relevant parts of BS 1470, BS 1471 and BS 1474. Aluminum shall be anodized natural silver finish to BS 1615 grade A25. Insect screens shall be of galvanized steel wire mesh with voids not exceeding 2 x 2 mm.

1.5.11.2 Aluminum Windows

All aluminum windows shall be of proprietary manufacture to the approval of the Engineer.

A sub-frame of primed soft wood with minimum section dimensions of minimum thickness 1", anchored to the structural opening shall be installed first to receive the aluminum frame. The wooden frame shall be concealed in the aluminum frame section.

Window frames shall be constructed from sections with mechanically mitred corners and joints reinforced with extruded aluminum cleats. The main legs of the sections shall not be less than 2 mm thick and glazing beads not less than 1.5mm thick.

The window frames shall be fitted with extruded aluminum clip-in beads to give a flush internal appearance. Both the glazing leg of the mainframe sections and the surface of the bead shall be fluted to ensure adequate adhesion of the glazing compound. The bead sections at the head and cell shall run full width and the jamb beads shall be neatly blunted.

Glass edges in window frames shall be filled with acrylic sealant. Glazing shall be carried out using mastic glazing tape externally and P.V.C. vision strip internally.

Glazed panels shall be set in dry glazing system and held in place with natural silver anodized aluminum angle glazing beads fixed to the frame with stainless steel countersunk set screws.

Where an aluminum frame is adjacent to another aluminum frame (door, fan, ... etc.), the two horizontal aluminum frame sections shall be reinforced with two "T" sections of galvanized steel anchored to the structural elements on both sides of the smaller frame opening to ensure that the lower frame is not eventually a support to the upper one.

1.5.11.3 Aluminum Doors

A sub-frame of primed soft wood with minimum section dimensions of minimum thickness 1", anchored to the structural opening, shall be installed first to receive the aluminum frame. The wooden frame shall be concealed in the aluminum frame section.

Door frames shall be of hollow sections of minimum size 100mm x 44mm with projected stops. Frames shall be pre-drilled for fixing to structural openings with stainless steel screws into sunk fixing plugs. Frames shall be complete with floor dowels.

The meeting stiles of double doors shall be rebated 12 mm.

Aluminum alloy sunk angle thresholds shall be fixed at thresholds of doors with the top edge set upstanding 12 mm.

1.5.11.4 Accessories and Hardware

(i) General

Hardware shall be of suitable design and have sufficient strength to perform the function for which it is intended, it shall be attached securely to the unit with non-corrosive bolts or screws.

All types of windows and doors shall be provided with hardware necessary for working perfectly as shown on shop drawings or specification. Hardware shall be the best of its kind according to samples approved by the Engineer.

All hardware, for each type, shall be supplied to the site without fixing, except hinges and movement pieces for sashes and shall be tested for working in the workshop before transportation and supplying. Hardware shall be installed in places after installation and fixing of each type into the prepared opening.

Hardware required for each type shall include all pieces necessary for working sashes, locking pieces, fixing including all pieces for installation and fixing to indicated places in frames, moving or fixed sashes.

Hinges shall be of steel having movement pieces of anti-rust material, holders shall be anodized aluminum or chromium plated brass. Hooks and fixing pieces of chromium plated brass, locks shall be mortise type with suitable sizes. All hardware shall be approved by the Engineer before supplying and installation.

(ii) Sliding Sashes

Sashes shall move by lower ball-bearing 20 mm diameter, over brass T type 16 x 10 mm section weighting 0.500 kg/m, the upper member shall have a steel pivot 15 mm diameter moving by ball-bearing rough steel-iron channel.

Each sash shall have a stop of steel bar 38 x 12 mm and 4 mm thickness, with a piece of soft rubber 8 mm thick, fixed by two sinking head screws.

Sashes shall be locked by a mortise brass espagnolette bolt consisting of movement box, steel rubber bar espagnolette shall move by anodized aluminum holder 90 mm length with a base.

(iii) Side-Hinged Sashes

Sashes shall have heavy steel hinges 110 mm length, electrically welded to sash and frame. Sash not more than 1.00 m high shall have two hinges, sash over 1.00m high shall have three hinges.

Sashes shall be locked by mortise brass espagnolette. Espagnolette shall move by anodized aluminum holder 90 mm length.

Each sash shall have a brass and nickel plated hook 100, 120 or 150 mm length as required, made of straightened brass wire 4 mm diameter, fixed on a circular base 25 mm diameter made by pressing of brass sheet 2 mm thick. The hook base shall be fixed to frame by sinking screws, and to walls by steel bolt 100 mm length by cement mortar.

Notice: Doors sashes shall have three hinges 140 mm.

(iv) Lower-Hinges Sashes

Sashes shall have lower hinges 110 mm length, electrically welded to sash and frame. Sashes not more than 1.00 m width shall have two hinges, sashes over 1.00 m width shall have three hinges.

Sashes shall be locked by mortise brass espagnolette. Espagnolette shall move by anodized aluminum holder 90 mm length.

High sashes (fanlight) shall be locked by a thumb with brass and nickel plated spring.

Install - at side of sashes - a mortise pull handle of steel bar 20 x 4 mm section to control the opening to sashes at about 30 angle.

(v) Reversible Sashes

Sashes shall rotate around vertical or horizontal bronze pivots, electrically welded to sash and frame.

Install to sashes a pull handle of steel bar 20 x 4 mm section to control the opening of sash at about 30 angle.

