TENDER DOCUMENT

(SPECIFICATIONS AND VENDOR LIST)

VOLUME – 2



PROJECT	**:**	**PROPOSED MIXED USE (RESI. + RETAIL) BUILDING G+2P+8+R**
CLIENT	**:**	**NBCC OVERSEAS REAL ESTATE L.L.C**
LOCATION	**:**	**ON PLOT NO. IC1-CTYL-16_013 AT WARSAN 1-621, DUBAI, U.A.E.**
DATE	**:**	**NOVEMBER 2026**

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GENERAL SPECIFICATIONS

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GENERAL SPECIFICATION

FOR

PROPOSED G+2P+8+R MIXED USED (RESI. + RETAIL) BUILDING ON PLOT NO. IC1-CTYL-16_013 AT WARSAN 1-621, DUBAI, U.A.E

GENERAL ITEMS

1.1 Use and Protection of Site

The Contractor shall be responsible for the site including his own and sub-contractors work, plant, materials, etc. and the safety of public and adjoining property and shall be liable for any claims arising for any loss or damage suffered.

The Contractor shall keep all persons including those employed by sub-contractors under control and within the boundaries of the site. He will be responsible for the care of the work generally until their completion.

The Contractor shall protect the site during the course of the works as directed by and to the entire satisfaction of the Engineer.

All temporary building and work areas such as site offices, workshops, stores building and yards, living accommodation, mess rooms, etc. shall be constructed inside the site / contract limits and in positions approved by the Engineer.

The Contractor shall confine his apparatus, the storage of materials and operations of his workmen to limits indicated by law, ordinance, permits or direction of the Engineer. The Contractor shall erect suitable temporary fences as required by the Engineer.

The Contractor shall not load or permit any part of the structure to be loaded with a weight that will endanger its safety.

Areas surrounding the latrines shall be deodorized.

1.2 Setting Out and Leveling

The contractor shall verify the site survey and shall provide the Engineer with full facilities for checking the setting out.

The Contractor shall be held responsible for any inaccuracy in the site survey after checking.

1.3 Scaffolding

The Contractor shall provide, erect, maintain, dismantle and clear away at completion proper and adequate scaffolding including that required for sub-contractors and specialists. Fixings and log holes should be made good to match the adjacent surface as the scaffolding is dismantled. The contractor shall be entirely responsible for all safety precautions in connection with the scaffolding and for its entire for the work.

1.4 Protection of the work and the public

In pursuance of his obligations under the Conditions of Contract the Contractor shall wherever required or directed by the Engineer cover up and protect the Works from the weather and from damage by his own or other workmen performing subsequent operations. He shall provide all necessary dustsheets, barriers and guard rails etc. and clear away same at completion. The Contractor shall be responsible for any damage arising out of non-compliance with this clause. The Contractor shall take all reasonable and proper steps for the protection of all places on or about the

Work whish may be dangerous to his workmen or any other persons or to traffic. The Contractor shall provide and maintain warning signs, red warning lamps and barricades as necessary in all such places.

1.5 Separate Contracts

The Employer reserves the right to let other separate Contractors in connection with this work under similar conditions. The Contractor shall afford other Contractors reasonable opportunity for the introduction and storage of their materials and the execution of their works, and shall properly connect and co-ordinate his work with theirs.

If any pert of the Contractor's work depends on the proper execution of work by any other Contractor, the Contractor shall inspect and promptly report to the Engineer any defects in such work that render it unsuitable. His failure to so inspect and report shall constitute an acceptance of the other Contractor's work shall proceed contemporaneously and without delay to the Contract.

1.6 Sheds

The Contractor shall erect and maintain ample temporary and watertight sheds for proper storage and protection of his own and Sub-Contractors materials. Cement and other perishable material shall have floors raised 150m off the ground. The Contractor shall clear away at completion and make good all work or ground disturbed.

1.7 Advertising

The Contractor shall not affix or place any placards or advertisements of any description or permit the same to be affixed or upon any hoardings, gantry, building or structure other than approved by the Engineer.

1.8 Approved, Directed, Selected

The terms "approved", "directed" or "selected" mean the approval, direction or selection of or by the Engineer.

1.9 Local Authority Workmen

The Contractor shall at all times give access to workmen employed by the local or other authorities and provide with proper, sufficient and if required special scaffolding, hoists and ladders and provide them with water and lighting and leave or make holes, grooves, chases as required, etc., without extra charge.

1.10 Keeping the Site Free from Rubbish

The Contractor shall keep the building and the site free from rubbish the progress of the work and at completion, including that of sub-contractors and local authority or special tradesmen. All materials condemned by the Engineer are to be removed immediately and replaced at the Contractor's expense.

1.11 Engineer Temporary Office

Immediately his tender is accepted the contractor shall provide temporary weatherproof offices for the sole use of the Engineer and to his entire satisfaction complete with office furniture. The floor area shall be minimum of 15 sq. meters unless otherwise specified in details on the appendix to this section of 'General Items'.

The accommodation shall have electric lighting and power sockets and shall be fitted with air conditioning units. The Contractor shall clean the office daily and clear away at completion and make good all work disturbed.

1.12 Materials to be imported

The Contractor will required to produce documentary evidence that all materials to be imported have been ordered within 8 weeks after the contract has been signed. This means materials which are not obtainable on the local market and which have to be ordered specially from abroad. As soon as orders have been placed, copies of such orders shall be submitted to the Engineer. Unless such proof has been produced, no claim will be considered for extension of the contractor period due to non-availability of materials necessary for the completion of the work were readily available for purchase locally.

1.13 Materials, Good and Workmanship Generally

The whole of the workmanship, goods and materials incorporated in the works shall be new and of the best quality available and shall be to approval of the Engineer.

Where propriety materials are referred to in the specification for building works by stating specific manufactures and trade names, the intention is to establish the type and quality of materials required. Similar materials of alternative manufacture may be substituted by the contractor with prior approval in writing of the Engineer.

Should the Engineer discover on the works any materials other than those approved he may order their removal from the site.

All proprietary materials incorporated in the works shall be fixed or applied strictly in accordance with manufacturer's printed instructions.

1.14 Telephone

The Contractor shall arrange for telephones to be installed on the site for the duration of the contractor and shall pay all charges in connection therewith and for local telephone calls (within UAE) only.

1.15 British Standard

In this and in any other contract documents and/or drawing the letters "BS" followed by a number will refer to the edition of the British Standard current at the time of tendering.

Reference to British Standard shall not preclude the use of materials from sources where other standard apply, but no materials to be incorporated in the works shall be in any respects inferior to those which specifically comply with the relevant British Standard.

1.16 Co-ordination of Builders work

The Contractor shall co-ordinate the requirement for holes, fixing and other similar builders work.

The Contractor shall ensure that such builder's work as shown on the drawings is in accordance with his own and his sub-contractor requirements. Details of holes, fixing, etc., which are not shown on the drawings but are required by the contractor or sub-contractors, shall be forwarded to the Engineer for his written approval at least three weeks before work proceeds. No claim will be entertained for work executed abortively due to lack of co-ordination.

1.17 Temporary Works

The Contractor shall furnish to the Engineer full particulars, drawing etc. of all temporary works necessary for the execution of the work and shall allow sufficient time for the Engineer to consider the same.

The Engineer reserve the right to comment on the contractor's proposals if he considers the modification should be made, but the contractor shall solely be responsible for the stability and safety of all temporary works and unfinished permanent works and for the quality of the permanent work resulting from the arrangements eventually adopted for their execution.

1.18 Temporary Roads

The Contractor shall from all temporary roads, crossovers, footpaths, tracks, hard standing etc. within the site.

1.19 Work Reasonably Inferred

The Contractor's shall execute the work in accordance with the intent and meaning of the drawings and specification taken together and shall supply all necessaries and other items essential for the proper execution of the work and shall executed all work which may be reasonably inferred whether or not specially shown or described.

1.20 Protecting Finished Works

The Contractor shall carefully protect his own finished work, the of sub-contractors of the work of local authority workmen and he shall be liable for the reinstatement of any work damaged during the progress of the work, caused by any reason whatsoever.

1.21 Attendance

The Contractor shall allow for the attendance of one trade upon another and shall execute and make good all necessary chases, holes, mortises, channels, etc. in any materials and shall provide all necessary attendance on sub-contractors.

1.22 Competence of Tradesmen

Only competent and experienced tradesmen who have proved their ability in performing their specialist trades shall be employed on the work.

1.23 Dimensions

Figured dimensions only shall be followed. No dimensions shall be scaled from drawings.

1.24 Samples and Testing of Materials

Prior to ordering or delivering any material or manufactured items to the site the name or names of the manufacturer (s) and, where required by the Engineer, adequate samples, schedules and manufacture's certificates of all materials and goods to be used in the works shall be submitted to the Engineer for approval and in case of rejection further samples until such are approved.

If judged necessary by the Engineer, the samples shall be tested for compliance at the Contractor's expense. All such tests shall be carried out at the Dubai Municipality C.Q.C&R. Section; only such shall be allowed to be carried out by independent labs, for which the facilities are not available at the C.Q.C&R. Section.

1.25 Shop Drawings

The Contractor shall furnish the Engineer, with any shop drawings which he shall reasonably require, detailing materials, layouts, sizes, dimensions, etc., clearly and neatly. Such drawings must be provided at least ten days prior to the commencement of the relevant work on site. No such work shall be put in hand until the Engineer's Approval, of shop drawings has been obtained in writing.

The approval of shop drawings shall not relieve the Contractor of his responsibilities To check, verify, cross examine, properly interpret and confirm the adequacy of the Shop drawing during execution to point out any discrepancy or physically Mismatching dimensions or detail and propose necessary modification to the shop Drawings to circumvent any such problems.

These should cover all items of work and shall include any necessary charts, drawings etc., required to be fixed in plant rooms, mechanical rooms etc. as directed By the Engineer.

1.26 Delivery, Handling and Storage of Materials.

All materials or manufactured items that are liable to damage shall be delivered in the original package, containers, etc. bearing the names of the manufacturer and the brand.

Materials or manufactured items shall be carefully loaded, transported, unloaded and stored in an approved manner, protected from damage and exposure to weather or dampness during transit and after delivery to the Site. Damaged material or manufactured items shall not be used in the Work. Any material or manufactured items damaged during or after fixing in position shall be removed, repaired or replaced by and at the Contractor's expense as required by the Engineer.

1.27 Water for the Works

The Contractor shall provide water for the Works including that required by the sub-contractors, pay all charges and provide all necessary temporary pipe work, pumps, storage tanks etc., and

remove on completion, and make good all work disturbed. Any cost of importing water by tanker and storing on site, should this prove necessary, shall be allowed for by the Contractor. No extension of time will be granted due to failure of and dependence upon a mains water supply.

1.28 Electricity for the Works

The contractor shall provide electric light and power for the works including that required by Sub-contractors, pay all charges and provide all temporary installations and remove on completion and make good all work disturbed.

1.29 Existing Services

The contractor shall allow for ascertaining for himself the position of any live services within the confines of the site. Any services found in situ must not be disturbed. If it is necessary to move any of the services the respective Government Department must be informed. Any accidental damages must be reported to the Engineer immediately and the contractor shall be liable for any charges incurred for repairs.

1.30 Safety Regulations

The contractor and all persons employed by him on the site in or about the execution of the works shall conform in all respects with the provisions of all Acts and Orders and Regulations made by any competent authority that shall be applicable to the works or any temporary works and binding upon the contractor or persons employed as aforesaid and in particular, but without prejudice to the generality of the foregoing, such matters as concern the safety, health or welfare of persons working on the site. The Engineer may require the, immediate removal from the works of any persons who in the opinion of the engineer, fails properly to observe the provision of this Clause and such personal shall not be. Again employed upon the works without the permission of the Engineer. The provisions of this Clause shall apply to and be binding upon any sub-contractor employed by the contractor.

1.31 Accidents

The contractor shall promptly report by telephone and in writing to the Engineer any accident whatsoever arising out of or in connection with the performance of the work whether on or adjacent to the site which caused death, personal injury or property damages, giving full details and statements.

If any claim is made by anyone against the contractor or any sub-contractor on account of any accident, the contractor shall promptly report the facts in writing to the Engineer giving full details of the claims.

1.32 Notice Boards

The contractor shall provide and erect 2 substantial notice boards with all lighting arrangements on site to the Engineer's design and approval. The boards shall be approximately 3.0 x 7.5m in size constructed in steel tubing and metal sheet and shall be sign written by a skilled sign writer in English and Arabic with the title and particulars of the Contract, the Owners name and the names and addresses of the Consultants and General Contractor. Space shall be provided on the boards for

sub-contractors and suppliers name boards. Other name boards may be fixed on hoardings or elsewhere on the site subject to the approval of the Engineer.

If required the contractor shall also collect standard name boards from the various consultants offices, transport to the site, fix and eventually return them when required or on completion of the work

1.33 Cleaning at Completion

The contractor shall clean the whole of the buildings at completion to the Engineers satisfaction and leave the work and the site tidy.

The contractor shall arrange for professional cleaning of the window glazing and all the marble or granite works. The complete works including the structure and associated works shall be left in a clean and tidy condition. The surrounding areas, if affected, shall be left in an acceptable condition.

1.34 Maintenance Manual

Arrange for and provide the Engineer at Practical Completion with 6 nos. copies of a maintenance manual in 4 ring binder, size A4, with rigid plastic covers, containing guarantees and manufacturers printed brochures and detailed instruction sheets prepared for this contract covering items of plant, equipment an~ controls used for all works described in this electrical and mechanical specifications.

The Manual is to contain names, addresses and telephone numbers of:

- Installation Contractors
- Place where spare parts may be obtained. Service Departments
- Service Department.

Include a list of contents sheet and rigid divider sheet to separate each section. The face and spine of the manual to have approved engraved or embossed plastic labels identifying its purpose (i.e. maintenance manual) together with the name of the development.

The manual is to be approved design and format, agree details with the Engineer prior to its assembly.

The manual is to contain the manufacturer's instructions for the removal of ceiling tiles in suspended ceilings and their refixing, together with recommendations for cleaning.

The manual is to contain manufacturer's instructions for the maintenance of all plastic, stainless, aluminium and enamel finishes (plain or anodised).

1.35 As Built Drawings

Provide 'As-Built Drawings' of the Architectural, Structural, Mechanical and Electrical Engineering installation works consisting of 3 hard copy sets printed on paper. One hard copy set printed on Negatives and one soft copy set recorded on electronic CDs.

The 'As Built’ drawings are to show how and where items are actually installed.

These should be submitted on completion of the works and prior to the issue of the Completion Certificate.

Make 'As Built' drawings at least equal in number, scale and scope to the contract drawings and together with their method of presentation to the approval of the Engineer.

Except as otherwise specified (any additional requirements contained in the particular Trade Specification shall apply) 'as- built' drawings for the Mechanical and Electrical work are to consist of one set of negatives and one set of electronic copy on CDs showing:

- The complete installation, including the sizes and, runs of the cables, conduit, trunking and their contents, the sizes and runs of all pipework and the precise locations of all pipework which may "be buried within the structure.

- The position of all underground services including electrical. Cold water. Telephones. Gas, drainage and sewerage services on the site together with their depths and the locations of switch and fuse gear and isolating cocks, the positions of all other apparatus.

- Thermal or other protecting envelopes around buried services.

- The geographical location and identification number of each fuse board, distribution board, isolating devise and control valves.

- The manufacturer's name, model and type numbers, duty and rating of all plant including thermostatic control equipment.

Fixing a print of each "as-built" circuit and layout diagram securely to the inside of the hinged front of the main electrical control panels as appropriate or as agreed with the Engineer and protect by non-flammable material. Where inadequate space exists reduce the prints to an agreed size.

1.36 Mobilisation Period - Contractor's Work

1.36.1 Submission for Approval

The contractor shall submit the following items for approval and perform the work described below during the mobilisation period. Permission to commence permanent works will not be given until the following is completed. The items listed are intended to be the minimum required. The Engineer may instruct the contractor to carry out additional work within the mobilisation period.

1. Performance Bond Bank Guarantee
2. Insurances
3. Programme of works
4. Plan of contractor's temporary works.
5. List of materials for the works.
6. List of sub-contractors.
7. No objection certificates from Etisalat, Water Department, Electricity Company and Drainage Department.
8. Testing of aggregates, sand cement, steel reinforcement and blocks. Concrete mix design after approval of materials tests.
9. Concrete mix design after approval of materials tests.
10. Soil investigation:

10.1 Borehole inspection for water table level.
10.2 Standard penetration test.
10.3 Any other tests or analysis, which may be required.

11. Material ordering schedule giving date of ordering and expected time of arrival.
12. Cash flow chart or curve.

1.36.2 Works to be performed

1. Clear the site of rubbish and superficial obstructions.
2. Erect temporary site boarding and security gate.
3. Erect temporary accommodation, workshops, stores, etc.
4. Provide temporary water, electricity and telephone.
5. Erect sign boards.
6. Provide the concrete batch plant and bring to the site sufficient materials to immediately commence the works, e.g. sand, aggregates, cement, steel reinforcement, filling material, etc.
7. Bring to the site plant and equipment for the permanent works.

The above submission and works to be performed shall first be approved by the Engineer.

02-100 CLEARING THE SITE AND EXCAVATON

0101 CLEARING THE SITE:

1. Demolish and break up all existing buildings, structures, obstructions, pavements and abandoned pipelines that are not designated or permitted to remain. The whole of the materials from the demolition shall become the property of the Contractor, except where otherwise specified, and shall be removed from the site by him.
2. All bushes, undergrowth and small trees less than 300mm girth at 1 m above ground level, tree stumps less than 100 diameters; and hedges within the site boundaries defined on the drawing shall be uprooted and removed from the site or disposed of by burning.
3. All holes or cuttings left as a result of demolition and clearance shall be made, good as directed by the Engineer.
4. Destroy all ants' nests and vermin encountered during excavation.

   Anti-termite treatment shall be applied in accordance with the manufacturer's recommendations. The Contractor shall submit proposals for treatment. All materials shall have Dubai Municipality Approvals

0102 EARTHWORKS GENERAL:

1. Definition, Classification and General Use of Earthwork Materials.

   (a) The following definitions of earthworks materials shall apply to this and other Clauses of the Specification in which reference is made to the defined materials.

   (b) Top Soil' shall mean the top layer of soil that can support vegetation.

   (c) 'Suitable materials' shall comprise all that which is acceptable in accordance with the Contract for use in the Works and which is capable of being compacted in the manner specified in Clause 0203 to form a stable fill.

   (d) 'Unsuitable material' shall mean other than suitable material and shall include:

   - logs, stumps and perishable material;
   - material, which is incapable of being compacted by permitted methods;
   - Materials having moisture content greater than the maximum permitted for such materials in the Contract, unless otherwise permitted by the Engineer.

   (e) 'Rock' shall mean limestone, sandstone or similar material but excluding cemented sands, loose screed and gravel or boulders of less than 0.5m. The Engineer shall decide what material constitutes rock and his decision shall be final.

   (f) Rock fill' shall consist of hard materials of suitable size for deposition and compaction and may comprise rock as defined in this Clause, broken stone, hard brick, concrete or Other comparable hard inert material.

   (g) 'Soft material' shall mean suitable material with the exception of rock fill.

   (h) 'Hardcore' shall be hard stone, concrete or coarse gravel free from rubbish and other

foreign matter, all capable of passing a 150mm ring in every direction, compacted in accordance with Clause 0302 of the Specification.

(j) 'Select Fill' shall consist of 'Suitable materials' arising from general excavation

(k) 'Foundation' shall mean the surface of the ground after completion of all excavations.

(l) 'Formation' shall mean the surface of the ground in its final shape after the completion of the earthworks.

2. No excavated suitable material other than that surplus to requirements of the Contract shall be removed from the Site except on the direction or with the permission of the Engineer. Should the Contractor be permitted to remove suitable material from the site to suit his operational procedure, then he shall make good at his own expense any consequent deficit of filling arising there from.
3. If any suitable material excavated from within the Site is, with the permission of the Engineer, taken by the Contractor for a purpose other than the forming of embankments and other areas of fill, sufficient suitable filling material to occupy, after full compaction, a volume corresponding to that which the excavated material occupied shall, unless otherwise directed by the Engineer, be provided by the Contractor from his own resources.
4. Suitable material and top soil surplus to the total requirement of the Works and all unsuitable material shall, unless the Engineer permits otherwise, be run to spoil in tips provided by the Contractor.
5. Where the excavation reveals a combination of suitable and unsuitable materials the Contractor shall, unless otherwise agreed by the Engineer, carry out the excavation in such a manner that the suitable materials are excavated separately for use in the Works without contamination by the unsuitable materials.
6. Unless otherwise described in the Contract, all topsoil to a minimum depth of 200mm shall be removed from the areas of cut and fill and, unless surplus to requirements, stockpiled for re-use for the soiling of slopes of cuttings and embankments, berms, verges, central reserves and for the provision of beds for the cultivation of trees and shrubs.
7. The Contractor shall make his own arrangements for stockpiling of topsoil and/or suitable material and for the provision of sites for the purpose. The permission of the Engineer is necessary for proposed stockpiles within the Site Area.
8. Surplus material shall be disposed of to approve tips, the location of which shall be agreed with the Engineer.
9. Before commencing any excavation or filling, the Contractor shall take cross-sections through the Site with levels at agreed intervals and shall agree these with the Engineer. Should the Contractor fail to comply with this Clause, the Engineer's sections and levels shall be used for measurement purposes.
10. The works are to be set out from the primary datum level(s) and setting out point(s) indicated on the drawings or from information provided by the Engineer. The Contractor shall submit his proposals for setting out and controlling the alignment of the works, to the Engineer and obtain his approval prior to the start of construction. The Contractor shall furnish to the Engineer details of the level and location of all temporary benchmarks and reference points that he establishes.

11. Should the contractor dispute the original ground levels shown on the drawings he shall agree these with the Engineer before disturbing the original ground.
12. Prior to the commencement of the work the Contractor shall submit to the Engineer his detailed proposals for method of construction including the details of all plant, site logistics, temporary works installation and removal, protection of existing, services, supervision and controls to ensure quality assurance and safety.

0103 EXISTING BURIED SERVISES

Existing services shall be located, diverted if necessary, and protected at all times. The Contractor shall submit to the Engineer details of proposed measures to make safe existing services that are to be retained and nearby thoroughfares. Contractor shall provide and

Maintain throughout the demolition period sufficient and adequate temporary supports. The location of all existing services is to be recorded and details submitted to the Engineer.

0104 EXISTING DRAINS

1. Drains, manholes and gullies that are to remain" shall be protected and kept clear at all times. They shall be left clean and in working order.
2. Unless directed otherwise by the Engineer, all abandoned services above and below ground obstructing the Works shall be taken up and removed from the Site. Any remaining pipes, ducts and drains shall be plugged with concrete grade C10.

0105 BLASTING

Blasting will not be permitted unless authorized by the Engineer.

0106 GENERAL EXCAVATION

1. Comply' with BS 8000: Part 1 sections 3.1, 3.2 and 3.3.
2. Any excess depth excavated below the formation level tolerance of ± 50mm without the Instruction of the Engineer shall be made good at the Contractor's expense by backfilling with suitable materials of similar characteristics to that removed, compacted in accordance with Clause 0203.

0107 TOLERANCE

Permissible deviations from formation levels:

- Beneath mass concrete foundations: 0 and -25mm
- Beneath ground bearing slabs and reinforced concrete foundations: 0 and -15mm
- Embankments and cuttings: ± 50mm
- Ground abutting external walls: ±15mm, but such as to ensure that finished level is not less than 150mm below dpc.

0108 BENCHING

1. Where an embankment is to be placed on appreciably sloping ground, this surface shall be benched in steps or trenched, as shown in the Drawings, including if necessary any under draining of the affected part of the Site.

2. The benching or trenches shall be kept free of water in accordance with Clause 0207.

0109 EXCAVATION BELOW FORMATION LEVEL

1. Where any material below the natural ground level under embankments or below formation level in cuttings is required to be excavated, it shall be removed to such a depth and over such areas as are shown in the Drawings or as the Engineer shall direct and disposed of or stored for reuse in a manner depending on its nature and condition at the time. The resultant excavation shall be backfilled with suitable material as defined in Clause 0102, deposited and compacted as specified in Clause 0203.
2. If after removal of material as specified in 1. Above, the Contractor allows the material so exposed to reach a condition where compaction of backfill is impracticable, he shall make good at his own expense by additional excavation and filling in the manner specified in Clause 0203.

0110 EXCAVATION OF PITS AND TRENCHES

1. The sides of pits and trenches shall be adequately supported at all times. Alternatively, except where the Contract expressly requires otherwise, they may be suitably battered.
2. Trenches and pits shall be kept free of water in accordance with Clause 0207.
3. The bottom of all excavations shall be leveled carefully and stepped or benched horizontally as shown in the Drawings. Any pockets of soft material or loose rock in the bottoms of the pits and trenches shall be removed and the resulting cavities and any large fissures filled with suitable material or concrete as directed by the Engineer.
4. All excavated materials from such excavations not required for refilling shall be disposed of in accordance with the requirements of Clause 0102.
5. The Contractor shall made good with suitable material as defined in Clause 0102. Or concrete as directed by the Engineer:
   (a) Any excavation greater than the net volume required for the Works as described in the Contract
   (b) Any additional excavation at or below the bottom of the foundations to remove material, which the Contractor allows to become unsuitable.

0111 REFILLING OF PITS AND TRENCHES

Unless otherwise shown on the Drawings or directed by the Engineer, all filling for this-purpose shall consist of suitable material as defined in Clause 0102 deposited and compacted by permitted plant in accordance with Clause 0203. Timber sheeting and other excavated supports shall be carefully removed as the filling proceeds except where they are required by the Contract to be left in position, but the removal of such supports will not relieve the Contractor of his responsibilities for the stability of the Works.

02-0200 FORMATION

0201 COMPACTION OF THE NATURAL FOUNDATION:

1. The natural foundation shall be compacted to 95% of the maximum dry density to a depth of 200mm as determined in accordance with Clause 0402.

2. Density tests shall be carried out as described in Clause 0402. Where the compacted natural foundation will be overlaid by bituminous pavement, it shall have a California Bearing Ratio of not less than 10% as measured in accordance with Clause 0403.

0202 LAYING OF FILL:

1. All filling shall be laid in layers not exceeding 200mm thick and each layer shall be separately compacted by the method adopted as the result of the compaction trials (Clause 0203).
2. No fractions exceeding 150mm in the longest dimension shall be placed less thar;1 300mm below formation level.
3. Embankments and other areas of fill shall be formed of material defined as 'suitable material' in Clause 0102.
4. All earthworks material placed in or below embankments and other areas of fill, below formation level in cuttings or elsewhere in the Works shall be deposited and compacted as soon as practicable after excavation. Embankments and fill areas shall be built up evenly over the full width and shall be maintained at all times with a sufficient camber and a surface sufficiently even to enable surface water to drain readily from them.

   During the construction of embankments the Contractor shall control and direct constructional traffic uniformly over the full width.

   Damage to compacted layers by constructional traffic shall be made good by the Contractor.

5. Compaction of embankments and other areas of fill shall be undertaken to the requirements of Clause 0203.

6. If the material deposited as fill subsequently reaches a condition such that it cannot be compacted in accordance with the requirements of the Contract the Contractor shall either:

   (a) make good by removing the material off the embankment, either to tip or elsewhere until it is in a suitable physical condition for re-use, and replacing it with suitable material, or

   (b) make good the material by mechanical or chemical means to improve its stability, or

   (c) cease work on the material until its physical condition is again such that it can be compacted as described in the Contract.

7. In carrying embankments up to or over the culverts or pipe drains, the Contractor shall bring the embankments up equally on both sides. Where special forms of compaction, adjacent" to structures are described in the Contract, filling may proceed over widths less than the full width of the embankment and in steps not exceeding the depth of one layer above the adjoining area of fill.

8. Where the maximum particle size exceeds 7Smm, the top layer of the filling shall be brought to the required level and profile by a layer of material of consolidated thickness of 40mm of which the maximum particle size is 28mm.

9. On completion of compaction and preliminary shaping of the upper course of filling beneath paved areas, or shoulders or overruns, the necessary excavation for all structures which occur in the area and which extend below its surface shall be carefully made so that the surrounded compacted filling remains compacted after completion of the structure.

0203 COMPACTION OF SUITABLE MATERIAL AS FILL:

1. All materials used in embankments and as filling elsewhere shall be compacted as soon as practicable after deposition. Compaction shall be undertaken to the requirements of this Clause by permitted plant, such as smooth and pneumatic tyre rollers, vibrating rollers, plate compactors or power rammers. Earthmoving plant shall not be accepted as compaction equipment under this Clause.

2. (a) At the time of compaction, the moisture content shall be such that the specified relative compaction will be obtained.

   (b) All suitable material available from the areas of cut, 60% or more of which passes a 20mm BS sieve, shall be compacted to not less than 95% of its maximum dry density measured in accordance with Clause 0402.

   (c) Suitable material, more than 40% of which is retained on a 20mm BS sieve, shall be compacted, after watering as necessary, until no further compaction takes place, to the satisfaction of the Engineer.

3. Where the compacted fill will be overlaid by bituminous pavement it shall have a California Bearing Ratio (CBR) of not less than 20% as measured in accordance with Clause 0403.

4. The Engineer may at any time carry out comparative field density tests determined in accordance with Clause 0402 on material, which he considers has been inadequately compacted. If the tests results, when compared with the results of similar tests made on adjacent satisfactory work in similar materials, show the state of compaction to be inadequate and this is held to be due to failure of the Contractor to comply with the requirements of the Contract, the Contractor shall carry out such further work as the Engineer may decide is required to comply with the terms of The Contract. The Contractor will provide the necessary test apparatus when required by the Engineer.

5. Without prejudice to the provision of the Conditions of Contract and in order that the Engineer may make proper provision for the supervision of compaction in the permanent work, the Contractor shall, not less than 24 hours before he proposes to carry out compaction processes during periods of overtime, apply in writing to the Engineer for permission to do so. If compaction is carried out during period of overtime without such permission the Engineer will carry out field density tests to determine the state of compaction achieved. The results of these tests will be compared with the results of similar tests made on the work known to have been carried out in accordance with the Specification under supervision. If the state of compaction is thereby shown to be inadequate the Contractor shall at his own expense carry out such further work as the Engineer may decide is required to comply with the terms of the Contract.

6. When materials of widely divergent characteristics are used in embankments and fill areas they shall be spread and compacted in separate clearly defined areas.

7. If more than one class of material is used in such a way that it is not practicable to define the areas in which each class occurs, compaction plant shall be operated as if only the material which requires the greatest compactive effort is being compacted. .

8. Compaction can be carried out using smooth wheeled rollers, vibrating rollers, vibrating plate compactors or power rammers. In certain cases pneumatic tyres rollers will be allowed. The maximum depth of the compacted layer, the number of passes and the speed of the machine will be determined from the manufacturer's recommendations and also, if necessary, by the result of tests in trial areas.

9. On completion of the works the Engineer shall, in company with the Contractor, inspect the works. If in any area the level of compaction, though previously complying with the Specification, has deteriorated for any reason such that it no longer complies with this Specification, this shall be made good at the expense of the Contractor.

0204 COMPACTION OF SUITABLE MATERIAL AS FILL:

1. The most suitable method of compaction to achieve the requirement specified in Clause 0201 and 0203 shall be determined by compacting trials, carried out by the Contractor, on the natural formation, or on each layer of filling to satisfy the Engineer that the plant the proposes to use will achieve the requirement without over-stressing the layer being compacted, or the underlying layers already compacted.
2. The trials include density tests on each layer expect where more than 40% of the fill material is retained on a 20mm BS Sieve. The trail area shall be built up in layered construction as described in Clause 0203. It shall be of sufficient over all size to allow separate portion to be set aside for trials on each layer of each type of fill material. Each portion shall be not less than 15 metres long or narrower that four times the width of the largest item of plant in use in the trails.
3. The trails shall be carried out on each layer at optimum moisture content and at moisture contents on each side of optimum. Each item of plant shall be operated at the various loads and speed recommended by the manufacturers for the type of material in the layer, and the optimum number of passes at the most satisfactory load speed shall be established.
4. If necessary, thinner layer than the maximum permitted in Clause 0202 shall be laid to establish the maximum layer thickness at which the stipulated requirement can be consistently achieved.
5. Density tests shall be carried out on each compacted layer except where more than 50% of the imported fill is retained on a 20mm BS sieve. The results shall be recorded separately for each fill material and thickness of layer. The recorded densities shall be related to the various types of plant at each load and speed, to the number of passes and to the moisture content of each layer.
6. As a result of the trails the most efficient combination of moisture content, plant and conditions of operating, to obtain the stipulated requirement is to be agreed for each filling material and layer. Until trials are complete the general laying of fill material will not be permitted to start.

0205 COMPACTION OF FORMATION:

1. Prior to the completion of the formation, all trenches or other cuttings which lie within the construction area shall be filled with the appropriate filling compacted in layers not exceeding 200mm to the density appropriate to the area through which

they run. The completed formation is to be inspected by the Engineer and any soil in the exposed natural foundation at formation level which in the opinion of the Engineer is soft and unsuitable shall be removed and replaced with compacted filling, or lean mix mass concrete as directed by the Engineer.

2. After all soft spots have been made good, the formation shall be finally formed to the required lines and profiles and to levels which will result in the finished pavement surface being to the required levels, all to the approval of the Engineer.

0206 TRAFFIC ON COMPLETED FORMATION:

1. All traffic on the completed formation in excess of the minimum required to place the overlying construction is prohibited.
2. The contractor shall be responsible for maintaining the completed formation. If the completed formation is loosened or damaged in any way, the Contractor shall be responsible for repairing or replacing before laying the overlying construction.

0207 DISPERSAL OF WATER:

The Contractor shall arrange for the rapid dispersal of water, shed on to the earthworks or completed formation during construction, or which enters the earthworks from any source, and when practicable the water shall be discharged into the permanent outfall. Adequate means for trapping silt shall be provided on temporary systems discharging into permanent drainage systems. The arrangements shall be made in respect of all earthworks including excavations whether for pipe trenches, foundations or cuttings.

02-0300 GRANULAR BASES

0301 GRANULAR MATERIAL:

1. Base material shall consist of hard, durable, angular rock, clean and free from dust, blended with sand or other suitable fine screenings. Rock aggregates shall conform to the requirements of Clauses 0402.3 and 0402.4 of BS 4987.

2. The combined dry aggregate grading shall conform to the following:

BS 410 Sieve (mm)	% by mass passing
50	100
37.5	95-100
20	60-100
10	40-60
5	25-40
2.36	15-30
425 micron	6-18
75 micron	3-9

Not less than 10% is to be retained between each pair of successive sieves (excepting the largest and smallest pair), and the percentage of material passing the 425 micron sieve shall not be greater than twice the percentage passing the 75 micron sieve.

The through grading of the material is to give a smooth grading curve throughout the entire range of sieves.

3. The material passing the 425-micron sieve shall have a liquid limit not exceeding 25% and a plasticity index not exceeding 6% when tested in accordance with BS 1377.
4. All material shall have an aggregate crushing value of less than 30 when measured in accordance with BS 812.
5. A naturally occurring material conforming to the grading specified above cannot normally be obtained; therefore base material shall be produced by batching several separate stock aggregate the sizes and mixing them in a plant similar to an asphalt mixing plant.
6. In the mixing process water may be added to prevent segregation during transit and to facilitate compaction. The exact amount of water required will depend upon the nature of the aggregate, the percentage of aggregate passing the 75 micron BS sieve and the; weather conditions, and shall be found by trial and error; but can be expected to be within a range of 2% to 4%.
7. Where crushed gravel is used it shall consist of particles with not less than 50% by volume retained on a 5mm sieve and having at least two fractured faces.

0302 GRANULAR SUB-BASE MATERIAL:

1. Sub-base material shall consist of durable granular material such as gravel or crushed rock. If necessary it shall be blended with sand or other suitable fine screenings.

2. The combined dry aggregate grading shall conform to one of the following:

	Aggregate size	BS 410 sieve (mm)	% by mass passing
1	75mm nominal	75	100
		37.5	80-100
		20	60-80
		10	45-65
		5	30-50
		600 micron	1 0-30
		75 micron	0-10
2	40mm nominal	37.5	100
		20	80-100
		10	55-80
		5	40-60
		2.36	30-50
		600 micron	15-30
		75 micron	0-10

3	20mm nominal	20	100
		10	80-100
		5	50-75
		2.36	36-60
		600 micron	13-35
		75 micron	0-10

Not less than 10% is to be retained between each pair of successive sieves specified for each column (excepting the largest and smallest pair). The through grading of the material is to give a smooth grading curve throughout the entire range of sieves.

3. The materials passing a 425 micron sieve shall have a liquid limit not exceeding 25% and a plasticity index not exceeding 6% when tested in accordance with BS 1377.
4. All material shall have an aggregate crushing value of less than 30 when measured in accordance with BS 812.
5. Where a naturally occurring material conforming to one of the permissible grading specified above cannot be obtained two or more separate stock sizes shall be batched together as necessary.

0303 COMPACTION TRIALS

1. The requirement for the compaction of granular base and sub-base materials is stipulated in Clause 0305 and the Contractor shall carry out compaction shall carry out compaction trials, for each grading, to satisfy the Engineer that the plant he proposes to use will achieve the requirement without over-stressing the layer being compacted or the underlying layers already compacted.

2. The trial areas shall be built up in layered construction, as described in Clause 0304, above the completed formation. It shall be of sufficient overall size to allow separate portions, each not less than 15 metres long and not narrower than four times the width of the largest item of plant used in the trials, to be set aside for trials on each layer of each grading.

3. The trials shall be carried out on each layer at optimum moisture content and at moisture contents on either side of optimum. Each item of plant shall be operated at the various loads and speeds recommended by the manufacturer for the type of material in the layer, and the optimum number of passes at the most satisfactory load and speed shall be established. If necessary thinner layers than the maximum allowed in Clause 0304 shall be laid to establish the maximum layer thickness at which the stipulated requirement can be consistently achieved.

4. Density tests shall be carried out on each compacted layer as described in Clause 0402. They shall be recorded separately for each grading and thickness of layer. The recorded densities shall be related to the various types of plant at each load and speed, the number of passes and the moisture content of the layer.

5. As a result of the trials the most efficient combination of moisture content, plant and conditions of operating to obtain the stipulated requirements is to be agreed for each grading and layer. Until trials are complete the general laying of base and sub-base material will not be permitted to start.

6. To help the Contractor to assess the overall compaction requirement at the time of tendering, Table 0301 is included as a general guidance only to compaction methods for the sub-base materials.

7.

TABLE 0301
GENERAL GUIDE TO COMPACTION OF BASE AND SUB-BASE MATERIALS:

Type of Compaction	Compaction Category	No. of Passes
Smooth-wheeled roller	Force per 100mm width:	
	• 2.6 kN – 502 kN	16
	• More than 502 kN	8
Pneumatic-tyre roller	Wheel load:	
	• Not less than 4 tonnes and up to 6 tonnes	16
	• Not less than 6 tonnes and up to 8 tonnes	12
	• Not less than 8 tonnes and up to 12 tones	10
	• More than 12 tonnes	8
Vibratory roller	Static force per 100mm width of vibrating roll:	
	• 0.71 kN – 1.25 kN	16
	• 1.26 kN – 1.75 kN	6
	• 1.76 kN – 2.3 kN	4
	• 2.31 kN – 2.8 kN	3
	• 2.81 kN – 3.5 kN	3
	• 3.51 kN – 4.2 kN	2
	• 4.21 kN – 4.9 kN	2
Vibrating-plate compactor	Static force under base plate:	
	• 13.8 kN/m sq – 17.2 kN/m sq	8
	• 17.2 kN/m sq – 20.7 kN/ sq	5
	• More than 20.7 kN/m sq	3
Vibro - tamper	Mass:	
	• Not less than 50 kg and up to 65 kg	4
	• Not less than 65 kg and up to 75 kg	3
	• More than 75 kg	2
Power-rammer or dropping weight compactor	Mass:	
	• 100 kg to 500 kg	5
	• More than 500 kg	5

0304 LAYING OF GRANULAR MATERIALS:

1. The total thickness of the base and sub-base courses are shown on the drawings. When a nominal course thickness is specified it shall be the minimum thickness of the course at any point after compaction. Base and sub-base materials shall be laid in layers not exceeding 200mm thick before compaction, subject to sub-clause 2 below.
2. The optimum layer thickness related to the compaction equipment being used shall be decided as a result of the compaction trials required by Clause 0303.
3. Spreading shall be by means of mechanical spreaders, spreader boxes, or other suitable methods, which give a uniform distributed thickness. The material, as spread, shall be of uniform grading without segregation of the course particles from the fine fractions. Methods of spreading the material that lead to a separation of the various fractions will not be permitted.

