Federation of Malysia

EDICT OF GOVERNMENT

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JRK 20800 (2005) (English): Standard Specifications for Building Works

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Jabatan Kerja Raya Malaysia

STANDARD SPECIFICATIONS FOR BUILDING WORKS

2005

Ketua Pengarah Kerja Raya Malaysia

STANDARD SPECIFICATIONS FOR BUILDING WORKS
(2005 Edition)

SECTION A - PRELIMINARIES AND GENERAL CONDITIONS

1. Scope of Works

1.1 The Works covered in this Contract comprise the provision by the Contractor at his own risk and cost of all materials, scaffolding, tools, plant, labour, transport, water, light and everything else necessary for the construction and completion of*

all to the entire approval of the Superintending Officer hereinafter referred to as the S.O.

1.2 The Conditions of Contract for the Works which is embodied in the Form of Contract (Form PWD 203/ Form PWD 203A) shall be read in conjunction with this Specification. A copy of the Form of Contract is available for inspection on the Tender Table on any working day up to the time appointed for receiving tenders. If the tenderer considers that any of the clauses of the Contract involves expenses, he shall allow for the money value of such clauses in his Tender.

2. Location of Site

2.1 The Site is located †

3. Contract Documents

3.1 The Contract Documents shall consist of:

(a) PWD Form of Contract (Form PWD 203 Rev.10/83 for contract based on Specification and Drawings or Form PWD 203A Rev.10/83 for contract based on Quantities);
(b) Form of Tender;
(c) Letter of Acceptance of Tender;
(d) Special Provisions to the Conditions of Contract as listed in the PWD Form of Contract;
(e) Contract Drawings;
(f) Specifications;
(g) Summary of Tender (for contract based on Quantities, this item is part of the Bills of Quantities);
(h) Schedule of Rates (for contract based on Specifications and Drawings) or Bills of Quantities (for contract based on Quantities);
(i) Treasury Instructions as set in the Appendix to the Conditions of Contract; and
(j) Any other relevant documents included therein.

3.2 The documents shall be taken as mutually explanatory of each other and in case of any discrepancy or inconsistency, the following rules shall apply:

(i) The Conditions of Contract (Form PWD 203/ Form PWD 203A) shall take preference over all other documents.
(ii) Special Provisions to Conditions of Contract shall take preference over Conditions of Contract.
(iii) In Drawings, large scale details are to take preference over small scale Drawings.
(iv) The Addendum Specification shall take preference over the Standard Specifications and Drawings.
(v) Drawings shall take preference over Standard Specifications.

Any discrepancies shall be referred as soon as possible to the S.O. who shall decide which shall be followed.

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* Give details.
† Highlight any special restrictions.

4. Special Provisions to the Conditions of Contract

4.1 The Contractor's attention is drawn to the Special Provisions to the Conditions of Contract as listed in the PWD Form of Contract.

5. Examination of Tender Documents and Visit of Site

5.1 The Contractor is deemed to have fully examined the Tender Documents and have had full opportunity to consider the details therein and make every investigation in relation thereto.

5.2 Any discrepancies in the Tender Documents shall be referred in writing, as soon as possible and before submitting the tender, to the S.O. who shall, if necessary, amend or clarify the matter by means of a formal Addendum to the Tender Documents. A copy of the Addendum will be issued to every Tenderer and shall become part of the Tender Documents. Receipt of the Addendum must be acknowledged on the form issued with the Addendum.

5.3 The Contractor is deemed to have visited the Site while preparing the tender to ascertain for himself the extent of the work involved and the nature of the working conditions and make himself thoroughly acquainted with any site restrictions, obstructions and all other details.

5.4 The Contractor's attention is drawn to the fact that no extra payment, extension of time, right to damages or any other concession consequent upon misinterpretation or lack of knowledge will be considered.

6. Adjoining Property

6.1 Where the property adjoining the Site is in constant use by the Employer/adjoining owners and occupiers, the Contractor shall arrange and carry out the Works so as to cause minimum interference or interruption to the use of adjoining properties including roads, footpaths, other access and any existing services thereto. He shall comply with all instructions or directions given by the S.O. in these matters.

7. Goods, Materials and Workmanship

7.1 Materials and workmanship throughout the Works shall be in accordance with the Drawings and Specifications and to the approval of the S.O.

7.2 Where goods, materials and workmanship are referred to, the abbreviations BS, CP or MS, reference is respectively made to the British Standard, Codes of Practice and Malaysian Standard and they are to conform thereto unless otherwise stated. The current edition at the date of closing tender shall be referred to in each case.

7.3 Wherever, in this Specifications any proprietary goods or materials are specified, goods or materials of alternative manufacture may be considered for acceptance provided they comply in all respect as regards to appearance and quality, and are approved by the S.O.

7.4 If, however, the Contractor has shown beyond reasonable doubt that the specified goods or materials cannot be obtained and the S.O. is satisfied with regard to the non-availability of the goods and materials, the benefit of cost savings, if any, resulting from the Contractor's proposal or substitution of goods or materials approved by the S.O., shall be deducted from the Contract Sum.

8. Use of Local Materials

8.1 The Contractor shall use locally manufactured materials and goods as listed in the 'Senarai Bahan/ Barangan Binaan Buatan Tempatan' issued by IKRAM QA Services Sdn. Bhd. and/ or 'Senarai Bahan/ Barangan Buatan Tempatan' issued by SIRIM QA Services Sdn.Bhd., whichever is relevant. If the Contractor fails to comply with this requirement, a penalty shall be imposed and/ or the materials supplied shall be rejected.

The locally manufactured materials and goods which are not listed aforesaid, may be permitted if the materials have been tested and certified by IKRAM QA Services Sdn.Bhd. or SIRIM QA Services Sdn.Bhd. whichever is relevant. If the testing cannot be carried out by IKRAM QA Services Sdn.Bhd. or SIRIM QA Services Sdn.Bhd., the Contractor may apply and, subject to the approval of the S.O, carry out the testing by other agencies**.**

8.2 Under no circumstances will the Contractor be permitted to incorporate or supply imported materials, plant, equipment, or other goods into the Works or forming part of the scope of the Works except those approved by the Government, prior to the execution of the Contract. The Contractor shall substitute any materials, plant, equipments, or other goods proposed to be imported but not approved by the Government, with suitable local materials, plant, equipment, or other goods, including making any necessary subsequential changes or adjustments to the design of the Works to accommodate such substitution, all to the concurrence of the S.O.

8.3 The Contractor shall ensure that the procurement of approved imported materials, plant, equipment, or other goods are obtained directly from the country of origin based on Free On Board (F.O.B) or other similar basis. The transportation and insurance of such imported materials, plant, equipment, or other goods from the country of origin to the Site shall be arranged by the Contractor through approved Government's Multi Modal Transport Operators (MTO). The Contractor shall allow in his tender all costs and time required in complying with the requirements of this clause including the cost required for the services provided by the MTO.

8.4 The Contractor shall submit documentary evidence of compliance with this clause to the S.O within one (1) month from the date of each delivery to the Site of such materials, plant, equipment, vehicles or other goods.

9. Metrication

9.1 Unless otherwise specified hereinafter or shown in the Drawings, only materials of metric dimension shall be used for the Works. Materials of equivalent imperial dimension may only be used if the Contractor can satisfy the S.O. that the required materials are not available in metric dimension.

10. Ordering

10.1 The Contractor shall place his orders for specified materials at the earliest possible date after notification of acceptance of tender or at such times as may be specifically stated for any particular material.

11. Supply of Materials by Government

11.1 If the Contractor fails for any reason to supply any materials which he has contracted to supply or if he fails to supply any such materials in sufficient time to enable the Contract to be completed by the agreed date for completion, the Government may supply any portion, or all of such materials.

11.2 If the Government supplies such material, the cost in respect thereof to be borne by the Contractor shall be either the current market rates or the actual cost to the Government, whichever is greater, plus 5% on cost charges.

11.3 The cost to be borne by the Contractor, as detailed above, shall be deducted from any money due or to become due to the Contractor under this Contract and the Contract Sum shall be adjusted accordingly.

11.4 No action by the S.O. under this clause shall be deemed in any way to affect or modify the right of the Government to claim for damages in the event of the Contractor's failure to complete the Works by the agreed date of completion.

12. Samples

12.1 The Contractor shall submit samples of materials or execute samples of workmanship for S.O.' s approval, and for further samples as required until the samples submitted or executed are, in accordance with this Specification.

12.2 Samples, after approval, shall indicate the standard of materials and workmanship to be maintained in the execution of the Works.

13. Contractor's Plant

13.1 All mechanical plant used by the Contractor shall be of such type, size and method of working suitable to the type and nature of the Works and site conditions where the Works are to be executed.

14. Schedule of Rates/ Bills of Quantities

14.1 Schedule of Rates

14.1.1 The tenderer is required to check all the rates given in the Standard Schedule of Rates. The tenderer may propose to vary any rate in the Schedule and his proposed rate/rates subject to agreement by the S.O. as to their reasonableness and shall be used as a basis for calculating the cost of any variations which may be ordered in accordance with the terms of the Contract.

14.1.2 The rates in the Schedule of Rates may also be varied by percentage increase or decrease according to the trades or sections of work as listed therein. These percentages shall also be subjected to the agreement of the S.O. The percentage increase or decrease shall not be applicable to the rates which had been varied.

14.1.3 Any proposed changes or amendments to the rates in the Standard Schedule of Rates shall be submitted together as part of the Tender Document at the time of submission of the tender.

14.2 Bills of Quantities

14.2.1 The Bills of Quantities are to be priced in Malaysian currency i.e. Ringgit Malaysia and Sen. Pricing shall be in INK throughout. The sum of the amounts of all items of the Bills of Quantities priced by the tenderer shall truly represent the amount shown in his tender. The rates set down by the tenderer against each item in the Bills of Quantities shall be the full inclusive rates and prices for the finished work (unless expressly provided to the contrary) and shall be held to include providing and delivering all materials, unloading, cutting and waste on

materials, storage, packing, carriage and cartage, hoisting, all labour, setting, fitting and fixing in position, use of plant, providing of suspension, establishment charges, profit and all other labour and everything else necessary for the due and proper completion of each item.

14.2.2 Where the tenderer leaves any item blank in the Preliminaries or insert only a dash against any item in this Bills of Quantities the value thereof shall be deemed to be included in the prices or rates of other items therein.

14.2.3 No unauthorized alteration, addition or note entered in these Bills of Quantities shall modify the printed text.

14.2.4 Headings and notes appearing shall not by itself be deemed to be comprehensive and do not modify the meaning of the items in the Bills of Quantities.

14.2.5 Any rates found to be overpriced, inconsistently priced, underpriced or erroneously priced shall be subjected to adjustment and rectification before the signing of the Contract and the authority to fix the reasonable rates/ amount shall be with the S.O. The amended rates shall be used for computing the progress payments and the measuring of variations.

14.2.6 Where quantities in the Bills of Quantities are marked provisional, the works shall be remeasured on completion basing on Drawings certified as true and correct representation of the completed works by the S.O.

15. Tendering Particulars

15.1 Tenders on the form supplied and duly filled in shall be delivered within the time and to the place specified on the published notification.

15.2 The lowest or any tender shall not necessarily be accepted and no claim for any expenses incurred in the preparation of tender is allowed.

16. Withdrawal of Tender Within Tender Validity Period

16.1 In the event that the tenderer withdraws his tender or fails to sign the Contract upon the acceptance of his tender, whilst the tender validity period remains enforced, his registration as a Government Contractor shall be suspended for a period of two (2) years for the first offence, five (5) years for the second offence and the registration shall be cancelled for the third offence, without prejudice to any other rights of the Government under the Contract.

17. Access and Temporary Roads

17.1 The Contractor shall provide and maintain all necessary temporary entrance to the Site and temporary culverts, tracks, bridges, etc. for access to and within the Site as long as required to the approval of the S.O. The position where the site access is to be made shall be as indicated on the site plan or as approved by the S.O. and the Contractor shall make all arrangements and obtain all approvals and permissions required at his own cost.

18. Temporary Diversion and Relocation of Existing Overhead and Underground Services

18.1 Before commencing any excavation, etc, the Contractor shall enquire from the various authorities whether any underground pipes, cables, etc are present on the Site and if so, he shall make arrangements for the disconnection, removal and if necessary, the

relocation and reconnection of such services and pay all necessary cost and fees in connection with all temporary diversion and relocation of existing services.

18.2 If during excavation, the Contractor comes across any underground cables, etc, he shall immediately stop work and refer to the S.O for further instructions and make arrangements for the disconnection, etc. The Contractor shall be responsible for making good all damage to the cables, etc, and shall indemnify the Government against any claims as a result of such damage.

19. Mosquito Prevention

19.1 All excavation and any portion of the Site where water stagnates or accumulates shall be kept dry by pumping, bailing or other operations.

19.2 The Contractor must refrain from dumping or depositing rubbish, spoil, unused materials, empty bottles, cans and other containers capable of collecting water which afford breeding places for mosquitoes. He shall pay all charges as may be required by the Local Authority and employ whatever mosquito destructive measures as are necessary entirely at his own cost and expense.

20. Environmental Protection and Enhancement

20.1 The Contractor shall at all times adhere to all existing statutes regarding protection of the environment.

20.2 The Contractor shall be aware of the following legislation and take all measures to ensure the compliance of:

a) Environmental Quality Act, 1974 (Act 127) and subsidiary legislation made thereunder;
b) Environmental Quality (Sewage and Industrial Effluents) Regulations 1979
c) Environmental Quality (Clean Air) Regulations 1978
d) Environmental Quality (Scheduled Wastes) Regulations 1989
e) Sewerage Services Act 1993 - Act 580;
f) Street, Drainage and Building Act, 1974: Act 133 and amendment, 1978
g) Protection of Wildlife Act, 1972 (Act 1976)
h) Land Conservation Act, 1960
i) Drainage Work Ordinance 1954
j) Water Enactment - Chapter 146:Water (1935)
k) Explosives Act 1957 (Act 207 Revised1978)

20.3 The Contractor shall be liable for and shall indemnify the Government, S.O and the S.O.'s Representatives against any damages, expenses, liabilities, losses, claims, prosecutions, proceedings, fines and penalties caused by noncompliance or contravention of the above legislation.

21. Control of Noise and Disturbance

21.1 All work shall be carried out without unreasonable noise and disturbance. The Contractor shall indemnify the Government, S.O and S.O.'s Representatives against any liability for damages on account of noise or other disturbance created while or in carrying out the Works and from and against all claims, demands, proceedings, damages, costs charges and expenses whatsoever in regard or in relation to such liability.

21.2 The Contractor shall ensure that all equipment and machinery are in proper working condition so as to minimise the amount of noise generated. The S.O may require the

Contractor to replace any machinery that to his discretion, is emitting excessive noise.

21.3 The Contractor shall comply with the general recommendations set out in BS 5228: Code of Practice for Noise control on Construction and Demolition Site. The Contractor shall ensure that the noise levels at the work site does not exceed Leq = 65dBA and also undertake measures to ensure that a noise level of Leq = 55dBA shall not be exceeded at settlements and villages.

22. Drainage of Site and Erosion Control

22.1 The Contractor shall make proper provision for the drainage of surface water from the work site including rainwater from surrounding areas which drain on to the Site.

22.2 The Contractor shall at his own cost, provide, form, fix and maintain such pumps, chutes, walls, drains, bunds and other temporary works necessary for the proper drainage of the Site so that no flooding or other damage or disturbance is caused to areas surrounding the Works or to the Works throughout the duration of the Contract.

22.3 Silt trap shall be constructed as shown in the Drawings. The silt trap shall be maintained regularly throughout the contract period, including desilting when full or as directed by the S.O and making good of any damaged portions during the course of the Works. The desilted material shall be transported to disposal site approved by the S.O.

22.4 The Contractor shall, if and where directed by the S.O, install silt fences as shown in the Drawings for trapping silt and sediment from disturbed area during construction. The silt fence shall be constructed of a vertical barrier of geotextile supported by poles at regular intervals. The geotextile shall be made of non-woven material with minimum weight of 200g/m^2 and tensile strength 15 kN/m. The fence shall be inspected after every rain and when a sediment accumulation of approximately two third (⅔) of the fence height is observed, the silt shall be removed and disposed of properly. The geotextile shall be checked for rips, tears and other types of deterioration and replaced as needed.

22.5 The Contractor shall, if and where directed by the S.O, construct gabion walls which shall consist of layers of gabion as shown in the Drawings for trapping sediments in catchment area.

22.6 The Contractor shall, if and where directed by the S.O, construct sediment pond or basin as shown in the Drawings for collecting and trapping sediments before the water leaves the Site. The sediment basin shall be maintained such that the silt shall be removed when a sediment accumulation of approximately one third (⅓) the basin depth is observed.

23. Maintenance of Existing Roads, etc.

23.1 The Contractor shall arrange for the conveyance of materials, plant, etc. so as to minimise damage to existing roads and culverts. The Contractor shall be responsible for any damage caused by his lorries or workmen to any existing roads, culverts, etc. and shall maintain, repair and reinstate same to their original condition to the approval of the S.O. Alternatively, the Contractor shall bear the cost of such maintenance and restoration as a deduction from any money due or to become due to the Contractor under this Contract.

23.2 If directed by the S.O, before the Contractor's trucks or equipment which utilise public or private roadways leave the Site, they shall be cleaned of all dirt and muds by hosing, passing through lorry wash-troughs, etc.

23.3 For Contractor's trucks carrying sand, aggregates, earth and other loose construction materials, tarpaulin or other suitable materials shall be used to cover such open trucks/equipment when these are passing on all roadways to avoid spillage.

23.4 The Contractor shall provide suitable spraying equipment for regular spraying of water over existing roads and access roads, completed as well as incomplete road and other barren areas of the Site used by the Contractor and as when directed by the S.O.

23.5 The Contractor shall provide for the prompt removal of all dirt and materials spilled from his or his sub-contractors' vehicles on public or private roadways by reason of his work or carelessness in execution of the Works. The Contractor shall also avoid interfering with drainage or creating a traffic hazard to vehicles or impeding the passage of pedestrians.

24. Control of Workmen at Site

24.1 The Contractor shall be responsible for controlling all persons under his employment and those employed by his sub-contractors, merchants and hauliers at the work site and shall take all necessary precautions to prevent damage and nuisance of any kind and shall indemnify the Government against any claim arising therefrom.

25. Construction Industry Development Board (CIDB) Act and Regulations

25.1 The Contractor shall comply with the Lembaga Pembangunan Industri Pembinaan Malaysia Act 1994 and/or regulations under the act.

25.2 For compliance with the Construction Industry (Collection of Levy) Regulation 1996, the Contractor shall submit a notification on Form CIDB L1/96 to the CIDB not later than fourteen (14) days after the issuance of the Letter of Acceptance/ Letter of Award/ or any document that constitutes acceptance of a contract of Works, or not less than fourteen (14) days before the commencement of the Works, whichever date is earlier.

26. Employment of Local Labour, Sub-contractors and Suppliers

26.1 The Contractor shall use his best endeavour to employ all labour, Sub-contractors and suppliers used in connection with the Works from within the District or State where the Works are situated. The Contractor shall immediately after taking possession of Site, arrange with the local labour office, district office or penghulu to effect such employment.

27. Particulars of Employees

27.1 The Contractor shall on each working day furnish to the S.O., maintain and update a full list of all his workers including all workers employed by his Sub-contractors or Nominated Sub-contractors on the work site giving all particulars in the form as stated in the format as approved by the S.O.

28. Contractor's Temporary Accommodation and Facilities for Workmen Living On Site

28.1 The Contractor shall provide and maintain all temporary accommodation and facilities including temporary lighting, plumbing and water storage for his labour and staff living on Site, necessary for the execution of the Contract. Such accommodation shall be in the form of standard cabins or constructed of plywood and/or metal deck or of other materials approved by the S.O. and provided with adequate facilities to the approval of the S.O., in accordance with the following requirements:

(a) The temporary accommodation shall be provided with adequate ventilation and lighting. The sleeping area or resting area shall not be less than 5 sq metre per person. Each accommodation unit shall be maintained, kept tidy and clean at all times.

(b) The accommodation quarters shall not be more than two storeys high. Common areas for dining, recreation and praying purposes shall be provided.

(c) Plywood used shall be new and of minimum thickness 12mm. The external walls shall be painted.

(d) Not less than 1 no. latrine shall be provided for every 25 workmen. Bathing areas and toilets shall be enclosed and provided with septic tank. Bathrooms and toilets shall be maintained in a clean and sanitary condition at all times to the satisfaction of the S.O and the health authority.

(e) A separate center is to be provided if firewood, gas or kerosene stove is used for cooking.

(f) Water used for consumption shall be obtained directly from water authority mains. Where such water supply is not available, potable water shall be provided from sources approved by the S.O. Potable water shall comply with the requirements of the guidelines issued by the Ministry of Health.

(g) Electricity shall be obtained from Tenaga Nasional Berhad. Where such power supply cannot be supplied, generator set can be used but safety precautions must be taken. The use of kerosene lamps shall be not allowed.

(h) Under no circumstances shall the accommodation be provided in buildings under construction.

(i) The location of the accommodation quarters shall be to the approval of the S.O. before the erection and shall be such as to avoid obstruction and nuisance to the Works and public, and shall be laid out in an approved and orderly manner.

(j) Suitable types of fire extinguishers shall be installed and maintained at the Site.

(k) The Contractor shall appoint a person to be responsible for keeping and maintaining a register of the workmen and other persons occupying the site accommodation.

(l) No rearing of animals shall be allowed at the Site.

(m) Proper provision shall be made for the disposal of all waste and refuse.

29. *Contractor's Storage and Office

29.1 The Contractor shall provide and maintain on the Site in positions as approved by the S.O. the following adequate, secure and weatherproof temporary buildings for use during the execution of this Contract:

*(i) Shed for storage of cement with the floor raised 300 mm above the ground.
*(ii) Shed for bar-bending and similar works.
*(iii) Store for other building materials.
*(iv) Office for Contractor's use.
† (v)
† (vi)

* Delete if not applicable.
† Insert other item if required.

29.2 The Contractor is prohibited from discharging oil and grease to any water course. Storage tank for oil and grease shall be placed on concrete base with upstand edges to contain any spillage. Any spilled oil and grease shall be promptly removed by the Contractor. The Contractor shall collect and store used oil and grease and dispose these according to methods approved by Department of Environment.

30. First Aid Kit

30.1 The Contractor shall be required to provide a complete First Aid Kit which shall be kept and properly maintained in the Contractor's site office. The kit shall be in the charge of either the Contractor's site representative or some other responsible person who shall be on the Site during all working hours to ensure that the first aid facilities are available without delay at all times when work is in progress. At least one (1) responsible member of the Contractor's staff shall be trained in first aid duties.

31. Sanitation

31.1 The Contractor shall provide for his workmen adequate temporary latrine and bathing place, built on concrete floors and provided with all necessary water and drainage. These facilities shall, in every respect, conform to all requirements of Department of Environment and other relevant authorities.

31.2 All waste water must be treated such that its effluent meets the requirements of all existing regulations and legislations.

32. Office Accommodation for S.O.

32.1 The Contractor shall provide and maintain a site office for the use of the J.K.R. supervisory staff all in accordance with J.K.R. design type as shown in the relevant Drawings inclusive of all fittings and furniture as stated therein.

32.2 The Contractor is permitted to provide relocatable site office as an alternative to the J.K.R. design type. The quality of such relocatable site office shall be of equivalent standard but not inferior to the J.K.R. design type and shall be equipped with similar fittings and furniture as indicated in the J.K.R. design site office.

32.3 Where relocatable site office is to be provided, the Contractor shall submit details of the relocatable site office together with his tender. Such details shall include the name of the manufacturer, floor area and layout, list of fittings and furniture and brochures (if available). The Contractor shall also indicate whether the proposed site office is new or had been previously used.

32.4 Unless otherwise shown in the Drawings, the office is to be sited, positioned and constructed as approved by the S.O.

32.5 The Contractor shall make proper arrangement for and pay all charges in connection with conservancy. The site office shall comply with local building by-laws. It shall be erected or provided by the Contractor and approved by the S.O. within four (4) weeks from the date of possession of Site.

32.6 On completion of the Works, unless otherwise stated, the site office with all fittings and furniture shall become the property of the Contractor and shall be removed from the Site forthwith.

33. *Telephone for S.O.

33.1 The Contractor shall provide a telephone at the S.O's site office for the sole use of the S.O. in connection with the supervision and administration of the Contract and pay for all installation, rental, call charges and disconnection. Call charges up to a maximum limit of RM per month shall be paid and borne by the Contractor.

34. *Site Items for S.O./ Office Equipment and Facilities

34.1 Safety Facilities

The Contractor shall provide the following items of a standard to be approved by the S.O. for the sole use of J.K.R. supervisory staff and official visitors throughout the duration of the Contract:

(i) Safety helmets.....numbers.
(ii) Safety boots.....number pairs.
† (iii)
† (iv)

34.2 Office Equipment and Facilities

34.2.1 The Contractor shall provide the facilities listed in Appendix…….. for the use of staff JKR Headquarters and the Superintending Officer (S.O.) and/ or his staff. All equipments(s) provided for the facilities shall be new, delivered, tested and installed within a month of the issuance of the Letter of Acceptance.

34.2.2 The facilities provided shall be maintained by the Contractor or his appointed agent throughout the contract period until the issuance of the Certificate of Making Good Defects. Maintenance shall include all necessary monthly servicing according to manufacturers Specifications and supply of accessories and consumables.

34.2.3 The equipments(s) and facilities shall be in the custody of the Contractor at all times. Upon issuance of the Certificate of Making Good Defects or the determination of the Contractor's employment, the ownership of the equipments(s) shall be reverted to the Government.

34.2.4 If the Contractor fails to provide or maintain any equipments(s) for the facilities as listed in Appendix…….. the Government shall have the right to procure the equipments(s) from other sources or maintain it and all expenses arising shall be borne by the Contractor and an appropriate adjustment shall be made to the Contract Sum.

34.3 Transport Services For The S.O and His Staff

34.3.1 General

34.3.1.1 The Contractor shall provide suitable transportation service by means of vehicle as stipulated in Appendix……..

34.3.1.2 The Contractor shall ensure that the vehicle(s) are accident free and are in a well maintained condition subject to certification from PUSPAKOM at every six (6) months.

34.3.1.3 The vehicle(s) shall be in the custody of Contractor at all times.

***** Delete if not applicable.
† Insert other item if required.

34.3.1.4 The Contractor shall provide comprehensive insurances to cover all drivers and passengers, and ensure that all road tax are valid throughout the contract period.

34.3.2 Arrangement for Transport and Failure to Provide Transport

34.3.2.1 The Contractor shall provide the necessary transport from the office(s) of the S.O or his staff or from designated pick-up points to the Site and vice versa as requested by the S.O or his staff. The transport shall at all times be readily available for the use of the S.O and his staff.

34.3.2.2 The Contractor shall notify the relevant officer should there be any delay in the pick-up times. If the Contractor fails to notify the delay or fails to provide the required transport, the officer shall have the option to arrange alternative transport and the Contractor shall bear the expenses and an appropriate adjustment shall be made to the Contract Sum.

35. *Survey Instruments and Personnel

35.1 The Contractor shall provide for the sole use of the S.O. and his staff all such instruments, equipment and survey personnel as may be required to check the accuracy of the setting out. The Contractor shall be responsible throughout the Contract period for all such instruments, equipment and survey personnel and shall ensure that all instruments and equipment are at all times maintained in good working condition.

37. Watching

37.1 The Contractor shall provide all necessary watching and lighting at all times for the whole period of the Works.

38. Care and Protection

38.1 The Contractor shall provide and maintain everything necessary for proper protection of materials and Works from any damage by weather, carelessness or otherwise. Any damage caused shall be made good to the approval of the S.O.

39. Safety On Site

39.1 The Contractor shall supply, erect and maintain for as long as is considered necessary adequate fencing, hoarding, warning lamps and such other safety measures necessary to ensure the safety of the public and others who may be on or within the vicinity of the Site. Where required, the Contractor shall employ a competent person as safety and health officer and all safety measures shall be carried out in accordance with Occupational Safety and Health Act (OSHA) and relevant local by-laws. The Contractor shall be held solely responsible for all accidents arising from any negligence in this respect.

* Delete if not applicable.

40. Nominated Sub-contractors

40.1 The Contractor shall allow in his tender price for attendance and facilities upon all Nominated Sub-contractors. Such attendance and facilities shall include the following:

(i) Ascertaining from Nominated Sub-contractors all particulars relating to their work in regard to sizes and positions in which chases, holes, mortices, etc. are required to be formed or left.

(ii) Making good of walls, ceilings, floors, roofs, etc. and finishes thereto including touching up of all paintwork necessitated, damaged or disturbed by the Nominated Sub-contractor's work.

(iii) Supplying all setting out information.

(iv) Giving all necessary dimensions and taking responsibility for their accuracy.

(v) Affording free and full use of standing scaffolding whilst it remains erected on the Site.

(vi) Affording free and full use of storage accommodation for materials, equipment and plant which are for incorporation into the Works and/or which require protection against weather and deterioration, messrooms, sanitary and welfare facilities.

(vii) Providing site space only for Nominated Sub-contractor's temporary office, workshops, workmen's accommodation and storage of materials, tools, plant and equipment which are not for incorporation into the Works and not requiring protection against weather or deterioration.

(viii) Providing temporary water supply, electric power supply, artificial lighting and paying all fees and charges for fuel, water and electricity consumed.

(ix) Liaising with the relevant supply/service authorities for the expeditious installation of the connections for permanent water and electricity supplies in the Works making available such supplies to the Nominated Sub-contractors; and paying all fees and charges for such installation, deposits for such supplies/services on behalf of the Government. All such payments made, shall be reimbursed to the Contractor on production of receipted bills.

(x) Providing competent personnel in compliance with the Electricity Regulations 1994 to take responsibility for the operation of the electrical installation from the time the permanent electricity supply is made available until testing, commissioning and handing over of the Works.

(xi) Protecting, watching and taking full responsibility for all Nominated Sub-contractor's work and unfixed materials and goods intended for use thereon.

(xii) Removing rubbish and debris off the Site and cleaning the Works internally and externally.

40.2 It is deemed that the Nominated Sub-contractor shall include in the Sub-contract Sum, inter alia, the costs in connection with the following:

(a) Unloading, getting in, storing and all handling and hoisting of these materials, plant and tools into required positions.

(b) Providing, erecting, maintaining and removing of all his temporary office, workshops and workmen's accommodation including paying all assessment and

other charges.

(c) Connecting to temporary water and power supplies made available by the Contractor for the execution of the Works, supplying and running distribution pipes, hoses, cables, leads, electrical gear, etc. but excluding payment for water and electricity consumed.

(d) Provision of fuel, gas, steam, oil lubricants, chemicals and everything else necessary (other than water and electricity) for the test running and commissioning of the Sub-contract Works.

(e) Any scaffolding, staging, etc. that are required for the Sub-contract Works not covered by paragraph 40.1(v) above.

41. Nominated Suppliers

41.1 The Contractor shall allow in his tender, price for attendance upon all Nominated Suppliers which is to include taking delivery, unloading, setting in, checking and accepting delivery, returning empties, handling, storing and hoisting of the materials/goods supplied by the Nominated Suppliers. Packing and carriage to Site shall be borne by the Nominated Supplier unless specifically stated to the contrary.

42. Works Programme

42.1 Except where the works programme is furnished by the Government in the tender document, the Contractor shall within 14 days after the receipt of the Letter of Acceptance of Tender, submit to the S.O for his approval, a programme using the Critical Path Method (CPM) including copies of all data on computer medium and printed hard copies. The programme shall be presented in bar chart and network diagrams indicating the critical activities and interface dates critical to complete the work on time. The Contractor shall be required to update all information and maintain the planned programme using the CPM weekly/monthly by trained and qualified personnel or as when instructed by the S.O.

42.2 Where the works programme is furnished by the Government in the tender documents, the Contractor shall comply with such works programme and provide all the necessary resources required as specified in the programme. Alternatively the Contractor may subject to the S.O's approval, propose an improved works programme which shall not exceed the contract period stipulated, also using CPM to denote all the critical milestones for the successful implementation and completion of the project.

42.3 The Contractor shall also furnish in writing to the S.O or S.O's representative particulars of the Contractor's method statements for carrying out such works and of the construction plant and temporary works, if any, which the Contractor intends to supply, use or construct as the case may be. The submission to and approval by the S.O or the S.O's representative of such programme or the furnishing of such particulars shall not relieve the Contractor of any of his duties or responsibilities under the Contract.

42.4 If at any time it should appear to the S.O that the actual progress of the Works does not conform to the approved works programme, the Contractor shall submit for approval, a revised programme showing the modifications to the previously approved programme and additional resources necessary to ensure the completion of the whole Works within the time set for completion.

43. Construction Plan (C-Plan)

43.1 In addition to the works programme the Contractor shall within 14 days after the receipt of Letter of Acceptance, submit in writing to the S.O, the following information for the preparation of Construction Plan.

(i) Contractor's organisation chart which shall show the staff involved, including their relationship and interfacings for successful implementation of the project.

(ii) List of duties and responsibilities of each member of the Contractor's project team as shown in the organisation chart in item (i).

(iii) Maintenance and calibration schedule of the plant and equipment to be used in the Works.

(iv) Works Programme

(v) Method Statements

(v) Inspection and Testing Schedule to be executed, itemising the type and frequency of inspection and testing.

44. Progress Photographs

44.1 The Contractor shall take progress photographs at monthly intervals or more frequent as directed by the S.O. The photographs to be taken from different angles as approved by the S.O and the average number of photographs shall be sufficient enough to show the progress of the Works but in any case the average number per month shall not be less than six (6) per block of building.

44.2 The photographs shall be provided in jpeg or other approved format with each image set at minimum size of 1280 x 960 pixels and at resolution of 72 pixels per inch and submitted to the S.O monthly, in diskettes or compact discs. The Contractor shall also supply six (6) sets of bound hard copies of the approved photographs, all properly titled and dated.

45. Project Signboard

45.1 The Contractor shall provide, erect, paint and maintain a project signboard in Bahasa Melayu as shown in the relevant drawing or as directed by the S.O. The signboard shall be erected at a prominent position at the Site as approved by the S.O.

46. Clearing, Cleaning and Making Good on Completion

46.1 The Contractor shall ensure the existing roadside drains bounding the Site are clear of any building debris, earth, etc., at all times before handing over of the Works to the S.O upon completion.

46.2 The Contractor shall remove and clear away from Site all temporary buildings, temporary works and temporary installation, before handing over of the Works to the S.O. upon completion.

46.3 The Contractor shall gather up and clear away all rubbish as it accumulates during the progress of the Works at least twice each week at times approved by the S.O. The services shall be continued until the completion of the Works. Garbage or construction waste shall be disposed in a locally available landfill or hauled to disposal sites approved

by the S.O. The Contractor shall leave the Site in a clean and tidy manner upon completion.

46.4 No burning of rubbish, construction waste and debris, etc, shall be allowed unless necessary approval from the Director General of the Department of Environment has been obtained.

46.5 Before handing over the Works to the S.O., the Contractor shall scrub all floors, pavings, staircases etc. and clean out all gutters, gulleys, manholes, sumps and drains. The Contractor shall also clean all glass panes and leave every part of the completed Works included in this Contract in a clean, sound and tidy condition to the approval of the S.O.

SECTION B - PILING WORKS

SECTION B.1 - GENERAL REQUIREMENTS

1. General

1.1 Unless otherwise specified, all piling shall conform in all respects to BS 8004. All materials and workmanship for piling shall be in accordance with the appropriate sections of this Specification.

2. Soil Investigation Reports

2.1 Any information and report on soil investigation for the Works made available to tenderers are intended for guidance only. The S.O. shall not be responsible for the scope, completeness or accuracy of the information, or for any opinion or conclusion given in the report.

3. Tolerances

3.1 Setting out

Setting out shall be carried out from the main grid lines of the proposed structure. Immediately before installation of the pile, the pile position shall be marked with suitable identifiable pins, pegs or markers.

3.2 Position

For a pile cut-off at or above ground level, the maximum permitted deviation of the pile centre from the centre points shown in the Drawings shall not exceed 75mm in any direction. For a pile cut off below ground level, an increase in this tolerance is permitted in accordance with clauses 3.3 and 3.4 herein below.

3.3 Verticality

The maximum permitted deviation of the finished pile from the vertical shall be 1 in 75.

3.4 Rake

The piling rig shall be set and maintained to attain the required rake. The maximum permitted deviation of the finished pile from the specified rake or the rake shown in the Drawings shall be 1 in 25.

3.5 Forcible correction

Forcible correction to concrete piles shall not be permitted. Forcible corrections may be permitted to other types of piles only if approved by the S.O. However, no forcible correction shall be made to piles which have deviated beyond the permissible limits specified in clauses 3.2, 3.3 and 3.4.

3.6 Piles out of Alignment or Position

The Contractor shall, if ordered by the S.O., extract and reinstall any pile which has deviated out of position or alignment by more than the specified limit, or alternatively the substructure shall be modified to the approval of the S.O. The cost of such extraction and reinstallation, or any extra cost in the design and construction of a modified foundation

shall be borne by the Contractor, if, in the opinion of the S.O., such extra work has been made necessary due to the incompetency and/or negligence of the Contractor.

4. Piling Programme

4.1 The Contractor shall submit to the S.O. his proposed programme for the execution of the piling work at least seven (7) days before commencement of the Work. In addition, the Contractor shall inform the S.O. daily of the programme of piling for the following working day and shall give adequate notice of his intention to work outside working hours, if this has already been approved by the S.O.

5. Records

5.1 The Contractor shall keep records of particulars as listed in Table 1 hereof for each pile installed, and shall submit two (2) signed copies of these records to the S.O. not later than noon of the next working day after the pile was installed. The signed records shall form part of the records for the Works.

5.2 Any unexpected driving condition shall be noted in the records.

6. Nuisance and Damage

6.1 Noise and Disturbance

The Contractor shall take all necessary precaution in carrying out the work so as to minimise noise and disturbance during driving.

6.2 Damage to Adjacent Structures, Utilities

6.2.1 The Contractor's attention is specially drawn to his responsibilities under the clause ‘Damage to Property’ of the Conditions of Contract. The Contractor is deemed to have familiarised himself with the risks likely to be imposed on adjacent structures and all utilities by the proposed method of piling.

6.2.2 Before commencing any piling work, the Contractor shall accompany the S.O. on a site inspection in order to consider any circumstances which may indicate the presence of underground mains and services at or in the vicinity of the Site. If, during execution of the Work, damage is or is likely to be caused to any utilities or adjacent structures, the Contractor shall submit to the S.O. his proposals for repair or avoidance of such damage.

7. Damage to Piles

7.1 The Contractor shall execute the Work in such a manner so as to minimise damage to piles.

7.2 All piles damaged during handling, transporting, pitching, driving or at any other time shall be replaced by the Contractor at his own expense.

8. Safety Precautions

8.1 The Contractor shall take safety precautions throughout the piling operation in accordance with the requirements of the relevant laws and by-laws.

9. **Definition**

9.1 Preliminary Pile

A preliminary pile is a pile installed before the commencement of the main piling work for the purpose of establishing the driving criteria for subsequent working piles and for confirming the adequacy of the design, dimensions and bearing capacity. This pile shall be treated as a working pile unless otherwise directed by the S.O.

9.2 Working Pile

A working pile is a pile which is installed as part of the permanent foundation work.

9.3 Ultimate Load

9.3.1 Where pile test is carried out, the Ultimate Load is defined as the constant load at which the pile continues to settle at a steady rate, or the load at which the maximum settlement of the pile during one continuous loading cycle is one tenth of the pile base diameter or least dimension, whichever is the lesser.

9.3.2 Where a pile test is not carried out, the Ultimate Load is defined as the calculated Ultimate Load, derived from appropriate static bearing capacity calculations.

9.4 Design Load

9.4.1 The Design Load shall be defined in relation to a pile loaded in isolation, without nearby piles being loaded, except those providing test reaction.

9.4.2 Where the Ultimate Load is measured by means of pile tests, the Design Load is the Ultimate Load divided by the specified factor of safety.

9.4.3 Where the Ultimate Load is not measured by means of pile tests, the Design Load is the lesser of the following:-

(a) the calculated ultimate load for the pile divided by the specified factor of safety.

(b) the calculated ultimate load of the pile base together with the calculated shaft adhesion, as derived from appropriate static bearing capacity calculations, divided by a factor of safety of 3.0.

9.5 Factor of Safety

Unless otherwise stated in the Drawings, the Factor of Safety shall be taken as not less than 2.0 for piles in compression, and not less than 3.0 for piles in tension.

9.6 Working Load

The Working Load is the Design Load modified to allow for group effect, pile spacing or any other factors changing the efficiency of the total foundation from that of a single isolated pile, and is at least equal to the dead plus imposed loads on the pile together with downdrag or uplift loads as appropriate.

TABLE 1 - (Ref. Cl.5.1- Section B.1)

(a) Contract particulars.

** (b) Pile type.

(c) Pile reference number (location).

(d) Nominal cross-sectional dimensions or diameter.

(e) Supplied length of pile.

(f) Date and time of starting and finishing and redriving.

(g) Ground level at commencement of installation of pile.

(h) Cut-off level.

(j) Type, weight, drop and mechanical condition of hammer and equivalent information for other equipment.

(k) Number and type of packings used, and type and condition of dolly used during driving of the pile.

** (l) Pile driving log.

(m) Set of pile in mm per blow or number of blows per 25mm of penetration.

(n) If required, the sets taken at intervals during the driving.

(p) If required, temporary compression of ground and pile from time of marked increase in driving resistance until pile reaches its final level.

(q) All information regarding obstructions, delays and other interruptions to the sequence of work.

** e.g. Precast concrete; timber; vertical or rake; compression or tension; friction or end-bearing or both.

SECTION B.2 - PRECAST REINFORCED CONCRETE PILES

1. General

1.1 The materials and the manufacture of precast reinforced concrete piles shall comply with MS 1314.

2. Reinforcement

2.1 The main reinforcing bars in piles not exceeding 12m in length shall be in one continuous length unless otherwise approved by the S.O.

2.2 In piles exceeding 12m long, joints shall be permitted in main longitudinal bars at 12m nominal intervals. Joints in adjacent bars shall be staggered at least 1m apart along the length of the pile. Joints shall be butt-welded as specified in SECTION D: CONCRETE WORK. Other means of jointing reinforcement, such as by means of mechanical couplings, shall be to the approval of the S.O.

3. Pile Shoes

3.1 The type of pile shoes to be used shall be as shown in the Drawings and shall comply with the following as relevant:-

(a) Chilled-hardened cast iron shoes as used for making grey iron castings to BS 1452 Grade 10; or

(b) Mild steel to BS 7668, BS EN 10029, BSEN 10155 ;or

(c) Cast steel to BS 3100, Grade A.

3.2 Mild steel straps cast into the shoes shall be as shown in the Drawings. Rock shoes where required, shall consist of wrought iron shoes and mild steel straps cast into chilled-hardened cast iron blocks, as shown in the Drawings.

4. Supply of Piles

4.1 The Contractor shall only use precast concrete piles supplied by approved manufacturers. Before the commencement of piling work, the Contractor shall notify the S.O the name of the manufacturers.

5. Production of Piles at Site

5.1 In any area or condition where supply of piles is not practicable, the S.O. may allow the Contractor to make arrangement and produce the piles of the same or better quality at the construction site.