Sashes shall be locked by mortise brass espagnolette. Espagnolette shall move by anodized alum. holder 90 mm length.

Window types consisting of number of sashes required to be opened in combination, shall have side handle of steel bar fixed to sashes at upper and lower members to facilitate the sash movement together.

1.5.12 Iron and Metal Works

1.5.12.1 Standards

The following standards in their latest editions shall be applicable for this section in addition to all relevant standards that are previously mentioned.

BS 1161	Aluminum alloy sections for structural purposes.
BS 1245	Metal door frames (steel).
BS 1449	Stainless and heat resisting steel plate, sheet and strip.
BS 1470	Wrought aluminum and aluminum alloys for general engineering purposes-plate-sheet and strip.
BS 1471	Wrought aluminum and aluminum alloys for general engineering purposes-drawn tube.
BS 1474	Wrought aluminum and aluminum alloys for general engineering purposes-bars extruded round tubes and sections.
BS 1494	Fixing accessories for building purposes.
BS 1615	Anodic oxidation coatings on aluminum and its alloys.
ASTM A 167	Corrosion resisting chromium nickel steel plate, sheet and strip.

1.5.12.2 Drawings

Before any manufacturing and assembly work is commenced, the Contractor must submit fully detailed drawings of all shop assembled materials for the approval of the Engineer. These details shall cover such items as metal doors, transformer fence, ladder and any such other details as the Engineer may require. No work may commence until the Engineer approval of all details has been received.

1.5.12.3 Time of Delivery

Metal doors, fence, ladder and other such details shall not be delivered at site until they are required for fixing in the buildings. Metal works which do not require to be built in as the work proceeds shall not be brought to site and fixed until the permission of the Engineer is obtained.

1.5.12.4 Transport and Protection

The metal doors, fence, ladder and other details shall be kept under a water proof cover during transit and shall be similarly covered and kept clear of the ground on site. They are to be handled and stacked carefully to avoid damage.

1.5.12.5 Steel Doors

Doors and frames unless otherwise specified shall be made of sheet steel and the design and construction shall ensure stability under all practical conditions. They shall be constructed according to the relevant standards. Complete detailed drawings shall be submitted by the Contractor for the approval of the Engineer before manufacturing of the doors.

Steel profiles shall be formed by mechanical means and all joints shall be made carefully and in accordance with the best modern practice. No joints shall be permitted in the metal facing; and if the steel thickness of the metal facing is less than 5 mm steel reinforcement not less than 5 mm thick shall be provided for the door closer.

Door frames shall be provided with metal cramps for grouting into the wall. Spun mineral wool insulation shall be provided over the whole interior area of the door and shall be fixed with a plastic binder such that no part of the door may become uninsulated due to shocks, blows and slamming or long and repeated use of the door.

Doors shall be provided with lock cut-outs and these shall be reinforced between the facings. Steel lugs of minimum thickness 3 mm shall also be provided for the cut-outs for the attachments of the locks, and each cut-out shall have a support for the lock. Edges of the recesses to the locks, bolts etc. shall be blunt. External doors shall have an external weather stop.

All doors and frames shall be marked with a type number at the factory, and during transit they shall be kept under waterproof cover. They shall not be stacked on the ground either during transit or at the site and they should be handled and stacked carefully so as to avoid damage.

Doors and frames shall be painted in accordance with the section of painting.

1.5.12.6 Door Fitments, Handles, Knobs Etc.

All doors fitments shall be strong and robust and in all respects adequate for their respective purposes. Unless specified otherwise they shall be stainless steel or chromium plated and to the satisfaction of the Engineer.

After hanging of the door a check shall be made to ensure that the weight is being borne equally on all the hinges. Screws for use with the hinges shall be stainless steel or chromium plated as shall the hinges themselves and they shall also be well oiled at the moveable faces.

Doors shall be fitted with locks, adequately protected against corrosion, cylinder locks of suitably type shall be used. The locks shall be provided with suitable handle. Handle levers shall be mounted in strong handle plates firmly screwed to the doors, and lever plates and bolts shall be of a type approved by the Engineer.

Handle operation and locks shall be thoroughly lubricated before fitting and a check on lubrication shall be carried out on all movable parts, including hinges. Lever and grip handles, knobs, etc. shall be of approved type. Door stops and holders shall be fitted with rubber cushions and fixed with suitable clamps for grouting into drilled holes. Door holders shall be fitted to secure the maximum opening angle.

The Contractor shall obtain the Engineer approval on samples of all the ironmongery items prior to manufacturing of the steel doors.

Keys and Master Keys Systems shall be to the approval of the Engineer while grand master keys shall be identical with those used for the existing substations.

1.5.12.7 Gratings

Gratings shall be of longitudinal flat bars and spacers welded to form a cover of the required size. The spacing between the bars is to be in the order of 50 mm. Margin bars shall be provided at the edges of all covers and to the edges of all openings required for the passage of hoses etc.

All gratings shall be hot dip galvanized after manufacture.

1.5.12.8 Steel Ladder

The access ladder to the roof of the switchgear room shall be made of one pair of 50 mm x 10 mm flat steel bars as stringers 500 mm apart. Rungs shall be 22 mm mild steel round bars welded to the stringers at both ends 350 mm on centers. The stringers shall be welded to two common steel plates of size 800 x 150 mm at top and bottom which will be fixed to the wall and floor with 6 galvanized bolts in each plate. The ladder rungs are to be fixed 200 mm from the wall face. Intermediate fixations to the wall are to be provided as necessary.