0305 COMPACTION OF GRANULAR MATERIALS:

1. Each layer of base and sub-base material shall be separately compacted to not less than 95% of its maximum dry density. Density tests shall be carried out as described in Clause 0402 and 0202.
2. The compaction method agreed as a result of the trials completed in accordance with Clause 0303 shall be regularly used throughout the contract.
3. Compaction shall be carried out parallel to the centre line of the pavement. Each pass is to connect up with the previous pass so as to give full coverage to the whole area. If so required, immediately prior to compaction operations, materials shall be watered with sprinklers to produce the required moisture content. They shall be lightly scarified, bladed or otherwise agitated as necessary to ensure adequate mixing of the water to the full depth of the layer. Compaction shall follow as closely as possible after the controlled moistening of the material. The Contractor will be responsible for any damage during compaction due to excessive moisture content in the material. If the agreed compaction process cannot be carried out because of excessive moisture compaction shall be suspended and the layer shall be scarified to the extent required to allow it to dry out. Compaction is only to continue thereafter when the layer is capable of supporting the whole of the agreed compaction process. Any depressions or ridges that develop during the compaction process shall be corrected by loosening and removing or adding additional blended material as necessary until a smooth uniform surface has been achieved to the correct level and required profiles.
4. On completion of compaction but before the final shaping of the upper layer of the base material, the necessary excavation for all structures which occur in the area and which extend below its surface shall be carefully made up so that the surrounding compacted base remains fully compacted after completion of the structure. The final shaping shall then be made and the protection of the finished surface required by Clause 0306 shall be carried out immediately.
5. Compacted granular material forming a base for bituminous surfacing shall have a California Bearing Ratio (CBR) of 20% as measured by the methods specified in Clause 0403.

0306 TRAFFIC ON COMPACTED GRANULAR BASES:

All traffic on the completed base in excess of the minimum required to place the overlying Construction shall be prohibited.

0307 MAINTENANCE OF GRANULAR BASES:

It is the Contractors responsibility to maintain the granular base in proper shape and condition and, if necessary, re grading and re rolling shall be carried out periodically throughout the time it is exposed.

It shall be lightly scarified, bladed or otherwise agitated as required to maintain a uniform finish, and the surface dressing shall be made good as necessary to maintain an unbroken cover.

0308 GRANULAR SURFACING

1. Granular surfacing material for stabilised shoulders to pavement areas shall consist of a durable material such as selected wadi gravel.
2. Crushed rock or similar material shall not be used.
3. Granular surfacing material shall conform to the following grading:

BS 410 sieve (mm)	% bv mass passing
150	100
75	40-60
37.5	0

4. The through grading of the material is to give a smooth grading curve throughout the range given in (3) above.
5. Granular surfacing material shall be compacted until no further compaction takes place to the satisfaction of the Engineer.

02-0401 TESTING

0401 INITIAL TESTING

- Before laying starts the Contractor shall carry out tests to determine the qualitative values of the materials specified in Clauses 0301 and 0302.
- The Contractor shall mix trial batches of the above materials to establish the proportioning necessary to achieve the specified overall grading and California Bearing Ratio (CBR).
- 3. The Contractor shall carry out tests to BS 1377 to assess the liquid limit, plastic limit and plasticity index of the mixed material and determine the maximum dry density by Test 134 of BS 1377 (4.5kg rammer method).
- Where a base, sub-base or filling material is required to have a particular CBR in addition to the other characteristics detailed in this Specification, the Contractor shall carry out laboratory tests on samples of the material by the method described in Test 16 of BS 1377.
- The maximum dry density and optimum moisture content for suitable material obtained from the areas of cut shall be determined by laboratory tests on samples of fill material using BS 1377 Test 13 (4.5kg rammer method).

0402 INSITU DENSITY TESTS:

- Insitu density tests shall be carried out in accordance with test 15(a} or 15(b} of BS 1377.
- Three tests at approximately equal intervals shall be made of the dry density of the compacted material for each 1000 m2 or part thereof laid each day. The methods shall be used so that they are representative of the full depth of the material.

0403 CALIFORNIA BEARING RATIO (CBR) FIELD TEST:

- Field in-place tests to evaluate the California Bearing Ratio of compacted natural foundation, compacted fill material or granular base material shall be carried out as directed By the Engineer.
- Tests shall be carried out in groups of three.
- Tests shall be made only after a period of 4 hours has elapsed since the completion of the compaction and within a period of 24 hours.

0404 PLATE LOAD TESTS:

- Plate load tests shall be carried out on compacted natural foundation and compacted fill material as directed by the Engineer.
- Tests shall be carried out on all new work in groups of three.

0405 GRADING ANALYSIS (PARTICLE SIZE DISTRIBUTION):

- On completion of compaction four separate samples shall be cut each day from each layer of granular material being laid, from locations representative of the day's laying as agreed with the Engineer. The samples shall be of sufficient quantity to permit duplicate grading analysis of each sample to be made.
- Sampling and testing shall be in accordance with Test 7A of BS 1377.
- The grading shall be reported as the mean of the duplicate tests for comparison with the permitted grading specified in Clauses 0301 and 0302.
- .Where crushed gravel to Clause 0301 is used then the samples taken shall also be tested for angularity in accordance with BS 812: Part 1.
- If more than any 3 *of* 20 consecutive results fail to comply with the required grading the work shall be stopped and the necessary adjustments shall be made before work restarts.

0406 TESTING LABORATARY

Contractor shall be required to provide the services *of* an approved independent testing laboratory for the purposed *of* carrying out the testing, everything as prescribed in the specification.

0105 EXCAVATION FOR STRUCTURES:

0501 SCOPE OF WORKS

This work shall consist of all excavation for structures, culverts, headwalls, catch basins, manholes. inlets, and retaining walls and shall include all necessary clearing and grubbing, all necessary bailing, drainage, pumping, sheeting, strutting and the construction of coffer dams or cribs, if found necessary and their subsequent removal, also the disposal of all

material obtained from such' excavation and backfilling to the level of the original ground it shall include the removal of that portion of existing structures below the ground which is necessitated by the construction of the new structure.

0502 SUBMITTALS

Prior to commencing any structural excavation work 1.5 metres or more in depth, the Contractor shall design and submit to the Engineer for review and approval, within a minimum period of 1 week before the intended commencement date, 'detailed working drawings of the structural excavation support member material, sizes, spacing and engineering calculations to validate their design, including the maximum theoretical deflections of the support members. The system shall be designed in such a manner that no raker struts or any other support members extend through surfaces exposed in the finished construction, and no shoring or bracing is placed under permanent structures.

0503 DESIGN LOADS

The engineering calculations shall show lateral earth pressure for the full excavation depths, forces at various stages of support during installation and removal and concrete placement. The anticipated equipment loads, surcharge loads of any description, the maximum design loads to be carried by various members of the support system and strut preload forces.

0504 TIEBACK ANCHORS

If the structure support system proposed includes tieback anchors, the Contractor's submittal drawings shall show the profile of the soil in which each anchor is to be installed, the design load for the full depth of the excavation, the maximum design and proof loads, surcharge loads of any description; equipment loads, forces at various stages, support during installation and removal, and the criteria proposed for deformations under proof loads. Where a proposed system of tieback anchors projects beyond the vertical projection of the Contract limit lines shown on the Drawings on to the adjoining property. The permission of the owner shall be obtained in writing and such permission submitted to the Engineer at the time the shop drawings of the support systems are submitted.

0505 DEWATERING

At locations where the excavation extends below the ground water table, a dewatering system shall be provided which will effectively reduce the hydrostatic pressure and lower the ground water levels below excavation levels. as required for the safe and proper execution of the work and which will result in obtaining a stable, dry subgrade for the execution of subsequent operations. The Contractor shall design dewatering methods and settling basins so that no critical amounts of soil, sand or silt are removed during either the initial operations or the construction operations. Complete working drawings showing the type of dewatering and ground water control system proposed shall be submitted to the Engineer for his review.

The Contractor's submittal drawings shall show the arrangement, location and depths of the proposed dewatering system if required. A complete description of the equipment and materials to be used and the procedures to be followed shall be shown, together with the standby equipment, standby power supply and the proposed location or locations of points

of discharge of water. Any required dewatering system design shall also include the measures taken to prevent damage due to settlement of pavement, utilities, sewers, buildings and other structures outside the excavation but with in area affected by the procedure.

The designs of the structure excavation support system and the dewatering system specified above shall be prepared by and signed by a Professional Engineer approved by the Engineer specialising in this type of design work. Approval of the designs and shop drawings shall not relieve the Contractor of the adequacy and performance of these temporary works.

0508 PRE-CONSTRUCTION INSPECTION

Prior to the beginning of construction, the Contractor and the Engineer shall make a detailed inspection of all adjacent buildings, pavements, wells and other structures in order to determine its preconstruction condition and the Contractor shall prepare, for the Engineer's approval, a typed Inspection report of the findings.

The Report shall include photographs, drawings and sketches with levels and dimensions illustrating the structures condition, noting in particular any existing damage or structural inadequacy. Deficiencies and damage shall be suitable marked on the structure such that it is not permanently defaced.

0509 EXCAVATION

Notify he Engineer sufficiently in advance of the beginning of any excavation so that cross-sectional elevations and measurements may be taken of the undisturbed ground. The natural ground adjacent to the structure shall not be disturbed without the permission of the Engineer.

Trenches or foundation pits for structures or structure footings shall be excavated to the lines and grade 3 or elevations shown on the drawings, or as ordered by the Engineer. They shall be of sufficient size to permit the placing of structures or structure footings of the full width and length shown. The elevations of the bottoms of footings, as shown on the Drawing shall be considered as approximate only and the engineer may order, in writings, such changes in dimensions of elevations of footings as may be deemed necessary, to ensure a satisfactory foundation.

Unless otherwise provided for in the Drawings or Contract Documents or directed by the Engineer Structural excavation shall be carried out for a width of at least 500mm beyond the horizontal. Outside limits of the foundation, footing, box culvert or structural member to which the excavation relates. Concrete blinding or sub-foundations are not to be considered as structure for the purpose of defining such excavation.

If during the progress of the work, loose or improperly compacted soil is encountered below the structural foundation levels, or adjacent thereof, which is the result of prior removal of utilities or structures such material shall be completely removed within the limits as directed by the Engineer, backfilled with suitable material and compacted to 95% of the maximum dry density as determined by BS 1377 Part 4 (method 3.5 or 3.6). Any previous excavations encountered which would in the opinion of the Engineer be detrimental to load distribution of new foundations to the underlying soil, shall be excavated and backfilled with Grade C2 concrete.

After each excavation is completed, the Contractor shall notify the Engineer, for approval of the depth of excavation and the character of the material, prior to further structural works. Any over excavation shall be backfilled with Grade C2 concrete at the Contractors expense.

All rock or other hard foundation material shall be cleared of all loose material and cut to a firm surface, either level, stepped, or serrated as directed by the Engineer. All seams or crevices shall be cleaned and grounded. All loose and disintegrated rock and thin strata shall be removed.

When the footing is to rest on material other than rock, excavation to final grade shall not be made until just before the footing is to be placed and special care shall be taken not to disturb the excavation. When the foundation material is soft or otherwise unsuitable as determined by the engineer, the Contractor shall remove the unsuitable materials and backfill with approved granular material. This foundation fill shall be placed and compacted to 95% of the maximum dry density-as determined by BS 1377 (method 3.5 or 3.6)

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0510 NOTIFICATION OF DAMAGE

Notify the Engineer immediately of any movement or any damage not noted in the pre-construction report, to any structure. The contractor shall immediately cease his construction operations in the vicinity and shall take immediate action to prevent further movement or damage. The Contractor shall keep the Engineer fully informed of all such action.

0511 REMEDIAL AND PREVENTIVE WORKS

Should remedial works be necessary due to damage caused to the structure of should the engineer direct the contractor to carry out any works necessary to prevent damage to the structure due to the Contractor's construction works, the Contractor will present, without delay, detailed drawings and specifications, as necessary, showing his proposed remedial or preventive works for the Engineer's approval.

In either case the Contractor will suspend all construction activities in the vicinity of the structure until such time as the remedial or preventive works are carried out to the Engineer's satisfaction at the Contractor's expense.

0512 POST CONSTRUCTION INSPECTION

On completion of, but prior to final acceptance of the works, the Contractor and the Engineer shall reexamine the structure to determine any change from the original conditions. The Contractor shall supply to the Engineer for approval five copies of a report describing measure he proposes to take to correct any damage that resulted from the construction of the works. The approved corrective measures shall be carried out by the Contractor at his expense, to the before final acceptance of the works. Engineer’s satisfaction

0513 UTILISATION OF EXCAVATED MATERIALS

All excavated material determined as suitable by the Engineer, may be utilised as backfill or roadway fill. The surplus material shall be disposed of to approved tips. Excavated material shall not be deposited, at any time, so as to endanger the partly finished structure or cause an obstruction of any kind. All unsuitable material shall be disposed of to approved tips.

0514 BACKFILL

Excavated areas around structures shall be backfilled with excavated materials or imported granular material approved by the Engineer. Backfill materials shall be placed in horizontal layers not exceeding 200mm in depth after compaction to 95% of the maximum dry density as determined by BS 1377 Part 4 (Method 3.5 or 3.6). The field density shall be determined by BS 1377 1990 Part 9 (Method 2.1 or 2.2). Each layer of material shall be moistened or dried as required to enable thorough compaction as specified. Backfill shall be placed to the original ground level or as indicated on the drawings.

Backfill or embankment shall not be placed behind the walls of concrete structures or rigid frame structures until the top slab is placed and cured. Backfill and embankment behind abutments when held at the top of the superstructure shall be carried up simultaneously behind opposite abutments. Backfill shall be carried up equally on either side of box culverts.

100 CONCRETE GENERAL

101 MAKING CONCRETE

Composition of mixes, production of concrete, information to be provided, sampling, testing and compliance to be in accordance with BS 5328 unless otherwise specified herein.

102 READY-MIXED CONCRETE

Ready-mixed concrete shall not be used unless previously approved by the Engineer and, where used, shall comply with all the requirements specified herein and any additional requirements of BS 5328. Ready-mixed concrete plants and mixer trucks shall be subject to the approval of the Engineer, which approval may be withdrawn in the event of non-compliance with the requirements of this Specification. Unless otherwise agreed by the Engineer, truck-type concrete mixers and their discharge performances shall comply with the requirements of BS 4251.

103 CONCRETE DOCUMENTATION

Send daily to the Engineer a return showing the quantities of cement and the total volume batched of each class of concrete for each section of the Works and in Temporary Works.

104 BATCHING

1. The aggregates and cement shall be batched by means of efficient, weigh batching machines except as otherwise approved by the Engineer. The machines shall be carefully maintained and cleaned and they shall be provided with simple and convenient means for checking the accuracy of the weighing mechanism, and they shall be checked and adjusted when required by the Engineer.
2. A simple and convenient system of accurately varying the water supply to the concrete mixers must be installed with a suitable metering system to ensure that the amount fed into the machine can easily be controlled, ascertained and recorded.
3. Air entraining agents shall be batched at the mixer in solution in a portion of the mixing water by a suitable mechanical dispense~. The dispenser shall be capable of distributing the agent uniformly throughout the mix. The accuracy of the dispenser shall be checked each day before mixing starts. Throughout mixing, tests shall be carried out as specified in Clause 503.
4. Batched materials shall be measured out within the following tolerances and shall be discharged into the mixer without loss:

CEMENT	±2% of the weight of the cement in the batch.
AGGREGATE	± 2% of the weight of each aggregate in the batch.
WATER	±2% of the weight of water added to the batch.
ADMIXTURE	±3% of the amount to be added to the batch.

105 WEIGHING EQUIPMENT

1. Sufficient test weights shall be kept available on site for checking the accuracy of all scales. The scales shall be checked at the commencement of preliminary concrete tests and checks shall be carried out at intervals as directed by the Engineer but in any case not greater than 2 weeks. The results of these checks shall be recorded and submitted to the Engineer. '

2. All scales shall be inspected and tested over their complete range by a specialist at least every three months, the results being recorded and submitted to the Engineer.
3. A calibrated container shall be provided to check the accuracy of measurement of admixture dispensers at least once each month.
4. The divisions on the scales for cement, aggregate and water (if the latter is measured by weight) shall be readily discernible and not less than 2.5mm in width. They shall represent a weight not greater than 0.5% of the nominal capacity of the appropriate weighing hopper or compartment.

   At the time of installation or reconditioning the indicated weight at any point of the scale shall not vary from the correct weight by more than 1.0% of the actual scale reading in the range quarter to full-scale capacity. For indicated weights of less than quarter-scale capacity, the variation shall not be greater than 1.0% of quarter-scale reading. At any time of operation, the indicated weight at any point of the scale shall not vary from the correct weight by more than 1.5% of the actual scale reading in the range quarter to full-scale capacity. For indicated weights less than quarter-scale capacity the variation shall not be greater than 1.5% of the quarter-scale reading.

106 MIXING CONCRETE

1. Submit details of the mixers he proposes to use, including the manufacturer's name, type of mixer and estimated output.

2 Mixers shall be of sufficient mixing capacity to provide the required output without overloading. .

The Contractor's proposals will be considered and, if called upon to do so, he shall obtain and submit the following additional information from the manufacturer:

(a) Technical description of the plant, including recommended methods of erection, maintenance and operational control.
(b) The results of tests carried out on prototype mixers in accordance with BS 3963.
(c) Minimum mixing time recommended for all the mixes specified.
(d) Time required for charging and discharging.
(e) Estimated theoretical output in terms of unit time for all the mixes specified.
(f) Any other information required for the production of a consistently uniform concrete of the quality required by this Specification.

The use of a mixing plant other than that agreed following the action outlined above would not be allowed.

3. The shifting of mixing plant on the site shall be agreed with the Engineer.
4. During concrete production mixers that have been out of use for more than 30 minutes shall be thoroughly cleaned out before mixing restarts.
5. Water measuring devices shall be calibrated before production starts and shall be checked at weekly intervals.

107 TRANSPORTING CONCRETE

Concrete shall be discharged from the mixers and transported by means which shall be agreed by the Engineer and which shall prevent contamination (by dust, rain or other

cause), segregation or loss of ingredients. The means of transport shall ensure that the concrete is of; the required workability at the point and time of placing and is transported and placed with the minimum of delay.

108 TEMPERATURE RECORDS

Supply suitable maximum/minimum thermometers and record the shade and sun temperatures adjacent to all parts of the works where concrete is being placed.

109 CONCRETING IN ADVERSE WEATHER

No concreting shall take place in the open during storms or heavy rains. Where such conditions are likely to occur arrange for adequate protection of the material, plant and formwork so that the work may proceed under proper cover. Where strong winds are likely to be experienced additional precautions to ensure protection from driving rain and dust shall also be taken. The Engineer may withhold approval of commencement of concreting until he is satisfied that full and adequate arrangements have been made.

110 CONCERTING AT NIGHT

Where approval has been given to carry out concreting operations at night, provide adequate lighting to all points where mixing, transportation and placing of concrete are in progress.

111 CONCRETING IN HIGH TEMPERATURES AND DEEP SECTIONS

When concrete is to be manufactured, transported and placed in hot weather the following limitations shall apply:

1. The temperature of the concrete when placed shall not exceed 30°C nor shall concrete be mixed or placed when the shade air temperature is 40°C or above, or is expected to reach such a level during concreting and 3 hours after placing, without special permission from the Engineer.

   The temperature at placement of concrete in deeper sections/ massive concrete (cross section greater than 1000mm) shall not exceed 25°C.
2. For all concrete sections take precautions to limit the effects of heat of hydration.
3. In general the "Recommendations for Hot Weather Concreting" contained in ACI 305: 1977 shall be followed. Take any or all of the following measures in order to control the temperature of concrete at the time of placing:
   (a) Effectively shade aggregate stockpiles, cement silos, water tanks and concrete handling plant.
   (b) Paint all concrete handling plant white.
   (c) Run all concrete handling plant with flake ice to reduce the temperature of the machinery before mixing/transporting concrete.
   (d) Add flake ice to the mixing water.
   (e) Concrete at night.
4. The following measures shall be taken:
   (a) All forms, moulds, mixed and placed concrete shall be shaded from sunlight and protected from any drying wind.

(b) Transit time shall be restricted to a minimum to be agreed in advance between the Engineer and Contractor, taking into account the use of admixtures, etc.

5. The size of concrete pours may be restricted if the Engineer decides that shrinkage and other factors are a consideration for particular elements of the construction.

6. For concrete sections greater than 1000mm thick, submit to the Engineer for approval detailed proposals of the measures to be taken. These measures shall include but are not limited *to:* control of concrete mixes constituents; curing water; formwork type; surface insulation. All submissions shall be based on measured values of heat of hydration. generated by the proposed mix to meet the criteria set out below.

   (a) Maximum temperature difference between the core and the surface of any pour. Design target 15°C. Field maximum 20°C.
   (b) Maximum temperature difference between a new pour and a previous pour. Design target 12°C. Field maximum 15°C.
   (c) Absolute maximum temperature anywhere in a pour. Design target 60°C. Field maximum 70°C.
   (d) Instrumentation shall be installed in the Works to verify compliance with the above criteria. Temperature measurements shall be made by means of thermocouples positioned in a line perpendicular to the concrete faces. The thermocouples shall be fixed: at the concrete faces; at the centre of the section; and, at equal intervals of approximately 300mm.
   (e) Temperatures shall be measured and logged continuously from the start of the pour until instructed to stop by the Engineer. Submit to the Engineer for approval details of the proposed methods and equipment for the measuring and logging of temperatures.
   (f) If temperature measurements exceed any of the criteria above then action in accordance with the sub-section on defective concrete.

112 INITIAL SET

All concrete and mortar must be placed and compacted within 30 minutes of water being added to the mix or otherwise included through damp aggregates, unless admixtures are in use. If a plasticiser/admixture is used, tests shall be carried out to determine the initial set time. No partially set material shall be used in the works.

113 SULPHATE CONTENT

1. The levels of acid-soluble sulphates (as S03) shall generally not exceed the following limits, which are indicative for the individual constituents of the mix and are subject to the overriding maximum specified for the total mix:

   (a) Coarse aggregate 0.4% by weight
   (b) Fine aggregate 0.4% by weight
   (c) Fresh water 500 mg/I

2. The total estimated sulphate content, as S03 of any mix, including that present in the cement, shall not exceed 3.7% by weight of cement in the mix.

3. Notwithstanding the requirements given above, regular tests in accordance with BS 1881: Part 124 shall be made on hardened concrete to determine the total sulphate

content as S03 of any mix. The concrete will be judged acceptable if this does not exceed 4% by weight in the mix.

114 CHLORIDE CONTENT

1. For concrete manufactured with OPC or MSRPC (see 201) the following criteria shall apply:

   The levels of equivalent acid-soluble chlorides as NaCI (CI x 1.65 = NaCI) shall generally not exceed the following. The levels are indicative for the individual constituents of the mix and are subject to the overriding maximum specified for the total mix, which shall not be exceeded:

(a)	Coarse aggregate:	
	Reinforced concrete	0.03% by weight
	Mass concrete	0.10% by weight
(b)	Fine aggregate, all concrete	0.06% by weight
(c)	Fresh water, all concrete	500 mg/I

2. The total estimated chloride content (as NaCI) of any mix, including that present in the cement, should not exceed the following:

   For reinforced concrete 0.3% by weight of cement in the mix.
   For mass concrete 0.6% by weight of cement in the mix.

   Carry out tests at regular intervals (and at least once for every 30m3 of concrete produced) during the production of concrete to ensure these criteria are consistently achieved.

3. Notwithstanding the requirements given above, regular tests in accordance with BS 1881: Part 124 shall be made on hardened concrete to determine the acid-soluble chloride content. The concrete will be judged acceptable if.

   (a) For reinforced concrete:
   (i) 95% of the test results are less than 0.3% NaCI by weight of cement;
   (ii) No result is greater than 0.4% NaCI by weight of cement.

   (b) For mass concrete:
   (i) 95% of the test results are less than 0:6% NaCI by weight of cement;
   (ii) No result if greater than 0.8% NaCI by weight of cement.

4. For concrete made with SRPC, the NaCI content by weight of cement in the hardened concrete as determined by BS 1881: Part 124 shall not exceed 0.10%.

WATER-CEMENTITIOUS RATIO:

1. The water/cementitious ratio for the various classes of concrete shall be determined by preliminary trial mixes and shall not exceed the values given in the table of concrete mixes.
2. Efficient means shall be provided for determining the moisture content and absorption value of the sand and coarse aggregate at all times. Monitor the moisture content and absorption values of all sand and coarse aggregate as they reach the mixer and make such adjustments to the mix as are necessitated by changes in the moisture content and absorption values of all aggregates.

3. Whenever required by the Engineer, free water/cementitious ratio shall be determined in an approved independent laboratory on concrete samples cored from locations selected by the Engineer. The Contractor shall bear all the costs.

116 ADMIXTURES

1. Admixtures will only be permitted to be used in the concrete with the agreement of the Engineer or when specified and in no circumstances will admixtures containing chlorides or other corrosive agents be allowed. All admixtures shall meet the requirements of BS 5075: 1982.
2. In the event of admixtures being used the concrete tests described in the Specification shall be carried out with the correct proportion of admixtures incorporated to ensure the specified strengths are achieved and comparison shall be made with concrete manufactured without the admixture to prove that the density has not been reduced. If air entraining agents are used the density shall not be reduced by more than 5%.
3. When admixtures are used in the Works very strict control is to be maintained to ensure that the correct quantity of admixture is used at all times. The equipment to be used for dispensing and the method of incorporating the admixture in the concrete shall be agreed by the Engineer.

   The dispensing unit shall be translucent such that the operator can see the discharge of the admixture.
4. Set-retarding and/or water-reducing admixtures shall be limited to those consisting of ligno-sulphonate. Air entraining agents shall conform to BS 5075: Part 2.

117 DAMP PROOF MEMBRANES

Refer clause 218.

200 MATERIALS

201 CEMENT

1. The cement to be used throughout the Works shall be Portland cement obtained from manufacturers approved in writing by the Engineer.
2. The cement shall be as described under one of the following headings:

(a) Ordinary Portland Cement (OPC).

Cement complying with BS 12 containing not less than 4% and not more than 13% proportion by weight of tri-calcium aluminates.

(b) Moderate Sulphate Resisting Portland Cement (MSRPC).

Cement complying with BS 12 but containing not less than 4% and not more than 8% proportion by weight of tri-calcium aluminates. The cement shall not contain more than 2.7% proportion by weight, of sulphur trioxide.

(c) Sulphate Resisting Portland Cement (SRPC).

Cement complying with BS 4027, but containing not more than 4% by weight of tri calcium aluminates (C3A).

(d) In addition to the above requirements for cement to be used in permanent Works the acid soluble alkali level measured as (Na20 + 0.658 K20) shall not exceed 0.6% by weight. Also the heat of hydration at 7 days in accordance with ASTM C186 shall not exceed 290kJ/kg and the fineness (specific) in accordance with BS 4550 shall not be less than 280 m2/kg.

(e) Cement shall be free flowing and free of lumps. It shall be supplied in the Manufacturer's sealed and unbroken bags or in bulk.

(f) Cement, which has become hardened or lumpy or fails to comply with this Specification in any way shall be removed from the site.

(g) High alumina cement shall not be used.

3. Unless otherwise agreed by the Engineer, all cement shall comply with all of the following requirements:

(a) The acid-soluble alkali level determined in accordance with BS EN 196-2 shall not exceed 0.6% by weight.

(b) The specific surface shall not be greater than 325 m2/kg and not less than 225m2/kg when tested as described in BS EN 196-6.

(c) The temperature of the cement shall not exceed 55°C at the time of incorporation into a concrete mix

4. Combination of Cement with ground granulated blast furnace slag (g.g.b.f.s) or pulverized fuel ash (p.f.a).

(a) Where approved by the Engineer g.g.b.f.s. or p.f.a. may be combined in the concrete mixer with Portland cement complying with BS12 as an alternative to the use of factory combinations. G.g.b.f.s. and p.f.a. shall not both be added to the same concrete mix. The procedure given in Clause 4.4.3 of BS5328 Part 1 shall be followed.

(b) The alumina (A1203) content of the g.g.b.f.s. shall not exceed 14%.

(c) No g.g.b.f.s. shall be added to any mix containing cements to BS6588 or BS6610, or any other cement combinations containing p.f.a.

(d) No p.f.a. shall be added to any mix containing Portland Blast Furnace cements to B8146, B84246 or B84248 or any other cement combination containing g.g.b.f.s.

(e) Combination of cement with g.g.b.f.s. or p.f.a. shall be carried out under controlled conditions and the proportions used shall be within the limits in B8146, B84246, B84248, B86588 or B86610 as appropriate.

(f) No g.g.b.f.s., p.f.a. or cement combination including either of them shall be included in concrete mixes containing sulphate-resisting cement to B84027.

(g) Super sulphated cement to B84248 shall not be combined with any other type of cement.

5. Silica Fume

(a) Where approved by the Engineer the concrete mix may contain an approved silica fume. The silica fume shall originate from production of silicon from Ferro-silicon alloys and shall have silicon dioxide content not less than 90%.

(b) Chemical/physical analysis shall be provided for the following:

Parameter	**Criteria**
Specific gravity	2,200 kg/m³ minimum
Bulk density(densified power)	500-650 kg/ m³
Specific surface	18 m³/gram minimum
Cao	2.0% maximum
SiO2	90% minimum
A1203	1.0% maximum
Fe203	1.5 maximum
Mgo	2.0 maximum
So3	1.5 %maximum
Alkali as Na2O(include K2O)	4.5 %maximum
C	3%maximum
Activity index	Minimum 95% after 28 days
Loss of Ignition	Maximum 4%
Percentage of particles greater than 44µ	Maximum 2%
Moisture content	Maximum 2%
Chloride content	Maximum 0.1%

(c) Methods of test shall be in accordance with Norsk 8tandard N8 3045 or B8 4550 where applicable.

(d) Certification shall be provided for each consignment of silica fume delivered.

(e) The silica fume supplied shall be from a single furnace and shall not be sub supplied. The process of production of silica fume, Le. The furnace product, of which the silica fume is a by-product, shall not vary.

(f) The method of incorporation of the silica fume in the mix. A letter from the silica fume supplier approving the methodology shall support the method statement.

(g) Silica fume shall be used in conjunction with a superplasticising admixture specially to aid dispersion of the silica fume throughout the mix. Details of the proposed admixture shall be submitted to the Engineer for approval.

(h) Ensure that the silica fume supplier provides periodic on-site monitoring of batching, mixing, placing and curing of the concrete and reports on the above shall be submitted to the Engineer for inspection. The representative of the silica fume supplier shall have the necessary technical expertise and local experience.

6. Hydrophobic Pore Blocker

(a) Where approved by the Engineer the concrete mix may contain an approved hydrophobic pore blocking ingredient at a rate not exceeding 30 liters per cubic metre such that the concrete shall have a corrected 30 minute water absorption of not greater than 1.5% as measured by BS1881: Part 122 except that the age at test shall be 7 days.

(b) The absorption test is to be conducted on cores taken from cubes or cylinders as specified in the standard unless the Engineer approves the use of cast specimen.

(c) Prior to construction, trial mixes shall be conducted under the supervision of the Engineer or his representative to confirm that the proposed mix conforms to absorption requirement.

(d) During construction, absorption samples shall be taken at the same time as samples for compressive strength testing. These shall be tested as above and shall conform to the absorption requirement. In the event of non-compliance, carry out remedial measures as described elsewhere in the Specification.

(e) The concrete as placed and cured in the actual structure is required to comply with ,the water absorption limit within 7 days of placement in the structure, The Engineer reserves the right to .take cores to confirm compliance. In the event of non-compliance, carry out remedial measures as described elsewhere in' the Specification.

(f) Any admixture or ingredient other than cement, aggregate or approved water reducing admixture, used by the Contractor to comply with the absorption requirement must be shown by an independent authority to have been used in concrete exposed to a coastal or marine environment for a minimum of 10 years without significant deterioration of the cement matrix, embedded reinforcing steel or measurable reduction in performance of the product on absorption.

(g) The hydrophobic pore blocking ingredient and other related admixtures shall be obtained from a single manufacturer.

202 STORAGE OF CEMENT

1. The cement shall be delivered to site in bulk or in sound, properly sealed and marked bags and while being loaded or unloaded and during transit to the concrete mixers, whether conveyed in vehicles or by mechanical means, shall be efficiently protected from the weather by fully enclosed transfer systems or in the case of bagged cement by tarpaulins or other effective coverings.
2. If the cement is delivered in bulk, provide silos of adequate size to store sufficient cement to ensure continuity of work and the cement shall be placed in these silos immediately it has been delivered on the Site. Adequate precautions must be taken during unloading to ensure that the resulting dust does not constitute a nuisance. If the cement is delivered in bags, provide perfectly waterproof and well-ventilated sheds

having a floor of wood or concrete raised above the ground. The sheds shall be large enough to store sufficient cement to ensure continuity of work and to enable the suitability of the cement to be determined by the Engineer before use. Each consignment must be stacked separately there in to permit easy access for inspection and testing. On delivery at the Site the cement; is at once to be placed in these sheds and shall be used in the order in which it has been delivered.

203 CEMENT TESTING

1. All cements shall be certified by the manufacturer(s) as complying with the requirements of the appropriate specification. Before orders are placed submit details of the proposed supplier(s) together with sufficient information on the proposed methods of transport, storage and certification to enable the Engineer to satisfy himself that the quantity and quality required could be supplied and maintained throughout the construction period. Where necessary the Engineer may require further representative samples of the proposed cement to be taken and forwarded to a nominated laboratory for analysis and testing before the source is approved. .
2. Having obtained the Engineer's approval of the source(s) of supply, do not modify or change the agreed arrangements for transport, storage and certification of the cement without first having obtained the Engineer's permission.
3. Each consignment of cement delivered to the site shall be accompanied by a certificate showing the place of manufacture and the results of standard tests carried out on each day's bulk supply from which the cement was extracted.
4. In addition to the tests described above, test each consignment of cement on arrival at the site and also after it has been stored on the site prior to use. Such tests will be in accordance with the requirements of as EN 196.
5. Ensure that the arrangements for the storage of the cement on the site are sufficient for the separation and identification of each consignment until the results of the sampling and testing referred to above are available.
6. The cement shall be used in order of delivery. Cement held on site for more than 28 days shall be tested prior to use for 'loss-on-ignition' as detailed in as 4550: Part EN 196-2.
7. Cement condemned by the Engineer shall be immediately removed from site.

204 AGGREGATE SOURCES

Aggregates for concrete shall be obtained from sources to be approved for this purpose by the Engineer. Suitable aggregates and samples of sand and stone shall be obtained for specified tests to be carried out before any arrangements for obtaining aggregates from new or alternative sources are approved by the Engineer. Laboratory check tests shall be made of the aggregates at regular intervals to confirm their suitability for concrete and the consistency of the grading. .

205 AGGREGATES GENERAL

1. Aggregate for concrete, mortar or for other purposes shall be in all cases free from earth, clay, loam, soft clayey shale or decomposed stone, organic matter and other impurities and shall be hard and dense.
2. The percentage of hollow shells shall be limited to an agreed level compatible with the

production of dense concrete to the satisfaction of the Engineer. This percentage is unlikely to exceed 3% by weight determined in accordance with as 812: Part 106. This criterion shall apply to all aggregate with the exception that all aggregate to be used in the construction of structures for retaining aqueous liquids shall comply with the requirements of as 8007.

3. Aggregate for use in concrete shall conform in all respects with as 882: 1992 "Specification for aggregates from natural sources for concrete" and as 1199 and 1200: 1976 (1996), except where specifically stated otherwise below.
4. Sand for use in mortar shall conform in all respects with as 1199 and 1200 "Specifications for building sands from natural sources".

206 FINE AGGREGATE

1. The grading of the fine aggregate shall be within the limits prescribed in C or M of as 882 Table 4 and it shall be so graded that when mixed with the coarse aggregate and cement it shall produce a concrete of the maximum density. Crushed sand may be added to natural sand in proportions agreed by the Engineer in order to achieve the required grading. Crushed sand alone may only by used with the agreement of the Engineer.

2. Fine aggregate shall not contain appreciable amounts of flaky and or elongated particles.
3. The use of beach sand may be permitted but shall. comply in all respects with the Specification.

207 COARSE AGGREGATE

The term coarse aggregate means an aggregate retained on a 5.00mm BS test sieve, The grading of the coarse aggregate shall be within the limits prescribed in BS 882, Table 3 and shall be such that when combined with the fine aggregate and cement it shall produce a workable concrete of maximum density, The Engineer shall fix the required densities of the various classes of concrete after tests have been carried out on the Site,

208 STORAGE OF AGGREGATE

1. All sand and aggregate for concrete shall be stored in concrete-based bins or on stages designed to prevent intermixing of different aggregates and to avoid the inclusion of dirt and other foreign materials in the concrete. Each size of aggregate shall be stored separately.

   The storage bins shall be emptied and cleaned and the grading of the aggregates checked at intervals, or as required by the Engineer.
2. Grading of combined aggregate:

(a) Ensure that the combined grading of the aggregates is constant. The percentage passing any sieve size as determined by trial mixes shall be the target grading for all concrete of that type. The combined grading of the works concrete shall not vary by more than: 4% from that found from the trial mixes. If the estimated or measured combined grading of the permanent works concrete does not meet this requirement then a new trial mix shall be prepared.

If the plastic properties are not the same as the agreed trial mixes, the mix shall be re-designed.

(b) If at any time samples prove unsatisfactory, either change to a new supply or make arrangements acceptable to the Engineer to remedy the situation.

209 TESTING AGGREGATES

1. Tests to assess the suitability of the aggregates proposed for use on concrete to be placed in the permanent works shall be as follows:

(a) Grading
(b) Magnesium sulphate soundness;
(c) Specific gravity and water absorption;
(d) Clay, silt and dust content
(e) Organic impurities;
(f) Sulphate and chloride content;
(g) Aggregate crushing value not to exceed 20%; (alternatively 10% fines value and aggregate impact value subject to the agreement of the Engineer);
(h) Elongation and flakiness;
(i) Potential alkali reactivity;
(j) Aggregate drying shrinkage in accordance with BS 812: Part 120 - shrinkage not to exceed 0.0575% (equivalent to 0.05% when tested to BRE Digest 35);
(k) Water absorption not to exceed 2.0%.

These tests shall be carried out in accordance with the appropriate British Standards and the results shall comply with the limits given therein or as otherwise stated in this Specification. Grading tests shall be carried out at least at weekly or at 100m3 intervals, whichever is the sooner, when concrete is being produced on a regular basis or before the start of production when irregular.

2. The amount of material passing a 75 micron BS 410 fine test sieve when tested in accordance with BS 812: Part 103 (wet sieving method) shall not exceed 3 per cent by weight of fine aggregate.

3. Fine aggregate subjected to five cycles of the soundness test, specified in ASTM C88 shall not show a loss exceeding 10% when magnesium sulphate solution is used except where otherwise approved.

4. Coarse aggregate subjected to five cycles of the soundness test, specified in ASTM C88, shall not show a loss exceeding 10% when magnesium sulphate solution is used, except where otherwise approved.

5. The amount of material passing a 75 micron BS 410 fine test sieve, when tested in accordance with BS 812: Part 103 (wet sieving method) shall not exceed 1% by weight for coarse aggregate.