5.2 Piles made from Ordinary Portland Cement shall be kept damp for a period of at least ten (10) days after casting. Side forms shall not be stripped less than three (3) days after casting. After 14 days, piles may be lifted and removed to a suitable stacking area but they shall not be driven until they are at least 28 days old.

5.3 For piles made from Rapid Hardening Cement, the above periods may be modified as approved by the S.O.

6. Marking, Handling and Storage of Piles

6.1 After a pile has been cast, the date of casting, reference number, and the length shall be clearly marked with indeletable marker on the top surface and on the head of the pile. In addition, each pile shall be marked at intervals of 300mm along its length before being driven.

6.2 The method and sequence of lifting, handling, transporting and storing piles shall be such that piles are not damaged. Only the designed lifting and support points shall be used. During transport and storage, piles shall be placed on adequate supports located under the lifting points of the piles.

6.3 All piles within a stack shall be in groups of the same length. Packings of uniform thickness shall be provided between piles at the lifting points.

7. Tolerances in Pile Dimensions

7.1 The cross-sectional dimensions of the pile shall not be less than those shown in the Drawings, and shall not exceed them by more than 6mm.

7.2 Any face of a pile shall not deviate by more than 6mm from a straight edge 3m long laid on the face, and the centroid of any cross-section of the pile shall not deviate by more than 12mm from the straight line connecting the centroids of the end faces of the pile.

8. Length of Piles

8.1 The length of a pile shall be taken to mean the overall length measured from the tip of the shoe to the top of the head. The length of piles shall be to the approval of the S.O. Based on the results of pile driving resistance and/or load tests carried out on piles driven on the Site, the S.O. may, from time to time, order the lengths of piles to be modified.

9. Pitching and Driving

9.1 Driving Equipment

The driving equipment to be used shall be of such type and capacity to the approval of the S.O. If a drop hammer is used, it shall be of a free fall type, and the weight of the hammer shall be as specified in BS 8004. For driving piles of sizes smaller than 200mm, diesel hammer shall not be used.

9.2 Pitching of Piles

Piles shall be pitched accurately in the positions as shown in the Drawings. At all stages during driving and until the pile has set or been driven to the required length, all exposed piles shall be adequately supported and restrained by means of leaders, trestles, temporary supports or other guide arrangements to maintain position and alignment, and to prevent buckling and damage to the piles.

9.3 Driving of Piles

9.3.1 Each pile shall be driven continuously until the specified set and/or depth has been reached. However, the S.O. may permit the suspension of driving if he is satisfied that:

a) the rate of penetration prior to the cessation of driving will be substantially re-established on its resumption, or

b) the suspension of driving is beyond the control of the Contractor.

9.3.2 A follower (long dolly) shall not be used for driving end bearing piles. It may be used for driving frictional piles with the prior approval of the S.O.

9.3.3 The Contractor shall inform the S.O. without delay if an unexpected change in driving characteristics is encountered.

9.3.4 Where required by the S.O., the set shall be taken at approved intervals during the driving to establish the behaviour of the piles. A set shall be taken only in the presence of the S.O. unless otherwise approved. The Contractor shall provide all facilities to enable the S.O. to check driving resistance.

9.3.5 Redrive checks, if required, shall be carried out in accordance with an approved procedure.

9.4 Pile Driving Log

A detailed record of the driving resistance over the full length of each pile shall be kept. The log shall record the number of blows for every 300mm of pile penetration.

9.5 Final Set

9.5.1 The final set of a pile other than a friction pile, shall be recorded either as the penetration in millimetres per 10 blows or as the number of blows required to produce a penetration of 25mm.

9.5.2 When a final set is being measured, the following requirements shall be met:-

a) The exposed part of the pile shall be in good condition, without damage or distortion;

b) The dolly and packing shall be in sound condition;

c) The hammer blow shall be in line with the pile axis, and the impact surfaces shall be flat and at right angles to the pile and hammer axis;

d) The hammer shall be in good condition and operating correctly;

e) The temporary compression of the pile shall be recorded.

9.6 Driving Sequence and Risen Piles

Piles shall be driven in an approved sequence to minimise the detrimental effects of heave and lateral displacement of the ground. When required, levels and measurements shall be taken to determine the movement of the ground or any pile resulting from the driving process. If any pile rise occurs as a result of adjacent piles being driven, the Contractor shall submit to the S.O. his proposals for correcting this and to avoid the same in subsequent work.

9.7 Preboring

If preboring is specified, the pile shall be pitched into a hole prebored to the depth shown in the Drawings, unless otherwise instructed by the S.O.

9.8 Jetting

Jetting shall be carried out only when the Contractor’s detailed proposals have been approved, and not for the last 3 metre of the required depth of penetration.

10. **Repair and Lengthening of Pile**

10.1 Repair of Damaged Pile Heads

10.1.1 Damaged pile head shall be cut off square at sound concrete, and all loose particles shall be removed by wire brushing, followed by washing with water. If the pile is to be subjected to further driving, the head shall be replaced with concrete of an approved grade. The new head shall be cast truly in line with the remainder of the pile, and be properly cured and allowed to harden sufficiently to develop the strength necessary for further driving.

10.1.2 If a pile has been driven to the required set or depth but sound concrete of the pile is below cut-off level, the pile shall be made good to the cut-off level with concrete of a grade not inferior than that of the concrete of the pile.

10.2 Lengthening of Piles

Where piles have to be lengthened, other than by means of welding of steel plates as detailed in the Drawings, the reinforcement shall be stripped of all surrounding concrete for a distance equal to 40 times the diameter of the main reinforcement measured from the pile head for spliced joints and 300mm for butt welded joints, and all lateral reinforcement shall be removed. The lengthening bars shall butt on the exposed bars in true alignment, and shall be butt welded as specified or shall be spliced with bars of the same diameters as the main pile bars, 80 times diameter in length and lapping the main bars for a distance of 40 times diameter above and below the joint, and shall be securely bound with 1.63mm soft annealed iron wire. New binders of similar size shall be provided and spaced at half the centres of the binders in the main body of the pile, and shall be securely bound with 1.63mm diameter soft annealed iron wire, and the pile extended by concreting in properly constructed mounds to the length required. Steps shall be taken to ensure that the concrete at the joint between the old and the new concrete is not of inferior grade and quality than that of the concrete of the pile. The extension shall be truly in line with the remainder of the pile, and be properly cured and allowed to harden sufficiently to develop the strength necessary for further driving.

10.3 Driving Repaired/Lengthened Piles

Piles which have been repaired or lengthened by adding cast-insitu concrete as specified in clauses 10.1 and 10.2 shall not be driven until the added concrete has reached the specified strength of the concrete for the pile.

11. **Cutting and Stripping of Pile Heads**

11.1 When a pile has been driven to the required set or depth, the head of the pile shall be cut off to the level shown in the Drawings or as instructed by the S.O. The length of reinforcing bars projecting above this level shall be as shown in the Drawings.

11.2 Care shall be taken to avoid cracking or otherwise damaging the rest of the pile. Cracked or defective concrete shall be cut away and made good with new concrete properly bonded to the old.

SECTION B.3 - STEEL H-BEARING PILES

1. Pile Sections and Dimensions

1.1 All steel H-bearing piles shall comply with JIS A5526 with regards to profile and tolerances and the steel shall comply with the requirements of BS EN 10025 and BS 4360. The profile and grade to be used are as specified or as shown in the Drawings.

2. Straightness of Piles

2.1 For standard rolled profiles, the deviation from straightness in millimetres shall not exceed 1.04(L-4.5) where L is the length of the pile in metres.

2.2 For proprietary sections made up from rolled profiles, the deviation from straightness shall not exceed 1/1000 of the length of the pile.

3. Strengthening of Piles

3.1 Unless otherwise approved by the S.O., the strengthening of the toe of the pile in lieu of a shoe or the strengthening of the head of a pile shall be made from material of the same grade as the pile and to the details as shown in the Drawings.

4. Marking of Piles

4.1 Each pile shall be clearly marked with white indeletable marking at the flanged head showing its reference number and overall length. In addition, each pile shall be marked at intervals of 300mm along its length before being driven.

5. Handling and Storage of Piles

5.1 All operations such as handling and transporting of piles shall be carried out in such a manner that damage to piles and their coatings are minimised. Piles that are damaged during handling and transporting shall be replaced by the Contractor at his own expense. All damaged and rejected piles shall be removed from the Site forthwith.

5.2 Piles within a stack shall be in groups of the same length and on approved supports.

6. Pitching and Driving of Piles

6.1 Pitching and driving of piles shall be in accordance with Clauses 9.1 to 9.8 as specified hereinbefore under ‘PRECAST REINFORCED CONCRETE PILES’.

7. Lengthening of Piles

7.1 Where lengthening of piles are required, the piles shall be jointed by butt-welding, stiffened with plates fillet-welded on all four sides as detailed in the Drawings. All welding shall be continuous and complying with BS 5135 and BS 5950. The type and size of welding shall be as detailed in the Drawings.

8. **Preparation of Pile Heads**

8.1 When a pile has been driven to the required set or depth and before encasing in concrete, the piles shall be cut to within 20mm of the levels shown in the Drawings, and protective coatings, if any, shall be removed from the surfaces of the pile heads down to a level 150mm above the soffit of the concrete. Pile heads shall be constructed to the details as shown in the Drawings.

SECTION B.4 - PRESSURE -TREATED TIMBER PILES

1. Timber

1.1 General

Pressure-treated timber piles to be used for the Works shall be those approved by SIRIM.

1.2 Species of timber

Unless otherwise approved by the S.O., only Kempas (Kempassia Malaccensis) shall be used.

1.3 Definitions

The timber terms used in the Specification shall have the meaning assigned to them in BS 5268 or the Malayan Grading Rules for Sawn Hardwood Timber (1968) whichever is applicable.

1.4 Quality

Timber used for the piles shall not be of a lesser quality than the Selected Structural Grades Specified in Section J (Stress Grading) of Part III of the Malayan Grading Rules for Sawn Hardwood Timber. The timber shall be free from rot, fungal or pest attack, and any other defects not permitted for its grade.

1.5 Tolerances in Dimension

The dimension of sawn timber piles shall be within the range of 2mm less and 6mm greater than their specified cross-sectional dimensions. The centroid of any cross-section of a sawn timber pile shall not deviate by more than 25mm from the straight line connecting the centroids of the end faces of the standard length of a 6 metre pile.

2. Workmanship

2.1 Where applicable, the standard of workmanship shall conform to BS 5268.

3. Preservative Treatment

3.1 The method for treatment of timber shall be the full-cell process. The full-cell process, compositions of preservatives, the test methods for determining the depth of penetration of preservatives, and the weight of net salt retention in the treated timber shall be as described in MS 1302, MS 1304 and MS 360. The minimum depth of penetration of preservative shall be 25mm and the minimum weight net dry salt retention in the treated part of the timber shall not be less than 16 kg/m^3.

4. Marking of Pile

4.1 The treated pile shall be permanently marked with identifications which indicate that they comply with this Specification, manufacturer's trade mark, charge number and date of treatment and the length of the pile.

5. **Inspection**

5.2 The S.O. may require inspection of the treatment plant to observe and ensure that the manufacturing process and control testings of the piles are carried out in accordance with this Specification. Records of the actual treatment schedule shall be kept during the treatment process, and the Contractor shall furnish such records for the piles supplied when requested by the S.O.

6. **Warranty**

6.1 Before commencement of work, the Contractor shall notify the S.O. the name of the supplier and manufacturer for approval.

6.2 Before the treated timber pile is accepted for the work, the Contractor shall obtain from the manufacturer of the treated piles, a warranty on an approved form, which provides that the treated piles shall be free from such fungus and insect attack which may render the supported building structurally unsound, for a thirty (30) years period.

7. **Delivery and Stacking**

7.1 The Contractor shall notify the S.O. of the delivery of timber piles to the Site and provide the necessary facilities to enable the S.O. to inspect each pile and take random sampling for determination of depth of penetration and the net dry salt retention.

7.2 Accepted piles shall be marked and stacked in lengths on levelled and well-drained hard ground. Each pile shall be stacked clear off the ground with an air space around it. The piles shall be separated by sticks or blocks placed vertically one above the other and closely spaced horizontally to avoid sagging of the piles. All rejected piles shall be removed from the Site promptly.

8. **Pile Head**

8.1 The pile head shall be adequately protected during driving so that brooming does not occur.

8.2 The pile head shall be fitted with toothed metal plates as approved by the S.O. for protection against brooming and splitting during normal driving.

8.3 In the case of hard driving, unless otherwise approved by the S.O., a metal helmet shall be fitted to the top of the pile. The top of the pile shall first be trimmed to fit closely into the recess of the underside of the helmet. A hard timber dolly and, if necessary, a packing piece shall be used above the helmet.

8.4 If during driving, the head of the pile becomes excessively broomed or otherwise damaged, the damaged part shall be cut off and the helmet refitted.

9. **Pitching and Driving of Piles**

9.1 Pitching and driving of piles shall be in accordance with clauses 9.1 to 9.8 as described hereinbefore under ‘PRECAST REINFORCED CONCRETE PILES’.

10. **Lengthening of Piles**

10.1 Piles shall be provided in one single length of 6.0m each, unless otherwise approved. Any pile driven to the required set at a depth of 6.0m or less shall be in one continuous

length.

10.2 If jointing is required, pile joints shall be made by using mild steel welded boxes, 450mm long, fabricated from 5mm thick plates, unless otherwise shown in the Drawings. The internal dimensions of the box shall be 3mm undersize of the pile cross-sectional dimensions. The joint and the ends of the piles to be jointed shall be constructed so that the necessary strength and stiffness are developed at the joint.

11. Defects on Piles while Driving

11.1 When fissures appear in a pile during driving, which, in the opinion of the S.O., will affect its strength, the pile shall be rejected and replaced at the Contractor's expense.

12. Preparation of Pile Heads

12.1 When a pile has been driven to the required set or depth, the head of the piles shall be cut off square to sound wood and treated with an approved preservative and a waterproof coating to the approval of the S.O.

12.2 The pile head shall be embedded for a depth of not less than 150mm in the concrete cap**,** with a minimum of 150mm concrete surround.

SECTION B.5 - PILE TESTING

1. General

1.1 Type of Tests Necessary

The Maintained Load Test shall be carried out on a test pile. The Contractor shall, if required by the S.O., carry out the Constant Rate of Penetration Test on completion of the Maintained Load Test.

1.2 Safety Precautions

When preparing, conducting and dismantling a pile test, the Contractor shall carry out the work in a safe manner, and shall in addition make such other provisions, as may be necessary, to safeguard against any likely hazards.

2. Definitions

2.1 Compression Pile

A pile which is designed to resist an axial force such as would cause it to penetrate into the ground.

2.2 Anchor Pile

A pile which is designed to resist an axial force such as would tend to cause it to be extracted from the ground.

2.3 Test Pile

A compression pile to which a load is applied to determine the load versus settlement characteristics of the pile and the surrounding ground.

2.4 Reaction System

The system of kentledge, piles or anchors that provides resistance against which the pile is tested.

2.5 Kentledge

The dead weight used in a loading test.

2.6 Maintained Load Test

A loading test in which each increment or decrement of load is held constant either for a defined period of time or until the rate of settlement or rebound falls to a specified value.

2.7 Constant Rate of Penetration Test (CRP)

A loading test in which the pile is made to penetrate the soil from its position at a constant speed while the force applied at the top of the pile to maintain the rate of penetration is continuously measured, until the force versus penetration relationship obtained does not represent an equilibrium condition between load and settlement.

3. Supervision

3.1 All tests shall be carried out only under the direction of an experienced and competent

Contractor's supervisor, with approved test equipment and test procedure as specified hereinafter.

3.2 All Contractor's personnel operating the test equipment shall have been trained in its use. Tests shall be carried out only in the presence of the S.O. or the S.O's representative.

4. Reaction System

4.1 General

Compression test shall be carried out using a kentledge, anchor piles or specially constructed anchorages as reaction system. The reaction system used shall be designed to transfer safely to the test pile the maximum load required for testing. Full details of the reaction system shall be submitted to the S.O. prior to any work related to the testing process being carried out on the Site.

4.2 Kentledge

Where kentledge is to be used, it shall have adequate weight to resist load up to 1.2 times the maximum test load. The kentledge shall be supported on cribwork, beams or other supporting structure disposed around the test pile so that its centre of gravity is on the axis of the pile. Kentledge shall not rest directly on the pile head. The bearing pressure under the supports shall be such as to ensure stability of the kentledge stack and shall not impair the efficiency of the testing operations. The distance from the edge of the test pile to the nearest part of the supports to the kentledge stack in contact with the ground shall not be less than 1.3m.

4.3 Anchor Pile and Ground Anchor

4.3.1 Where anchor piles or ground anchors are to be used, they shall be of adequate strength to resist load up to 1.2 times the maximum test load on the ground, in a safe manner without excessive movement or influence on the test pile. The method employed in the installation shall be such to prevent damage to any test pile or working pile.

4.3.2 The Contractor shall ensure that when the test load is applied, the load is correctly transmitted to all the bolts and tie rods. The extension of rods by welding shall not be permitted, unless it is known that the steel will not be reduced in strength by welding. The bond stress of the rods in tension shall not exceed normal permissible bond stresses of the type of steel and grade of concrete used.

4.3.3 Where anchor piles are used, the centre to centre spacing of these piles from a test pile shall be not less than three (3) times the diameter of the test pile, or the anchor piles, or 2m, whichever is the greater. Under-reamed piles shall not be used as anchor piles. Where permanent working piles are approved by the S.O. to be used as anchor piles, their levels shall be observed during application of the test load to ensure that there is no residual uplift.

4.3.4 Where ground anchors are used, no part of the section of the anchor transferring load to the ground shall be closer to the test pile than three (3) times the diameter of the test pile. Furthermore, no part of the ground anchor shall be closer to a working pile than one-and-a-half times the diameter of the test pile along the unbonded length of the anchor, and three (3) times the diameter of the test pile along the bonded length of the anchor. Under-reams on ground anchors shall not exceed 170mm in diameter.

5. **Testing Equipment**

5.1 The Contractor shall ensure that when the hydraulic jack and load measuring device are mounted on the pile heads, the whole system will be stable up to the maximum load to be applied.

5.2 The test loads shall be applied by means of a hydraulic jack of adequate capacity, fitted with a load measuring device.

5.3 The hydraulic jack, pump, hoses, pipes, couplings and other apparatus to be operated under hydraulic pressure, shall be capable of withstanding a test pressure equivalent to one and a half (1½) times the maximum test load without leakage.

5.4 Where the C.R.P. test is required, the jack pump capacity shall be adequate to maintain the required rate of penetration. The permissible extension of the jack shall be such that the pile can be moved continuously and without repacking for a distance of at least 50mm.

5.5 The measuring device shall be of the type approved by the S.O., capable of registering loads in increments not exceeding 20 KN.

5.6 The hydraulic jack and measuring device shall be calibrated together to the approval of the S.O. before and after each series of tests, whenever adjustments are made to the device or at intervals appropriate for the type of equipment used. Certificates of calibration shall be submitted to the S.O.

5.7 The loading equipment shall be capable of adjustment throughout the test to obtain a smooth increase of load or to maintain each load constant at the required stages of the maintained load test.

6. **Preparation of a Working Pile to be Tested**

6.1 General

If a test is required on a working pile, the Contractor shall prepare the pile for testing to the approval of the S.O.

6.2 Driving Records

For each working pile which is to be tested, a detailed record of driving shall be made and submitted to the S.O. daily, not later than noon on the next working day.

6.3 Cut-off Level

The pile shall terminate at the normal cut-off level or at a level required by the S.O. However, where necessary, the pile shall be extended above the cut-off level of working piles so that gauges and other apparatus to be used in the testing process will not be damaged by water or falling debris. If the cut-off level is below ground level, the pile is not extended and there is a risk of the borehole collapsing, a sleeve shall be left in place or inserted above the pile, or other approved action shall be taken. Adequate clearance shall be given between the top of the pile and the bottom of the sleeves to permit unrestricted movement of the pile.

6.4 Pile Head for Compression Test

For pile that is tested in compression, the pile head or cap shall be formed to give a plane surface which is normal to the axis of the pile. An approved mild steel bearing plate shall be mounted on top of the pile head or cap to accommodate the loading and settlement measuring equipment, and to prevent damage from the concentrated application of load

from the loading equipment.

6.5 Notice of Test

The Contractor shall give the S.O. at least 24 hours notice of the commencement of test.

7. Settlement Measurement

7.1 An independent reference frame shall be set up to permit measurement of the vertical movement of the test pile. The support for the frame shall be located not closer than 2 metres from the test pile, and shall be rigidly fixed to the ground to a depth of not less than 1m with concrete surround. In addition, the elevation of the supports shall be checked frequently with reference to a fixed benchmark.

7.2 The entire measuring assembly shall be protected against rain, direct sunlight and other disturbances that might affect its reliability. Temperature readings shall be taken when requested by the S.O. The measurement of pile movement shall be made by four dial gauges rigidly mounted on the reference frame that bear on machined metal or glass surfaces, normal to the pile axis fixed to the pile cap or head. Alternatively, the gauges may be fixed to the pile and bear on surfaces on the reference frame. The dial gauges shall be placed in diametrically opposite positions, and be equidistant from the pile axis. The dial gauges shall enable readings to be made to within an accuracy of 0.1mm, and shall have a minimum travel of not less than 50mm.

7.3 The Contractor may submit other methods of measuring the movement of pile heads for approval.

8. Test Procedure

8.1 General

Throughout the test period, all equipment for measuring load and movement shall be protected from the effects of weather. Construction equipment and persons who are not involved in the testing process shall be kept at a sufficient distance from the test to avoid disturbance to the measurement apparatus.

8.2 Maintained Load Test

8.2.1 The load shall be applied in increment of 25% of the working load, up to the working load and appropriately smaller thereafter, until a maximum test load of twice the working load is reached. Each increment of load shall be applied as smoothly and as expeditiously as possible. Settlement readings and time observations shall be taken before and after each new load increment.

8.2.2 A time-settlement graph shall be plotted to indicate when the rate of settlement of 0.05mm in 15 minutes is reached. A further increment of load shall be applied when this rate of settlement is achieved, or until a minimum time of 2 hours has elapsed, whichever is later. The process shall be repeated until the maximum test load is reached.

8.2.3 The maximum test load shall then be maintained for a minimum of 24 hours, and time-settlement readings shall be taken at regular intervals, as for the earlier load stages.

8.2.4 The test load shall then be decreased in four equal stages, and time-settlement readings shall be as specified aforesaid, until the movement ceases. At least 60

minutes interval shall be allowed between the unloading decrements.

8.3 Constant Rate of Penetration Test

8.3.1 The load shall be applied to achieve a constant rate of penetration value between 0.75mm per minute to 1.50mm per minute. The rate chosen shall suit the jacking equipment used.

8.3.2 Both settlement and time readings shall be recorded at every minute period. Further loading shall be discontinued when the loading varies indirectly as the penetration in the case of end bearing piles in sand or gravel, or when the rate of penetration is constant without further increase in the load in the case of friction piles in clay. Loading shall then be released gradually and rebound readings taken.

9. Presentation of Results

9.1 Submission of Results

Results shall be submitted as a signed summary in duplicate to the S.O. immediately on completion of the test, which shall give:

i. for the Maintained Load Test for each stage of loading, the period for which the load was held, the load and the maximum settlement. These are to be plotted as time-settlement graphs.

ii. for the CRP test, the maximum load reached and a graph of load against penetration.

9.2 Schedule of Recorded Data

The Contractor shall provide information about the tested pile in accordance with the following schedule, where applicable -

a) General

i) Site Location
ii) Contract Identification
iii) Proposed Structure
iv) Main Contractor
v) Piling Sub-contractor (if any)
vi) Site Office
vii) Client's Name
viii) Maintained Load or CRP Test
ix) Date of Test

b) Test Procedure

i) Weight of Kentledge
ii) Tension of Pile, Group Anchor Details
iii) Plan of Test Arrangement showing position and distance of kentledge supports, tension piles and reference frame to test pile.
iv) Jack Capacity
v) Method of Load Measurement
vi) Method (s) of Penetration Measurement
vii) Relevant Dates and Times

c) Test Results

i) In Tabular Form
ii) In Graphical Form: Load Plotted against Settlement, with Times
iii) Ground Heave (if any)
iv) Effect on Adjacent Structure (if any)

d) Site Investigation

i) Site Investigation Drawing Number
ii) Borehole Reference nearest to Test Pile.

10. **Interpretation of Test Results**

10.1 The S.O.'s interpretation and conclusions on the test results shall be final. The pile so tested shall be deemed to have failed if:

a) The residual settlement after removal of the test load exceeds 6.5mm;
or
b) The total settlement under the Design Load exceeds 12.5mm;
or
c) The total settlement under twice the Design Load exceeds 38.0mm, or 10% of pile diameter/width, whichever is the lower value.

11. **Completion of Test**

11.1 Measuring Equipment

On completion of a test, all equipment and measuring devices shall be dismantled, checked and either stored, so that they are available for use in further tests, or removed from the Site.

11.2 Kentledge

Kentledge and its supporting structure shall be removed forthwith from the Site on completion of all tests.

11.3 Ground Anchors and Temporary Piles

On completion of a pile test, tension piles or ground anchors shall be cut off below ground level and the ground made good with approved material.

SECTION C - EXCAVATION AND EARTHWORKS

1. **General**

1.1 This Work shall consist of all the required excavation within the limits of the Works. It shall include the removal and proper utilisation and hauling, or disposal of all excavated materials, and constructing, shaping and finishing of all earthworks over the entire extent of the Works, in conformity with the Drawings and this Specification.

1.2 The excavation and earthworks shall be executed in such a manner and order as approved by the S.O. The Contractor shall be responsible for compliance with by-laws and regulations relating to earthworks.

1.3 Excavation in rock and/or hard material shall respectively be measured and paid for as extra over to excavation and earthworks in accordance with the Provisional Bills of Quantities. The Contractor shall give reasonable notice to the S.O to examine, classify the excavation and to take measurement prior to breaking up. For contract based on Specifications and Drawings, unless otherwise provided in the Contract, for the purpose of pricing the excavation and earthworks, the whole excavation shall be assumed to be without rock and/or hard material as defined hereunder.

1.4 For contract based on Quantities, the pricing shall be in accordance with the Bills of Quantities.

1.5 Computation of volume of rock excavation for payment shall be based on nett volume excavated as indicated in the Drawings.

2. **Site Clearing**

2.1 The whole Site shall be cleared to the extent as shown in the relevant Drawings. These shall include clearing, grubbing and removing all trees, shrubs, vegetation and butts; and clearing, demolishing, breaking up and removing all structures above ground level such as buildings, walls, fences and other obstruction within the Site which have been designated to be demolished or removed. All spoil and debris shall be removed and disposed off as approved by the S.O. in accordance with Environmental Quality Act 1974 (Act 127) and Regulations.

3. **Preservation of Existing Trees**

3.1 The Contractor shall take precaution to protect from damage, all existing trees and shrubs which are designated to be preserved as specified under SECTION N.4: LANDSCAPING AND TURFING.

4. **Demolition of Existing Structures**

4.1 Any existing structures and other obstruction which are designated to be removed shall be demolished, broken up, removed and disposed as approved by the S.O.

4.2 All salvaged materials arising from the demolition work shall, unless otherwise specified, become the property of the Contractor, and shall be removed from Site as soon as possible.

5. **Relocation of Existing Utilities and Services**

5.1 The Contractor's attention is specially drawn to his responsibilities under the Clause headed ‘Damage to Property' of the Condition of Contract.

5.2 Before commencing on any excavation, the Contractor or his representative shall accompany the S.O. on a site inspection to identify the presence of underground cables, water or other service pipes at or in the vicinity of such excavation. Thereafter, the Contractor shall carry out the excavation work in a manner and sequence as approved by the S.O.

5.3 If during excavation, the Contractor's workmen uncover any cables, water or other service pipes, work shall be stopped immediately and shall not be again started until the matter has been reported to the S.O. who will notify the appropriate local authority, and subsequently issue whatever directions he deemed appropriate.

6.0 **General Excavation**

Excavation shall be divided into two categories i.e. common excavation and hard material/ rock excavation. Payment on excavation is to be made based on the method and equipments used.

6.1 Common Excavation

6.1.1 Common excavation shall mean excavation in any material other than hard material/ rock excavation.

6.2 Hard Material/ Rock Excavation

6.2.1 Hard material/ rock excavation shall mean excavation in any material that cannot be loosened by an excavator with a minimum mass of 44 tons and a minimum rating of 321 BHP. The excavator shall be in good condition, and operated by an experienced personnel skilled in the use of excavator equipment.

Hard material/ rock excavation shall require one or a combination of the following methods:

i. Excavation using track excavator exceeding a mass of 44 tons and 321 BHP rating.
ii. Ripping using a tractor unit of minimum weight of 37 tons and 305 BHP rating and a ripper attached.
iii. Excavation using hydraulic rock breaker.
iv. Excavation using pneumatic tool.
v. Open blasting
vi. Controlled blasting.

Excavation of boulders of individual mass less than 0.5m^3 shall not be considered as rock but as common excavation.

6.2.2 Trial Excavation

If it is apparent that common excavation as per clause 6.1.1 cannot be carried out, than the S.O may instruct the Contractor to submit his method statement to the S.O., based on his proposed method of excavation for approval. A trial excavation shall be carried out to verify and confirm the proposed method of excavation. The trial excavation shall be witnessed by the respective representatives of the Contractor and S.O. In the case where the method statement is rejected by the S.O., the Contractor shall submit a new method statement to the S.O. and the whole process of trial excavation shall be repeated to enable the S.O. to consider the new method statement for approval.

6.2.3 Method of Measurement

Levels shall be taken before and after excavation, to calculate the volume for each method of excavation. Levels taken shall be subject to approval by the S.O. The levels taken shall be certified by the representatives of the Contractor and S.O, respectively. For determination of the volume of boulders, diameters in three orthogonal directions shall be taken at 2m intervals or lesser. The average of the three diameters shall be used to calculate the volume of boulder. Records of measurements and photographs shall be taken and kept to support the calculation of the volume of excavation.

6.2.4 Mechanical Equipment In 'Good Running Condition'

Prior to the execution of trial excavation, the Contractor shall furnish the following documents to the S.O as evidence that the excavator is in good running condition:

i) A copy of the Original Equipment Manufacturer (OEM) performance handbook or catalogue, with details of the operating weight, BHP and maximum drawbar pull of the excavator.

ii) Relevant records showing that the excavator has been appropriately and routinely up-kept and adequately maintained in accordance with the recommendations of the OEM's schedule.

7. Excavation for Foundations, Pits and Trenches

7.1 Foundation trenches, pier holes, etc. shall be excavated to the levels and dimensions as shown in the Drawings, with sides trimmed and bottoms levelled and stepped as required.

7.2 All excavation shall be carried down to hard ground. On no account shall foundations rest on made or filled ground. The depths of foundation shall be decided on the site by the S.O., but for tendering purposes, unless otherwise shown in the Drawings, the Contractor shall assume the uniform overall depth 1.5m below formation level. Any variation to such depth, together with any variation caused thereby to concrete and brickwork, etc., shall be measured and valued as variations, as provided for in the Contract, and the Contract Sum shall be adjusted accordingly. The Contractor shall at his own cost and expense, make good any over excavation below the required depth with suitable material or concrete as approved by the S.O.

8. Sides of Excavation

8.1 The Contractor shall ensure that at all times, the sides of the excavation are maintained in a safe and stable condition, and shall be responsible for the adequate provision of all shoring and strutting including sheet piling required for this purpose. All temporary works shall comply with requirements of BS 5975.

9. Excavation To Be Kept Dry

9.1 The Contractor shall be responsible for keeping dry all excavations, whether in open cut or in trench, so as not to interfere with the work in progress. The Contractor shall, without extra cost to Government, provide, fix, maintain and work, as and when directed by the S.O., such pumps, wells, drains, dams and other things necessary to effectively deal with all water which may collect or find its way into the excavation from any cause whatsoever. Nevertheless, such directive shall not relieve the Contractor from his liability for any damage to the Works or adjoining land and property or water courses due to his

operations.

10. **Bottom of Excavation**

10.1 Unless otherwise stated, the excavation, whether in open cut or in trench, shall be proceeded with in such portions at a time as the S.O. may approve, and shall not, in the first instance, be carried down to a depth nearer than 150mm above the required excavation level; the last 150mm of depth to the said level shall be carried out by manual labour immediately in advance of placing concrete.

10.2 Any pockets of soft material or loose rock in the bottom of pits and trenches shall be removed, and the resulting cavities and any large fissures filled with properly compacted blinding concrete (1:3:6). The Contractor shall take such steps as and when necessary, to prevent damage to the bottom of excavation due to exposure to the weather. After the placing of any blinding concrete, no trimming of the side faces shall be carried out for the next 24 hours.

11. **Inspection**

11.1 The Contractor shall report to the S.O. when the excavation are ready to receive concrete, and no concrete shall be laid until the excavation have been inspected and approved by the S.O.

12. **Backfilling**

12.1 A portion of the excavated material shall be returned, filled around walls, columns and the like in 225mm layers and each layer thoroughly compacted using rammers or mechanical compactors as the S.O. may approve, until compaction is complete. However, only suitable and approved fill materials shall be returned for backfilling. The surplus excavated materials shall be deposited, spread and levelled on site or elsewhere as approved.

12.2 Shoring used for the sides of the excavation shall be withdrawn in stages as the compaction of backfilling proceeds.

13. **Anti-Termite Treatment**

13.1 Termiticide chemicals shall be applied in accordance with the manufacturer's recommendation and label instructions prior to the pouring of concrete to construct the ground slab or for blinding. Notwithstanding the manufacturer's recommendation, the minimum surface application rate shall be five (5) litres per sq. meter on all ground floor built-up areas including apron areas, and also on all areas extending one (1) meter beyond the perimeter drain all around the building. In addition, termiticide chemical shall be sprayed on interfaces between the concrete ground beam and the hardcore at a minimum rate of one (1) litre per linear meter.

13.2 Treatment shall not be performed just before or after heavy rain, unless the area to be treated can be physically protected to avoid leaching and runoff before the termiticide chemical has bound to the soil.

13.3 Immediately after spraying of chemical, all surfaces exposed to direct sunlight or rain shall be covered with an impervious black PVC sheet of minimum thickness of 0.08mm to reduce the loss of chemical by UV light, alkaline wet concrete, leaching and runoff caused by rain on exposed treated soil. In the case of areas receiving blinding, the coverings shall be removed immediately prior to the placement of the blinding concrete.

13.4 As soon as practicable after the completion of anti-termite treatment and prior to the issuance of the Certificate of Practical Completion, the Contractor shall submit to the S.O., the anti-termite treatment specialist's Guarantee against any termite attack to the Works which may arise during a period of two (2) years from the date of Practical Completion of Works due to any defect, fault or ineffective anti-termite treatment. The terms of the Guarantee shall be such as shall be approved by the S.O.

14. Cut and Fill To Formation Level

14.1 General

Area for buildings, open spaces**,** fields, roads and footpaths shall be cut and filled to the required formation levels and grades as shown in the Drawings. Trimming and forming of banks shall be to the profiles as shown in the Drawings or as directed by the S.O. All ditches, ponds or wells that are to be filled shall first be excavated to remove all soft spots if so directed by the S.O. All excavated materials shall be removed from Site and the depressions including holes resulting from the grubbing of tree roots shall be filled with approved fill materials and well compacted. Unless otherwise provided in the contract, if the fill materials obtainable from Site are insufficient, the Contractor shall at his own cost, obtain such materials from outside source.

14.2 Fill Materials

14.2.1 Only suitable materials such as medium stiff clay, clayey sand or other approved soils shall be used for filling.

14.2.2 Materials from swamps, peats or top soils and other highly organic clay or silt, materials containing logs, stumps or boulders, which are susceptible to combustion, and any other materials which, by virtue of their physical or chemical composition or at their moisture content will not compact properly, shall not be used for filling.

14.3 Spreading and Compacting

14.3.1 Prior to placing any fill upon any area, all clearing and grubbing operations shall have been completed.

14.3.2 All earth filling generally, shall be carried out in layers not exceeding 225mm thick loose layers. Each filling layer shall be thoroughly compacted by means of six (6) passes of a smooth wheel 6T roller or other approved compacting equipment.

14.3.3 Maximum use shall be made of earthmoving plants for initial compaction, and the Contractor shall be required to vary the routes uniformly to reduce 'tracking' and to obtain uniform compaction over as wide an area as possible.

14.4 Finish to Formation Level

14.4.1 Unless otherwise shown in the Drawings, the upper surface of all platform shall be finished to a cross fall of 1:400 and where practicable, shall, in addition, be given a longitudinal fall to ensure rapid disposal of surface water.

14.4.2 For areas to be turfed, the formation shall be completed to an appropriate level below the finished level indicated, to allow for placement of top soil and turf.

14.5 Soft Spots

14.5.1 Where any undue movements due to the presence of soft unstable soil under the fill occur, or unsuitable material is encountered at the bottom of the fill, it shall be

excavated to such depth and over such areas as approved by the S.O., and shall be removed to spoil. The resulting excavation shall be backfilled with suitable material as specified hereinbefore, and deposited in layers not exceeding 225mm thick and compacted as described above, or with compaction equipment suitable for working in small excavation.

14.5.2 The Contractor shall allow for settlement or displacement of fill over soft areas, and shall build up to the required finished level with necessary compaction. Should any settlement of fill occur during construction or within the Defects Liability Period, the Contractor shall make good the same at his own cost and expense.

15. Filling under Floors, Aprons etc.

15.1 Filling shall be provided and laid under floors, aprons, etc. where required. Filling shall be of suitable material as specified hereinbefore, deposited in layers not exceeding 155mm loose thickness, and each layer well watered where necessary, rammed and compacted. No clay shall be used for filling under floors and aprons.

16. Temporary Drainage Channels and Bunds

16.1 As earthwork progresses, the Contractor shall provide and maintain efficient drainage of the Site as specified under SECTION A: PRELIMINARIES AND GENERAL CONDITIONS, until such time as the permanent surface water drainage is installed.

17. Clearing of Existing Ditches, Drains, Rivers, etc.

17.1 During the execution of the earthwork, the Contractor shall take all necessary precautions to prevent blockage or obstruction, and to ensure free-flow of existing drains, ditches, streams and the like.

18. Protection and Maintenance of Earthworks

18.1 The Contractor shall provide all necessary protection and maintenance of earthwork, particularly from the damaging effects of water entering the works from rainfall, runoff, springs, rivers or streams. Damage to finished or partly completed work arising from the lack of such protection and maintenance work, shall be made good by the Contractor at his own cost and expense.

18.2 Where turfing is required for slope protection, they shall be planted immediately after the embankment is formed. The turfing shall be executed as specified hereinafter under SECTION N.4: LANDSCAPING AND TURFING.

18.3 If due to unforeseen circumstances turfing cannot be carried out immediately, temporary protection/cover (eg. plastic sheets or equivalent) shall be laid on exposed slopes by the Contractor.

19. Hardcore

19.1 Where shown and required, approved hardcore consisting of good, sound broken bricks or stones shall be provided and laid to the thickness shown in the Drawings, well rammed, compacted and blinded with sand. All hardcore shall be well watered immediately prior to the depositing of concrete thereon.

SECTION D - CONCRETE WORKS

1.0 General

This section shall apply to the construction of all structures or parts of structures to be composed of concrete with or without steel reinforcement. The Work shall be carried out all in accordance with this specification and the lines, levels, grades, dimensions and cross-sections shown in the Drawings and as required by the S.O.

2.0 Material

2.1 Cement

The cement to be used throughout the Work shall be Portland cement obtained from an approved manufacturer. The cement shall be described under the following headings:

i) Ordinary Portland Cement to comply with MS 522
ii) Rapid Hardening Portland Cement to comply with MS 522
iii) Sulphate Resisting Portland Cement to comply with MS 1037
iv) Portland Pulverized-Fuel Ash Cement to comply with MS 1227
v) Portland Slag Cement to comply with MS 1389

2.1.1 Certificates of Test

Manufacturers' certificates of test shall in general be accepted as proof of soundness. Additional tests shall be carried out on any cement including those of imported cement, which appears to have deteriorated through age, damage to containers, improper storage, or any other reason. The test shall be carried out at any approved laboratory at the expense of the Contractor. Any batch of cement that has been sampled and tested and found not to have complied with the requirements shall be rejected and removed from the Site.

The S.O. may, without tests being made, order that any bag of cement, a portion of the contents of which has hardened, or which appears to be defective in any other way, be removed from the Site.

2.1.2 Transportation and Storage

The cement shall be transported to the Site in covered vehicles adequately protected against water. It shall be stored in a weatherproof cement store to the approval of the S.O. Cement stored in bags shall not be laid directly on the ground. It shall be taken for use in the Work in the order of its delivery into the store. Cement delivered in bulk shall be stored in silos of an approved design.

2.2 Aggregates

Aggregates shall be naturally occurring sand, granite or limestone, crushed or uncrushed except as otherwise specified, and shall comply with MS 29. They shall be obtained from a source approved by the S.O.

Marine aggregates shall not be used unless otherwise specified in the Drawings.

2.2.1 Coarse Aggregates

Coarse aggregates shall comply with MS 29. For work below ground level, only crushed granite shall be used. Unless otherwise specified in the Drawings, tests shall be carried out according to MS 30. The property limits shall be as specified in Table 1. The maximum nominal size of aggregate shall be as specified in the Drawings.

2.2.2 Fine Aggregates

Fine aggregates shall comply with MS 29. In the context of MS 29, the term 'sand' is used to mean 'fine aggregate'. If it is found necessary, the fine aggregate shall be washed and screened to the approval of the S.O. Unless otherwise specified in the Drawings, tests shall be carried out in accordance with MS 30. The property limits shall be as specified in Table 1.

2.2.3 Grading

(a) Coarse Aggregates

The grading of coarse aggregates shall be analysed as described in MS 30 and shall be within the limits specified in Table 2.

(b) Fine Aggregates

The grading of fine aggregates shall be analysed as described in MS 30 and shall be within the limits specified in Table 3. However, for prescribed mixes Grading Limit M shall only be used.

2.2.4 Sampling and Testing of Aggregates

Where site mixing is used, samples of fine and coarse aggregates approved by the S.O. shall be kept on Site. These samples shall give a fair indication of the general quality of the aggregates for comparison with the aggregates delivered during the course of executing the Work. Tests shall be carried out on samples of the latter, taken at intervals as required by the S.O., or whenever there is a change of source. The appropriate method of sampling and testing shall be in accordance with the standards as specified in Table 1. Any batch of aggregate rejected by the S.O. shall be removed from the Site.

2.2.5 Storage of Aggregates

Separate storage facilities with adequate provision for drainage shall be provided for each different size of aggregate used.

Aggregate shall be handled and stored so as to minimise segregation and contamination.

2.3 Water

Water shall comply with the requirements of MS 28. It shall be clean and free from materials deleterious to concrete in the plastic and hardened state and shall be from a source approved by the S.O. The S.O. may instruct the Contractor to carry out chemical tests at any approved laboratory at the expense of the Contractor. The Contractor shall make adequate arrangement to supply and store sufficient water at the Site for use in mixing and curing of concrete.

2.4 Admixtures

Suitable admixtures may be used in concrete mixes with the prior approval of or as directed by the S.O.