1.5.12.9 Chequer Plate

Chequer plate shall be 8 mm thick mild steel and hot dipped galvanized after all cutting for lifting eyes, penetrations and fitting have been completed. After suitable priming, the plate shall receive a further 2-coat epoxy paint system in a colour approved by the Engineer. Where chequer plate spans more than 750 mm it shall be suitably stiffened with angle backing.

Chequer plate shall be supported on 50 mm x 50 mm angle anchored into the concrete with lugs at 1.0 m centers. On top of the angle is to be welded an 8 mm deep by 10 mm wide bar to retain the chequer plate. This to be flush with the finished floor level (FFL).

1.5.12.10 Galvanizing

All steel and iron works of whatever kind described to be galvanized shall be thoroughly descaled in a solution of sulphuric acid and cleaned by picking in a bath of warm (60°C) phosphoric acid, sandblasting, or other approved method and immediately after is to be galvanized by a hot deep process. The molten zinc in the galvanizing bath shall contain not less than 98.5 percent of zinc by weight. All articles are to be immersed in the bath only for a time sufficient for them to attain the temperature of the bath and they are to be withdrawn at such a speed that a coating of 90 microns thickness is achieved or such other practicable maximum thickness for the article defined in BS 729 Part 1 "Hot dip galvanized coatings on iron and steel". The galvanizing is to be done in all cases after drilling chipping trimming, filling, fitting or bending is completed. Every article is to be covered evenly on all sides.

Galvanizing on steel works where required is to be carried out after fabrication and assembly.

1.5.13 Painting

1.5.13.1 Standards

The following standards and Code of Practice in their latest editions shall apply to works covered by this section.

BS 332	Liquid driers for oil paints
BS 381 C	Colours for identification, coding and special purposes.
BS 544	Linseed oil putty for use in wooden frames
BS 1070	Black paint (tar based)
BS 1336	Knotting
BS 2523	Lead-based priming paints
BS 3900	Methods of tests for paints

BS 4800	Schedule of paint colours for building purposes
BS 5358	Solvent - borne priming paint for woodwork
BS 6150	Code of practice for painting of buildings
BS 6900	Raw, Refined and boiled linseed oil for paints and varnishes.

1.5.13.2 Paints - Definitions

Alkyd

Synthetic resins of great versatility, used as the basis of high quality paints, enamels and staving finishes. For building and decorative paints they contain a high proportion of drying oil ('long-oil' alkyds) and harden by oxidation.

Base

- (i) A term used to indicate the major or characteristic ingredient in a particular paint, e.g. lead base, oil base.
- (ii) Used to denote the ground or substrate which is to be painted.

Binder

The non-volatile part of a paint vehicle which on drying binds the particles of pigment together to form a coherent film. Examples - linseed oil, alloyed resin, polyvinyl acetate.

Emulsion

A suspension of very small droplets of an oil resin bitumen or other liquid in water, usually brought about or stabilized by the aid of a third component called an emulsifying agent.

Emulsion Paint

A paint in which the vehicle is emulsified in water. The term is usually applied to paints in which the dispersed binder is a synthetic polymer.

Enamel

A paint with superior qualities of hardness gloss and flow.

Epoxy Resin

A synthetic resin containing a chemical grouping (the epoxy group) conferring the ability to form coatings by various hardening (drying) mechanisms.

Filler

A liquid or paste composition suitable for filling pores, cracks, joints and blemishes in surfaces, applied by brush or knife.

Finish

- (i) (Finishing Coat) the final coat of a painting system
- (ii) The general appearance of a painted surface

Lacquer

Strictly a coating which dries to a hard, generally glossy surface without the absorption of oxygen. Drying is purely by the evaporation of the solvent in which the resinous binder is dissolved. Lacquers may be clear, pigmented or transparently coloured.

Medium

The liquid portion of paint that carried the pigment, composed of the binder and solvent or thinner. (Synonymous with 'vehicle' in the liquid paint, and with 'binder' in the dry film).

Oleoresinous

A term applied by media composed of oils and natural (or modified natural) resins, usually in contact to alkyd and synthetic resin media.

Paint

A suspension of finely divided solid pigment in an oil or varnish which is applied to a surface as a liquid and becomes converted to a solid film. (The term is used in general sense to include lacquers and enamels).

Petrifying Liquid

Usually an emulsion of oil or oleo-resinous binder added to a distemper to confer extra durability or easier application on absorbent surfaces, or applied as sealing coat.

Pigment

A finely divided insoluble powder acting as colouring matter, the term also includes extenders or 'fillers' which have little or no colouring or capacity action.

Primer

The first coat of a paint system used on a specific surface to provide adhesion, satisfy absorption or prevent corrosion. Not to be confused with undercoat.

Sealer

A clear or pigmented composition used to prevent excessive suction or porous surfaces or to prevent soluble matter of alkali in the surface from bleeding into or affecting subsequent coats.

Solvent

A volatile liquid used to dissolve the binder or resinous component and lost from the film by evaporation during drying.

Stopping (Stopper)

A stiff paste composition used for filling holes and crevices before painting.

Thinner

A volatile solvent used to reduce the viscosity of paints or paint vehicles to the correct degree for application. Water is the thinner in emulsion paints.

Undercoat

The coat(s) intermediate between primer (or existing paint) and finishing coat. Not to be confused with 'primer'.

Vehicle

The liquid portion of a paint in which the solid pigment is dispersed.

1.5.13.3 Submissions

The following submissions are required for approval before commencement of painting work is :-

- (i) Details of all paints to be used;
- (ii) Sample reference areas of completed Works for each type of paint and surface.