6. The flakiness and elongation indices of the predominant size fractions in each single sized coarse aggregate, determined in accordance with BS 105, shall not exceed 20% and 35% by weight respectively.

7. Aggregate for use in concrete which is subject to abrasion and impact shall comply with the test requirements of BS 812: Parts 112 and 113 and the specifications of BS 63 and BS 882 respectively.

8. Coarse aggregate shall be tested for drying shrinkage characteristics in accordance with BS 812: Part 120.

9. Aggregates shall not contain any materials that are deleteriously reactive with:

   (a) Alkalis in the cement;
   (b) Alkalis in the aggregate itself;
   (c) Alkalis in the mixing water

   (d) Alkalis in water in contact with the finished concrete or mortar in amounts sufficient to Cause excessive localised or general expansion of the concrete or mortar.

10. Mortar Bar tests shall be conducted by the Contractor in accordance with ASTM C227 when aggregate sources are unproven, or when directed by the Engineer, to determine whether or not any aggregate to be used as a constituent of concrete is alkali-reactive to a deleterious extent, as indicated by the criteria given in the standard employed. For the purpose of initial assessments the ASTM C289 or other approved test shall be used. Should these tests indicate that any rock constituent is deleteriously reactive, then aggregates containing such constituents shall not be permitted to be used in permanent works concrete, unless or until the Mortar Bar tests, performed in accordance with ASTM C227, demonstrate conclusively that the effects do not exceed the permissible limits laid down in ASTM C33 when combined with the other constituents in the proportions agreed for use in the permanent works mixes.

210 WATER

1. For mixing and curing concrete and mortar, water shall be fresh and free from all sediment and dissolved or suspended matter which may be harmful to the manufacture of concrete as specified and shall comply with the requirements of BS 3148. Water samples from the intended source of supply may be taken by the Engineer for analysis before any concrete work is commenced and at intervals throughout the duration of the Contract. If at any time samples prove unsatisfactory either change to a new supply or make arrangements acceptable to the Engineer to remove the offending matter.

2. Water used for mixing and curing of concrete shall have a pH value in the basic range of 7 to 9 and the soluble solids shall not exceed the following limits:

Total dissolved solids	2000 mg/1
Chlorides (NaCI)	600 mg/1
Sulphate (S03)	500 mg/1
Alkali Carbonates & Bicarbonates	1000 mg/1

3. The temperature of water for concrete shall not be less than 5°C nor more than 25°C at the time of mixing. Water may be by the gradual addition of chilled water or flaked ice but no ice particles shall be present when the water is added to the mix. The ice to be used shall be the product of water that complies with the above acceptance criteria.

211 STEEL FOR REINFORCED CONCRETE

1. Steel reinforcement, other than steel for prestressing, used in reinforced concrete shall comply with the following British Standards as appropriate:

BS 4449	Specification for carbon steel bars for the reinforcement of concrete.
BS 4466	Specification for scheduling, dimensioning, bending and cutting of Steel reinforcement for concrete.
BS 4482	Specification for cold reduced steel wire for the reinforcement of Concrete.
BS 4483	Specification for steel fabric for the reinforcement of concrete. .
BS 8110	Structural use of concrete.

2. Furnish the Engineer with copies of the manufacturer's certificates of tests for the steel reinforcement to be supplied. The Engineer may; however, order independent tests to be made and any steel, which does not comply in all respects with the appropriate foregoing specifications, will be rejected.
3. All steel reinforcement shall be stored above ground and under cover racked as necessary and protected from all aggressive elements to the approval of the Engineer.

212 SEPARATION LAYER

The separation layer shall be natural colour polythene sheet, 1000 gauge, complying with BS 3012 or the voluntary standard No. PFMS 2/65 Third Edition: Revised and Amended November 1969, of the Packaging and Industrial Films Association (UK) - "Polythene Film for Building Applications".

213 JOINT FILLER BOARD

1. The joint filler boards shall be manufactured filler, which meets with the requirements given below for weathering, compression and recovery and extrusion when tested in accordance with AASHTO T42-49.
2. The thickness of the filler shall be as shown on the drawings.
3. The depth of the filler shall be equal to the thickness of the slab in the case of expansion joints.
4. Where the laying width between the road forms is 3.00 m or less the boards shall be in single lengths in the joint. Lengths greater than this may be made up with two boards of equal length.
5. Around obstructions in the continuity of the slab, single lengths of board shall be used \ along each side of the obstructions when the sides are 3.00 m or less.
6. Provide the Engineer with a sample of the proposed filler board, together with a copy of the manufacturer's technical description of its composition and qualities and obtain the Engineer's approval before placing order for the bulk supply.
7. When submitting the sample, detail the proposed methods to hold the filler board in place to ensure that it remains truly vertical and straight, during and after the laying of the concrete.
8. If, after approving the sample, the Engineer is not satisfied that this requirement is being met in the work, all concreting shall stop until either an alternative material or a new method of placing has been devised and approved.
9. Tests shall be carried out on specimens cut from representative samples. The

specimens shall be accurately prepared with straight cleanly cut square edges. When more than one thickness of filler is required in the joints the tests shall be carried out on specimens of each thickness. The thickness of the specimens shall be accurately measured.

10. Weathering: The specimens will have passed this test if they show no sign of Disintegration.

11. Compression and Recovery: At the end of the test the material shall recover at least 70% of its original thickness within a period of 2 hours of the release of the last loading.

12. Extrusion: the amount of extrusion of the free edge at the 50% thickness shall not exceed 6.5mm.

214 CURING COMPOUND

1. The liquid for the curing of concrete surfaces shall be a compound complying with. ASTM C309-81, which when applied at the rate of spread specified by the manufacturer, has a minimum curing efficiency of 85 per cent, as determined by the test method given in ASTM C156-80a and Sub-Clause 6 below. The liquid shall not react chemically with the concrete. It is to contain flake aluminium in finely divided dispersion, which will not separate out when the compound is applied as specified. After application the liquid shall produce a continuous film of uniform thickness with an unbroken finish, free from pinholes or other imperfections, over the entire surface of the concrete. The film shall be touch-dry within 5 minutes and stable within 60 minutes, and shall not disintegrate for 3 weeks.

2. At least 2 weeks before the compound is required, provide the Engineer with a 5-litre sample together with a certificate from an independent laboratory reporting the results of tests carried out by the laboratory on the product within the previous six months. The compound shall not be used until the Engineer has given approval.

3. Each consignment delivered to the site shall be clearly marked by the manufacturer with his name and that of the product, and shall be accompanied by a certificate stating that the consignment is equal to the sample tested and giving the rate of spread required for the specified efficiency. The delivery certificates shall be passed to the Engineer for his retention.

4. The compound shall not be harmful to those handling it and shall be proof against fire risk and explosive hazard.

The efficiency index (E) shall be calculated as follows:

$E = 100(W-W1)/W$

Where W = average of the moisture losses of 3 control specimens expressed as a percentage of the original mass of water in the specimens,

And W1 = average of the moisture losses (assessed after correction for volatile losses) of the 3 test specimens expressed as a percentage of the original mass of water in the specimen.

215 JOINT SEALANT

1. STRUCTURAL CONCRETE:

(a) In the locations shown on the drawings joints shall be sealed with cold poured or gun applied two-part polysulphide sealant to BS 4254 (BS Kite marked) as appropriate.

(b) For joints in floor slabs and water retaining structures the depth of sealant shall be 20mm.

(c) Sealant shall be applied in accordance with the manufacturer's recommendations.

(d) Compounds shall not be used before samples have been approved by the Engineer.

216 DOWELS AND TIE BARS

1. Dowels and tie bars shall be of mild steel complying with BS 4449. Tie bars shall be deformed bars. Dowel bars shall be smooth and round with clearly sawn and trimmed ends.
2. All reinforcement shall be free from mill scale, loose rust, oil, grease, paint, dirt or any other material likely to have an adverse affect on the bond with the concrete.

217 WATER BAR

For water retaining and basement structure a proprietary water bar shall be provided at all construction joints and movement joints. A Water stop that swells in the presence of moisture shall be fixed to provide a watertight barrier.
The water bar shall have the following properties:

Swelling Capability	50%
Basis	Polymer composite
Water pressure resistance	50m (5bar)
Water seepage (expansion joint).	None
Application Temperature	-20 deg C to + 50 deg C
Freeze! Thaw resistance	No influence before and after concreting

A company certified to the requirements of ISO 9002/ ISO 14001 shall manufacture the product.

218 WATERPROOFING MEMBRANES

GENERAL

All work shall be undertaken in strict accordance with the Manufacturers recommendations. The Manufacturers representative shall be required to visit site on a daily basis to ensure that workmanship and application is acceptable.

COMPOSITE SHEET SYSTEM

i) Waterproofing shall be a 1.5mm thick flexible, self-adhesive sheet membrane comprising a rubber! Bitumen compound and a grey coloured, dimensionally stable, HOPE solar reflective film. The membrane shall have a typical water vapour transmission rate of 0.06g/m2/day (ASTM E96-92) and be tested to withstand 70m hydrostatic head at laps (ASTM 05385-93).

Additional values are:

Tensile Strength (Carrier Film)	Longitudinal	48.4N/mm²	ASTM D638-91
	Transverse	45.4N/mm²	
Puncture	280N		ASTM E154-93

The membrane shall be specially formulated to allow application in hot climatic conditions and provide a surface which is solar reflective to reduce heat gain while the membrane is temporarily exposed. Factory printed overlap lines to ensure correct alignment and minimum laps shall facilitate installation.

The substrate shall be prepared and primed, and the membrane installed with overlaps and corner detailing formed and fully sealed, all as recommended by the manufacturer. Penetrations by services, etc. shall be sealed with a compatible waterproof liquid membrane as recommended by the sheet manufacturer.
Immediately after laying, the membrane shall be inspected for any damage made evident by the special grey film and repaired using oversize patches of the membrane. The inspected membrane shall then be protected permanents by using rot proof protection boards or thermal insulation as appropriate.

ii) In areas where it is necessary for the waterproofing membrane to be applied before the structural elements are cast, e.g. below base slabs or against permanent formwork. The membrane shall be a flexible, multi-layered composite sheet membrane capable of forming an integral bond to structural concrete cast against it, which prevent water tracking. It shall consist of a tough HOPE sheet and aggressive, pressure sensitive adhesive with weather resistant coating.

The horizontal membrane grade must be capable of taking site trafficking and support heavy reinforcement without puncturing. The vertical membrane grade must allow for mechanical fixing to the permanent formwork or soil retention systems or temporary works without damage.

The membrane shall be independently certified (BBA or equivalent) to provide zero permeability to water vapour and resistance to hydrostatic pressure> 6 metres at overlaps. The membranes shall be chemically resistant and provide protection to the concrete against sulphate and termite attack, and ground water with pH values outside the range 5-10 range. .

The membranes shall be installed with fully bonded laps and corner details formed and fully sealed as recommended by the manufacturer to prevent grout loss and potential water paths. Penetrations by services, piles, etc. shall be sealed with a compatible liquid compound to ensure continuity. The membrane shall not be adversely affected by exposure to ponded water or adverse weather conditions.

iii) Primer

Single-component solvent based primer.

iv) Protection Board
Multi layer fibreboard Non-compressive, Robust and bonded & laminated with water-resistant adhesive.

300 CONCRETE FOR STRUCTURES

301 CONCRETE MIXES

1. The reinforced concrete works have been designed generally in accordance with the recommendations of BS 8110 and comply with the recommendations of this British Standard unless specifically excluded or modified thereafter. .

Performance requirements in accordance with Table 3.2 and relevant clauses of this specification.

2. Schedule of Concrete Mixes

Type	C1	C2	C3	C4
General description	Blinding concrete	Mass structural concrete (no reinforcement)	General reinforced concrete	High performance Reinforced concrete

Note: the descriptions are given as general guidance: the drawings indicate the area of use of each mix.

3. Prescribed Mixes (P) to BS 5328: Part 2:

(a) Supplied in accordance with the relevant clauses of BS 5328: Parts 2, 3 and 4.

(b) Permitted types and standard strength classes of cement in accordance with Table 3.1 of this specification.

(c) Nominal maximum aggregate size in accordance with Table 3.1 of this specification.

(d) Aggregate types in accordance with clauses 205, 206 and 207 of this specification.

(e) Workability in accordance with Table 3.1 of this specification.

(f) Sampling in accordance with Table 3.1 and relevant clauses of this specification.

4. Designated Mixes (GEN/RC/FND) to BS5328: Part 2

(a) Aggregates to be within the grading limits of Tables 3 and 4 of BS882.

(b) The minimum cement content to be in accordance with Table 6 of BS5328: Part 2.

(c) The maximum free water/cement ratio to be in accordance with Table 6 of BS 5328: Part 2, unless specified otherwise.

(d) Cements to be in accordance with Table 3.1 of this specification.

5. Standard Mixes (ST) to BS 5328: Part 2:

(a) Aggregates to be within the grading limits of Tables 3 and 4 of BS 882.

(b) The proportion by weight of cement to aggregate to be in accordance with table 3.1 of this specification. ;

(c) Quantity of water used is not to exceed that required to produce a concrete with sufficient workability to be placed and compacted where required.

6. Designed Mixes (D) to BS 5328: Part 2

(a) The Grades of Concrete to be supplied to be in accordance with Table 3.1 of this specification.

(b) Provide full details of each mix type for comment, including.

i) Proportions.
ii) Batch weights
iii) Aggregate test results
iv) Water/cement ratio.
v) Workabilty
vi) Driving shrinkage of aggregate
vii) Surface absorption
viii) Admixtures

(c) Laboratory trial mixes will. Not be accepted for strength criteria.

(d) Prepare trial mix in accordance with BS5328: Parts 3 and 4:1990 if required by the Engineer to test the water: cement ratio.

(e) Declare any changes of source of materials. Inform Engineer of all proposed changes to mix design resulting from statistical quality control 48 hours before use.

(f) Do not use designed concrete mixes before results of preliminary tests have been obtained.

(g) Existing data showing that the proposed mix design meets the requirements of this specification will not be accepted.

The design mean strength shall exceed the minimum CCS specified in the performance requirements by a margin of 1.64 times the standard deviation expected from the concreting plant, except that no standard deviation less than 3.5 MPa shall be used as a basis for designing a mix.

7. Watertight concrete

a) Watertight concrete shall also comply with the requirements of BS 8007, particularly Clauses 6.2 and 6.3 therein.

Table 3.1 – Mix descriptions

Type		C1	C2	C3	C4
Type of mix (P, GEN, RC, FIND, SP, D)		GEN	FND	0	0
Cement	Type	*OPC/* MSRP C	*OPC/* MSRP C	*OPC/* MSRP C+SF	OPC/MSRPC +SF
	BSNo	12	12	12	12
Coarse aggregate	BSNo	882	882	882	882
	Nominal maximu m size mm	20	20	20	20
Fine aggregate	Grading	Cor M	Cor M	Cor M	Cor M
	BS No	882	882	882	882
Grade to BS 5328: Part 2		GEN1	FND3	C40/50	*C50/C60/C75*
Minimum cement content kg/m3		175	300	380	420
Sampling rate/m3		CLAUSE 403			
Workability (slump mm)		30-1 00	100	100	100
Maximum free water*/* cementitious ratio		0.65	0.50	0040	0.38
Maximum cementitious content kg/m3		No limit	No limit	420	450

SF - Silica fume

302 TRIAL MIXES

1. Carry out trial mixes with the proposed materials within the limits of the proportions described in Clause 0401.
2. The concrete shall be of suitable workability for full compaction to be achieved with the plant used without undue flow.
3. The Compacting Factor shall be determined in accordance with BS 1881. A job standard value for the mix and plant being used shall be determined by the Contractor and agreed by the Engineer. The workability shall be maintained so that the Compacting Factor measured in subsequent batches shall be within the tolerance specified in Clause 0407.
4. The slump test in accordance with BS 1881 will be permitted in lieu. In this case the slump shall be maintained within the tolerance specified in Clause 0407.
5. Samples for tests as specified shall be taken and tested in accordance with Clause 0403.
6. Report the proportion of each constituent used in the satisfactory mix to the Engineer for his agreement. .
7. After trials the mix shall not be changed without the Engineer's consent. Any change will involve a repetition of the tests detailed in this clause.

8. Where required by the Engineer trial pours of typical reinforcement details shall be cast and cores taken for examination in accordance with Clause 404.
9. Actual Characteristic Strength

303 FORMWORK

1. Provide all necessary formwork to produce finished concrete work to required dimensions and finishes.
2. Provide details of forms as follows:

(a) Positions and types of construction joints.

(b) Layout of panel joints where exposed to view.

(c) Layout of form tie holes where exposed to view.

(d) Means of sealing panel joints, form tie holes and at construction joints.

(e) Surface of forms and other means of obtaining required finish.

(f) Calculations showing adequacy of proposed formwork.

3. Design and construct formwork to withstand worst loading combination of:

(a) Total weight of formwork, reinforcement and concrete.

(b) Construction loads including dynamic effects of placing, compacting and construction traffic.

(c) Wind load

(d) In designing forms and centring, concrete shall be regarded as a liquid. In computing vertical loads, a weight of twenty four hundred (2,500) kilograms per cubic metre shall be assumed, and not less than thirteen hundred and sixty (1.360) kilograms per cubic metre shall be assumed in computing horizontal pressure.

(e) Detailed drawings for false work and centring shall be prepared by the Contractor and submitted to the Engineer for approval. The Engineer must approve the drawings before the work is started.

(f) Submit to the Engineer for approval at least one (1) month before commencing work, complete and full details of the proposed system of false work, including, detailed drawings and calculations. False work shall be capable of accommodating temperature changes without causing damage to the concrete.

(g) False work and centring shall be designed and constructed to provide the necessary rigidity to support all loads placed upon it without appreciable settlement or deformation. False work columns shall be supported on wood or metal bases to support all false work that cannot be founded on rock, shale or thick deposits of other compact material in their natural beds. False work shall not be supported on any part of the structure, except the footings, without the written permission of the Engineer. The number and spacit: 1g of false work columns, the adequacy of s1lls, caps and stringers and the amount of bracing in the false work framing shall be subject to approval of the Engineer.

(h) Provide means for accurately measuring settlement in false work during placement of concrete, and provide a competent observer to observe and correct the settlement.

(i) The Engineer may refuse permission to proceed with other phases of the work if he deems the false work unsafe or inadequate to support properly the loads to which it will be subjected.

(j) The review or approval of false work drawings by the Engineer or permission to proceed with the work shall not relieve the Contractor of the responsibility for successful erection or satisfactory results.

4. Prop through floors if construction load on a particular floor exceeds the design load.

5. Unless otherwise shown on drawings construct forms to achieve the following:

Member	Upward camber (% Of span)	Measure at
Slabs	0.2%	Centre
Beams	0.2%	Centre
Cantilevers	0.4%	Free end

6. Kickers to be 75mm high, cast monolithically with base slab.

7. Construct joints in forms to prevent loss of grout, including joints in form linings and between forms and completed work.

8. Unless shown on drawings determine positions of construction joints in accordance with the following criteria:

Slabs:	Maximum area Maximum length	100m² 10m²
Walls:	Maximum area Maximum length	6m 3m

Joints may be spaced more closely that the maximum stated. Location of Joints to be approved by the Engineer.

(a) Joint shall be:
   i. Straight, vertical, horizontal or as detailed or as approved.
   ii. Formed as necessary with rigid stop ends designed to accommodate projecting reinforcement without temporary bending or displacement.

(b) Clean face of joint immediately before assembly of forms. Keep clean until Concrete is placed.

9. Construct rigid stop ends and formwork at contraction and expansion joints to permit Separate construction of the structurally separate parts of the work.

10. Confirm positions and details of all:

(a) Permanent fixings.
(b) Pipes and conduits.
(c) Holes and chases.

Ensure that alterations are not made without the knowledge and approval of the Engineer.

Fix inserts or box out as required in correct positions before placing concrete. Form all holes and chases. Do not cut hardened concrete without approval.

11. Allow for formwork to vertical faces of walls and foundations below ground level.
12. No metal part of any device for securing forms is to remain within 40mm of exposed Face of concrete.
13. Use the same type and make of release agents throughout the entire area of anyone finish visible in the finished works. Apply evenly to form faces using the minimum amount necessary to obtain a clean release. Prevent excessive local collection. Do not reinforcement, hardened concrete or other materials not part of the form face.
14. Do not use surface retarders without prior written approval.
15. Before concrete is placed, all formwork and supports shall be thoroughly cleaned. Temporary openings shall be provided to assist in the removal of the rubbish.
16. Consideration will be given to the use of controlled permeability formwork to assist in achieving the durability requirements.
17. A period of not less than 24 hours notice shall be given to the Engineer to allow for the examination and approval of the formwork and reinforcement prior to placing concrete.

    Concrete shall not be placed until the relevant formwork has been inspected and approved by the Engineer.

304 PLACING OF STEEL REINFORCEMENT

1. Steel bar reinforcement shall be cut, bent and fixed in accordance with BS 4466 and BS 8110. Generally it shall be bent cold in a manner, which will not damage the material.
2. Bends, cranks or other labours on reinforcing bars shall be carefully formed in accordance with BS 4466 "Bending dimensions and scheduling of bars for the reinforcement of concrete", with BS 8110, and as detailed on the working drawings.
3. The length of laps shall be calculated in accordance with BS 8110.
4. The number, size, form and position of all steel reinforcing bars, ties, links, stirrups and other parts of the reinforcement shall be in accordance with the Drawings and kept in the correct position in the forms without displacement during the process of vibrating, tamping and ramming the concrete in place. Provide all necessary distance pieces and spacer bars to maintain the reinforcement in the correct position. Any ties, links or stirrups connecting the bars shall be taut so that the bars are properly braced and the inside of their curved parts shall be in actual contact with the bars around which they are intended to fit. Bars shall be bound together with best black annealed mild steel. Wire approximately 1.5mm diameter or other approved binding. Wire binding shall be twisted tight with proper pliers. The free ends of the binding wire shall be bent inwards.
5. Reinforcement shall be grit-blasted before use and loose rust, oil, grease, salt, causes and products of pitting, and other deleterious matter shall be removed. Partially set concrete adhering to exposed bars during concreting operations shall also be removed.
6. Bending schedules and reinforcement detail drawings in the following scales shall be prepared and submitted to the Engineer for comment before cutting and bending the reinforcement.
   (a) Walls and slabs 1:50

(b) Beams and column elevations 1:20
(c) Beam and column sections 1:20 or 1:10

Reinforcement details drawings shall be in accordance with the Standard Method of Detailing Structural Concrete published by the Institution of Structural Engineers/Concrete Society,

7. Reinforcement temporarily left projecting from the concrete at construction or other joints shall not be bent out of position during the period in which concreting is suspended, except with the approval of the Engineer. When such approval is given the reinforcement shall be bent out over a suitably sized former to prevent damage or over-stressing of the reinforcement.

8. The concrete cover to reinforcement shall be in accordance with the Drawings. If no cover is specified on the Drawings, refer this matter to the Engineer. No pieces of steel, timber blocks or materials other than approved concrete or plastic spacers shall be permitted.

9. Where concrete spacing blocks are used they shall be of similar quality to the concrete specified for the particular element of the structure. For concrete having a characteristic strength of 25 N/mm2 or greater, the spacing blocks shall comply with the requirements of this Specification for water absorption and the ties shall be made from non-metallic material.

305 PLACING CONCRETE

1. The concrete shall be placed in the positions and sequences indicated on the Drawings or in the Specification, or as directed by the Engineer. Except where otherwise directed, concreting shall not be commenced unless the Engineer or his representative is present or has previously examined and approved the positioning, fixing and condition of reinforcement and any other items to be embedded and the cleanliness, alignment and suitability on the containing surfaces or formwork. Make due allowance in the concreting programme for the period of the Engineer's inspection.

2. The limit of individual pours and the height of lifts shall be as stated in clause 303.

3. The length of wall that may be poured in one operation shall not exceed 6 metres, unless otherwise approved by the Engineer, and no fresh concrete shall be poured against other concrete in the horizontal direction for 21 days thereafter or after such other time has elapsed as may be approved by the Engineer. Further vertical lifts shall not be poured within 48 hours subject to the approval of the Engineer.

The sequence of pours shall be arranged to minimise thermal and shrinkage strains.

4. Floors, roofs and paving shall be laid in sequential fashion. Concrete shall not be placed in adjacent slabs until 7 days or such other time has elapsed as may be approved by the Engineer. The area of floor, which shall be laid at any time, shall not exceed that specified in Clause 305 unless otherwise approved by the Engineer.

Concrete paving blocks shall not be laid directly onto an impermeable membrane.

5. The concrete shall be deposited as nearly as possible in its final position without re--handling or segregation and in such a manner as to avoid displacement of the reinforcement, other embedded items and formwork.

6. Wherever possible concrete shall be placed by pumping or bottom-opening skips. Where chutes are used to convey the concrete their slopes shall not be such as to cause segregation and suitable spouts or baffles shall be provided where necessary. Concrete

shall not be dropped through a free height greater than 2.0 metres except with the approval of the Engineer. Where the work requires the concrete to be deposited from a height exceeding 2.0 metres trunking and chutes to the Engineer's approval shall be used to prevent segregation of materials. Concrete shall not be placed in standing water or running water unless so specified or approved.

7. All formwork and reinforcement shall be clean and free from standing water immediately before placing concrete.
8. Prior to placing any concrete on natural surfaces a blinding layer of concrete shall be laid to a minimum of 75mm thickness unless otherwise specified on the drawings. This blinding shall be suitably cured prior to subsequent concrete placement. The blinding shall be clean and free from any dust or impurities prior to subsequent concrete placement.
9. No concrete shall be placed in a foundation until the extent of excavation and the character of bearing material have been approved and no concrete shall be placed in any structure until the placement of reinforcing steel and the adequacy of the forms and false work have been approved.
10. Concrete shall not be placed in any part of the Works until the Engineer's approval has been given. If concrete has not started within 24 hours of such approval being given, approval shall again be requested. Concreting shall then proceed continuously over the area between construction joints. Fresh concrete shall not be placed against in-situ concrete, which has been in position for more than 30 minutes unless a construction joint is formed in accordance with the Specification. When the concrete has been in place for 4 hour, or less as directed by the Engineer, further concrete shall not be placed against it for at least a further 20 hours.
11. Surfaces on which concrete is to be placed shall be moist but free of standing water at the time of concreting. This shall be achieved by spraying the forms and reinforcement prior to placing concrete. Shading shall be provided to prevent solar heat gain of forms and reinforcement.
12. When daytime temperature and drying conditions are critical the concreting shall be scheduled to begin during the late afternoon to prevent the occurrence of severe thermal effects. Consideration should also be given to nighttime concreting.

306 COMPACTION OF CONCRETE

1. Except where otherwise permitted by the Engineer, concrete shall be compacted during placing by approved pattern internal vibrators. The vibrators shall operate at a frequency of not less than 6,000 cycles per minute and shall be designed for continuous operation. The performance of vibrators shall be such as to suit the working conditions and they shall be selected accordingly. For normal use they shall be not less than 75mm diameter and will be subject to scrutiny by the Engineer. The radius of influence in such a manner that the whole of the mass under treatment shall be adequately compacted at a speed commensurate with the supply of concrete from the mixers and to the satisfaction of the Engineer. Internal vibrators should penetrate the full depth of the layer of concrete placed and just into the layer below and be withdrawn slowly so as to avoid the formation of voids.
2. Vibration is not to be applied directly or indirectly to masses of concrete after the initial set has taken place. Vibration shall not be used to make the concrete flow in the formwork.
3. Vibration shall not be applied by way of the reinforcement. Where immersion vibrators are used, contact with reinforcement.

4. Vibrators shall be so manipulated as to work the concrete thoroughly around the reinforcement and embedded fixtures and into corners and angles of the forms. Vibrators shall not be used as a means to cause concrete to flow or its position in lieu of placing. The vibration at any point shall be of sufficient duration to accomplish compaction. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of the projecting reinforcement.
5. Placing of concrete in each section of the work shall be carried out as a continuous operation between construction joints. Make adequate provision for standby equipment. If the placing of concrete is unavoidably delayed due to mechanical or other breakdown for a period longer than 30 minutes then remove the concrete already placed and restart the operation after the breakdown has been rectified. No extra payment will be made for the initial placement or the removal of concrete, which is wasted because of a cold, joint.
6. Concrete shall be compacted in its final position within 30 minutes of discharge from the mixer unless carried in purpose made agitators operating continuously, when the time shall be within 1 hour of the introduction of cement to the mix and within 30 minutes of discharge from the agitator.
7. Precautions shall be taken to ensure that the loss of slump due to temperature rise during transport, pumping and placing does not exceed 25mm.
8. Except where otherwise agreed by the Engineer, concrete shall be deposited in horizont~1 layers to a compacted depth not exceeding 400mm where internal vibrators are used or 300mm in all other cases.
9. Concrete shall not be pumped through aluminium alloy conduits.
10. Approved measures shall be taken to avoid premature stiffening of concrete placed in Contact with hot, dry surfaces. Surfaces including reinforcement against which concrete is to be placed shall be shielded against the direct rays of the sun and shall be sprayed with water to prevent excessive absorption by the surfaces of water from the fresh concrete.
11. A complete record shall be kept of the date, time, temperature and conditions of placing the concrete in each portion of the work and shall be available for inspection by the Engineer at any time.

307 CURING OF CONCRETE

1. Immediately after compaction and for 7 days thereafter all concrete shall be protected against harmful effects of sunshine, drying winds, cold, rain or running water to the satisfaction of the Engineer. During this period the measures given in Sub-Clause 3 of this Clause shall be taken to prevent the loss of moisture from the concrete and to minimise thermal stresses caused by the difference in temperature between the surface of the concrete and the core of the concrete mass. No other methods shall be employed except with the Engineer's approval.
2. Where water is to be used for curing concrete it shall be fresh water in accordance with the requirements of this Specification.
3. Unless otherwise agreed by the Engineer curing shall be carried out as follows:

(a) Horizontal surfaces:

i. Polythene shall be placed immediately after finishing.

ii. After final set has taken place, the polythene shall be replaced by wet hessian, which shall then be immediately covered with polythene and retained in place for at least 14 days.

iii. The hessian shall be kept permanently damp. Concrete shall be shaded as approved by the Engineer;

iv. The water used for curing shall be within 5°C of the placed concrete temperature.

v. Subject to the approval of the Engineer a proprietary curing compound may be used as an alternative to the above.

vi. Where specific surface textures are required then alternative methods of curing may only be employed with the approval of the Engineer.

4. Where timber or other insulating formwork is used it shall be left in place for 72 hours after casting or until such time after the temperature peak of the concrete is reached as the Engineer may direct. The initial curing period in 3. (b)(i) above may then be reduced in proportion.

5. Air circulation shall be prevented as far as possible along the exposed faces of concrete during the curing period.

6. Joints which have to be filled with sealing compound, or surfaces formed as construction joints, shall be protected in a manner which will ensure that no curing compound is placed on the bonding surface and adjacent concrete and is to remain in place until the joint surface is sealed or for the periods specified.

7. All concrete shall be protected from anything likely to interfere with the process of setting. No load of any kind shall be imposed upon any concrete members after the removal of the struts until the concrete is thoroughly set and hardened and has reached the specified 28-day strength.

8. The surfaces of the concrete shall be. Protected from contamination of any sort for a period of not less than 30 days from the date of pouring.

9. Where curing compounds are used they shall be compatible with waterproofing or other materials that may subsequently be applied to the surface of the concrete.

308 REMOVAL OF FORMWORK

1. Notwithstanding the other clauses in this specification the responsibility for safe removal of any part of the formwork shall rest with the Contractor.

2. Strike formwork without disturbing, damaging or overloading structure.
If partial striking of formwork is required retain supports undisturbed as follows:

   (a) To soffit of beams where side forms is struck.

   (b) To slabs where soffit forms are struck.

3. Minimum periods for retaining formwork in position before striking to be set out in (a) or (b) below at the Contractor's discretion.

   Minimum periods for retaining formwork in position before striking to be as follows:

Type of formwork	Ordinary Portland Cement		Rapid Hardening Portland Cement	
	Average surface temperature of concrete (in °C)			
	7°C	16°C	7°C	16°C
Vertic formwork to columns, walls and beams	18 hours	12 hours	12 hours	9 hours
Soffit forms to slabs	6 days	4 days	5 days	3 days
SUDDorts to slabs	15 days	11 days	11 days	8 days
Soffit forms to beams	14 days	9 days	11 days	6 days
Supports to beams	21 days	15 days	16 davs	11 days

Increase the times given for 7°C for soffit forms and supports by 1/2 day for each day on which the minimum temperature is between 2°C and 7°C. Do not count any day on which the temperature falls below 2°C.

(b) Retain formwork in position until the minimum crushing strength exceeds both of the following:

(i) 10 N/mm2 for concrete in bending and 5 N/mm2 for all other concrete.
(ii) Twice the stress to which the member will be subjected at the time of striking.

The minimum crushing strength is to be the lower of the strength obtained from two 150mm cubes made from the same batch of concrete as the member and cured under the same conditions as the concrete in situ. The Contractor may propose alternative methods of establishing the strength of concrete for approval. All tests to be at the Contractor's expense.

4. Clean, make good and store to approval formwork that is to be re-used. Remove from the site struck formwork that is not to be re-used.

5. Re-propping will not be permitted.

6. After removal of formwork no remedial works shall be attempted until the Engineer has inspected the work. If, in his opinion, any defect cannot be made good satisfactorily he may direct the Contractor to replace such work at the Contractor's expense.

309 CEMENT MORTAR AND GROUT

1. Cement mortar shall, unless otherwise specified, consist of one part of cement mixed with three parts of fine sand by volume thoroughly mixed together with just enough water to achieve workability.

2. Grout shall consist of neat cement mixed with just enough water to let it run freely, in situations where it is possible and desirable .in the opinion of the Engineer to mix fine sand with the grout the proportions of sand to cement will be determined by the Engineer.

310 CONCRETE FINISHES

1. The type of finish required will be as follows:

   (a) Formed finishes not exposed to view in the completed works: Normal Finish Type B.
   (b) Formed finishes exposed to view in the completed works: Superior Finish Type C.
   (c) Unformed finishes to receive finishes/screed: Smooth Floated Finish SF.
   (d) Unformed finishes not exposed to view in the completed works: Power Float Finish PF.

   Prepare all samples as required by the Engineer of each type of finish described in this clause using the proposed method of construction for the job including plant, formwork, release agent, reinforcement, specified concrete mix and method of obtaining finish. Approved samples of finishes to be the control standard for all subsequent work.

2. Normal Finish Type B: No requirements as to finish except those for full compaction and tolerances.

3. Superior Finish Type C:

   (a) Produce an even finish with a sheet material (e.g. plywood).

   (b) Arrange panels in a regular pattern.

   (c) Blowholes not more than about 10mm in diameter will be permitted but otherwise surface to be free from voids, honeycombing and other large defects.

   (d) Variation in colour resulting from the use of an impervious form lining will be permitted but the surface to be free from discoloration due to contamination or grout leakage.

   (e) Tolerances for superior finish surfaces:

      i). abrupt irregularities: 3mm.

      ii). Gradual irregularities expressed as maximum permissible deviation for a1m straight edge: 5mm.

   (f) After inspection by the Engineer making good of - small defects will normally be permitted. Fill blowholes and form tie holes with a matching mortar to an approved sample unless otherwise instructed by the Engineer.

   (g) Projecting fins to be removed and rubbed down with carborundum stone but otherwise the finish is to be left as struck.

4. Smooth Floated Finish SF: use a hand float, skip float and suitable to receive specified finishes (if any).

5. Power Float Finish PF: use a power float to give an even surface with no ridges or steps, free from trowel marks and other blemishes.

6. Tamped Finish TF: tamp surface with edge of a board or beam to give an even texture of parallel ribs.

7. Surface Hardener:

   Areas of type PF Finish to be left exposed in the completed works shall receive an application of an approved proprietary chemical surface hardener in accordance with the manufacturer's recommendations.

8. Carry out all finishing operations at optimum times in relation to the setting, and hardening of the concrete. Do not wet surfaces of concrete to assist surface working. Do not sprinkle cement onto surface.

9. Where shown on the drawings type PF floated finish shall be further treated with a one pack polyisocyanate hardener, to be 'Rezex' PS14' by Con mix Ltd or equal and approved, brush applied a minimum of 3 days after placing concrete. Method and rate of application to be in accordance with the manufacturers recommendations.

311 TOLERANCES

1. All work shall be built true to line and level to a tolerance of ±6mm in any floor-to-floor height. All dimensions over 3m shall be true to ±6mm and those under 3m ±3mm. Columns shall not be more than 6mm out of plumb in anyone-storey height and shall not be more than 19mm out of plumb in the total height. These tolerances shall not be cumulative.

2. Tolerances for floors: sudden irregularities not permitted. Gradual irregularities expressed as maximum permissible deviation under

   a. 3m straight edge: ±:3mm.

      1 m straight edge: ±1 mm

   b. Tolerance about datum: ±12mm but applied in accordance with 1.0 above

312 PROTECTION OF CONCRETE

Prevent damage to concrete including:

1. Surfaces generally: from rain, indentation and physical damage.
2. Surfaces to be exposed in the finished work from dirt, rust marks and other disfiguration.
3. Immature concrete: from thermal shock, physical shock, overloading, movement and vibration.

313 SURFACE TREATMENT

1. Refer to the specification related to Below Ground Waterproofing / drawings.
2. Unless otherwise noted all the concrete elements below ground shall be applied with 2 coats of bituminous paint such as Masterseal420 HB by MBT or equal approved.
3. All concrete faces above ground on the building perimeter (wall faces, slab edges, beam sides) shall be treated as follows:
4. For concrete that is subsequently concealed beneath cladding, apply a single coat of water-based bitumen emulsion over the entire area, such as Masterseal410 by MBT or equal approved.

5. For concrete, which subsequently has a render, the render shall contain styrene butadiene co-polymer latex waterproofing admixture which also acts as a bonding agent, such as Rheomix 141 by MBT or equal approved. The concrete surface shall be prepared in accordance with the recommendations *of* the admixture manufacturer, but otherwise no surface coatings are required and as per Green Building Regulation.

6. Unless otherwise noted all above ground concrete (including soffit of slabs, walls, columns, facia units) shall be treated as follows:

   (a) All concrete, except that given below, shall be treated with a penetrating silanesiloxane primer overlaid by an acrylic protective and decorative coating which is UVstable, such as Deckguard S by Fosroc or equal approved. Colour to be selected by the Architect.

   (b) Roof deck to be treated with anti-skid waterproof coating in accordance with the Architectural specification

   (c) Floor surfaces to be treated as specified in the Architectural drawings/specification. Unless noted otherwise all the floors to be treated and finished suitably matching with the location and in conformity with the purpose (e.g. traffic coating, epoxy painting etc.), everything subject to the approval of the Engineer.

   (d) For concrete, which subsequently has a render, applied, the render shall contain a styrene butadiene co-polymer latex-waterproofing admixture, which also acts as a bonding agent, such as Rheomix 141 by MBT, or equal approved. The concrete surface shall be prepared in accordance with the recommendations *of* the admixture manufacturer, but otherwise no surface coatings are required.

400 TESTING CONCRETE

401 RECORDS

1. Complete correlated records must be maintained for each mix type, including:
   (a) Composition of the mixes tested, including any additives.
   (b All sampling and site tests;
   (c) Identification marks or numbers of all specimens tested in the laboratory;
   (d) The location of the part(s) of the works represented by each sample;
   (e) The location in the works of the batch from which each sample is taken;
2. Two copies of reports to be dispatched to the Engineer within one day of completion of each test. Keep a complete set of reports on site.
3. Test reports must include at least the following:
   - Test laboratory and name of person responsible for test. .
   - Title of project.
   - Identification mark or number
   - Date of casting
   - Curing place and conditions.
   - Date of receipt by laboratory.
   - Condition on receipt by laboratory, i.e. dryness, compaction, damage.
   - Actual dimensions.
   - Density (or weight).
   - Date of test.
   - Age when tested.
   - Confirmation of testing in accordance with BS 1881.
   - Failing load.
   - Strength.
   - Type of fracture.
   - Date of dispatch of report to Engineer
4. Keep separately the pieces of each test specimen, which fails to meet the compliance Requirements for individual results. Obtain agreement of Engineer before discarding.