The admixtures, the sampling and testing of the admixtures and the information to be provided with the admixture supplied shall comply with MS 922.

All admixtures shall be used strictly in accordance with manufacturer's instructions.

Before allowing the admixture to be used in the Work, relevant tests based on trial mixes

shall be carried out. A control mix shall be made using a conventional trial mix that is without using the admixture, to determine the free water: cement ratio and mix proportion required to give the specified strength with the required slump. Using the same mix proportion as in the control mix but with a modified water: cement ratio whenever necessary, a test shall be carried out using the recommended dosage of the admixture. The results of the relevant test obtained from the control mix and test mix shall be compared. The S.O. may allow the use of the admixture only when the results are found to be satisfactory and comparable to the effects as claimed by the manufacturer. The admixture acceptance test shall comply with the requirements specified in Table 4.

The uses of admixtures that are chloride based are not permitted for structural concrete containing reinforcement, prestressing tendons or other embedded metal. The Contractor shall submit documentary evidence on the contents of the admixture to be used.

When the Contractor proposes the use of super-plasticiser, special control tests shall be carried out with prior approval of the S.O. The tests shall be carried out in accordance with the latest standard and the manufacturer's recommendations.

If two or more admixtures are proposed to be used simultaneously in the same concrete mix, the Contractor shall furnish the S.O. with supporting data on their suitability and compatibility.

2.5 Additional Materials

Condensed silica fumes (CSF) complying with ASTM C1240 – 93 or any other equivalent standards may be used provided that the concrete complies with the same grade as would be achieved by the Portland cement concrete complying with MS 522 and prior approval of the S.O is obtained

3.0 **Classification of Concrete Mixes**

Unless otherwise stated in the Drawings, the concrete mix shall be designed mix. However, prescribed mix may be used provided: -

(a) The work is of minor nature or involving a small quantity of concrete,
(b) Prior approval of the S.O. is given, and
(c) The strength of the concrete is still the responsibility of the Contractor.

When Portland Pulverized-Fuel Ash Cement or Portland Slag Cement is specified to be used, the concrete mix shall be of designed mix only.

3.1 Prescribed Mix

Prescribed mix shall be as detailed in Table 5. The mix prescribed in the table does not require the use of admixture.

For small volume concreting work, volume batching is permitted provided prior approval of the S.O. is obtained. The proportion shall be as specified in Table 5A.

3.2 Designed Mix

Designed mix shall comply with the recommendations of MS1195. The minimum cement content and maximum free water: cement ratio to be used shall be as shown in Table 6 and this shall supersede Table 14 of BS 5328.

The Contractor shall comply with the following requirements:

a) Notify the S.O. whether the designed mix is to be produced as site mix or ready mix.
b) If the Contractor chooses to use ready mix concrete, he shall notify the S.O. the name of the

supplier, location of the ready mix plant, journey time taken to transport the concrete to the Site and production capacity of the plant.

c) Submit a mix design report covering all concrete mixes to the S.O. for approval. The designed mix shall comply with the requirements specified in Table 6.
d) The Contractor shall ensure that the S.O. be permitted to visit or station his representative at the plant at any stage of the concrete production.
e) The sampling, making, curing and testing of the cubes shall be carried out by the Contractor in accordance with MS 30 or as directed by and in the presence of the S.O. or his representative. Test cubes shall be stored by the S.O. at a secured place. The Contractor shall provide all facilities in connection therewith.

When Portland Pulverized-Fuel Ash Cement complying with MS 1227 or Portland Slag Cement complying with MS 1389 is used, depending on the percentage combination used as allowed by MS 1226 or MS 1387 respectively, it may be necessary to increase the total cement content to achieve concrete of equal strength development when compared with concrete using Portland cement complying with MS 522. Tests on trial mixes shall be carried out in accordance with 3.2.3 and the results shall be approved by the S.O.

In all cases, it is the responsibility of the Contractor to ensure that the designed mix shall be durable, workable, comply with the strength grade and other requirements as specified in the Drawings.

3.2.1 Target mean strength

The concrete mix shall be designed to have at least the required minimum cement content, as specified in Table 6, and to have a target mean strength greater than the required grade of concrete by at least the current margin.

The current margin for each particular type of concrete shall be determined by the Contractor and shall be taken as the lesser of:

a) 1.64 times the standard deviation of cube tests on at least 100 separate batches of concrete of nominally similar proportion of similar materials and produced over a period not exceeding 12 months by the same plant under similar supervision, but not less than 2.5 N/mm^2 for concrete, of grade 15 or 3.75 N/mm^2 for concrete of grade 20 or above.

b) 1.64 times the standard deviation of cube tests on at least 40 separate batches of concrete of nominally similar proportions of similar materials and produced over a period exceeding 5 days but not exceeding 6 months by the same plant under similar supervision, but not less than 5 N/mm^2 for concrete of grade 15 or 7.5 N/mm^2 for concrete of grade 20 or above.

Where there are insufficient data to satisfy (a) and (b) above, the margin for the initial mix design shall be taken as 7.5 N/mm^2 for concrete of grade 15 and 12 N/mm^2 for concrete of grade 20 or above. This margin shall be used as the current margin only until sufficient data are available to satisfy (a) or (b) above. However, subjected to the approval of the S.O., when the specified characteristic strength approaches the designed target mean strength of concrete made with a particular aggregate, a smaller margin not less than 5 N/mm^2 for concrete of grade 15 or 7.5 N/mm^2 for concrete of grade 20 or above may be used for the initial mix design.

3.2.2 Suitability of Proposed Mix Proportions

The Contractor shall submit for the approval of the S.O., prior to the supply of any designed mix, the following information:

a) The nature and source of each material,
b) Appropriate existing data as evidence of acceptable previous performance for target mean strength, current margin, workability and water: cement ratio; OR full details of tests on trial mixes carried out in accordance with 3.2.3, and
c) The proposed quantities by weight of each material per cubic meter of fully compacted concrete.

3.2.3 Trial Mixes

Unless otherwise stated and approved by the S.O in writing that the Contractor has complied with the submission specified in 3.2.2, trial mix shall be carried out.

The Contractor shall give early notice, to enable the S.O. to be present at the making of trial mixes and preliminary testing of the cubes. The Contractor shall prepare trial mixes, using samples of approved material typical of those he proposes to use in the Work, for all grades to the approval of the S.O. prior to commencement of concreting.

Sampling and testing procedures shall be in accordance with MS 26. Three separate batches of concrete shall be made. The workability of each of the three trial batches determined by means of the slump test or compacting factor test or vebe consistometer test or as specified in accordance with MS 26, shall be appropriate to the proposed uses and methods of placing and compaction of the mix and shall be approved by the S.O. Six cubes shall be made from each batch. Three from each set of six shall be tested at an age of 7 days and three at an age of 28 days. The average strength of the nine cubes tested at 28 days shall exceed the specified characteristic strength by the current margin minus 3.5 N/mm^2. The approved trial mixes shall then be designated as the 'designed mix' and its corresponding workability as the 'designed workability'.

During production, the S.O. may require additional trial mixes to be made before a substantial change is made in the materials or in the proportion of the material to be used. Trial mixes need not be carried out when adjustments are made to the mix proportions in accordance with 3.2.4.

3.2.4 Control Strength of Designed Mixes

a) Adjustment to Mix Proportions

Adjustment to mix proportions shall be made to the approval of the S.O. in order to minimise the variability of strength and to maintain the target mean strength. The specified limits of minimum cement content and maximum free water: cement ratio shall be maintained. Changes in cement have to be declared.

An increase or reduction of cement content by greater than 20 kg/ m^3, or of fine aggregate by greater than 5%, or any changes in the type or dosage of admixture, or any changes in the type of cement, or consistency is considered a change in mix design.

b) Change in Current Margin

A change in current margin used for judging compliance with specified characteristic strength becomes appropriate when results of a sufficiently large number of tests show that the previously established margin is significantly too large or too small.

Recalculation of the margin shall be carried out in accordance with 3.2.1. Although a recalculated margin is almost certain to differ numerically

from the previous value, the adoption of the recalculated value will not generally be justified if the two values differ by less than 18% when based on tests on 40 separate batches or less than 11% when based on tests on 100 separate batches or less than 5% when based on tests on 500 separate batches.

On the adoption of a recalculated margin, it shall become the current margin for the judgment of compliance with the specified characteristic strength of concrete produced subsequent to the change.

3.3 Requirements for Concrete

3.3.1 Workability

The workability of the fresh concrete shall be judged by its suitability for the condition of handling and placing so that after compaction, it surrounds all reinforcement, tendons and ducts and completely fills the formwork.

Workability of the concrete shall be within one of the following limits:

i) Slump
± 25mm or ± one third of the 'designed workability', whichever is greater.

ii) Compacting Factor
± 0.03 where the 'designed workability' is 0.9 or more.
± 0.04 where the 'designed workability' is between 0.8 and 0.9.
± 0.05 where the 'designed workability' is 0.8 or less.

iii) Vebe
± 3 seconds or ± one fifth of the 'designed workability' whichever is lesser.

3.3.2 Concrete Grade

The grade of concrete to be used in the work shall be as stated in the Drawings and /or in the Bill of Quantities.

(Concrete shall be designated as GRADE X/Y where 'X' is the numerical value of the characteristic strength at 28 days in N/mm^2, and 'Y' is the nominal maximum size of aggregate in mm. For prescribed mix, a suffix 'P' shall be added after 'X').

3.3.3 Cement Content

Cement content in this specification shall refer to the total quantities of cement as approved in 2.1, or the total quantities of cementitious materials comprising Portland cement and p.f.a or g.g.b.s.

3.3.3.1 Minimum Cement Content

The minimum cement content shall be in accordance with Table 6, unless otherwise shown in the Drawings.

3.3.3.2 Maximum Cement Content

The maximum cement content shall not exceed 550 kg/ m^3 unless otherwise shown in the Drawings or as approved by the S.O.

3.3.4 Total Chloride Content

The total chloride content of the concrete mix arising from the aggregate or any

other source shall not in any circumstances exceed the limits in Table 7 expressed as a percentage relationship between chloride ions and weight of cement in the mix.

When necessary, tests shall be carried out in accordance with BS 1881: Part 124 for each grade of concrete, to demonstrate that these limits are not exceeded.

3.3.5 Maximum Sulphate Content

The total estimated sulphate content of any mix, including that present in the cement shall not exceed 4% by weight of cement in the mix. Where necessary, tests shall be carried out in accordance with BS 1881: Part 124 for each grade of concrete to demonstrate that this limit is not exceeded.

4.0 Concrete Compressive Strength Tests and Compliance

4.1 General

All sampling, curing and testing of concrete, fresh or hardened, shall be carried out in accordance with MS 26 and the relevant Parts of BS 1881. The compressive strength of concrete shall be measured by crushing tests on nominal 150mm cubes as specified in MS 26. Tests shall be carried out in an engineering laboratory approved by the S.O.

4.1.1 Prescribed Mix

A prescribed mix shall be judged on the basis of the specified mix proportions based on the batches observation. The mix proportion shall be within 5% of the values specified and the workability shall be chosen to suit the construction requirements as described in Table 5.

4.1.2 Designed Mix

The characteristic strength of a designed mix concrete is the compressive strength below which not more than 5% of the test results may be expected to fall. Compliance with the specified characteristic strength shall be judged by tests made on cubes at an age of 28 days. The workability shall be as described in 3.3.1.

4.2 Sampling and Testing

Notwithstanding this, compressive strength tests shall be carried out during the progress of Work. The rate of sampling shall be as specified in 4.3. For each sampling, three cubes shall be made from a single sample taken from a randomly selected batch of concrete. The sample shall be taken at the point of discharge from the mixer or, in the case of ready mixed concrete, at the point of discharge from the delivery vehicle. All cubes shall be clearly marked with undeletable paint with the date of casting and serial number. A record shall be kept to identify each cube by date and by serial number relating to the part of the work from which they are taken.

One cube from each sample batch shall be tested for the 7-day compressive strength. The remaining two cubes from the sample batch shall be tested for the 28-day compressive strength.

4.3 Rate of Sampling for Testing

The indicative sampling rate shall be as follows:

a) One sample per 10.0 m^3 or every group of 10 batches for critical structures e.g. prestressed concrete, masts, cantilevers, columns, footing, pile caps, shear wall, retaining wall.

b) One sample per 20.0m^3 or every group of 20 batches e.g. slabs, beams.

c) One sample per 50.0 m^3 or every group of 50 batches e.g. raft foundation and mass concrete.

Notwithstanding the above, a minimum of two samples shall be taken on each concreting day for a particular grade and source of concrete for prescribed mix.

However, for designed mix, at least four samples (12 cubes) shall be taken of concrete on the first day of concreting for each grade of concrete to be used in the Work, irrespective of the volume of concrete produced or the sampling rate. Subsequent rate of sampling shall be at least one sample from each source of production on each day that concrete of any particular grade is used.

The actual rate of sampling may be increased in appropriate circumstances e.g. for critical elements, when required by the S.O.

4.4 Cubes Strength at 7 Days

One cube from each sample batch shall be tested for the 7-day compressive strength. The cube compressive strength shall not fall below the corresponding values given in Table 8 for prescribed mix, and two-third of the 28-day compressive strength for designed mix.

4.5 Cube Strength at 28 days and Compliance Requirements

The remaining two cubes from the sample batch shall be tested for the 28-day compressive strength.

4.5.1 Prescribed Mix

The appropriate strength requirement shall be considered complied if at least one of the following conditions is satisfied with:

a) None of the two test cubes is below the specified compressive strength as specified in Table 8
b) The average strength of the two test cubes is not less than the specified compressive strength and the difference between the two strengths is not more than 20% of the average.

4.5.2 Designed Mix

The average strength of the two cubes shall constitute the 28-day compressive strength of the sample. When the difference between the two results divided by their mean exceeds 15%, the test results shall be deemed invalid.

For compliance purposes of the specified compressive strength, both of the following conditions shall be satisfied:

a) The mean strength determined from the first two, three or four consecutive test results, or from any group of four consecutive test results complies with the appropriate limits in column A of Table 8A. In this respect, consecutive samples are samples taken at intervals for the day of concreting or one complete continuous process of concreting.
b) Any individual test result complies with the appropriate limits in column B of Table 8A.

4.6 Tests for Consistency

While work on concreting is in progress, tests on workability of the mix shall be carried out at suitable interval and in addition whenever any materials or the proportions of the mix

are changed, or when directed by the S.O. The test shall consist of the Slump test, the Compacting Factor test or Vebe test where applicable as described in MS 26. The workability shall be as described in 3.3.1.

4.7 Action to be taken in the Event of Non Compliance

In the event that the compressive strength results of the test do not meet the specified requirements mentioned in 4.4 and 4.5, or otherwise arising from the result of the statistical analysis carried out in 4.11, the S.O. shall determine the action to be taken.

If the 7-day strength is less than the specified strength requirements, no more concrete shall be placed on the suspect concrete and no removal of propping on the affected area shall be allowed until the 28-day strength result compliance is available, or unless otherwise approved by the S.O in writing.

For non-compliance of 28-day compressive strength, the section of work represented by the samples which fail the test carried out in accordance with 4.5 shall be removed. However, in the event of non-compliance arising from the result of the statistical analysis carried out in 4.11 for the designed mix, the whole of work represented by the samples used in the analysis shall be removed. The work shall be replaced by concrete meeting with this specification. For the case of designed mix, the Contractor shall redesign his mix based on an increased target mean strength.

Alternatively, the S.O may direct other measures to be taken to make the works secure. The S.O may instruct that additional tests be carried out on the hardened concrete to determine the quality of the suspected concrete. The test may include non-destructive methods (MS 26), taking cored samples (MS 26), load test or combination of several methods. The results shall be assessed in accordance with BS 6089. The results of any such tests shall not nullify the establishment of non-compliance with 4.5.

All works instructed under this clause shall be at the Contractor's expense and no extension of time shall be granted for such works.

4.8 Other Failures

All defective concrete works such as badly constructed concrete members with poor alignment and plumb, honeycombing, badly formed surfaces, and failure during construction such as sagging of beams and slabs shall be removed and made good or otherwise rectified in accordance with the S.O.'s instruction at the Contractor's expense.

4.9 Additional Cubes

Additional cubes may be required for various purposes. These shall be made and tested in accordance with MS26 but the methods of sampling and the conditions under which the cubes are stored shall be varied according to the purpose for which they are required.

For determining the cube strength of prestressed concrete before transfer or of concrete in a member before striking formwork, sampling shall be at the point of placing and the cubes shall be stored under the same conditions as the concrete in the members.

The extra cubes shall be identified at the time of marking and shall not be used for normal quality control or compliance procedures.

4.10 Recording of Test Results

All concrete cube test results and summary shall be recorded using appropriate forms in a manner and format approved by the S.O. The 7-day and 28-day strength results shall be recorded separately with its corresponding cement content obtained from the batching record submitted during delivery (if ready mix concrete is used) of fresh concrete. The corresponding workability shall also be recorded.

Changes to sources of materials, concrete supplier, current margin, target mean strength, cement content or any other such changes to the parameters of the concrete mix, shall also be recorded separately. All records shall be duly verified jointly between the S.O or his Representative and the Contractor.

The records shall be analysed to meet the following compliance requirements as stipulated in 4.5:

a. The individual test result and the average values obtained from the samples noting the validity values and to comply with column A of Table 8A.

b. The group test results and analyse the mean values to comply with column B of Table 8A.

4.11 Statistical Analysis

Statistical analysis shall be carried out based on the test results recorded in 4.10. The Contractor shall submit to the S.O, the following analysis:

a) Running analysis of group test results and the mean values plotted for normal distribution graph. Standard deviation (S.D) is then calculated. The value of S.D obtained, when multiplying with 1.64 (statistical constant complying with MS 1195) will give the value of the current margin.

b) The current margin value should not fall below the designed current margin specified when performing the earlier trial mix. If the current margin falls below the designed value, the S.O may inspect the plant supplying the concrete, instruct the Contractor to redesign his mix and to take appropriate action as per 4.7

5.0 **Production of Concrete**

5.1 Supervision

The Contractor shall ensure the required standard of control over materials and workmanship. The S.O. shall be afforded all reasonable opportunities and facilities to inspect the constituent materials and the production of concrete and to take samples for testing.

5.2 Batching and Mixing

The quantities of cement, fine aggregate and various sizes of coarse aggregate shall be measured by weight unless otherwise approved by the S.O. A separate weighing machine shall be provided for weighing the cement. Alternatively, the cement may be measured by using a whole number of bags in each batch. The quantity of water shall be measured by volume or by weight. Any solid admixtures to be added shall be measured by weight; liquid or paste admixtures shall be measured by volume or weight.

The batch weight of aggregate shall be adjusted to allow for the moisture content of the aggregate being used. All measuring equipment shall be calibrated on site or their calibration status established by certificates from accredited laboratories.

The mixer shall comply with the requirements of BS 1305 where applicable. The mixing time shall be not less than two minutes and not more than five minutes or any other time recommended by the mixer manufacturer after all the ingredients have been placed in the mixer.

Mixers that have been out of use for more than 30 minutes shall be thoroughly cleaned before any fresh concrete is mixed. Unless otherwise agreed by the S.O., the first batch

of concrete through the mixer shall contain only two thirds of the normal quantity of coarse aggregate. The mixer shall be thoroughly cleaned before changing from one type of cement to another.

The water content of each batch of concrete may be adjusted so as to produce concrete of the workability required. However care shall be taken to ensure the free water: cement ratio is maintained. The total amount of water added to the mix shall be recorded.

5.3 Ready Mixed Concrete

Ready mixed concrete is concrete produced by a third party supplier for delivery to a Contractor in a plastic state. The materials of the concrete are batched, either dry or wet, at a control plant and transported in purpose-made agitators operating continuously or truck mixers to the Site.

Ready mixed concrete shall comply with the requirements of designed mix as in clause 3.2 and MS 523. All concrete materials, including water and admixtures shall be mixed in the plant and delivered to Site in purpose made truck mixers. No extra water or admixtures are allowed to be added after the concrete has left the plant.

Ready mixed concrete delivered to the Site shall be accompanied by delivery ticket and manufacturer's batching record stating the details of mix proportions by weight, the grade of concrete, type and size of aggregate, date and time of loading at plant, type and dosage of chemical admixtures and other relevant production details in suitable format, failing which the S.O, or his representative, shall immediately reject the total load of the concrete. The S.O, or his representative, and the contractor shall ensure the information provided in the delivery tickets and the manufacturer's batching record complies with the details of the approved 'designed mix' and its corresponding 'designed workability' as in 3.2.3 before discharging the concrete.

Rejected concrete shall be removed from the Site. The delivery ticket shall be marked 'REJECTED'.

5.4 Transporting

Concrete shall be transported from the mixer to the formwork as rapidly as practicable by methods, which will prevent segregation or loss of any constituents or ingress of foreign matter or water and maintain the required workability. It shall be deposited as near as practicable in its final position to avoid rehandling or moving the concrete horizontally by vibration. The concrete shall be conveyed by chutes or concrete pumps only with permission from the S.O.

5.5 Placing

5.5.1 Placing of Concrete in Dry Condition

For all concrete whether mixed on or off the site of the Work, each batch shall be placed and compacted within two (2) hours of adding the cement to the dry aggregates and within 45 minutes (or any other period of time based on the trial mix as per 2.4, 3.2.3 and approved by the S.O. if an admixture is used) of adding water to the cement and aggregate. Concrete shall not be placed in any part of the structure until the approval of the S.O. has been obtained. If concreting is not started within 24 hours of approval given, approval shall again be obtained from the S.O.

All formwork and reinforcement contained in it shall be clean and free from standing water immediately before the placing of concrete. Concreting shall be carried out continuously between and up to predetermined construction joints in one sequence of operation. It shall be thoroughly compacted by either hand tamping or mechanical vibration or both and shall be thoroughly worked into the

corners. After tamping into place the concrete shall not be subjected to disturbance other than such as incidental to compaction by vibration. In the event of unavoidable stoppage in positions not predetermined, the concreting shall be terminated on a horizontal plane and against vertical surfaces by the use of stop boards. The location for termination shall be subjected to the approval of the S.O.

Fresh concrete shall not be placed against in-situ concrete which has been in position for more than 45 minutes (or any other period of time based on the trial mix as per 2.4, 3.2.3 and approved by the S.O. if an admixture is used) unless a construction joint is formed in accordance with sub-section 6.1. When in-situ concrete has been in place for four hours, no further concrete shall be placed against it for a further 20 hours. Where retarding admixture has been used, the S.O. may approve variation to this limit.

Except where otherwise approved by the S.O., concrete shall be deposited in horizontal layers to a compacted depth not exceeding 450 mm when internal vibrators are used or 300 mm in all other cases. The surface of the concrete shall be maintained reasonably level during placing.

Concrete shall not be dropped into place from a height exceeding 1.5 meters. However, higher drops may be allowed provided the mix has been well designed and proportioned. When trunking or chutes are used, they shall be kept clean and used in such a manner as to avoid segregation.

The Contractor shall maintain an experienced steel fixer at the site of reinforced concrete works during the placing of concrete to reposition any reinforcement which may be displaced.

5.5.2 Placing of Concrete Under Water

No concrete shall be placed in flowing water. Underwater concrete if deemed unavoidable, shall be placed in position by Tremie pipes from the mixer. Concrete to be placed under water shall be of an approved mix with the amount of cement increased by 20%. During and after concreting under water, pumping or dewatering operations in the immediate vicinity shall be suspended until the S.O. permits them to continue. Where the concrete is placed by a Tremie pipe, the following requirements shall be applicable: -

i) The hopper and tremie pipe shall be a closed system. The bottom of the Tremie pipe shall be kept as far as practicable beneath the surface of the placed concrete.

ii) The tremie pipe shall be large enough with due regard to the size of aggregate. For 20 mm aggregates, the Tremie pipe shall be of a diameter not less than 150 mm and for larger aggregates, a bigger diameter Tremie pipe approved by the S.O. shall be used.

iii) Unless otherwise agreed by the S.O., the first charge of concrete shall be placed with a sliding plug pushed down the Tremie pipe ahead of it to prevent mixing of concrete and water.

iv) The Tremie pipe shall always penetrate well into the concrete with an adequate margin of safety against accidental withdrawal if the pipe is surged to discharge the concrete.

v) The concrete shall be deposited wholly by Tremie pipe and the method of deposition shall not be changed part way up to prevent the laitance from being entrapped within the structure.

vi) All Tremie pipes shall be properly cleaned after use.

5.6 Placement Temperature

Placement temperature shall comply with MS 1195 to prevent premature setting and loss of water during placing of concrete in the formwork and the following precautions shall be taken:

a) At the time of placing, no part of the concrete shall have a temperature exceeding 36^{o}C. This may be achieved by cooling the water and aggregate prior to mixing.

b) Concrete shall not be placed in forms or around reinforcement whose temperature exceeds 36^{o}C. This can be achieved by providing shading or other means to protect from direct sunlight.

c) Freshly placed concrete shall be protected from direct sunlight and from loss of moisture by covering, shading or other means.

d) No concrete shall be placed when the air temperature at the point of deposition exceeds 36^{o}C

However, higher temperatures may be allowed provided it can be proven that it shall not result in any detrimental effect to the concrete work.

5.7 Compaction

Unless otherwise approved by the S.O., concrete shall be thoroughly compacted by vibration and thoroughly worked around the reinforcement, tendons or duct formers, around embedded fixtures and into corners of the formwork to form a dense, homogenous mass, free from voids and which will have the required surface finish when the formwork is removed. Vibration shall be applied continuously during the placing of each batch of concrete until the expulsion of air has practically ceased and in a manner which does not promote segregation of the ingredients.

The concrete maintained between the two walls of formwork shall be compacted by internal or external vibrators. Concrete in slabs with no formwork on its upper surface shall be compacted either by vibrators of the pan type or by a vibrating screen.

The internal vibrators shall be inserted and withdrawn slowly and at a uniform pace of approximately 100 mm per second. Compaction shall be deemed to be completed when cement mortar appears in an annulus around the vibrator. Over vibration leading to segregation of the mix must be avoided. The internal vibrators shall be inserted at points judged by the area of mortar showing after compaction, with a certain allowance made for overlapping and they shall not be allowed to come into contact with the formwork or the reinforcement and shall be inserted at a distance of not less than 75 mm from the formwork.

The pan vibrator shall be placed on the surface of the concrete, which shall have previously been tamped and leveled leaving an allowance in height for compaction until the cement mortar appears under the pan. The vibrator shall then be lifted and placed on the adjoining surface and this operation shall be repeated until the whole surface has been compacted. Alternatively, a vibrating screen spanning the full width of the surface may also be used.

Whenever vibration has to be applied externally, the design of formwork and disposition of vibration shall receive special consideration to ensure efficient compaction and to avoid surface blemishes. The vibration shall be such that there will be no excess water on the top surface on completion of compaction.

External vibrators shall be firmly secured to the formwork which must be sufficiently rigid to transmit the vibration and strong enough not to be damaged by it.

Internal vibrators shall be capable of operating at not less than 10,000 cycles per minute and external vibrators at not less than 3,000 cycles per minute. Sufficient vibrators in serviceable condition shall be on Site so that spare equipment is always available in the event of breakdowns. Vibrators shall be operated by workmen skilled in their use.

Concrete shall not be subjected to any disturbance within 24 hours after compaction. No standing or flowing water shall be allowed to come into contact with exposed concrete surfaces during the first two (2) hours after placing and compaction of the concrete.

In the event where inadequate or improper compaction is suspected, the S.O. has the right to inspect and to carry out further tests. The tests may include non-destructive and destructive methods. All expenses incurred in carrying out such sampling, testing and remedial works shall be borne by the Contractor irrespective of whether the tests prove the structure to be sound or otherwise.

5.8 Curing and Protection

All concrete work shall be cured for the full period of curing which shall not be less than five (5) days for F1, F2, F3 and F4 surfaces, but not less than three (3) days for F11, F12, F13, F14 and F15 surfaces.

Curing and protection shall start immediately after compaction of the concrete to protect it from:

a) Impact damage such as shock, overloading or falling earth which may disrupt the concrete and interface with its bond to reinforcements.

b) Premature drying out from direct sunlight and wind.

c) Leaching out by rain and flowing water.

d) High internal thermal gradients.

5.8.1 Normal Curing And Protection

Concrete, after it is placed and until the expiration of the curing duration, shall not be allowed to dry out. Provision shall be made for adequate protection against direct sunlight and wind to allow the process of curing to complete within the specified period.

Curing and protection shall be accomplished by covering the exposed concrete surface with an impermeable material such as polyethylene sheet, which should be well sealed and fastened and if required, this treatment can be continued efficiently throughout the whole period of curing.

When the concrete has attained its final set, one of the following curing methods shall be adopted:

a) Water curing shall be accomplished by keeping the surface of the concrete continuously wet by ponding with water.

b) Curing may be accomplished by sealing in the water as specified above by covering with an approved waterproofed curing paper or plastic sheeting laid with airtight joints. It must be securely positioned to prevent displacement by wind and protected from tearing or other injury.

The use of other methods of curing may be deemed necessary when the concrete is subjected to high internal thermal gradient, or with large exposed surface area. The Contractor shall submit a method statement to the approval of the S.O.
In the event where the Contractor does not do proper curing, the S.O. has the

right to inspect and to carry out further tests which may include destructive methods. All expenses incurred in carrying out such sampling, testing and remedial works shall be borne by the Contractor irrespective of whether the tests proved the structure to be sound or otherwise.

5.8.2 Accelerated Curing

Elevated temperature curing may be used only with Ordinary Portland Cement. After the completion of the placing of concrete, four (4) hours shall elapse before its temperature is raised, unless the Contractor is able to prove that curing can start earlier by furnishing all the relevant supporting data to the S.O. The rise in temperature within any period of 30 minutes shall not exceed $10^{o}C$ and maximum temperature attained shall not exceed $70^{o}C$ unless it can be proven that any deviation from this provision shall not result in any detrimental effect to the concrete work. The rate of subsequent cooling shall not exceed the rate of heating. The use of accelerated curing methods for concrete containing other types of cement or any admixture or any additional materials shall be to the approval of the S.O.

6.0 **Construction with Concrete**

6.1 Construction Joints

The position and detail of any construction joints not described in the Drawings shall be to the approval of the S.O. and shall be so arranged as to minimise the possibility of the occurrence of shrinkage cracks.

If for any reason the Contractor has to interrupt a planned pour for more than 45 minutes (or any other period of time based on the trial mix as per 2.4, 3.2.3 and approved by the S.O. if an admixture is used), additional construction joints shall be positioned and constructed as directed by the S.O.

The number of construction joints shall be kept as few as possible consistent with reasonable precautions against shrinkage. Concreting shall be carried out continuously up to construction joints. The joints shall be at right angles to the general direction of the member and shall take due account of shear and other stresses.

Concrete shall not be allowed to run to a feather edge and vertical joints shall be formed against a stop board. The top surface of a layer of concrete shall be level and flat unless design considerations make this undesirable. Joint lines shall be so arranged that they coincide with features of the finished work, wherever possible.

At horizontal construction joints, gauge strips about 25 mm width shall be placed inside the forms along all exposed surfaces to ensure a straight joint on those surfaces.

Where a kicker (i.e., a starter stub) is used for the construction of walls and columns, it shall be at least 50 mm high, to be constructed monolithically with the base concrete.

Where vertical construction joints are necessary in mass concrete structures, reinforcing bars shall be placed across the joints so as to make the structure monolithic, all to the approval of the S.O.

Prior to recommencement of concreting on a joint, the surface of the concrete against which new concrete will be cast shall be free from laitance and shall be roughened to the extent that the coarse aggregate is exposed but not disturbed. Care shall be taken to avoid damaging the lines of the joint. Care shall also be taken that the joint surface is clean and damp but not wet and the exposed adjoining surfaces shall be of consistent colour. Immediately before the fresh concrete is placed against the joint, fresh rich cement mortar (1:2) shall be applied to the exposed surface.

Where the S.O. considers that special preparation is necessary, e.g. for an in-situ structural connection, preparation shall be carried out, preferably when the concrete has set but not hardened, by spraying with a fine spray of air and water or brushing with a stiff brush sufficiently to remove the outer mortar skin and expose the larger aggregates without disturbing them. Where this treatment is impracticable, sand blasting or a needle gun shall be used to remove the surface skin and laitance. Hardened surfaces shall be chipped manually or mechanically to be free from laitance and properly roughened to the extent that the coarse aggregates are being exposed.

6.2 Fixing Blocks, Brackets, Built In Bolts, Holes, Chases, etc.

All fixing blocks, brackets, built in bolts, holes, chases, etc. shall be accurately set out and formed and carefully sealed prior to the concrete being placed. It is the responsibility of the Contractor to obtain all such information for these items of work and obtain the permission of the S.O. before incorporating such work prior to the concrete being placed.

Bolts and other inserts to be cast into the concrete shall be securely fixed to the formwork in such a way that they are not displaced during the concreting operations and that there is no loss of materials from the wet concrete through holes in the formwork.

Unless otherwise shown in the Drawings or instructed by the S.O., reinforcement shall be locally moved so that the minimum specified cover is maintained at the locations of inserts, holes, chases, etc. In the event where the minimum cover cannot be maintained, the Contractor shall take the necessary precautions to protect the reinforcements against corrosion by applying an approved coating materials to the reinforcements and the concrete cover.

Temporary plugs shall be removed and the threads of built in bolts shall be cleaned and greased before handing over any part of the Work.

6.3 Precast Concrete Construction

6.3.1 Manufacture off Site

After the method of manufacture has been approved, no changes shall be made without the approval of the S.O.

The Contractor shall inform the S.O. in advance of the date of commencement of manufacture and casting of each type of precast concrete component.

When the S.O. requires tests to be carried out, none of the precast concrete components to which the tests relate shall be dispatched to the site until the tests have been completed and the results approved by the S.O.

All precast concrete components shall be indelibly marked to show the identification marking as specified in the Drawings, the production batch on which they were manufactured and the date on which the concrete was cast. If the components are symmetrical, the face that will be uppermost when the member is in its correct position in the work shall be clearly identified.

6.3.2 Storage

When the precast concrete components are stored, they shall be firmly supported only at the points specified in the Drawings. No accumulation of trapped water and deleterious matter shall be allowed in the components. Care shall be taken to avoid rust staining and efflorescence.

The precast concrete components shall be stacked in such a manner that their removal in correct order of age is facilitated.

6.3.3 Handling and Transport

The precast concrete components shall be lifted only at points specified in the Drawings or otherwise approved by the S.O. and shall be handled and placed without impact. The method of lifting, the type of equipment and transport to be used, and the minimum age of the components to be handled shall be to the approval of the S.O.

6.3.4 Assembly and Erection

The method of assembly and erection specified in the Drawings shall be strictly adhered to on site.

Immediately a unit of precast concrete component is in position, and before the lifting equipment is removed, temporary supports or connections between components as necessary, shall be provided. The final structural connections shall be completed as soon as is practicable.

6.3.5 Forming Structural Connections

For structural purposes, cement mortar shall compose of one (1) part of cement to one (1) part of sand (1:1), mixed with water so that the free water: cement ratio does not exceed 0.4 by weight and cement grout shall have a water: cement ratio between 0.4 and 0.6, or such other proportions as shall be directed by the S.O.

No structural connections shall be made until approval has been given by the S.O.

Unless otherwise approved by the S.O., the composition and the free water: cement ratio of the in-situ concrete or mortar used in any connection and the packing of joints shall be in accordance with the assembly instructions.

Levelling devices shall be released or removed only with the approval of the S.O.

Non load bearing joints between precast concrete components and adjoining structures shall be filled with appropriate grout and/or mortar protected by proprietary sealants and backing rod. They shall be waterproof.

Load bearing joints and connection shall be grouted, mortar packed or concreted. The respective mix design shall be free of lime and chloride. They shall be durable, waterproof, non-shrink and possess a strength higher than that of precast concrete. Curing for at least three (3) days shall be provided. Designed mixes shall be submitted to the S.O. for approval.

The method of sampling and testing of grout and mortar shall be carried out according to MS 26. The compressive strength shall be determined by crushing test on 100 mm cubes. For each casting day and for each grade of grout and mortar, three samples shall be taken from three (3) separate batches. Two (2) cubes shall be cast from each sample for testing at seven (7) and 28 days. The appropriate strength requirement shall be considered to be satisfied if the average strength is greater than the specified characteristic strength.

6.3.6 Protection

At all stages of construction, precast concrete components and other concrete associated therewith shall be properly protected to prevent damage to permanently exposed surfaces, especially arrises and other decorative features.

6.4 Permanent Structure Joints.

6.4.1 Expansion joints, contraction joints or other permanent structure joints shall be provided in the positions and constructed and sealed with waterproofing materials as detailed in the Drawings.

6.4.2 Unless otherwise shown in the Drawings, all exposed expansion joints shall be covered with 0.7 mm thick aluminium cover strips fixed with masonry nails at 300mm centers.

6.5 Sealants and Special Materials

6.5.1 General

The installation method and the selection, mixing, application and curing of all joint waterproofing materials shall be in accordance with the manufacturer's recommendations. The Contractor may propose to use alternative joint waterproofing materials by submitting supporting technical information, test reports and samples of the proposed waterproofing materials to the S.O. for approval.

6.5.2 Waterproofing Materials

All waterproofing materials used at public access areas shall be protected with non shrink grout covering.

6.5.3 Waterstops

Waterstops shall be as specified in the Drawings and shall be installed and butt jointed according to BS 8007 and the manufacturer's recommendations. Waterstops shall be securely positioned in the formwork to prevent displacement during concreting.

6.5.4 Two-part Polysulphide or Two-part Polyurethane Sealant

Two-part Polysulphide or two-part polyurethane sealant for external use shall comply with the following requirements:

(a) Conformance to BS 4254
(b) Minimum joint movement capacity of ± 27.5% of joint width at 27.5^{o}C;
(c) Shore 'A' Hardness of 25 ± at 27.5^{o}C;
(d) Resistance to dilute acids, alkali and all kind of fuel.

6.5.5 Preformed Flexible Strip Sealant

Preformed flexible strip sealant shall comply with the following requirements: -

a) Shall only be used in horizontal joints and be subjected to pressure throughout its length;
b) Good adhesion;
c) Water resistant;
d) Non-staining.

6.5.6 Bitumen/Rubber Cold Applied Membrane

Bitumen/rubber cold applied membrane shall comply with the following requirements: -

a) Minimum joint movement capacity of ±10% of joint width at 27.5^{o}C;
b) 90% solid content;
c) Resistant to dilute acid and alkali.

6.5.7 Hot-Poured Rubber/Bitumen Sealing Compound

Hot-poured rubber/bitumen sealing compound shall comply with BS 2499.

6.5.8 Bituminous Sheeting

Bituminous sheeting with non asbestos fibre shall comply with the following requirements:

a) Resistant to lime water (no visual effect after two weeks immersion);
b) Maximum water absorption of 10% of dry weight;
c) Minimum tensile strength of 50 kg/cm^2;
d) Ozone and ultraviolet resistant.

6.5.9 Neoprene Bearing Pads

Neoprene bearing pads shall comply with the following requirements:

a) Shore 'A' Hardness of 60 ± 5 at 27.5^{o}C;
b) Minimum rupture strength of 105 kg/cm^2;
c) Minimum rupture elongation of 300%.

6.5.10 Polyurethane Foam Backing Rods

Polyurethane foam backing rods used as sealant stops in panel joints shall have the following properties: -

a) Minimum compressibility of 75% of original volume at 27.5^{o}C;
b) Excellent resilient properties;
c) Density between 35 kg/cm^3 and 45 kg/cm^3;
d) Total resistance to common acids, lubricants and detergents;
e) Total resistance to water infiltration by capillary action;
f) Suitability for up to 70^{o}C.

7.0 **Steel Reinforcement**

7.1 General

The Work shall consist of furnishing and placing reinforcing steel in accordance with this specification and in conformity with the Drawings or as directed by the S.O.

7.2 Materials

Hot rolled mild steel and high yield bars shall comply with the requirements of MS 146. Cold worked steel bars shall comply with the requirements of BS 4461. Hard drawn mild steel wire shall comply with the requirements of MS 144.

Steel fabric reinforcement shall comply with the requirements of MS 145 and shall be delivered to the Site in flat sheets, unless otherwise specified.

Dowel bars shall be plain, round bars conforming to the requirements of MS 146. They shall be free from burring or other deformations restricting slippage in the concrete. Dowel bar sleeves used for debonding shall be of approved synthetic material. The closed end of the sleeve shall be filled with 25 mm thick compressible foam fillers and the sleeve shall fit tightly over the length of the bar to be debonded.

Before any reinforcement steel is brought to Site, the Contractor shall furnish the mill certificates of tests and these shall be submitted for acceptance by the S.O. In addition the Contractor shall on request, furnish the S.O. with a test sheet from approved laboratories for any batch of bars, giving the results of each of the mechanical tests and/or chemical composition analysis required under the Malaysian Standards or any equivalent international standards approved by the S.O. The specified characteristic strength of steel

reinforcement shall be as given in Table 9.

During the course of the work, any reinforcement found to be not in accordance with the Malaysian Standards or British Standards may be rejected by the S.O. notwithstanding any previous acceptance on the strength of the test certificates. The S.O. may call for additional tests to be made at the Contractor's expense on samples taken from the batch of the defective reinforcement. If the samples do not comply with the Malaysian Standards or British Standards, then the S.O. may reject the whole batch and instruct its removal from the Site.

Steel reinforcement shall be stored in clean and dry conditions. When placed in the work it shall be clean and free from loose rust, mill scale, oil, grease, paint, dirt or anything which may reduce its bond with concrete. If directed by the S.O., the steel bars shall be brushed or otherwise cleaned before use, at the Contractor's expense.

Binding wire shall be 1.6 mm diameter soft annealed steel wire complying with the requirements of BS 1052.

7.3 Construction Methods

7.3.1 Cutting and Bending of Reinforcement

Bars shall be of their correct lengths and bent to the exact shapes required before being fixed in the work.

Bars shall be cut and bent cold by the application of slow, steady pressure or in an approved bar-bending machine. Bending at temperatures in excess of 100 ^{o}C may only be carried out with the S.O.'s approval and under his supervision. Except where otherwise indicated in the Drawings, bars shall be bent and measured in accordance with BS 4449.

Cold worked and hot rolled bars shall not be straightened or bent again once having been bent. Where it is necessary to bend the free end of mild steel reinforcement already cast in the concrete, the internal radius of the bend shall not be less than twice the diameter of the bar.

Special care shall be taken that the overall length of bars with multiple bends is accurate and that after bending and fixing in position the bars remain in place without wrap or twist.

7.3.2 Fixing of Reinforcement

The number, size, length, shape, type and position of all reinforcing bars, links, spacer bars and other parts of the steel reinforcement, shall be in accordance with the Drawings.

Reinforcements shall be secured against displacement. Unless specified otherwise, the actual concrete cover shall be taken as the distance between face of concrete and the nearest steel surface. All intersecting bars shall be tied together with binding wire and the ends of the wire shall be turned into the main body of the concrete.

Reinforcement temporarily left projecting from the concrete at construction or other joints shall not be bent out of position during the periods in which concreting is suspended except with the approval of the S.O.