Metal, wood and other surfaces shall be prepared as detailed in the appropriate schedules herein.

All painting shall be carried out by men skilled at such work.

In the absence of specific instructions in the Specification, the preparation and painting of surfaces shall be carried out in accordance with the recommendations of BS 5493 or BS 6150 as appropriate subject to the approval of the Engineer.

1.5.13.4 Paint - General

The Contractor shall provide all labour, materials, scaffolding, tools and implements required for preparation of surfaces, application of paint, making good any defects and cleaning of any paint splashes to other work.

Procedures and workmanship shall comply with B.S No. 6150.

All materials shall be of such quality as to produce first class and durable finishes and to be at least equal to the requirements of the relevant Standard. Full details of proposed materials and manufacturers shall be submitted to the Engineer for approval. Failure to do so may lead to rejection of materials on site and failure to meet program requirements.

Unless otherwise approved by the Engineer all the different paints forming part of the system applied to a particular surface shall be supplied by the same manufacturer. Primers used for coating the surfaces of pre-primed components shall be exempt from this requirement.

The Contractor shall not change the source of supply of any paint, or the formation without first obtaining the approval of the Engineer.

Paints shall have the correct consistency to suit the method of application. It shall normally be supplied with a consistency suitable for brush application and the Contractor shall include in his proposal, information relating to the consistency of undercoat, gloss and similar paints which are to be supplied by the manufacturer for spray application.

1.5.13.5 Protection of Surfaces

All necessary precautions shall be taken by the Contractor before the commencement of any painting activities to ensure that no damage or disfigurement of any kind is caused thereby to any part of the Works. If in the opinion of the Engineer the Precautions taken are inadequate, the Contractor shall at his own expense make all such improvements as the Engineer directs.

1.5.13.6 Storage of Paint

Paint shall be stored on site under cover and in conditions as recommended by the manufacturer.

Paint shall be stored in such a manner that each batch can be issued for use in the order of delivery.

A separate store shall be provided for cleaning solvents used for brush or other cleaning purposes. Cleaning solvents shall not be stored where paint or paint thinners are stored or where paint is prepared for application.

Paint with a limited safe shelf life shall not be used after the period stated in the manufacturer's data sheets.

Inflammable materials shall be stored in accordance with the appropriate regulations.

Paints of different types shall not be boxed up together and part used tins of paint which has formed a skin on top shall be discarded.

1.5.13.7 Safety Precautions - Paint

The implementation of the manufacturer's recommendations concerning health and safety aspects of paints, approved by the Engineer for use on the Works, shall be mandatory under this Contract.

1.5.13.8 Preparation of Surfaces for Painting

The Contractor shall regard the preparation of surfaces to be painted as Works of fundamental importance, the object of which is to ensure the production of sound, clean, smooth and dry surfaces. The preparation shall have no detrimental effect on the sub-strata to be painted nor shall it be prejudicial to subsequent painting operations.

In addition to the specific processes described below and/or in the manufacturer's instructions and Specification, all surfaces shall be cleaned free from all dirt, grease, oil and/or other deleterious matter both before the application of primer and between subsequent successive coats of paint.

All surfaces prepared and made ready for painting shall be to a standard approved by the Engineer before painting Works begins.

1.5.13.9 Preparation of Wood Surfaces

Wood surfaces shall not be painted when the moisture content of the timber measured with an electric moisture meter, exceeds twelve (12) percent for interior surfaces and eighteen (18) percent for exterior surfaces.

Hardwoods or softwoods for which a clear finish is specified, shall be rubbed down with abrasive paper to give a smooth surface which shall be free from contaminating substances, scratches and/or other imperfections.

Surfaces which are to be painted shall be rubbed down to remove all contaminating substances and imperfections which would be visible in the finished paint film. The surfaces of knots and resinous streaks shall then be painted with two coats of knotting, the first being allowed to dry before the second is applied.

The surfaces of timber treated with a water-borne preservative by an impregnation process, shall be rubbed down and dry-brushed to remove all traces of efflorescence before the primer is applied.

Where surfaces are suspected of being infected with mould, they shall be thoroughly treated with a fungicide.

1.5.13.10 Preparation of Plaster, Brickwork and Concrete Surfaces for Decorative Painting

Efflorescence present on the surfaces of plaster, brickwork and concrete shall be removed by scraping and brushing before any paint is applied. When efflorescence has been removed, surfaces shall be left for at least three (3) days before priming. Painting shall be deferred where further salt deposits form on the surface during this period.

Plaster surfaces to be painted shall be cleaned down smoothed as necessary and all cracks shall be filled with stopping for plaster. All filling shall be carried out before paint is applied to the surface.

Brickwork, blockwork and concrete surfaces shall be cleaned of all contaminating matter before being primed. Subject to the approval of the Engineer, and large holes which would cause a break in the paint film shall be filled with mortar and the surface being rubbed down to match the surrounding areas.

1.5.13.11 Preparation of Metal Surfaces

Metal surfaces to be painted shall be either blast cleaned or prepared by thorough wire brushing followed by rubbing with suitably graded abrasive paper.

In both cases, all oil and grease shall be first removed by swabbing with an emulsion cleaner. The metal surface shall be bright and free of oxidization and the preparation shall provide the metal surface with an adequate key for paint.

1.5.13.12 Application of Paint

All paints shall be prepared and applied in strict accordance with the manufacturer's instructions. Copies of appropriate data sheets and of the relevant parts of the Specification shall be issued to all the supervisors and foremen concerned with surface preparation and coating. Where such instructions conflict with the Specification a ruling shall be sought from the Engineer.