402 TESTS ON CONCRETE TRIAL MIXES

1. Preliminary tests shall be carried out to determine that the trial mixes will satisfy the Specification, with the available materials.
2. Tests shall be carried out to determine the following properties of the mixes proposed for initial field trials.

   (a) Bleeding in accordance with ASTM C232,
   (b) Drying shrinkage in accordance with BS 1881.
   (c) Air content (where applicable);
   (d) Free water/cementitious + ratio;
   (e) Workability;
   (f) Wet and dry density.

   Should any of the values obtained in the above tests be in the opinion of the Engineer unacceptable the mixes shall be re-designed:

3. Three trial mixes using the proposed proportions shall be made on different days. A batch of six cubes and two beams from each mix shall be made. Three cubes and one beam shall be tested at 7 days and the remaining cubes and beams shall be tested at 28 days. The average 28-day strength of the three trial mixes shall not be less than the designed mean strength, subject to the conditions noted below.

4. Further trial mixes shall be made if the range, that is the maximum minus the minimum of the three cube results in any batch, exceeds 15% of the average of that batch, or if the range of the three batch averages exceeds 20% of the overall average of the batches.

5. Tests shall be carried out on these mixes to determine the following properties:

   (a) Bleeding in accordance with ASTM C232.

   (b) Air content (where applicable);

   (c) Free water cement ratio;

   Should any of the values obtained in the above tests be in the opinion of the Engineer unacceptable the mixes shall be re-designed:

403 SAMPLING AND TESTING FRESH CONCRETE

1. Samples shall be taken on site at the point of delivery. Test cubes shall be made, cured, stored, transported and tested to BS 1881 Parts 108, 111 and 116.

2. A sample of concrete shall be taken at random on eight separate occasions during the first five days of using a mix as set out in the table below Table A.

3. Thereafter one sample shall be taken at random for each class of concrete in accordance with the table below - Table B.

4. In addition to the above requirements, at lease one sample shall be taken from each individual structural unit or part of a unit, when the latter is the product of a single pour.

5. From each sample three cubes shall be made for testing at 28 days and three for testing at 7 days for control purposes.

6. The frequency of sampling may be required to be varied if directed by the Engineer.

7. The procedures shall be repeated when materials or design mixes are changed.

8. The results will be acceptable only if the conditions below are met:

   a. The average strength determined at the age of 28 days from any sample exceeds the Actual Characteristic Strength by 2N/mm^2.

   b. No individual result of the sample is less than the Actual Characteristic Strength minus 2N/mm^2.

   c. Only one sample is less than the specified characteristic cube strength.

9. If the above criteria is not satisfied, the unit represented by the sample is questionable and any or all of the following actions may be instructed by the Engineer at the Contractor's expense:

   a. Changing the mix.

   b. Improving quality control.

   c. Cutting and testing cores from placed concrete.

d. Non-destructive testing of placed concrete.

e. Cutting-out and replacing defective concrete.

10. If any individual 28-day cube strength from a sample exceeds the Target Mean Strength achieve in the trial mixes by more 6MPa then any or all of the actions listed above may be instructed by the Engineer at the Contractor's expense.

11. In the event cutting and testing of cores are required, cut cores from approved locations, and test them to BS1881 as modified by BS6089.

TABLE A. SAMPLING AND TESTING CONCRETE: FIRST 5 DAYS ONLY

Concrete mix type	Frequency of sampling	Number of test cubes per sample		Number of test beams per sample	
		To be Tested at			
C2 to C4	Minimum 8 per day	7 days	28 days	7 days	28 days
		1	2	-	-

TABLE B SAMPLING AND TESTING CONCRETE: AFTER FIRST 5 DAYS

Type of Structure	Sampling To Represent a Volume of Concrete (m3)	
	Cube Strength Tests	Flexural Strength & Durability Tests
Critical structures e.g. masts, cantilevers,columns		50
Intermediate structures e.g. Beams, slabs, waifs, piles		250
Heavy concrete construction e.g. breakwaters, solid rafts		500

404 FLEXURAL TENSILE STRENGTH TESTS.

1. Samples shall be taken and two beams cast to determine the tensile strength of the concrete at 7 days and 28 days, as specified in BS 1881 Part 118.

2. The samples shall be taken in accordance with the minimum test requirements for concrete in the Specification.

405 DURABILITY TESTS

1. Samples shall be taken in accordance with the minimum test requirements for concrete in the Specification and shall coincide with samples taken for test cubes. The concrete shall be tested for durability properties by undertaking absorption and permeability tests

as directed by the Engineer as directed below. (Refer to table 3.2 for performance requirements)

2. Chloride Permeability to ASTM C1202:

Type of Concrete	**Maximum Charge Pass (Coulombs) at 28 days**
Concrete OPC	3000
SF, GGBS, PFA & High performance Concrete	1000

3. Initial Surface Absorption to BS 1881 Part 5:

Type of Concrete	Maximum ISAT at 28 days: 10 minute test
Concrete generally	0.22 ml/m/sec
Silica Fume Concrete	0.15ml/m2/sec
Hydrophobic Pore Blocker Concrete	0.15ml/m2/sec

4. Water Permeability to DIN 1048:

Type of Concrete	Maximum Penetration (mm) at 28 days
Concrete OPC	15mm
SF, GGBS, PFA & High performance Concrete	8 mm

5. Minute Absorption to BS 1881 Part 122;

Type of Concrete	30 minute absorption
Concrete generally	2.0% at 28 days
SF, GGBS, PFA & High performance Concrete	2.0% at 28 days
Hydrophobic Pore Blocker Concrete	1.5% at 7 days

6. The concrete will be deemed to comply with the permeability requirements of this specification if all test results comply with the following:
   a. ISAT results for unprotected surfaces:
   b. Limit given in paragraph 3 above.
   c ISAT results for protected surfaces:
   One fifth of the limits for the unprotected surfaces.
   d. Rapid Chloride Permeability test results for unprotected surfaces; Limit given in paragraph 1 above.
   e. Rapid Chloride Permeability test results for protected surfaces:
   Charge passed should be less than 500 coulombs.

7. If any of the ISA T and the rapid chloride permeability test result of unprotected or protected surfaces of a sample failed to meet the above requirements, then all the concrete work represented by such sample shall be deemed not to comply with the permeability requirements.
8. If in the opinion of the Engineer, the concrete that has failed to meet the permeability requirements of this specification is like to cause durability problems, three cores shall be cut from the area represented by failed samples for additional ISAT and rapid chloride permeability testing. The Engineer shall decide the actual location.
9. The cost of cutting and testing cores and any resultant delay shall be borne by the Contractor regardless of whether the permeability of the deposited concrete proves to be satisfactory or not.
10. Where the permeability test results found by testing the three cores taken from the structure is confirmed as not complying with the permeability requirements, then the Engineer may instruct the further cores to be cut and tested in order to determine the full extent of the defective concrete and further investigations to be carried out.
11. Defective concrete shall be cut out and replaced, or alternative remedial action shall be taken, as the Engineer directs, and the cost of such work and any resultant delay shall be borne by the Contractor.

406 OTHER TESTS

1. Where required, submit to the Engineer for approval the proposed methods for complying with the creep stain criteria of the performance requirements of the Specification. These shall include, but are not limited to:
   a. Tests to establish the strength of the concrete and the static modulus of elasticity of the concrete to BS 1881: Part 121 at 7 days, 28 days, 3 months and 6 months.
   b. Sufficient tests shall be undertaken to allow an accurate assessment of the creep strain to be made prior to, and during the concreting operations. These tests shall only cease when directed by the Engineer.
2. When instructed by the Engineer concrete shall be tested for drying shrinkage and wetting expansion, for which 75 x 75mm prisms shall be prepared and tested in accordance with BS 812 Part 120. The maximum acceptable limits shall be:
   a. Drying Shrinkage : 0.05%/0; 04%.
   b. Wetting Expansion : 0.03%
3. Cubes may be required and trials carried out to determine stripping times for formwork, the duration of curing and to check testing and sampling errors.
4. The air content of air entrained concrete shall be determined in accordance with ASTM C231 for each batch produced until consistency has been achieved when one in five batches may be tested. The maximum value shall not exceed 2%.
5. Compaction factor, slump, Vebe or other workability tests shall be carried out as required during concreting of permanents Works to control workability at the batching pant and at the site of the pour. For each sample the temperature of the concrete shall be measured and recorded with the time the test was performed. The degree of workability shall be as for the trial mixes; permitted tolerances shall be in accordance with BS 5328.

407 DEFECTIVE CONCRETE

1. The action to be taken in the event of non-compliance of test results with the Specification, including but not limited to cube strength results, shall be determined by the Engineer and may range from qualified acceptance to rejection and removal of all or part of the affected works as described in 403(9).
2. Provide all records, samples, including core samples, tests and their results as may be required by the Engineer, whether the concrete be finally accepted or not.

408 WORKABILITY

1. As a check on the workability and uniformity of concrete mixes, compacting factor or slump tests shall be carried out daily.
2. Samples for the tests shall be taken at least once daily, and the tests shall be carried out on each sample without delay, in the presence of the Engineer or his representative. If more than 3 out of 20 consecutive results fail to fall within the tolerances of compacting factor (or slump if appropriate) specified in paragraph 4 of this Clause, mixing shall be stopped and the necessary adjustments shall be made before work restarts.
3. Additional tests shall be carried out on all batches from which test cubes are made.
4. The workability of the concrete shall be within the following limits as appropriate:

(a) Slump ±25mm or ±1/3 of the specified value, whichever is the greater

(b) Slump (sample taken in accordance with BS 1881: Part 101)

Specified value	Tolerance
25mm	+35mm -25mm
50mm	:t35mm
75mm and over	:t(1I3 of specified slump + 10mm)

Limits for intermediate slumps shall be found by interpolation.

(c) Compacting factor:

±03 where specified value is 0.90 or greater
±04 where specified value is less than' 0.90 but more than 0.80;
±05 where specified value is 0.80 or less.

409 SURFACE ACCURACY

1. The finished surface of the concrete shall conform to the levels and contours shown on the drawings.

2. The surface accuracy including accuracy across joints shall be as specified below when the straightedge is placed unsupported on the surface, anywhere in any direction.
3. Notwithstanding the above, a continuous longitudinal depression in excess of two bays in length and of a depth, which will hold water, is not acceptable.
4. Mark with red paint all areas, which fail to pass the test for cutting out and replacement as specified in Clauses 409 and 410.
5. Local isolated high spots may be removed by scoring as described in Clause 411.
6. If the Contractor fails to meet the specified requirements for surface accuracy in any two consecutive days work all concreting work shall stop until the spreading, compacting and finishing processes have been checked, the cause of the failure has been established and corrections have been made to the satisfaction of the Engineer.
7. Refer to Clause 311 of this section for permissible tolerances

410 CUTTING OUT CONCRETE

1. When concrete is cut out it shall be removed for the full depth of the slab. The area to be cut out shall extend across the full width of the cast bay.
2. Care shall be taken to ensure that all concrete remaining in the vicinity of cutting-out is sound and without fracture.
3. The exposed edges of the adjoining bays or sections shall be trimmed to a vertical and reasonably fair face.

411 REPLACEMENT OF CONCRETE

1. The replacement of concrete cut out as specified in Clause 410 shall be carried out in accordance with the foregoing Clauses.
2. If the separation layer is damaged it shall be replaced as specified in Clause 212 with Minimum laps of 75 mm.
3. The approved mix shall be spread and compacted and finished to the surface accuracy Specified in Clause 409.

All areas to be scored shall be scored transversely by a single pass of a cutting drum incorporating not less than 50 number 3 mm wide equally spaced circular segmented diamond saw blades per 300 mm width of drum. The drum shall be set to give a 3 mm depth of cut. It shall be mounted on a multi-wheeled articulated frame with outrigger wheels, designed to give a uniform depth of scoring over the entire surface.

500 PRECAST CONCRETE

501 SCOPE OF WORKS

1. Precast Concrete work shall consist of furnishing all materials and constructing structures of the forms, shapes and dimensions shown on the Drawings or as directed in accordance with the details shown on the Drawings and these Specifications.
2. Precast Concrete shall generally follow the provisions of this Section for Cast-in-Place Concrete and shall be manufactured off-site in a facility adequate for the purpose and relevant sections of the Architectural Specification. The particular material, finish and manufacturing requirements of Architectural Specification should also be considered.

502 GENERAL

1. Comply with pertinent provisions *of* the Conditions of Contract
2. Prior to starting work on the contract submit for approval details of the proposed sources of all materials, and place *of* manufacture, together with full documentary evidence that the materials and manufacture will comply with the specification. .
3. Further submissions shall be made for any change *of* material quality or source and the Engineer's approval obtained before the new materials or place *of* manufacture are used.

503 MATERIALS

1. Comply with pertinent provisions *of* the Conditions of Contract
2. Materials shall be obtained from suppliers operating quality systems in accordance with either ISO 9001 or an in-house system approved by the Engineer.

504 DELIVERY, STORAGE & HANDLING

1. Comply with pertinent provisions of the Conditions of Contract
2. When elements are stored, either in the place *of* manufacture or on site, they shall be supported at such bearing positions as will ensure that any stresses induced in the elements are always less than the permissible design stresses. Avoid bearing on elements, which will be exposed to prevent discolouration of exposed surfaces.
3. Elements shall be handled or supported only at the points described on the working drawings and shall be handled and placed without impact

505 CONCRETE

1. Concrete generally shall be in accordance with this Section for Cast-in-Place Concrete.
2. For exposed faces, constituent materials must be carefully controlled to ensure Consistency of colour and appearance. Aggregates must comply with the relevant parts *of* the section specification and must be free from absorbent materials or other particles such as coal or iron sulphide that may cause unsightly staining. Refer to the

Architectural Specification for particular aggregate specification for Architectural precast panels.

506 CAST-IN ITEMS

1. All cast in items for handling and lifting, and all fixings and restraints shall be grad 315 (marine grade) stainless steel. Care shall be taken to prevent bi-metallic reaction between stainless and mild steel.
2. Cover spacers may not be used on exposed faces with specialised finishes (exposed aggregate, polished, etc.)

507 DRAWINGS

1 The Contract Drawings indicate the location, sizes and structural requirements of the precast elements. The Contractor will design the elements for all permanent and temporary loads and submit calculations and shop drawings for the Engineer's approval.

Shop drawings shall show the following:

(a) Location of each unit in the completed structure.

(b) Dimensions of each unit including holes, irregularities and thickness of facing unit.

(c) Reinforcing details, including grade of reinforcement.

(d) Concrete strength and details of any admixture proposed.

(e) Joint clearances and clearances between units and structural building framework.

(f) Completed connection and insert details including materials, size and length of, welds

(g) Identification mark, finish designation number and location of each precast unit.

(h) Location and details of lifting and handling points.

(i) Erection sequence and any special handling instructions or bracing required.

(j) Joint sealant details.

(k) Special precautions to be taken by other trades affecting work of this Section.

2. All lifting devices shall be designed for all loads by lifting and placing plus an additional allowance for impact of 100%
3. Moulds shall be constructed from materials that shall ensure a consistency of appearance on all exposed surfaces. Casting surfaces and profiles for features shall be checked and replaced whenever necessary. The proposed construction of moulds and number of uses shall be submitted for the Engineer's approval.

508 CASTING

1. Construction will not normally be allowed on a precast element. Where the element can not be cast in one operation, submit details of construction joints for the Engineer's approval.
2. Refer to relevant Architect's drawings for details of surface finishes.
3. Dimensional Tolerances in casting should comply with pertinent provisions of this section for concrete.
4. Curing by high pressure steam, steam vapour or other accepted processes may be used to accelerate hardening or striking times with the Engineer's approval.
5. No elements shall be cut, drilled or chased without the Engineer's approval.
6. The precast elements shall be protected at all stages of manufacture, handling and storage and also during and after erection on site.
7. Units shall be indelibly marked during manufacture in a place, which not show on finished elevations as follows:

   (a) Location or identification mark shown on Contractor's working drawings.
   (b) Date of casting
   (c) The way up for handling, transportation and building into the Works
   (d) Lifting points
   (e) Repairs will not permitted without the Engineer’s prior approval, either at the point of manufacture or on site.

509 QUALITY

1. The Engineer shall be afforded the facility to inspect and workmanship at any time during the manufacture or installation of precast elements and shall have the right to reject any unit for reasons including (but not limited to) any of the following:

   (a) Broken edges, whether the reinforcement is exposed or not
   (b) Cracks, other than hair cracks (cracks defined as being less than 0.1mm wide)
   (c) Unauthorised repairs
   (d) Inadequate or no cover to reinforcement
   (e) Failure to comply with Architect's requirements for finishes

2. Rejected units will be clearly and indelibly marked, removed and replaced at the Contractor's expense.

   Testing shall comply with pertinent provisions of this specification for concrete

510 ERECTION

1. Precast elements shall be erected to the lines and levels shown on the drawings. Where elements are bedded in mortar or where in-situ joints are made after installation, such work shall be carried out to details shown on the Contractor's working drawings.
2. The elements shall be lifted and supported in the final position both temporarily and permanently, in such a way that they shall be stressed only in the manner for which they have been designed.

3. The units shall be adequately braced and supported during erection to ensure correct alignment and safety and such bracing and support shall be maintained until adequate permanent connections have been made.

511 DIMENSIONAL TOLERANCES IN ERECTION

1. Unless specified otherwise, the precast elements shall be erected or located such that each surface edge or corner of a unit shall be not more than the following distance from its true intended position in space:

   (a). 8mm for units more than 1m overall in any direction

   (b). 10mm for units more than 1m but not m ore than 6m overall in any direction

   (c). 15mm for units more than 6m in any direction

2. In addition to the above, each surface, edge or corner shall not be more than 3mm from its true position in space relative to the corresponding surface, edge or corner of the adjacent units or units.

3. Any or all the above requirements may be varied by the consultant if the position of the units is not suitable for structural reasons. for reasons of appearance or for the proper assembly of the unit or other adjacent units or components.

   In addition, notwithstanding any tolerances stated in this clause or in clause 8 or stated or implied elsewhere in this Specification, when the precast units have been erected the resulting structure shall also meet the requirements for dimensional tolerances stated in Clause 311.

   Unless otherwise specified the initial camber to be limited to a maximum of 8mm.

512 TRIAL ASSEMBLIES

Where units are to be erected together to form a larger unit arrange a trial assembly to verify the suitability of erection methods and tolerances.

700 SLIPFORMED CONCRETE

701 SUMMARY

1. Slipformed concrete shall be concrete that is cast in either continuously rising forms or intermittently rising forms. This specification does not cover the slipforming of pavements.

2. All slipforming operations, including the provision of temporary works and slipforming equipment, shall be carried out by a specialist organisation experienced in such work and approved by the Engineer. Supervisors and labour shall be experienced in slipforming operations and approved by the Engineer.

3. Pertinent provisions of this section affecting work shall be followed as well as all good practices subject to the satisfaction of the Engineer.

4. Prior to starting work on the contract, the Contractor and the specialist organisation responsible for the slipforming operations shall attend a meeting with the Engineer to explain in detail their proposals. At least 14 days before the meeting provide the documents as per the following clauses:

5. A comprehensive Method Statement complete with drawings and diagrams fully explaining the proposed procedure and including the following information:

   a) Proposed minimum, average and maximum rates of slide.
   b) Proposed type, number, capacity and output of mixing and batching plant.
   c) Proposed concrete mix, formwork materials and finishing techniques and method of Curing.
   d) The numbers and deployment, by trades, of the workforce on each shift.
   e) Suitably dimensioned plan showing the location of all items of plant and equipment relative to the working area on the site generally.
   f) The programme for the slip forming operation.
   g) Details of measures to be taken in the event of cold or inclement weather.
   h) Details of measures to be taken in the event of hot weather.
   i) Details of proposed services.
   j) Health and Safety statement by Contractor with defined safety procedures.
   k) Quality Assurance procedures.

6. Drawings showing full details of the slip forming equipment, including the following information:

   a) Fully detailed drawings showing the arrangement of the forms, yokes, jacks, working platforms (indicating use and design loading) and plan bracing. The details shall include redundancies for all of slip forming operations. They should clearly show that the failure of an element such as a jack, bracing or similar will not cause the failure of the working platform and will not unduly limit the progress of the form.
   b) Plans showing the disposition of the jacks, pumps and hydraulic systems at all levels, together with specifications for the equipment comprising the jacking system.
   c) Details of stop ends, box outs and openings.
   d) Details and written proposals of the procedure where the shutter is to be adapted to accommodate a change of section.

702 QUALITY ASSURANCE

1. Comply with pertinent provisions of this Section.
2. Implement and operate a Quality Assurance System for all stages of the work. The Contractor shall have internationally acceptable accreditation to the approval of the Engineer.

703 PRODUCTS

1. Comply with pertinent provisions of this Section plus the following for aggregates and admixtures subject to review and approval by the Engineer.
2. Aggregate for use in continuously rising forms shall have the following properties:
3. Coarse aggregate shall be rounded. Harsh, angular aggregates shall be avoided.
4. Fine aggregate shall have a "soft" sand grading.
5. An appropriate retarding agent approved by the Engineer may be used for construction during hot weather. .

704 SLIPFORMING EQUIPMENT

1. The shutter shall be rigidly fixed together and braced in plan to maintain the lines and dimensions shown on the drawings. The shutter shall be de-bonded from the concrete with an approved de-bonding agent. The de-bonding agent shall not adversely affect the adhesion of subsequent concrete surface treatments.
2. The form panels shall be of timber or insulated steel and shall be slightly tapered to ensure release from the concrete as movement takes place.
3. Yokes shall be welded or bolted steel construction, and capable of satisfactorily transmitting he jack forces to the forms and working platforms.
4. External corners which will be exposed when the work is complete shall be formed with a 20mm x 20mm chamfer.
5. The shutter shall be designed to accommodate any changes in section shown on the drawings, safely and efficiently.
6. The design of the shutter shall be such as to permit safe and efficient dismantling and removal on completion.
7. The system shall be provided with a means of determining and controlling level over the entire form.
8. Suitable means of adjusting the rate of slide and plumb of the shutter shall be provided.
9. Suitable means of adjusting the forms shall be provided.
10. Hydraulic Jacks
    a) Jacks shall be hydraulically operated acting on steel jacking rods. The stroke of the jack shall be adjustable to ensure even lifting of the forms in small increments. The jacks shall be proven reliable and capable of lifting at least twice the calculated loads. Test certificates for all jacking equipment shall be

submitted to the Engineer for approval. The test certificates shall not be older than one month at the time of their submission.

b) Where jacking rods are removed, the tubes remaining shall be grouted up to the satisfaction of the Engineer. Sealing shall not be adopted as an alternative.

c) Hydraulic pumps shall be electrically operated using mains power.

d) Hydraulic oil shall be of a type which is not injurious to concrete. Unset concrete contaminated with hydraulic oil shall be taken out of the shutter. Reinforcement contaminated with hydraulic oil shall be cleaned or replaced.

11. Access

a) Working platforms shall be sheeted where necessary and shall be fitted with proper handrails and toe boards. Where hanging platforms are suspended with chains, the chains shall have been tested and certificates made available to the Engineer.

b) Suitable access towers shall be provided. Fixing for these towers may be cast into the concrete as work proceeds.

12. Standby Equipment and Materials

a) A standby pump, standby jacks and replacement components shall be provided for all items included in the hydraulic circuit. They shall be kept on the slip form and made available at all times.

b) Demonstrate to the Engineer's satisfaction that adequate spare supplies and contingency plans for all materials and equipment are available to ensure that the slipform is not interrupted.

c) An alternative source of concrete shall also be arranged. Sundry Items

d) Where approved by the Engineer, cast-in fixings and holding down bolts may be cast accurately into preformed pockets or installed by some other means after completion of the slipforming.

e) Carry out a survey of the fixings and bolts. This information shall be passed to the Engineer for approval and subsequently to other Contractors to enable them to make their own arrangements to suit the as-built conditions.

705 ACCURACY

1. In addition to the requirements of this Section, the accuracy of the work shall also be within the following limits:

(a)	Overall dimension of any pocket, opening or box out, not subsequently filled with concrete:		±10mm
(b)	Horizontal position of any encast item, pocket or box out (relative to main setting out lines).		±10mm
(c)	Top of any wall, vertical location of any encast item, pocket, opening, box out, or keyway and reinforcement for future construction, relative to datum.		±10mm
(d)	Rotation around circumference	- in20M	±10mm
		- over full height	±25mm

2. Particular attention shall be paid to accurate positioning of encast items to minimise the need for shims/packs when fixing to the encast items.
3. Where the Contractor considers that the proposed method of construction is not sufficiently accurate to accommodate the work of other trades, bring the matter to the attention of the Engineer and submit to the Engineer for approval, detailed proposals for overcoming any discrepancies.

706 CONCRETE MIX SPECIFICATION

1. Comply with pertinent provisions of this Section.
2. The mix design shall take account of the special features of the construction method. Including:
    a) Friction between shutter and concrete.
    b) Rates of setting and hardening, with regard to rate of slide.
    c) Surface finish specified.
3. Trial Mixes
    a) Prior to commencement of slipforming, a mix permitting the agreed rate of slide by test or otherwise shall be submitted to the Engineer for approval. A range of mixes for various ambient conditions may be required.
    b) If necessary, adjust the mix proportions or the dosage of admixtures or the temperature of the materials in order to maintain the agreed setting time. All such adjustments are subject to the Engineer's approval.

707 MIXING PLANTS

1. Concrete shall be batched and mixed in accordance with the pertinent provisions of this Section
2. The rated output of the plant shall be at least twice the volume required to maintain the stated rate of slide.
3. Stand-by batching facilities shall be provided to maintain a minimum rate of slide.

708 PREPARATION AND PERMISSION TO CONCRETE

1. Comply with pertinent provisions of this Section.
2. As a minimum requirement, preparations for concreting shall follow the guidelines below:
3. A shift system shall be operated. Shift changes shall be organised such that personnel do not leave the working areas before their relief arrives.
4. The following minimum supervision shall be provided on each shift:
    a.) Rig master
    b.) Foreman Carpenter
    c.) Foreman Steel fixer
    d.) Ganger - Concrete and Other Operations
5. Office
    a) A site office shall be provided solely for the purpose of administering the slipforming operation, located not more than 20m from the foot of the works to be

Slipformed and shall be manned at all times by the Rig master or suitably qualified nominees, during slipforming operations.

b) Telephone links shall be provided between the working platform and the slide office and the Contractors main office.

c) Radio links shall be provided between the Rig master, Foreman, Engineers, Tower Crane and Mixer Drivers.

6. Safety

a) Adequate fire-fighting equipment shall be provided. Fire extinguishers shall be provided on the working platforms.

b) First Aid facilities shall be available on the working platforms and in the Slide Office.

709 TRANSPORTING, PLACING, COMPACTING AND CURING

1. Comply with pertinent provisions of this Section.
2. Wherever possible, the concrete shall be delivered from the mixer to the forms in one operation by means of a crane or a concrete pump. Where a crane is used, it shall be used solely for concreting and another means of lifting shall be provided for lifting other materials and for general duties. Craneage for concrete delivery shall be located to minimise handling times. Make provision for alternative hoist delivery of concrete in case a single crane is out of operation. Where a concrete pump is used, a standby pump of the same output shall be available at all times in case of breakdown.
3. The concrete shall be discharged directly into the shutter not more than 1.5m from where it is required and in such a manner that no segregation occurs. Purpose-made chutes, funnels and tremmies used in conjunction with specially designed skips may be necessary to achieve this. Concrete shall not be placed manually without the prior approval of the Engineer.
4. Concrete shall be placed evenly over the slipform section in layers no greater than 200mm thick and to suit the rate of sliding. The forms shall at all times be filled to within 300mm of the top of the shutter during the slipforming operation.
5. Particular care shall be taken to ensure that concrete that is placed under box outs and around encast items is adequately compacted.
6. The top 220mm of the forms shall be cleaned continually of adhering grout, which may otherwise damage the setting concrete, impair the finish and hinder the fixing of embedded items. Sufficient standby vibrators shall be available for use throughout the slipforming activity.
7. If a stoppage is absolutely unavoidable, for example due to a breakdown of all concrete mixing plant, the following procedure shall be adopted:

(a) The concrete in the forms shall be thoroughly compacted and leveled.

(b) The forms shall continue to be raised at reduced speed (but not so slowly as to cause binding) and with great care. They shall be raised until the batter on the form has just broken bond with the concrete without causing an appreciable lip when concreting is recommenced.

(c) The form shall then be cleaned off.

(d) Where watertight construction is required, a galvanised steel water bar of 1S0mm x 3mm shall be inserted into the concrete surface before the initial set has taken place at positions agreed by the Engineer.

(e) The aggregate in the top surface of the concrete shall be exposed by wire brushing and hosing whilst the concrete is still green.

(f) The top surface of the concrete shall be thoroughly cleaned off before slipforming is restarted using normal procedures which shall have been previously approved by the Engineer.

(g) Provide for the approval of the Engineer a method statement for the restart of the slip form in the event of stoppage. The method statement shall be concise and rigorous to ensure any restart 'in done in accordance with current good working practices.

8. Immersion vibrators shall be inserted into the previously compacted layer of concrete to a sufficient depth to cause the layers to knit together whilst not disturbing the setting concrete below. The vibrators shall be powered by electricity or compressed air.

710 FIELD QUALITY CONTROL

1. Comply with pertinent provisions of this Section.
2. Concrete samples for testing during slipforming shall be taken directly from the supply. The samples shall be stored under conditions such that their temperature does not deviate by more than 2.SoC from the ambient temperature measured on the slipforming deck.
3. Survey Checks
   a) Provide suitable means of checking the accuracy of the work as it proceeds, and of making adjustments to the line where necessary.
   b) Plumb shall be checked, using optical or other suitable instruments, against previously established survey stations at the foot of the slide.
   c) Level shall be checked using tapes fixed to the working platform, which unwind as the slide proceeds. Clamp plates shall be fixed to the wall to anchor the tapes, at centres not exceeding S metres. If possible, tapes should be fixed inside the structure to eliminate wind effects. An optical level shall be used to transfer datum marks to the climbing tubes if used.
   d) Submit proposals for checking the accuracy of the work and obtain the Engineer's approval of these proposals prior to commencement of the slipform.
   e) All necessary equipment for making survey checks shall be made available to the Engineer's staff, as required, along with the necessary access to the survey stations and working areas.
4. Records
   a) Keep proper records of the work as it proceeds.
   b) These records shall be submitted to the Engineer for approval and as a minimum shall include:
      i. Diary of events during slipforming
      ii. Cube strength results
      iii. Concrete mixes used - cement content, admixtures and dosage

iv. Air temperature
v. Rate of climb of slip form, stops and measures taken
vi. Method of curing
vii. Fallouts, remedial measures
viii. List variances from drawings or Specification where they occur

5. Where the Contractor considers that the slip form, or part of the slip form equipment, is not adequate during erection, notify the Engineer and submit detailed proposals for rectification of the defect to the Engineer for approval.

711 REINFORCEMENT

1. Comply with pertinent of this station.
2. Bar laps shall normally be staggered.
3. Submit proposals for maintaining the correct cover and location of the reinforcement to the Engineer for approval.
4. Horizontal bars shall be tied to vertical bars or otherwise held place (but not welded) to ensure location and cover.
5. Particular care shall be taken to ensure that the reinforcement is guided into its correct position. Through-wall U-bars or similar devices shall be provided to tie together the wall reinforcement on both faces, spaced at sufficiently close centers to provide the specified cover within a tolerance of plus or minus 5mm.

712 FORM WORK

1. Comply with pertinent provisions of this Section.
2. Stripping time
   a) The concrete emerging from the shutter shall be inspected at a minimum of 1 hour intervals, both inside and outside, to determine stripping time, and hence the rate of slip forming. The concrete emerging shall be self-supporting and firm to the touch. If the concrete is wet and soft, the slip form shall be slowed down. Conversely, if the concrete is hard and dry the slide rate shall be increased.
   b) Adjust the rate of slide as required to satisfy the Engineer as to the structural stability of the green concrete.

713 CLASSES OF FINISHES

1. Comply with pertinent provisions of this Section.
2. Ensure that the concrete mix, formwork, materials and working techniques will specify finish to be achieved to the satisfaction of the Engineer.
3. Formed Surfaces
   (a) Class F2: Normal finish for exposed surfaces unless specified otherwise.
      i) The finish shall be achieved on trial panels, which shall be approved by the Engineer before slip forming commences.
      ii) The finished concrete shall be thoroughly compacted and all surfaces shall be true with clean arrises. Only minor (less than 3mm diameter) surface

blemishes shall remain and the surface shall have a uniformly even texture and colour to achieve the required finish.

iii) This finish may be obtained by rubbing off with polystyrene blocks by using stiff brushes or by other methods which the Contractor may propose, based upon previous experience. The finishing work shall be carried out continuously on the freshly exposed concrete immediately below the shutter.

(b) Class F3: Superior finish for exposed work. This finish is to be provided where specified.

i) The finished concrete shall be thoroughly compacted and all surfaces shall be true with clean arrises. Only very minor surface blemishes shall remain and the surface shall be smooth, with a uniform even texture and colour.

ii) This finish may be obtained using techniques such as trowelling/floating with a steel tool and smoothing with a soft brush and wet sponge.

iii) An acceptable finish shall be demonstrated by the Contractor on a trial panel and approved by the Engineer before slip forming commences.

4. Unformed Surfaces

(a) Comply with pertinent provisions of this Section.

(b) When the final level of the concrete is reached, ensure that the unset concrete at the top is not damaged by continuing movement of the forms

(c) Submit proposals to the Engineer for approval, to demonstrate that the finished work will be sound and constructed to the lines and level shown on the drawings.

5. Remedial Treatment of Surfaces

(a) If necessary to achieve the required finish, minor surface blemishes such as blow holes shall be filled with a sand cement mortar paste, made with the same mix constituents proportioned as the original concrete mix, excluding coarse aggregate, to a suitable consistency

(b) Wherever possible, any remedial work necessary shall be carried out in accordance with the approved repair methods, from the finishing platform as the slide progresses in order to alleviate access difficulties later.

(c) The Engineer shall be informed promptly of defects requiring attention, to facilitate inspection and approval of repair methods prior to commencement of work.

(d) The Engineer shall also be provided with access to inspect all remedial works after completion.

(e) Any small fallout shall be trowelled back immediately. If a significant number of fallouts occur, the cause shall be determined and modifications made to the procedures with the approval of the Engineer.

BLOCKWORK

4.1 General

All blocks. Either hollow or solid, shall he manufactured strictly in accordance with the specifications of Dubai Municipality Local Order No.44 of 1990 for concrete blocks.

4.2 Cement and Water

The cement and water shall be as described in the "Concrete Work" Section.

4.3 Sand

Sand shall be clean, sharp and free from salt and organic matter. it shall comply with BS. 1200. The chloride and sulphate contents of sand shall not exceed the limits given for aggregate in the "Concrete Work".

4.4 Water-reducing Admixture

A liquid admixture based on selected Iignosulphol13tc5 and complying with BS 5075: Part 1 is to be incorporated in all mixes for precast concrete blocks. It shall be obtained From: 10 .approved .manufacture and beaded to the mix in the manner and proportions Recommended by the manufacture.

4.5 Precast Concrete Blocks

The precast concrete solid or hollow blocks shall he manufactured from" mix of 250kgs of Portland Cement to 1500kg5 of sand (maximum 10mm. diameter) in approved vibrating machines.

If, for any reason, the strength requirement given below is not achieved, the cement/sand ratio shall be adjusted. The water used in the mix sha1I be clean and of sufficient quantity to allow complete hydration of the cement without providing an excess when moulding.

The concrete blocks shall be hard, sound, sharp, and clean, of rectangular shape with well defined: arises and free from cracks and flaws or other defects.

Concrete blocks may he obtain from an approved local factory or manufactured on the site manufactured on site, the blocks shall be press moulded in approved moulds using a vibrating pressure machine with: 1 minimum of 2800 cycles per minute. Blocks from the same source shall be used throughout the works.
The approva1 or the Engineer must he obtained prior to any change of supplier.

Prior to manufacture the Contractor shall prepare ten samples of each type of block for the Engineer’s approval; the approved samples shall be clearly marked and retained until completion of the Contractor.

The blocks manufactured on site shall be cured in the shade and kept thoroughly moist. . With water applied by sprinklers or other approved means for a period of at least seven days. The blocks shall be stacked on a clean and level platform free, from earth or other impurities during the curing process and shall be stacked in honey-comb 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.

The concrete blocks (solid or hollow) shall be of the following dimensions:

- Height - 200mm +/-2mm Tolerance
- Length - 400mm +/-2mm Tolerance
- Width - (as required) +/-3mm Tolerance

The nominal width of blocks shall be as indicated on the drawings.

The concrete blocks shall comply with the following requirements.

1. Compressive Strength at Twenty Eight Days

Hollow block	>	7.5N/mm² average of 10 blocks (For Non Load Bearing Wall)
Solid block	>	12.5N/mm²average of 10 blocks (For Load Bearing Walls)
Hollow blocks	>	6.0N/mm² minimum for any block
Solid blocks	>	10.ON/mm² minimum for any block

2. Water Absorption: (TO ASTM CI40175 & ASTM C145175)

20 % or less of dry weight

The design of the cavities and webs of the hollow blocks shall be submitted to the Engineer prior to manufacture. The thickness of the face shell and of the membrane of solid portions shall not he less than one quarter of the width and length of the block respectively.

Blocks below damp proof course level sha11 he solid sulphate resisting concrete blocks, or shall be solid blocks coated with thick black bitumen or tar composition unless otherwise stated.

Blocks sha11 comply with the requirements of nSG073 (r & II) unless otherwise stated herein.

4.6 Mortar

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

Cement mortar shall be used within thirty minutes after mixing. Hardened mortars shall not be used in the work and shall be removed immediately from the site on the request of the Engineer. Mortar shall be prepared in the following proportions with the addition of the minimum quantity of water for workability.

Cement and sand mortar (1:3)' shall be composed of one: part of cement to three parts of sand by volume. This type of mix shall be used in blockwork only where high strength is required.

Cement and sand .mortar with plasticizer (1:4) shall be composed of one part of cement to four parts of sand with the addition of an approved plasticizing admixture complying with

BS:4887. The proportions of the mortar mix shall be adjusted in accordance with the manufactures recommendations. This type of mortar shall be used for external wal1s, internal partitions and, with the use of sulphate resisting cement, work below ground in contact with earth.

4.7 Workmanship

Set out and build all blockwork to the lengths, thicknesses and heights shown on the, drawings and/or instructed by the Engineer in writing.

All walls and partitions shall he built in hollow concrete blocks, unless specifically stipulated otherwise in the documents.

All blocks shall be well soaked before being used and the tops of walls left off shall be Wetted before work is restarted.

All blocks shall be spread with the appropriate mortar before being laid and all joints sha1l be thoroughly flushed up as the work proceeds. All joints shall be uniform and shall not exceed13mm. The blockwork shall be built up in a uniform manner, no one portion being raised above another by more than 1000mm at any one time, any wall or partition necessarily left at different levels must be racked back. All perpends, internal and external angles, etc., shall be kept strictly true and square and the whole properly bonded together and leveled round at each floor.

All blockwork shall he plumbed vertically and surface of the walls or partitions to receive plastering or rendering shall have the joints raked out 20mm from the face of the wall to form a key.

All block works shall be bonded to adjacent reinforced concrete structures by means of wall ties complying in all respects with BS 1243. The ties shall be installed at 500mm centers and be a minimum 200mm long of which 100mm shall he embedded in the reinforced concrete structure and the remainder set into the blockwork.

Partitions shall be bonded to main walls by tooting at every fourth course into main walls to a depth of not less than 100mm

All walls and partition shall be properly cured by sprinkling water for a period of not less than three days after completion of' laying.

Walls and partitions terminating against soffits of beams or slabs shall be lightly wedged with metal wedges after mortar in bed joints has attained its initial set and the joint packed with 12mm thick compressible joint filler.