The Contractor shall take particular care that the reinforcement is laid out correctly in every aspect and temporarily suspended by annealed wire or supported on concrete blocks or other approved spacers in the forms to prevent displacement during the placing and compacting of concrete. Links shall tightly

embrace the longitudinal reinforcement to which they shall be securely wired or spot welded. The top reinforcement in slabs shall be rigidly supported on mild steel ‘chairs’ or equivalent spaced in each direction to prevent sagging during concreting.

No concrete shall be placed until the reinforcement has been inspected and approved by the S.O.

7.3.3 Splicing

Joints to reinforcement bars shall be effected by lapping of bars at positions shown in the Drawings. Where other types of joints are to be used, prior approval of the S.O shall be obtained and their use shall be strictly in accordance with manufacturer’s instructions, at the positions approved by the S.O.

7.3.4 Supporting and Spacer Blocks

Supporting and spacer blocks required for ensuring that the reinforcement is correctly positioned shall be as small as possible, consistent with their purpose, of a shape approved by the S.O., and designed so that they will not overturn when the concrete is placed.

The nominal size of aggregates used shall be 10mm. The concrete spacers shall be of at least the same strength and material’s source as the concrete to be poured. Wires cast in these blocks for the purpose of tying them to the reinforcement shall be as described in clause 7.2.

Spacers left in situ shall not impair the desired appearance or durability of the structure by causing spalling, rust staining or allowing the passage of moisture.

Other types of spacers may be used only with the approval of the S.O.

7.3.5 Welding of Reinforcement

Reinforcement in structures shall not be welded except where detailed in the Drawings or permitted in this specification.

Welding shall be carried out in accordance with BS 5135 and BS 638. Butt welds shall be of the double V type and two butt weld bond tests shall be carried out on a specimen prepared to represent each form of the butt welded joint used in welding the reinforcement and for each position of welding. The method of making butt weld tests shall be as laid down in BS 709. The specimen shall pass the test to the approval of the S.O. before using the joint, which the specimen represents.

Welded joints shall not be made at bends in reinforcement. Unless otherwise approved by the S.O., joints in parallel bars of the principal tensile reinforcement shall be staggered in the longitudinal direction at a distance not less than the end anchorage length for the bar.

All welding shall be performed by a competent welder approved by the S.O.

The S.O. shall be informed in advance of when welding is to be carried out so that he may supervise and inspect the work. Welding shall not be performed in the field during rain or other adverse conditions.

8.0 Formwork and Surface Finish For Structure

8.1 Design and Construction

8.1.1 Description

Formwork shall include all temporary or permanent forms required for forming the concrete, together with all temporary construction required for their support. The Contractor is deemed to have made a study of the Drawings at tender stage and is aware of all areas of construction, requiring heavy and specially designed propping to provide the support and the necessary bracing for the stability of such propping.

The design and construction of formwork shall be carried out by a competent person. The Contractor shall identify all critical formwork design and submit the strength and deflection calculations and Drawings or the proposed design, certified by a Professional Engineer to the S.O. for prior approval. Notwithstanding any approval by the S.O. with respect to the design submitted by the Contractor, the responsibility or the adequacy and safety of the design shall remain with the Contractor. The Contractor shall also appoint a competent formwork coordinator whose duties would be similar to those outlined in BS 5975.

When the use of proprietary type of formwork is proposed by the Contractor, the design shall be certified by a Professional Engineer.

The formwork shall be sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages of construction and shall be appropriate for the methods of placing and compacting.

Formwork (including supports) shall be sufficiently rigid to maintain the forms in their correct position, shape, profile and dimensions. The supports shall be designed to withstand the worst combination of forces due to self weight, formwork weight, formwork forces, reinforcement weight, wet concrete weight, construction and wind loads, together with all incidental dynamic effects caused by placing, vibrating and compacting the concrete. Guidance on these loadings is given in The Concrete Society Manual Formwork – Guide to good practice, and in CIRIA Report 108, Concrete Pressure in Formwork, and in BS 5975. Vertical propping to formwork shall be carried down sufficiently far to provide the necessary support without overstressing the completed concrete structure.

Metal ties may only be used with the prior approval of the S.O. Where metal ties are permitted, the use of storey height steel soldiers shall be used to reduce the number of tie bolts required. Tie bolts with rubber or plastic cone against the form face are to be used to prevent unsightly grout loss. No metal part of any device for maintaining formwork in the correct location shall remain permanently within the specified concrete cover to the reinforcement. Except for ties used for anchoring void formers, all ties shall be at least 1.2 meters apart and through bolts will not be permitted on exposed form finished faces. All holes left by ties shall be made good within one day of the removal of the formwork using a mortar of the same strength as the cast concrete. Metal ties which allow for holes through the concrete being cast shall not be permitted to be used in concrete for water-retaining structure, roof slabs and walls.

The formwork shall be so arranged as to be readily dismantled and removed from the cast concrete without shock, disturbance or damage. Where necessary, the formwork shall be so arranged that the soffit form, properly supported, can be retained in position for such period as may be required by the condition of the maturing concrete or the specification. If a component is to be prestressed whilst still resting on the soffit form, provision shall be made to allow for elastic

deformation and any variation in weight distribution. As far as practicable, formwork joints shall coincide with construction joints.

8.1.2 Form Lining

The type and treatment of any lining (plywood, metal, plastic, Controlled Permeability Formwork liner etc.) of the forms shall be appropriate to the concrete finish required.

The Controlled Permeability Formwork (CPF) liner shall have the following requirements:

i. The requirement for a special finish shall be as for traditional formwork finishes except that the formwork shall be covered by a CPF liner.

ii. CPF liner shall be used on all surfaces as detailed on the Drawings.

iii. The CPF liner shall be a Water Bylaws Scheme – Approved Product for use with potable water in accordance with BS 6920.

iv. The CPF liner shall have the following properties:
   a) Compression of less than 10% under a pressure 200kPa.
   b) Maximum pore size of less than 0.030mm.
   c) Minimum water retention capacity of 0.35 litres per square metre.
   d) Result in bleed water from the liner which is free from cement and fine aggregate particles.

v. The concrete cast against the CPF liner shall have an even uniformly textured matt finish and shall be free of blowholes and other surface blemishes. The use of the CPF liner shall meet the following performance requirements which should be demonstrated by the supply of test certificate:
   a) The mean surface strength for the CPF cast face shall exceed that for the control face by at least 70%.
   b) The mean 10 minute ISAT result for the CPF cast face shall be not more than 15% of that for the control face.
   c) The mean depth of carbonation for the CPF cast face shall be not more than 15% of that for the control face.
   d) The mean concentration of chlorides at a depth of 11mm from the CPF cast face shall be not more than 15% of that for the control face.

vi. The CPF liner shall be used once only. Release agents shall not be used with the liner and any residual release agent remaining on forms from previous use shall be removed.

vii. To ensure conformity with the performance requirements, the CPF liner is to be used in accordance with the manufacturer's technical guidelines.

viii. The CPF liner shall unless otherwise directed, be left in place on the concrete after formwork removal for the curing period specified by the S.O. It shall be kept wet and covered with plastic sheeting to promote efficient curing.

8.1.3 Projecting Reinforcement, Fixing Devices

Where holes are needed in form to accommodate projecting reinforcement or fixing devices, care shall be taken to prevent loss of grout when concreting or damage when removing forms.

8.2 Surface Finishes for Concrete

8.2.1 Control of Colour

When specified in the Drawings, the Contractor shall obtain each constituent material from a single consistent source. The aggregates shall be free of any impurities that may cause staining. The mix proportions and the grading, particularly of the fine aggregate, shall be maintained constant. The same type of plywood or timber shall be used in formwork throughout similar exposed areas.

8.2.2 Formed Surfaces

Formed concrete surfaces shall have one of the following classes of finish. Unless otherwise specified, all exposed concrete surfaces shall be of Class F12, all unexposed surfaces shall be of Class F1. Other classes of finishes shall be used only where shown in the Drawings:

(a) Class F1

This finish shall be obtained by the use of properly designed forms of closely joined sawn timber or other approved material. Small blemishes caused by entrapped air or water may be expected but the surface shall be free from voids and honeycombing.

(b) Class F2

This finish shall be obtained by the use of properly designed forms of closely jointed wrought boards, approved plywood or other approved material. Only very minor surface blemishes shall occur, with no staining or discolouration.

(c) Class F3

This finish shall be obtained by the use of properly designed steel forms or plastic coated plywood or wrought boards or other approved material. The surface shall be improved by carefully removing all fins and other projections, thoroughly washing down and then filling the most noticeable surface blemishes with a cement and fine aggregate paste to match the colour of the original concrete. Form release agents shall be carefully chosen to ensure that the surface shall not be stained or discoloured.

After the concrete has been properly cured, the surface shall be rubbed down where necessary, to produce a smooth and even surface.

(d) Class F4

The requirements for Class F4 are as for Class F3 except that internal ties and embedded metal parts will be permitted. The ties shall be positioned only in rebates, or in other positions as shown in the Drawings or as agreed by the S.O.

(e) Class F11

The requirements for Class F11 surface finish are identical to those for Class F1 except that it shall be achieved using Controlled Permeability Formliners.

(f) Class F12

The requirements for Class F12 surface finish are identical to those for Class F2 except that it shall be achieved using Controlled Permeability Formliners.

(g) Class F13

The requirements for Class F13 surface finish are identical to those for Class F3 except that it shall be achieved using Controlled Permeability Formliners.

(h) Class F14

The requirements for Class F14 surface finish are identical to those for Class F4 except that it shall be achieved using Controlled Permeability Formliners.

(i) Class F15

The requirements for Class F15 are as for Class F4 except that plywood shutters lined with an approved patterned formliner shall be used to produce a patterned profile finish. Where possible, full height formliners shall be employed so that no horizontal joints in the liners are required. Tie holes shall be spaced so that they occur at overlap joints in the lining sheet.

8.2.3 Unformed surfaces

(a) Class U1

The concrete shall be uniformly levelled and screeded to produce a plain, ridged or broom roughened surface. No further work shall be applied to the surface unless it is used as the first stage for a Class U2 or Class U3 finish.

(b) Class U2

After the concrete has hardened sufficiently, the concrete Class U1 surface shall be floated by hand or machine to produce a uniform surface free from screed marks.

(c) Class U3

When the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, a Class U1 surface shall be steel-trowelled under firm pressure to produce a dense, smooth uniform surface free from trowel marks.

(d) Class U4

This finish is for surfaces that are to receive waterproofing systems.

The concrete shall be levelled and floated to produce a uniform surface and immediately before the waterproofing operation this surface shall be water jetted or grit blasted to provide a lightly textured finish.

The finished surface shall not deviate from the required profile by more than 5mm over a 3m gauge length or have any abrupt irregularities of more than 3mm.

8.2.4 Trial Panels for Exposed Form Finished Surfaces

In order to ensure that the specified formed finishes can be obtained by the method of construction proposed and to provide a standard by which the finishes in the Works can be assessed, trial panels shall be cast on Site. These panels shall be subjected to the S.O.'s approval before similar casting is permitted in the Works.

The trial panels shall employ the materials, plant and concrete mix proposed for the Works. They shall be at least a storey height and 1m wide. They shall be of similar thickness and similarly reinforced as the elements they represent and shall incorporate all features which contribute to the final appearance of the Works.

8.3 Preparation of Forms Before Concreting

Before concreting, all forms shall be thoroughly cleaned out, free from sawdust shavings, dust, mud or other debris.

The inside surfaces of forms shall, unless otherwise approved by the S.O., be coated with an approved non-staining form oil or other approved material to prevent adhesion of the concrete. Such release agents shall be applied strictly in accordance with the manufacturer's instructions and shall not come into contact with the reinforcement or prestressing tendons and anchorages. For any exposed surface only one release agent shall be used throughout the entire area.

All formwork shall be inspected by the S.O. after preparation and immediately prior to depositing concrete and no concrete shall be deposited until approval of the formwork has been obtained.

8.4 Removal of Forms

The Contractor shall inform the S.O. and obtain his approval before striking any formwork, but such approval shall not relieve the Contractor of his responsibilities for the safety of the work.

Formwork shall be removed without such shock or vibration as would damage the concrete. A period of time shall elapse between the placing of the concrete and the removal of the formwork for various parts of the structure so as to suit the requirements for its curing.

The minimum periods between concreting and the removal of forms are given in Table 10. The periods stated in this table are based on the use of Ordinary Portland Cement. They may be changed with the approval of the S.O., if other types of cement as described in 2.1, admixtures or additional material as described in 2.4 and 2.5 are used. The result of the compressive strength obtained from the additional cubes taken as described in 4.9 may also be used for early removal of forms provided always the Contractor provide proof of calculation to the S.O for approval.

For prestressed in-situ components, temporary supports shall not be removed until the components is stressed to the approval of the S.O.

Where it is intended that forms are to be reused, they shall be cleaned and made good to the approval of the S.O.

Following the removal of forms, no further loads shall be imposed upon the concrete until at least after the completion of the curing period or until such later time as in the opinion of the S.O. the concrete shall have attained sufficient strength to safely withstand such loads. Full design loads shall not be applied to any structure until all load bearing concrete is at least 28 days old.

8.5 Inspection and Making Good

The surface of the concrete shall be inspected for defects and for conformity to the surface finish specified and where appropriate, with approved sample finishes.

Subject to the strength and durability of the concrete being unimpaired, the making good of surface defects may be permitted but the level of acceptance shall be appropriate to the type and quality of the finish specified and ensure satisfactory permanence and durability.

Any remedial treatment of surfaces shall be approved by the S.O. following inspection immediately after removing the formwork and shall be carried out without delay.

9.0 Mass and Lean Concrete

Mass and lean concrete shall consist of cement, fine aggregate and coarse aggregate in the nominal ratio by volume of 1:3:6 and 1:4:8 respectively. However where a denser and more workable concrete can be produced by a variation in the ratio of the fine aggregate to that of coarse aggregate, this ratio may be varied within the limits (1:1½) and (1:3), provided that the volumes of fine and coarse aggregate, each measured separately, shall nevertheless equal the sum of the volumes of fine and coarse aggregate appropriate to the nominal mix. The concrete shall be mixed as described for reinforced concrete.

10.0 Building Accuracy

After removal of formwork, the Contractor shall take measurements as directed by the S.O. to check the deviation of the reinforced concrete works from specified dimensions shown in the Drawings. All measurements shall be recorded and submitted to the S.O. Any deviation in building accuracy shall comply with BS 5606.

11.0 Apparatus

The Contractor shall provide the following apparatus for use on the Site at all times: -

(a) Concrete slump test apparatus or flow test apparatus complying with MS 26. One set of the apparatus shall be provided for each concreting location.

(b) At least twelve (12) numbers of steel or cast iron moulds for casting 150mm concrete test cubes and six (6) numbers of 100mm mortar or grout test cube moulds complete with tamping bars and base plates in accordance with MS 26. A minimum number shall be provided such that no stripping of cubes is required prior to 24 hours setting and hardening period.

(c) Three (3) measuring cylinders of 250 ml capacity, graduated to measure to the nearest 2.0 ml., for determination of silt content (field setting method).

(d) An approved apparatus for measuring moisture content in fine aggregate.

(e) One electronic calculator with statistical functions.

(f) One 300 mm steel rule.

(g) One set of sieves in compliance with BS 410.

(h) Scale or balance 25 kg maximum capacity and weights.

(i) Trowel, shovel, spanner and other tools.

12.0 **Other Requirements for Building Works.**

Other requirements for building works shall be as in Appendix D/1.

Tables

TABLE 1 - TESTING OF AGGREGATES

Properties	Type of Aggregate	Test Methods	Limits
Grading	Both	MS30	Table 2 & Table 3
Elongation Index	Coarse	MS30	Not exceeding 30%
Flakiness Index	Coarse	MS30	Not exceeding 35%
Water Absorption	Both	MS30	Not exceeding 8%
Clay Lumps	Coarse	MS30	Not exceeding 1% by weight
Clay, Silt and Dust	Fine	MS30	Not exceeding 3% by weight or 8% by vol.
Organic Impurities	Fine	MS30	Not exceeding 0.4%
Aggregate Crushing Value	Coarse	MS30	Not exceeding 40%
Soundness Test	Coarse	MS30	Loss in mass after 5 cycles shall not be more than 12% for sodium sulphate or 18% for magnesium sulphate.
Chloride Content	Both	MS30	Not exceeding 0.06% by weight of chloride ions
Sulphate Content	Both	MS30	Not exceeding 0.44% by weight of SO_3

TABLE 2 - GRADING FOR COARSE AGGREGATE

Sieve size (BS410)	Percentage by mass passing BS 410 sieve for nominal sizes					
	Graded Aggregates			Single-sized Aggregate		
	40 mm to 5 mm	20 mm to 5 mm	14 mm to 5 mm	40 mm	20 mm	10 mm
50.0 mm	100	-	-	100	-	-
37.5 mm	90 to 100	100	-	85 to 100	100	-
20.0 mm	35 to 70	90 to 100	100	0 to 25	85 to 100	-
14.0 mm	25 to 55	40 to 80	90 to 100	-	0 to 70	100
10.0 mm	10 to 40	30 to 60	50 to 85	0 to 5	0 to 25	85 to 100
5.0 mm	0 to 5	0 to 10	0 to 10	-	0 to 5	0 to 25
2.36 mm	-	-	-	-	-	0 to 5

TABLE 3 - GRADING FOR FINE AGGREGATE

Sieve size (BS 410)	Percentage by mass passing BS 410 sieve			
	Overall limits	Additional limits for grading		
		C	* M	F
10.0 mm	100	-	-	-
5.0 mm	80 to 100	-	-	-
2.36 mm	60 to 100	60 to 100	65 to 100	80 to 100
1.18 mm	30 to 100	30 to 90	45 to 100	70 to 100
600 μm	15 to 100	15 to 45	25 to 80	55 to 100
300 μm	5 to 70	5 to 40	5 to 48	5 to 70
150 μm	0 to 15#	-	-	-

\# Increase to 20% for crushed rock fines, except when they are used for heavy-duty floors.
* For prescribed mix only Grading Limit M is applicable. See also clause 2.2.3(b).
NOTE: Individual sands may comply with the requirements of more than one grading. Alternatively some sands which satisfy the overall limits but may not fall within any one of the additional limit C, M or F may also be used provided that the supplier can satisfy the S.O that such materials can produce concrete of the required quality.

TABLE 4 - ADMIXTURE ACCEPTANCE TEST REQUIREMENTS

Categories of Admixture	Water Reduction	Stiffening Time			Minimum Strength as a percentage of the control mix	Age	Length change, maximum shrinkage	
		Time from completion of mixing to reach a resistance to penetration of:-					% of control	Increase
		0.5 N/mm²	3.5N/mm²	27.5 N/mm²	Compressive			
Type 1: **Accelerator**	-	More than 1hr.	Within 1hr.and 3hrs. earlier than control mix	At least 1hr. earlier than control mix	125 125 100 100	24 hrs. 3 days 7 days 28 days	135	0.010
Type 2: **Retarder**	-	At least 1hr.later than control mix	Within 1hr. and 3hrs. later than control mix	Not more than 3hrs. later than control mix	90 90 95	3 days 7 days 28 days	135	0.010
Type 3: Normal water-reducing	At least 5%	Within + 1hr. and - 1hr.of control mix	Within + 1hr. and - 1hr. of control mix	Within + 1hr. and - 1hr. of control mix	110 110 110	3 days 7 days 28 days	135	0.010
Type 4: Accelerating water-reducing	At least 5%	More than 1hr.	Within 1hr. and 3hrs. earlier than control mix	At least 1hr. earlier than control mix	125 125 100 100	24 hrs. 3 days 7 days 28 days	135	0.010
Type 5: Retarding water-reducing	At least 5%	At least 1hr. later than control mix	Within 1hr. and 3hrs. earlier than control mix	Not more than 3hrs.later than control mix	110 110 110	3 days 7 days 28 days	135	0.010

TABLE 5 - PRESCRIBED MIXES FOR GENERAL USE PER CUBIC METER OF CONCRETE BY WEIGHT BATCHING

Grades of Concrete	28-day Strength of Concrete (N/mm^2)	Nominal Max.Size of Aggregate (mm) 20			Max free water: cement ratios
		Workability	Medium	High	
		Slump limits(mm)	25 - 75	75 - 125	
15P	15	Cement (kg) Total aggregate(kg) *Fine aggregate (%)	280 1800 35 - 50	310 1750 35 - 50	0.6
20P	20	Cement (kg) Total aggregate(kg) *Fine aggregate (%)	320 1800 25 - 40	350 1750 20 - 45	0.55
25P	25	Cement (kg) Total aggregate(kg) *Fine aggregate (%)	360 1750 25 - 40	390 1700 30 - 45	0.5
30P	30	Cement (kg) Total aggregate(kg) *Fine aggregate (%)	400 1700 25 - 40	430 1650 30 - 45	0.45

* Fine aggregate is expressed as a percentage by weight to the total weight of the dry aggregate.

TABLE 5A - PROPORTIONS AND STRENGTH REQUIREMENTS FOR PRESCRIBED MIXES BY VOLUME BATCHING

Mix Proportion (Grade)	Slump Limits (mm)	Cubic Meters of Aggregate Per 50 kg of cement		Max. Free Water: Cement Ratio	Quantity of Water (Liters)	Strength of Concrete	
		Fine	Coarse (20mm)			At 7 Days (N/mm^2)	At 28 Days (N/mm^2)
1:1:2(30P)	25-50	0.035	0.07	0.45	22.5	20	30
1:1.5:3(25P)	25-50	0.05	0.1	0.5	25	17	25
1:2:4(20P)	25-50	0.07	0.14	0.55-0.6	27.5-30	14	20
1:3:6(15P)	25-50	0.10	0.20	0.6	30#	11	15

or as approved by S.O.

TABLE 6 - MINIMUM CEMENT CONTENT AND MAXIMUM FREE WATER: CEMENT RATIO FOR DESIGNED MIX

Exposure	Prestressed Concrete			Reinforced Concrete			Plain Concrete		Max. Free Water: Cement Ratio
	Nominal max.size of aggregate (in mm)			Nominal max.size of aggregate (in mm)			Nominal max. size of aggregate (in mm)		
	40	20	10	40	20	10	40	20	
a)Surface sheltered from severe rain:-	(kg/m³)			(kg/m³)			(kg/m³)		
1) surface protected by a waterproof membrane;									
2) internal surfaces, whether or not subject to condensation;	300	320	360	300	320	360	250	280	0.55
3) surfaces continuously buried and/or submerged under water.									
b) soffits;									
c) surfaces exposed to driving rain, alternate wetting and drying, e.g., in contact with backfill.	330	350	390	330	350	390	270	300	0.50
d) surfaces exposed to the action of sea water with abrasion having a pH of 4.5 or less.	360	380	420	360	380	420	320	350	0.45
e) surfaces exposed to sulphate attack.	References shall be made to Table 6.1 - MS1195 Part 1:1991								

TABLE 7 - MAXIMUM TOTAL CHLORIDE

Type or Use of Concrete	Maximum Total Percentage of Chloride Ions by Mass of Cement
Concrete containing embedded metal and made with cement complying with MS522	0.4
Prestressed Concrete and Heat-Cured Concrete containing embedded metal	0.1
Plain, non-structural concrete	No limit

Notes on Table 7:-
(1)% Chloride ions x 1.648 = % equivalent sodium chlorides.
(2)% Chloride ions x 1.56 = % equivalent anhydrous calcium chlorides.

TABLE 8 - COMPRESSIVE STRENGTH REQUIREMENTS FOR PRESCRIBED MIX

Grades of Concrete	28-day Strength of Concrete	Cube Strength at 7 Days*	Average Cube Strength at 28 Days*
	N/mm^2	N/mm^2	N/mm^2
20P	20.0	14	20.0
25P	25.0	17	25.0
30P	30.0	20	30.0
40P	40.0	27	40.0

*Only for Portland Cement

TABLE 8A - 28 DAY STRENGTH COMPLIANCE REQUIREMENTS FOR DESIGNED MIX

Specified Grade of Concrete	Group of Test Results:	A The mean of the group of test results exceeds the specified characteristic compressive strength by at least:	B Any individual test result is not less than the characteristic compressive strength less:
20 and above		N/mm^2	N/mm^2
	First 2	1	3
	First 3	2	3
	Any consecutive 4	3	3
Below 20		N/mm^2	N/mm^2
	First 2	0	2
	First 3	1	2
	Any consecutive 4	2	2

TABLE 9 - CHARACTERISTIC STRENGTH
OF STEEL REINFORCEMENT

Type	Nominal Sizes (mm)	Specified Characteristic Strength, fy (N/mm^2)
Hot rolled grade 250 (MS 146)	All sizes	250
Hot rolled grade 460 (MS 146)	All sizes	460
Cold worked (BS 4461)	All sizes	460
Hard drawn steel wire (MS 144)	Up to and including 12	485

TABLE 10 - MINIMUM PERIODS BETWEEN CONCRETING AND REMOVAL OF FORMS

Vertical faces of beams, wall, columns, piles, foundation plinths and precast components	3 days
Slabs (props left under)	4 days
Removal of props to slab	10 days
Beam soffits (props left under)	8 days
Removal of props to beams	21 days

Note: **This table is applicable only for Ordinary Portland Cement**. Where other types of cement, admixtures or additional material are to be used, the minimum periods between concreting and removal of forms shall be as approved by the S.O.

1.0 Foundation

All reinforced concrete footings and pile caps shall be constructed according to the Drawings and to the exact depths required. The Contractor shall supply, maintain and remove any necessary planking and strutting, sheet piling and coffer dams, and shall by pumping or other approved means keep the excavation free from water.

The bottom of excavation shall be cleaned or if in loose or disturbed ground shall be well rammed, and the whole shall be approved before it is covered with a blinding layer of lean concrete not less than 50 mm thick. The required cover of concrete under the reinforcement shall be entirely above the blinding layer.

2.0 Pile Caps

Before commencing to construct pile caps, the Contractor shall check and verify the eccentricities and the cut-off levels of all piling works in the ground are as provided in the Drawings, and shall notify the S.O. in the event of any discrepancy.

The Contractor shall straighten the steel reinforcement projecting above the piles for anchoring pile caps, carry out excavation, erect formwork and temporary timbering for the construction of pile caps and ground beams.

3.0 Lift Pits

For lift pits below ground level, the concrete in the base slab and walls shall be of reinforced concrete with minimum cement content and maximum free water: cement ratio in accordance with the exposure C in table 6 and shall be constructed in operations which shall ensure water tightness in the structure below the ground level.

All external or internal wall surfaces of lift pits shall be waterproofed with three (3) coats of bitumen solution complying with BS 3416 or any other type of waterproofing material as approved by the S.O. The concrete surface shall be thoroughly cleaned and dried before application of the waterproofing material.

4.0 Floors

After initial set, the upper surface of cast-in-situ reinforced concrete floors shall be trowelled smooth with a steel float to true level and even surface. No screeding of any kind shall be applied to the floor slabs except where specified. Care shall be taken to ensure that the steel reinforcement is not displaced or lowered during trowelling.

For areas, which are to receive rendering or other finishes, the fresh concrete shall be trowelled to true level or as required using a long timber trowel. Before it hardens it shall be brushed with a stiff broom in one direction to give a rough and tidy surface.

The reinforced concrete ground floor slab shall not be laid directly onto earth surfaces. A blinding layer of 50mm minimum thick of lean concrete as specified in clause 9.0 shall be laid on well prepared firm ground. Plastic sheeting or other suitable material with sufficient overlaps at joints, shall be laid on the blinding layer before any reinforcement is placed in position.

5.0 Toilet Floors

The Contractor shall ensure that all suspended floor for toilet areas are constructed to be watertight and leak proof. All construction method or alternative details proposed by the Contractor must be based on his acceptance of and compliance with the requirements for watertightness. The Contractor shall ensure that holes and fixings are properly constructed. The floor must be concreted in one sequence of operation. No construction joints for toilet floor are to be allowed. All pipes and fittings encased in the concrete floor shall be provided with sleeves to

the approval of the S.O and shall be build in situ. No holes shall be left for later incorporation of fittings and no subsequent hacking of floor shall be made. Not withstanding whatever shown in the Drawings, all toilet floor slabs shall have a minimum thickness of 150mm.

5.1 Testing for watertightness

The toilet floor areas should be ponded with water continuously over a period of 7 days. During this period the exposed soffit shall show no signs of leakage and remain dry. If any area is found not to be watertight, the Contractor must repair at his own expense.

6.0 Roofs

6.1 Reinforced concrete roofs shall be constructed to fall as shown in the Drawings and finished with steel trowelling, leaving the surface smooth and free from mortar droppings.

6.2 The base slab shall be concreted as described for concrete generally, ensuring thorough compactions by the use of a pan vibrator or a vibrating screen. Concrete shall be poured continuously between pre-determined construction joints as decided by the S.O., or as shown in the Drawings. Expansion joints, where applicable, shall be allowed and constructed exactly as indicated in the Drawings.

6.3 Unless otherwise specified or shown in the Drawings, waterproofing screed to reinforced concrete flat roof shall consist of a 32 mm thick screed reinforced with temperature steel.

6.4 The waterproofing screed shall consist of one (1) part of cement and three (3) parts of clean well-graded sand (1:3), and shall be mixed with an approved waterproofing agent and approved plasticiser in the proportion recommended by the manufacturer.

6.5 The temperature steel shall consist of a mesh 6 mm diameter mild steel bars at 150 mm centers each way, or alternatively steel fabric of MS 145. The temperature steel shall be placed directly on top of the base slab, and a minimum cover of 19 mm to top bars of the temperature steel shall be maintained.

6.6 The screed shall be laid after the base slab concrete has sufficiently hardened but not later than 36 hours after the concreting of the base slab, to obtain a thorough bond between the screed and the base slab. The surface shall be finished with a wood float, and followed by a steel trowel to a smooth finish.

6.7 Unless otherwise specified or shown in the Drawings, joints in the screed shall be allowed and located over the main roof beams and shall be filled with approved bituminous compound as soon as possible.

6.8 After the screed has been placed, the full area shall be properly protected and cured for a period of at least seven (7) days. Alternatively as soon as the screed has sufficiently hardened to withstand a man's weight without marking, an approved plastic sealing agent shall be sprayed in accordance with the manufacturer's instructions.

7.0 Drips

Unless otherwise shown in the Drawings or directed by the S.O., a 15mm wide drip shall be formed along edges of soffits to concrete roof slabs, hoods, undersides of balconies, cantilevered beams and slabs and other parts of building where rain water is likely to adhere in drops**.**

8.0 Refuse Chutes

Where shown in the Drawings, all cast-in-situ reinforced concrete refuse chutes shall be constructed without bolt holes made through the chute walls. If such holes are unavoidable then they shall be completely grouted with cement mortar as specified in clause 6.3.5 or sealed and waterproofed by other means to prevent leakage to the approval of the S.O.

Frames which shall not be of asbestos cement, shall be cast into refuse chute walls for fixing chute hoppers. Such frames shall be obtained from the same supplier of chute hoppers.

SECTION E - BRICKWORKS

1. **Cement**

1.1 The cement, unless otherwise described, shall be Ordinary Portland Cement complying with MS 522 and as specified under SECTION D: CONCRETE WORK.

2. **Sand**

2.1 Sand for mortar shall comply with MS 29 and as specified in SECTION D: CONCRETE WORK.

3. **Mortar**

3.1 Mortar shall consist of one (1) part of cement to six (6) parts of sand, with the addition of an approved mortar plasticiser used strictly in accordance with the manufacturer's instructions. The ingredients for mortar shall be measured in proper gauge boxes and shall be mixed on a clean boarded platform or in an approved mechanical batch mixer.

3.2 All mortar shall be used within 45 minutes of mixing and no remaking up of mortar shall be permitted thereafter.

3.3 Mortar for brickwork below damp proof course or ground floor level shall be in the proportion of one part of cement and three parts of sand.

4. **Bricks and Blocks**

4.1 Samples

Separate samples of each type of bricks and blocks taken at random from the load, shall be submitted to the S.O. for approval before the bricks and blocks are used. All subsequent deliveries shall generally be up to the standard of the samples approved. No soft, broken, twisted or otherwise defective bricks and blocks will be permitted to be used.

4.2 Clay Bricks

All ordinary clay bricks shall be machine-made and wire cut complying with MS 76 and shall be hard, well burnt, sound, square and clean.

4.3 Cement Sand Bricks and Hollow Blocks

4.3.1 All cement sand bricks and hollow blocks shall comply with MS 27.

4.3.2 Size

Cement sand bricks shall be of a nominal size as given below:

Length(mm)	Width(mm)	Depth(mm)
225 ± 3.2	113 ± 1.6	75 ± 1.6

Dimensional tolerances for hollow blocks shall be ± 3mm on all faces. The shell of each hollow block shall be 38mm thick minimum on all sides.

4.3.3 Composition

Cement sand bricks and hollow blocks shall consist of an intimate and uniform mixture of sand and cement. The sand and cement shall be mixed in the ratio of six (6) parts of sand to one (1) part of cement by volume in a mechanical mixer capable of taking one (1) bag of cement (50kg of cement shall be taken as 0.035 cube). The sand used shall be as described hereinbefore and the maximum size shall pass through a 4.8mm mesh BS sieve. The cement used shall be Ordinary Portland Cement as described under SECTION D: CONCRETE WORK.

4.3.4 Supply

The Contractor shall only use cement sand bricks and hollow blocks supplied by approved manufacturers.

4.3.5 Compressive Strength

The minimum permissible average compressive strength shall be 5.2N/mm sq. for bricks and 2.8 N/mm sq. for hollow blocks per 10 samples taken at random from the Contractor's stock pile of 1000 or part thereof. All rejected or condemned bricks shall be removed from the Site at the Contractor's expense.

4.4 Autoclaved Aerated Concrete Block

4.4.1 Autoclaved aerated concrete blocks shall be high pressure steam cured consisting of a mixture of ordinary cement, sand and lime. The mix shall be free of asbestos or toxic substances.

4.4.2 Where autoclaved aerated concrete blocks are used in lieu of clay bricks, the equivalent thickness shall be as below: -

Thickness of Brickwall	Thickness of Autoclaved Aerated Concrete Blockwall
Half Brickwall	100mm thick
One Brickwall	200mm thick

4.4.3 The autoclaved aerated concrete blocks shall have the following performance criteria: -

(a) dry density of between 500kg/m^3 and 700kg/m^3;
(b) dimensional accuracy of ± 1.5mm on all faces;
(c) the minimum permissible compressive strength shall be 2.5 N/mm sq. per 10 samples taken at random from the Contractor's stock pile of 1000 or part thereof.
(d) minimum fire rating of two (2) hours.

4.5 Patented Block

Patented blocks shall comply with MS 27 and shall be used strictly in accordance with the manufacturer's instructions.

5. Walling

5.1 Brick Walling

5.1.1 The whole of the brickwork shown in the Drawings, unless otherwise specified, shall be constructed with standard size clay bricks in mortar as described and leave the surface ready for plastering.

5.1.2 Notwithstanding paragraph 5.1.1 above and anything else to the contrary elsewhere contained in the Drawings and*/* or Bills of Quantities, the Contractor may with approval of the S.O. construct all non load bearing brickwork above damp proof course or ground floor level and which will be plastered on both sides, with cement sand bricks thereinbefore specified. Provided always that in the event of the S.O. allowing the substitution of clay bricks with cement sand bricks, a deduction shall be made from the Contract Sum for such substitution at rates to be derived from the prices to Site of clay bricks and cement sand bricks, and the average size of the clay bricks and cement sand bricks concerned, using the formulas shown in APPENDIX E1.

5.1.3 All clay bricks shall be soaked in a suitable tank or pit to be provided by the Contractor for at least half an hour before being laid and shall be kept wet whilst being laid. The top of walls left off shall be thoroughly wet before work is resumed. All constructed walling must be left wet and properly protected from the direct sunlight during the following day. The Contractor shall provide sufficient means to ensure that this is done.

5.1.4 Cement sand bricks shall not be soaked but dipped in water before being laid and all constructed brickwork shall be protected from direct sunlight during the day on which it is laid and also during the following day and the Contractor shall provide sufficient means to ensure that this is done.

5.1.5 All bricks shall be properly bedded in mortar and all joints shall be thoroughly flushed up and raked out to a depth of 13mm as the work proceeds. No joint shall exceed 10mm in thickness.

5.1.6 Brickwork shall be carried up perfectly true and plumb in a uniform manner. No one portion being raised more than 1m above another at one time. No overhand work shall be permitted and scaffolding shall be carried up as the work proceeds. The vertical points of every alternate course shall be kept perpendicular over one another, and all perpends, quoins, etc. shall be kept strictly true and square.

5.1.7 All intersections and angles of walls shall be properly bonded together, and all walls and piers of lengths and widths not multiples of brick sizes shall be cut and bonded in the best approved manner. No broken bricks shall be used except where required to form bonds.

5.1.8 All half brick (113mm) walls and partitions shall be reinforced at every fourth course with approved brick reinforcement commencing two courses above floor level. For block walling, reinforcement shall be at every second course commencing one course above floor level.

5.2 Hollow Block Walling

5.2.1 The cement sand block wall shall be laid in the manner specified for brickwall. The hollow block shall not be soaked but dipped in water before laying. The hollow block wall shall be reinforced at every second course with reinforcement commencing one course above floor level.

5.3 Autoclaved Aerated Concrete Block Walling

5.3.1 Where shown in the Drawings and**/** or described in the Bills of Quantities or as alternative to clay bricks, the Contractor may use autoclaved aerated concrete blocks for non load bearing walls and partitions. The autoclaved aerated concrete block work shall be constructed strictly in accordance with the manufacturer's instructions. Any extra cost in connection therewith shall be borne by the Contractor.

5.3.2 The autoclaved aerated concrete block work shall be installed using an approved thin layer of adhesive mortar to all horizontals and perpends. The first course must be made true and level using a normal layer of mortar with thin layer of adhesive to fully seal the perpends. The thin layer of adhesive shall be applied using a notched trowel to obtain an even distribution of adhesive to achieve joint thickness of 2-3mm.

5.3.3 A damp-proof course slip-joint membrane shall be laid on top of floor slab or beams before receiving the mortar bedding to allow for differential movement between the blocks and the supporting structure.

5.3.4 The autoclaved aerated concrete block work shall be laid in a manner that the vertical joint of the lower course shall be staggered at least 100mm relative to the vertical joint of the overlaying course.

5.3.5 Unless otherwise directed and/or shown, where concrete block walls abut concrete faces, the face shall be flushed.

5.3.6 Control joints should be built into walls at spacing not greater than 8.0 meter centres, and at locations in accordance with the manufacturer's recommendation.

5.3.7 Care must be taken to keep the walls clean, strictly in accordance with the manufacturer's recommendation. Excess adhesive must be removed progressively.

5.3.8 In lieu of cement sand plastering, the wall surfaces may be finished with suitable surface coating that has the dual properties of being waterproof and water vapour permeable and shall be applied in accordance with the manufacturer's recommendation.

6. **Bond**

6.1 All half brick walls shall be built in Stretcher Bond.

6.2 All other brickwork shall be built in English Bond or as shown in the Drawings.

7. **Damp Proof Course**

7.1 Unless otherwise shown in the Drawings, bituminous sheet damp proof courses shall comply with BS 8215 laid in brickwork on a level bed of cement mortar (1:1) and coated on the upper surface with hot bitumen and lapped at least 150mm at angles and joints.

7.2 In all cases of doubt as to the exact location of the damp-proof course the Contractor shall refer to the S.O. before laying the damp-proof course.

8. Building in Cramps

8.1 Unless otherwise shown in the Drawings, cramps for frames, metal windows and precast units shall be built in at 1m centres on the vertical side of the frame. Mild steel cramps shall be 25mm x 3mm x 225mm long for fixing wooden frames, etc. One end of the cramp shall be turned up and screwed to back of the frame and the other end shall be split and fish-tailed for building in. Cramps which are to be fixed to concrete shall be embedded in concrete and built into brickwork as the work proceeds.

9. Scaffolding

9.1 All scaffolding shall be carried up as the work proceeds and shall be safe for use.

10. Facing Brickwork

10.1 All facing brickwork shall be executed in first quality approved facing bricks in Stretcher or Flemish Bond as shown in the Drawings, properly bonded into any backing walls, piers, etc. Joints shall be raked out to a depth of 13mm and point up in coloured cement mortar to approved tints, finished with a neat struck weathered joint.

10.2 Facing brickwork shall be kept perfectly clean and no rubbing down of brickwork will be allowed.

11. Cutting

11.1 All arches, cuttings, sinks, setbacks, and projections shall be properly formed. Chases and holes through walls and slabs for the passage of pipes, wiring and the like shall be neatly cut or formed.

12. Stonework

12.1 Unless otherwise shown in the Drawings or described in the Bills of Quantities, all stone blocks used shall be of limestone or granite whichever is more readily available within the locality of the Site and shall be free from cracks, fissures or other defects to the approval of the S.O. The stone blocks shall in general, have their largest faces parallel. Unless otherwise required, the maximum thickness of the stone blocks shall in no case exceed the thickness of the wall or portion of the structure into which it is being built.

12.2 Stone walling shall be laid random uncoursed or random coursed as shown in the Drawings. Through or bonded stones shall be used at one stone per metre square for random uncoursed work, and two stones per metre square for random coursed. Where backing brickwall is shown, the through stone shall be properly bonded in such brickwall.

12.3 Unless otherwise shown in the Drawings, all stonework shall be bedded in cement and sand mortar (1:3) mix and finished with a flushed joint rubbed down with sacking. All interstices between individual stone shall be filled with mortar. Finish to exposed surfaces or random walling shall be hammer-dressed.

APPENDIX E 1

FORMULA FOR SUBSTITUTION OF CLAY BRICKS WITH CEMENT SAND BRICKS

	Description of Brickworks	Rate of Deduction Per Sq. M	
1.	Half Brickwall	1,000,000	$\left(\frac{(1.025Ht1)}{(Pt1 + 10)(Tt1 + 10)} - \frac{(1.100Hsp)}{(Psp + 10)(Tsp + 10)} \right)$
2.	One Brickwall	2,000,000	$\left(\frac{(1.025Ht1)}{(Pt1 + 10)(Tt1 + 10)} - \frac{(1.100Hsp)}{(Psp + 10)(Tsp + 10)} \right)$

Where,

Ht1	-	The price to Site of clay to be agreed
Pt1	-	The average length of the clay bricks concerned in millimeters
Tt1	-	The average thickness of the clay bricks concerned in millimeters
Hsp	-	The price to Site of cement sand bricks to be agreed
Psp	-	The average length of the cement sand bricks concerned
Tsp	-	The average thickness of the cement sand bricks concerned in millimeters

SECTION F -SOIL DRAINAGE

1. **General**

1.1 The work to be done under this section unless otherwise shown or described in the Bills of Quantities shall consist of the supply, delivery, construction and testing of all soil drainage and ancillary works, connecting the vertical stack to and including the septic tank or imhoff tank and all necessary works up to the point of final discharge of the effluent. In the case of discharge into the public sewer or the package sewage treatment plant, the work shall terminate up to and including the last manhole or intercepting trap of the system. This section of the work shall be carried out strictly in accordance with the appropriate by-laws and to the approval of the S.O.

2. **Cement, Sand, Aggregates and Bricks**

2.1 Cement, sand and aggregates shall be as previously specified in SECTION D: CONCRETE WORK. All bricks used unless otherwise shown in the Drawings or described in the Bills of Quantities shall be clay bricks as previously specified in SECTION E: BRICKWORK.