No thinners or cleaners shall be employed other than those recommended by the paint manufacturer.

Exposure of intermediate coats of paint for periods in excess of a few days shall not be permitted except in the case of Works delivered to site in a primed condition.

The dried films of the specified paints shall be free from bloom shrinkage, wrinkling, sagging, curtaining, discoloration and extraneous matter.

No exterior or exposed paint Works shall be carried out under adverse weather conditions.

Painting shall; insofar as is practicable; be shaded from direct sunlight to prevent wrinkling and blistering. Whenever possible exterior painting shall be so programmed during the day as to be carried out in shadow.

Painting of surfaces shall not be carried out when the relative humidity of the atmosphere is such that condensation is present on such surfaces or the application and/or drying of the paints is likely in the opinion of the Engineer to be affected.

1.6 Soft Scape & Hard Scape

1.6.1 Scope of Work

This section covered the specifications and requirements for soil improvement works and agriculture and forestation inside green land and area and pavement and sidewalks works as shown according to landscape drawings.

1.6.2 General Specification

First : Surface Soil

Soil shall be obtained from empty valley from blots, base soil and strange materials, it should be taken from dry areas, and clear from strange bulks greater than 20 mm, soil institute by the following percentage :

- Clay (Silt) maximum limit 60 %, sand minimum limit 40 %.
- PH (hydrogen ion in solution) maximum limit 8.3, it's hydrogenous condensed degree in soil.

The Contractor shall present an analysis for soil including the value of (hydrogen ion in solution) - PH value - and electrical conductivity extra to the contents from nitrogen, phosphoric, potassium and magnesium.

Acceptable maximum limits for each 100 gram of soil :

Phosphoric	10 milligram.
Magnesium	10 milligram.
Potassium	40 milligram.

Electrical conductivity should be not more than 2000 micro mho/cm, if it's more than this value, it's necessary to bring about the execution of soil washing to remove the mineral salt from it in a good dry area, suggestion that the water quantity 300 lit/m² with a soil depth equal 30 cm.

To obtain a top soil, valley soil must be mixed with clear sand and improvement additions for soil according to the analysis of sand and soil. And according to the project mentioned documents.

Example for mixture : Valley soil	50 %
Clear sand	20 %
Improvement additions for soil:-	
Organic fertilizer	5 %

Rocky timber half algal carbon	10%
Rind Blinders	10%
Organic resin foam	5%
Inorganic fertilizer	200 gram/m ²

Care shall be taken for top soil carefully to prevent the destroy in wet times, extension must be done not more than 150 mm thickness and the thickness must be as follows :

- a. Grassy area : 150 – 155 mm
- b. Brushwood area : 400 mm
- c. Trees area : 600 mm

Sand

Sand must be natural and free from toxic material, easy crashing congruent with hind of site soil and free from base soil, stones, ground clay blocks, wood remain, tree trunks, silt blocks, roots not desirable or debris and rubbles.

Properties shall be as follows :

- Clay less than (0.002 mm) maximum limit 3%
- Silt (0.002 – 0.005 mm) maximum limit 7%
- Sand (0.05 – 2.0 mm) minimum limit 90%
- Hydrogen ion in solution PH, maximum limit 8
- Electrical conductivity less than 1000 micro mho/cm
- Commutative Sodium less than 10 % in case of ammonium

Clear Sand

It should be well form, aeration and good drainage, with ability keeping a height moisture content, soil shall be cured in planter by adding peat with 20 % ratio, top soil shall be cured to 15 – 20 cm depth by adding hydrogenous condensed PH range between 5.5 and 6.5, if acidity degree is less than 5.5 prefer to add sulfur.

Careful shall be taken to use it, it's possible to reduce plant utility from zinc and phosphoric.

Second : Additional Material to Topsoil

Inorganic Fertilizer

Dry fertilizer shall be used with regular granular component form, easy flow, supplied in closed original cases with analysis information manufacturer's body. It should be contained nitrogen N, phosphoric P₂ O₂ and potassium K₂O in suitable mixture to accommodate the purpose.

Limited systems shall be adhered to transact with inorganic fertilizer published from agriculture ministry.

Organic Fertilizer :

Trade product fertilizer shall be completely crushed and sterile, loose and according to packager sheep fertilizer, green fertilizer (Fresh) shall not be used.

Rocky Timber Half Algay Carbon

It should be from accepted kind to use as a soil refined, rate of hydrogen ion in solution PH between 3.7 and 5.0 and no fertile, consist of only from sphagnum (Trees wood extracted from swamp after dry).

Rind Finders of Trees

Rind finders of trees product from piney trees, consist of trees rind with special form and filled in closed cases and stamped, and according to the following specification :

- Maximum capacity for water absorption 50 %
- Concentrated nitrogen
- Hydrogen ion value PH in solution 5.5 – 7

Available Alimentary:-

- Nitrogen N 100-250 milligram/liter
- Phosphoric P₂O₂ 200-400 milligram/liter
- Potassium K₂O 200-600 milligram/liter
- Magnesium Mg 300 milligram/liter

Organic Resin Foam :

Organic resin foam consist from urea foam – formaldehyde- for use in garden farming, it resist the decomposition in general conditions for climate and proposed life more than 10 years, granules are 30 mm diameter with a minimum limit for moisture absorption with a capacity of 50 % from bulk.