Cut and fit blockwork next to door and window jambs and sills, and form chases for the end of door and window lintels. No bollow block shall a but any built in fixtures, e.g. door and window frames, apertures, louvers, etc.

Where blockwork is described as fair faced, selected hard, sharp clean blocks shall be used with well defined arises and of a perfectly rectangular shape, free from all cracks, flaws or other defects. No marred blocks whatsoever will be allowed in fair faced work. The joints shall he finished off with near flush pointing, taking care to keep mortar from adhering o

any part of the block.

4.8 Compressible joint Fillers

"Flex cell" obtainable from Expedite Ltd, Chase Road, London, N.W.10, England, shall be used where specified at joints indicated on drawings or as requested by the Engineer.

Filler shall be cut to exact widths and shall have all edges neatly trimmed.

Exposed edges of filler shall be pointed in Secomastic/Seelastik manufacture by Expandite Ltd, Local Agent Specialties Co. Dubai or other equal and approved sealant used strictly in accordance with the manufacture printed instructions.

4.9 Damp Proof Courses

Damp proof courses shall be tropical quality bituminized fiber felt to comply with BS 743 type 5B and be provided under every block wall at ground bearing slab level, and elsewhere as indicated on the Drawings or as directed by the Engineer. The damp proof course shall be well lapped at corners and joints and bedded in the cement mortar mix and pointed both sides.

4.10 External Pointing of Joinery or Metalwork

Joinery or metalwork shall be pointed externally in standard grade "Seelastik" as manufactured by Expandite Ltd., 1-9 Chase Road, London N.W 10 6PS England, or other equal and approved used strictly in accordance with the manufactures painted instructions.

4.11 Cramps for Fixing Timber Frames, etc.

See Metalwork Sections.

4.12 Cavity Wall Construction

Cavity wall construction shall be generally as detailed on the drawings consisting of two layers of block masonry with insulation infill to approval.

The cavities shall be free of all mortar droppings, debris, concrete or any organic material. Insulation shall be fixed in position with approved non-ferrous fasteners.

The two block wall layers shall be bounded with stainless steel non-corrosive wall ties (Butterfly or any other approved type) at a minimum of two ties/m^2 area spaced one meter apart horizontally and approx. 400mm apart vertically and staggered. Extra will be provided at reveals, quoins and openings.

ROOFING

5.1 Roofing System

The roofing system shall be as shown on the standard roofing detail drawing. However, if the Contractor desires to submit on alternative proprietary system he must first obtain the approval of the Engineer. Below are approved systems and basic specifications of materials for approved systems. The Contractor must provide a ten year Unconditional Guarantee for the roofing system installed on the project. The guarantee will be issued by the Contractor (Not Subcontractor) in favor of the Employer and shall cover all necessary remedial works or complete renewal so determined by the Engineer during the guarantee period.

5.2 Waterproofing Membrane

Roof water proofing shall be 4mm thick SBS membrane with minimum 180 glm2 spunbonded polyester reinforcing. The elongation shall be minimum 50% in longitudinal and transverse directions. The membrane shall be fully heat bonded to the contact surface with bitumen primer.

5.3 Lightweight Concrete

Lightweight concrete shall be approximate density of700 kg/m3 laid to falls of not less than 2% and to a minimum thickness of 50mm. The falls shall be even and no deviation greater than 6mm measured with a 4 meter straight edge will be accepted. An angle fillet 100 x 100mm shall be provided at junctions with vertical surfaces. The screed shall be laid in alternate bays each not exceeding 20m2.

5.4 Insulation Layer

The insulation layer shall be minimum 30mm thick either spray applied or board type thus:-

5.4.1 Spray Applied Insulation

Shall be I.C.I. polyurethane foam density 60kg/m3, 100mm thick applied onto a clean, dry, dust free surface.

5.4.2 Board Type

Shall be very hard, rigid, closed cell structure extruded polystyrene foam board, 50rnm thick, minimum density 32 kg/m2, with denser skin on outer sides having high resistance to water absorption, water vapour diffusion, permeability, moisture, condensation and with very good mechanical properties. The boards shall have rebated edges and shall be laid loose on the waterproofing membrane ready to receive either gravel or tiles.

5.5 White Cement Paving Tiles

The white precast paving tiles shall be formed with a minimum 12mm facing of white cement and sand (1:3 min) on a backing, of sulphate resisting cement and sand (1:3 mix). Tiles shall be 300 x 300 x 25mm thick overall and slightly rounded on the arises. Tiles shall have keyed backs and shall be cured for a period of not less than two days after the initial

set by being totally immersed in water, after which they should be stacked on edge for a period of seven days and kept moist by spraying with water.

The finished surfaces of the tiles shall be completely waterproof, flat, smooth and free from projections or depressions.

Precast tiles shall be provided at all junctions with vertical surfaces. Joints with horizontal and vertical surfaces shall be filled with tropicalised, non-hardening mastic to the Engineer's approval.

5.6 Gravel

50mm size, round edge river bed washed white color rubble stone loosely laid on the roof.

5.7 Workmanship

The slabs or screeds which are to receive the waterproofing shall be smooth, firm, clean and thoroughly dry before any waterproofing is commenced.

Rainwater connections shall be set up to permit the free flow of water and provide with fluting flanges to receive finishes. This and similar work shall be completed before the screed is accepted for roofing application to begin.

Before the work is started, all rubbish shall be removed and during the work the screed surface shall be maintained clean and free of loose or foreign materials and obstructions. Screeds that are scaling or that are covered with fine dust shall not be primed until thoroughly cleaned.

Screeds shall not be laid during rain. After laying they shall be protected by approved means from the effects of rain, excessive heat, etc. The screeds shall be allowed to dry out thoroughly before subsequent roofing operations are carried out. To facilitate drying the contractor may insert 19mm diameter temporary ventilating tubes obliquely through the topping.

All roofs are to be left perfectly watertight at completion to the satisfaction of the Engineer.

The contractor must provide a ten year warranty between himself and the client for the roofing system to remain watertight. This should allow for any necessary remedial works or complete renewal if necessary during the above period.

CARPENTRY, JOINERY AND IRONMONGERY

6.1 Carpentry Generally

Carpenters work shall include all structural and temporary timber work, grounds, etc. and shall be carried out in accordance with the drawings and the principals of good construction. It should be noted that sizes shown on the drawings are finished sizes.

The whole of the structural timber used in building shall comply with and be used in accordance with the provisions of BS 5268 (1978) Part 5 revised 1965, Structural use of Timber in Buildings (incorporating CP 112:100 - Preservative Treatments for Construction Timber).

Timbers referred to in this Code of Practice shall comply with BS 4978 for structural Softwood.

6.2 Joinery Generally

Joiners work shall include all finishing and non-structural-timber work and shall be carried out in accordance with the drawings and the principals of good construction. It should be noted that sizes shown on the drawings are finished sizes.

6.3 Softwood

Softwood shall comply in all respects with BS 881/589 and BS 1186.
Timber shall be of an approved variety and quality suitable for the purpose for which it is to be used and equal to samples approved by the Engineer.
All timber shall be properly seasoned and shall be sawn square, straight, and true.
All timber shall be free from the following defects:

- Splits, ring shakes, soft pith:
- Checks exceeding 300mm long
- Checks exceeding 20mm wide
- Checks exceeding in depth one half of the thickness of the timber. . Knots exceeding 30mm
- Knots exceeding one half of the width of the surface.
- Decayed or dead knots unless cut out and plugged.
- Loose knot or knot holes unless cut out and plugged.
- Pith pockets.
- Decay and insect attack.

6.4 Hardwood

Hardwood for clear finishing shall be selected First Grade Teak, or otherwise specified, and shall be obtained from an approved supplier.

Hardwood for painting shall be a stable hardwood suitable for the purpose.

All timber shall be properly seasoned and shall be planed square, straight and true and shall be free from the following defects:

- Sapwood, splits, ring shakes, soft pith.
- Checks exceeding 300mm long.
- Checks exceeding 20mm wide.
- Checks exceeding in depth one quarter of the thickness of the timber. .
- Knots of any description in surface for staining or polishing.
- Knots exceeding 20mm mean diameter.
- Knots exceeding one half the width of the surface.
- Knots of any description in glazing bars.
- Decayed or dead knots unless cut out and plugged.
- Pith pockets.
- Decay and insect attack including pinworm holes.

In joined panels each piece shall be of the same species. Timber for staining or polishing shall have all surfaces of the same character and grain running in the same direction.

6.5 Plugging

Timber which is to be plugged to the structure shall be properly and securely fixed by means of rawl-plugs, rawl-plastic or hardwood plugs cut on the twist. Nails shall be in accordance with **BS** No. 1202.

6.6 Plywood

Plywood shall be constructed in accordance with **BS** 6566 and shall be obtained from an approved manufacturer and shall be to the thickness shown on the drawings. The Contractor will not be allowed to make up thickness by glueing together sheets of thinner plywood.

Plywood shall be free from end joints, (including scarf joints in veneers) overlaps in core sheets, dead knots, patches and plugs, open defects, depressions due to defects in core, insect attack, (except isolated pinworm holes through face veneers only), fungal attack and from discolouration 'differing from that normally associated with the species.

Face veneers shall be hard and durable and shall be capable of being finished to a smooth surface. Face veneers shall closely match the general joinery timber supplied. They shall be free from knots, worm and beetle holes, splits, glue stains, filling and inlay of any kind or other defects.

Adhesives shall comply with the requirements of BS 1203, Grade W.B.P. and shall ensure proper adhesion between layers.

All plywood shall be of exterior grade unless otherwise stated.

Where required, lippings are to be hardwood, tongued and glued to the edge of the plywood to finish a minimum of 12mm thick.

6.7 Blockboard

Blockboard shall comply with BS 3444 and shall be generally in accordance with the specification for plywood above.

Blockboard shall be from an approved manufacturer and guaranteed not to warp or change in size or suffer any kind of deformation. It shall be of timber specified and glued with anti-insect resin waterproof glue all through.

6.8 Special Veneers

Where panels or doors are to receive a clear finish, the face veneers and lippings shall be of the hardwood indicated on the drawings. They shall be free of the defects as described above for "Hardwood".

Where panels or doors are to have a special veneer on one side only, a balancing veneer shall be applied to the other side to prevent warping.

6.9 Glue

1. For exterior joinery shall be water resistant caseline or other moisture resistant type.

2. For interior joinery shall be grade best suited for the purpose. Adhesives shall comply with BS 1203.

6.10 Preservative

All grounds and other timber to be built into concrete or block walls or otherwise covered shall first be coated all over with approved wood preservative and anti-termite solution suitable for the position in which the member is to be incorporated.

6.11 Flush Doors

The hollow core flush doors are to be constructed from 25mm x 75mm top and bottom rail and stiles, 25mm x 50mm intermediate crossrails at 100mm centres, both sides covered with plywood glued and pinned to framing and veneered as described for painting or clear finish and with extra blockings in the lock position.

The flush doors are to comply generally with BS 459 (1988) in the case of hollow cored and semi-solid doors and BS 459 Part 3 in the case of half hour and one hour fire resisting doors. Doors are to be constructed to the thickness, size and type as shown on the drawings or as directed by the Engineer.

All doors are to be hardwood lipped on all edges. The lipping shall be a minimum of 12mm thick securely jointed and tongued into the framing of the door. Where rebate meeting stiles are required on pairs of door, the lippings on the meeting edges shall be a minimum of 20mm thick.

In the case of hollow cored or semi-solid doors, blockings shall be built into the construction of the door to provide firm fixings for locks, bolts, hinges, springs, and other ironmongery. Positions of these blockings shall be indicated on the facing of the door, care being taken to avoid permanent marking.

Where observation panels are required they shall be formed to the dimensions and using the type of glass shown on the drawings. The opening is to be lipped all-round similarly to the edges of the door. The glass is to bedded in non-setting mastic as described in the "Glazing

Section It and held in position with two sets of glazing beads to the section shown on the drawings, fixed with small brads or lost -head nails.

Where observation panels occur in doors with a clear finish, the lippings and beads shall be in a hardwood to match the veneer, and the beads shall be fixed with brass cups and screw.

Doors shall be carefully and accurately fitted to give a uniform clearance of not more than 3mm all rounds.

6.12 Frames and Linings to Doors and Windows

Frames and linings shall be provided and built to the dimensions and sections shown on the drawings or as directed by the Engineer. Frame members are to be framed together and linings are to be tongued at angles all in accordance with the principles of good construction.

6.13 Architraves, Stops, Etc.

All architraves, stops, cover beads, glazing beads, etc., are to be provided and fixed to the dimensions and sections shown on the drawings or as directed by the Engineer with neatly mitred angles.

Stops to half hour fire resisting doors are either to be worked out of the solid frame or otherwise fixed with screws at maximum 450mm centres. Stops to one hour fire resisting doors are to be worked out of the solid frame, all in accordance with BS 459 Part 3.

Glazing beads shall be fixed with small brads or lost-head nails or in the case of work to receive a clear finish, with brass cups and screws.

6.14 Skirting

All skirtings shall be 20mm x 100mm Teak fixed to walls with plugs and screws. All mitres, stops, fair ends, etc. shall be neatly formed. Skirting shall be stained and lacquered to the Engineer’s approval. Skirting shall be treated with wood preservative on the rear side.

6.15 Kitchen Fittings

The Kitchen fittings shall be obtained from a company included in the list of approved Manufacturers included in the Particular Specification.

Provide and fix approved stainless steel sink units and taps in the positions shown on the drawings.

All kitchen or sink units should be built off a 100rnrn high plain concrete plinth and the tender shall allow for this accordingly in the relevant rates.

6.16 Workmanship

All carpentry and joinery shall be accurately set out, framed and executed in accordance with the detailed drawings.

Where timber work is required to be wrought it shall be machine dressed, unless otherwise directed

Joinery shall be cut and framed at an early stage, but shall not be glued or wedged until the building is ready to receive it.

Framed work shall be properly morticed and tenoned, wedged and glued, and cramped and dowelled together where necessary. All joints, mortices, tenons, housings, etc., shall be perfectly formed and fitted, and all joints shall be painted over with the best red lead before fixing. All faces of joinery in direct contact with blockwork, concrete or rendering shall be painted over with best red lead before fixing. All external joinery is to be put together with waterproof glue. Butter, screwed or nailed joints will not be acceptable for framed work.

The jointing and fabrication are to be such that the shrinkage of any part shall be. Compensated at the joint, and shall not impair the strength of the finished work nor interfere with the construction tolerances.

The Contractor shall take all necessary measures to check or prevent capillary penetration of water in the joints and open connections of external joinery works.

The use of nails for fixing any items of joinery will not be permitted. Sprigs may be used for glazing beads only.

Screws shall be in accordance with BS 1210. All screws shall be countersunk and puttied and all sprigs shall be punched and puttied. All joinery work such as architraves, beads, ~c., required to fit against the contour of irregular surfaces shall be accurately scribed to ensure a close connection.

All joinery which is to be polished varnished or painted shall be finished smooth and clean by rubbing down with fine glass paper.

Except where the work is to be built-in the Contractor shall obtain all dimensions for joinery works from the building structure. Joinery work which does not form an essential part of the structure fabric shall not be carried out nor brought on to the building site until required.

The Contractor shall provide and maintain all temporary covering and box in and protect all work liable to damage, and shall provide temporary doors where necessary during the progress of the work. The Contractor shall ensure that the work of other trades is properly arranged to obtain the best results, both in the joinery and the other trades.

6.17 Ironmongery Generally

The ironmongery shall be obtained from a manufacturer approved by the Engineer as indicated in the Particular Specification and each door set, etc. shall be properly tagged or labeled for its respective floor and location so as to be easily identified.

During and after installation the ironmongery shall be wrapped and protected from construction activities or other hazards that will interfere with its function, appearance or finish by means of adequate measures approved by the Engineer.

Unless otherwise specified or shown on the drawings, all locks shall have two keys with the lock number stamped upon them and the corresponding number stamped on the face of the lock in English and Arabic. The locks shall be master keyed as directed by the Engineer. All keys shall be handed to the Engineer on completion with a typed schedule detailing all lock and key numbers.

The ironmongery supplier shall furnish all necessary templates for the fabrication of the various doors and for any other ironmongery for which they are required in order to make proper provision for the accurate setting out and fitting of such material.

Ironmongery shall be furnished with wood or other type screws or fastenings to suit the job condition. The screws and fastenings must match the finish of the ironmongery with which they will be associated.

6.18 Fixing of Ironmongery

Prior to the installation of ironmongery items, all mobile parts and mechanisms shall be carefully lubricated in accordance with the manufacturers printed instructions.

Mortices in wood shall be carefully sized so as to suit the fittings and not impair the strength of the wood. Screws, nuts, rivets and other fastenings shall be carefully adjusted so that they are presented flush on the finished surface. Marred or scratched screw-heads, face plates, etc., shall be replaced at the Contractors expense. Only matching screws shall be used. The strength of fastening shall be as required for the intended use. The use of hammered screws is strictly prohibited. Holes for screws shall be commenced with a bradawl or drill before screwing.

All ironmongery shall be removed before painting commences and refixed on completion.

METAL WORK

7.1 Generally

All metalwork shall be produced in accordance with the drawings and the following specification to the entire satisfaction of the Engineer.

The contractor shall submit dimensioned sketches of all work to be fabricated for the approval of the Engineer before commencing manufacture.

During and after installation metalwork shall be protected from the construction or other hazards that will interfere with its function, appearance or finish by means of adequate measures approved by the Engineer.

7.2 Materials

All materials shall be free from scale, rust, corrosion, damage or other defects and shall be finished smooth to the required size. All ferrous materials shall be thoroughly cleaned and given one shop coat of an approved rust inhibitor before shipment unless otherwise specified or directed in writing by the Engineer. All parts which will be inaccessible after assembly or erection shall receive two coats of an approved rust inhibitor before being fastened together.

7.3 Steel

7.3.1 Generally

All steel shall conform to B.S. 4360, Weld able Structural Steels.
Steel hot-rolled sections shall comply with B.SA, Part 1.
Steel tubes shall be seamless tubes in accordance with B.S. 1387 or 6323

Bolts and nuts, where used, shall be in accordance with B.S. 4395. Bolts shall be of sufficient length to show at least one full thread beyond the nut after tightening. Bolted joints subject to vibration shall be securely locked.

Washers, where used, shall be in accordance with B.S. 4320. The size of the holes shall not exceed the bolt diameter by more than 2mm.

7.3.2 Workmanship

The Contractor shall complete all the works required to the steel members including holes, brackets, ironmongery, fittings and accessories such as bolts, rivets, cramps, holdfasts, anchors, etc. to the satisfaction of the Engineer.

All wrought and steel parts shall be accurately set out, cut, framed and executed using proper rivets, bolts or welding electrodes. All cut parts shall be sawn cut; no oxygen burning shall be permitted except for pipe trusses. All welding shall be electrical welding, clean and with proper workmanship. All cut parts and welded sections shall be ground even and filled with rounded edges.

All metal members in contact with the soil shall be painted with two coats of protective bitumen paint. All doors, frames, etc. shall be given at least one coat of an approved rust inhibiting paint before delivery to site.

Frames shall be provided with not less than three adjustable type anchors on each jamb, the maximum distance between anchors shall be 750mm.

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

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

All work shall be erected plum and true to lines and rigidly secured to walls, floors or ceilings as shown on the detailed drawings.

The plain surfaces shall be smooth and free from warp or buckle. Moulded members and mitres shall be clean, cut straight and true.

Construction joints shall be welded along their full length and cleaned off flush on exposed surfaces.

The rates for all wrought steelwork shall include for all labours, drilling and cutting to short lengths.

All welded joints shall be ground smooth after welding so that no blemishes or other imperfections remain before paint is applied.

7.3.3 Cramps, Wall Ties, Anchors, Etc.

The cramps for fixing wood frames to walls shall be 200mm long 30mm wide and 3mm thick and shall have one end bent and twice countersunk drilled for screwing to the frames and the other end fishtailed for setting into walling. Cramps shall be galvanised or dipped in bitumen before fixing.

All fixing cramps, wall ties, anchors, etc. shall be stainless steel proprietary type. The contractor is responsible for submitting suitable samples to the Engineer for approval.

7.3.4 Cladding Fixing Systems

Cladding restraining or fixing systems shall be stainless steel proprietary system such as Pep con Marble fixing system or equal and approved.

The Contractor shall include for all necessary stainless steel channel or angle framing fixing system or stainless steel expender shells as recommended by the Manufacturer and approved by the Engineer.

7.4 Galvanised Steel Channels and Chequered Plate

Where Site Electrical Rooms or DEC Substations are required, the Contractor must allow for all necessary galvanised steel channels and chequered plate as directed by the Engineer, including framing, supports, handrails, etc. as necessary.

7.5 Aluminium

7.5.1 Generally

All aluminium doors, windows, frames, transomes, mullions, etc. where shown on the drawing shall be manufactured of extruded section aluminium alloy, heat treated to B.S. 1474, free from defects. They shall be supplied by a manufacturer approved by the Engineer. Fixings shall be aluminium alloy in accordance with B.S. 1473.

All exposed surfaces shall be powder coated to the colour indicated on the drawings. The powder coating shall comply with B.S. 6496.

Aluminium coated materials shall not be permitted in lieu of the aluminium items specified herein. Samples of the powder coated finish must be provided for approval before; proceeding.

All aluminium sections shall present clear, straight and sharply defined lines and shall be free from defects and imperfections that may impair their strength.

Samples of aluminium shall include a comer joint and glazing gasket.

The Contractor shall be responsible for the protection of all aluminium work until the completion of the Works, and only units in perfect working order and in perfect condition will be accepted. All hardware, screw, bolts and other necessary accessories shall be of aluminium or other non-corrodible material and shall match in colour and consistency the finish of the aluminium.

Where aluminium is in contact with wood, the wood shall be treated with pentachlorophenol, or equal and approved, 5% minimum concentration, followed with the protective measures described for aluminium in contact with wood or other absorptive materials.

The aluminium work shall be designed and anchored so that work will not be distorted nor the fasteners overstressed from the expansion and contraction of the metal.

7.5.2 Protection.

Before shipmen from the factory, aluminum surface requiring protection shall be given a coating which will protect the metal during construction. In areas where appearance of the finish on aluminium items is important a coating of methacrylate lacquer shall be applied.

Apply two sprayed coats of water-white methacrylate lacquer having a total minimum thickness ofO.125mm, which when applied to the aluminium surface shall be capable of withstanding the action of lime mortar for a period of at least one week in an atmosphere of 100% relative humidity at. 1 00 degree F, and the action of 10% (by weight) muriatic acid

for a period of six hours at 70 degree F and the action of atmospheric weathering for a period of 12 months; Alternatively a thick adhesive tape may be used. The coating or tape shall be applied in. the manufacturer's plant to the exposed surfaces of all aluminium components subject to staining from alkaline mortar and plaster abrasion and other construction abuses.

7.5.3 Workmanship

The Contractor shall provide all aluminium units as indicated on the drawings.

Workmanship and installation shall be in accordance with recommended standards of First Class Aluminum Manufacturers.

The Contractor shall provide all labour, materials and equipment to complete the aluminium work indicated on the drawings or specified herein to the satisfaction of the Engineer.

The work shall include all the various items required to produce a complete installation including shop drawings, fabrication, installation, caulking, priming and back coating, etc.

All aluminium work shall be produced in a factory where the grade of metalwork is of a recognised quality acceptable to the Engineer. All items shall be installed plumb, straight, square, level and in proper elevation, plane, location and alignment with other work. All work shall be designed for adjustment to field variations, fitted with proper joints and intersections and adequately anchored in place.

All workmanship and finishes shall be first class and strictly in accordance with the best practice. All work shall be complete in every detail. Finished work shall be approved by the Engineer before the job will be accepted.

Where aluminium surfaces come into contact with metals other than stainless steel, zinc, white bronze or small areas of other metal compatible with aluminium, they shall be kept from direct contact with such parts by painting the dissimilar metal with a primer, followed by two coats of aluminium metal and masonry paint or other approved suitable protective coating, excluding those containing lead pigments, or a non-absorptive type or a gasket shall be placed between aluminium and dissimilar metals. Steel anchors and connecting members shall be hot dip galvanised or zinc plated after fabrication.

Aluminium in contact with wood or other absorptive materials which may become repeatedly wet shall be painted with two coats of aluminium metal and masonry paint or a coat of heavy bodied bituminous paint. Alternatively paint the wood or other absorptive material with two coats of aluminium house paint and seal joints with a good caulking compound.

Before application of lacquer, the manufacturer shall remove all fabrication compounds, moisture, dirt accumulations and other foreign materials to ensure proper lacquer adhesion.

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

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

Acid, caustics and abrasives shall not be used. Where cleaners are used to remove excess sealing compounds care shall be taken to prevent damage to the seal or staining or damage to adjacent work.

7.5.4 Doors, Window Frames, etc.

All aluminium doors, windows, frames, etc. shall be factory assembled and reinforced according to the drawings, complete with hinges, stops, closers, locks, glazing gaskets and anchors. The only site work allowed on aluminium units is fixing in position and glazing. The finished surfaces shall present a clear surface free from alloy defects, streaks or other surface blemishes.

Joints shall be accurately machined to ensure a perfect fit and shall be connected with reinforced screwed plates, using stainless steel screws or bolts. Door stiles and rails shall be securely jointed. And reinforced by means of die cast structural comer assemblies of 2,000 lb. tension without noticeable deformation.

All units shall be reinforced to receive ironmongery and all doors shall be reinforced for door closers whether or not required. Cut-outs for ironmongery shall be neatly made and suitably reinforced.

Doors and windows shall accurately fit the frames. Doors and opening windows shall incorporate a woven pile metal backed weather strip to exclude draughts.

Doors windows, etc., shall have aluminium or galvanised steel fasteners and other ironmongery to the Engineers approval. The hinges shall be stainless washered aluminium with stainless steel pins. Fine mesh aluminium fly screens shall be provided to opening windows and sliding doors to the Engineer's approval.

All doors, windows, etc. are to have a finish as per the drawing and must be generally equal in all respects to a sample approved by the Engineer.

Sliding doors or windows shall have toughened nylon, or similar, rollers. All frames shall be heavy section.

7.5.5 Balustrading, Handrails, etc.

Balustrading, handrails, etc. shall be as per the details in the drawings and as specified in the Particular Specification.

All mitres and ramps are to be neatly and rigidly formed and all ends neatly capped to the satisfaction of the Engineer. All balustrades, handrails, etc. shall be factory assembled and only the final fixing will be allowed as insitu work.

FLOOR. WALL AND CEILING FINISHES

8.1.1 Preparation of Surfaces to be plastered

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

Plastering shall not be commenced until the background has been suitably prepared. Blockwork joints shall be deeply raked out, efflorescence brushed off and all dust and foreign matter removed. On all external surfaces and on all smooth internal surfaces a spatterdash of cement and sand which shall contain not less than 250kgs of cement per one metre cube of salt free sand shall be applied.

Before plastering is commenced all junctions between differing materials shall be reinforced. This shall apply where walls join columns and beams, particularly where flush, and similar situations where cracks are likely to develop and as directed by the Engineer. The reinforcement shall consist of a strip of expanded lathing 300mm wide which shall be plugged, nailed or stapled as required at intervals not exceeding 450mm at both edges, fixed to cover both materials evenly.

The reinforcement is also to be provided over all electrical conduits and service pipes running within the walls.

As far as is practicable, plastering shall not be commenced until all mechanical and electrical services, conduits, pipes and fixtures have been installed and the installations tested.

Where rendering is to be carried out on concrete backgrounds, the concrete is to be treated with two coats of Unibond bonding agent as manufactured by Unibond Ltd, Industrial Estate, Camberley, Surrey, England or other equal and approved.

8.2 Materials for Plastering

8.2.1 Cement, Water and Sand

The cement and water shall be as described in the "Concrete Work" Section. The sand shall be salt free and washed with demineralised water. Its grading shall conform to B.S. 1199.

8.2.2 Galvanised Metal Lathing and Angle Beads for Internal Plaster

Galvanised metal lathing for internal plastering shall comply with B.S. 1369 minimum weight 1.5kg per square metre. Lathing and angle beads shall be obtained from am approved manufacturer

8.2.3 Stainless Steel Lathing and Angle Beads for external plaster

Stainless steel lathing and angle beads shall be obtained from an approved manufacturer and installed in all external plastering situations.

8.3 Mixing of Plaster Ingredients

Except where hand-mixing of small batches is approved by the Engineer, mechanical mixers of an approved type shall be used for mixing of plaster. Caked or lumped materials shall not be used.

Mechanical mixers, mixing boxes and tools shall be cleaned after mixing, each batch and kept free of plaster from previous mixes.

Plaster shall be thoroughly mixed with the proper amount of water until uniform in colour and consistency. Retempering will not be permitted and all plaster which has begun to stiffen shall be discarded.

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

8.4 Workmanship

All plastering shall be executed in a neat workmanlike manner and internal and external angles shall be true, straight and plumb.

The Contractor shall form vertical guide bands 50mm wide. The spacing shall not exceed 1500mm.

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

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

Plaster shall be made good adjacent to wood or metal frames, skirtings and around pipes or other fittings.

The base coat shall be applied after the spatter-dash coat has set but in no case earlier than 24 hours after the application of the spatter-dash coat. When applied to masonry or to concrete surfaces the base coat shall be applied with sufficient pressure to prevent air pockets and to secure a good bond.

The base coat shall be lightly scratched in both directions to provide a key for the finishing coat and shall be kept moist with fog spray for 72 hours and then allowed to dry out.

The finishing coat shall not be applied until the rendering or base coat has seasoned for 7 days, immediately prior to the application of the finish coat the rendering or base coat shall be wetted evenly with a fog spray. The finish coat shall be first floated to a true and even surface, then trowelled in a manner that will force the sand particles down into the plaster and with final trowelling, leave the surface finish smooth and free from rough areas, trowel marks, checks or other blemishes.

Proportions and minimum thickness of finished plasterwork shall be in accordance with the following table:

Plaster	Mix	No. of coat	Minimum thickness
Cement and sand internal and as External plaster	1 part cement 4 parts sand	Two coat work	20mm total thickness or shown on the drawings
Cement and sand plaster for Soffit	1part cement cement 4 parts sand	Two coat work	20mm thick
Cement and sand backing For internal wall tilling work.	1 part cement 4 part sand	Two coat work	12mm thk

8.5 Screed and Beds

Screeds shall be composed of one part of cement to three parts of sand by volume measured dry.

The surface of concrete beds and slabs which are to receive screeds shall be hosed down in a green state and brushed with a stiff brush to remove laitance and form a key for the screed. Before laying the screed the surface of the concrete shall be thoroughly cleaned and a coat of cement grout (1:1) applied. Where required to have a trowelled finish the screed shall be finished with a steel trowel to a hard, level and smooth surface.

The mixture of cement and sand screed shall be mixed with sufficient water to produce a workable mixture. Maximum slump shall be 50mm.

The cement and sand screed shall be laid after walls and partitions are built.

Screeds are to be maintained in a moist condition for at least three days by covering with a layer of sacking, canvas, hession, straw mats or similar absorbent material kept constantly wet. Screeds shall be protected from damage until the laying of the floor finish. No floor finish shall be laid until the screed is sufficiently dry to receive such finish. Screeds which are to be laft exposed shall be laid in alternate bays not exceeding 20m2.

8.6 Ceramic Floor and Wall Tiles

The ceramic tiles shall be true in size and shape, free from flaws, cracks and crazing, uniform in colour and texture and keyed on the back. They shall be equal in all respects to samples approved by the Engineer.

External angles and exposed edges of tile areas shall be formed with rounded edge tiles. Misfits as well as damaged or defective tiles shall be removed and replaced with good tiles. Where tiling abuts frames, surrounds, etc., or where holes are required for pipes, etc., the tiles shall be carefully cut and fitted to form a neat close joint. Fair exposed edges of tiled areas shall be finished with tiles having a glazed, polished edge matching the surface.

The wall tiles shall be fixed with high quality approved adhesive to a true vertical face with continuous vertical and horizontal joints. Joints shall be straight, level, perpendicular and pointed neatly in approved grout. The width of joints -shall be as directed by the engineer. Any surplus grout which adheres to the tiling shall be wiped off with a damp cloth before it sets hard.

The floor tiles shall be laid symmetrically about the centre lines of the room and any cut tiles shall be made by using a proper tool leaving the cut edges square and smooth. The tiles shall be solidly bedded in cement and sand mortar (1:4) and pointed in coloured cement to match the tiling.

Before setting in position, glazed tiles shall be thoroughly immersed in clean potable water for 24 hours and drained off so that no free moisture remains on the back of the tiles.

The surface of concrete or blockwork shall be thoroughly cleaned, wetted and well dried before applying the base coats and screeds. Mixes, thicknesses and methods of application of beds and backing, for wall and floor tiling shall be as shown on the drawings. Mortar for base coats shall be used within one hour after mixing and retempering will not be permitted. The base coat shall be applied with sufficient pressure to prevent air pockets and to secure a good bond and shall be scored or cross-scratched, when nearly set, to form a key. The surface of the base coat shall be well wetted and dried immediately before the tiling is commenced.

Floor and wall tiling to kitchens shall be run under and behind cupboard units.

Movement joints are to be provided at the perimeter of areas of ceramic tiling and at intervals not exceeding 4 metres in either direction in larger areas. In addition, the Contractor shall take adequate precautions against lifting or cracking of ceramic tiles for any other reason.

Upon completion, all tiling shall be left clean and free from cement or stains.

8.7 Acid Resistant Ceramic Tiles

For areas specified tiles shall be certified acid resistant minimum thickness 8mm and size and colour to approval and shall be fixed in mortar bed or adhesive to the approval of the Engineer.

8.8 Marble, Granite and other natural stone

8.8.1 Generally

Stone for walls treads.risers and pavings shall be obtained from a source approved by the Engineer. The colour. texture and finish shall be equal in all respects to samples approved by the Engineer.

The stone supplier shall prepare fully dimensioned working drawings from details supplied by the Engineer. No stone shall be incorporated in the works until these drawings are approved by the Engineer.

Stone shall be stored in a water-free area on a raised platform and shall be covered with clean tarpaulins or similar material until required for use. Executed work shall be protected at comers with non-staining wood, boards or similar material. Any work damaged, stained or otherwise harmed at the time of handing over shall be replaced or cleaned as required by the Engineer.

All stone shall be thoroughly cleaned by scrubbing with fibre brushes and mild alkaline solution that contains no caustic or harsh additives. The use of wire brushes or acid solutions shall not be permitted. Upon completion all stone shall be left clean and free from stains. or traces of cleaning fluid and with all joints pointed to the entire satisfaction of the Engineer.

8.8.2 Paving

Marble for paving and risers shall be 25mm thick bedded in cement and sand mortar. Marble for treads shall be 30mm thick. All exposed edges shall be finished as the main face.

Joints between slabs are not to exceed 3mm and are to be pointed with coloured cement to the Engineer's approval.

8.8.4 Movement Joints

Movement joints for the full depth of the screed and stone shall be provided as shown on the concrete flooring layout. The joints will be neatly sealed with a proprietary sealant as specified in the Particular Specification in colours to approval.

8.8.5 Final Polishing

Before handing over the building the stonework shall be thoroughly cleaned and final waxing, polishing or hardner applied to the satisfaction of the Engineer.

8.9 Terrazzo

Terrazzo tiles shall be manufactured and laid as per BS 4131.

8.9.1 Material

Coloured cement for terrazzo work shall be non-staining and contain not more than 0.30% by weight of soluble alkali.

Marble chips for terrazzo work shall be of approved origin in irregular pieces varying in size depending on the exact requirement as directed by the Engineer. The pieces shall be roughly cubical in shape and flaky shaped pieces shall not be used.

The precast terrazzo tiles shall be formed with a (1 :2%) mix of white or tinted Portland cement with a colour pigment added and granular marble chips for the topping (wearing layer) set on cement and sand backing (1 :5) mix and shall be obtained from an approved manufacturer.

The tiles shall be cast in heavy steel moulds under pressure to the proportions and dimensions shown in the following table:

Size of Tile	Total Thickness	Thickness of facing (Minimum)	Facing Mix	Thickness of Backing (Maximum)
200x200mm	20mm	8mm	1:2Yz	12mm
250x250mm	25mm	8mm	1:2Yz	17mm
300x300mm	25mm	10mm	1:2Yz	15mm
400x400mm	30mm	10mm	1:2Yz	20mm

The maximum allowable tolerance shall not exceed + 1.0mm in the tile sizes.

8.9.2 Workmanship

All tiles, skirtings, etc., shall be well shaped with straight edges perfectly flat and free from defects which affect appearance or serviceability. Chipped tiles or tiles with cracks or other defects will not be accepted and if laid by the contractor shall be removed and replaced with sound tiles.

Cement and sand screeds, setting beds and tiles shall be laid with their respective surface true and level or pitched to drains, and the surface of the completed flooring will be at the levels and grades shown on the drawings.

Tiles shall be laid out from the centreline of each space outward and adjustment made along walls partitions and borders, so as to symmetrize the pattern with a minimum of cut tiles. Tiles shall be cut with a suitable cutting tool and rough edges shall be rubbed smooth. Cut tile misfits shall be replaced with properly cut tiles. Straight edges shall be accurately set into the line established and reset at suitable intervals to keep. the joints parallel over the entire area. The tiles shall be laid to the straight edges.

All terrazzo surfaces shall be polished on completion. Large areas such as floors shall be wet polished by means of approved machines using a No. 140 carborundum wheel. Any surface too small for convenient machine polishing may be polished by hand using a No. 140 carborundum stone and water. Care must be taken during any polishing operation not to damage any angles or arrises.

8.9.3 Movement joints

Movement joints for the full depth of the screed and tiling shall be provided to the perimeter of the work and dividing the flooring into areas not exceeding one square metre using 6mm x 32mm ebonite strips fixed before the screed is laid.

Areas not exceeding 3metres wide do not require longitudinal movement joints.

8.10 Transition Strip

Wherever differing floor finishes abut each other they are to be finished with a fair square cut edge and separated by means of a dividing strip.

The dividing strip shall be formed of PVC or aluminium or Stone and to be of a section approved by the Engineer and fixed in accordance with the manufacturer's printed instructions.

8.11 PVC Sheet and Tile Flooring

The PVC sheet and tiles shall be obtained from a manufacturer approved by the Engineer. The flooring shall be laid in strict accordance with the manufacturer's written instructions.

The tiles shall be laid symmetrically about the centre lines of the room and accurately cut, with a proper tool, against the walls or any obstruction. The tiles shall be fixed with an approved adhesive used strictly in accordance with the manufacturers printed instructions.

100mm high coved vinyl tile skirtings shall be provided where shown.

Screeds for vinyl tiling shall be perfectly smooth. Where the surface of the screed is considered by the Engineer to be unsuitable, a coating of latex compound shall be applied, at the Contractor's expense, before tile laying is commenced. No tiling shall be executed until the screed is completely dried out.

Kitchen floor tiling shall be run under any floor standing kitchen units.

On completion, surplus adhesive shall be removed and the floor allowed to harden before finally washing down with a proprietary cleaner. At final completion an approved sealer shall be applied and the floor polished with an approved floor wax. Both sealer and floor wax shall be as recommended by the manufacturer of the vinyl tiles.

8.12 Suspended Ceilings Generally

The Contractor shall provide shop drawings, for approval by the Engineer, showing the layout and sizes of all suspension system members and coordinate the design and work with other trades to provide for the installation and support of light fittings, outlets, fixtures, etc. for any services situated in the ceiling.

Suspended ceilings shall be erected in accordance with the manufacturer’s written instructions by competent tradesmen in a rigid and secure manner to provide a final surface free from any waves, buckles, sags or other defects.

All profile and trimming exposed at the perimeter or elsewhere shall be powder coated in an approved colour.

All necessary accessibility to services above suspended ceilings is to be provided by way of access tiles, access hatches, etc.

Suspensions and framing shall be of metal sections only. No timber framing will be allowed. The Contractor is to allow for metal straps bolted to concrete soffits as no shot-fired wire hangers will be allowed.

8.13 Mineral Tile Ceilings

The fibre tile suspended ceiling shall be 600 x 600 x 12mm mineral fibre tiles obtained from a manufacturer approved by the Engineer.