3. **Layout**

3.1 The whole of the drainage work shall be carried out to the layout as shown in the Drawings.

4. **Excavation**

4.1 Generally, all excavation works in this section unless otherwise specified hereunder shall be as previously specified in SECTION C: EXCAVATION AND EARTHWORK.

4.2 The depth of excavation for manholes, septic tank/or filter bed shall be as shown in or inferred from the Drawings.

4.3 The trench shall be excavated to the depths intended or as shown in the Drawings and shall be finished and trimmed to the correct level and grade. Unless indicated otherwise, the bottom of the trench shall be graded so that the pipe invert slopes evenly between the appropriate outlet invert of the proceeding manhole and the inlet invert of the next manhole.

4.4 The trench shall be excavated to such width so as to ensure that a working space of 150mm will be available on either side of the pipe when properly aligned. At all joints, the trench shall be so excavated to give a minimum working space of not less than 300mm all round the joint.

4.5 The sides of all excavation unless otherwise approved by the S.O. shall be cut vertical and where necessary shall be protected against caving in by timbering to the approval of the S.O.

4.6 Should the ground be so wet or soft that does not form a firm base for the pipe, if it is necessary in the opinion of the S.O. then the trench shall be excavated 225mm below the level intended or shown in the Drawings and then brought to the correct level with good selected earth, quarry dust or sand well rammed into place. Such deepening of pipe trench and filling back shall be treated as a variation under the terms of the Contract. Should the bottom of the trench be inadvertently excavated below the specified level, it shall be brought back at the Contractor's expense to the correct level with good selected earth, quarry dust or sand carefully rammed into place.

4.7 When excavating pipe trenches in roadway or other paved surfaces, the Contractor shall first remove all metal, slabs or bricks forming the existing pavement to the width of the trenches and reinstate to the approval of the S.O. after the trenches have been backfilled.

4.8 Generally where rock is encountered in the trench excavation, it shall be removed to the approval of the S.O. Where layer of rock is encountered along the bottom of the excavation, it shall be cut and trimmed to the required level of the trench. All voids formed at the bottom of the trench by the removal of rocks shall be back filled to the required level with 1:3:6-20mm concrete or other suitable materials well rammed and compacted all to the approval of the S.O. Jaggered surfaces of rocks at the bottom of the excavation due to the trimming shall be levelled and smoothened with sand blinding to the approval of the S.O.

5. Pipes and Fittings

5.1 Generally, all soil drains unless otherwise shown in the Drawings, shall be vitrified clay pipes and fittings complying with MS1061.

5.2 All drains shown passing under buildings up to the immediate manhole outside the buildings, roads, pavements and the like and exposed pipes above ground shall be coated cast iron pipes and fittings complying with BS 437 or complying with BS 416 and BS 78 respectively whichever is appropriate.

5.3 Where pitch impregnated fibre pipes and fittings are shown in the Drawings, they shall be to the approval of the S.O. Where unplasticised polyvinyl chloride (uPVC) pipes and fittings are shown, they shall be manufactured according to MS 979 for under ground installation and MS 1063 for above ground installation. For pumping application, pipes and fittings shall be manufactured to MS 628 and to the approval of the S.O. All pipes and fittings shall be of an approved manufacture.

6. Joint for Drain Pipes

6.1 Unless otherwise approved by the S.O, joints of flexible and watertight type shall be used on all vitrified clay pipes. The spigot and socket of each pipe shall be cleaned and lubricated before the running of each joint.

6.2 Cast iron pipe shall be jointed with a gasket of hemp or yarn and malleable lead well-caulked home to the approval of the S.O. The internal side of each pipe shall be carefully cleaned after jointing to leave a clear and unobstructed water way.

6.3 Where pitch impregnated fibre pipes and fittings are shown in the Drawings, they shall be jointed by means of tapered coupling joint. Couplings shall be made either of the same materials as the pipe or of a plastic material to the approval of the S.O. The pipes and coupling shall have accurately machined or moulded tapered ends, the internal taper of the couplings matching the external taper of the pipes.

6.4 Where uPVC pipes and fittings are shown in the Drawings, they shall be jointed by using solvent weld joints.

7. Pipe Laying

7.1 All pipes shall be laid in compliance with MS 1228 and in accordance with the sizes, locations, dimensions, grades and other particulars as shown in the Drawings. Each pipe shall be carefully examined on arrival at the site. Sound pipes shall be carefully stored. Defective pipes shall be marked and removed from the site forthwith.

7.2 Prior to fixing or laying all pipes and fittings shall again be carefully examined for damage and only those found to be sound in every aspect shall be fixed or laid. Any pipes, specials, etc. found to be damaged in any way shall be clearly marked, set aside and removed from the site.

7.3 No pipe shall be laid until the trench has been inspected and approved by the S.O.

7.4 The pipes shall be gently lowered into the trench by means approved by the S.O. No pipes shall be rolled or dropped onto the trench. The pipe shall be laid true to alignment as shown in the Drawings or as instructed by the S.O. Interior and exterior of each pipe at the joint shall be thoroughly cleaned before the joint is made.

7.5 To prevent the entry of earth and other foreign matter into the pipes, the Contractor shall provide and fix suitable stops for efficiently closing all open ends of pipes in the trench while work is not actually being carried out at such open ends.

7.6 Socketed pipes shall be laid with the sockets laid against the direction of flow. At every position of pipe joints, the foundation shall be recessed sufficiently to allow the workman room to work right round the pipes.

7.7 Where drains are to be laid on concrete bed, haunched or encased in concrete surrounds, these shall be as shown in the Drawings and as specified hereinafter.

7.8 The soil pipes shall be laid to the gradients as shown or inferred in the Drawings. Where the gradients are not shown or cannot be inferred, the drain shall be laid to the following gradients: -

Size diameter (mm)	Gradient
100	1 : 60
150	1 : 80
225	1 : 110
250	1 : 120
300	1 : 140
375	1 : 170
450	1 : 200

7.9 Where drain pipes are laid above ground, they shall be supported at intervals to the details as shown in the Drawings or to the approval of the S.O.

7.10 All external underground soil drainage shall have a minimum cover of 450mm unless otherwise shown in the Drawings.

8. Concrete Bed, Haunching and Surround

8.1 Concrete bed, haunching and surround shall be of concrete (1:3:6-20mm aggregate).

9. Connections

9.1 The Contractor is to allow and provide for all bends, junctions, traps, gullies as shown in the Drawings or where necessary. If a gully is used, it shall be of the inlet type, and shall be set level on a concrete base, with a riser to finish 50mm above the surrounding surface level, complete with concrete surrounds rendered on all sides and galvanized iron grating. Bends turned up to receive various stacks shall be set on concrete bases to the approval of the S.O. The bends at the foot of vertical stacks shall be of gentle radius type.

9.2 All underground fittings shall be completely surrounded in concrete and the Contractor shall allow for any additional excavation and jointing of pipes.

10. Manholes and Inspection Chambers

10.1 Manholes and inspection chambers shall be constructed to the sizes shown in the Drawings. Unless otherwise shown or specified, all dimensions on the plan shall be the inside measurement.

10.2 Unless otherwise shown in the Drawings, manholes and chambers shall be constructed in brickwork in cement mortar (1:2) and the brickwork shall be of clay bricks and constructed on (1:3:6-20mm) concrete foundation. The thicknesses and sizes shall be as shown in the Drawings. Each manhole and chamber shall have channels and open channel junctions of sizes stated in the Drawings. Concrete benching shall be to a gradient of 1:6 and shall be of (1:3:6-20mm) concrete finished with 19mm steel trowelled water proofed cement and sand (1:3) rendering. The internal sides of the manholes and chambers shall be lined with 20mm thick water proof cement render (1:2). Externally, the exposed concrete or brick surfaces shall be rendered with 12mm cement and sand mortar (1:3) and terminated 150mm below the finished ground level. All internal angles shall be rounded off. Manholes and chambers shall be provided with covers and unless specified or as shown in the Drawings, covers shall be medium duty 450mm x 600mm cast iron covers with air tight frames. Approved type wrought iron steps shall be built into the brick wall of all manholes and chambers of depth 1m or more and they shall be spaced not more than 300mm apart, projecting 100mm over the face of the wall.

11. Septic Tank, Filter Bed & Sewage Treatment System

11.1 Septic tank and filter bed shall be constructed as shown in the Drawings and to the approval of the S.O.

11.2 Sewage Treatment System

11.2.1 All sewage treatment system shall be manufactured only by government approved sewage treatment system providers producing quality assured products and services, to the approval of the S.O. The limit for sewage effluent at the discharge point shall comply with Standard A of Environmental Quality Act as in APPENDIX F/1

11.2.2 Prior to the installation of the sewage treatment system, the Contractor shall submit to the S.O two (2) copies of design calculations, Drawings and method statements certified by an independent Professional Engineer to be used in the construction and installation of the sewage treatment system.

11.2.3 As soon as practicable after the completion of the installation of the sewage treatment system and prior to the issuance of the Certificate of Practical Completion, the Contractor shall submit the following documents to the S.O for information and record:

i) System Provider's Guarantee against any defects or damages which may arise during a period of five (5) years from the Date of Practical Completion of Works due to any defect, fault or insufficiency in design, material or workmanship or against any other failure which an experienced Contractor may reasonably contemplate but shall not include normal replacement and maintenance The terms of the Guarantee shall be such as approved by the S.O.

ii) Two (2) sets of as built Drawings of the sewage treatment system signed by the system provider and certified by a Professional Engineer.

12. Connections with Public Sewer

12.1 Connections to the public sewer, if any, shall be strictly carried out in accordance with requirements of the Local Authority and to the approval of the S.O.

13. Testing for Soil Drainage Installation

13.1 The Contractor shall carry out tests to the soil drainage installation in accordance with the method and requirements as described hereinafter. The Contractor shall give reasonable notice in writing to the S.O. before such tests are carried out.

13.2 Testing of pipework shall be carried out before backfilling and wherever possible, such testing shall be carried out from manhole to manhole. Short branch pipes connected to a main sewer between manholes shall be tested as one system with the main sewer. Long branches and manholes, shall be separately tested.

13.3 All pipework shall be subjected to water tests or any other test required by the Local Authority and to the approval of the S.O.

13.4 For the water test, the pipe shall be subjected to an internal test pressure of 1.2metre head of water above the crown of the pipe at the higher end but not more than 6 metres at the lower end. Steeply graded pipe shall be tested in such a manner that the above maximum heads is not exceeded.

13.5 The test shall be carried out by inserting suitably strutted plugs in the lower end of the pipe and in connections if necessary and by filling the system with water. The test section shall stand full of water for at least 15 minutes prior to testing and such testing shall be applied for a testing period of not less than 30 minutes.

13.6 The loss of water over a period of 30 minutes shall be measured by adding water from a measuring vessel at regular intervals of 10 minutes and noting the quantity required to maintain the original water level. For the purpose of the test, the average quantity added for pipes up to 460mm diameter shall not exceed 0.12 litres per hour per linear metre per 100mm of nominal internal diameter of pipe.

13.7 Any leakage, including excessive sweating which causes a drop in the test level, and the defective part of the work shall be removed, made good and subsequently retested as above.

13.8 The pipework may also be subjected to mirror test to ascertain the straightness of the alignment between manholes as and when required by the S.O. The test shall be carried out by inserting a light source at one end and viewing its image on a mirror placed at the other end of the pipe.

14. Backfilling

14.1 After the pipes have been tested and approved, the trench shall be backfilled with approved fill material, free from rock and other hard material, well compacted around the pipes up to a level of at least 75mm above the top of the pipes. After this has been approved, the remaining excavation shall be backfilled in 300mm layers, each layer being well compacted.

APPENDIX F/1

PARAMETER LIMITS FOR SEWAGE AND INDUSTRIAL EFFLUENTS

PARAMETER	UNIT	STANDARD*	
		A	B
(1)	(2)	(3)	(4)
(i) Temperature	°C	40	40
(ii) pH Value	-	6.0 – 9.0	5.5 – 9.0
(iii) BOD5 at 20°C	mg/l	20	50
(iv) COD	mg/l	50	100
(v) Suspended Solids	mg/l	50	100
(vi) Mercury	mg/l	0.005	0.05
(vii) Cadmium	mg/l	0.01	0.02
(viii) Chromium Hexvalent	mg/l	0.05	0.05
(ix) Arsenic	mg/l	0.05	0.10
(x) Cyanide	mg/l	0.05	0.10
(xi) Lead	mg/l	0.10	0.5
(xii) Chromium, Trivalent	mg/l	0.20	1.0
(xiii) Copper	mg/l	0.20	1.0
(xiv) Manganese	mg/l	0.20	1.0
(xv) Nickel	mg/l	0.20	1.0
(xvi) Tin	mg/l	0.20	1.0
(xvii) Zinc	mg/l	1.0	1.0
(xviii) Boron	mg/l	1.0	4.0
(xix) Iron(Fe)	mg/l	1.0	5.0
(xx) Phenol	mg/l	0.001	1.0
(xxi) Free Chlorine	mg/l	1.0	2.0
(xxii) Sulphide	mg/l	0.5	0.50
(xxiii) Oil and Grease	mg/l	Not detectable	10.0

A : Discharge upstream of water supply sources
B : Discharge downstream of water supply sources

Source: Environmental Quality (Sewage & Industrial Effluent) Regulations 1979

SECTION G - ROOFING WORKS

1. General

1.1 Unless otherwise stated, the pitch and laps for each type of roof covering shall be strictly in accordance with the manufacturer's instructions.

1.2 Unless otherwise approved, all roof covering accessories such as eaves piece, hips, ridges and valley pieces, shall be of the same material as the general covering.

2. Interlocking Concrete Tiles

2.1 Interlocking concrete tiles shall be of approved type and colour and shall conform to MS 797. The tiles shall be free from all defects.

2.2 Interlocking concrete tiles shall be laid on timber or steel battens approved for roofing at spacings and tightly screwed as recommended by the manufacturer.

2.3 Tiling fillers consisting of 1:3 cement mortar as specified under SECTION E: BRICKWORKS, shall be provided at the feet of the rafters.

2.4 Verges, ridges, hips and valley tiles shall be provided and laid to bond with the general tiling in accordance with the manufacturer's instructions.

3. Clay Tiles

3.1 Unless otherwise stated in the Drawings, clay tiles shall be of Marseilles pattern conforming to BS 402. The tiles shall be 400mm to 425mm in length by 225mm to 263mm in width and shall be free from cracks, chips and warps.

3.2 Clay tiles shall be laid on timber or steel battens approved for roofing at spacings and tightly screwed as recommended by the manufacturer.

3.3 Ridge capping, hip and valley tiles shall be provided to match the general tiling and these shall be bedded in matching 1:3 coloured cement mortar.

4. Corrugated Aluminium Roofing Sheets

4.1 Where aluminium roofing sheets are to be used, unless otherwise stated, they shall be of the type, gauge and finish as shown in the Drawings and to be fixed strictly in accordance with the manufacturer's instructions.

5. Concrete Flat Roofs

5.1 Concrete flat roofs shall be as specified under SECTION D: CONCRETE WORK.

6. Galvanized Steel Prepainted Steel Roofing and Wall Cladding

6.1 Where metal roof decks or wall claddings are to be used, unless otherwise stated, they shall be of prepainted hot-dipped zinc-coated roof decking of standard nominal thickness, width and length prior to corrugation and shall comply with JKR Standard No.2-95(BN) JKR 20709-0347-95.

6.2 Surfaces of galvanized steel roof decking or wall cladding shall be uniformly produced by coating and baking durable synthetic resin paint over either one or both surfaces of hot-

dipped zinc-coated steel sheets and coils using cold rolled steel sheet base metal as specified in JKR Standard No.2-95(BN) JKR 20709-0347-95. Where quality is guaranteed for one side only, the reverse side shall be coloured beige.

6.3 All fixing accessories shall be rust-resistant and of suitable design and construction as recommended by the manufacturer for the roofing system and shall conform to every aspect of JKR Standard No.2-95(BN)JKR 20709-0347-95 or other equivalent standards as approved by the S.O.. All connectors such as fasteners and screws shall be of the self drilling type either concealed or screwed fixing, complete with preassembled neoprene bonded washers. For non self drilling fasteners, holes through the sheets must be drilled and not punched.

6.4 Identification, storage and packaging of galvanized steel roof decking or wall cladding shall be strictly in accordance with the manufacturer's instruction and comply with JKR Standard requirements.

6.5 All roof decking sheets, capping, flashing etc. or wall cladding shall be new, clean, regular, straight and true to shape with sharp defined profiles, free from cracks, chips, bends and defects detrimental to practical use or from other surface imperfections.

6.6 On arrival at the Site, the sheets should be lifted from the transport carrier by a crane and properly stacked clear of the ground, ready to be lifted up to the roof structure for laying. Where sheets are to be manually lifted, care should be taken not to drag the sheets to avoid scraping away the surface coating. The sheets shall arrive just-in-time for installation. Where storage is necessary, stack heights shall be kept to a minimum and the sheets shall be stacked in a sloping position. Sheets shall be stacked off a dry firm ground, under cover by tarpaulin or polythene sheets but ventilated and away from building operations. Should the stacked sheets become wet, they shall be immediately dried to prevent staining and degradation of the surface coatings.

6.7 If it is necessary to cut sheets, care should be taken to ensure that sheets are cleanly and squarely cut using preferably a power driven saw or electric nipper. If power tools are not available, fine-toothed sheet metal saws or hand shears could be used.

6.8 The Contractor shall be responsible for the absolute watertightness of the roof and must ensure that the method of installation, fixing and fastening decking sheets, caps, flashings etc. including acoustical, insulation and expansion joints, whenever required shall conform strictly to the manufacturer's instructions.

6.9 The completed portions of the roof should be clear of all metallic particles such as blind rivet shanks, screw, nuts, nails, etc. and dirty foot prints should be wiped off to avoid early deterioration/corrosion and discolouration. Damages to the coating shall be repaired with touch-up paint as recommended by the manufacturer and approved by the S.O.

7. Heat Insulation

7.1 General

Heat Insulation System shall comply with MS1020. Samples of the insulation material shall be submitted to the S.O. for approval before they are used and subsequent delivery shall be up to the standard of samples approved.

7.2 Reflective Insulation

7.2.1 Reflective insulation material may be used on its own with all types of roofs except with metal decking roof. Where roof is of metal decking, the reflective insulation material shall be laminated on rockwool or fibreglass quilt.

7.2.2 The insulation material shall be installed strictly in accordance with the manufacturer's instruction. A uniform air space of 20mm between the roof covering and the insulation material shall be provided to ensure the effectiveness of the reflective surface. All punctures shall be effectively sealed with similar reflective material to prevent air leakage and moisture transfer. The reflective surface shall be free from any thin film of oil, plastic or lacquer coatings. All dust and/or moisture, if any, shall be thoroughly cleaned prior to installation. Printings and/or trademarks shall be limited to a maximum of 5% of the total reflective areas. The insulation shall be fitted closely around electrical outlet boxes, plumbing etc., and taped securely to eliminate gaps or voids through which air or water vapour might pass into the cooler space.

7.3 Fibreglass Quilt Insulation

7.3.1 Unless otherwise shown in the Drawings, fibreglass insulation quilts shall be 50mm thick with a nominal weight of 9.6kg per cubic metre. It shall have a thermal conductivity of 0.032-0.035 Kcal /mh degree centigrade at normal building temperature.

7.3.2 Where a fibreglass insulation quilt is to be used, it shall be laid over 13mm chicken wire mesh unless otherwise specified.

7.4 Rockwool Insulation

7.4.1 Unless otherwise shown in the Drawings, rockwool insulation shall be 50mm thick of sheet size 1200mm x 600mm with a nominal weight of 60kg/m^3, a maximum service temperature of 350^{o}C and thermal conductivity of 0.29 Kcal/mh degree centigrade at 20^{o}C.

7.4.2 Where rockwool is to be used, it shall be fixed in accordance with the manufacturer's instruction and to the approval of the S.O.

SECTION H - CARPENTRY, JOINERY AND IRONMONGERY WORKS

1. General

1.1 Unless otherwise specified or shown in the Drawings, the timber species used for the Works shall be as stated hereinafter in the Schedule of Timber Species */*Grouping and Usage. The strength grouping for timber shall be in accordance with Malaysian Standard MS 544-Table 2.3 as shown hereinafter in the Schedule of Strength Grouping.

1.2 All carpentry and joinery work shall include all necessary notching, halving, morticing and tenoning, wedging, scarfing, dovetailing, sinking for heads of bolts and nuts and trimming for opening.

1.3 All carpentry work shall be left with a sawn surface except where particularly described to be wrot. All joinery shall be wrot and finished with sand paper as required and all sizes stated are the finished sizes. Sizes for carpentry shall be within the tolerances stated in clause 3.1 and sizes for joinery shall be within the tolerances stated in clause 3.2.

2. Treatment of timber

2.1 All timber except the heartwood of the naturally durable timbers as schedule hereinafter and timber for formwork, scaffolding, and other temporary works shall be impregnated by means of vacuum pressure processes in accordance with MS 360 using copper/chrome/arsenic (CCA) wood preservatives conforming to MS 733 in the treatment plant registered with the Malaysian Timber Industry Board. The minimum nett dry salt retention for CCA shall be as follows:

	Use	Minimum nett dry salt retention for CCA
(i)	Interior and above the ground	5.6 kg/m^3
(ii)	Exterior and above the ground	8.0 kg/m^3
(iii)	Exterior and in contact with the ground (other than foundation piles)	12.0 kg/m^3
(iv)	Foundation piles	16.0 kg/m^3

2.2 The timber shall, as far as is practicable, be cut to its final dimensions before treatment, and timber for joinery shall be wrot and fully worked and ready for framing before treatment. Where crosscutting cannot be avoided or where further dressing is necessary, all surfaces exposed by such work shall be liberally swabbed with the approved preservatives.

2.3 The Contractor, when required by the S.O. shall produce a certificate from a preservative treatment plant which certifies that timber required to be impregnated by means of vacuum pressure processes has been impregnated and has achieved the necessary nett dry salt retention. Notwithstanding the certificate, the S.O. reserves the right to carry out independent tests to determine the nett dry salt retention and the result so obtained shall be conclusive.

2.4 All sapwood shall be fully penetrated by the preservative and for heartwood, the depth of penetration shall be 12mm for uses in clause 2.1 (i), (ii) and (iii).

3. Timber Grades and Size Tolerances

3.1 Unless otherwise specified, sawn timber for carpentry work shall be as stated hereunder:

(i) Select Grade – for roof truss

(ii) Standard Structural Grade - for structural work
(iii) Sound Grade - for General Market Specification (GMS) and strips
(iv) Serviceable Grade - for scantling.

Grading shall be carried in accordance with the Malaysian Grading Rules (MGR) by timber graders registered with the Malaysian Timber Industry Board. Every timber consignment shall be accompanied by the Grading Summary certified by the registered timber grader. The sizes of sawn timber, except where otherwise specified, shall be within the margin of permissible variations stated hereunder:

(i) For widths, depths or thicknesses not exceeding 75mm - within 3mm of the specified size
(ii) For widths, depths or thicknesses exceeding 75mm - within 5mm of the specified size.

The Contractor shall provide any necessary blocks, wedges or battens to compensate for irregular surfaces caused by any variations in size of timbers hereby permitted.

3.2 Unless otherwise specified, sawn timber for joinery work shall be of Sound Grade (General Market Specification (GMS) and Strips) and Serviceable Grade (Scantlings). The finished size for joinery, unless otherwise specified, shall be within the margin of permissible variation stated hereunder:

(i) For widths, within 3mm of the specified finished size.
(ii) For thicknesses, within 2mm of the specified finished size.

4. Moisture Content & Storage

4.1 On delivery to the site, all timber other than timber for foundation piles, formworks and temporary works shall be properly open-stacked, under cover. Kiln dried timber shall be properly wrapped and stored under cover if it is not used immediately. At the time of installation, the moisture content of the timber for the various applications shall not exceed that as specified in the Schedule of Moisture Content as shown hereafter.

4.2 Moisture content for foundation piles, formworks and temporary works is not critical for these applications and therefore is not specified.

4.3 Moisture content of timber shall be determined in accordance with MS 837.

5. Prefabricated Timber Roof Truss System

5.1 All prefabricated components shall be manufactured only by reputable licensed truss fabricators producing quality assured products and services, to the approval of the S.O. The design, supply, delivery and erection of the trusses shall be in accordance with JKR's Standard Specifications for Timber Roof Trusses No.JKR 20600-0020-99.

5.2 Prior to the fabrication of the roof truss system, the Contractor shall submit to the S.O. two (2) copies of the Drawings, certified by an independent Professional Engineer as required in clause 2 of the JKR Standard Specification for Timber Roof Trusses, to be used in the construction and installation of the roof truss system.

5.3 As soon as practicable after the completion of the installation of the roof truss system and prior to the issuance of the Certificate of Practical Completion, the Contractor shall submit the following documents to the S.O. for information and record:

i) System Provider's Guarantee against any defects or damages which may arise during a period of five(5) years from the Date of Practical Completion of Works due to any defect, fault or insufficiency in design, materials or workmanship or

against any other failure which an experienced Contractor may reasonably contemplate but shall not include normal replacement and maintenance. The terms of the Guarantee shall be such as shall be approved by the S.O.

ii) Certification that the connector plates conform to the relevant standards and are protected against corrosion, together with proof that such certification have been verified by tests carried out by SIRIM for the current year or the previous year.

iii) Certification that the correct timber grades were used in the fabrication of the trusses and roof structure by including of a copy of the grading summary for the timber used in the truss system, certified by a timber grader registered with the Malaysian Timber Industry Board.

iv) Certification that the timber used in the fabrication of the trusses and roof structure has been adequately treated by including a copy of the treatment certificate for preservation on the batch of timber that was treated in the preservation process.

v) Two (2) sets of as built Drawings of the roof truss system signed by the system provider and certified by a Professional Engineer.

6. Plywoods

6.1 Unless otherwise specified, plywood used for interior and exterior purposes other than for formworks and temporary works shall be manufactured with Moisture Resistant (MR) bond and Weather and Boil Proof (WBP) bond respectively in compliance with MS 228. Boards which are to be painted or varnished shall be properly sanded down and holes and crevices filled with approved wood putty or filler.

6.2 Plywood intended for use as shuttering board shall be of the Weather and Boil Proof (WBP) type.

6.3 Plywood intended for structural use, shall be of Malaysian Basic Structural Grade (MBSG) rated or equivalent or better and shall comply with MS 544:Part4:Section1.

6.4 Plywood to be used in marine or severe wet conditions shall be in accordance with MS 544: Part 4: Section 2.

7. Blockboard

7.1 Blockboard shall comply with MS 1123. Fixing of blockboards shall generally be in accordance with the manufacturer's instructions. Boards which are to be painted or varnished shall be properly sanded down and holes and crevices filled with approved wood putty or filler to the satisfaction of the S.O.

8. Chipboards

8.1 Chipboards shall be of the type manufactured from wood chips or shavings combined with a thermosetting synthetic resin glue binder bonded and hot-pressed together and complying with MS 1036 for medium density chipboard. The type and quality of boards shall be as approved by the S.O. The boards shall be fixed as detailed in the Drawings with a minimum edge distance for nailing of 12mm. Boards which are to be painted or varnished shall be properly sanded down and holes and crevices filled with approved wood putty or filler.

9. Fibre Building Boards

9.1 All fibre building boards namely, Hard Board, Medium Board and Medium Density Fibre Board (MDF) shall comply with BS 1142. The type and quality of fibre building boards shall be as approved by the S.O. Perforated hardboards shall be not less than 3.2mm thick with maximum of 4.8mm perforation at 19mm centers unless otherwise stated in the Drawings.

9.2 All fibre building boards shall be fixed strictly in accordance with the manufacturer's instruction. Unless otherwise detailed in the Drawings, the ceiling boards shall be butt and 'v' jointed.

10. Gypsum Plasterboards

10.1 Gypsum plasterboards shall comply with BS 1230 Pt.1 and shall be of the type and quality approved by the S.O. They shall be fixed/ installed strictly in accordance with the manufacturer's instruction.

11. Composite Boards

11.1 The type and quality of composite boards shall be as approved by the S.O. and shall be fixed strictly in accordance with the manufacturer's instructions.

12. Woodwool Slabs

12.1 Woodwool slabs shall comply with MS 1036 and shall be of the type and quality as approved by the S.O. Unless otherwise detailed in the Drawings, the slab shall be laid with its length at right angles to support, fixed strictly in accordance with the manufacturer's instruction.

13. Wood Cement Boards

13.1 Wood cement boards shall be manufactured from wood fibres chemically treated and mixed with Portland Cement, compressed and cured in temperature controlled conditions. These boards shall complying with the requirement of MS 934 or MS 544: Part 4: Section 3. In fixing, the board must be supported on all four edges and at intermediate positions at centres not exceeding 610mm. Joints between boards shall occur on centers of supports. Minimum edge distance shall be 20mm. Boards which are to be painted shall be lightly sanded and any dust shall be removed from the surface with a piece of clean coarse cloth. Any filling compounds used shall be alkali-resistant. Fixing of the board shall be in accordance with the manufacturer's instructions.

14. Structural Assemblies of Timber

14.1 The workmanship and method of assembly of structural timber shall generally be in accordance with MS 544 and in particular, the following requirements.

14.1.1 The quality of the surface, as finished, shall be appropriate to the position and use of the timber.

When grade or other necessary marks are removed, provisions shall be made for remarking in accordance with Malaysian Grading Rules. Surfaces at any joint in an assembly shall be such that the parts may be brought into contact over the whole area of the joint before connectors are inserted or any pressure or restraint

from the fastening is applied. These surfaces shall have a good sawn or planed finish.

Bearing surfaces of notches and other cuttings shall be true and smooth and in appropriate relation to the other surfaces of the piece.

14.1.2 Notches other than at the ends of beams shall be U-shaped formed by parallel cuts to previously drilled holes. The diameter of the hole shall be equal to the width of the required notch.

14.1.3 Where splitting is likely to have a deleterious effect, end sealing is recommended. For timbers known to split and check especially after installation, the ends of the boards and scantlings shall be protected with a coating designed to minimise end checking and checking and splitting. In severe cases where the ends and sides of heavy joists of timbers are liable to excessive split and check due to exposure to windward slanting sunlight, appropriate skirting or cover with a thin timber board shall be necessary.

14.1.4 Where necessary to avoid splitting, nails shall be driven into pre-drilled holes or diameter not greater than four-fifths of the diameter of the nails. Care shall be taken to avoid placing nails in any end split.

14.1.5 Lead holes shall be used to ensure good workmanship in making screwed joints. The diameter of the hole for the shank shall be equal to the diameter of the shank, and for the threaded portion, the diameter of the hole shall not be greater than seven-eights of the diameter of the root diameter of the screw thread adjacent to the shank. Care shall be taken to avoid placing screws in any end split.

14.1.6 Bolt holes shall be drilled to diameters as close as possible to the nominal diameter of the bolt and in no case more than 2mm larger than the bolt diameter. Care shall be taken to avoid placing a bolt in any end split. A minimum of one complete thread shall protrude from the nut.

A washer shall be fitted under the head of each bolt and under each nut. The minimum sizes of washers are as given in Part 6 of MS 544. Where joints using split-rings are to be used, as shown in the Drawings, the members of the joints shall be fitted together in their appropriate positions and clamped or spiked together before drilling. Alternatively, drilling jigs or multiple head boring machines may be used, or individual members may be marked out from the setting-out or by use of prepared templates.

If either of the latter methods is employed, sample members (usually the first ones produced) shall be carefully checked against the setting-out.

In all instances bolt hole positions shall be accurately determined by reference to the point intersection of the center lines of the member. Great care is necessary if the first set members marked out is to be used subsequently as drilling templates. Greater accuracy can usually be obtained by the use of special marking or drilling templates located by a pin at the intersection of the center lines.

Bolts holes shall be drilled at right angles to the surface of the joint. The contact surfaces of the members should be grooved to the appropriate dimensions as given in Part 6 of MS 544.

Drilling and grooving may be done in a single operation; alternatively, if the hole is predrilled the pilot of the grooving tool shall fit in the bolt hole, thus centering the groove about the hole.

Care shall be taken to ensure that all chips and shavings are removed, and rings

shall be expanded before being placed in the grooves.

The joint shall be finally assembled and bolts inserted. Washers of the correct dimension shall be placed under the head of the bolt and the nut, and the nut tightened to hold the members together.

14.1.7 Recess for shear-plate connectors shall be accurately cut by means of a suitable tool to be appropriate dimensions as given in Part 6 of MS 544.

14.1.8 Assembly of units shall be done on a level bed and in such a way as to avoid damage to any of the members and so that the finished structural units conform to detailed Drawings and specification supplied.

When assembly is to be performed on the site, one set of component parts shall be fitted together and dismantled prior to dispatch to the site, in order to ensure that the assembled structural units conform to the detailed Drawings and Specifications. Twisted or damaged members shall be replaced before erection on the site.

Before proceeding with bulk production, a complete assembly of one of each framed truss or other structural unit shall be checked to prove the accuracy of the templates, etc. A similar check shall be carried out from time to time to control the wear and tear on templates and gauges.

Timber members and built-up units shall be marked in accordance with a marking diagram.

15. Carpentry Works

15.1 All carpentry shall be accurately set out in strict accordance with the Drawings and shall be framed together and securely fixed to the satisfaction of the S.O. Timber framing shall be properly braced and checked, halved, screwed or bolted together as required. Longitudinal joints in plates, ridge, fascias, etc. shall be formed over supports. Those timber members with lapped joints shall lap at least 150mm or twice the depth of the timber whichever is the greater. The brads, nails, screws, spikes, plugs, bolts, framing anchors and timber connectors shall be provided wherever necessary and as detailed. Other than those detailed, no joints are permitted in structural work unless prior permission is obtained from the S.O. No structural member shall be notched unless instructed by the S.O.

15.2 For other carpentry works, timbers shall, as far as possible be in one piece between continuing lengths. At corners, timbers shall be halved for materials of the same thickness, and sufficiently lapped for materials of different thicknesses.

16. Joinery Works

16.1 All doors, windows, louvres, screens and the like shall be constructed as shown in the Drawings. Frames shall be assembled at the commencement of the work and all members shall be carefully morticed and tenoned together but no wedging, pinning or gluing shall be done until the framing is prepared in readiness for immediate fixing. All doors, windows, louvres, screens and the like shall be properly stored on site. Immediately before fixing in its final position, joinery shall be wedged and pinned by drawn hole pinning with 10mm diameter Strength Group 1 and 2 timber dowels pins. The pins shall be left projecting until permission is given for flushing off. The methods of framing and putting together of all Works shall be approved by the S.O. before being executed. Any portions that warp, twist or develop any other defects shall be replaced before wedging up. All framed work shall be pinned before being framed together.

17. Flooring

17.1 Unless otherwise shown in the Drawings, timber floors shall be constructed using 100mm x 38mm wrot, tongued and grooved boardings, well cramped up and secret nailed to each joist or batten with 62mm wire nails. Floor boardings shall be in long lengths with splayed heading joints and no two adjacent joints shall occur over the same joist. On completion, the flooring shall be planed, sanded and all gaps sealed with an approved sealer. The floor shall then be cleaned off and unless otherwise specified, it shall be finished with three coats of approved polyurethane paint applied strictly in accordance with the manufacturer's instructions.

17.2 Wrot timber skirtings shall be provided where shown and as detailed in Drawings. Skirtings shall be in long lengths with splayed heading joints and with mitres, returns and ends neatly cut and fitted and fixed to grounds.

18. Ceilings

18.1 Chipboard for ceilings shall be fixed to the frames with butt `V' joint using nails or screws as described hereinbefore. Asbestos-free cement flat sheets for ceiling shall be 5mm thick fixed to frames using mitred timber cover battens and brass screws. Ceiling panels shall be set out symmetrically from the centre line of the ceiling.

19. Partitions

19.1 Partitions, screens and vent panels, shall be constructed as detailed in the Drawings. Where shown, galvanised welded wire mesh or expanded metal of the required sizes and patterns shall be fixed to vent panels and window openings. The mesh shall be secured in position using rebated and mitred timber battens and screws.

19.2 Where proprietary partitions are used, they shall be constructed in accordance with the manufacturer's instructions.

20. Fascia and Barge Boards

20.1 Unless otherwise shown in the Drawings, fascia and barge boards shall be 25mm thick wrot timber and supplied in long lengths. The boards shall be fixed in whole lengths and where joints are necessary, they shall be scarfed jointed and the joints shall occur only over the ends of roof framing members and mitred corners. Boards, 250mm wide and less shall be in one width and those deeper shall be formed by multiple of boards jointed together by tongue and groove and `V' joint.

21. Doors

21.1 All fire doors to be provided shall be of the appropriate Fire Resistance Period (FRP) in accordance with the Ninth Schedule of the Uniform Building By-Laws.

21.2 All fire doors including frames shall be constructed to a specification of the relevant FRP in accordance with MS1073 Pt.1 and shall be tested by a laboratory, approved and certified by Jabatan Bomba dan Penyelamat and have obtained a Product Certification Scheme from an accredited certification body.

21.3 All double leaf fire doors with rebated meeting stiles shall be provided with coordinating device so as to fit fully within the door openings with a gap of not more than 3mm between the frame and the edge of the door when closed.

21.4 Where shown in the Drawings, vision panel of size not exceeding 25mm x 25mm per leaf shall be incorporated in the Fire Rated Door.

21.5 Flush doors shall generally comply with MS 1506 with plywood facing and strength group 1 and strength group 2 timber lipping, mitred around all edges. The plywood and strength group 1-4 timber shall comply in all respects with the Specifications mentioned hereinbefore.

22. PVC Toilet Doors

PVC toilet doors shall be of full single panel of flush type. It shall be 100% waterproof, strong impact resistance and not be discoloured easily. Unless otherwise shown in the Drawings, the door shall be 38mm thick. PVC door shall be delivered to Site complete with ironmongery as listed in 'SCHEDULE OF IRONMONGERY'.

23. Built-in Fittings

23.1 Built-in fittings shall be constructed and properly framed in wrot timber as detailed in the Drawings. Where fittings are not to be painted, unless otherwise specified, they shall be stained and varnished as hereinafter described under SECTION M: PAINTING WORK.

24. Staircase and Balustrades

24.1 Staircases and balustrades shall be constructed as detailed in the Drawings.

25. External Boarding

25.1 Unless otherwise shown in the Drawings, all external boarding shall be formed with 150mm x 19mm horizontal, vertical or diagonal boarding in wrot pressure-treated timber in long lengths and to the sectional profile as detailed in the Drawings. Unless otherwise shown, lapping for plain weather boarding shall be 38mm. Boardings shall be secured to the frames using 75mm galvanised steel nails and in the case of plain weather boarding, nails shall not be driven through the lapped portions. The exposed bottom ends of all external vertical boarding shall be splayed inward at an angle of 30 degrees and treated with preservatives.

26. Ironmongery

26.1 Unless otherwise shown and/or scheduled in the Drawings, the Contractor shall supply and fix all ironmongery as listed in the Schedule of Ironmongery attached hereinafter, complete with fixing screws of the same material and finish.

26.2 Proper sockets shall be provided for all bolts to fix flush in floors, cills and door and window frames. Each lock shall be provided with two keys and no two locks shall have identical keys, unless specifically required by the S.O.

SCHEDULE OF STRENGTH GROUPING
(Ref.cl.1.1)

Schedule Of Timber Species In Accordance With Strength Grouping
(MS 544- Table 2.3)

S.G 1	S.G 2	S.G 3	S.G 4	S.G 5	S.G 6	S.G 7
A) Naturally Durable						
Balau	Belian	Bekak	Giam	Jati		
Bitis	Mata Ulat	Delek	Malabera	Tembusu		
Cengal	Kekatong	Keranji	Merbau			
Penaga			Resak			
B) Requiring Treatment						
	Dedaru	Agoho	Berangan	Alan Bunga	Bayur	Ara
	Kempas	Balau Merah	Dedali	Babai	Damar Minyak	Batai
	Merbatu	Kelat	Derum	Balik Angin Bopeng	Durian	Geronggang
	Mertas	Kembang Semangkuk	Kapur	Bintangor	Jelutung	Laran
		Kulim	Kasai	Brazil Nut	Jenitri	Pelajau
		Pauh Kijang	Keruntum	Gerutu	Jongkong	Pulai
		Penyau	Mempening	Kundur	Kasah	Sesenduk
		Perah	Meransi	Kedondong	Macang	Terentang
		Petaling	Meranti Bakau	Keledang	Medang	
		Ranggu	Merawan	Keruing	Melantai/ Kawang	
		Ru	Merpauh	Ketapang	Meranti Merah Muda	
		Surian Batu	Nyalin	Kungkur	Meranti kuning	
		Tualang	Perupuk	Melunak	Mersawa	
			Punah	Mempisang	Sengkurat	
			Rengas	Mengkulang	Terap	
			Simpoh	Meranti Merah Tua		
				Meranti Putih		
				Nyatuh		
				Penarahan		
				Petai		
				Ramin		
				Kayu Getah		
				Sengkuang		
				Sepetir		
				Tetebu		

Notes :

1. For naturally durable timbers, sapwood should be excluded. If sapwood is included, preservative treatment is necessary. (Source: MS 360:1986)
2. For timber requiring treatment, they should be amenable to preservative treatment.