Another Material added to Soil

Another material added can be used for soils as phosphate and silica after the approval by supervisor direction, these material for example not for restriction, because the nature and formation for additional material to soil must be limited in project documents.

Irrigation Water

Special water for plants irrigation and corollary for washing soil to remove the mineral salt from it, should be fresh water.

The Contractor shall present an analysis for water showing the value of hydrogen ion in solution, life and electrical conductivity which should be not greater than 1500 micro mho/cm

Third : Attachment and Integrals (annex)

Supports

Supports for fixing trees formed from proper, right and regular sizes free from knobs and it has a capability to stay on land for two years at least.

Supports which using for fixing the small trees with small caulis, net length up to 1.0 m support by 50 mm diameter at least and length of 2.0 m (0.75 m from it is under the ground surface) but big trees has a net length for caulis up to 1.8 m support by 75 mm diameter at least, and length of 3.0 m (1.0 m from it is under the ground surface).

Trees which has a net length for caulis more than 1.8 m , wires fixing shall be used.

Covering Material for Trees

Covering material for trees consist of two layers from craft paper (elastic paper made from trees pith tempered by potassium carbonate) glued with layer from bituminous material.

Width of covering material 100 mm at least and protraction factor sufficiency 33 %, tie braiding from tabular rough fibers or median roughness from hemp painting with a light layer from bitumen.

Fixing Wires

Fixing wires for trees and bracing wires from elastic, soft, galvanized wires 2-3 mm diameter.

Cable's diameter 4.5 mm and consist of 7 braidings from cable's wire painted by cadmium, clasps and spiral bracings from galvanized iron by sizes and dimensions which provide a tension resistance equal that the property of cable and spiral bracing vents not less than 75 mm.

Friction resistance formed (which fold around tree caulis to prevent the scratch) from two layers from reinforced rubber, or from plastic garden trunk with regular color through spread of work.

1.6.3 Preparation for Planting

Cultivate the soil by adding soil improvement and feeding according to previous specifications and recommendations as the report of soil analysis, fertilizer shall be occurred before cultivation a period not more than 24 hours.

Spreading the fertilizer by fertilizer distributor, additional and feeding shall be completely mixed and good conflation with soil by using round buster.

Plane and ever the speed beds and determine the passage in two directions, with a depth nearly 300 mm and water add to the soil and to soil additional before mixing, during and after the process.

Margin stock from fine sand must be free from stones for all kinds, shrubs, plants, and other strange materials such before spreading.

No warrant to use the sand which shall be spread over plane area at any other works.

Clear sand shall be spread over prepared area for agriculture or garden 150 mm depth and assure to fill seed voids to the required depth.

At spread and use both kinds of sand must be with sufficient depth great than the required so as the finished work – after occurrence of natural settlement- according to stripes, gradation and certain plane of design.

1.6.4 Agriculture and Forestation Works

Source and quality of soil and sand shall be checked at supply and through works to acceptance or refusal. The Contractor shall designate apart proficient for analysis accomplish to prepare a natural and chemical analysis for soil according to topsoil specifications addition to report and recommendation of fertilizer treatment.

Supervisor direction shall be received prematurely by soil analysis report and the special recommendations for operation fertilizer and source of supply soil to approval. Any soil shall not be supplied to site before having the supervisor approval.

Fertilizer shall be added with another improvement material for soil to topsoil which approved before according to recommendation of soil analysis proficient.

Plants shall be checked, reviewed and approval at nursery and supply to fit with certain specifications for quality, size and kind. Addition the procedure of water tests shall be done at routine period and also through maintenance period, the Contractor shall be presented the required instruments for testing the property of electrical conductivity for water.

Plants and agriculture material shall be achieved through transportation against atmospheric contracts, seasonal and damages which cause breaks. The Contractor before transportation shall make sure of all the agriculture material spread by ferbam twice of two weeks interval.

All storage plants in site shall be protected from dry during storage period and should be kept in wet condition continually upon to cultivate by water sprinkle by refined spray distributor.

1.6.4.1 Trees

The used kinds from trees shall be as shown in bill of quantities and drawings there upon the length of caulis for 2.00 m for trees.

Also, caulis' diameter of 5 cm for trees, whole shall be in a good condition and free from infection.

Also, excavation's diameter should be increased 60 cm than the diameter of surrounded clay blocks around roots or expanded roots for a depth allow a presence of layer 150 mm thickness from agricultural soil under root blocks or roots.

Planting excavation should be irrigated with fresh water a period of alternate two days with enough quantity to remove salts from salty soil.

Used water should be double the volume of hole and the bottom of planting hole shall be filled with clear sand with height around 500 mm.

If the soil was rocky, the hole should be filled with covering stones with height around 300 mm, between the covering stones and topsoil an infiltration panel from glassy fiber shall be laied, and filled the remainder of hole by topsoil.

Plants has root blocks and plants has rough hemp fiber shall be covered for 5 cm length at least under the soil level, Hessian shall be cut carefully around sides and bottom of root blocks to allow an easy penetration for roots. The level of tree hole must be less than 10 cm from the level of green area around it to allow the water to interpenetrate directly to the roots. Shoring and protection for plants in planting period, necessary to use two bracings to fix the trees and joint the trunks with supports in one plane, supports shall be linked in the perpendicular direction in conformity with a strong wind direction.

Trees which has a height more than 3.0 m should be supported, or the net diameter for trunk is greater than 1.80 m, by using three supports and strings for fixation.