The ceiling shall be fixed on a proprietary grid suspension system strictly in accordance with the manufacturers instructions.

The ceiling shall be set out symmetrically around the centre of the room. Perimeters are to be neatly trimmed with angle securely fixed to the walls, Bulkheads shall be constructed where necessary.

Tiles shall be neatly cut, fitted and trimmed around obstructions, fittings, etc.

8.15 Linear Aluminium Ceilings

The Linear aluminium ceilings shall be 'Luxalon' ceilings 130mm wide strips complete with infill strips manufactured by Messers. Hunter Douglas or other equal approved. All other specifications shall be as described for the fibre tile ceiling.

8.16 Expansion Joint Cover Strip (for all Types of Finishes generally)

Expansion joint cover strips shall be "Clipstrip" extruded mill finish aluminium profiles, powder coated to approve colour, as manufactured by Expandite Ltd, or other equal and approved, fixed in accordance with the manufacturer's instructions.

GLAZING

9.1 Generally

All glazing work shall be installed by skilled workmen experienced in this work in Accordance with BS 6262.

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The contractor shall fix glass with all the necessary gaskets, clips, beads, etc.

AIl glass shall be of the type, shape and size indicated on the drawings and/or Particular Specification. AIl types of glass shall be free from waves, bubbles, and other defects, they shall be of first quality such as manufactured by Glaverbell, Saint Gobain, Pilkington or approved equal.

AIl glass panes shall have rounded edges to prevent any damage to gaskets.

Any glazing damaged before the work is handed over shall be replaced at the contractor's expense.

9.2 Materials

9.2.1 Glass in General

All glass shall comply with the specification given below and shall be delivered to the site in cut sizes and in package marked as to the quality of the content.

9.2.2 Clear & Tinted Glass

The clear and tinted glass sheets shall be to BS 952 selected glazing quality 6mm thick or as otherwise shown all to the approval of the Engineer.

9.2.3 Mastic

The mastic for glazing shall be of non-setting type to the Engineer's approval.

9.2.4 Double Glazing

The glazing units shall comprise two layers of glass with tinted or coloured glass to the outside face and clear glass to the inside face. Units shall be factory vacuum sealed with moisture excluding silica strips.

9.3 Workmanship

Prior to proceeding with any works, the contractor must take all necessary measurements on site to verify dimensions and conditions shown on the drawings.

Glazing rebates' shall be cleaned of mortar droppings or other foreign matter before glazing commences. All glass is to be properly bedded, sprigged in where necessary and cleaned off to true lines and the glass left properly clean.

The glass shall be cut to allow a 3mm gap all around and bottom edges of glass shall be supported 3mm away from the frame. The glass shall be fixed firmly but not rigidly.

The bead glazing in aluminium windows shall be special PVC sections that fit into the aluminium frame and hold the glass firmly in position.

9.4 Mirrors

The mirrors shall be of the best quality 6mm thick anti- condensation backed polished plate glass, with bevelled, and polished edges all around. The mirrors shall be fixed to the walls with rubber washers and chromium plated dome-headed mirror screws driven into rawl-plugs fixed in the walls.

9.5 Protection

The whole of the glazing works is to be properly protected during the progress of the works and all cracked, broken and defective panes are to be removed and replaced with new and the whole left perfect at completion.

PAINTING AND DECORATING

10.1 Generally

The term “Paint" as used herein includes emulsions, enamels, lacquers, sealers and other coatings or inorganic finish whether used as primer, intermediate or finish coats.

The contractor shall protect all painting and decorating work and shall provide adequate dust sheets, canvases, etc. in order to protect adjacent work.

All painting and decorating shall be applied by skilled workmen experienced in this work. The contractor shall repaint at his own, expense any work where the paint is found to be incorrectly applied.

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

The contractor is to submit to the Engineer for approval the brand and quality of the paints he proposes to use. If approval is given to a brand of paint the contractor shall use the primers, undercoats, etc. manufactured or recommended by the manufacturer of that brand and notwithstanding anything herein contained shall prepare the surface and carry out the work in accordance with the manufacturer’s specification to give the best finish on the surface to be painted.

All paints to be used under this contract shall be delivered to site and stored in sealed labelled containers a minimum of 30 days prior to application. Upon notification by the contractor that the material is at the site, samples of each material shall be obtained at random from sealed containers by the Engineer in the presence of an authorised representative of the contractor.

Samples shall be clearly identified by conunercial name, type of paint and intended use. If judged necessary by the Engineer the paint sample may be tested for compliance at the contractor's expense in a laboratory designated by the Engineer.

Complete colour charts for the paints to be used shall be submitted to the Engineer for approval and the preparation of the colour schedules.

Paints shall be factory manufactured and delivered to the site in unbroken containers which shall show the designated name, formula, colour, manufacturer's directions and name of manufacturer all of which shall be plainly legible at the time of use.

Pigmented paints shall be supplied in containers not larger than 25 kg. Ail paints shall be products that have a minimum of 2 years satisfactory field service.

All paints shall be thoroughly stirred before use.

Mixing and applications of paint shall be in accordance with the specification of the manufacturers concerned and to the approval of the Engineer. The mixing of paints, etc. of different brands before or during application will not be permitted. No dilution of painting

materials shall be allowed except strictly as detailed by the manufacturer and as approved by the Engineer. Spraying will only be allowed with the Engineer's written approval.

10.2 Materials

10.2.1 Materials in General

The materials to be used as required by the Schedule of Finishes and the drawings shall be of the best quality and of approved types obtained from an approved manufacturer.
All paints shall comply with the following requirements:

1. The product shall be thoroughly mixed and ground. It shall not be settled, caked or thickened to such a degree that *it* cannot be mixed easily with a paddle by stirring to a good uniform brushing consistency.
2. The colour of the paint shall match the approved sample.
3. Paint shall show no evidence of cracking, chipping, flaking or dusting.
4. Paint shall not skin (form a thin membrane surface on the top of the liquid) within 48 hours in a filled closed container.
5. Paint in the containers during and after application shall not be abnormally pungent, offensive or disagreeable.
6. Paint shall show easy brushing, good flowing and spreading and good leveling properties. Those properties shall be demonstrated on test specimens at the request of the Engineer. Coats that have any noticeable pull under a large brush and that show poor spreading and flowing properties will not be accepted.
7. Paint shall dry to a uniform, smooth, flat or semigloss appearance under ordinary conditions of illumination and wearing. There shall be no laps, skips, high-lighted spots or brush marks. Tinted paints shall dry to a uniform colour.
8. Recoating of a previously painted surface shall produce no lightening, softening or other film irregularities.

10.2.2 Knotting

Knotting shall be composed of dissolved shellac or other resin which remains unaffected by the resinous materials in the wood or the following paint coating, thereby preventing the resinous materials in the timber leaching into the paint film and causing discoloration or defective drying, it shall be in accordance with BS 1336.

10.2.3 Fillers

Filler shall be "Polyfilla", "Alabastine" or other equal and approved.

10.2.4 Stopping

Stopping shall be hard stopping composed of white lead paste, gold size and whiting.

10.2.5 Thinners

Thinners shall be approved turpentine or white spirit, except where paints are specified to be water thinned, in which case fresh water shall be used for thinning.

10.2.6. Etch Primer

The etch primer shall be mordant solution, slightly acidic in nature and containing solvents, for application to new smooth metallic surfaces to remove grease and organic soaps and provide a physical key.

10.2.7 Rust Inhibiting Primer

The rust inhibiting primer shall be calcium plumbate red lead, chromate, zinc chromate or other equal and approved primer.

10.2.8 Primers Generally

Primer generally shall be etch primer, rust inhibiting primer, alkali resisting primer or other primer recommended for the particular surface to be painted, and the particular paint to be used.

10.2.9 Undercoating Paints

Undercoating paints for exterior or interior shall be as supplied or recommended by the manufacturer of the finishing coat.

10.2.10 Finishing Paints

Finishing paints shall have either a matt, eggshell, semigloss or gloss appearance as indicated on the Schedule of Finishes and requested by the Engineer or stated in these Specifications. Allowance must be made for a full colour range.

10.2.11 Clear Finish

The clear finish is to be polyurethane matt lacquer or other equal and approved.

10.2.12 Vinyl Emulsion Paint

Emulsion paint shall have either a matt or eggshell appearance as indicated on the schedule or requested by the Engineer or these Specifications. Allowance must be made for a full colour range.

10.2.13 Special Decorative Finishes

External walls and other surfaces indicated on the drawings shall be painted with proprietary paint as stated in the Particular Specification. The paint shall be applied strictly in accordance with the manufacturer's printed instructions.

10.3 Workmanship

10.3.1 Generally

Hardware, hardware accessories, machine surfaces, switch plates, lighting fixtures and similar items in place prior to cleaning and painting which are not intended to be painted

shall be removed prior to painting operations and repositioned upon completion of painting work in each area or shall otherwise be protected as directed by the Engineer.

Equipment adjacent or against walls shall be disconnected by workmen skilled in these trades and moved to permit the wall surface to be painted and following completion of painting shall be replaced and reconnected.

All oil and grease shall be removed with clean cloths and cleaning fluids prior to mechanical cleaning.

Cleaning solvents shall be of low toxicity and shall have a flash point in excess of 38ºC or as may be otherwise agreed.

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

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

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

Paints shall be stirred in their original container until smooth before use. "Edges, comers, curves, welds and rivets shall receive special attention to ensure that they receive an adequate thickness of paint.

10.3.2 Painting on Plaster, Rendering, Concrete and Blockwork

Such works shall be allowed to dry out completely before carrying out painting operations. Plaster or rendering shall be at least five weeks old before commencing painting operations.

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

Alternatively, the surfaces may be neutralised by brushing on a solution of 3 % phosphoric acid and 2% zinc chloride and removing all loose particles after drying.

No painting shall be carried out until the Engineer is satisfied that no efflorescence is occurring. Painting shall not be permitted when the relative humidity of the atmosphere exceeds 80% Relative Humidity.

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

10.3.3 Internally

All plastered or rendered surfaces shall be twice stopped with approved putty filler. The first coat of stopping shall be applied after the primer coat has dried out completely and the

second coat after the first undercoat application. Each coat of stopping shall be allowed to dry and harden thoroughly and shall then be rubbed by sandpaper until a smooth surface is achieved.

The emulsion or P.V.A. paint is to be applied in three coats, the first a thinned coat and the other two full coats. Each coat shall be allowed to dry and harden thoroughly before the next coat is applied.

10.3.4 Painting on Non-Ferrous Metal Surfaces

All surfaces shall be thoroughly cleaned to remove dirt and grease before any paint application is commenced.

Aluminum, aluminum alloys, zinc or similar non-ferrous metal be treated with one coat of etch, primer to give maximum adhesion before the application of the further primer and paint coats.

Copper and lead surface shall be lightly abraided with wet abrasive paper, after which it shall be treated with one coat of etch primer to maximum adhesion for subsequent applications.

Non-ferrous surface which are to be built into walls shall first be treated as described above and primed.

Once maximum adhesion of subsequent coat is assured the surface shall be primed with the relevant primer and painted. A minimum of two approved undercoats as recommended by the manufacture of the finishing coat shall be applied. Each coat shall be allowed to dry and thoroughly harden before the next coat is applied.

10.3.5 Painting on Wood surfaces

Internal wood surface except surface to be given natural finish or other finish specified shall receive one coat primer, two coats undercoat with undercoating paint as recommended by the manufacturer and one coat of kont sealer and the surface primed.

External wood surface shall be painted as described for internal surface but with one undercoat and two finishing coats.

Wood surface shall be sanded to a fresh surface. Moulds where present shall be removed by washing, rubbing and burning off as necessary. Oily wood shall be swabbed with white sipirt. Resinous exudation and large knots shall be removed and replaced by approved filler or treated with two coats of knot sealer and the surface primed.

Parts of wood to be enclosed in walls shall be primed unless already impregnated with creosote or other preservative.

Priming shall be brushed on and minimum of two coats shall be applied to end grain. After the primer coat is hard all cracks, holes open joints, etc. shall be made good with hard stopping and rubbed free with fine abrasive paper. If the first process of stopping is found to be unsatisfactory it shall be repeated after the first undercoating is applied and well dried.

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

Wood surfaces specified as for clear finish shall be thoroughly cleaned down of all dirt, oil grease, etc. rubbed down to a smooth finish and two coats of polyurethane clear finish applied to the Engineer's approval.

PLUMBING SYSTEM

11.1 Sanitary and Rainwater Plumbing

11.1.1 Generally

All work shall be designed and installed in accordance with BS 5572 and ns 6465 (Part 1) and with the requirements of this specification, local byelaws and other regulations. The Contractor shall notify the Engineer of any discrepancies between these requirements and the drawings and instructions.

11.1.2 Materials

Unplasticised PVC rainwater goods shall comply with BS 4576 Part 1 and unplasticised PVC soil and ventilating pipes and fittings shall comply with BS 4514.
Plastic waste pipes and fittings shall comply with BS 5255 and plastic traps shall comply with ns 3943.

11.1.3 Access

Access to the interior of vertical piecework shall be provided at or near the foot of each stack. Access to the W. C. branches shall be provided at the branch connection to the fitting. Other access shall be provided in the positions shown on the drawings or as directed by the Engineer.

11.1.4 Cover Plates

Where pipes pass through walls, floors and ceilings in exposed positions, cover platcs shall be supplied and fixed.

11.1.5 Jointing of Pipes

All joints in pipe work and of pipe work to appliances shall be made in such a manner as to be airtight and water-tight and to remain so during use. Care shall be taken to ensure no jointing material projects inside the bore of the pipe.

Joints in UPVC or plastic pipes shall be of the solvent welded type made strictly in accordance with the instructions of the pipe manufacturer.

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11.1.6 Support and Fixing

The Contractor shall layout all pipes and fittings to the approval of the Engineer and shall check alignment, gradients and verticals before jointing and securing in position.

All final fixings shall be firm and secure, carefully aligned and spaced at a constant distance from the structure to give reasonable all round access for maintenance and inspection. .

Plastic pipe work shall be fixed firmly tit the fittings and at sockets of vertical pipe work, the fixing shall allow for thermal expansion and contraction.

Plastic pipe work shall have expansion joints at every fixed point; these shall be positioned in vertical runs immediately above the fixed point. On horizontal runs intermediate expansion joints shall be used at a maximum of 4 metro centers between fixed points.

11.1.7 Ventilating Pipes

Ventilating pipes (i.e., both ventilating and soil stacks) shall terminate a minimum 600mm above the level of the roof. The outlet shall be protected at its topmost end with a guard of durable material which does not unduly restrict the flow of air.

11.1.8 Protection during Construction

Every care shall be taken to prevent the entry of foreig11 matter into any part of the system during construction and all open ended pipe work shall be kept sealed with purpose made caps or stoppers. Plugs of wood, paper, rags, or other makeshift device shall not be used.

11.1.9 Testing

After completion of the soil pipe installation related to each stack for each floor the connection openings together with the lower end of the stack shall be plugged and filled with clean water to a height of at least 3 meters above the tested joint and the installation inspected for any visible leaks.

The water must remain without dropping from the level marked for at least 8 hours and any such drop during this time, will mean improper and defective installation.

The contractor may perform the test after the complete installation of the sanitary piping to approva1. In this case, the connections must introduced on the stack at each floor interval, in order to make it easy to plug for testing purpose.

Rain water pipes shall be tested with water to ensure that they are to correct falls, and pipes are unobstructed and do not leak. . .

11.1.10 Sanitary Fittings

The manufacture of Sanitary Fitting shall be Twyfords. Armitage Shanks, Ideal Standard or other equal and approved.

The design and color shall be selected by the Engineer. All fittings sha11 be carefully protected during delivery, storage and installation so no crazing, chipping, cracking or other damage occurs. All fittings so damaged shall be removed from the site and. replaced with new at the Contractor's expense.

11.2 HOT AND COLD WATER SERVICE

11.2.1 Generally

All work shall be designed and installed in accordance with BS 6700 and the requirements of this specification, local byelaws and other regulations. The Contractor shall notify the Engineer of any discrepancies between these requirements and the working drawings and instructions.

11.2.2 Pipework

Copper pipes for hot and cold water shall comply with BS 2871 Part 1 Table X.
Where possible, bends will be formed from the pipes. Where not possible purpose made fittings shall be used. All fittings shall be capillary type to comply with BS 864 Part 2.

UPVC pipe for cold water services and main installations shall comply with BS 3505 jointed with solvent cement fittings in accordance with the manufacturer's instructions. The clipping distance shall be in strict accordance with the manufacturer's instructions. Copper pipe work where buried shall be wrapped in "Denso" tape or other equal and approved sheathing.

11.2.3 Gate valves, stopcocks and draining taps

Globe, globe stop & check, check and gate valves shall be in accordance with BS 5154 with solid wedge non-rising stem and flanged ends.
Draw-off taps and stop valves shall be in accordance with BS 1010.
Draining taps shall be in accordance with BS 2879.

11.2.4 Solar Water Heaters

Provide thermostatically controlled water heaters by Chab, Hot Point, or other equal and approved supplier, of the capacity and in the positions shown on the drawings. The water heater shall be provided with sufficient flex to reach the power point and shall be fixed where shown on the drawings in accordance with the manufacturer's instructions and ventilated if required. Water Heaters will be with recirculation pump and electric back up.

11.2.5 Storage Tank

The roof water storage tank shall be constructed of glass reinforced plastic and shall be obtained from a manufacturer approved by the Engineer. The roof tank shall be supported on painted steel bearers and a rot proof platform for its entire area.

11.2.7 Protection during Construction

Every care shall be taken to prevent the entry of foreign matter into any part of the system during construction and all open ended pipework shall be kept sealed with .purpose made caps or stoppers. Plugs of-wood, paper, rags or other makeshift device shall not be used.

11.2.8 Handling and Storage

All pipes and fittings shall he handled with care and all precautions shall be taken to avoid damage and abrasion to the surface finish.

11.2.9 Installation

The Contractor shall provide, lay, joint. assemble and fix ,in3ccordance with the appropriate details and in the position shown, pipes, specials, materials, fittings and accessories of the kinds and dimensions shown, together with all items, whether shown or not, which are necessary to complete the installation.

Where pipes pass through walls or floors, they shall be provided with approved sleeve pieces.

Pipes shall be concealed wherever possible. Changes in direction are to be made with long radius bends.

All horizontal runs of pipes shall be installed with a slight rise or fall, as the case may require, for the release of air to cisterns or taps and to enable the system to be drained. The pipe runs shall be set out and fixed in such a manner that traps and airlocks shall he avoided. Air release valves shall be fitted at high points for the release of air.

Care shall be taken to ensure that proper anchor points are provided and that the system can expand and contract without noise and vibration. The system shall also permit draw-off points and valves to be closed quickly against full water pressure without water hammer. Shock absorbing air bottles shall be installed by the Contractor if necessary.

Drainage taps shall be installed so as to permit complete drain down of each and every part of the system.

11.2.10 Testing

The Contractor shall provide all clean water, assistance and appliances for testing during the progress of the Contract and for the final tests. He shall also provide, fix and adequately support all necessary blanked ends and plugs and shall remove them as directed by the Engineer. The Contractor shall ensure that all pipework is completely clear of any obstruction, debris and superfluous matter before any tests are applied to' such sections and upon completion of the contract.

The Contractor shall locate all defects revealed by the test, shall remedy them and shall repeat the tests until a satisfactory result is obtained.

Water pipes shall be slowly tilled with water so as to exclude all air. Pressure shall then be applied until a test pressure of 50 metre head or the maximum working pressure plus 50%, subject to the limitations of the pressure class of the pipes, whichever is the greater, is indicated on-the gauge. This pressure shall be maintained without further pumping and without measurable loss for a minimum period of thirty minutes.

After testing, all distribution pipes, storage tanks and heaters shall be slowly filled with water so as to allow air to escape. With all draining taps closed, the system shall be absolutely watertight.

11.2.11 Insulation to Hot Water Pipes.

Hot water pipes shall be of pre-insulated type to approval. Ail fittings on the pipes shall be wrapped with a suitable insulating material (Fiberglass or equal) after completing the necessary pressure test on the pipe line.

Temporary and Permanent Mains Connections and Installation of Water Mains and Meters

The Contractor is to organize and liaise with the local authority regarding mains connections to the site and any installation of water mains and meters and pay any charges for temporary water supply that may be levied. He is to co-ordinate the programming and execution of the works with the local authority. The Employer will pay for the permanent water supply direct to the Authority.

Any permission which may be required from the Engineer or the Employer must be requested by the contractor sufficiently well in advance of the intended commencement of the relevant work on site to avoid any delays. Any costs incurred due to delays because of non-compliance with this clause by the Contractor shall be entirely borne by him.

11.4 Builders Work

The expression "Builders Work" shall mean the ancillary work carried out by the Contractor in connection with the plumbing installation.

The drilling cutting leaving of holes or aperture through structural floors, walls, beams, etc., shall be avoided but where this becomes a necessity, the contractor must obtain the written approval of the Engineer before such work is put in hand.

Builders work in connection with plumbing installation will include the following, but it should be noted that this list is not intended to be exhaustive.

a. Drilling, cutting or leaving of holes for pipes, ducts, and the like through walls, floors, partitions, roof, etc., and subsequently making good.
b. Cutting and pinning ends of supports for pipes, equipment, appliances, fittings and the like t walls, floors, partitions, soffits, etc. and making good.
c. Cutting or leaving mortices, sinkings, etc., for holding down bolts, brackets, supports and the like and grouting in.
d. Cutting chases for pipes and the like in walls, floors, partitions, etc., and subsequently making good.
e. Cutting and fitting around, boring holes through and making good finishes up to pipes, supports, brackets and the like.
f. Excavation and backfilling of external pipe or service duct trenches.
g. The building of meter pits, access chambers and the like.
h. The construction of concrete, block and /or timber ducts.
J. The formation of ducts within concrete slabs together with access covers and frames.
k. The building of timber frames, panels and doors, including ironmongery, to give access to pipes. ducts, equipment .and he like.
l. The formation of concrete bases, plinths, etc., for plant, tanks and equipment including anti-vibration pads if necessary.
m. The painting of exposed pipe work, fittings, equipment, etc.

11.5 Disinfecting

All water mains and domestic services inclusive of storage tanks shall be flushed and disinfected with a chlorine solution before being put into regular service. Prior to introducing the disinfectant the mains shall be flushed with clean water at a velocity of at least 7 I/s. Flushing water shall be discharged only on sites or into conduits as approved by the Engineers Representative.

All material and equipment (Le. pumps, water, gauges, chlorine, water, etc.) shall be supplied by the Contractor at his own expense.

ELECTRICAL INSTALLATION

12.1 Scope of the Works

The scope of Electrical and Associated Works shall be generally as detailed on the drawings and/or specification.

This specification covers the supply, installation testing and commissioning of the relevant installation and its associated components. For any particular job the relevant specifications would be applicable even in case of the slightest involvement of any' associated work.

12.2 Codes of Practice

Expect where they are varied by the requirements, the provisions of the British Standard Codes of practice conforming to the latest revised editions of such specification and the lEE Regulations (latest edition) shall be held to be incorporated in this specification.

If any of the 11S Codes or .lEE Regulation referred to in the specification have been revised at the date of tender then these shall be deemed to have superceded those referred to in the specifications.

12.3 Permanent Main Connection

The Contractor is to organise and liaise with the Local Authority regarding the new mains connection to the site including the installation of new mains and meters.

The Contractor shall pay all charges in connection therewith

The Contractor shall allow in his tender for profit and attendance in connection with the Permanent Main Connection and for liaising with the Local Authority so that the Permanent Main Connection is completed within his own programme time. The Contractor shall be liable for any delays in connection with the Permanent Main Connection.

The actual charges payable to the concerned authorities shall be reimbursed to the Contractors on receipt of original payment invoice.

12.4 Local Authority

For works in the Emirate if Dubai the local authority would be always deemed to the Dubai Electricity Company (DEWA).

12.5 Scope of the Works

This specification covers the supply, assembly, installation, connecting up, testing and setting to work of the electrical installation.

The Works to be executed under this Sub-Contract are described in detail in the following Specification of Works and are shown on the Drawings.

The Sub-Contractors shall provide everything necessary for the full completion of the Works and the work shall be executed in a workmanship like manner and to the reasonable satisfaction of the Engineer.

12.6 Electricity Supply

It is the Sub-Contractors responsibility to obtain information regarding the electricity supply from DEWA (Dubai Electricity & Water Authority) before placing any orders for electrical equipment and all such equipment shall be suitable for the supply available without loss of rated performance. The electricity supply is 380/3/50.

For Emirates other than Dubai such information should be obtained from the WED/Ministry of Electricity & Power and shall be suitable for rated supply of 415/3/50.

12.7 Compliance with Regulations and Standards

All the materials used and provided, all the electrical installations and components and all the tests, where such relevant British Standard exists, shall be in accordance and compliance with this Standard and the 16th Edition (1991) of the Institution of Electrical Engineers (U.K.) Regulations for the Electrical Equipment of Buildings and all subsequent amendments to the Regulations, and to the Regulations as issued by DEWA.

If the Sub-contractor offers materials, equipment or tests which conforms to standards other than the aforementioned, full details of the difference between the proposed standard and the equivalent British Standard in so far as they effect the design and performance of equipment, are to be supplied by the Sub-Contractor to the Engineer, at the earliest possible stages of the Works.

12.8 Materials and Testing of Materials

The whole of the Works shall be executed with the materials indicated in the subsequent Sections of this Specification.

Where the names of Manufacturers are stated, together with a detailed specification of their products, these are given as an indication of the quality and workmanship required.

Where such exists, the equipment shall comply with the requirements of the appropriate current British Standard Specification and shall be of the best of their respective kinds, free from all flaws and defects.

All Materials shall be new unless otherwise stated. Any materials not accepted and approved in writing by the Engineer shall be removed and replaced by the Sub-Contractor at his own expense.

In order to obviate any delays caused by the non-delivery of materials, the Sub-Contractor must place orders immediately instructions have been received by him to proceed with the works and copies of the orders must be sent to the Engineer for inspection, together with progress reports at the end of each month after order.

The Engineer shall have power to reject any materials and/or workmanship which, in his opinion, is unsatisfactory, and to instruct the sub-contractor to rectify the same. Forthwith at the sub -contractor's expense.

All fittings and/or equipment shall be delivered to the site complete in proper packings and any damaged in transit will be rejected and replaced by the Sub-Contractor without charge.

12.9 Samples

Before commencing the work the Sub-Contractor shall submit in writing for the written approval of the Engineer details of all apparatus. And fittings which he proposes to use in the works. The Sub-Contractor shall prepare or obtain and promptly submit to the Engineer free of charge for his written approval samples of materials and particulars as requested. All materials supplied which are not equal to the approved samples will be rejected. After being approved the Engineer shall retain such samples as standard reference until the completion of the Works if he so desires.

12.10 Restrictions

The Sub-Contractor shall employ none but workmen skilled in their respective trades and must not employ juveniles or unskilled labourers in lieu of skilled workmen. No more than one assistant shall be allowed to be assigned to each skilled workman.

The Engineer reserves the right to dismiss instantly from the works any workman employed by the Sub-Contractor who may misconduct himself on the site or be incompetent in the opinion of the Engineer.

The direction of the Engineer us to the manner of eX'ccutil1g the various Works and the proper mode of conducting them shall at all times be strictly adhered to and the work completed to the satisfaction of the Engineer.

The Sub-Contractor and his employee shall be bound to conform with the rules and regulations in force on the site for the proper conduct of the work and avoid any complications that might cause disputes or strikes amongst his own and the Main Contractor's workman.

12.11 Safety Precautions

The Sub-Contractor shall take all necessary safety precautions to prevent the possibility of accidents which may be caused mechanically, electrically or otherwise during th~ course of the works. The works shall include the provision and fixing of detachable guards of approved design to the provision and fixing of detachable guards of approved design to cover all moving machine parts wherever they may be located and whether they are intended to be permanent or temporary, and in such a manner as to comply with the appropriate government requirements. It shall also include such step-down transformers as to be used for portable electrical tools.

12.12 Maintenance of Finishes

The Sub-Contractor shall cover up and protect the various works and portion thereof from all damage due to inconsiderate or' rough treatment, dust, grit or injury in other ways. All bright parts of fittings shall he covered with transparent polythene sheeting and shall be cleaned and polished before being handed over.

12.13 Marking and labels

All items of switchgear shall be clearly labeled by means of Traffolyte labels fixed to the outer surface of equipment to indicate the function of the unit or circuit controlled by the unit in the English language and /or Arabic language.

The Sub-Contractor shall provide and fix adjacent to the MCBDBs an instruction chart and notice relating to the procedure for dealing with cases of electric shock.

The Sub-Contractor shall supply a black on white print mounted in a glazed frame by the MCBDB's and this shall show a diagrammatic arrangement of the electrical installation.

One copy of this shall be handed to the Engineer for checking and then this copy shall he forwarded to the Employer for his records and one copy provided for the Engineer's records.

Each circuit and each final sub-circuit shall be clearly labeled in an approved method indicating accurately the equipment, apparatus or area of supply. To this purpose, neatly typed schedules, both in Arabic and English mounted in clear transparent envelopes indicating the outgoing final sub-circuits, their rating and the points they supply, shall be required to be fixed on the inside of the MCBDSB's.

12.14 Alignment and Mounting height of Accessories

The Sub-Contractor shall pay particular attention to the method of fixing all conduit boxes, switch boxes and socket outlets boxes, etc., so that these shall, when completed, be in an exact position relative to the finished plaster to permit all the cover plates being fixed accurately and at the heights indicated by the Engineer or Architect or as specified below.

The Sub-Contractor shall take full responsibility for the alignment. of all such boxes and must ascertain all wall depths of finished plaster and the final finishing of all wall surface.

For any faults or inaccuracies in this respect, the Sub-Contractor shall be held fully responsible and will be required to carry out any necessary revision without extra charge.

The following schedule gives a guide line as to the fixing height of various fittings and accessories, but the final position is to be to the approval and satisfaction of the Engineer.

Item	**Height mm**	**Measured from Finished floor**
MCBDBs	500	Underside
Light switches & neon Switches	1200	Underside
15 A Switch Socket outlets	To be fixed relative to water	

	heater or air conditioning unit	
13A Switch Socket outlets	300	Underside
-Ditto-	200	From workbench surface
Cooker outlets	To be indicated on site	Underside
Telephone outlets	300	Underside
TV Socket outlets or	300	Underside
Firm alarm break glass	1200	Underside
Air Conditioning Controls	1200	Underside
Ceiling Fan Regulators	1200	Underside

12.15 Earthing and Bonding

The sheathing of PVC/SW AlPVC cables and/or outer sheath of NICC cable, all iron clad switchgear and fittings, etc., shall be made electrically continuous, bonding rings and nipples being provided and fixed at all junctions and connections to iron-clad fittings.

The earthing system shall be in accordance with chapter 54 of the LE.E. Regulations and shall satisfy the test specified in Appendix 3 of the said Regulations, and the local Electricity Authority Regulations. Neither structural steel nor water pipes, separately or jointly shall be used as the sole earth electrode of the installation. Particular attention should be paid to Table 54F relating to minimum size of earthing leads and conductors.

12.15 Tests

The following are the detailed tests which must be carried out in the presence of and to the satisfaction of the Engineer. These tests shall be carried out on the completion of the Installation.

12.15.1 Insulation Resistance.

- With all fuse, links, switches, etc., closed and poles or phases of the wiring electrically connected together, the insulation resistance to earth shall not be less than 1 megaohm.

- When measured between all conductors connected to any pole or phase of the supply, the insulation resistance shall not be less than 1 megohm.
- When measured between the framework or case and all live parts of each item of fixed apparatus it shall not be less than 0.5 megaohm to earth.

12.15.2 Continuity tests

All conductors (including earth continuity conductor) of every ring circuit. Earth loop impedance tests to check:

a. The polarity at various selected sockets on the installation.
b. The earth fault loop path to ensure that the fuse of circuit breaker of a given rating will operate satisfactorily under fault conditions.

- For the works related to the Earthing System the contractor's attention is drawn. towards the B.S. C.P. 1013 provision of which have to be duly considered and shall supercede the above in case of any conflict.

All tests shall be carried out by the Sub-Contractor in the presence of the Engineer or his authorized representative. The apparatus, instruments,. etc., which must be certified as accurate, shall be provided by the Sub-Contractor. Approval for final payment will not be given until the above tests are completed satisfactorily.

12.15.3 Special Note

Before final commissioning of any equipment referred herein the Sub-Contractor shall check for tightness of all clamps screwed and bolted connections regardless of whether the original connections were made before delivery of the equipment to site or not. The Sub-Contractors shall also ensure that all fusible links and trip settings are correctly calibrated to give discrimination and protection to the circuits and final sub-circuits forming this installation.

12.16 Drawings – General

All drawing, other information and samples must be supplied to the Engineer as laid down in this Specification and as and when agreed during site meetings, in the Progress Chart as indicated by the Engineer.

12.16.1 Drawings etc., supplied by the Engineer

The Engineer shall supply to the Sub-Contractor during the progress of the work, details, drawings and instructions as may be necessary for the guidance of the Sub-Contractor in the construction and completion of the Works, and the Sub-Contractor shall execute and obey and be bound by the same. The Sub-Contractor shall carefully check al drawings and advise the Engineer of any errors or omissions discovered before any installation.

12.16.2 Shop Drawings

The Sub-Contractor shall prepare and submit detailed shop drawings for all equipment or distribution services described herein, based upon the Drawings to be supplied by the Engineer referred to above

The work described on any Shop Drawing submitted shall be carefully checked by the Sub-Contractor for all clearance, field conditions, maintenance of Architectural conditions, and proper co-ordination with all trades on the job. To this end the contractor during the production drawing stage shall ensure that he co-ordinates drawings of all other trades that might interfere with the proper installation of his work. No payment shall be made for any variations or alterations on site due to lack of knowledge of other trades. Any unresolved conflict between trades shall be referred to the Engineer.

The equipment lay out is to be detailed on the Drawings, showing the exact method' of installing and clearly illustrating components to be used in making all connections. These drawings are to be submitted for approval prior to any work on site.

12.16.3 Builder's Work Drawings

The Sub-Contractor shall prepare schedule and Drawings, showing precise details of holes in concrete, blockwork, etc., bases. Frames or supports required and the like. The Schedule shall show in detail the Builders work required to be performed by all other trades for the Electrical Installation. These Drawings and Schedules, in an approved form, must be submitted to and properly approved by the Engineer before any structural work requiring holes or other modification is constructed.

12.16.4 As Installed Drawings

The Sub-Contractor shall supply to the Engineer a set of "As Installed" Drawings showing the Electrical Works as installed together with any other information necessary for operation and maintenance, to the satisfaction of the Engineer. Four copies of each drawing are to be supplied.

The Sub-Contractor shall submit all drawings within the time specified hereunder. All drawings shall be supplied in the form of a second negative and signed by a principal of the Sub-Contractor. After approval, the negative will be signed by the Engineer will take as many prints from this negative as he required for his own use.

Signed and approved drawings will not be departed from unless a signed variation or omission certificate is issued in writing by the Engineer. Drawings returned to the Sub-Contractor for alteration or amendment shall be re-submitted to the Engineer for approval.

Amended or altered drawings shall shown the nature of the amendment or alteration in a revision block on the drawing, together with the revision number or letter and the date of the revision.

12.18 Sub-Contractor's Failure to Provide Shop Drawings.

Should the Sub-Contractor prove unable to produce satisfactory "Shop Drawings" or be unable to produce drawings to conform to the progress of the Work, the Engineer reserves the right to take whatever steps are necessary to have drawings undertaken by others and debit the Sub-Contractor's account.

Any decision taken by the Engineer to have "Shop Drawings" produced elsewhere will not relieve the Sub-Contractor of his contractual obligations and the Sub-Contractor must provide to the Architect all necessary details, physical dimensions, descriptive literature, etc., of all equipment to be incorporated on drawings within 10 days of a request from the Engineer.

12.19 Manufacturer's Data

Manufacturer's performance data, certified factory drawings of apparatus giving full information as to capacity, dimensions, materials and all information pertinent to the adequacy of the submitted equipment shall be submitted for approval.

Manufacturer's names, sizes, catalogue numbers and/or sample of all materials shall also be submitted for approval.

Submittals and shop drawings should, as far as possible, be complementary so that drawings and submittals can be cross-checked.

12.20 Engineer's Provisional Approval.

Orders of equipment submitted for approval must be accompanied by relevant drawings, technical data. Catalogues and samples. Where data, certified drawings or other required information is not available until after orders have been place, the Engineer will give provision approval, until all requested drawings and information have been supplied to the Engineer and approved by him. It is the Sub-Contractor's responsibility to ensure that all necessary information is supplied to the Engineer in accordance with the progress of the work.

Should the Engineer give provisional approval only of an order due to lack of complete information and should the missing information not eventually meet with approval, the Engineer will not be held responsible for any delay incurred. For equipment where information from the manufacturers is likely to be delayed, it is essential that the Sub-Contractor places provisionally approved orders at the earliest possible date so as to ensure approval of orders in complete conformity with the progress of the Works.

12.21 Provision of Record Documents

The Sub-Contractor shall keep on site an up to date record of the exact location of all apparatus, all pipe and conduit runs, cables and all buried works, and shall on completion of the Works, hand to the Engineer a set of record drawings as previously described and three securely bound folders which shall each contain:-

- Five sets of the Record Drawings.
- Five sets of manufacturer's maintenance and operating manuals as required.
- Five sets of operating maintenance instructions fully detailed and cross reference with a) and b), prepared specifically for the Works.

12.22 Monthly Schedule of Materials Ordered

As soon as practicable after the acceptance of his Tender or when called for by the. Engineer the Sub-Contractor shall be required to submit to the Engineer the following programme information monthly to the approval of the Engineer.

1. A fully detailed and up-dated bar chart agreed with the Main Contractor with each operation sub-divided to the approval of the Engineer.

2. A Chart showing:
   - Date of acceptance of order
   - Date of delivery F.O.E.
   - Date of arrival on site and
   - Last possible date for arrival on site to maintain overall programme.

3. A statement of availability of all materials for the Works to be purchased locally.

12.23 Lightning Protection System

Faraday cage type lightning protection systems shall be installed to cover the complete building in accordance with BS 6651.

A copper tape air termination network shall be f1xed to the building roof using purpose made fixings clamps. No part of the roof within the air termination network shall be more than 5m from a conductor.

Items of roof-mounted plant shall be bonded to the air termination network via copper tapes. All exposed metalwork on the roof or the structure shall also be securely bonded to the air termination network. A bimetal clamp shall be used to bind a different metal.

Down conductors shall be installed and run parallel with the edges of the building.
Down conductors shall not be positioned no more than 10m apart around the perimeter. Fixing method of the down conductor along the building facia to be. Agreed with the architect.

The connection between the down conductor and the earth electrode shall be made below ground level in a small purpose-made pit with removable concrete cover to facilitate future testing and maintenance. Each electrode shall consist of steel-cored, hard-drawn copper sheathed rods complete with a hardened driving cap and a contractor strip clamp. Sufficient number of rods of suitable length shall be installed to provide an overall resistance to earth not exceeding 1 ohms.

All metal work on or around the building must be bonded to the lightning protection network to avoid side flashing.

Where it is necessary to form tape to tape joints, they shall be tinned soldered and' riveted. Soldering alone will not be accepted. Clamped or bolted joints will only be accepted at test points and for connection of down conductors to earth rods.

All materials used throughout the installation shall be either copper or copper based components which are corrosion resistant or .compatible with the application.

LOW VOLTAGE DISTRIBUTION

12.24 General Requirements of Switchgear and/or Distribution Boards

Switchgear and distribution boards surface/reseed pattern suitable for conduit or cable entry as required and shall. Where specified, be mounted on the building structure by mounted of suitable mild steel straps or angle iron frames. Where distribution hoards or switchgear are required to be directly attached to brickwork etc... The fixing shall be by means of grouted. in bolts or bolts of the expansion type.

The circuit breakers shall be situated to allow wiring to be carried out with sufficient slack to enable them to be removed for inspection without disconnection any circuit wiring.