SCHEDULE OF TIMBER SPECIES / GROUPING AND USAGE (Ref.cl.1.1)

APPLICATION	STRENGTH GROUP
Foundation Piles	SG 1 – Balau, Bitis, Chengal SG 2 – Belian, Mata ulat, Kempas, Merbatu, Mertas SG 3 – Keranji, Kulim, Pauh kijang, Petaling SG 4 – Giam, Merbau, Resak, Merpauh, Punah, Simpoh SG 5 – Keruing, Mengkulang
Structural Components • Columns, beams, bearer, studs, joists, ties and struts • Formwork	SG 1, SG 2, SG 3 and SG 4 SG 1, SG 2, SG 3, SG 4 and SG 5
Roofing • Rafters, ties, struts, purlins and bracing • battens	SG 1, SG 2, SG 3 and SG 4 SG 1, SG 2, SG 3, SG 4 and SG 5
Staircase • stringers, treads, trimmer beam and handrail • balustrades	SG 1, SG 2, SG 3 and SG 4 SG 1, SG 2, SG 3, SG 4, SG 5 and SG 6
Flooring • floor boarding and parquetry • skirtings	SG 1, SG 2, SG 3, SG 4 and SG 5 SG 1, SG 2, SG 3, SG 4, SG 5 and SG 6
Walling • wall, partition framing and external wall boardings • internal wall boardings • fascia boards	SG 1, SG 2, SG 3, SG 4, SG 5 and SG 6 SG 1, SG 2, SG 3, SG 4, SG 5, SG 6 and SG 7 SG 1, SG 2, SG 3 and SG 4
Ceiling Frames • cover battens to joints of ceiling sheets • ceiling strips and soffit battens	SG 1, SG 2, SG 3 and SG 4 SG 1, SG 2, SG 3, SG 4, SG 5 and SG 6
Door & Window Frames • door, window and vent frames including their stops and grounds • door leaves, window and vent sashes	SG 1, SG 2, SG 3 and SG 4 SG 1, SG 2, SG 3, SG 4, SG 5 and SG 6
Furniture • built in fittings, furniture generally and workshop furniture • science laboratory tops	SG 1, SG 2, SG 3, SG 4, SG 5 and SG 6 SG 1, SG 2, SG 3 and SG 4
Beading fillets and edgings generally	SG 1, SG 2, SG 3, SG 4, SG 5 and SG 6

SCHEDULE OF MOISTURE CONTENTS (M.C) OF TIMBER FOR VARIOUS POSITIONS IN BUILDING

(MS 544) – (Ref. Cl. 4.1)

APPLICATION	MAXIMUM M.C. AT TIME OF INSTALLATION FOR NON AIR-CONDITIONED APPLICATION	MAXIMUM M.C. AT TIME OF INSTALLATION FOR AIR-CONDITIONED APPLICATION (KILN-DRIED TIMBER)
Structural Components		
• columns, beams, bearer, studs, joists, ties and struts	30% (Thickness >100mm) 25% (Thickness <100mm)	Not applicable Not applicable
Roofing		
• rafters, ties, struts, purlins and bracing	25%	Not applicable
• battens	25%	Not applicable
Staircase		
• stringers, treads, trimmer beam and handrail	19%	12%
• balustrades	19%	12%
Flooring		
• floor boarding and parquetry	19%	12%
• skirtings	19%	12%
Walling		
• wall, partition framing	19%	12%
• external wall boardings	19%	Not applicable
• internal wall boardings	19%	12%
• fascia boards	19%	Not applicable
Ceiling Frames		
• cover battens to joints of ceiling sheets	25%	Not applicable
• ceiling strips and soffit battens	19%	12%
Door & Window Frames		
• door, window and vent frames including their stops and grounds	19%	12%
• door leaves, window and vent sashes	19%	12%
Furniture		
• built in fittings, furniture generally	19%	12%
• workshop furniture	19%	12%
• science laboratory tops	19%	12%
Beading fillets and edgings generally	19%	12%

SCHEDULE OF IRONMONGERY
(Ref. Cl. 24.1)

No	Type of Doors, Windows etc.	Ironmongery for each type of doors, windows etc.
1.	Single Leaf Door	
	1.1 Plywood Flush Door	a. 3 nos.of 100mm x 69mm galvanised steel butt hinges with nylon ring. b. 1 no.upright 3 lever mortice lockset with satin chrome lever handle furniture of approved manufacture with 2 nos chrome plated keys of different serial number for each building. c. 1 no. rubber door stopper.
	1.2 Timber Panelled Door	a. 3 nos. of 100mm x 69mm stainless steel butt hinges with nylon ring. b. 1 no.medium duty cylindrical lockset, 5 pin tumbler with knob and rose of stainless steel with hairline finish complete with 2 nos. nickle-plated brass keys of different serial number for each building. c. 1 no. rubber door stopper.
2.	Double Leaf Door	
	2.1 Plywood Flush Door	a. 6 nos. of 100mm x 69mm galvanised steel butt hinges with nylon rings. b. 1 no. upright 3 lever rebated mortice lockset with satin chrome lever handle furniture of approved manufacture with 2 nos. chrome plated keys of different serial number for each building. c. 1 set of 150mm anodised aluminium barrel and 250mm anodised aluminium bolt. d. 2 nos. rubber door stopper.
	2.2 Timber Panelled Door	a. 6 nos. of 100mm x 69mm stainless steel butt hinges with nylon rings. b. 1 no.medium duty cylindrical lockset, 5 pin tumbler with knob and rose of stainless steel with hairline finish complete with 2 nos. nickle-plated brass keys of different serial number for each building. c. 1 set of 150mm anodised aluminium barrel and 250mm anodised aluminium bolt d. 2 no. rubber door stopper.
3.	PVC Door To Toilet/Bathroom Cubicles	a. 3 Nos. 100mm x 69mm galvanised steel butt hinges with nylon ring. b. (i) For residential Quarters 1 no. cylindrical mortice bathroom lockset complete with locking device operated by turn from inside and knob handle furniture in satin chrome finish. (ii) For non-residential buildings 1 no. indicating bolt c. Anodised aluminium hook with rubber buffer.
4.	Single Leaf Fire Rated Door	
	4.1 For standard size of 800mm x 2100mm ½ hr & 1 hr fire rated door	a. 3 nos of 125mm x 87mm x 2mm thick heavy duty stainless steel butt hinges. b. 1 no upright 3 lever mortice lockset with satin chrome lever handle furniture of approved manufacture with 2 nos. Chrome plated keys of different serial no. for each building. c. 1 no rubber door stop. d. 1 no hydraulic floor springs for double swing door. e. 1 no automatic door closer of hydraulically spring operated type (for swing doors) or of wire rope and weight type (for sliding doors).

SCHEDULE OF IRONMONGERY (cont.)

No	Type of Doors, Windows etc	Ironmongery for each type of doors, windows etc.
	4.2 For standard size of 900mm x 2100mm ½ hr & 1 hr fire rated door	a. As per item 4.1a b. As per item 4.1b c. As per item 4.1c d. As per item 4.1d e. As per item 4.1e
	4.3 For standard size of 900mm x 2100mm 2 hr fire rated door	a. 4 nos. of 125mm x 87mm x 2mm thick heavy duty stainless steel butt hinges. b. As per item 4.1b c. As per item 4.1c d. As per item 4.1d e. As per item 4.1e f. 2 nos. of ball bearings g. 1 no of heavy duty stainless steel latch with 75mm long backset
5.	Double Leaf Fire Rated Door	
	5.1 For standard size of 1200mm x 2100mm	a. 4 nos. of 125mm x 87mm x 2mm thick heavy duty stainless steel butt hinges. b. 1 no. 3 lever rebated mortice lockset with satin chrome lever handle furniture of approved manufacture with 2 nos. chrome plated keys of different serial number for each building. c. 1 no. 150mm stainless steel barrel bolt. d. 1 no. 200mm ditto. e. 2 nos. rubber door stop f. 2 nos. hydraulic floor springs for double swing door. g. 2 nos. automatic door closer of the hydraulically spring operated type (for swing doors) or of wire rope and weight type (for sliding doors).
	5.2 For standard size of 1800mm x 2100mm	a. 6 nos. of 125mm x 87mm x 2mm thick heavy duty stainless steel butt hinges. b. As per item 5.1b c. As per item 5.1c d. As per item 5.1d e. As per item 5.1e f. As per item 5.1f g. As per item 5.1g
	5.3 For standard size of 2400mm x 2100mm	a. 8 nos. of 125mm x 87mm x 2mm thick heavy duty stainless steel butt hinges. b. As per item 5.1b c. As per item 5.1c d. As per item 5.1d e. As per item 5.1e f. As per item 5.1f g. As per item 5.1g
6.	Single Leaf Fire Escape Door	a. 3 nos. of 125mm x 87mm x2mm thick heavy duty stainless steel butt hinges. b. 1 complete set of approved make fire rated panic bolts.
7.	Double Leaf Fire Escape Door	a. 6 nos. of 125mm x 87mm x 2mm thick heavy duty stainless steel butt hinges. b. 1 complete set of approved make fire rated panic bolts.

SCHEDULE OF IRONMONGERY (cont.)

No.	Type of Doors, Windows etc	Ironmongery for each type of doors, windows etc.
8.	Kitchen Cabinet Door/ Workbench	a. Galvanised steel continuous 'piano' butt hinges. b. 1 no 100mm aluminium 'D' handle. c. 1 no.bales catch. d. 1 no galvanised steel cupboard lock in satin chrome finish.
9.	Wardrobe	a. 3 nos. of 75mm brass butt hinges (per door leaf). b. 2 nos.100mm anodised aluminium barrel bolt (for double leaf doors) c. 1 no 100mm aluminium 'D' handle. d. Chromium plated steel clothes hanger rail. e. Steel cylinder cupboard lock in satin chrome finish.
10.	Drawer	a. 1 no. steel cylinder drawer lock in satin chrome finish. b. 1 no.100mm aluminium 'D' handle.
11.	Sliding and Folding Door**/** Partition	a. Top or bottom running set sliding and folding door gear, complete with tracks, channel, brackets, roller guides, hangers and all necessary butt hinges, flush bolts and flush door pulls, etc. as recommended by the manufacturer. b. 1 no.upright 3 lever rebated mortice lockset for sliding and folding door with satin chrome lever handle furniture with 2 nos. keys of different serial number for each building.
12.	Straight Sliding Door	a. Top or bottom running set straight sliding door gear complete with tracks, brackets, hangers, roller guides, channels, door stops, flush brass bolts, brass flush pull etc. as recommended by the manufacturer. b. 1 no. upright 3 lever mortice lockset with satin chrome finish for straight sliding door with 2 nos. keys of different serial number for each building.
13.	Timber Casement Window	a. 2 nos. 400mm long approved electro-galvanised steel friction hinges. b. 1 no. approved brass with satin chrome finish combination handle and fastener.
14.	Top Hung Casement Timber Window.	a. 2 nos. 750mm long approved electro-galvanised steel friction hinges. b. 1 no. approved brass with satin chrome finish automatic locking fastener.
15.	Top Hung Vent/Sashes	a. 2 nos. 400mm long approved electro-galvanised steel friction hinges. b. 1 no. approved brass with satin chrome finish automatic locking fastener

SECTION I – STRUCTURAL STEEL AND METAL WORKS

1. **General**

All materials shall conform to the relevant Malaysian or British Standards. Other equivalent standard may be accepted with the approval of the S.O.

2. **Hot Rolled Structural Steel Works**

2.1 All hot rolled structural steelwork design, materials and workmanship shall comply with the JKR Standard Specification For Structural Steelwork No. 20600-0019-99 and shall be in accordance with the latest version of BS 5950.

2.2 Materials

Unless otherwise approved by the S.O, all structural steel components shall conform to the standard as shown in Table A.

The Contractor may with the approval of the S.O propose other equivalent structural steel components at no extra cost. The Contractor shall submit with his proposal his design calculations, sketches, detailings and Specifications which shall be certified by a Professional Engineer. In addition, the Contractor shall submit documents and details as listed in Clause 2.3 hereof, if required by the S.O.

Proprietary products may only be used with the approval of the S.O and shall be installed in accordance with the manufacturer's specification and recommendation.

TABLE A - MATERIAL & DIMENSION STANDARDS

Form	Material Quality	Dimension	Dimension Tolerances
H - Sections	BS EN 10025[1]	JIS G3192	JIS G3192
Joists		JIS G3192	JIS G3192
Channels		JIS G3192	JIS G3192
Angles		JIS G3192	JIS G3192
Plates & Flats		Not Applicable	BS EN 10029[3]
Structural Hollow Sections Hot Finished	BS EN 10210-1[2]	BS 4848:Pt.2	BS 4848:Part 2
Hollow Sections Cold Formed	BS 6363	BS 6363	BS 6363
Galvanised Open Sections & Strips	BS EN 10147	Not Applicable	BS 2989

Notes: 1 Material quality requirements for Fine Grain Steels are given in EN 10113
Material quality requirements for Weather Resistant Grades are given in EN10155
2 BS EN 10210 -1 contains material quality requirements for non alloy and fine grain steels
3 Tolerances for plates cut from wide strip produced on continuous mill are given in BS EN 10051

Unless otherwise shown in the Drawings, the equivalent steel grades are as in Table B below:

TABLE B - STEEL GRADE		
BS 5950: Part 1	BS 4360	BS EN's
Design Grade 43	43	S275
Design Grade 50	50	S355

All materials testing and verification shall comply with BS 4360 and not limited to the requirements as specified in the JKR Standard Specification for Structural Steelwork.

The manufacturer's mill certificates shall be produced to the S.O before any structural steel can be accepted. All test certificates shall contain embossed seal and**/**or watermarked logo of the manufacturer.

2.3 Contractor's Design

Unless connections and other details are provided or where the Contractor is required to design any structural member/ truss or temporary support system, the Contractor shall engage an approved structural steelwork fabricator to design such details and prepare fabrication Drawings in accordance with Section 2.4 hereof.

Prior to fabrication, the Contractor shall submit the following documents and details for the S.Os' approval:

a. The design plan defining the principal design activities in a logical sequence, type of design output, target dates to meet the programmed requirements and allocation of design responsibilities.
b. Design documentation, production and checking procedures (verification).
c. Fabricator's certification that the software used has been validated.
d. Method Statement for handling and transportation requirements for unusually shaped or large components to ensure stability during movement.
e. A report of the design review before the issuance of detailed Drawings.

2.4 Drawings

The Contractor shall prepare Drawings with details in accordance with BS 5950 or other relevant standards. The Drawings shall be certified by a Professional Engineer. He shall also prepare Drawings and arrangements of temporary steelworks for the different stages of construction in compliance with the requirements specified in the JKR Standard Specification for Structural Steelwork.

2.5 Workmanship

The workmanship for all aspects of fabrication and erection shall comply with the JKR Standard Specification for Structural Steelwork. All permissible deviations and tolerances for accuracy of erection work shall strictly adhere to the values specified therein.

All welding shall be of metal arc process in accordance with BS 5135 and BS 4570.

All welding works shall be executed by qualified welders with valid certificate issued by approved Authorities such as Pusat Latihan Pengajar & Kemahiran Lanjutan (CIAST) and Malaysian Oxygen Bhd. MOX).

Visual inspection of welds shall be carried out by a suitably qualified welding supervisor or welder who can provide evidence of having been trained and competent in visual inspection of the relevant types of welds.

Prior to erection work, the Contractor shall submit for the S.O's approval, the Method Statement for erection which among others shall include the following:

a. Pre- erection survey and formal acceptance of foundations.
b. Phased component delivery.
c. Safety and environmental controls.
d. Operative certification.
e. Plant and equipment certification.
f. Inspection of each phase of construction.

Whenever bolts and nuts are tightened by part turn method as in accordance with BS 4604 part 1, each nut shall be tightened, preferably with power operated wrench, by the amount given in Table C below:

TABLE C - ROTATION OF BOLT AND NUT

Nominal size & thread dia.of bolt	Grip of bolt for rotation of the nut (relative to the bolt shank)	
	Not less than ½ turn	Not less than ¾ turn
M 16	Up to 115 mm	-
M 20	Up to 115 mm	Over 115 to 225 mm
M 22	Up to 115 mm	Over 115 to 275 mm
M 24	Up to 160 mm	Over 160 to 350 mm
M 27	Up to 160 mm	Over 160 to 350 mm
M 30	Up to 160 mm	Over 160 to 350 mm
M 36	Up to 160 mm	Over 160 to 350 mm

If after final tightening, a bolt or nut is slackened off for any reason, the bolt, nut and washer or washers shall be discarded and not re-used.

Whenever bolts and nuts are tightened by the torque – control method, in accordance with BS 4604 part 1, such tightening shall be carried out with a calibrated tightening device, either a power-operated or a hand-operated torque wrench. The wrench shall be calibrated regularly at least once per shift or more frequently as instructed by the S.O. The equipment shall be re-calibrated if there is a change in the diameter of bolt used or a change in grip length exceeding one fifth of that used for calibration.

For inspection purposes, a sample of at least 32 bolts, shall be selected at random from a batch such as that comprised in the daily work of one gang. If the torque for any bolt is less than that found in the calibration required to induce the correct shank tension, every bolt in the batch shall then be examined and tightened further.

Bolts and nuts found to be in any way defective shall be discarded and replaced by new ones.

2.6 Surface Preparation And Protective Treatment

All procedures and precautions mentioned in JKR Standard Structural Steelwork Specification Section 10 shall be adhered to strictly for the cleaning and coating process of structural elements.

The Contractor shall submit the Method Statement for the surface preparation and protective treatment to the S.O for his approval before commencement of fabrication works, giving details of the protective treatment specification and shall indicate quality control and inspection to ensure conformity with the JKR Standard Specification for Structural Steelwork.

2.7 Welding Inspection And Testing By Independent Authority

The Contractor shall appoint an independent Inspection Authority to endorse the welder's certification and also to approve the welding procedures and test procedures for welding works.

Welding inspection and testing shall be carried out by an independent Welding Inspector who holds a valid certificate of competence from a nationally recognised body such as SIRIM and CIDB or other established recognised private organisation. Not withstanding such inspection by the independent Welding Inspector, the S.O may at his absolute discretion carry out any test to verify the integrity of the weld.

2.8 Fire Protection

Unless otherwise shown in the Drawings, all fire protection materials and systems, shall show evidence that they have been subjected to the fire resistance test in accordance with BS 476 and shall be endorsed by the local Jabatan Bomba Dan Penyelamat Malaysia. The Contractor shall provide the manufacturer's Data Sheet of the material proposed which shall contain important information such as the characteristic and application techniques of the proposed material as formatted in Appendix I/1.

The materials proposed shall be suitable and appropriate for the protection of the structural steel element, wherever they are located whether internally or externally.

The materials supplied shall be free from defect and of equivalent quality to that supplied for testing and approval purposes. The materials shall be designed specifically for the fire protection of structural elements and shall be suitable for this purpose when applied/installed in accordance with the manufacturer's comprehensive instructions. The materials shall be handled and stored as directed by the manufacturer and shall be applied/installed by a recognised trained applicator/installer.

All fire protection works in progress shall be regularly monitored in order to eliminate the risk of defective workmanship or failures.

The use of intumescent coating systems to metallic substrates for providing fire resistance shall comprise a primer, an intumescent coating, a top sealer coat and/or a decorative coat.

The minimum thickness of any sprayed mineral coating type of fire protection materials applied shall be as in Table D below:

TABLE D - MINIMUM SPRAY THICKNESS						
Hp / A	Thickness in mm to provide fire resistance of :-					
	½ hour	1 hour	1½ hour	2 hour	3 hour	4 hour
150	10	12	25	36	57	79
170	10	13	26	38	60	83
190	10	13	27	40	63	87
210	10	14	28	41	65	90
Note : Hp - Perimeter of section exposed to fire (m) A - Cross sectional area of the steel member (m^2)						

However, for any type of fire protection applied, the minimum thickness of protection to be applied and the minimum dry film thickness required shall strictly adhere to the requirement stated in the Data Sheet of the relevant proposed material.

2.9 Records

The Contractor shall submit to the S.O, document and records which shall include but not limited to:

a. Document register
b. Drawings and design calculations and documentation registers.
c. Certificates for materials and consumables.
d. Calibration of equipment.
e. Weld procedures, concessions etc.
f. Inspection and test reports.
g. Delivery schedules and method statements.
h. Surveys and final inspection results.
i. Completion of erection and hand over certification.

2.10 Quality Assurance

The Contractor shall submit a Quality Assurance program as specified in the JKR Standard Specification for Structural Steelwork.

3. Prefabricated Cold Formed Steel Roof Trusses

3.1 All prefabricated cold formed structural steel roof truss components shall be manufactured and assembled only by truss fabricators accredited by system provider. The design, supply, delivery and erection of the trusses shall be in accordance with JKR's Standard Specifications for Prefabricated Cold Formed Steel Roof Trusses No.JKR 20600-0022-2001.

3.2 Prior to any work on a roof structure, the Contractor shall seek the S.O's approval by filling in the application form to use the intended proprietary prefabricated cold formed steel roof truss system for the roofing works. The roof truss system shall be selected from the most current

list of approved Cold Formed Roof Truss System Providers issued by Pengarah Cawangan Pakar dan Kejuruteraan Awam, Ibu Pejabat JKR Malaysia.

3.3 The Contractor shall enclose with his application all other documentation as mentioned in the JKR Standard Specifications for Prefabricated Cold Formed Steel Roof Trusses No.JKR 20600-0022-2001.

3.4 The S.O shall have the absolute discretion to reject any system provider or their accredited truss fabricators regardless of their status in the approved list, if in the opinion the S.O their track record has been unsatisfactory.

3.5 Notwithstanding the requirement above, the Contractor shall be held responsible to supervise the supply, fabrication and installation work carried out by the system provider or their accredited fabricator. In addition the Contractor shall ensure that all works are carried out with due regards to public safety.

3.6 As soon as practicable after the completion of the installation of the roof truss system and prior to the issuance of the Certificate of Practical Completion, the Contractor shall submit to the S.O all relevant documents as mentioned in the JKR Standard Specifications for Prefabricated Cold Formed Steel Roof Trusses No.JKR 20600-0022-2001 for information and record.

4. Metal Frames For Doors And Windows

4.1 Steel Frames

4.1.1 The Contractor shall supply, assemble and fix steel frames for doors and windows as shown in the Drawings. The steel frames shall comply with BS 6510, and shall be from an approved source and shop-primed with two coats of red lead oxide or other approved rust resisting primer.

4.1.2 The steel frames shall be manufactured from sections rolled from good commercial grade galvanised mild steel in single sections, mechanically straightened with all corners pre-cut with a 45 degrees mitre joint giving a snug and accurate fit, fully electrically welded, and carefully ground and cleaned, or shall be mechanically jointed by an approved method.

4.1.3 All screws, nuts, bolts and washers shall be of stainless steel.

4.1.4 Steel frames shall be painted as specified in SECTION M - PAINTING WORK.

4.2 Aluminium Frames

4.2.1 The Contractor shall supply, assemble and fix aluminium frames for doors and windows as shown in the Drawings. Unless otherwise specified, all aluminium frames shall be fabricated from sections extruded from aluminium alloy conforming to MS 832.

4.2.2 Unless otherwise shown in the Drawings or described in the Bills of Quantities, aluminium surfaces shall be natural anodised finish, free from alloy defects, dye marks, scratches and other surface blemishes in accordance with BS 3987 with an anodic coating of 25 microns average thickness.

4.2.3 All coloured anodised finish to aluminium exposed surfaces shall be subject to the

S.O.'s approval.

4.2.4 All aluminium extrusion or sheet exposed surfaces after anodising and after colouring, if required by the S.O., shall be sealed, and the adequacy of the sealing shall be determined by method specified in BS 1615.

4.2.5 All screws, nuts, bolts, rivets, washers and other fastenings shall be of stainless steel or aluminium.

4.2.6 Ancillary members such as sills, couplings and the like formed from sheet materials, shall be fabricated from designated aluminium alloys complying with BS 1470 or equivalent.

4.3 Frames For Adjustable Louvre Windows

4.3.1 The Contractor shall supply, assemble and fix frames for adjustable louvre windows as shown in the Drawings.

4.3.2 Unless otherwise specified, the frames shall be of approved manufacture.The frames shall be supplied complete with weather seal and non-ferrous bearings, spring clips, locking device and weather stripping with all necessary spacing pieces. The frames, coupling mullions and spacer brackets shall be minimum 1.219 mm thick (18 SWG) or otherwise specified cold-rolled steel strip galvanised with hot-dipped process. The clips to receive the louvres shall be minimum 0.711 mm thick (22 SWG) rolled steel strip galvanised with hot dipped process.

4.3.3 The operating rods shall be 2.132 mm thick (14 SWG). The handle and lock shall be 2.642 mm thick (12 SWG) steel.

4.3.4 Bolts, nuts and screws shall be of stainless steel.

4.3.5 Unless otherwise specified, the finish shall be of aluminium lacquer.

4.4 Accessories

Each steel or aluminium frame for doors and windows shall be supplied complete with:-

i. Sufficient number of built-in stainless steel hinges as per Schedule of Ironmongery under SECTION H - CARPENTRY, JOINERY AND IRONMONGERY WORKS;

ii. Two (2) rubber buffers per closing jamb, to reduce noise and vibration;

iii. Welded mortar guard;

iv. Adjustable stainless steel striker plate with a gently curved lead-in edge;

v. Removable spreader bars, to ensure a perfect square during transportation and installation; and

vi. Minimum of eight (8) pieces of 4mm brick ties, to ensure a tight permanent fit.

4.5 Samples

Samples of steel or aluminium sections for the doors and windows frames, together with completed shop Drawings of all works shall be submitted for the S.O's approval prior to the

commencement of any work.

4.6 Installation

4.6.1 Unless otherwise specified or shown in the Drawings, fixing and installation of all types of frames shall be strictly in accordance with the manufacturer's instructions and procedures.

4.6.2 Frames for adjustable louvre windows to be fixed to brick or concrete jambs shall be screwed to patent wall plugs in accordance with the manufacturer's instructions; otherwise the frame shall be screwed to timber surround.

5. Ceiling Suspension System

5.1 General

5.1.1 Where shown in the Drawings, ceiling suspension system shall consist of metal members comprising main tees, cross tees, wall angles and hanger wires complete with hanger jackets and clips, designed to support the suspended ceiling, light fixtures and/or air diffusers with a maximum deflection of 1/360 span.

5.1.2 Unless otherwise specified, all exposed members of the suspension system shall be of colour to match that of ceiling tiles, to the approval of the S.O.

5.2 Design Considerations

5.2.1 The width of all main tees and cross tees with double-web design shall be 24mm. Wall angles shall be of the same width as the exposed tees.

5.2.2 Hanger wires shall be galvanised carbon steel, soft tempered, pre-stretched with a yield stress load of at least three (3) times the design load, but in any case shall not be less than 12 gauge (12.6 mm) diameter. Thicker gauge wire shall be used for heavier load carrying installation or in situations where the hanger wires spacing exceeds 1200mm centre to centre.

5.2.3 The system shall be designed with double locking system to ensure safety, as well as to allow easy and speedy installation.

5.2.4 Stainless steel wire or nickle-copper alloy wire shall be used in corrosive environment.

5.2.5 Supplementary bracing or substantial hanger devices such as metal straps, rods, or structural angles shall be installed for installations subject to wind uplift.

5.3 Installation

5.3.1 Installation shall not be carried out until all wet work such as concreting, laying of floor finish, plastering or painting has been completed and thoroughly dried.

5.3.2 All suspension systems shall be installed strictly in accordance with the manufacturer's instructions and recommendations.

5.4 Warranty

5.4.1 The Contractor shall submit to the S.O., a manufacturer's warranty against any defect or damage which may arise during the period of 10 years from the date of the issuance of the Certificate of Practical Completion. Terms of the warranty shall be such as shall be approved by the S. O.

6. Collapsible Gates, Roller Shutters etc.

6.1 The Contractor shall provide and fix approved collapsible steel gates, folding shutters, roller shutters, etc. complete with all necessary accessories as approved by the S.O. to the sizes and positions as shown in the Drawings. Unless otherwise specified, they shall be galvanised and fixed in accordance with the manufacturer's instructions.

7. Sundries

7.1 Mild steel balustrading to staircases, verandahs, balconies, etc. shall be fixed as shown in the Drawings.

7.2 All iron and steel for the sundries shall be of the quality approved by the S.O. Screws and bolts shall have washers where appropriate. Hooks for carrying ceiling fans shall be formed from 13mm diameter mild steel rods bolted to timber ceiling members or ragged into concrete.

7.3 Welded mesh, expanded metal, aluminium sheets etc. shall be provided and fixed as shown in the Drawings.

7.4 Mild steel grilles, drain cover gratings shall be provided and fixed as shown in the Drawings. Unless otherwise stated, all steelwork shall be jointed by continuous welding.

7.5 Ant caps shall be of 16 gauge galvanised iron sheets formed to shape as shown in the drawing. The caps shall be fixed between concrete stumps/brick piers or walls and timber posts or plates as required. The caps shall project 60mm and inclined at 45 degrees from the surface.

APPENDIX I/1

Data Sheet of Proposed Fire Protection Material

PRODUCT NAME :	
1. Product Description	
2. Name of Manufacturer	
3. Name of Supplier	
4. Protection Technique	
5. Application Technique	
6. Steel Preparation Requirements	
7. Additional Mechanical Fixing or Reinforcement	
8. Nominal Density	
9. Thickness Range	
10. Fire Resistance Range	
11. Constraints For Fire Resistance	
12. Appearance	
13. On Site Use	
14. Durability	
15. Other Application	

SECTION J - PLASTERING, PAVING AND TILING WORKS

1. **General**

1.1 Cement

1.1.1 The cement, unless otherwise described shall be Ordinary Portland Cement, complying with MS 522 as specified in SECTION D: CONCRETE WORK or Masonry Cement complying with MS 794.

1.1.2 White and coloured cement shall be of approved manufacture.

1.2 Plasticiser

1.2.1 The plasticiser shall be of approved manufacture and used strictly in accordance with the manufacturer's instructions.

1.3 Plasterlime

1.3.1 The plasterlime shall be of approved manufacture and shall comply with BS 890 and shall be applied strictly in accordance with the manufacturer's instructions.

1.4 Sand

1.4.1 The sand for external rendering, internal plastering and floor screeding shall comply with MS 29 for fine aggregates. Sand for plastering using gypsum shall comply with MS 701.

1.5 Water

1.5.l Water for mixing shall be clear and free from harmful matter as specified in SECTION D: CONCRETE WORK.

1.6 Mixing

1.6.1 All mixing of mortar for plaster and screed shall be done by machine. Hand mixing shall only be allowed for small quantities and with the approval of the S.O. Hand mixing shall be done on a clean platform. The water content of the mix shall be only the minimum required to give a workable mix.

1.6.2 Mortar for plaster and screed shall be used up within 45 minutes after mixing.

1.6.3 For gypsum plaster, mixes shall be used up within one hour after mixing.

1.6.4 No remaking of the mix shall be permitted thereafter.

1.7 Surface Preparation

1.7.1 Where possible cement paving, screeding and rendering on concrete surface shall be laid while the concrete is still green i.e. after the final set but not later than 24 hours of laying concrete. The concrete surfaces shall be brushed with a stiff broom before it has hardened to remove laitance and give a roughened surface. Hardened concrete surface**s** shall be thoroughly hacked to form key to the approval of the S.O.

1.7.2 Before any paving, screeding or rendering is applied, all surfaces shall be thoroughly cleaned and wetted and be in damp state at the time the paving, screeding or rendering is applied.

1.7.3 Where plastering and rendering are to be applied in several coats, the surface of each preceding coat shall be scratched while still green to form key for the subsequent coat.

1.8 Bay

1.8.1 Paving and screeding shall be laid in alternate bays. On hardened concrete bases, each bay shall not exceed 15 sq. metres. On the surfaces where the concrete is still green, each bay shall not exceed 30 sq. metres. Where bays are not square, the ratio of the length between adjacent sides of each bay shall be approximately 1:1½. The joints in paving screed shall coincide as nearly as possible with joints in the base.

1.9 Curing and Protection

1.9.1 Unless otherwise specified hereinafter, the screeds shall be cured for 3 to 7 days after laying, and protected from rapid drying by covering with polyethylene sheets or tarpaulins and shall also be protected from any damage.

1.10 Making Good

1.10.1 Defective screeds shall be cut out and made good with fresh screed and sufficient time shall be allowed for the screed to dry prior to the laying of the floor finish.

1.10.2 Defective plastering and rendering shall be made good by cutting out the defective part to a rectangular shape, and the edges shall be undercut to form dovetail-key and finished flush with the surrounding work.

1.11 Samples

1.11.1 The Contractor shall supply the S.O. with samples of materials and/or sample of finished work for approval. Approved samples shall be kept at site for reference.

1.12 Tools

1.12.1 Proper tools shall be used for all scribing, scoring, splicing, smoothing edges, making angles etc. of tiles, bricks and others so as to produce neat and fit joints.

1.13 Types of Finishes

1.13.1 The appropriate type of finishes to be used in the various locations of the works shall be as shown in the Drawings or as tabulated in the schedule of finishes. Unless otherwise shown in the Drawings or described in the Bills of Quantities, the finishes and their dimensions shall be as specified hereinafter.

1.14 Cornices and Angles

1.14.1 All cornices and moulded work shall be run clean and accurately formed to the section shown in the Drawings. All mitres, stops and enrichments and moulding shall follow the details as shown in the Drawings, all to the approval of the S.O.

1.14.2 All arrises, rounded and moulded angles shall be of the same material mix as the adjacent finish. For narrow reveal, splays and returns under 30mm wide, Class D plaster to BS 1191 may be used.

2. Plaster Work

2.1 Plain Plaster

2.1.1 Plain plaster shall consist of one part masonry cement to six parts sand by volume. Where Ordinary Portland Cement is used, plasticiser or plasterlime shall be added to the mix in accordance with the manufacturer's instructions.

2.1.2 The plaster shall be applied in two coats generally to a total thickness of 16mm to brickwall and 12mm to soffits, beams, columns, block-walls and other smooth surfaces. The first coat shall consist of rough plastering to a thickness of 10mm for the 16mm plainface, and 6mm for 12mm plainface. The second coat of 6mm thick shall be finished with a steel trowel for internal surfaces and with a straight-edged wood float for external surfaces.

2.2 Granolithic Plaster

2.2.1 Granolithic plaster shall consist of by volume, two parts cement, one part sand, five parts granite chipping passing 6mm mesh and retaining upon 3mm mesh, applied in two coats to a total thickness of 10mm to a backing coat, finished smooth with wood float. The backing coat shall consist of 12mm thick plain plaster as described hereinbefore. The finished surface shall be brushed lightly to achieve the required texture after it has reached initial set.

2.3 Shanghai Plaster

2.3.1 Shanghai plaster shall consist of two parts approved coloured cement, one part sand and five parts of selected lime-stone chipping passing 6mm mesh and retaining upon 3mm mesh by volume applied in two coats to a total thickness of 10mm to the backing coat, finished smooth with wood float. The backing coat shall consist of 12mm thick plain plaster as described hereinbefore. The surface shall be brushed lightly to achieve the required texture after it has reached initial set.

2.4 Textured Finish Plaster

2.4.1 Textured finish plaster shall consist of a 20mm thick backing coat of plain plaster as described hereinbefore ruled into a plain and even surface and a finishing coat as shown in the Drawings and described hereinafter.

2.4.2 For rough cast finish, the mix shall consist of selected cement, sand and aggregate in the proportion to give the required finish to the approval of the S.O.

2.4.3 For Tyrolean finish, the mix shall consist of one part selected coloured cement and two parts sand by volume applied to the backing coat by means of a Tyrolean machine in accordance with the manufacturer's instructions. The finish shall be built up in three layers to a total thickness of not exceeding 6mm. Each coat shall be allowed to dry before the application of a subsequent coat.

2.4.4 For pebble-dash finish, the dry pebble for the finish shall be thrown onto the backing

coat while the latter is still wet. The pebbles to be used shall be clean and of size and quality approved by the S.O.

2.5 Lath Plaster

2.5.1 Lath plaster shall consist of metal lathing and plaster. Metal lathing shall be galvanised expanded metal sheets having a minimum weight of 1.5 kg/m sq. and complying with BS 1369. The expanded metal sheets shall be fixed with the longer side of the mesh spanning across the supports. All sheets shall be lapped not less than 25mm at the sides and ends. The lapping shall not occur within 150mm along the axis of angles or curves and end laps shall occur only at supports. Sides of sheets between supports shall be wired together at every 75mm spacings with galvanised wire of not less than 1.22mm diameter. Cut ends of wire used for fastening, etc. shall be bent inwards and not towards the plaster finishing coat. The expanded metal shall be secured to timber supports by means of galvanised nails or staples at intervals of not more than 100mm. Where expanded metal sheet is to be fixed to steelwork, it shall be secured by wire or clips at interval of not greater than 350mm apart. Proprietary types of metal lathing, where used, shall be fixed strictly in accordance with the manufacturer's instructions.

2.5.2 The plastering to metal lathing shall be applied in three coats. The first and second coat shall consist of cement and sand in the proportion of 1:6 by volume with an approved mortar plasticiser applied in accordance with the manufacturer's instruction. Approved fibre shall be incorporated in the mix in the proportion of 5 kg of fibre to one meter cube of sand, well beaten and evenly distributed. The final coat shall consist of cement and fine sand in the proportion of 1:3 with an approved mortar plasticiser applied in accordance with the manufacturer's instructions. The total thickness of the first and second coat shall be 10mm measured from the outer surface of the metal lathing. The thickness of the final coat shall be 3mm. Each coat shall be scratched for key after an appropriate time interval and be allowed to dry thoroughly before the subsequent coat is applied.

2.6 Barium Plaster

2.6.1 The plastering for internal surfaces of X-Ray room walls shall be of barium plaster consisting of one part cement, one part barytes (barium sulphate) fines and three parts barytes sand by volume.

2.7 Plaster to Sides of Manholes, Inspection Chambers and Septic Tanks

2.7.1 Plastering to sides of manholes, inspection chambers and septic tanks shall be as specified under SECTION F: SOIL DRAINAGE.

3. Paving Work

3.1 Cement Paving

3.1.1 Unless otherwise shown in the Drawings or described in the Bills of Quantities, cement paving shall be 20mm thick consisting of one part cement to three parts sand by volume. The paving shall be thoroughly rammed within 30 minutes of laying and trowelled smooth after it has stiffened sufficiently to prevent laitance being brought to the surface. Paving to apron shall finish to a slight fall towards surface drains.

3.1.2 Unless otherwise shown in the Drawings or described in the Bills of Quantities,

skirtings shall be formed to a height of 150mm and thickness of 20mm, coved at bottom and rounded at top.

3.1.3 The paving forming the nosing edge of concrete stair treads shall be slightly rounded and shall have four rows of 6mm half round grooves set at 12mm apart as non-slip nosing edge.

3.2 Granolithic Paving

3.2.1 Granolithic paving shall be 20mm thick, consisting of two parts cement and five parts granite chipping passing 6mm mesh and retained upon 3mm mesh by volume. The chipping shall be washed and free from dust. The paving shall be trowelled smooth to proper level or fall where appropriate. After initial set the surface shall be brushed lightly to achieve the required textured finish. Unless otherwise shown in the Drawings, granolithic skirtings shall be 100mm high and 20mm thick, coved at bottom and slightly rounded at top.

3.2.2 The edge of threshold and treads of concrete stairs shall be finished with 150mm x 75mm x 12mm thick vitreous non-slip nosing tiles laid lengthwise bedded and pointed in 1:3 cement and sand mortar. The sides of open stringers shall be finished with granolithic plaster worked to profile of treads and risers to the approval of the S.O.

3.3 In-Situ Terrazzo

3.3.1 In-situ terrazzo shall consist of one part approved coloured cement and three parts selected limestone chipping passing through 12mm mesh and retained upon 3mm mesh by volume. The terrazzo topping shall be 20mm thick laid on 20mm thick cement and sand (1:3) screed. The concrete base to receive the screed shall be thoroughly cleaned and wetted. While laying the screed, aluminium or brass strips of size 32mm wide x 3mm thick shall be set in vertically on edge into the screed to form panels. Each panel shall not exceed 4 sq. metres with top edges of the strips standing sufficiently high to finish flush with the finished terrazzo floor level. The terrazzo shall be trowelled to a dense even finish. When sufficiently hard but not less than two days after being laid it shall be rubbed down to a smooth surface by means of Carborundum stone. Tile impregnator then shall be applied strictly in accordance to the manufacturer's instructions onto the terrazzo surface to prevent future staining.

3.3.2 Unless otherwise shown in the Drawings or described in the Bills of Quantities, terrazzo skirtings and girths shall be of 100mm high x 20mm thick rounded at top and coved at bottom.

3.3.3 The edge of the threshold and treads of concrete stairs shall be finished with 150mm x 76mm x 12mm vitreous non-slip nosing tiles of approved colour laid lengthwise bedded and pointed. The sides of open stringers shall be finished with in-situ terrazzo working to profile of treads and risers to the approval of the S.O.

3.4 Waterproof Paving to Roof Slabs

3.4.1 Waterpoofed paving to roof slabs shall be as specified under SECTION D: CONCRETE WORK.

3.5 Precast Concrete Paving

3.5.1 Precast concrete paving slabs shall be of size 600mm x 600mm x 50mm thick each

and made of 1:2:4-20mm concrete reinforced with `A6' fabric reinforcement to MS 145. The top surfaces of slab shall be brushed with stiff broom or wire brush after the initial set to give a rough finish. Paving slabs shall be laid to the pattern as shown in the Drawings or approved by the S O. The slabs shall be bedded on 25mm thick semi-dry cement and sand (1:3) screed laid on 100mm properly compacted and blinded hardcore. The joints shall be 20mm wide filled with cement mortar (1:3) and raked to a depth of 6mm.

3.6 Interlocking Concrete Paving

3.6.1 Interlocking concrete paving shall comprise of segmental interlocking concrete paving units laid on minimum 30mm thick sand bedding course. The grade of the concrete and the thickness of the paving unit shall be as detailed in the Drawings. Concrete edge restraints shall be provided at the perimeter of the pavement to ensure the paving units are tightly abutted and to separate areas of different laying pattern. The gap between paving units shall be filled with fine sand of different grading to that required for the bedding sand. The pavement which has been laid shall be compacted by vibrator.

3.7 In-Situ Concrete Paving Footpath

3.7.1 In-situ concrete paving shall consist of 75mm thick concrete of 1:3:6-20mm mix by volume as specified in SECTION D: CONCRETE WORK, laid on 100mm thick properly compacted and blinded hardcore to panels as shown in the Drawings or as approved by the S.O. The concrete shall be well compacted and floated with a wooden float to a smooth and even finish. After the concrete has achieved the initial set, the surface shall be brushed with stiff broom or wire brush to give a rough finish. The joints between the panels shall be filled with approved cold-poured polyurethane joint filler.

3.8 Brick Pavings

3.8.1 Bricks for paving shall be of semi-vitreous bricks 225mm x 75mm x 50mm thick of approved quality and colour. The bricks shall be soaked as specified in SECTION E: BRICKWORKS before laying and shall be laid flat on 25mm semi-dry cement and sand (1:3) screed with 6mm spacing to the pattern as shown in the Drawings or as approved by the S.O. The screed shall be laid on 75mm thick concrete (1:3:6-19mm) base founded on properly compacted and blinded 100mm thick hardcore. The joints shall be filled with cement mortar (1:2) and finished flush.

4. Tiling Work

4.1 Precast Terrazzo Tiles

4.1.1 Unless otherwise shown in the Drawings, precast terrazzo tiles of an approved manufacture shall be 300mm x 300mm x 20mm thick machine-pressed tiles comprising of 6mm limestone aggregate and coloured cement. The tiles shall be soaked prior to laying and shall be laid butt jointed on 20mm thick semi-dry cement and sand screed. The laying shall be done while the screed is still green. All joints between the tiles shall be grouted with coloured cement to match. The tiles shall be rubbed down to a smooth surface after a minimum of two days or laying by means of Carborundum stone. Tile impregnator shall then be applied strictly in accordance with the manufacturer’s instructions on to the terrazzo surface to prevent future staining.

4.1.2 All skirtings, girths, edges of threshold and treads etc. shall be as described for in-situ terrazzo.

4.2 Mosaic

4.2.1 Unless otherwise shown in the Drawings, mosaic tiling to floors shall be semi-glazed tiles and shall be of an approved colour and manufacture.

4.2.2 Unless otherwise shown in the Drawings, mosaic tiling to walls shall be fully glazed tile and shall be of approved colour and manufacture.

4.2.3 Unless otherwise shown in the Drawings or described in the Bills of Quantities, all skirtings shall be 100mm high to match floor tiling. The tiles at the bottom of the skirting shall be set at 45 degrees to the horizontal and the top finished with cove tiles. The tiles required to form angles to skirting shall be neatly cut and fit to all abutments.

4.2.4 Mosaic tiling to floors shall be bedded on 20mm thick semi-dry cement and sand (1:3) screed, laid on the concrete base which has been thoroughly cleaned and wetted.

4.2.5 Mosaic tiling to walls shall be evenly buttered with cement paste before bedding on 20mm thick cement and sand (1:3) screed which has sufficiently hardened. Alternatively the tiling shall be bedded with 6mm thick approved adhesive onto the screed.

4.2.6 During bedding, the surface of the mosaic shall be checked and any unevenness shall be made good. Any misaligned or defective tiles shall be adjusted or replaced. All joints shall be grouted with approved adhesive or cement grout to match. The tiling shall be allowed to mature under damp condition for at least four (4) days before cleaning down.