1.6.5 Maintenance of Improvement Works for General Site Maintenance

1.6.5.1 Maintenance works shall be started immediately after the completion of planting all nurslings, continue according to the following requirements:

- All plants shall be checked once a month at least through the maintenance period.
- Protection all site plants in a good condition through growth till the end of maintenance period.

Maintenance works include irrigation, trim edges and remove weeds, tilling, forming, stones covering, fertilization, bracing fixture, repair, remove weeds, fixation plants with right steps or perpendicular position, spray with insecticidal and all other necessary works to obtain of integral growth, at the end of maintenance period all covering materials shall be removed.

1.6.5.2 Rehabilitation

The Contractor shall be adhered to exchange trees which pass or become in bad situation, or loss the natural shape as result of atrophy, branches fall, increase of paring or a bad, unsuitable maintenance works.

Rehabilitation shall not be started in late time within the start of agriculture season, supervisor should be known about this rehabilitation.

Instauration of all areas which damaged and return back to the normal shape.

1.6.6 Pavements Materials

1.6.6.1 Concrete Paving Blocks

- Manufacturer

Company specializing in exterior concrete paving block manufacturing with three (3) years experience unless otherwise agreed by the Engineer.

- Installer

Company specializing in installing exterior pavers with three (3) years experience, unless otherwise agreed by the Engineer.

- Materials and Manufacture

Aggregates shall conform to the requirements above mentioned Ref. to original except as follows.

Nominal size aggregate of coarse aggregate shall be 10mm. Maximum aggregate size shall not exceed 14mm.

Grading of the aggregate need not necessarily comply.

Portland cement conforming to BS 4027 (SRC) or ASTM, C150 Type V.

Pigment (inorganic) shall comply with BS 1014.

- Minimum pigment content shall be 5% by weight of cement, unless otherwise approved by the Engineer.

Thickness shall be 40mm on footpaths

Color and pattern of the blocks shall be as noted on the drawings or as directed by the Engineer.

Shall be locally manufactured.

Shall comply with BS 6717: Part 1 in all aspects, unless otherwise modified in this section.

Compressive Strength.

- Average strength of 10 blocks tested in accordance with BS 6717: Part 1 Shall be not less than 49 N/mm².
- Strength of any individual block shall be not less than 40 N/mm².

Water Absorption

- Average of 3 specimens tested in accordance with ASTM C140 shall not be greater than 5%.
- No individual result shall be greater than 7%.

Sulphate and Chlorides

- The total sulphate content shall not be more than 4.0% by weight of the cement in the mix.
- The total chloride content (as NaCl) shall not be more than 0.15% weight of mix.

Bedding Sand

Shall consist of non-plastic, black crushed sand meeting the following properties, unless otherwise approved by the Engineer.

TABLE 1

Sieve Size (mm)	Percent Passing by Wet Sieving	
10	100	
5.0	95 – 100	
2.36	80 – 100	
1.18	50 – 85	
0.300	10 – 30	
0.150	5 – 15	
0.075	0 – 3	
Test	Standard	Limit
Clay, silt and dust content (Wet sieve)	BS 812: Part 103.1	3.0% Max
Sulphates (SO ₃)	BSI 377: Part 3 Method 5	0.3% Max
Chlorides (Cl)	BSI 3777: Part 3 Method 7	0.5% Max

Shall be obtained from a single source.

Allowed to drain before use.

Shall be covered with suitable sheeting to minimize moisture changes.

Jointing Sand

Shall consist of non-plastic sand meeting the following requirements, unless otherwise approved by the Engineer.

TABLE 2

Sieve Size	Percent Passing by Wet Sieving
2.36mm	100
1.18mm	90 – 100
0.300mm	15 – 50
0.075mm	0 - 3

- **Edge Restraint**

Kerb stones compliant with Section 2.09 shall be provided, unless otherwise agreed by the Engineer.

1.6.6.2 Installation of Precast Concrete Kerbs

- Precast kerbs shall be set to the lines and grades as shown on the Drawings, unless otherwise agreed with the Engineer.

Under no circumstances will it be permitted for levels to be set by direct measurement from pavement layers.

Any excavated surface for the concrete bedding shall be watered and compacted to a minimum of 95% MDD.

Unless otherwise indicated, elements shall be laid either directly onto a wet concrete base or on to a cement/sand (1:3) mortar bedding, 25 mm thick placed on a previously laid concrete base on approved sub-grade.

Dimensions of the base and backing shall be as shown on the Drawings.

Concrete base shall be constructed with Grade 20 Concrete.

Unless otherwise indicated, after kerb units have been laid a continuous backing of Grade 20 Concrete shall be poured for the elements using steel forms.

No pavement layers shall be laid against kerbing until such time as the backing is complete, back filled and approved by the Engineer.

Joints between radius kerbs, shall have a width not greater than 4mm and be filled with a cement / sand (1:3) grout with 1/5 part hydrated lime and sufficient water to make the mixture plastic and easily smoothed.

Bull noses and curved faces shall be of constant radius with the smooth change from radius to plain face.

A grooving tool shall be used to produce a smooth, circular section groove not more than 3 mm deep in all joints.

Grouted joints shall be cured by an approved method to the Engineer's satisfaction.

Joints between straight kerbs shall have a width of 4mm and be filled with the above specified grout, unless otherwise directed by the Engineer.

Immediately after any concrete is in place and for 7 days thereafter the kerbs, base backing and mortared joints shall be fully cured and protected from drying out and against the harmful effects of weather, including rain and rapid temperature changes.

Method of protection shall be subject to the Engineer's approval.