Barriers of tire proof materials shall be fitted between all phases and neutral. Any live metal in the distribution hoard shall be screened with insulation material, so that circuit breakers can be withdrawn and replaced without any danger to the operator.

Where single core cables enter or leave any item of metal clad switchgear, distribution gear, etc. the cable cores shall all pass through the same aperture in the enclosure or case of the unit concerned, to avoid the setting up of eddy currents. Where separate holes are provided by the manufacturer for the cables, the ho1es shall either be cut out to form a continuous slot, or alternatively the holes shall all be joined together with saw cuts through the solid metal separating the holes. In all cases end plates shall be of non-ferrous metal. All such cuttings if required, to be done by the manufacturer of the boards or his authorized agency.

Switch board shall be designed to operate on a 3801220V 3 phase and neutral 50HZ. Supply for Emirates of Dubai and 4151240v, 3 phase and neutral 50Hz supply for all other Emirates. They shall have a minimum short circuit rating of 31 MV A for three seconds, switch boards shall comply with BS 5486 Part 1.Form 2,

Main distribution panel(s) shall be equipped with all necessary circuit breakers and components with enough spare outgoing for any future use. Automatic transfer switches and timing devices should be incorporated for connecting the essential load to standby supply in case of mains failure (if the emergency supply is specified).

All air circuit breakers shall be triple-pole withdrawable type. They shall have manually and electrically operated spring charge closing mechanisms and three dual-magnetic (long time-delay and instantaneous) over-current trip devices unless specified otherwise (such as short time delay for selective tripping). Electrically operated breakers shall have a push button on the eseutheon of the breakers.

All the incoming breakers shall have six changes over auxiliary contacts. All outgoing ACB/MCCI3 shall have four changeover auxiliary contacts.

Each breaker of 630A or more shall be supported within its compartment by a roll out track which is part of the withdrawable mechanism attached to the sides of the compartment. All the circuit breakers of the same type and rating shall be entirely interchangeable.

All circuit breakers shall be temperature compensated at the manufacturer's works to give the current rating indicated 011 the drawings at 50 deg. C. Non compensated breakers will not be approved. A formal certificate will be required from the manufacturer confirming that the breakers have been suitably temperature compensated.

The contractor will be responsible for ensuring that any back-up (current limiting) fuse protection is provided in circuit breaker switch boards as necessary. Any such current limiting fuses shall be appropriately labeled to indicate their function.

The cubicle shall be front operated with a mechanical ON/OFF position indicator and shall be designed and tested in accordance with relevant standards.

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The cubicle shall be capable of being extended in either direction for further MCCBs as necessary.

The main incoming supply shall he complete with a flush mounted unbalanced polyphase KWh meter, an ammeter, CTs, phase to phase voltmeter. Each meter shall have a phase selector switch and indication lamps. And set for the main incoming supply an~ the other two sets for the essential distribution panels to indicate that the load is "ON" through the generator (if specified).

The switchboard shall be complete with adjustable gland plates, clamps, cable boxes for the incoming and outgoing circuits. There shall be adequate channel frames, drilled or slotted for ease of assembly, to support cable tails, clamps and terminations within the cubicles. All entries and openings shall be vermin-proof. All live conductive parts shall be shielded in such a manner that they cannot be accidentally touched when the doors are open.

The degree of protection of the switch boards enclosure should be IP 31 or above.

12.25 Distribution Circuit Breaker Boards (Sub Main Boards)

These shall be self contained, rust proof, durable stoves silver grey hammered enameled. cubicle pattern form 2 sheet steel units complete with circuit breakers of the size and ratings required to meet the power demand, All distribution boards shall contain an integral main isolator/MCC8 and MCCB as outgoing of appropriate capacity.

The short circuit capacity of the distribution boards shall be rated to withstand the sort circuit level of the position it is installed. A short circuit level calculation shall be submitted to the Engineer and the short circuit level of the distribution board shall be sized accordingly.

A sub-feed neutral assembly with a removable link for isolation shall be available as an integral part of the distribution board. Earthing bar assembly shall also be available to facilitate the connection of carth continuity conductors.

Door locks shall be fitted as standard to all distribution boards and all the locks shall be keyed alike. The degree of protection of switch board shall comply with BS 5490 and IP 31 of IEC 529 or upgrade to meet the requirement of particular location.

12.26 MCB Distribution Boards

The MCB distribution boards shall be flush-mounting type, rust proof sheet units, complete with miniature circuit breakers providing thermal overload and magnetic short-circuit protection, as shown on the drawings. The. Enclosure protection shall be IP 31 while the complete assembly sha1l comply with BS 5486 Part 12.

The MCBs shall be mounted on either 3 phase or single phase or split busbars as appropriate. All MCB main distribution boards shall be provided with an integral main isolator/MCB with a suitable capacity. All spaces which are not provided with breakers shall be covered with blank plates. As a standard item, all MCB boards shall be provided with permanent circuit identification charts to the approval of the Engineer.

A final sub-circuit neutral assembly and an earthing bar assembly shall be available to facilitate the connection of neutral conductors and protective conractors respectively.

All MCSs connected to incandescent and fluorescent lighting shall be protection Type 3 and those connected to general purpose sockets and water heater shall be protection Type 2. Final sub-circuit for FCUs and other inductive loads to be provided with Type 3 breaker. The three pole circuit breaker shall be common trip with individual spring pressure on each contact. The minimum short circuit breaking capacity of MCBs shall 6 KA. All the circuit

breakers shall comply to BS 3871 part I, with amendments and shall be constructed and tested with same.

All circuit breakers shall be factory calibrated to ambient temperature of 50 degree C.

Earth leakage circuit breakers or circuit breakers with integral residual current devices shall be provided in accordance with the DEWA regulations.

NOTE:
The electrical load calculations have been worked out on a basis of 415/240v, 50 Hz supply and a power factor of 0.8.

The contractor will be responsible to improve the power factor upto 0.9 by using suitably designed capacitor hank to be installed in the main incoming circuit of MDB.

12.27 Silicon Rubber Insulated Cables

In the even of conductors in connections to lighting fittings, accessories or appliances being subjected to possible excessive temperature through transfer to heat from such equipment, then cables of a heat resisting type such as silicon rubber flexible cord complying with BS 6500 shall he used.

12.28 Flexible Cords

Flexible cords shall be of an approved manufacture to BS 3456 and shall comply with the lEE Regulations with respect to current ratings and weight supported.

12.29 Compression Glands for PVC/SWA/PVC

Compression glands shall be weatherproof/water proof type having all metal parts of brass, bright dipped to resist corrosion and shall comply with BS 4121 and have a PCP shroud.

12.30 PVC Insulated Wire Armoured PVC Sheathed Power Cables (PVC, SWA and Sheathed).

PVC and PVC sheathed cables sha11 have high conductivity copper conductors complying with BS 6360 and the insulation and armour shall comply with BS 6346. The cables used on 380 volt 3 phase and neutral 4 - wire supply shall be rated 600/1100 volt.

It will be the Electrical Contractor's responsibility to ensure that the ohmic value of the sheathing wires of any cable installed is within the requirements laid down by the Institution of Electrical Engineers. If any cable is installed and found not to comply, a separate earth continuity conductor shall be installed and all expenses incurred will be the responsibility of the Electrical Contractor.

Where joints are permitted by the Engineer they shall:-

- be in standard underground junction boxes purpose made for PVC/Wire armouredl PVC cable, Lind filled with a cold pouring compound.
- have conductors joined with soldered split ferrules. The conductor joint being wrapped with PVC tape to give an installation value equal to that of the original insulation.

- have conductor joints made using solder to BS 219(1959) Grade G or F Cables shall be installed:

1. on routes approved by the Consulting Engineers before installation in commenced.

2. In such a manner that the cables and cleats do not come into contact with gas, oil, steam, hoc or colt! Water pipes.

3. In ducts and on walls of buildings by means. of silicon aluminium claw type cleats as manufactured by S.L Callenders Cables Ltd., or cleats of other designs approved by the Engineer, or cable trays throughout their length. Sample of alternativc cleats must be submitted to the Engineer for approval.

4. Using cleats of the correct type and size to suit the overall diameter of the cable and /or cable tray. The cleats being installed at spacing centres positioned to prevent sag and give satisfactory support to cables in such a manner that no undue strain is put on the cable or sealing glands. All cables shall be supported individually when installed on multi-route runs and spaced at not less than 25 mm from each other.

5. In pitch fibre or ADS ducts of diameters as shown/approved by the Engineer, sealed with compound where cable access is required to buildings/structures. Bung type seals of approved manufacture may be allowed and all spare pipes to be sealed properly.

6. buried to a minimum depth of 600mm in undeveloped ground, and to a minimum depth of 750mm where crossing roadway, where it shall be enclosed in a pitch fibre pipe having minimum diameter of 200mm

7. Surrounded by a minimum of 75mm of sifted soil or sand where buried in the ground and at approx. 200mm below surface Electrical Contractor shall supply and install heavy gauge polyethylene type coloured yellow complete with printed warning, all as manufactured by Hepworth Iron Co. Ltd., equal and approved. .

8. Inspected by the Engineer before backfilling is commenced.

9. Indicated where buried by concrete cable markers laid at level with the finished ground surface. The markers shall be spaced at intervals of 50m on straight runs and shall be installed at all 'tees', through joints and sudden change. of direction. Where change of direction occurs the marker should be fitted with arrows t denote same. Markers shall be fitted with lead inserts indicating voltage, direction and type of joint. In unmade ground markers shall be suitable concrete posts standing 150 - 200mm above the ground and complete with the relevant information.

10. The supply of the cable markers will be the responsibility of the Electrical Contractor.

11. Indicated where entering buildings by a brass plate fixed to the wall above, - suitably engraved detailing size and voltage of cable.

12.31 Electrical Accessories

12.31.1 Local Switches

The local switches shall be 5/15120 amp. circuit switches shall be one way. two way, intermediate or double pole as required. Where more than one switch is required at any position multiple gang units shall be used.

Switches shall be of the quick start make, slow type specially designed for AC circuits to BS 3676. The operation of the switch shall not depend wholly on the action of the spring. The switches shall generally be of the rocker operated type.

All switch boxes shall be galvanized steel and shall be supplied with adjustable steel grids and earthing terminals.

Generally, switch units shall be of the adjustable grid pattern and to be secured to the adjustable grid by means of screws. For flush mounting switches the switch plate shall overlap all edges of the box by not less than 7mm. For surface mounting switches the switch plate shall finish flush with the edges of the switch boxes. Switches for water heaters and fan coil units shall be complete with neon indicator lights.

In plant rooms the switch units weather proof and shall be surface or flush as required.

Local switches shall be arranged in convenient positions for switching the various circuits.

The switches shall be of the same manufacture for a particular type of switch throughout the installation. All accessories in wet and damp areas shall be of the splash proof type to IP54 protection standard.

12.31.2 Power Outlets

The switch socket outlets shall be in accordance with BS 1363 and BS546 as appropriate. Unless otherwise stated 13 amp switch socket outlets and spur boxes shall be wired on ring main circuits.

The switch socket outlets shall be assembled in single or multiple units in steel boxes.

All boxes shall be supplied with adjustable steel grids and earthing terminals.

All floor mounted socket outlets shall be fixed as part of the under floor trunking service boxes.

These outlets shall be of the sai11e manufacturer throughout the installation.

12.31.3 15 amp outlets

All 15 amp switched socket outlets shall be of the switch shuttered 15A type to BS 546: 1950 with round pins. They shall be coloured white with pilot light and suitable for flush mounting. Each socket outlet shall be provided with a white unfused round pin 15 amp. Plug.

12.31.4 Neon Indicators

These switches shall be used to control the circuits with water heaters and shall be flush mounted white and of the rating indicated with the words "Water Heater" inscribed.

12.31.5 30/50 Amp Cooker Control Unit

The cooker control units shall be of the flush mounted type, ivory colour and shall incorporate two pilot lamps, one for the cooker and one for the 13 amp auxiliary switched socket outlet.

A switch shall also be incorporated for the cooker as manufactured by MK, MEM or equal and approved.

12.31.6 Telephone Socket Outlets

Telephone outlets shall be flush mounted type. These shall be of the same make and plate finish of the adjacent socket outlets.

12.31.7 TV/FM Socket Outlets

These sockets shall be suitable as either loop wired sockets or terminal sockets as appropriate. When used as a terminal socket, free clamp shall be closed with a terminal socket free clamp shall be closed with a terminal resistor of 75 ohm. These sockets shall incorporate two numbers of outlets, designated TV and FM systems respectively. The through pass attenuation shall not be less than 1.2 D over the frequency range 47-890 MHz.

The TV IFM socket outlets shall have the same finish as the adjacent outlets.

12.31.8 Fuse Connection Units/DP Switches

These shall he of flush or surface mounting type as manufactured in compliance with BS 5733 and BS 3676 as appropriate. The fuse connection units shall incorporate integral switch, neon indicator and 13 amp fuse links to BS 1362. The DP switches supplied for water heaters shall be incorporated with neon indicator lights and these also shall be engraved 'Water Heater'. When the 20 A DP switches are used to connect air handling units, these shall be supplied with an integral switch and a flexible outlet.

These shall he of the same manufacturer for a particular type of switch throughout the installation and shall be complete with the other accessories installed.

12.31.9 Air Operated Pressure Switch

The remote air switch system shall be operated by momentarily depressing a soft touch pressure transmitter button, which shall. Create pressure and operate via 1 /4" PVC air hose, a remote air pressure switch completing electrical circuit.

The electrical circuit shall remain activated until the soft touch button is momentarily depressed again. The shape of the switch shall be to Architects approval. However, the plate and the switch finish shall he electroplated matching other electrical accessories.

12.32 Isolators

These shall be of the surface mounted type comprising rust-protected sheet steel enclosures having conduit knockouts in the top and bottom plates and an access plate.

They shall incorporate quick make break contacts switches suitable for 380 Volt 50 Hz.

If situated outside they shall be protected against the weather. Where "Fireman's Switch" is indicated these shall be similar to MEM list No. 215/230 A, together with Nameplate list No.2 FNP.

12.33 Starters

Contactor starters shall be used where necessary and where indicated on the drawings. These shall be complete with stop/start buttons or be suitable for remote control depending on application, but shall have motor isolator switch and thermal overloads as part of contactor. Enclosures shall be fitted with dustproof gaskets or neoprene wall mounting and shall be similar to Crabtree Ltd., T6 or T16 or MEM Ltd., Memline or equal and approved.

12.34 Weather proof Housings

These shall be as manufactured by GEC - Henley Ltd. Dwarf range with Castell locks on door or equal and approved and shall be used where electrical equipment is mounted externally, e.g. distribution board for football floodlights.

12.35 Mineral Insulated Copper Covered Cables PVC Sheathed (MICC PVC)

All MICe cables shall be of an approved type and shall be complete with PVC sheath. The ends of the mineral insulated copper cables shall be protected from moisture by being suitably sealed and the insulation shall be thoroughly dry before scaling material is-applied. Such sealing material, and any material used to insulate the conductors' where they merge from the insulation shall have insulation and moisture proofing properties and shall retain these properties throughout the range of temperatures to , which the cable is subjected to in service. All terminations shall t BS 6207/Part 1 or any additional amendments to this specification.

It shall be fastened to wall cable trays at intervals recommended by the manufacturer with the correct saddles, i.e. plastic covered for PVC MICC etc., and in accordance with Table B2M of the lEE Regulations.

High temperature seals shall be used throughout and for temperatures up to 185°C' shall comprise high temperature compound as recommended by the cable manufacturer with fibre glass disc and P.T.F.E. slceving. Seals for temperatures above 185°C shall comprise a fused powder glass compound with porcelain bead sleeving.

Wedge type post seals shall not be unless stated otherwise in the contract documents.

Standard brass ring type compression glands shall be used at all terminations except for flameproof installations and flush mounted accessories. The standard gland shall terminate in a factory made metal box or enclosure suitably rapped to accept the gland

thread, or alternatively where a tapped hole is not practical, a ring type bush gland shall be used secured with suitable brass bush and compression washer.

Made off by means of coupling, male bush and compression washer where entries are made to equipment and which do not have a spouted *entry.* Where ample clearance is available and clearance holes are provided cable may be made off with brass locknuts and female bushes.

Standard glands for tapped entry units shall have a minimum of five full thread engagements. PVC shrouds shall be fitted to all glands.

Flameproof glands shall be used on fireproof installations, suitable for use with certified enclosures in atmospheres containing groups 2 and 3 as defined in BS 229 and in accordance with the cable manufacturer's recommendations.

All terminations and bends shall be made with the correct tool as recommended by thecable manufacturer.

12.36 Conduit and Fittings

All conduits shall he of high impact heavy gauge PVE conduit to BS 4607. Each point switch or switch socket shall be enclosed in a non-ferrous metal or rigid PVE box and at each lighting point a riding PVE coiling box to which a ceiling rose of fitting may be directly attached shall be provided and fixed. This shall be a deep well box type for cover on fair faced concrete. All sections of the conduit and relevant boxes shall be properly cleaned and glued using appropriate epoxy resin glue and the proper connecting pieces.

Inspection type conduit fittings such as inspection boxes, drawn boxes, bends elbows and tees shall be so installed that they can remain accessible for existing cables or the installing of the additional cables.

The number of conductors installed in any conduit shall not exceed, the number specified in the relevant IEE regulations

Conduit runs shall be so arranged that all lead and return wires of each circuit shall be run in the same circuit. All conduits shall be run on vertical and horizontal planes and not diagonally. All conduits shall be smooth in bore, true in size, and all ends where conduits are cut shall be carefully made true and all sharp edges trimmed. Proper bushes shall be used where terminating in boxes. All joints between lengths of conduit or between conduits and fitting boxes shall be pushed firmly together and glued properly with suitable glue.

All conduit work shall be erected complete with distribution boards, main switches, boxes, etc., connected and shall be inspected and approved before any cables are installed.

In general, conduit systems shall he concealed in floors, walls and roof slabs wherever practicable. Conduits recessed in block walls shall be fixed in chases cut in the blockwork, at a depth *to* permit a full 10 mm covering of cement and sand before plastering.

Earth continuity shall be provided by the appropriate earth continuity conductor as per the relevant TEE regulations.

12.37 Cable Tray

Prefabricated mild steel cable trays shall be constructed of 1.6mm (16swg) steel and finished hot dipped galvanized. All trays supporting power cables shall be heavy duty and those supporting tire alarm MICS/PVC covered cables shall be light duty.

Cable trays, bends and junctions shall be provided as necessary and shall be similar type and finish. The trays shall be of adequate widths to support the necessary cables. They shall be adequately supported throughout the length or run at intervals not exceeding 1200mm. All cables will be fixed to the cable tray utilizing cable ties.
Ventilated covers to be provided for all cable trays exposed *to* direct sunlight

12.38 Cable Trunking

Cable trunking shall be of sheet steel fabrication, galvanized. The access plate of the trunking shall be removable in easily handled sections over the entire length of straight runs. Overlapping collar sections or other similar approved linking arrangement shall be provided at the junction of the various sections of the trunking. A fixing shall be so arranged that there are no projecting screw threads or similar points within the. trunking which may cause damage to the cables. The section of the trunking shall not be so changed at deviations from the straight as to decrease the cross sectional area.

Positive continuity links shall be supplied and fixed at all trunking section interconnection points.

The whole of the requirements for conditions elsewhere in this specification shall wherever appropriate be deemed to apply to steel trunking.

Drawings showing all details of manufacture of the trunking and in particular drawings and details of special sections, sets of intersections shall be submitted to the Engineer for approval before proceeding. Draw wire will be left in all service trunking for ease of installation.

Cable trunking, ducting and fit1ings should comply with BS 4678. All materials and accessories should be from one manufacturer.

12.39 Cables in Conduit and Trunking

All single core PVC cables shall comply with BS 6004 and elastomer insulated cables with BS 6007 and shall be rated for 600 volt phase to earth and 1000 volt between phases.

12.40 Sealing Materials

Neoprene and similar synthetic compounds, not subject to deterioration due to climate conditions are to be used to gaskets, sealing rings, diaphragms etc., and not rubber based materials.

12.41 Adhesives

Adhesives are to be specially selected to ensure the use of types which are impervious to moisture and resistant to mould growth.

12.42 Nuts, Bolts, Studs and Washers

Nuts, and bolts for incorporation in the installation are to conform with the requirements of the appropriate British Standards. When in position all bolts and studs are to project through the corresponding nut a minimum of two threads, and such projection is not to exceed 1cm. Bolts shall be provided complete with all washers including locking devices and anti-vibration arrangements. These are to be brass or galvanized for prevention against corrosion.

12.43 Wood

When used, woodwork shall he free of sap and wane, warp knots, faults and other blemishes and rendered thoroughly resistant to fungal decay and termite attacks.

12.44 Screws, Springs, etc.

Steel screws when used are to be zinc, cadmium or chromium plated or, when plating is not possible, are to be corrosion resisting steel. Al1 wood screws are to be of an approved finish and springs whenever used are to be of non-rusting materials, e.g. Phosphor bronze or nickel silver.

12.45 Telephone Installations

The contractor shall be responsible for providing conduiting and trunking system suitable for the necessary future cabling works. to the approval of ETISALAT.

The contractor shall liaise with ETISALAT to ensure that the cable entry ducts and internal conduit/trunking tray installations are approved prior to carrying out the installation work.
.
Telephone outlet plates shall be of a type approved by ETISALA T and shall be supplied and installed by the Contractor. The outlet plate finish shall match the finish of other wiring accessories in the same area Electrical Installation

All external cable ducts, manholes and draw pits shall be of a size and specifications that is approved by ETISALAT.

12.46 Central Antenna Television System (M.A.T.V.)

The contractor will supply, install and commission a television/radio distributor system of an approved design, capable of receiving and distributing all present transmissions as listed with sufficient allowance as made to include any future, transmissions, within the foreseeable future, without degrading of the system parameters. Provision within the system shall be made in order to install a second satellite dish in future.

12.46.1 System Parameters

BS 6330:1983

Conform to an overall minimum total signal/cross modulation ratio of 46 dB with a max. output for all present and future programmes set with an allowance of at least 3 dB output under all known conditions.

Confirm to a minimum 42 dB signal/noise ration for all stipulated programmes except by agreement, where received signals. Will not allow this condition

A pre-planning site survey will take into account the following factors which must be satisfactory as agreed by a representative of the authority.

a. Adequate signal levels (not less than 73 dB) to provide the specified signal/noise ratio or an agreed satisfactory subjective result.

b. Clean signals free from reflections and co-channel interference effects.

c. Regard to be paid to any very high level local field strengths leading to possible. Immunity and pre-image problems.

d. Possibility of interference from any source that may interfere with the system performance.

12.46.2 Selected-Channels for the System

• Abu Dhabi	I	CH	6
• Abu Dhabi	I	CH	11
• Abu Dhabi	II	CH	43
• Dubai	I	CH	41
• Dubai	II	CH	33
• Qatar	I	CH	9
• Qatar	II	CH	49
• Bahrain	II	CH	55
• Saudi	II	CH	29
• Sharjah		CH	22 OR 54
• BBC World Programme			
• Sport Channel			
• Entertainment Channel			
• Video modulator			
• CNN			
• ESC Egyption Satellite Channel			
• DTV Dubai Satellite Channel			
• A/D TV-Abu Dhabi Satellite Channel			
• MBC Middle East Broad Channel			
• Jordan			
• Radio			

The system shall be of a modular construction, thus making it possible to add extra stations at a later date

The system shall be designed to function on field strength levels of local transmissions and designed output level from the CH amp shall be 118 dB/uv for the highest transmission frequency within the system.

12.46.3 Signal Levels at Subscriber Outlets

	Max.	Min.	Max. Difference between Channels	
			In Bands	Between Bands
VHF and UHF systems (including signal adapter outputs)				
Band 1 & 3	5mv	0.7mv	12dB	16dB
Band 4	10mv	1.9mv	12dB	16dB
Band 5	10mv	15mv	J2dB	1GLIB

The system shall be manufactured by a single supplier and mounted within a steel cabinet. A 13 amp test socket shall be installed within the cabinet for the future connection of signal test equipment to aid the service requirement.

12.47 Dish Antennae System

The system shall include but not be limited to the followings:3

- Semi professional TV aerials
- 12" star satellite dish 2 No. with A V output
- Pre-amplifiers.
- Sound broadcast band amplifiers
- VHF/UHF channel amplifier with AGC +/- 10 dB and frequency converter including all necessary power supply and mounting accessories.
- All necessary sockets, splitters, taps and filters.

The aerials shall be of a semi-professional construction with the following specification. The UHF aerials to be of a double boom design so as to increase the stability of the incoming signal.

12.47.1 Band 4/5

- Bracket: Hot galvanized steel sheet 4mm thick coating at least 700101.
- Antenna Support: Hot galvanized steel tube 42 x 20 x 2mm coating 2t least 700101.
- Supporting Tube: Aluminium 20 x 20 x 201m cremated.
- Director Elements Aluminium ': 10 x 1 mm cremated.
- Gain 16.5dB (with the exception of local station)

12.47.2 Band 3

- Bracket: Hot galvanized *steel* sheet 2mm thick coating at least 70mm.
- Antenna Support: Aluminium 20 x 2mm cremated.
- Supporting Tube: Aluminium 20 x 20 x 2rnrn cremated.
- Director Elements Aluminium: 12 x 1mm cremated.

- Gain 12dB (with the exception of local station)

12.47.3 FM

A suitable uni-directional FM aerial will be used for the AM/FM reception.

12.47.4 Satellite Receiving System

The system shall consist of, but not he limited to the following typical equipment for the reception of the following channels:

a. ASIA SAT.

- BBC World News
- MTV Music Programme
- Sports Channel
- Entertainment Channel plus 1 spare receiver and modulator for future channel.

b. ARAB SAT.

- CNN
- ESC Egyptian Sate1litc Channel
- DTV Dubai Sate1lite Channel
- A/D TV-Abu Dhabi Satellite Channel
- MBC Middle East Broad Casting Channel
- Jordan

12.47.5 Typical Equipment

no. 12" mesh dish complete with "C" band LNBS and all necessary feeder cables and line splitters.
11 nos. Channel receivers.
11 nos. Modulators with RF output.

12.47.6 Satellite Dish

• Band	: C band/3.7 – 4.2 GHz
• Diameter	: 12 feet
• Gain	: 44dB
• Materials	: Solid Aluminium/Mesh
• Polarization	: Linear or circular
• Operating	: Up to + 60 deg. C
• Mounting	: Horizon to horizon

12.47.7 Feed Horn & LNB Output

• Output Frequency	950 MHz – 1450 MHz
• Gain	64 dB
• Gain Flatness	+/- dB p-p
• Noise Figure	75 deg. K

12.47.8 Modular Receiver

• Input frequency	950 – 1750 MHz
• PLL Tuning steps	64 dB
• Frequency stability	+/- 50 KHz
• Input Impedance	75 ohms
• Image rejection	47dB

12.47.9 Modular Modulator

• Output Channel	Non adjacent to existing
• Video Output	IV P-P
• PLL Tuning	250 KHz
• Frequency Stability	+/- 20 KHz
• Output	95 dB/uv

12.47.10 Notch Filters & Mast Head Amp

Notch Filters will be used to cut out strong adjacent signals particularly in the VHF Band 3 range min. notch depth shall be 20dB

Channel mast head amplifier shall be installed to cover all remote stations with the minimum gain and noise figure as listed.

DB	Gain DB	Noise
Band 1	15	4.5
Band 3	20	5.5
UHF	20	6

12.47.11 Channel Amplifier

High qualify AGC with a minimum range +/- 10dB shall be used for each channel. The minimum output to be 123 dBuv per amp. The minimum gain noise:

DB	Gain DB	Noise
Band 1	40	5.0
Band 3	45	6.5
UHF	45	8.5

12.4 7 .12 Channel Convertor

All channels shall be converted. The channel converters shall convert the input CH to IF anti then the IF to output channel.

Because of the large number of outlets it will be necessary to convert the high frequency channels to lower frequency in order to aid the distribution system. A1so to avoid interference caused by neighbouring channel and prevent interference due to direct radiation of strong loca1 stations direct on the TV receiver.

12.47.13 Power Supply

The correct number of power supplied to be given to cover the required load to spares and extra power supply capacity, shall be given within the unit to add a possib1e 2 extra channe1s at a later date.

12.47.14 AGC Extender

AGC extenders shall be used for channels 1, 22, 33, 4 and 43 to extend the AGC range to minimum 40 dB.

12.47.15 TV/FM Socket

These sockets shall be used as terminal socket free clamps shall be enclosed with a terminal resistor of 75 ohm. Separate conduit/ wire shall be provided from a splitter/ tapoff for each socket outlet. These sockets shall incorporate two numbers of outlets, designated TV and FM systems respectively. The contractor allow for the through pass attenuation for the particular type of outlet used when designing the TV distribution system. The TV /Fm socket outlets shall be of the same make and finish of the adjacent power/telephone outlets.

12.47.16 Mast/Dish

The mast and the dish assembly to be designed and submitted for approval prior to commencing works. All load and wind factors must be taken into consideration when designing the above mast. The mast shall be self supporting and connected to the 1ighting protection network. The mast shall be suitable for withstanding a wind speed 160 km/hr.

12.47.17 Cables

Low loss 75 coax cable to be used for trunk feeder and sub-distribution circuits. Typical loss for the coax cable shall be as follows based on 100 meters at 800 Mz.

- For internal room wiring 18 dB/IOO Mtrs.
- For trunk feeder and main line 11 dB / 100 Mtrs.

12.48 Music /Paging System

12.48.1 General

The contractor 5hal1 design, supply, install, test and commission a background music/public address system comprising of amplifier rack, paging microphone, loudspeaker5, twin tape deck, tuner, volumecontr01s, bed head pane1s or cabinet mounted panels and all necessary cabling and terminations. The system shall be generally as indicated in the drawings and as herein specified, to the approval of the Engineer. The systems shall camp1y with BS 6259:1982.

The installation shall be suitable for:

- Providing background music and paging facility in the corridors and general areas.
- Providing four channels of music at the bed head panels or cabinet mounted panels with local selection facility.

The general area shall be divided into eight zones for paging purposes; each floor forming a separate zone. It shall be possible to individually select any or all zones for paging. Any paging message shall precede a two or three note chime. Paging any zones shall not interrupt music in the other zones.

The music sources shall include and AM/FM tuner, two twin tape decks and a CD player, Selection of music in the general area shall be from the amplifier rack. The guest rooms shall be provided with bed head panels or cabinet mounted panels to the approval of the Engineer with built in volume controls and channel selectors. All equipment shall be from the same manufacturer.

12.48.2 Amplifier Rack

All the control equipment, amplifiers, cassette decks and tuners shall be housed in purpose built 19" racks. The rack shall have lockable front glass door and adequate ventilation louvers including fan.

12.48.3 Amplifiers

The amplifiers shall he modular in construction to .1110w plugging in of up to six input preamplifier modules to the main frame. The amplifiers shall have the following specifications.

- Output power: The nominal output power shall be 75w, 150w or 300w rms to meet the load demand.
- Output Voltage: 100V
- Output Regulation: 100V line, 3dB down: 1 to 1.5 dB
- Frequency Response: 60 Hz - 20,000 Hz.
- Total Harmonic Distortion: < 0.4%
- Sensitivity: 0dBm. 775m V01tc; @ 100 kohms unbalanced.

12.48.4 AM/FM Tuner

The tuner sha11 be a module plugable to the amplifier main frame with provision for up to six preset stations, two of which shall be dedicated to MW or LW. It shall have the following characteristics.

Sensitivity: 3uV for FM channels

20uV for, 26dB SNR for AM section.
Distortion: 1 % THD
IF rejection: 70dB

12.48.5 Tape Deck

The tape deck shall be a twin deck, auto-reversing cassette player, with silence sensing .and auto eject facilities for faulty tapes. It shall accept standard C60 and C90 music. cassettes. The playing sequence shall be cassette 1, side 1 followed by cassette 2, side 1.While cassette

2 is playing, cassette 1 shall be cued up by auto-reversing. The tape deck shall have the fo1lowing characteristics:

• Output level	0dBm (775m V) 600 ohms mono output
• Frequency range	60Hz to 12,500 Hz +/- 3 dB
• Distortion	< 3% THD at 1 KHz
• Single to Noise ration	< 49 dB
• Tape speed	4.75 cm/sec
• Fast forward/Rewind Times	<140sec to rewind .a C60 cassette

12.43.6 CD Player

The CD player shall be a multi-play one to allow loading of upto .six cards to provide many hours of unrepeated play. It shall be capable of playing all discs sequentially or randomly. The CD player shall have the following characteristics:

• Frequency range	20Hz to 20,000 Hz +/- 1 dB
• Distortion	0.008 % THD at 1 KHz
• Signal to Noise ration	90 dB
• Channel Separation	82 dB
• Quantization	16bit twin DAC, 4 times oversampling

12.48.7 Microphone

The paging microphone shall be desk top mounted on adjustable gooseneck with push buttons for selective paging of different zones and an all call button for total paging. Zone selections shall activate a tone generator and produce a chime tone prior to announcements. The microphone shall be muted during the period of chime tone. It shall have a frequency response for effective noise free performance. It shall have a frequency response of 150-11000 Hz, a sensitivity of 1.65 mV/pa +/- 3dB at 1 KHz and an impedance of 300 ohms floating.

12.48.8 Volume Control

Continuously rotation type with 6d13 steps via transformer tapping to control loads from 2 to 100w. A paging over ride relay sha1l be incorporated in the volume control", Volume controls shall be installed for each of the paging zones.

12.48.9 Loudspeakers

Loudspeakers shall be installed in the areas to achieve a uniform sound level and shall be recessed to the ceiling or wall mounting type as appropriate and as indicated in the drawings. all loudspeakers shall have 100 volt transformers to match 100 volt amplifier outputs.

12.48.10 Ceiling Mounted Loudspeakers

Recessed speakers shall have an appropriate front grille .and mounting plate with, locking clamps. The loudspeakers shall have' a power handling capacity of 6 watts with step-down facilities to 3 and 1.5 watts. They shall be provided with 100 volt transformers to match 100 Volts amplifier outputs. The frequency response shall be 75-12,500 Hz with a sound pressure level of96 dB at a load of 1 watt at 1 meter distance and at 100 Hz. The speaker grilles shall be circular and sha11 be housed in tire done cabinet.

12.48.11 Column Loudspeakers

Weatherproof column loudspeakers with .aluminium alloy finish shall be installed in the swimming pool area as indicated in the drawings. It shall have a maximum power rating of 20 watts and shall have a built in 100 volt line transformer. The transformer shall have tapings at 20, 10, 5 and 1.5 watts. The frequency response shall e from 180 to 12,000 Hz. Fixing brackets shall be provided for angled positioning of the speakers.

12.48.12 Bedheads panels or cabinet mounted panels.

The panel size should he coordinated with the furniture and the location to be approved by the Engineer at site with the co-ordination of the architect.

The panel shall be installed in the guest room to allow selection of six channels music, programmes.

The amplifiers and music sources for the channel music system shall be housed in the same rack for the background music/paging system. The amplifiers shall he selected to, meet the combined demand of both systems to achieve the system requirement" specified above.

12.49 Fire Alarm System

12.49.1 General

The contractor shall supply, install, test and commission a complete analogue addressable fire alarm and. detection system to meet the functional requirement of BS 5839 19S8and to 'comply with the local fire officer’s requirements.

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The system shall be an independent self contained system inc1uding the main fire alarm panel, smoke and heat detectors, manua1 break glass points, bells batteries and battery charger as indicated on the contract drawings.

12.49.2 Fire Alarm Control Panel

Where shown on the drawings, provide and install a mu1ti-zone fire 21arm control pal1el, construction shall be modular with solid state microprocessor based electronics. All visual indicators shall be high contract LED type.
The control panel shall contain the following features:

- Indication Device Circuits (smoke. heat. smash glass, etc.) two alarm indicating appliance circuits (bells, horns, etc.) with suitable rating.
- Supervised repeater panel circuits
- Two auxiliary alarm relays with suitable rating.
- One trouble auxiliary relay.

- Earth ground supervision circuit.
- Power supply unit with a tinkle charger rated in accordance with BS 5839. The batteries shall be scaled lead acid which require no maintenance with voltmeter and ammeter' *to* indicate battery voltage and charging current
- Supervised manual evacuation switch.
- Option for multiplex serial repeater panel. .
- Battery fault.
- Charger fault.

This panel shall be provided with controls and indications for satisfactory operation of the complete fire alarm panel.
The indicator lights should be dedicated to each fire zone ns follows:

• Fire manual or thermal	- Red
• Sprinkler flow switch.	- White
• Duct smoke detectors	- Blue
• Area smoke	- Blue

Each stair well and lift shafts shall be provided with separate indicators. The common control indicators shall include but not he limited to the following:

- Trouble signal, trouble indicator, silencing switch.
- Power on indicator
- System reset switch
- .Alarm signal silence switch C/W indicator
- Total evacuation switch with indicator
- Total evacuation cancel switch with indicator

The Control Panel Shall Have As Standard Facilities

a. Walk Test

Testing may be carried out by one Engineer by operating a facility switch. The control causes the sounders to pulse the number 'of the zone the detector is connected to an then resets automatically.

b. Alarm Verification

Actuation of a smoke detector shall initiate an alarm verification procedure wehreby *the* panel will reset the activated detector and wait for a second alarm activation. If within one minute after resetting a second alarm is reported from the same or any other detector, the system shall process the alarm immediately.

If no. second alarm is received, the. system shall resume normal operation. Alarm verification shall only function on smoke detector alarms. Other activated initiating devices shall be proceeded immediately.

c. Non Volatile Memory

System operating instruction shall not be erased or corrupted by loss of primary or secondary power. Re-programming shall be possible on site without the use of off board programmers modems or special tools.

12.50 Accessories

12.50.1 Smoke Detector

The detector shall be of the Dual Chamber Design and shall have mesh insect screens and have completely closed backs to restrict entry of dust and air turbulence. Electronics of the unit shall be completely shielded to protect against false alarms from EMI and RFI. The detector heat shall be easily dis-assembled to facilitate cleaning.

The detectors shall contain a red LED which shall pulse to indicate power on and which glow continuously to indicate alarm. The detector sha1l contain a functional test switch (magnetica1ly operated) which when operated, will test the electronics of the unit and put it into alarm.
Remote LED indicators shall be installed where indicated.

12.50.2 Heat Detector

The heat detector should be rate of rise type with solid state construction and monitoring LED. Inter changeable plug in base, supply voltage 17 - 28 V DC normal operating temperature 20 deg. C - 90 deg. C.

12.50.3 Alarm Bell

Alarm bells should be 6 and suitable FOR mounting either direct to a wall or to a conduit box. The bell gongs wall should be steel with moulded glass filled polypropylene base plate which houses the monitor and terminal blocks.

12.50.4 Break Glass Units

Break glass units should be standard model which fits a standard switch/socket box for flush installation. Testing should be carried out by inserting the test key which moves glass and can operate the switch.

12.50.5 System Operation

Actuation of a manual station, thermal detector, smoke detector or flow switch in the respective fire zone shall initiate the following:

a. A pre-signal alarm shall sound throughout the remainder of the building.
b. Automatically shut-off all fresh air supply fans, all air handling units and fan coil units. Restarting of these units should be manually controlled from the central control room depending on the fire situation and under fireman's advice.

c. Elevators shall return to the ground floor and keep the doors open. If the fire alarm is initiated on the ground floor the lifts shall stop on the first floor.

12.56 Builder's Work

The expression "Builder's Work" shall mean the ancillary work carried out by the Contractor in connection with the electrical installation.