4.3 Quarry Tiles

4.3.1 Quarry tiles shall be of non-slip type 150mm x 150mm x 12mm thick complying with MS 1088, 1089, 1090 and 1091. The tiles shall be bedded on 20mm thick semi-dry cement and sand (1:3) screed with joints about 2mm wide, laid on the concrete base which has been thoroughly cleaned and wetted. All tiles shall be soaked overnight before laying.

4.3.2 All skirtings shall be 100mm high with rounded top edge to match the tiles flooring. The tiles required to form angles to skirting shall be neatly cut and fit to all abutments.

4.4 Glazed Wall Tiles

4.4.1 Unless otherwise shown in the Drawings, glazed wall tiles shall be 200mm x 200mm x 6mm thick cushion-edged glazed tiles complying with MS 858.

4.4.2 The tiles shall be bedded with cement paste or alternatively with 6mm approved tile adhesive on 20mm thick cement and sand (1:3) screed which has sufficiently hardened. The surface of the screed shall be properly roughened to form key to the tiling. The tiles shall be laid closed-butt and all joints shall be filled with adhesive or approved white cement. Exposed edges of tiling shall be finished with rounded on edge tiles.

4.5 Ceramic Tiles

4.5.1 Unless otherwise shown in the Drawings, ceramic tiles for floor shall be vitreous hard wearing non-slip glazed tiles 200mm x 100mm x 12mm thick complying with BS 6431.

4.5.2 Unless otherwise stated in the Drawings or described in the Bills of Quantities, ceramic tile skirtings shall match flooring and shall be 200mm x 100mm x 12mm thick laid lengthwise on cement and sand (1:3) screed as described. All angles to skirting shall be neatly cut to fit all abutments.

4.5.3 Unless otherwise stated in the Drawings, nosing and edging tiles to edges of flooring and treads of concrete stairs shall be of an approved type and to match with the flooring.

4.5.4 Unless otherwise shown in the Drawings, ceramic tiles for walls shall be scruff-resistant glazed tiles 200mm x 100mm x 6.5mm thick complying with MS 858.

4.5.5 Unless otherwise stated in the Drawings, all ceramic tiles shall be of approved colour and manufacture.

4.5.6 Ceramic tiles shall be bedded with cement paste or alternatively with 6mm thick approved tile adhesive on 20mm thick cement and sand (1:3) screed as described. The tiles shall be laid close-butt and all joints shall be filled with tile adhesive or coloured cement to match.

4.6 PVC Tiles/Sheets

4.6.1 PVC tiles or sheets shall be of approved pattern and colour. PVC tiles or sheets are to be of non-slip type and shall comply with MS 602. Tiles shall be 250mm x 250mm x 2mm thick. Sheets shall be 1.5m wide x 2mm thick.

4.6.2 The tiles or sheet shall be laid and jointed on 20mm thick cement and sand (1:3) screed with an approved waterproof adhesive strictly in accordance with manufacturer's instructions. The screed shall be finished smooth with a steel trowel to an even surface and shall be dry, clean and free from dust and sand before laying the tiles and sheets.

4.6.3 Accessories such as skirting, stair nosing, edging strips etc. shall be of the same manufacture from similar material to match flooring. Unless otherwise described skirting shall be 100mm high; stair nosing shall be 60mm wide laid full length of the treads and of bullnose profiles; and edging strips shall be 25mm wide.

4.6.4 On completion, the flooring shall be well-cleaned and treated or polished in accordance with the manufacturer's instructions.

4.7 Timber Strip Flooring

4.7.1 Unless otherwise shown in the Drawings, timber strip flooring shall be ready-made, laminated three ply timber strip or floor board of approved manufacture. The timber species for use in timber strip flooring shall be as specified in SECTION H: CARPENTRY, JOINERY AND IRONMONGERY WORKS.

4.7.2 The flooring shall be laid to the pattern as approved by the S.O, on 20mm thick cement and sand (1:3) screed with an approved waterproof adhesive applied in accordance with manufacturer's instructions. The screed shall be finished smooth

with a steel trowel to an even surface and it shall be dry, clean and dust free before laying the timber strip flooring. After the adhesive has set, the timber strip flooring shall be sanded to a true smooth and even surface using suitable sanding machine. Any misaligned or defective timber strip shall be adjusted or replaced.

4.7.3 Unless otherwise shown in the Drawings or described in the Bills of Quantities, skirting to timber strip flooring shall consist of 100mm x 12mm thick wrot timber skirting rounded at the top, and fixed to the wall or column using 38mm masonry nails spaced approximately at 600mm centres in two rows 26mm away from the top and bottom edges. The nails shall be punched below the surface and the holes filled with approved putty. Any jointing of the skirting shall use splayed butt joints.

4.7.4 The face edges of the flooring shall be lined with wrot timber edging to match. The edging strips shall be 38mm wide approximately x 12mm thick fixed to the base using adhesive as specified hereinbefore, projecting 12mm from the finished sides of floor slabs. Edging strips shall be jointed using glued splayed butt joints.

4.7.5 After sanding the flooring shall be cleaned, any gap sealed with approved sealer, stained and finished with three coats of approved polyurethane paint. Each coat shall be applied strictly in accordance with the manufacturer's instructions.

4.8 Parquet Flooring

4.8.1 Unless otherwise shown in the Drawings, parquet tiles shall be ready-made 120mm x 120mm x 10mm thick consisting of 120mm x 25mm x 10mm pressure treated kempas, keruing or other approved medium hardwood timber battens. The timber species for use in parquet flooring shall be as specified in SECTION H: CARPENTRY, JOINERY AND IRONMONGERY WORKS.

4.8.2 The flooring shall be laid to the pattern as approved by the S.O, on 20mm thick cement and sand (1:3) screed with an approved waterproof adhesive applied in accordance with manufacturer's instructions. The screed shall be finished smooth with a steel trowel to an even surface and it shall be dry, clean and dust free before laying the parquet flooring. After the adhesive has set, the parquet flooring shall be sanded to a true smooth and even surface using suitable sanding machine. Any misaligned or defective parquet shall be adjusted or replaced.

4.8.3 Unless otherwise shown in the Drawings or described in the Bills of Quantities, skirting to parquet flooring shall consist of 100mm x 12mm thick wrot timber skirting rounded at the top, and fixed to the wall or column using 38mm masonry nails spaced approximately at 600mm centres in two rows 26mm away from the top and bottom edges. The nails shall be punched below the surface and the holes filled with approved putty. Any jointing of the skirting shall use splayed butt joints.

4.8.4 The face edges of the flooring shall be lined with wrot timber edging to match. The edging strips shall be 38mm wide approximately x 12mm thick fixed to the base using adhesive as specified hereinbefore, projecting 12mm from the finished sides of floor slabs. Any edging strips shall be jointed using glued splayed butt joints.

4.8.5 After sanding the flooring shall be cleaned, any gap sealed with approved sealer, stained and finished with three coats of approved polyurethane paint. Each coat shall be applied strictly in accordance with the manufacturer's instructions.

4.9 Homogenous Tiles

4.9.1 Unless otherwise shown in the Drawings, homogenous tiles for flooring shall be of

Gred A 300mm x 300mm x 8.5mm thick (interior flooring) and 100mm x 100mm x 11mm thick (exterior flooring) fully-vitrified hard-wearing, non-slip unglazed porcelain tiles of approved colour and manufacture.

4.9.2 The tiles shall be bedded with cement paste or alternatively with approved tile adhesive 6mm thick complying with ANSIA 118.1-1992 on to 20mm thick cement and sand (1:3) screed as described hereinbefore.

4.9.3 Accessories such as skirting (bull nose or cove base), step tiles, step nosings, edging strips, angle tiles (internal and external), etc, shall be of standard manufacture from the same material to match flooring. Unless otherwise shown in the Drawings, skirtings shall be 77mm high, stair nosing 20mm wide laid full length of the treads and of bull nose profile, and edging strips 25mm wide.

4.9.4 The tiles shall be laid closed-butt with joints not exceeding 3 mm wide and shall be filled with coloured grout mixed with grout admix. For polished tiles, tile impregnator solution shall be applied before grouting to prevent grout haze. On completion, the tiles shall be well-cleaned with tile cleaning solution.

4.10 Granite Slabs

4.10.1 Unless otherwise shown in the Drawings, granite slabs shall be 600mm x 600mm x 25mm thick shall be bedded with cement paste or alternatively with 9mm thick approved tile adhesive onto 25mm thick cement and sand (1:3) screed as described hereinbefore. The slabs shall be laid butt-jointed. Any gap shall be filled with approved grout powder mixed with grout adhesive. After grouting, the surface then shall be polished, buffered and finished with a layer of impregnator.

4.10.2 If used in wet or exposed areas, or on ground floor, waterproofing system shall be installed prior to laying of granite slabs.

4.11 Marble Slab

4.11.1 Unless otherwise shown in the Drawings, marble slabs shall be 600mm x 600mm x 25mm thick shall be bedded with cement paste or alternatively with 9mm thick approved tile adhesive onto 25mm thick cement and sand (1:3) screed. The slabs shall be laid butt-jointed. Any gap shall be filled with approved mixture of the adhesive and grout powder. After grouting, the surface then shall be polished, buffered and finished with a layer of impregnator.

4.11.2 If used in wet or exposed areas, or ground floor, waterproofing system shall be installed prior to laying of marble slabs.

SECTION K - WATER SUPPLY PLUMBING, SANITARY AND RAINWATER GOODS INSTALLATION

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1. Water Supply Plumbing

1.1 General

1.1.1 The whole of the water supply plumbing and installation shall be executed by a licensed plumber having valid and relevant license issued by the relevant state water authority. The Contractor shall at his own cost be responsible for employing the licensed plumber, and shall be responsible for all the work performed by the licensed plumber.

1.1.2 All water supply plumbing and installation shall be executed in accordance with the relevant state water supply rules and to the approval of the state water authority, notwithstanding any approval given by the S.O.

1.1.3 All pipes, fittings and equipment used for water supply plumbing and installation shall be of the type and make approved by the relevant state water authority.

1.2 Pipework

1.2.1 Pipework for water supply plumbing shall be to the dimensions shown or as specified hereinafter and shall be complete with all bends, tees, sockets, plugs, reducers, brackets, supports and everything else necessary to complete the installation.

1.2.2 Unless otherwise shown or stated in the Drawings, the unplasticed polyvinyl chloride (uPVC) pipes and fittings used in cold water supply pipework in distribution pipes above ground, below ground or concealed, shall be executed in approved Class 7 of MS 762 for sizes 50mm and below. For sizes greater than 50mm, a minimum pressure rating of approved Class 'E' of MS 628 (PN 15) (equivalent to 12 bar derated at 30^{o}C) shall be used. Both Class 7 of MS 762 and Class 'E' of MS 628 uPVC pipes and fittings shall comply with BS 6920 or MS 1583 on their effects on drinking water quality. Solvent cement used for both types of pipes and fittings shall be approved in accordance with MS 628. All uPVC pipes, fittings and solvent cement shall be supplied by the same manufacturers.

1.2.3 Where polyethylene (PE) pipe is shown or stated in the Drawings, the PE pipes and fittings used in cold water supply pipework in distribution pipes above ground, below ground or concealed, unless otherwise stated or shown in the Drawings, shall have a minimum wall thickness and pressure rating of PN 12.5 at 20^{o}C (equivalent to 10 Bar derated working pressure at 30^{o}C) and manufactured to MS 1058 or EN 12201. All PE pipes used shall be marked with SIRIM certification numbers. All metal fittings moulded integrally shall be dezincified brass with BSP threads to CZ132 of BS 2872 or BS 2874 and Nickel & Chromium plated to BS 1224, service condition No. 2, classification number Cu/Ni 10b Crr.

1.2.4 Where Acrylonitrile Butadiene Styrene (ABS) pipe (for cold water applications only) is stated or shown, ABS pipes and fittings used in the water supply pipework in distribution pipes above ground, below ground or concealed, unless otherwise stated or shown in the drawing, shall have a minimum wall thickness and pressure rating of class 9 to MS 1419 or PN 10 to EN 15493.

1.2.5 Where polybutylene (PB) pipe (for cold and hot water applications) is stated or shown, PB pipes and fittings used in the water supply pipework in distribution

pipes above ground, below ground or concealed, unless otherwise shown or stated in the Drawings, shall have a minimum wall thickness and pressure rating of PN 12.5 at 20^{o}C (equivalent to 10 Bar derated working pressure at 30^{o}C) and manufactured to EN 12319 or AS/NZS 2642. All metal fittings (in contact with water) moulded integrally shall be dezincified brass with BSP threads to CZ132 of BS 2872 or BS 2874 and Nickel & Chromium plated to BS 1224, service condition No.2, classification number Cu/Ni 10b Crr.

1.2.6 Where polypropylene random co-polymer (PP-R) Type 3 pipe and fitting (for cold and hot water applications) is stated or shown, PP-R Type 3 pipes and fittings used in the water supply pipework in distribution pipes above ground, below ground or concealed, unless otherwise shown or stated in the Drawings, shall have a minimum wall thickness and pressure rating of PN 16 or SDR 7.4 at 20^{o}C, designed for 10 Bar working pressure at 60^{o}C for a minimum operational life of 50 years and manufactured to DIN 8077, DIN 8078 and DIN 16962 Part 5-8. All metal fittings moulded integrally shall be dezincified brass with BSP threads to CZ132 of BS 2872 or BS 2874 and Nickel & Chromium plated to BS 1224, service condition No. 2, classification number Cu/Ni 10b Crr. The minimum wall thickness and pressure rating for cold water system, unless otherwise stated or shown in the Drawings is PN 10 or SDR 11 according to DIN 8077.

1.2.7 Where stainless steel pipe (suitable for cold and hot water) is stated or shown, all service pipes, pump delivery pipe works, plumbing works below and above ground level shall be welded austenitic stainless steel pipes (using Schedule 40S pipes for sizes ranging ½" to 2" diameter and threaded, and Schedule 10S pipes for 2" to 8" Diameter pipes by way of welding) manufactured according to ASTM A312/A312M together with stainless steel butt-welding fittings manufactured according to ASTM A403/A403M or stainless steel screwed fittings manufactured according to ASTM A351/A351M.

However for pipe work in plumbing above ground level (which include service pipes, pump delivery pipe works), as an option, stainless steel tubes manufactured according to BS4127 specification for light gauge stainless steel tube, primarily for water application, may be used. It shall be made of stainless steel material grade 304 S15 of BS 1449 Part 2. Compression fittings and capillary fittings made in accordance with the following standards shall be used with stainless steel tubes conforming to BS 4127:

(i) Copper alloy to BS 864
(ii) Stainless steel to BS 4368 or ISO 8434

1.2.8 Where copper pipe is shown, it shall be to BS EN 1057. Fittings to be used for joining copper pipe shall be to BS 864.

1.2.9 Unless otherwise shown or stated in the Drawings, service pipes and distribution pipes except those buried under ground level, shall be concealed. The Contractor shall execute the work in such a manner so as to avoid cutting into finished work in walls, aprons, beams, etc. where practicable as the work proceeds. Pipework to be buried or concealed shall not be covered or plastered before they are examined, tested and approved by the state water authority, notwithstanding any approval given by the S.O.

1.2.10 Unless otherwise shown or stated in the Drawings, final branches to fittings shall be 12mm diameters and the sizes of feeders from which these branches are taken shall be as follows: -

No. of Fittings Served	Diameter of Feeders
1	12mm
2	20mm
3, 4	25mm
5, 6, 7	30mm
8, 9,10,11,12	40mm
13, 14, 15,16,17,18	50mm

1.2.11 The installation and construction of all pipework to storage tanks shall be carried in such a manner that where necessary, flexible rubber joints of approved standards shall be used for connection next to the panel to avoid stress. Mechanical joints shall also be used for connection between the flexible rubber joints and the pipework.

1.2.12 Flange joints (nozzles) used for the inlet, outlet and scour of storage tanks shall be made of hot dipped galvanised mild steel externally and stainless steel grade 304 or polymeric coated hot-dipped galvanised mild steel internally. Joint gaskets shall be of 5mm thick, medium rubber reinforced with two-ply flexible fabric and complying with BS 5292, or approved silica sealant used in the Glass Reinforced Polyester Panel (GRP) tanks. All bolts, nuts and washers used for flange nozzles shall be made of stainless steel grade 304 or polymeric coated hot-dipped galvanised mild steel.

1.2.13 The Contractor shall provide all the necessary flexible rubber joints and mechanical joints for the proper installation and construction of the pipework to the tank.

1.3 Storage Tank

1.3.1 Storage tank for water supply shall be of the type and capacity shown or stated in the Drawings. The storage tank shall be watertight and properly supported. The storage tank shall be provided with dust and mosquito-proof cover. The cover shall be so constructed that it shall not be airtight. The storage tank shall be provided with a high pressure ball valve to BS 1212 on the inlet and of the same size as inlet pipe. Overflow/ warning pipe, scour pipe and outlet tapping shall be in accordance with the relevant state water supply rules. The scour and overflow/warning pipe shall discharge outside the building or to a point shown or stated in the Drawings.

1.3.2 Storage tanks of pressed steel sections shall be of approved type and shall comply with BS 1564 and shall be hot-dipped galvanised to MS 740.

Either one of the following liner systems is acceptable:

(A) Hot-dipped Galvanised Pressed Steel Tank With HDPE Liner

The internal surfaces of the storage tank shall be lined with an approved non-toxic potable water quality grade high density polyethylene (HDPE) liner of minimum thickness of 2 mm. All internal cleats and bracings to tank plates, bolts, nuts, washers and internal ladders shall be of stainless steel grade 304 or polymeric coated (cold-applied epoxy AWWA C210 or equivalent) hot-dipped galvanised mild steel. Roof covers and trusses to tank shall be fully hot-dipped galvanised mild steel and polymeric coated internally.

(B) Hot-dipped Galvanised Pressed Steel Tank With Epoxy Resin Liner

The internal surfaces of the storage tank together with the roof covers and trusses shall be treated with a suitable etch primer before applying

2 coats of solvent free, high solid epoxy resin with an approved non-toxic potable water certificate. The overall film thickness shall be not less than 500 microns. All internal cleats and bracings to tank plates, bolts, nuts, washers and internal ladders shall be of stainless steel grade 304.

Application requirement for Epoxy Resin Liner:

i) The new galvanised pressed steel shall be cleaned with a suitable degreaser to remove grease and other contaminates. The Etch Primer shall be applied by airless spray at a dry film thickness of 15-20 microns. The 2 part epoxy resin liner must be thoroughly mixed at the prescribed ratio with each coat giving a dry film of average 250 microns. Precaution must be taken to prevent contamination between coats.

ii) The minimum bond strength of the coating shall be 1.5 N/mm^2 to be determined by using an Elcometer adhesion testing machine. The testing requirement is one (1) pull-off test per every 100 m^2 of tank lining and one (1) pull-off test for tank lining less than 100 m^2. Any damage to the coating shall be rectified by following the original method statement.

For both the liner systems, beads of non-toxic elastomeric sealant shall be applied to cover all gasket joints. All external bolts, nuts and washers to tank plates, tank support, steel I beams and external ladders shall be hot-dipped galvanised mild steel.

The Contractor shall provide the tank manufacturer's guarantee for the new hot-dipped galvanised pressed steel water tank with any one of the above liner systems for a period of ten (10) years from the date of completion against leakages and all manufacturing, installation and liner's defects.

1.3.3 Storage tanks of stainless steel shall be of approved type and shall be made of stainless steel grade 304 and manufactured to JKR Standard Specification for Stainless Steel Water Tanks No.20200-0041-99.

1.3.4 Storage tanks of fibre glass (FRP) shall be of approved type and shall comply with MS 1241.

1.3.5 Storage tanks of high density polyethylene (HDPE) shall be of approved type and shall comply with MS 1225.

1.3.6 Storage tanks of glass reinforced polyester (GRP) panels shall be of approved type and shall comply with MS 1390.

1.4 Tank Components and Accessories

Unless otherwise shown or stated in the Drawings, the installation of storage tanks shall include the provision and installation of the following accessories and fittings to the tanks:

i) Openings for piping connection for inlet, outlet, overflow and drainage pipe connections with positions approved by the S.O.

ii) Access manholes with cover, the number, locations and details of which shall be approved by S.O.

iii) Air vents to the tank cover at the positions and as per details approved by the S.O.

iv) Water tanks of two metres depth or more shall be provided with internal and external ladders. The internal ladder shall be made of aluminium or of stainless steel grade 304 or polymeric coated (cold-applied epoxy AWWA C210: 1994 or equivalent) hot-dipped galvanised mild steel. The external ladder shall be made of hot dipped galvanised mild steel in accordance with MS 740. The ladder width shall not be less than 300 mm and the length shall be suitable for the tank specified.

v) Suitable type water level indicators and scales graduated in metres to suit the depth of the panel tank.

vi) All internal cleats and bracings to tank plates, bolts, nuts, washers in contact with water shall be of stainless steel grade 304 or polymeric coated (cold-applied epoxy AWWA C210 or equivalent) hot-dipped galvanised mild steel. All external bolts, nuts and washers shall be of hot dipped galvanised steel. The diameter of all bolts in accordance with BS 4190, shall not be less than 10 mm.

vii) Sealing material shall be nontoxic and chemically resistant to the water stored. The sealants shall also be able to withstand the prevailing environmental conditions during service.

viii) The internal supports and reinforcement members for the panels shall be chemically resistant to the water stored. They shall be made of stainless steel. The exterior reinforcement metal parts shall be fabricated from hot dipped galvanised mild steel.

ix) The exterior of the water storage tanks for the purpose of firefighting shall be painted as required by Jabatan Bomba dan Penyelamat.

1.5 Storage Tank Foundation

i) Unless otherwise shown in the Drawings, the Contractor shall construct foundations to provide continuous support to all base panel joints in one direction at 1000 mm nominal centres according to panel size. The concrete foundation shall have a width of at least 300 mm and height of at least 500 mm.

ii) If continuous foundations are used, dwarf walls or steel beams shall be placed between the tank and the base level to allow a minimum clearance of 500 mm to enable ease of tank installation and subsequent bolts tightening and adjustments after installation.

iii} Whenever recommended by the tank manufacturer, the steel skid base shall be designed and constructed in accordance with the manufacturer's instructions, details and BS 5950 or equivalent. In such cases, the continuous support can be spaced at greater than 1000mm nominal centres as recommended by the manufacturer.

iv) The steel skid base shall be joined by welding neatly and uniformly flushed with each other to enable the base of tank plate to be placed and sit properly on the skid base. Uneven surfaces of the skid base will be rejected. The skid base shall be rust free.

1.6 Stop Valves

1.6.1 High pressure full way brass screw-down stop valves of the same diameter as the pipe shall be provided and fixed for control in the following positions:

i) On the service pipe before it enters the building.
ii) On each branch of the service pipe.
iii) On the inlet to each storage or feed cistern.

iv) On the inlet to each flushing cistern.
v) On the outlet of each storage or feed cistern.
vi) In other positions on the pipe as shown or indicated, other than on overflow/warning pipe.

1.6.2 All stop valves shall be of the type approved and complied with MS 1022.

1.7 Examination, Test and Approval of Water Supply Plumbing

1.7.1 On completion of all the water supply plumbing and fittings installation, the Contractor shall notify the relevant state water authority that they are ready for examination and test and the Contractor shall carry out the test as required by the state water authority.

1.7.2 Test for water tightness and chlorination of storage tank

i) After completion, the tank shall be filled with water to the maximum operating capacity level and the level of water surfaces shall be fully recorded. The tank shall be accepted as satisfactory if after a period of 48 hours there is:

a) No measurable reduction in water level, due allowance being made for evaporation.
b) No visible signs of leakage from any parts of the tank and
c) No deformation of any part of the structure.

ii) If the test results do not satisfy the above conditions of tests, the Contractor shall proceed to locate and rectify all defects and leakages and the test shall be repeated as often as necessary until the structure satisfies the stipulated conditions. The Contractor shall bear all costs and expenses for all tests and remedial works.

iii) On completion of the water tightness test, the Contractor is required to chlorinate the water in the tank to the satisfaction of the S.O.

1.7.3 Testing of Pipework

i) The testing of pipework shall be carried out before the pipework are covered up or plastered.

ii) The Contractor shall at his own cost provide complete plant, including portable hydraulic pumps, blank flanges, "test-end" units fitted with caps or plugs, pressure gauges, all pipe connections and other fittings necessary for the testing of the pipework. All pipes attached to the tank shall be tested to the maximum head which they will attain under normal operating conditions. Only a closed end test shall be required for the valves.

iii) Pressure Testing

When a pressure test is carried out, it may be necessary to disconnect and cap the water service to isolate it from the water main, fixtures and appliances which may be damaged by the test pressure.

a) For Plastic Pipes (uPVC pipes, PE pipes, ABS pipes, PB pipes, PPR-R Type 3 pipes etc), the pipework shall be filled with water and the system shall be charged to a hydrostatic pressure of 15 bar at embient temperature 27 ± 2^{o}C.
For accurate testing, the installation must be filled slowly and be fully ventilated. Calibrated measurement devices, which show

pressure changes in steps of 0.1 bar, shall be used for the test. It shall be noted that a temperature change of 10^{o}C causes a pressure change of up to 2 bar, depending on the size of the system.

The pressure test shall be carried out in two stages: i.e. a preliminary test and a main test.

Pressure Testing may take place

- for compression joint, immediately after the last joint has been made.
- for fusion joint, no earlier than 1 hour after the last fusion joint.
- for solvent weld joint, no earlier than 24 hours after the last joint made.

Preliminary test:

The duration of the preliminary test depends on the size of the system, but usually requires about one hour and includes the following activities.

1) Measurement devices shall be installed at the lowest point of the piping system, if possible.
2) The piping system shall be filled with potable water, thoroughly ventilated and separated from the mains supply.
3) Increase pressure with a pressure pump to 15 bar (a) (refer to Pressure Test Diagram in Appendix K/2-1 and Log Sheet in Appendix K/2-2.)
4) Repeat pumping back up to 15 bar, 2 more times over the next 30 minutes (b) at an interval of 10 minutes.
5) After a testing period of another 30 minutes, the test pressure shall not have decreased by more than 0.6 bar (c).

The preliminary test is considered successfully completed when there are no leaks and the pressure drop in the last half hour of the preliminary test does not exceed 0.6 bar.

Main test:

6) The main test shall be carried out immediately following the preliminary test. Its duration is two (2) hours. The test pressure after the preliminary test at point (c) shall be recorded.

7) The main test is considered successfully completed, if the test pressure does not drop more than 0.2 bar (d) from the beginning of the main test and if no leakage is detected.

If the pressure drop is more than 0.2 bar during the main test, then the whole test must be repeated. There must not be any leakage in the system.

The results of the pressure test shall be recorded on a log sheet (see Appendix K/2-2). The test shall be accepted as satisfactory if there are no signs of leakage and pressure drops within the acceptable tolerances in the system. The Contractor shall make good all leakages, replace any defective parts and retest the

whole system all at his own expense to the approval of the state water authority.

b) For Metal Pipes (stainless steel pipes, copper pipes etc), the pipework shall be filled with water and the system shall be charged to a hydrostatic pressure of 15 bar and maintained for a period of not less than 30 minutes. The results of the pressure test shall be recorded on a log sheet (see Appendix K/2-2). The test shall be accepted as satisfactory if there are no signs of leakage and pressure drop in the system. The Contractor shall make good all leakages, replace any defective parts and retest the whole system to the approval of the state water authority all at his own expense.

1.7.4 The Contractor shall obtain a written certification from the relevant state water authority to prove that the examination and test have been satisfactorily concluded. Where the installation is proven to be unsatisfactory, the Contractor shall rectify the works in accordance with written notice of the state water authority all at his own expense. The repair or replacement of a faulty pipe or fitting shall be reported by the Contractor to the relevant state water authority within one week.

1.8 Meter Chamber

Where meter chambers are required, these shall be to the details shown in the Drawings. Unless otherwise shown or stated in the Drawings, connection to the meter, supply of meters and all communication pipes up to the meter point shall be done by the relevant state water authority.

2. Sanitary Installation

2.1 Fittings

2.1.1 Unless otherwise shown or specified in the Drawings, all fittings including all necessary brackets and accessories shall be as scheduled in Appendix K/1 hereinafter. The Contractor shall be responsible for determining the type of trap required for each fitting. All necessary concrete backing shall be provided to fittings secured to floors.

2.1.2 Vanity Top

Where shown in the Drawings, vanity tops of approved manufacture and colour shall be installed in accordance with the manufacturer's instructions. It shall be moulded as one solid piece with it's top sloping gently towards the wash hand basin and having a slight upturn or kerb as it's outer edges. It shall be manufactured from non-porous composite product composed of polyester resin and calcium carbonate marble dust with the permanence of stone and an aesthetic appeal of natural marble or granite. The slab surface shall have a glossy finish, and protected by suitable polymer to ensure durability and impermeability. It shall be stain and chemical resistant, and UV stabilised.

2.2 Water Supply Plumbing for Low Pressure W/C Flush Valve and Low Pressure W/C Flushing Cistern

2.2.1 Plumbing for Low Pressure W/C Flush Valve

A separate internal plumbing system shall be provided for low pressure w/c flush valves to have adequate dynamic pressure and flow, to ensure effective operation of each flush valve, i.e. for hydraulics of water closet to function

properly, as shown in Appendix K/3.

Alternatively water supply to flush valves for w/c pan shall be derived from a feeder tank which is isolated from the potable water supply main and is not connected in any way with all other fittings serving to basins, sinks, heaters etc. in the building.

The following requirement for each low pressure w/c flush valve as in Table A1 shall be followed in the design of internal plumbing for flush valve system.

Table A1 – Low Pressure W/C Flush Valve

Requirement	W/C Flush Valve
a) Dynamic/ operating head at the inlet of flush valve	3.25 m
b) Flow rate	1.8 litres/ sec

2.2.2 Plumbing for Low Pressure W/C Flushing Cistern

An internal plumbing system shall be provided for low pressure w/c flushing cistern, w/c taps, taps for toilet wash hand basins and urinal flush valves as shown in Appendix K/4.

The following requirement for each low pressure w/c cistern, urinal cistern and urinal flush valve as in Table A2 shall be followed in the design of internal plumbing.

Table A2: Low Pressure W/C Cistern, Urinal Cistern and Urinal Flush Valve

Requirement	Low Pressure W/C Cistern	Urinal Cistern	Urinal Flush Valve
a) Dynamic/ operating head at the inlet of cistern/ valve	3.2 m	2.0m	2.0m
b) Flow rate	0.1 litres/ sec	0.1 litres/ sec	0.1 litres/ sec

2.2.3 Materials for Pipes, Fittings and Isolating Valves In Pipeworks

a) Pipes and Fittings For Internal Plumbing, Concealed and Buried Pipework

Pipework for water supply plumbing shall be to the dimensions shown or as specified in the Drawings and shall be complete with all bends, tees, sockets, plugs, reducers, brackets, supports and everything else necessary to complete the installation. All the pipes and fittings mentioned in clause 1.2 are suitable for internal plumbing. Galvanised iron pipes and fittings shall not be used for internal plumbing.

b) Pipes and Fittings for Exposed External Pipework

ASTM A312 Schedule 40S stainless steel pipes and ASTM A351

stainless steel pipe fittings or BS 143 & 1256 brass threaded fittings for external pipework shall be used. High strength composite plastic/ metal pipes and fittings may be allowed with the S.O's approval. Galvanised iron pipes and fittings shall not be used for external pipework.

c) Isolation Valves for Internal Plumbing and External Pipework

Valves used for isolating the water supply system shall be of approved full bore brass gate valves (BS5154) or Type B ductile iron gate valves (JKR Standard Specification 20200-0083-00), brass ball valves (BS 6675:1986 or BS 1552:1995) shall be used. All fittings used shall be made of brass, stainless steel or other approved non-corrodible material. Stop valves (stop cocks with reduced flow areas) shall not be used for external pipework and internal plumbing systems for w/c flush valves and flushing cistern.

2.2.4 Operating/ Dynamic Pressure More Than 30 Metres

Unless otherwise instructed by the S.O, air vents and pressure reducing valves of approved type (JKR Standard Specification 20200-0114-01), shall be installed at 30 meters intervals along downpipes in order to restrict the pressure sustained by the fittings to prevent water hammer and other effects.

2.3 uPVC Soil, Waste and Vent Pipes

2.3.1 Unless otherwise shown or specified in the Drawings, approved uPVC soil, waste and vent pipes shall be provided.

2.3.2 uPVC pipes shall conform to MS 978 and MS 1063. The pipes shall be provided, fixed and connected to fittings and sanitary installation complete with all necessary bends, tees, sockets, branches, offsets, inspection pieces, hopper heads, holder bats etc. Pipes shall be joined with approved solvent cement in accordance with the manufacturer's instructions.

2.3.3 Expansion joints (expansion couplings for uPVC pipes)

Where pipework is constructed using solvent welded joints, expansion joints shall be provided to compensate for the linear thermal expansion of uPVC pipes which have a coefficient of linear expansion of $7x10^{-5}$ mm/mm^{o}C(e.g. for a difference of 10 ^{o}C, linear expansion of 3 m length uPVC pipe =10 x 3000x 7x 10^{-5} =2.1mm). Expansion joints must not be placed below ground level. All expansion joints shall be installed with the proper fittings in accordance with the manufacturer's instructions.

2.3.3.1 Expansion joints shall be provided at a maximum spacing of 6 meters for cold water pipelines and 4 meters for hot water pipelines (e.g. kitchen or etc.) or wherever specified

2.3.3.2 The permissible maximum length of pipelines between fixed points without an expansion joint or provision for movement is 2 meters for cold water pipelines and 1 meter for hot water pipelines. A fixed point is one at which longitudinal movement of the pipe or fitting is restrained.

2.3.3.3 An expansion joint shall be constructed with a device or a definite means to ensure the provision of the desired gap for thermal expansion between the two pipes during installation.

2.3.3.4 Any expansion joint provided shall incorporate a permanent shield to provide protection to the sliding surfaces and rubber ring seal from ingression of dust particles.

2.3.3.5 Rubber ring seal used in the expansion joint shall be made of natural rubber or mixture of natural and synthetic rubber or synthetic rubber complying with MS 672.

2.4 Cast Iron Soil, Waste and Vent Pipes

2.4.1 Where shown or stated in the Drawings, 100mm diameter cast iron soil and vent pipes internally coated with anti corrosive bituminous coating shall be provided, fixed and connected to the fittings and sanitary system. The pipe shall be jointed with an approved resin with molten lead and well caulked. All necessary bends, branches, offsets, inspection pieces, hopper heads, holder bats shall be provided where necessary.
Vertical stacks shall terminate 600mm above roof level with open ends and provided with approved galvanised balloon grating.

2.4.2 Where shown or stated in the Drawings, 50mm diameter anti siphonage pipes of similar quality as above shall be provided and fixed.

2.4.3 Galvanised wrought iron waste pipes of the same diameter as the outlet served shall be provided and fixed to fittings complete with all necessary bends, tees, sockets, plugs, etc. The waste pipes shall be carried through walls and angled to flow into concrete surface drains or if from upper floors connected to the waste or soil stack as shown in the Drawings. Cast iron waste pipes shall be as specified hereinbefore for soil pipes and shall be of an adequate diameter unless otherwise detailed in the Drawings.

3. Rain Water Goods

3.1 Flashing

Unless otherwise shown in the Drawings, all flashing shall be of aluminium sheet, free from cracks, dross, scales, excess blisters and any other defects which might be detrimental to its wearing or working properties. Sheets shall be reasonably flat before forming and cutting. All aluminium sheets used for flashing shall be at least 1.2mm thick. Flashing shall have a minimum depth of 180mm with the upper edge turned into the wall and pointed in cement. Where nails or screws are used for fixing, they shall be of the heavily galvanised type. The flashing work shall be performed by skilled workmen.

3.2 Gutters

3.2.1 General

3.2.1.1 Where gutters are to be provided they shall conform to the shape, dimensions and materials shown in the Drawings. All gutters shall be provided and fixed complete with all necessary angles, squares and obtuse, stop end, outlets and other necessary gutter fittings.

3.2.1.2 Gutter outlets shall be located at the position shown in the Drawings and each provided with a galvanised iron wire balloon grating.

3.2.1.3 All gutters other than those of reinforced concrete shall be properly fixed and adequately supported and all necessary brackets shall be provided. Brackets shall be of the type and pattern that will conform to the profile of the gutter and unless otherwise shown or stated in the Drawings, shall be of galvanised steel screwed to the fascia.

3.2.1.4 Unless otherwise shown or stated in the Drawings, all gutters shall be laid to a minimum fall of 12mm in 1m with properly constructed laps or

joints laid in the direction of flow.

3.2.2 Aluminium Gutters

Unless otherwise shown in the Drawings, all gutter linings, valley and eaves gutter shall be of aluminium and shall conform to the following weights and sizes:

Gutter lining**:**
1.2mm thick, 225mm minimum depth against walls, 330mm minimum width under roofing, to a fall of 50mm in 3m.

Valley gutter:
1.2mm thick, turned under roofing 330mm minimum each side.

Eaves gutter:
1.2mm thick jointed using soldered seams neatly and accurately executed.

Gutter linings and valley gutters shall be laid on 25mm thick close timber boarding adequately supported.

3.2.3 Unplasticised Polyvinyl Chloride (uPVC) Gutters

Where shown, approved uPVC gutters to BS 4576 shall be provided and fixed. The gutters shall be jointed using approved solvent cement used in accordance with the manufacturer's instructions.

3.3 Rainwater Downpipes

3.3.1 General

Where rainwater downpipes are to be provided, they shall conform to the shape, dimensions and materials shown in the Drawings and fixed in the position indicated therein to receive the gutter outlets.

All downpipes shall be provided complete with all necessary fittings including rainwater heads, rainwater shoes, radius, bends, offsets and everything else required. Outlets in flat roof and balcony connected to downpipe shall be provided with an approved uPVC or stainless steel grating.

All downpipes and fittings shall be properly installed and adequately secured into position using necessary clamps, brackets or holderbats. Unless otherwise shown in the Drawings, clamps, brackets or holderbats shall be secured using approved galvanised nails or screws driven not less than 8mm into hardwood plug or other approved plugs in walls or columns.

3.3.2 Aluminium Downpipes

Unless otherwise shown in the Drawings, all downpipes shall be fabricated from aluminium_sheets of 1.2 mm thick. Joints shall be formed using slot-in joint neatly and accurately executed.

3.3.3 Unplasticised Polyvinyl Chloride (uPVC) Downpipes

Where shown, approved uPVC downpipes complying with MS 1063 shall be provided and fixed. The pipes shall be jointed with approved solvent cement in accordance with the manufacturer's instructions.

Appendix K/1
(Ref.Cl. 2.1.1)

SCHEDULE OF SANITARY FITTINGS

TYPE		DESCRIPTION
1. Wash Basins(a)		560mm x 410mm wash basin in approved colour vitreous china complete with chromium plated tap, blank tap hole stopper, 30mm 'p' or 's' trap with 40mm seal, waste fittings, plug with chain and painted bracket supports.
	(b)	Ditto, but with two chromium plated tap, marked 'hot' and 'cold' (for cold and hot water supply only).
2. Vanity Tops	(a)	Vanity top as specified, with integrated sink as shown in the Drawings, complete with chromium-plated tap, blank tap hole stopper, 30mm 'p' or 's' trap with 40mm seal, waste fittings and plug with chain.
	(b)	Vanity top as specified, but with holes pre-punched to receive an under-counter vanity basin and tap respectively, as shown in the Drawings, complete with 555mm x 415mm under-counter vanity basin in vitreous china, complete with chromium-plated tap, 30mm 'p' or 's' trap with 40mm seal, waste fittings and plug with chain, and painted bracket supports.
3. Sink	(a)	600mm x 400mm x 200mm earthenware plain edge sink in white fireclay complete with chromium plated tap, 40mm 'p' or 's' trap with 40mm seal, waste fittings, plug with chain and painted cast iron brackets.
	(b)	Metal sinks in stainless steel to size and shape as shown in the Drawings, complete with chromium plated tap as required, 40mm 'p' or 's' trap with 40mm seal, waste fittings, plug with chain and painted cast iron supports.
4. Water Closet	(a)	Pedestal closet in white vitreous china conforming to MS 1522:2001 or JKR Standard Specification 20200-0110-01 complete with pedestal pan, 'p' trap and ventilation outlet, plastic hinged seat and rubber buffers.
	(b)	Squatting closet in white vitreous china conforming to MS 1522:2001 or JKR Standard Specification 20200-0110-01 complete with pair of raised foot treads in white fire clay with 'p' trap and 40mm diameter uPVC flush pipe.
5. Urinals	(a)	Single urinal bowl in white vitreous china conforming to JKR Standard Specification 20200-0131-01 or AS 3982:1996 complete with back inlets, hangers and steadying brackets, 40mm outlet with hinged gratings and 50mm uPVC waste pipe.
	(b)	Urinal range of 2 or more bowls as (a) but with white vitreous china division between bowls.
6. Cistern for water closet	(a)	All W/C Cisterns shall be low pressure or Type B flushing cisterns conforming to JKR Standard Specification 20200-0160-03. Note: Type B flushing cistern – flushing cistern complete with low pressure inlet valve that at 34.5Kpa (5psi) static pressure and 0.1 litre /sec flow rate, the time taken for refilling 6 litre of water through the inlet valve into the cistern shall be within 60 secs after flushing. The dynamic pressure at the inlet of the inlet valve shall be not less than 31.8 kpa**.**
	(b)	Single flush 6 litres or dual-flush 6 / 3 liters low level vitreous china

cistern conforming to JKR Standard Specification 20200-0160-03 with 40mm flush pipe, low pressure water inlet valve, 20mm diameter overflow for discharge externally and chrome flushing lever handle.

(c) 6 litres high level vitreous china cistern conforming to JKR Standard Specification 20200-0160-03 with 40mm flush pipe, water inlet valve, 20mm diameter overflow for discharge externally and chromed lever handle.

(d) Each flush cistern for w/c shall be tested as stipulated in the requirements of JKR Standard Specification 20200-0160-03.

7. Cistern for urinal

(a) Single flush 2.5 litres urinal flushing cistern in white vitreous china conforming to JKR Standard Specification 20200-0136-02 complete with chromium plated flushing inlet pipe, 20mm diameter overflow for discharge externally and chrome lever handle.

8. Flush valve for water closet

(a) W/C flush valve shall be low pressure single flush 6 litres gravity flush valve. It shall have a non-hold-open feature or an automatic shut-off system. Vacuum Breaker is optional, only applicable to w/c flush valves intended to be connected to direct potable water mains. It's performance requires proper match of valve and w/c pan conforming to MS 1522:01.

Note

Low pressure gravity flush valve shall, at 34.5Kpa (5psi) static pressure, flush 6 litres of water and pass all the tests stipulated in MS 1522:01. The dynamic pressure at the inlet of flush valve shall be not less than 32.5 kpa.

(b) Each flush valve shall be made of metal (preferably copper alloy) and corrosion resistant. All exposed surfaces to the users shall be chromed plated or made of stainless steel.