Use of colored curing membranes will not be permitted.

Concrete not properly cured and protected will be rejected and shall be removed from the works.

Expansion joints shall be placed as shown on the Drawings, unless otherwise approved by the Engineer.

Every 9 meters (or as directed by the Engineer) the joint between kerbs shall be filled with an approved joint filler 10mm thick.

The filler shall extend through the kerbs, bed, backing and channel and shall be trimmed to the finished slope of the kerb and channel.

At access points the kerbs (including the bed backing) shall be dropped to shown a face of 75mm or as shown on the drawing.

At the end of any kerb run, the end element shall be sloped down to ground level and angled away from the road at 30 degrees.

All kerbs shall be painted with approved materials to the satisfaction of the Engineer, unless otherwise agreed by the Engineer.

The pattern of the painting and the sub-contractors (if any) shall be approved by the Engineer.

Kerbs shall be level within a tolerance of ± 3 mm at each end of the element, to the designated lines and grades.

1.6.6.3 Installation of Concrete Paving Blocks

Prior to starting work, lay out lines marking the blocks area to be paved and establish grade elevation and slope of finished pavement surface.

The area to receive laying course shall be free from foreign materials, cut or soft spots and the level must be correct. Any defects shall be corrected by replacing unsuitable material or as necessary.

Edge restraint shall be fixed as shown on the drawings prior to laying operations.

Concrete paving blocks shall be laid on a sand bedding (laying course) of 100 mm thickness (after compaction) in such manner as not to disturb the blocks already laid.

- The manner of laying shall ensure that the blocks avoid disturbing the sand cushion until the unit is in correct position.
- Under no circumstance shall the sand cushion be compacted or walked upon after it has been screeded.
- Each block shall be placed firmly against its neighbor so that they fit closely together.
- Joints between blocks shall be between 2-4 mm.

- Laying of the concrete paving blocks shall commence at right angles to the main pavement axis starting at one end of the area.
- Paving blocks shall be laid in a herringbone pattern at 45° to the main pavement axis, unless otherwise shown on the Drawings or otherwise instructed by the Engineer.

Where gaps are less than 40mm dimension, they shall be filled with a 1:5 cement sand mortar or other suitable material acceptable to the Engineer.

Where blocks do not fit the edge restraints or other obstructions such as manholes or up-stands the gaps shall be filled using cut blocks.

Blocks shall be cut using only a mechanical block splitter.

Dimensional accuracy, uniformity of joint gaps, alignment and squareness shall be checked after laying the first three rows of blocks and thereafter at regular intervals

- If joints begin to open, the blocks shall be knocked together using a rubber or wooden mallet.

After each 15-20 m2 area has been laid, the blocks shall be vibrated with a plate vibrator having a frequency of 75-100Hz.

- For 40mm thick blocks the vibrator shall have a centrifugal force of 7-16 kN and a plate area of 0.2 - 0.4m2

A minimum of two passes of the plate vibrator shall be made in each direction, i.e. at 90 degrees to each other.

- Vibration shall continue until no further compaction of the sand layer is apparent.
- After block surfacing has been compacted dry jointing sand shall be spread over the surface and brushed into the joints.
- If necessary the joint sand shall be filled again and further passes of the plate vibrator shall be made in each direction, until the sand is no longer absorbed into the joints.
- The plate vibrator shall not pass closer than 1m to a temporarily unrestrained edge during laying.
- No paving shall be left in an un-compacted condition overnight, except for the 1m strip at the temporarily unrestrained edge.

On completion, the finished surface level, shall be within 5mm of the design level.

- Maximum deviation within the compacted surface, measured by a 3m straight edge shall not exceed 3mm.
- Level of any two adjacent blocks shall not differ by more than 1mm.
- Any areas of paving which do not comply with these tolerances shall be removed and replaced.
- Adjust the sand laying course and re-lay the paving blocks to the correct levels.

After all the joints are filled surplus sand must be swept away.

1.6.6.4 Lifting and Relaying Concrete Block Paving

This clause covers the lifting, removal, temporary storage and reinstatement of concrete block paving for work on buried services or other reasons.

The minimum necessary area of block to be removed shall be agreed with the Engineer before beginning work.

The Contractor shall carefully remove the concrete blocks, clean (chisel off any mortar or hardened sand) the exposed faces, protect, load, transport and unload the sound and unbroken blocks at locations designated by the Engineer.

The Contractor shall remove the concrete blocks by hand so as to preserve the blocks. Any damaged blocks shall be replaced by the Contractor.

The Contractor shall cart away and dispose of the remainder of the blocks to a location designated by the Engineer.

The Contractor shall break and remove the mortar or any concrete base laid below the blocks as directed by the Engineer. The Contractor shall cart away to the designated location mortar or any concrete base laid below the blocks.

Before beginning relaying of blocks, the Contractor shall agree with the Engineer the location where any new blocks are to be placed to minimize negative aesthetic impacts due to colour difference.

Additional or substitute pattern, if needed, can be used for laying blocks only after a written approval from the Engineer is obtained.

Blocks re-laid against existing blocks shall be placed slightly higher to accommodate any consolidation or settlement. This level difference shall be agreed with the Engineer after initial laying trials.

The Contractor shall supply new bedding sand for the laying of the blocks. The use of the old bedding sand will only be permitted if approved by the Engineer and only after the Contractor has carried out tests as per the requirements of this Specification.

1.6.6.5 Open Areas

This work consists of Supply and install Fine Sand 5 cm. Depth, all according to drawings and specifications.