Builder's work in connection with electrical installations will include the following, but it should be noted that this list is not intended to be exhaustive:

a. Drilling, cutting or leaving of holes for conduits cables, trunking and the like, through walls floors, partitions, roofs, etc., and subsequent making good.

b. Cutting and pinning ends of supports for equipment, switchgear, fittings and the like to walls, floors, partitions, soffits, etc. and making good.

c. Cutting chases for conduit, cnb1cs, trunking und the like in walls, floors, partitions, etc., and subsequent making good.

d. Cutting mort ices, sin kings, recesses, etc. for lighting points, switch points, socket outlet points fitting outlet points and the like in walls, floors, partitions, etc., and subsequent making good.

e. Cutting and fitting around, boring holes through and making good of finishing's up to trunking, lighting points, switch points, socket outlet points and the like.

f. Excavation and backfilling of external pipe or service duct trenches.

g. The construction of concrete, block and /or timber ducts.

h. The building of timber frames, panels and doors including ironmontery, to give access to pipes, ducts equipment and the like.

j. The formation of concrete bases, plinths, etc., for plant and equipment including anti-vibration pads if necessary.

k. The painting of exposed conduit, trunking, cables, equipment etc.

AIR CONDITIONING INSTALLATION

13.1 General

The Air Conditioning installation shall be carried out by a sub-contractor approved by the Engineer.

13.2 General conditions

The General Conditions of Contract and any supplementary conditions of contract shall apply to and form part of this section and all subsections.

The Conditions of contract shall apply to the works carried out by the air conditioning Sub-contractor.

Water, power and lighting shall be provided by the main contractor for the sub-contractor.

The tender drawing showing the air conditions installation are diagrammatic and indicate the general routing of pipes, etc., installation shall be as close to those positions shown on the drawings as possible.

13.3 Electrical Supply

All electrical wiring and conduit to thermostats, fan units, etc. shall be provided by the electrical sub-contractor. It is the responsibility of the sub-contractor to make the final connection and ensure proper operation.

Control diagrams shall be provided.

13.4 Maintenance Manuals

Provide the services of qualified and experienced personnel to prepare proper and complete documentation on the air conditioning system installed. These shall be turned over to the Engineer for approval prior to the final inspection and acceptance.

13.5 Accessibility

All work under this contractor shall be installed so as to be readily accessible for operation, maintenance and repair.

13.6 Guarantee

The Contractor shall guarantee the complete installation for a one year period against workmanship and equipment.

13.7 Tender Instructions

The work under this sub-contractor includes but is not limited to the following items:

- Supply and installation of air conditioning equipment.
- Supply and installation of necessary temperature control equipment.
- Supply and installation of flexible connections to all fan equipment.
- Supply and installation of drains as required.
- Supply and installation of ducts work, insulation, grilles and diffusers.
- Installation of balancing dampers etc.
- Installation of pipe work and insulation.
- Final commissioning and balancing of the complete system to the provision of the applicable ASHARAE standards.

13.8 Pipe work

Piping is not be solidly built in to walls or plaster finish. Pipe joints will not be positioned within the thickness of walls, floors or in any other inaccessible position. Copper pipe to be use for outdoor unit to indoor unit.

13.9 Dissimilar Metals

The contractor shall ensure that there will be no contact between dissimilar metal in order to avoid electrolytic action between metals.

13.10 Ductwork

All duct work shall be supplied and installed with hangers, turning vanes, splitters, balancing dampers, fire dampers, flexible connection etc., as shown on the drawings A.S.H.R.A.E Standard will apply thought out.

All ductwork shall be of the low velocity and low pressure type i.e. less than 2000 ft. / min and less 2 in. W.G All dimensions shown on the drawings are not clears inside dimensions.

All ductwork shall be manufactured from galvanized steel, lock forming quality having a galvanized coating of not less than 1.25 oz/sq.ft. Both sides. Flexible ducts where used for connection of grills and diffusers shall be of the corrugated aluminum or fabric type helically supported by steel wire. Insulation will be applied to flexible ducts.

13.11 Insulation

Insulation will be generally rigid non combustible rigid fibre board of thickness and density as specified on drawings, with a reinforced aluminum foil faced flame resistant craft paper vapour barrier having a maximum rating of 0.02 perms. The Contractor shall submit samples of proposed insulation materials for the Engineer’s approval prior to execution of any work.

13.12 Filters

All Air Handling System shall be provided with washable panel type filters. However, high efficiency V Bank after filters for equipment room air handling units shall be disposable type.

13.14 Condensate Drains

Allow for 25 mm condensate piping per A/H unit installed as shown on the drawing.

CONDITIONS AND WORKMANSHIP

13.15 Compliance with Regulations and Standard

All the materials used and provided and all component method of installation shall be to the relevant. British Standard or code of Practice. Where no such standard or code exits, the principle recommended by the following organization may be used:

1. American Society of Heating Engineers.
2. American Society of Heating, Refrigerating and Air Conditioning Engineers.
3. The British Institute of Chartered Building Services Engineers.
4. The Heating and Ventilating Contractors Association.
5. European DIN Standards.

If the sub-contractor offers material, equipment or test which conforms to standard other than the aforementioned, full details of the difference between the proposed standard and the equivalent B.S in so far as they affect the design and performance of equipment, are to be supplied by the Sub-Contractor to the Engineer.

The Whole of the Work shall be executed with the materials indicated in the subsequent Section of this Specification.

Where the names of Manufactures are stated, together with a detailed specification of their products, these are given as an indication of the quality and workmanship required.

Where such exits, the equipment shall comply with the requirement of the appropriate current British Standard Specification and shall be of the best of their respective kinds, free from all flaws and defects.

All materials shall be new unless otherwise stated. Any materials not accepted and approved in writing by the Engineer shall be removed and replaced by the sub-contractor as his own expense.

In order to obviate any delays caused by the non-delivery of materials, the sub-contractor must place orders immediately instructions have been received by him to proceed with the Works and copies of the orders must be sent to the Engineer for inspection, together with progress reports at the end of each month after order.

The Engineer shall have power to reject any materials and/or workmanship which in his opinion, is unsatisfactory, and to instruct the Sub-Contractor to rectify the same forthwith at the sub-contractor’s expense.

All fitting and/or equipment shall be delivered to the site complete in proper pickings and damaged in transit will be rejected and replaced by the sub-contractor without charge.

13.16 Samples

Before commencing the work the Sub-Contractor shall submit in writing for the written approval of the Engineer details of all apparatus and fitting which he proposed to use in the works. The Sub-Contractor shall prepare obtain and promptly submit to the Engineer to use in the works. The Sub-Contractor shall prepare obtain and promptly submit to the Engineer free of charge for his written approval samples of materials and particulars as requested. All materials supplied which are not equal to the approved samples will be rejected. After being approved the Engineer shall retain such samples as standard references until the completion of the works if he so desires.

13.17 Restrictions

The Subcontractor shall comply none but workmen skilled in their respective trades and must not employ juveniles or unskilled labourers in lieu of skilled workmen. No more than one assistant shall be allowed to be assigned to each skilled workman.

The Engineer reserves the right to dismiss instantly from the works any workman employed by the sub-contractor who may misconduct himself on the site or be incompetent in the opinion of the Engineer.

The direction of the Engineer as to the manner of executing the various works and the proper mode of conducting them shall be at all times be strictly adhered to and the work completed to the satisfaction of the Engineer.

The sub-Contractor and his employees shall be bound to conform with the rules and regulations in force on the site for the proper conduct of the work and must avoid any complications that might cause disputes of strikes amongst his own and the Main Contractor’s workman.

13.18 Safety Precautions

The Sub-Contractor shall take all necessary safety precautions to prevent the possibility or otherwise during the course of the works. The works shall include the provision and fixing of detachable guards of approved design to cover all moving machine parts wherever they may be Located and whether they are intended to be permanent or temporary, and in such a manner as to comply with such step-down transformers as to be used for portable electrical tools.

13.19 Maintenance of Finishing’s

The sub-contractor shall cover up to protect the various works and portions thereof from all damage due to inconsiderate or rough treatment, dust, grit or injury in other ways. All bright parts of fitting shall be covered with transparent sheeting and shall be cleaned and polished before being handed over.

13.20 Marking and Labeling

All items of equipment shall be clearly labeled by means of Traffolyte Labels fixed to the outer surface of equipment to indicate the functions of the unit or circuit controlled by the unit in the English language and/or Arabic language.

13.21 Drawings

Drawings by the sub-contractor shall be approved by the Engineer. The Main Contractor shall be responsible for obtaining approval so that no delay is caused to the works.

The subcontractor shall prepare and submit detailed shop drawings for all equipment and distribution services.

Equipment layout is to be detailed on drawings, showing the exact method of installation and clearly illustrating components to be used in making all connections.

Piping drawings must be fully detailed showing all piping in double line and indicating the precise size and fittings valves and equipment. Positions of hangers and support with reference numbers must be indicated and a large scale detail must be given showing the type and method of installation each type of hanger. A schedule is to included on each drawing, detailing the type of hanger fixing with a reference number for each type.

All general layout drawings to be drawn to 1/50 scale. Details of hangers, methods of fixing of pipes, detailed cross section of pipe ducts and rises, details of control and piping hook-up to equipment are to be drawn to 1/10 scale.

The Sub-Contractor shall supply submit all drawing within the times agreed. After approval, the negative will be signed by the Engineer and returned to the Contractor. Signed and approved drawings will not be departed from unless assigned variation or omission certificate is issued in writing by the Engineer. Drawings returned to the Sub-Contractor for alteration or amendment to be resubmitted to the Engineer for approval.

Amended or altered drawings shall show the nature of the amendment of alternative in a revision block on the drawing, together with the revision.

Manufacturer's performance date, certificated factory drawings and/or curves or apparatus giving full information as to capacity, dimensions, materials and all information pertinent to the adequacy of the submitted equipment shall be submitted for approval.

Manufacture's names, sizes, catalogue number and/or samples of all materials shall also be submitted for approval.

13.22 Submittals

Orders of equipment submitted for approval must be accompanied by relevant drawings, curves, technical data, catalogues and samples, where data, certified drawings or other required information is not available until after orders have been placed. The Engineer will give provisional approval until all request drawing and information have been supplied to the Engineer and approved by him. It is the Sub-Contractor's responsibility to ensure that all

necessary information is supplied to the Engineer in accordance with the progress of the work.

13.23 Provision of record Documents

The Sub-Contractor's attention is drawn to the fact that the records described in items: A) B)and C) below, form part of the sub-contract and the employer shall not accept the installation until all such documents have been handed to the Engineer and are to the satisfaction of the Engineer.

A. Three sets of Record Drawings.
B. Three sets of Manufacture Maintenance and operating Manuals as required.
C. Three sets of operating Maintenance Instructions, fully detailed and cross referenced with a and B, prepared specifically for the works.

13.24 Monthly Schedule of Materials

As soon as praticable after the acceptance of his Tender, or when called for by the Engineer, the Sub-contractor shall be required to submit to the Engineer a fully detailed bar chart, agreed with the Main Contractor, with each operation subdivided to the approval of the Engineer.

13.25 Testing and Commissioning

a) General

All testing, balancing and final adjustment shall be in accordance with the provisions of the applicable ASHRAE standards 2014.

b) Piping System (Refrigerant)

Pressure tests shall be applied to piping only before connection of equipment and appliances.

In no case shall piping, equipment or appliances be subjected to pressure exceeding their rating.

Tests shall be completed and approved before any insulation is applied or pipes, valves and fitting have been concealed. Any leaks or defects uncovered by the tests shall be repaired and the system re-tested.

c) Ductwork System

All branches and outlets shall be tested for air quality and the total of the air quantities shall be within five percent (5%) of the fan capacity. Volume dampers and splitter dampers shall be tested for proper circulation.

Where the equipment, or system, depends upon controls for proper operations, functioning and performance, the latter shall be operated simultaneously with the equipment or system during the tests.

d) **Performance Test**

The performance test of the air conditioning system shall be carried out in the peak summer season, irrespective of the dates of completion and handing over of the works. The contractor shall be responsible to attend all/any snags or rectifications as may be deemed fit by the Engineer, if performance is not satisfactory during this test.

13.26 Materials Plant Pipe work etc

Provide and fix materials, plant, pipe work, etc., all as shown on the drawing and schedule.

13.27 Builder's Works

The expression "Builder's Work" shall mean the ancillary work carried out by the contractor in connection with the air conditioning installation.

Builder's work in connection with the air conditioning installation will include the following, but it should be noted that this list is not intended to be exhaustive:

a) Drilling, cutting or leaving of holes for pipes, ducts, fans and like through walls, floors, partitions, roofs, etc., and subsequently making good.
b) Cutting and pinning ends of supports for pipes, equipment, appliances, fitting, and the like to walls, partitions, soffits, etc., and making good.
c) Cutting or leaving mortises, sinking, etc., for holding down blots, brackets support and the like and grouting in.
d) Cutting chases for pipes and the like in walls, floors, partitions etc. and subsequent making good.
e) Cutting and fitting around, boring holes through and making good of finishing up to pipes, ducts, fans, supports, brackets and the like.
f) Excavation and backfilling of external pipe or service ducts trenches.
g) The Building of meter pits, sumps, access chambers and the like.
h) The construction of concrete, block and/or timber ducts.
i) The formation of ducts within concrete slabs together with access cover and frames.
j) The building of timber frames, panels and doors, including ironmongery, to give access to pipes, ducts equipment and the like.
k) The formation of concrete bases, plinths, etc., for plant and equipment including anti-vibration pads if necessary.
l) The painting of exposed pipe work, fittings, ducting, equipment, etc.,
m) The waterproofing of all external duct work to the Engineer's approval.

13.28 INSULATION SCHEDULE

1. INTERNAL DUCTS

All ducts within the building shall be insulated on the outer side with minimum 40 mm thick rigid fibre glass board of 48 kg/m³ insulation. The insulation shall be

wrapped with approved type 8 oz. canvas and applied with two coats of foster seal FAS 30-36 to provide vapour barrier.

2. ACOUSTIC INSULATION

The supply ducting shall be provided with acoustic insulation of 25 mm thick and 32 kg/M3 density neoprene faced in order to minimize noise to acceptable level Noise level in all areas shall not exceed NR 40. The extent of acoustic insulation will be approved by the Engineer.

3. REFRIGENT PIPE INSULATION

The refrigerant pipe insulation shall be 19 mm thick preformed rubber type insulation suitable for maximum operating temperatures. The insulation shall be self extinguishing, durable and flexible. The insulation shall be wrapped with approved type 2 ozs. Canvas applied with two coats of foaster.

13.29 F.C.U's
Contractors to ensure that suitable partitions are provided above the false ceiling to allow the individual F.C.U's installed obtain separate supply of return air

13.30 Turning vanes shall be provided in all bends.

13.31 All condensing units must be installed on. suitable anti vibration isolators.

DRAINAGE AND EXTERNAL WORKS

14.1 Materials

The cement, sand aggregate, reinforcement, block and other building materials used in. connection with the drainage installation shall be as specified under the relevant sections.

14.2 Pipe work

The uPVC pipes and fittings are to comply with B.S. 4660. They shall be handled stored and installed in accordance with the Manufacturers instructions.

Pipes shall be laid in straight lines to even falls from manhole to manhole with the invert level maintained true at the joints irrespective of pip irregularities.

Upon completion of a drain length or temporary hold up in construction, all open ends of drainpipes shall be stopped or sealed off with purpose made fittings. Plugs of wood, paper, rag or other makeshift device shall not be used.

Where pipes pass through or under foundations precautions shall be taken to ensure that no load is transmitted to the pipe, by means of arches, lintels, bridges etc.

14.3 Gullies

Gullies shall be salt glazed stoneware with galvanised iron gratings.

14.4 Excavations

General clauses referring to excavation and earthwork as specified under the relevant section above shall apply equally to drainage work.

The Contractor shall perform all necessary excavation for drains, manholes, gullies, etc., uphold sides, level or grade bottoms, return fill and ram and remove surplus soil as directed. Trenches shall be of sufficient width to allow adequate working space for pipe jointers and joint holes shall be formed where necessary.

Backfilling to trenches shall be executed, wherever practical, immediately the drains have been tested to the satisfaction of the Engineer. The materials shall be deposited in layers not exceeding 150mm thick and thoroughly compacted.

14.5 Concrete Beds

Concrete beds under drainpipes, concrete haunching and concrete surround to drainpipes shall be formed in sulphate resisting mass concrete (Quality "D") as specified in "Concrete Work" section. Concrete beds shall be formed under all pipes a minimum 150mm thick and to a minimum width 150mm beyond each side of the pipe. Concrete haunching shall be taken from the outside of the bed to the crown of the drainpipe.

Where drainpipes pass beneath the building, they are to be complete encased in concrete to a minimum thickness 150mm all round.

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14.6 Manholes

Manholes shall be constructed in the positions and to the dimensions shown on the drawings or as directed on site. Construction shall be generally in accordance wit~ the Local Authority's specification. The standard of workmanship shall in all respects match that required in the relevant section above.

The channels in manhole bottoms shall be formed in fine concrete trowelled smooth. The channels shall be semi-circular in section and the concrete shall then be carried up vertically for a distance 75mm at each side and sloped back at a minimum fall of 1: 1 O. The benching shall then be rendered over in cement and sand (1:3) mix trowelled smooth.

Benching and channels shall be formed on a sulphate resisting mass concrete (Quality "D") base of 225mm which is to be levelled to form a foundation for the manhole side the manhole 'sides shall be constructed using 200mm thick solid sulphate resisting blocks rendered internally to a thickness of 19mm.

Pipes entering manholes shall not project beyond the internal face of the block sides. The invert of the pipes and the channel shall be continuous.

The step irons shall be galvanised malleable cast iron step irons complying in all respects with BS 1247 built into the walls of the manhole and be staggered each side of a centre line and spaced l50/300mm apart vertically.

14.7 Manhole Covers

The manhole covers and frames and access covers and frames shall be cast iron coated double seal flat covers and frames as manufactured by Broads Manufacturing Co. Ltd., Western Road, Bracknell, Berks, RG12 lQX, England, or other equal and approved.

Recessed type covers shall be used for manholes within the building, infilled to match the surrounding floor finish. The weight of the cover shall be that suitable for the local conditions of use approved by the Engineer. The manhole cover frames shall be bedded and haunched in cement and sand mortar (1:4) mix and the rebates sealed with a mixture of grease and sand.

14.8 Septic Tanks and Soakaways

The septic tanks and soakaways shall be constructed in the positions and to the dimensions shown on the drawings or as directed on site. Construction shall be generally in accordance with the Local Authorities specification. The standard of workmanship shall in all respects match that required in the relevant sections above.

Provide ventilating pipes to septic tanks as required by the Local Authority using unplasticised PVC pipes to B.S.4514 terminated where shown on the drawings.

14.9 Testing

Pipe runs shall be tested in the presence of the Engineer's representative when the pipe runs have been laid and again after backfilling of trenches has been completed.

The bottom end of the length of pipe under test and all branches shall be sealed off and a vertical pipe temporarily connected into the top end of the pipe run. The section of pipe shall then be filled with water until the water level reaches a level in the vertical pipe 600mm above the highest invert in the length under test. The test shall be considered satisfactory if the water level does not fall by more than 50mm in ten minutes.

If the test proves unsatisfactory, defect shall be made good to the satisfaction of the Engineer and the length retested. If the test is still unsatisfactory, the section under test shall be completely broken out and re-laid using new pipe. This procedure shall be continued until the whole of the drainage installation has passed the test satisfactorily. All testing is to be carried out in dry weather.

The Contractor shall give ten days written notice of testing to the Engineer.

14.10 External Works – Generally

The provisions of all other sections of these specifications shall be applicable to this section where relevant.

14.11 Boundary Walls

Boundary Walls shall be constructed to dimensions and details as shown on the drawings including providing expansion joints for the full height. Foundation shall be a minimum of 1000 mm deep below ground level, unless otherwise specified. Where boundary walls are in extension to existing boundary, they should completely match the existing unless otherwise specified.

14.12 Unpaved Areas

Unpaved areas within the boundary of the site shall be raked over to remove all debris rubbish and other unwanted material and shall be leveled off.

14.13 Footpaths

The footpaths are to be formed of 500 x 50 mm precast concrete slabs bedded in mortar 20 mm thick on 100 mm thick (finished) subkha bed compacted with a 500 kg vibratory roller, unless otherwise specified.

14.14 Interlocking Paving

Interlock block paving shall be 60 mm or 80 mm thick precast concrete block as specified, to shape, pattern, colours and layout subject to approval. Blocks shall be uniform in shape and colour, hard duty type suitable for vehicular traffic supplied by an approved manufacturer conforming to the requirements of BS 6717 and laid on well compacted bed of 50 mm layer of clean sharp crushed sand over min 150 mm layer of road base material compacted to 95% of the MDD as obtained in BS 1377 test 13 (field density test to be carried out at a frequency of 2 test per 1000 m2 as per BS 1377 test 15 B) and laid over a properly watered and compacted base course. All the works shall be subject to final approval of the Engineer.

Contractor’s attention is also drawn towards Dubai Municipality's specifications Ref. Local

Order No. 44 of Year 1990 for concrete block the requirement of which shall strictly be followed.

KERBS AND FOOTPATHS

14.15. Insitu Concrete Kerbs

1. Insitu concrete kerbs shall be laid by a method approved by the Engineer. The kerbs shall be dense with regular sides, arises and chamfers finished to a fine surface free from blowholes and dragging and to the dimensions described in the Contract.

2. The cement used in the concrete mix shall be Portland cement or Portland blast furnace cement with at least 60% cement replacement or ordinary Portland cement with graded pozzolanic pulverised fuel ash or when described by the Engineer.

3. The coarse and fine aggregates shall be as specified for concrete mix (section 5). The result of the 10 percent fines test of BS 812 on the coarse aggregate shall not less than 5 tonnes. The maximum size of aggregate shall not exceed 20 mm and the concrete shall have a 28 days cube strength of30.0 Nt mm2.

4. The mix shall contain not less than 370 kgs nor more than 540 kgs of cement per cubic metre of concrete and the ratio by mass of free water to cement for saturated surface dry aggregate shall not exceed that required to produce a dense concrete with suitable workability for full compaction to be obtained with plant used. The mix shall be designed by the Contractor who shall prepare and compact trial mixes in the presence of the Engineer using the same plant as will be used in the Works to ascertain that the mixes and the plant entirely satisfactory for the work, and shall comply with the test for absorption of water described in BS 340. When a proposed mix has been approved no variations shall be made in the mix proportions or in the type, size grading zone or source of any of the constituents without the consent of the Engineer.

5. Delivery, storage and batching of materials mixing concrete, transport and placing shall be in the manner specified in Section 5.

6. Immediately after compaction for 7 days thereafter the kerbs shall be protected against harmful effects of weather including rain rapid temperature changes, and from drying out. The methods of protection used shall be subject to the approval of the Engineer. The colour after weathering shall be similar to that of any adjacent precast units. Concrete not properly cured as stated. Above shall be removed. The use of curing membranes alone will not be deemed - sufficient for the curing process.

7. Kerbs shall remain firmly secure on the surface on which they are laid. Kerbs shall be cut. whilst the concrete is green to form expansion/contraction joints at two metre centres. The joints shall be filled and sealed with materials approved by the Engineer.

8. The vertical alignment of the finished kerb shall not depart from the true level more than ±6 mm nor vary by more than 6 mm in any 20 metre length and, at any point the maximum deviation of the top of the kerb under a straight edge shall not be greater

than 3 mm in 3 m.

9. The horizontal alignment shall not depart from that shown in the Contract by more than ±10 mm, nor deviate from the straight by more than 3 mm in 3 m.

10. Where filling placed adjacent tot he kerb is likely to have a harmful effect on the kerbs shall be protected from the fill material by a method agreed with the Engineer or as shown on the Drawings.

14.16 Precast Concrete Kerbs, Channels, Edgings & Quadrants

1. Precast concrete kerbs, channels, edgings and quadrants shall comply with BS 340 and shall be laid and bedded on a mortar bed on a concrete foundation as shown on the Drawings.
The carriageway or foundation shall be thoroughly cleaned and prior to placing the backing, the line levels and joints of all units shall be approved by the Engineer.

2. Precast concrete kerbs channels, edgings and quadrants shall be hydraulically pressed.

3. For radii less than 12 m, radius kerbs and channels shall be used.

4. Any units deviating more than 3 mm in 3 m from line or level shall be taken up and re-laid.

5. Clause (10) for insitu concrete kerbs shall apply to all precast concrete kerbs, channels, edgings and quadrants.

6. Expansion joints will be provided at 6 m spacing along the kerb run. The expansion joints shall be formed of suitable flexible material to the approval of the Engineer.

14.17 Footpaths (Concrete Paved)

1. Precast concrete flags shall be hydraulically pressed or vibrated and shall comply with the requirements of BS 368. The flags shall be 50 mm thick, and except where cutting is necessary of a uniform width of 500 mm and length of 500 mm or as directed by the Engineer.

2. Flags shall be laid to the required cross falls as shown on the drawings, and the maximum tolerance shall be 3mm under a 3 m straight edge.

3. Flags shall be bedded as shown on the Drawings or as directed by the Engineer.

4. Flags shall be laid to the patterns shown on the Drawings or as directed by the Engineer.

5. On circular work, where the radius is less than 12 m flags shall be out radially on both edges to the required line.'

14.18 Footpaths (Tiled Square)

1. The tiles shall be to the pattern used by the Dubai Municipality.

2. Where shown in the Drawings the titles shall be laid to a pattern approved by the Engineer. The laying of the tiled footpath is to take place only after substantial completion of the adjacent carriageway or building construction.

3. The tiles shall have a minimum thickness of 38 mm and shall be laid to a pattern agreed by the Engineer. The tiles are to be 300 mm square and shall be hydraulically pressed using a coloured concrete topping not less than 8 mm thickness.

4. The tiles shall be manufactured using a minimum of 400 kg sulphate resisting cement per cubic metre of mix.

5. All tiles shall be free from segregation, (honey-combing, broken or damaged corners and imperfect plane surfaces. Correction of any defects by a method of polishing or grouting will be allowed.

6. The tests for determining the suitability of tiles shall be for impact strength and transverse strength.

For the impact strength tests the specimen is bedded centrally in a box 500 mm x 500 mm minimum containing 100 mm of sand complying with BS 1200. The specimen shall be bedded to its full depth. The specimen shall not fracture when struck centrally by a steel ball weighing one kilogram dropped from height of 1200 millimetres.

For transverse strength the tiles shall comply with BS 4131.

7. The tiles shall be laid on 100 mm Type 2 sub base compacted t 95% of maximum dry density. The mortar shall be a minimum of25 mm thickness and shall be class 3. The tiles shall be immersed in water immediately prior to laying on the mortar bed.

8. The joints between the tiles shall be 3 mm wide and shall be completely filled with a 1:3 cement/sand grout to the full thickness of tiles ensuring the minimum of grout comes in contact with the tile face. All transverse and longitudinal joints shall be in a true line and the finish shall be of a neat and professional appearance using the appropriate tools to produce a 3 mm level between the tiles. The joints between the tiles and the adjacent kerbs shall be filled with class 1 mortar.

9. The tiles shall be colour washed with a suitable pigment cement grout after acceptance by the Engineer.

10. All foreign matter shall be removed from the pavement areas immediately following the completion of each day's work.

14.19 Footpaths (Interlocking Block Type)

1. Colored concrete interlocking 'blocks are to be of 60 mm thickness or as specified. The shape, size colour and pattern are to be to the approval of the Engineer.

2. The concrete used in manufacturing the stones shall comply with the strength requirements specified for precast concrete paving blocks. The thickness and chamfer correction factor for compressive strength expressing the value to the nearest 1 N/mm2 shall be as shown.

Block Thickness (mm)	Correction Factors	
	Plain Block	Chamfered Block
60 or 65	1.00	1.06
80	1.12	1.18
100	1.18	1.24

14.20 Precast Concrete Paving Blocks

14.20.1 Scope

This specification states the requirements for Concrete Paving Blocks for the construction of paved surfaces used by vehicular and pedestrian traffic.

14.20.2 Materials

i. Cement
The cement used in the manufacture of precast concrete paving blocks shall comply with the requirements of either BS 12,4027 or BS 146.The cement content of compacted concrete shall not be less than 400 kg/m3.

ii. Aggregates
The aggregates shall consist of naturally occurring crushed or uncrushed materials, which apart from grading requirements comply with BS 882. The salt contents shall not exceed the following limits:

Acid Soluble Chlorides	0.06% by wt. of Fine Aggregate 0.02% by wt. of Coarse Aggregate
Acid Soluble Sulphates	0.03% by wt. of Coarse and Fine Aggregates.

iii. Water
The water shall be clean and free from any deleterious matter having ph value in the basic range {7-9) and shall conform to BS 3148 (1980) and as specified for the concrete works.

iv. Pigments
Any pigment used shall comply with BS 1014.

1420.3 Dimensions and Tolerances

Standard rectangular blocks shall be manufactured with a nominal length of 200 mm and a nominal width of 100 mm. Alternative sizes and shapes shall have a ratio of length to width on plan of not less than 1.5 or greater that 2.5, the width shall not. be less than 80 mm or

greater than 115 mm. The minimum nominal thickness for paving blocks or any size shall be 60 mm. The preferred nominal thickness shall 60, 80 and 100 mm.

All arises shall be clean and of uniform dimension. Wearing surface area shall be not less than 70% of the plan area.

Tolerances:	Length	< ± >2mm
	Width	< ± >2mm
	Thickness	< ± >2mm

14.20.4 Compressive Strength

The average compressive strength of the block on delivery when sampled and tested in the manner described below shall not be less than 49 N/mm2.

14.20.5 Sampling Block

Two blocks shall be drawn from each group of 1000 blocks for sampling 10 blocks every designated 5000 block section or part there of in a consignment.

All samples shall be clearly marked at the time of sampling in such a way that the designated section or part thereof and the consignment represented by the sample, are clearly defined.

14.20.6 Test for Compressive Strength

The sample specimens shall be tested in a wet condition after being stored for at least 24 hours in water maintained at a temperature of 20°C <±> 5ºC. Before the specimens are submerged in water, the necessary area shall be determined as follow:

i. Where possible, the plan area or the wearing surface area shall be calculated by multiplying the length by the width.

ii. Alternatively the plan area or the wearing area shall be calculated by cutting out shapes of cardboard and weighing it to the nearest 0.01 g.

$$As = \frac{2000\ ms}{m}$$

Where As - Area of block (m^2)

ms - Mass of the cardboard shape matching test block (g) the block shall be placed wearing surface uppermost on the cardboard.

Mass of200 x 100 mm cardboard rectangle (g) cut from the same cardboard.

In case of chamfer or radius the width of chamfer or radius shall be measured and marked

on the cardboard shape. This shape shall then be cut out accurately and weighed for above calculation of the wearing surface area.

Plywood, nominally 4 mm thick, shall be used as packing between the upper and lower faces of the specimen and the machine platens, and these boards shall be larger than the specimen by a margin of at least 5 mm at all points. Fresh packing shall be used for each specimen tested.

The load shall be applied without shock and increased continuously at a rate of approximately 15 N/mm^2 per minute until no greater load can be sustained. The maximum load applied to the specimens shall be recorded. The strength shall be expressed to the nearest 0.1 N/mm^2.

14.20.7 Certificate of Compliance

This certificate is to be provided by the manufacturer at the time of sale as per item No. 12 of BS 6717 from an independent laboratory.

POST TENSION SLAB

15.1 Design Criteria (PT Slabs and Beams)

15.1.1 Design codes and references which should be used and respected:

8S6399	:	Part 1	1996 - Loading for buildings.
8S8110	:	Part 1	1997 - Structural use of concrete.
B8110	:	Part 1	1985 - Structural use of concrete.

Post-Tension Manual Sixth Edition (Published by PTI)

Guide for design of post-tensioned buildings PTI DC20.9-11 (published by PTI)
Concrete society technical report 43

CIRIA Guide 1- Anchor Block Design

In addition to the latest local authorities regulations and the requirements of MIs Dubai Municipality

15.1.2 Concrete:

The minimum concrete characteristic cube strength at 28 days for all the post-tension elements/floors shall be 45 N/mm2. The minimum concrete strength at transfer shall be 25 N/mm2 and the initial stressing will be required at a concrete strength at 12.5 N/mm2 to minimize the risk of shrinkage cracking in the slab in addition to that sufficient additional cubes (3 cubes) shall be tested to ensure the concrete has reached sufficient strength for each stage prior to stressing.

15.1.3 Reinforcement:

Yield strength 460 N/mm^2,

Modules at elasticity 200 KN/mm^2

15.1.4 Strand: Pre-stressing strands to have the following characteristics:

a) 15.7 mm o/d high tensile low relaxation strand (super strand to 8S5896/3)

b) Characteristic breaking load to be 265 KN.

c) Area of strand to be 150mm^2

d) 12.9 mm o/d high tensile low relaxation strand (super strand to 8S5896/3)

e) Characteristic breaking load to be 186 kN.

f) Area of strand to be 100 mm^2

g) Modulus of elasticity to be 200 KN-mm^2.

h) Relaxation class2; 1OOOhr value at 70% load to be 2.5%.

i) Coefficient 'of frication to be 0.20

j) Wobble factor, k, to be 0.0017/m,

k) Random samples to be taken from PT strands to verify the above readings,

15.1.5 Post Tensioning System and Stressing Operations:

Galvanized Ducting:

Galvanized steel ducting shall be corrugated and supplied with suitable couplings, grout saddles and vent tubes.

Anchorages:

To comply with the minimum requirements of BS 4447, Anchors to be compatible with the tendon used and to be fitted with compatible wedges, caps and pocket formers. Maximum wedge draw-in to be 6mm.

All anchors to be located such that the tendons are at right angles to the edges of the concrete slab.

All anchorages are cast anchorages and anchorage casting tubes have fixing holes in the tube unit flange in order to:

- Fix the tube unit to the formwork.
- Locate the jack bearing ring during stressing.
- Fix the grout cap.

All anchoraqes have a grout entry/exit hole in the flange of the casting.

Anchor cones, blocks and plates shall be positioned and maintained during concreting so that the centerline of the ducts passes axially through the anchorage assembly.

All bearing surface of the anchorage shall be clean prior to concreting and tensioning.

The anchoring procedure shall be strictly in accordance with the manufacturer's instructions and recommendations.

Grout: The grout shall comprise OPC to BS 12 supplied below 20ºC.

Water between 5°C,

15.1.6 Loading:

For loading refer to the general notes & details (drawing S00A)

15.1.7 Extensions:

- Record the initial length of each strand protruding from the face at the anchorage from a datum.

- Stress tendon up to 30% of the jacking force to take up any slack in the tendon and record the strand length.

- Stress the tendon up to 100% of the jacking force and record the final extended length from the datum.

- Plot a graph of extension against load and determine the total extension.

- Notify the engineer of any discrepant between actual and predicted extensions.

- After the engineer has approved the extensions strands can be cropped and ducts could be grouted.

- Submit results to the engineer for approval.

15.1.8 Grouting:

- Tendons to be grouted prior to the casting of the slab above and not more than ten (10) days from stressing all tendons and the approval of the stressing results.

- Grout to be OPC/Water grout with a maximum water/cement ratio of 0.40.
- Admixtures may be used to promote flow, reduce water/cement ratio to reduce shrinkage.

- Cubes shall be taken to demonstrate a grout strength of 33.75 N/mm^2 at 7 days [grout final strength at twenty eight (28) days should be 45 N/mm^2 .

- Water for mixing shall be provided at <5°C temperature to provide grout after mixing with a maximum temperature of 20°C.

- Vents to be provided at all high points and at live and dead ends .

15.1.9 Form Work/Propping;

- The contractors responsible for the provision of form work and propping to carry all construction loads including net weight of concrete.

- Slab loads during construction must not exceed design loads.

- Post-tensioning slabs shall not be used to store any construction materials.

15.1.10 Holes:

- Prior to post forming any holes through the slab the contractor must agree on an acceptable method of working with the subcontractor.

- Drill fixings should generally be restricted to 20mm in length.

- Tendons runs must be marked in the shutter so that they are visible after de-shuttering. These marks shall be 1" x 1" x 3mm thick plastic marks pinned at every 50cm. c/c.

- Drilling shall not be permitted at the tendons locations.

15.1.11 Storage, handling and positioning of pre-stressing tendons:

Tendon Materials: Tendons stored on site shall be periodically examined for damage and corrosion,

Protection from mechanical damage:

- Storage facilities and the procedures for transporting material into or out of store shall guard against the tendons being kinked or notched.

- Welding operations shall not be carried out on or close to tendon material under any circumstances. Tendons must be protected from temperature rises caused by welding operations and from weld splashes.

- Unless the engineer approves other methods of cutting, tendons shall be sawn or cropped using an abrasive disc cutter.

Anchor Components:

- The handing and storing procedure must maintain the anchor components in a condition in which they can subsequently perform their functions satisfactorily, Components shall be handled and stored so that mechanical damage and corrosion are prevented.

- Corrosion of the gripping and securing systems must be prevented: The instructions of the supplier regarding storage of gripping components must be followed.

- The use of correctly formulated oils or greases or of other corrosion' inhibiting material is recommended where prolonged storage is required. Such protective material should be guaranteed by the manufacturer to be non- aggressive and non-degrading.

- Anchor components are to be periodically examined. Any deterioration or removal of corrosion inhibiting material shall be made good,

Protection from Damage Resulting from Corrosion:

- Where the system requires the ends of the tendon material to project from the duct after installation the exposed ends must be protected with sleeves or wrapping and/or by a suitable. protective oil or grease in case of delay of the stressing operation.

Protection from Damage Resulting from Mechanical Causes:

- The tendons must not be dragged across the ground before installation.

- Any welding operations carried out near the tendon shall use techniques which ensure that no damage is caused to the tendons, Care must be taken to ensure that such operations shall not give rise to stray electric currents in the tendon.

- Welding operations must not be carried out on the tendons themselves.

- The concrete placing techniques must not result in damage to the sheathing.

15.1.12 Submittals:

- MEP shop drawings are to be submitted to the PT contractor for comments and coordination of holes prior to the commencement of construction.

- Normal reinforcement shop drawings are to be submitted to the Engineer.

- PT contractor will submit shop drawings with all necessary details as requested by the Engineer showing the location and sizes of all MEP, Shafts and cut outs openings and the distribution of the PT strands, dead and live anchors.

- Full post-tension detailed design drawings + full post-tension design calculations should be submitted to TRAKHEES review and approval.

General:

This is to define the specifications for the post-tensioning works to undertaken by Post-Tension Concrete Co. project mentioned above.

Post-tensioning materials and construction.

Concrete:

Concrete for post-tensioning shall be in accordance with the requirements of the section concerning concrete in general.

Concrete cube strength is specified on the drawings.

For concrete casting as far as post-tensioning works are concerned, due care shall be given while concreting in order not to move or damage'. the cables by site operatives, equipment (e.g. poker vibrators) or by dropping concrete directly onto cables from a height from a skip or pump.

Proper vibration shall be carried out behind all anchors to avoid honeycombs.

Unless otherwise specified, concrete shall not be stressed until it has reached the age at which at least 2 test specimens taken from it attain the specified transfer strength and three (3) days from the time of casting. The test specimens shall be cured in similar conditions to the concrete to which they relate. The contractor shall cast sufficient specimens to demonstrate that the required strength of the concrete at transfer has been reached.

15.1.13 Notes:

- The drawing should be read in conjunction with all other relevant drawings.

- Concrete is to be carefully placed and compacted to ensure that the tendon ducts are not displaced and that good compaction is achieved especially in the bursting zone, adjacent to the anchorages.

- For general arrangement and setting out refer to the architectural and a structural drawings.

- All normal reinforcement details on the PT drawings shall be supplied and fixed by the main contractor.

- It shall be the responsibility of the main contractor to check that the post-tensioning works is carried in accordance with the drawings.

15.1.14 Construction Notes:

Main Contractor's scope

- Cut & bend of normal reinforcement
- Shuttering & de-shuttering
- Supply of concrete
- Casting
- cranage, scaffolds, storage, security
- Electricity, Water, Power, etc,

15.1.15 De-Shuttering

Shall not be allowed until the slabs stressing results have been approved by the Engineer, PT tendons are grouted, the slab cubes concrete strength results (min. 2 nos.) at 7 days have reached 75% of the specified concrete characteristics strength,

Twenty eight (28) days cubes concrete strength results (min. 2 nos.) must also be submitted on their due dates.

15.1.16 System Warranty

PT contractor to submit in the name of the Client a 50 years PT System warranty covering the materials used, and the scope overall performance and the safety of the structure.

REMARK:

For all the design loads which should be used in the post-tension design refer to drawings and details.