(c) Each water closet flush valve used shall comply fully with ASSE 1037:1990, performance requirements for Pressurized Flushing Devices (Flush meters) for Plumbing Fixtures. Testing and certification by other approved testing body may be allowed with the S.O's approval. Each flush valve together with w/c shall pass all the tests listed below:

i) Endurance test;
ii) Hydraulic test;
iii) Performance tests according to test methods stipulated in MS 1522:01
    a) Newspaper test;
    b) Simulating solid test;
    c) Sawdust test and
    d) Ball test

9. Flush valve for urinal

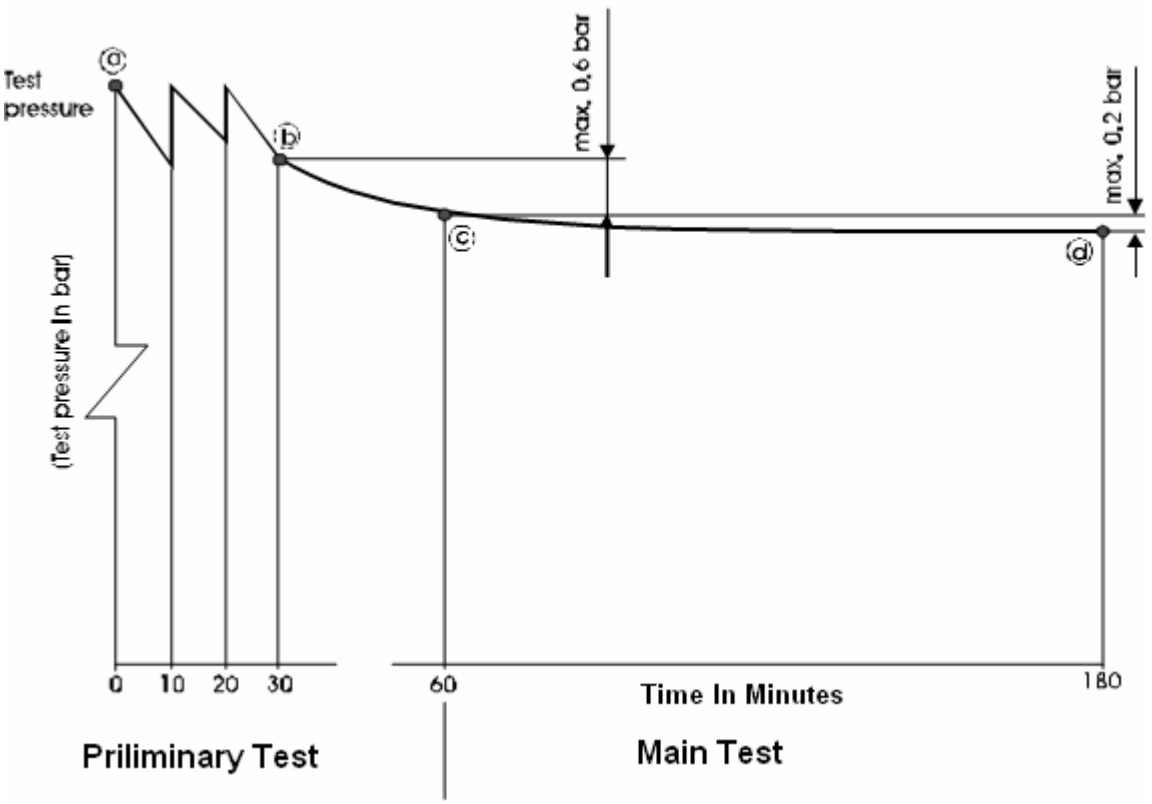
(a) Urinal flush valve shall be Single flush 2.5 litres gravity flush valve. It shall have a non-hold-open feature or an automatic shut-off system.

(b) Each urinal flush valve shall be made of metal (preferably copper alloy) and corrosion resistant. All exposed surfaces to the users shall be chromed plated or made of stainless steel.

(c) Each urinal flush valve shall be tested as stipulated in the requirements of JKR Standard Specification 20200-0131-01 or AS 3982:1996.

(OTHERS: state if required)

Pressure Test Diagram



Pressure Test Log Sheet

for water services installations JKR Malaysia

Project: _____
_____
_____

(A) **For Plastic Pipes (uPVC pipes, PE pipes, ABS pipes, PB pipes, PP-R Type 3 pipes etc)**

I. Preliminary Test

Test begin at _____(at least 15 bar) (a) _____ bar

Pressure after 30 minutes (b) _____ bar

Pressure after 60 minutes (c) _____ bar*1
*1 - shall not be more than 0.6 bar after 30 minutes

Leakage 9 yes 9 no

II. Main Test

Start after preliminary test completed _____ (c) _____ bar

Pressure after 120 minutes (d) _____ bar*2
*2 - shall not be more than 0.2 bar

Leakage 9 yes 9 no

(B) **For Metal Pipes (stainless steel pipes, copper pipes etc)**

Test begin at _____(at least 15 bar) (a) _____ bar

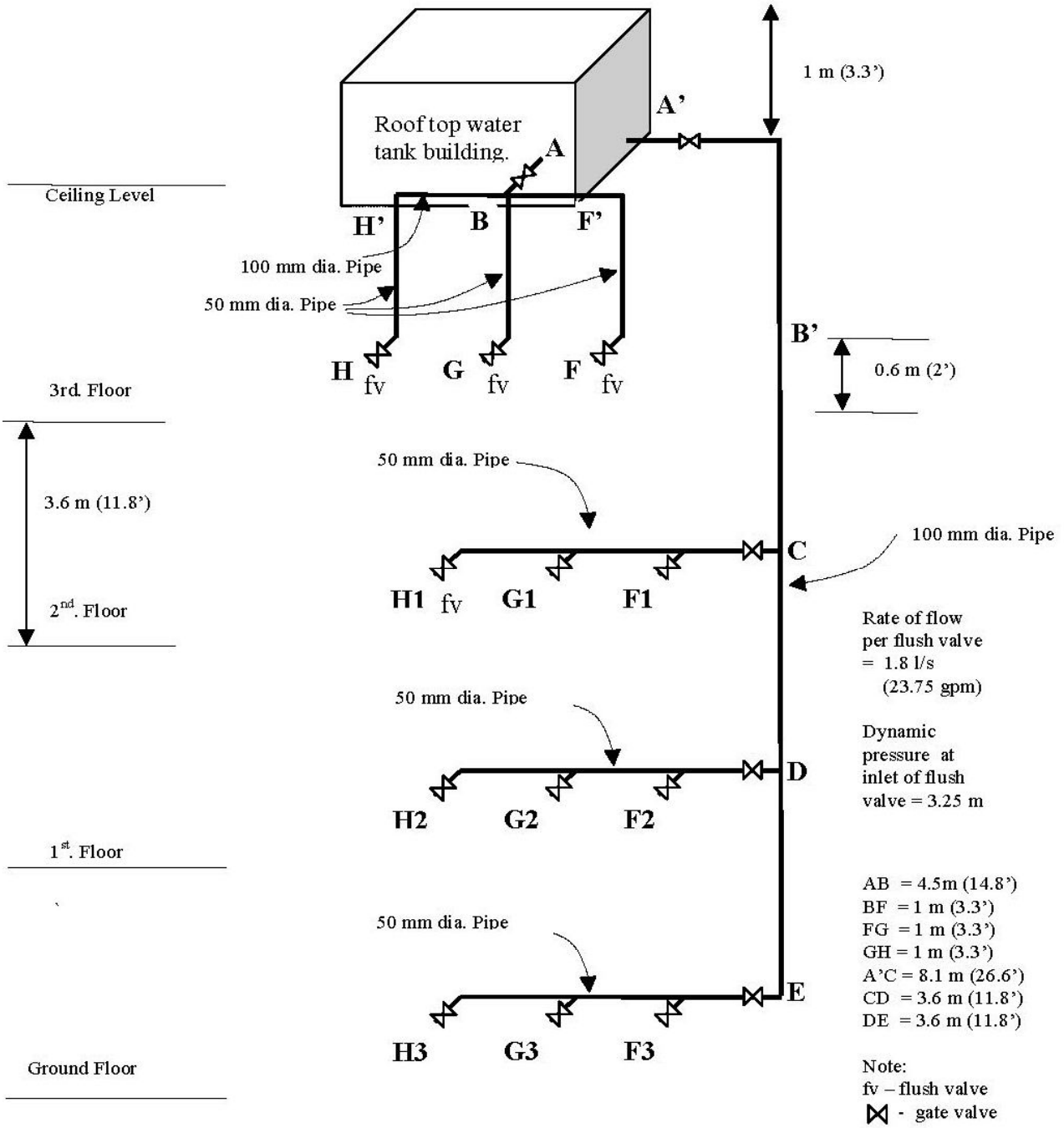
Pressure after 30 minutes (b) _____ bar

Leakage 9 yes 9 no

Installer/Company:

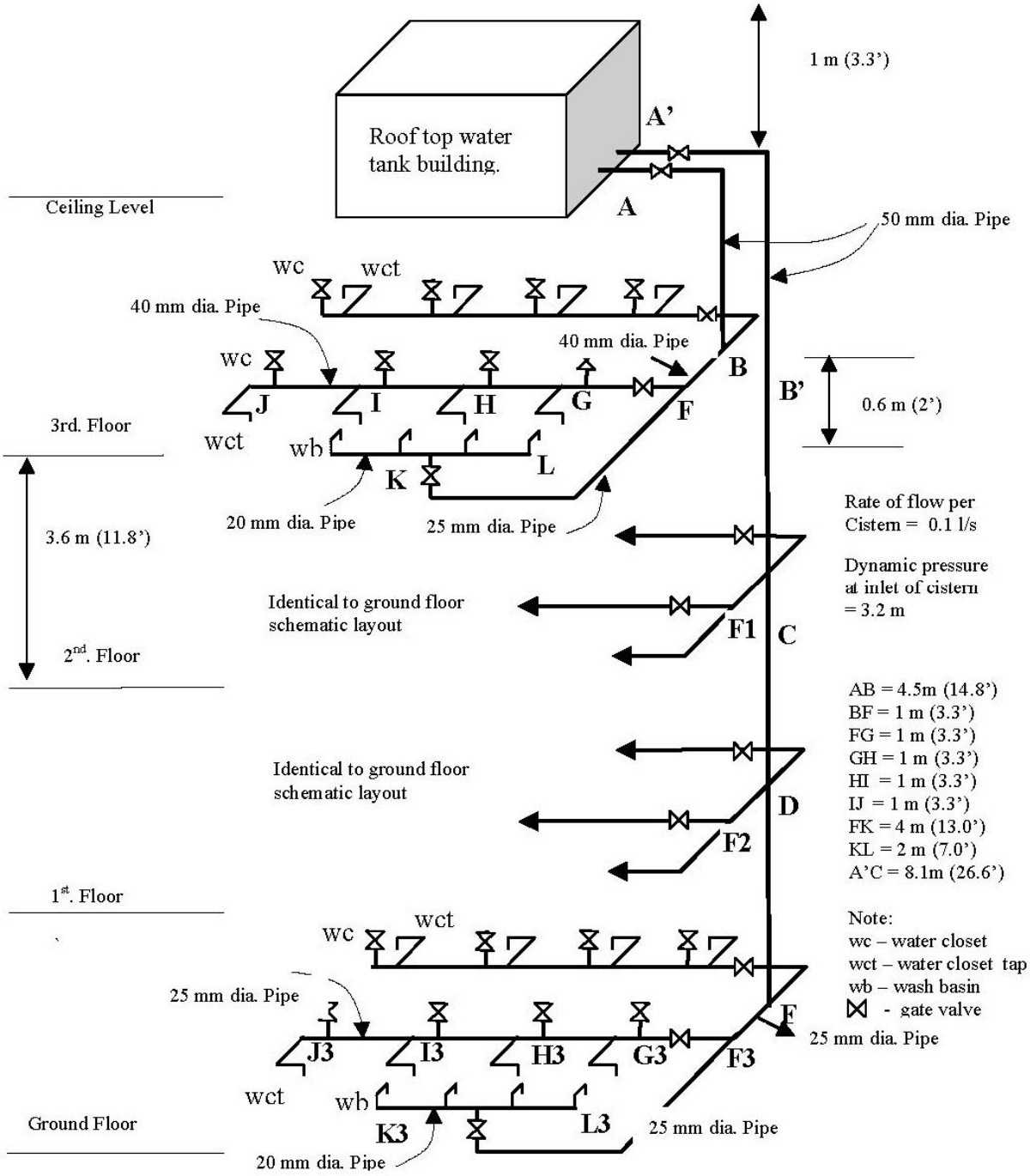
Date: _____ Completed by: _____

TYPICAL SCHEMATIC DIAGRAM OF INTERNAL PLUMBING FOR LOW PRESSURE FLUSH VALVES FOR A FOUR-STOREY BUILDING (in accordance with 2.2.1)



Note: separate system for top floor

TYPICAL SCHEMATIC DIAGRAM OF INTERNAL PLUMBING FOR LOW PRESSURE FLUSHING CISTERNS, WASH BASIN TAPS AND W/C TAPS FOR A FOUR-STOREY BUILDING
(In accordance with 2.2.2)



Note: separate system for top floor

SECTION L - GLAZING WORK

1. Glass

1.1 All glass shall conform to MS 1135 and shall be free from bubbles, specks and other defects. Samples shall be submitted for the approval of the S.O.

1.2 Unless otherwise shown in the Drawings, the type and thickness of glass and sealants shall be as stated in the Schedule of Glass in APPENDIX L/1.

2. Sealants

2.1 Unless otherwise stated in the Drawings, sealant shall be silicone, polysulphide or other approved type applied in accordance with the manufacturer's instructions.

2.2 The putty for glazing shall be of an approved type and shall comply with BS 544.

3. Glazing

3.1 All doors, windows, etc. except louvred windows shall be glazed as shown in the Drawings or as scheduled. All glass shall be cut to size with 2mm clearance all round the rebates. All exposed edges of glass panes shall be rounded off.

3.2 All glazing works shall be carried out strictly in accordance with the manufacturer's instructions.

3.3 Figured or textured glass surface for windows shall be installed facing the interior.

4. Glazing to Timber Windows

4.1 The grooves or rebates to be glazed shall first be cleaned, primed with wood primer, painted with one coat of oil paint and allowed to dry, followed by the application of a thin bed of glazing putty or sealant.

4.2 The glass panes shall then be properly placed and secured in the grooves or rebates with timber beading as detailed in the Drawings.

4.3 Where the glass pane is to be secured with putty or sealant, the glass shall be placed and held in the grooves or rebates with approved sprigs driven at intervals of not exceeding 300mm centres. The glass shall then be finally secured with back-putty or sealant finished true to profile and as detailed in the Drawings.

5. Glazing to Metal Windows

5.1 The grooves or rebates to be glazed shall first be cleaned of rust and primed with an approved metal primer and allowed to dry, followed by the application of a thin bed of glazing putty or sealant. The glass panes shall then be properly placed and secured in the grooves or rebates with metal beadings or neoprene rubber in accordance with the manufacturer's instructions or as detailed in the Drawings.

5.2 Where the glass panes are to be secured with putty, the panes shall be placed and held in the grooves or rebates with spring clips set in holes in the frame. The glass shall then be finally secured with back-putty or sealant finished true to profile or as detailed in the Drawings.

6. Glazing to Louvred Windows

6.1 The glass blades for fixed louvred windows shall be properly housed in the grooves of the timber frames and secured in position with timber beadings as shown in the Drawings.

6.2 In the case of adjustable louvred windows, the louvred frames shall be fixed on to the vertical members of the window frame and secured with 20mm long dome-headed galvanized screws fixed at 200mm centres. The louvre blades shall then be inserted and secured in the flanged clips, all in accordance with the manufacturer's instructions.

7. Glazing to Patented Windows, Doors, Panels, Sky Lights, etc.

7.1 Unless otherwise shown in the Drawings, the installation and glazing of patented windows, doors, roof-lights, etc., shall be strictly in accordance with the manufacturer's instructions.

8. Fixing of Glass Blocks

8.1 Glass blocks shall be laid butt-jointed in cement and sand mortar (1:4) by volume. Before the first course is laid, the base to receive the glass blocks shall be coated with an approved bitumen emulsion or similar material. Each panel of the glass blocks shall have a clearance of 13mm at sides and top with the surrounding structure. The clearance shall be filled with non hardening compound and finished as detailed in the Drawings or as approved by the S.O. Approved expanded metal reinforcement shall be provided at every fourth course. Unless otherwise shown or specified in the Drawings, all joints between the blocks shall be pointed with white cement and the exposed areas of the non hardening compound shall be painted to match the surrounding structure.

9. Cleaning on completion

10.1 On completion, all glass shall be cleaned both inside and outside and any broken, cracked or defective panes shall be replaced to the approval of the S.O.

APPENDIX L/1

SCHEDULE OF GLASS

No.	Type of Glass	Thickness (mm)	Application
1.	Clear Float Glass	5	• External use on windows and doors • Interior framed glass screens, partitions • Display windows, showcases, display shelves • Furniture :table-tops
2.	Tinted Float Glass	6	• External use on windows and doors • Interior framed glass screens, partitions • Display windows, showcases, display shelves • Furniture :table-tops
3.	Clear Figured (obscured) Glass	5	• Windows • Furniture, display bases, house fittings, partitions etc. • Decoration eg.front doors, display etc.
4.	Grey / Tinted Figured Glass	5	• Windows • Furniture, display bases, house fittings, partitions etc. • Decoration eg.front doors, display etc.
5.	Toughened / Tempered Glass	6	• Furniture & interior decorations, table tops, showcases, partitions and the like
6.	Laminated Glass	6	• Skylights, glass roofs and the like • Animal observatory windows & aquariums • High security places eg. Burglar-resistant showcases and the like • Places where safety is necessary eg. Verandah side panels and the like
7.	Wired Glass i) Clear & Polished ii) Figured & Translucent	6	• Places where safety and security are importance.
8.	Lead Glass	Minimum total thickness of 9mm laminated crystal clear glass with minimum 2mm thick lead sheeting sandwiched in between	• X-ray rooms
9.	Glass Block	190mm x 190mm x 80mm	

SECTION M - PAINTING WORK

1. **General**

1.1 All paints to be used shall be those supplied by approved manufacturers. The quality of paints shall comply with MS 125 in respect of oil/ enamel paints and MS 134 in respect of emulsion paints/acrylic paint.

1.2 Prior to commencement of the painting work, the Contractor shall submit the following to the S.O:

i) Name of the paint manufacturer and the manufacturer's certification that the paint conform to the relevant standard as specified in clause 1.1 hereof together with the proof that such certification have been verified by tests carried out by SIRIM or KISB in the last three (3) years.

ii) A copy of method statement including procedure for the painting works in accordance with this Specification and manufacturer's instruction.

1.3 Paints shall be delivered to the Site in the manufacturer's original sealed containers unopened and shall be used strictly in accordance with the manufacturer's instructions.

1.4 Paints shall not be adulterated and any paint that has deteriorated shall not be used and shall be removed from the Site forthwith.

1.5 Unless otherwise stated in the Drawings, the types of paints to be used for the work on exposed surfaces shall be as stated in the "Schedule of Paint Finish" attached hereinafter.

1.6 The colours and tints of paints shall be selected by the S.O. and the priming, undercoats and finishing coats shall be of approved differing tints and shall be obtained from the same manufacturer.

1.7 No painting shall be done under conditions which may jeopardize the quality of finished paintwork.

1.8 During painting, care shall be taken to prevent stain or damage to other works.

1.9 Surfaces to be painted shall be dry, free from dirt, oil, grease, old loose paint and other deleterious matter. All cracks shall be raked out and stopped and all holes and dents shall be filled.

1.10 Unless otherwise specified in the manufacturer's instructions, each coat of paint applied on timber or metal surfaces shall be allowed to dry and subsequently rubbed down lightly with sandpaper before the next coat is applied. Any dirt or dust shall be removed from preceding coats immediately before proceeding with application of the next coat.

1.11 All priming to shop fabricated components shall be done at the shop.

1.12 All prime surfaces shall be inspected and approved by the S.O. before commencement of painting works.

1.13 Finished surfaces shall be uniform in finish and colour and be free from brush marks or other defects.

1.14 Sample areas showing all tints of paints to be used shall be prepared by the Contractor as and when required by the S.O.

2. **Painting to Timberwork**

2.1 Painting to New Timberwork

2.1.1 Unless otherwise stated in the Drawings**,** all exposed wrot surfaces of timber shall be painted as specified hereinafter.

2.1.2 Before painting to new timberwork, all knots shall be covered with knotting and all nail holes, cracks, etc. shall be stopped with white lead and putty (1:3) and shall be primed with aluminium wood primer well brushed in. The prepared surface shall be painted with one undercoat and unless otherwise specified, shall be finished with two coats of gloss enamel paint. Each preceding coat shall be allowed to dry thoroughly and rubbed down lightly with fine sand paper and thoroughly cleaned before applying the next coat.

2.1.3 All timber surfaces abutting concrete or brickwork shall be primed before fixing or assembling.

2.1.4 All ironmongeries except hinges shall be removed before painting begins and shall be carefully refixed.

2.2 Repainting Existing Timberwork

2.2.1 Where repainting to existing timber work is specified, the following procedure shall be adhered to. If the surface is intact, it shall be rubbed down with fine sand paper to the approval of the S.O. Then one coat of undercoat shall be applied followed by two coats of gloss enamel paint unless otherwise specified. Where cracking and flaking have occurred, the entire existing paint shall be removed by burning off or by use of paint remover as approved by the S.O. The surface shall then be thoroughly cleaned and shall be applied with one coat aluminium wood primer followed by one undercoat and unless otherwise stated in the Drawings, shall be finished with two coats of gloss enamel paint.

3. **Painting to Metalwork**

3.1 Painting New Steel and Ironwork

3.1.1 The areas to be painted shall be cleaned down and be free from rust, scale, oil, grease, dirt and dust. One coat of approved metallic primer shall be applied followed by one undercoat and unless otherwise specified, shall be finished with two coats of gloss enamel paint. Soil and vent pipes shall be primed as above and given two coats of approved bituminous paint.

3.2 Repainting Existing Steel and Ironwork

3.2.1 Where repainting to existing steel or ironwork is stated in the Drawings, the following procedure shall be adhered to. Where a firm surface exists, it shall be scuffed with fine sand paper to the approval of the S.O. and spot primed if necessary before the application of one undercoat and unless otherwise specified, shall be finished with two coats of gloss enamel paint.

If the old paint is in a bad, deteriorated condition the whole paint shall be removed by the use of approved paint remover or by scraping as approved by the S.O. The surface shall be thoroughly cleaned and shall be applied with one coat approved metallic primer, one undercoat and unless otherwise specified, shall be finished with two coats of gloss enamel paint.

3.3 Painting New Galvanized Ironwork

3.3.1 Where painting to new galvanized ironwork is specified, the surfaces shall be applied with one coat of approved self-etching quick drying metallic primer followed by one undercoat and unless otherwise specified, shall be finished with two coats of gloss enamel paint.

3.4 Repainting Existing Galvanized Ironwork

3.4.1 Where repainting to existing galvanized ironwork is specified, the following procedure shall be adhered to. If the surface is not corroded, it shall be slightly sanded and all dirts, oil, and grease removed by washing with an approved solvent and applied with one coat approved metallic primer followed with one undercoat and unless otherwise specified, shall be finished with one coat of gloss enamel paint. If the surface has corroded, the whole paint shall be removed by the use of approved paint remover or by scraping as approved by S.O. When the surface is completely clean, it shall be applied with one coat approved metallic primer, one undercoat and unless otherwise specified, shall be finished with two coats of gloss enamel paint.

4. Painting to Masonry Work

4.1 Painting New Plastered/Masonry Surfaces

4.1.1 The new plastered or masonry surfaces shall be allowed to dry completely and shall be cleaned down to remove dust, dirt, plaster splashes, and the like. In case of old unpainted walls, all fungus, mosses, lichens and vegetative growth shall also be removed. The cleaned surfaces shall then be applied with one coat approved alkali resisting primer sealer and, unless otherwise stated in the Drawings, followed with two coats of emulsion paint.

4.2 Repainting Existing Plastered or Masonry Surfaces

4.2.1 Where repainting to existing plastered or the masonry surface is specified, the following procedure shall be adhered to. If existing paintwork is still intact, the surfaces shall be washed down and applied with two coats of emulsion paint. If the existing paintwork is loose or chalky, the paint shall be removed by scraping and the surface shall be washed. All cracks and other imperfections shall be made good and the surface allowed to dry completely. The surface shall then be applied with one coat approved alkali resisting primer sealer and, unless otherwise stated in the Drawings, followed with two coats of emulsion paint.

4.3 Where shown in the Drawings, acrylic paint to MS 134 shall be applied on new or existing surfaces such as brickwork, plaster and cement rendering in accordance with the manufacturer's instructions. Acrylic painting work shall be carried out by painting applicator approved by approved manufacturer. Prior to commencement of the painting work, the Contractor shall submit to the S.O the following:

i) The paint's performance warranty by the manufacturer to the Government on the performance of the paint against any peeling, cracking, fungus/ algae growth and discoloration which may arise during a period of three (3) years from the date of practical completion due to insufficiency in material or workmanship. The terms and conditions of the warranty shall be as stipulated in APPENDIX M/1.

ii) Name of the painting applicator approved by the manufacturer including written evidence of the current approval.

5. **Treatment to Fair Surfaces**

5.1 Surfaces that are to be left bare such as for fair-face brickwork, fair-face concrete or stones and the like shall be thoroughly clean, dry and free from grease, dust and loose or flaking materials. The surfaces shall then be treated with an approved colourless silicon-based water repellant liquid to BS 6477 applied in accordance with the manufacturer's instructions. The solution shall be applied in two coats over the entire area and crevices by brushing.

6. **Painting to Timber-Based Products**

6.1 Chipboard Surfaces

Before painting, all nail holes, crevices and the like shall be stopped with white lead and putty (1:3). The surface shall then be smoothened by rubbing down with fine sand paper and finally cleaned to remove dust. Where the board is to be finished with enamel paint, one undercoat and two finishing coats of gloss enamel paint shall be applied. If the board is to be finished with emulsion paint, two coats of emulsion paint shall be applied. Where repainting to existing enamel paint finished chipboard is required, the following procedure shall be adhered to. If the paintwork is still intact, it shall be rubbed down with fine sand paper to the approval of the S.O. Then one coat of undercoat shall be applied followed by one coat of gloss enamel paint. Where cracking and flaking has occurred, the entire existing paint shall be removed by burning off, as approved by the S.O. The surface shall then be thoroughly cleaned and shall be applied with one undercoat and finished with two coats of gloss enamel paint. Where repainting to existing emulsion paint finished chipboard is required, the surface shall then be thoroughly cleaned and applied with two coats of emulsion paint.

6.2 Hardboard Surfaces

Before painting to hardboard, all nail holes, crevices and the like shall be filled with approved putty. The surface shall then be applied with two coats of emulsion paint unless otherwise specified.

6.3 Wood Cement Board Surfaces

Before painting to wood cement board, all nail holes, crevices and the like shall be filled with approved filling compound of alkali resistant type. The surface shall then be lightly sanded and any dust should be removed from the surface with a piece of clean, coarse cloth. The surface shall then be applied with two coats of emulsion paint unless otherwise specified.

7. **Painting to Gypsum Board and The Like**

7.1 Before painting the surfaces shall be clean and free from dirt. The surfaces shall then be applied with two coats of emulsion paint. Similar procedure shall be followed where repainting to existing painted surfaces is required.

8. **Painting to Laboratory Bench Tops**

8.1 Timber tops of benches in laboratories that are required to be painted shall be prepared as described hereinbefore for timberwork. The surfaces shall then be applied with one coat aluminium wood primer followed by one coat approved chemical resistant primer and finished with two coats of approved chemical resistant gloss enamel paint in accordance with the manufacturer's instructions. Where repainting to existing timber tops laboratory benches is required, the surfaces shall be rubbed down lightly with fine sand paper. The surfaces shall then be thoroughly cleaned and shall be applied with one coat

of approved chemical resistant primer followed by one coat of approved chemical resistant gloss enamel paint.

9. Varnishing

9.1 Varnishing to New Timberwork

9.1.1 The surfaces to be varnished shall be smoothened with fine sand paper and all crevices, holes and the like, if any, shall be filled with approved whiting. It shall be clean, dry, free from dust, dirt and wax before the application of varnish. Unless otherwise approved by the S.O, the surfaces shall be applied with two coats of approved varnishing mixture used strictly in accordance with the manufacturer's instructions. Where non patented products are allowed to be used, the varnishing mixture shall consists of methylated spirit, shellac and approved stain forming the first coat followed by one coat of an approved mixture consisting of thinner and lacquer. The mixtures shall be of uniform consistency throughout. Unless otherwise stated in the Drawings, the finish shall be gloss.

9.2 Revarnishing to Existing Timberwork

9.2.1 Where revarnishing to timberwork is stated in the Drawings or described in the Bills of Quantities, the surface shall first be thoroughly scuffed to remove the existing varnish. The surface shall then be smoothened with fine sand paper, cleaned, dried and free from dust, dirt and wax. It shall then be varnished as described hereinbefore for new timberwork.

10. Completion of Painting Work

10.1 On completion of paintwork, all paint marks inadvertently left on glass, floors, tiles and other surfaces shall be removed. Any stain or marking on finished paintwork shall be removed and touched up to the approval of the S.O.

SCHEDULE OF PAINT FINISH - (*Ref.* ***Cl.1.6***)

		Surfaces to be painted	Type of paint
1.0	Masonry		
	1.1	Plastered surfaces	
		1.1.1 Internally	Emulsion
		1.1.2 Externally	Weather resistant acrylic
	1.2	Concrete blockwalls and grillwork	
		1.2.1 Internally	Emulsion
		1.2.2 Externally	Weather resistant acrylic
	1.3	Fair-faced brickwork (externally)	Water repellant solution
	1.4	Fair-faced concrete and other self-finished plastered surfaces such as Shanghai plaster, terrazzo, etc. (externally)	Water repellant solution
	1.5	Stonework (externally)	Water repellant solution
2.0	Timberwork		
	2.1	Wrot timber surfaces including plywood (other than 2.2 and 2.3)	Enamel
	2.2	Timber ceiling	Stain and varnish
	2.3	Joinery fittings	Stain and varnish
3.0	Timber-based products		
	3.1	Chipboard ceiling	Emulsion
	3.2	Chipboard panelling	Enamel
	3.3	Hardboard	Emulsion
	3.4	Other timber boards	Emulsion
4.0	Gypsumboard and the like		Emulsion
5.0	Steel and Metalwork		Enamel

APPENDIX M/1

WEATHER RESISTANT ACRYLIC PAINT PERFORMANCE WARRANTY

1.0 Coverage of Performance Warranty

We ..... the paint Manufacturer hereby warrants that for a period of three (3) years from the date of Practical Completion, the paint system shall not be affected by the following defects:

- Peeling

  This condition is manifested when the paint film peels away or detaches from the substrate

- Cracking

  This condition is manifested by any visible cracking on the paint film other than that caused by plastering cracks and structural defects.

- Fungus/Algae Growth

  This condition is established when there is growth of micro organisms on the surface of paint films which results in the marring of the appearance of the paint film through discoloration.

- Discoloration

  This condition occurs when the coating loses its original color in patches and excessive discoloration appears.

In the event of the occurrence of any defects covered under this warranty the Manufacturer shall take rectification action at his own cost.

2.0 Exclusion of Performance Warranty

This warranty is subject to the following conditions:

i) The applicator is to be approved by the Manufacturer
ii) The Manufacturer reserves the right to inspect and test the paintwork as and when necessary.
iii) The substrate must not be affected by seepage and constant dampness in the wall.
iv) If the walls are persistently damp with a moisture content above 15% as per reading of protimeter, this warranty, is not valid. Such high levels of moisture will cause the paint to fail and exhibit watermarks, discoloration, peeling or flaking which are not covered by this warranty. The onus is on the paint Manufacturer to substantiate the evidence.
v) This warranty does not cover any defect, damage or deterioration of the paint system arising from the structural defects, mechanical / electrical causes, physical knocks, job damage, accumulation of atmospheric dirt, stains on the paint system or repair work by others without notification to the Manufacturer.
vi) Claims for incidental or consequential damages resulting from a breach of this warranty are specifically excluded.

3.0 **Procedure for Claims**

i) Any defect claims shall be made in writing and delivered by post or by hand to the Manufacturer.

ii) A technical team from the Manufacturer will be despatched to evaluate the nature of the claim. Should their findings conclude the defects as within the scope of warranty, then the Manufacturer shall make good such defects.

iii) Should the Manufacturer's technical team conclude that the defect falls under the "Exclusion of Performance Warranty" or other factors alien to the scope of warranty, the Manufacturer will not be held responsible for the claim.

iv) Should the Government disagree with the conclusion of the technical team pertaining to the defects in particular, then an independent third party competent in such technical evaluation shall be appointed to investigate the disputed defects.

The appointment must seek prior mutual agreement between the Government and the Manufacturer.

The findings of the independent third party shall be conclusive and mutually accepted by the Government and the Manufacturer.

v) If the finding of the independent third party are within the coverage of this performance warranty, all cost shall be borne by the manufacturer; otherwise such cost shall be borne by the Contractor.

vi) All claims for the defects must be received by the Manufacturer not later than 14 days from the expiry of the warranty period.

Manufacturer

Company Stamp

Signature

Name

Date

Witness

Company Stamp

Signature

Name

Date

SECTION N - EXTERNAL WORKS

SECTION N.1 - ROADS AND HARDSTANDING

1. General

1.1 The construction of roads and hardstanding shall generally be carried out only after completion of all drainage systems, services and ducts which may affect the Works, unless otherwise agreed by the S.O.

2. Subgrade

2.1 Material for the top 300mm of subgrade shall have a minimum soaked laboratory California Bearing Ratio (CBR) of 5% when compacted to 95% of the maximum dry density determined in the BS 1377 Compaction Test (4.5 kg Heavy Rammed Method).

2.2 Throughout the top 300mm of subgrade, the materials shall be compacted to not less than 95% of the maximum dry density determined in the BS 1377 Compaction Test (4.5 kg Heavy Rammed Method).

2.3 In cut area, the top 300mm of the subgrade shall be scarified and recompacted to 95% of the maximum dry density determined in the BS 1377 Compaction Test (4.5 kg Heavy Rammed Method). If the S.O. is fully satisfied that the subgrade in its natural state possesses a density exceeding the requirements, then the surface of the subgrade shall be trimmed and rolled to obtain a smooth finish.

2.4 Where the material in cut area is found to be unsuitable for use in the top 300mm of subgrade or to a suitable level to be determined by the S.O., it shall be removed and replaced with suitable material which shall be compacted as indicated above. Alternatively, stabilizing agent may be used subjected to the S.O. approval.

2.5 The subgrade shall be finished in a neat and workmanlike manner, and the widths of embankments and cuts shall be everywhere at least of those specified or shown in the Drawings on both sides of the centreline. The top surface of the subgrade shall have the required shape, superelevation, levels and grades and shall be finished everywhere to within + 10mm and - 30mm of the required level.

i. Where rock surfaces extend over the whole width of the formation:

The rock surface shall be trimmed to a free draining profile, at or below formation levels. No high spot shall protrude above the formation level.

Any voids or cavities more than 0.5 metres below the formation level shall be filled up with approved lean concrete having 7-day cube strength greater than 7 N/sq.mm. The rock surface shall then be brought up to the formation levels with approved crushed rock or gravel, regulated and blinded.

ii. Where rock outcrop occurs over part of the formation only: -

The rock outcrop shall be cut down to at least the formation level.

3. Lower Subbase

3.1 Where shown or stated in the Drawings, this work shall consist of furnishing, placing, compacting and shaping lower subbase material on a prepared and accepted subgrade

in accordance with this Specification and the lines, levels, grades, dimensions and cross-sections shown in the Drawings and/or as required by the S.O.

3.2 The lower subbase material shall be of inorganic soil, sand, gravel, weathered or fragmented rock, or a mixture of any of these materials, essentially free from vegetative and other organic matter.

3.3 Prior to placing any lower subbase material, the underlying subgrade (particularly the top 300mm of the subgrade) shall have been shaped and compacted in accordance with the provisions of subsection 2. Notwithstanding any earlier approval of finished subgrade, any damage to or deterioration of the subgrade shall be made good to the satisfaction of the S.O. before the lower subbase is constructed.

The lower subbase shall be placed over the full width of the formation to the required thickness as shown in the Drawings or directed by the S.O. in one layer or more, each layer not exceeding 200mm compacted thickness. Where two or more layers are required, they shall be of approximately equal thickness and none shall be less than 100mm compacted thickness.

Each layer of lower subbase shall be processed as necessary to bring its moisture content to a uniform level throughout the material suitable for compaction, and shall then be compacted using suitable compaction equipment approved by the S.O. to not less than 95% of the maximum dry density determined in the BS 1377 Compaction Test (4.5 kg Heavy Rammer Method). Compaction shall be carried out in a longitudinal direction along the formation and shall generally begin at the outer edge and progress uniformly toward the crown on each side in such a manner that each section receives equal compactive effort, all to the satisfaction of the S.O.

The lower subbase shall be finished in a neat and workmanlike manner, and its average thickness over any 100-metre length shall not be less than the required thickness. The top surface of the lower subbase shall have the required shaped, superelevation, levels and grades and shall be everywhere within the tolerances specified in subsection 8.

4. Subbase

4.1 This work shall consist of furnishing, placing, compacting and shaping subbase material on a prepared and accepted subgrade or lower subbase in accordance with this Specification and the lines, levels, grades, dimensions and cross-sections shown in the Drawings and/or as required by the S.O.

4.2 The subbase material shall be of a natural or prepared aggregate comprising crushed rock, weathered or fragmented rock, gravel or crushed gravel, sand, or a mixture of any of these materials. The gradation of the material shall conform to one of the envelopes shown in Table 1.

TABLE 1 - GRADATION LIMITS FOR SUBBASE MATERIAL

BS Sieve Size	% Passing by Weight					
	A	B	C	D	E	F
50.0 mm	100	100	-	-	-	-
25.0 mm	-	79-95	100	100	100	100
9.5 mm	30-65	40-75	50-85	60-100	-	-
4.75 mm	25-55	30-60	35-65	50-85	55-100	70-100
2.0 mm	15-40	20-45	25-50	40-70	40-100	55-100
425 μm	8-20	15-30	15-30	25-45	20-50	30-70
75 μm	2-8	5-20	5-20	5-20	6-20	8-25

4.3 Prior to placing of any subbase material, the underlying subgrade (particularly the top 300mm of the subgrade) or lower subbase shall have been shaped and compacted in accordance with the provisions of subsection 2 or subsection 3.3 as appropriate. Notwithstanding any earlier approval or finished subgrade or lower subbase, any damage to or deterioration of the subgrade or lower subbase shall be made good to the satisfaction of the S.O. before the subbase is constructed.

The subbase shall be placed with an equipment approved by the S.O. over the full width of the formation to the required thickness as shown in the Drawings or directed by the S.O. in one layer or more, each layer not exceeding 200mm compacted thickness. Where two or more layers are required, they shall be of approximately equal thickness and none shall be less than 100 mm compacted thickness.

Compaction shall be carried out in a longitudinal direction along the formation and shall generally begin at the outer edge and progress uniformly toward the centre on each side, except on superelevated curves where rolling shall begin at the lower edge and progress uniformly toward the higher edge. In all cases, compaction shall be carried out in such a manner that each section receives equal compactive effort, all to the satisfaction of the S.O.

Throughout the placing, adjustment of moisture content and compaction of subbase material, care shall be taken to maintain a uniform gradation of the material and prevent its separation into coarse and fine parts, all to the satisfaction of the S.O.

The subbase shall be finished in a neat and workmanlike manner; its width shall be everywhere at least of that specified or shown in the Drawings on both sides of the centreline; and its average thickness over any 100-metre length shall not be less than the required thickness. The top surface of the subbase shall have the required shape, superelevation, levels and grades, and shall be everywhere within the tolerances specified in subsection 8.

5. Crushed Aggregate Base Course

5.1 This work shall consist of furnishing, placing, compacting and shaping crushed aggregate base course material on a prepared and accepted subgrade or lower subbase or subbase in accordance with this Specification and the lines, levels, grades, dimensions and cross-sections shown in the Drawings and/or as required by the S.O.

5.2 The crushed aggregate base course material shall be of crushed rock, or crushed gravel, or a mixture of crushed and natural aggregate, which is hard, durable, clean and

essentially free from clay and other deleterious materials.
The material shall conform to the following physical and mechanical quality requirement: -

i) The plasticity index shall not be more than 6;
ii) The aggregate crushing value when tested in accordance with MS 30 shall be not more than 30;
iii) The flakiness index when tested in accordance with MS 30 shall be not more than 30;
iv) The gradation shall comply with the envelope shown in Table 2 for the type specified.

TABLE 2 GRADATION LIMITS FOR CRUSHED AGGREGATE ROAD BASE

BS Sieve Size	% Passing by Weight	
	Type 1	Type 11
50.0mm	100	100
37.5mm	95 - 100	85 - 100
28.0mm	-	70 - 100
20.0mm	60 - 80	60 - 90
10.0mm	40 - 60	40 - 65
5.0mm	25 - 40	30 - 55
2.36mm	15 - 30	-
2.00mm	-	20 - 40
600μm	8 - 22	-
425μm	-	10 - 25
75μm	0 - 8	2 - 10

5.3 Prior to the placing of any crushed aggregate base course material, the underlying subgrade or lower subbase or subbase shall have been shaped and compacted in accordance with the provisions of the appropriate section of this Specification. Notwithstanding any earlier approval of finished subgrade or lower subbase or subbase, any damage to or deterioration of the subgrade or lower subbase or subbase shall be made good to the satisfaction of the S.O. before crushed aggregate base course is constructed.

The crushed aggregate base course shall be placed to the required width and thickness as shown in the Drawings or directed by the S.O. in one layer or more, each layer not exceeding 200mm compacted thickness. Where two or more layers are required, they shall be of approximately equal thickness and none shall be less than 100mm compacted thickness. Spreading shall be done by a mechanical spreader approved by the S.O. or, if approved by the S.O., by *a* motor grader.

Prior to spreading, crushed aggregate base course shall be processed as necessary to bring its moisture content to a uniform level throughout the material suitable for compaction. Spread material shall be maintained at the correct moisture content for proper compaction by sprinkling with water or drying as may be necessary, and shall be compacted using suitable compaction equipment approved by the S.O. to not less than 95% of the maximum dry density determined in the BS 1377 Compaction Test (4.5 kg Heavy Rammer Method).

Compaction shall be carried out in a longitudinal direction along the carriageway, and shall generally begin at the outer edge and progress uniformly toward the centre of each side, except on superelevated curves where rolling shall begin at the lower edge and

progress uniformly toward the higher edge. In all cases, compaction shall be carried out in such a manner that each section receives equal compactive effort, all to the satisfaction of the S.O.

Throughout the placing, adjustment of moisture content and compaction of crushed aggregate road base material, care shall be taken to maintain a uniform gradation of the material and prevent its separation into coarse and fine parts, all to the satisfaction of the S.O.

The material shall have a CBR value of not less than 80 when compacted to 95% of the maximum dry density determined in the BS 1377 Compaction Test (4.5 kg Heavy Rammer Method) and soaked for 4 days under a surcharge of 4.5 kg.

The crushed aggregate base course shall be finished in a neat and workmanlike manner; its width shall be everywhere at least of that specified or shown in the Drawings on both sides of the centrelines; and its average thickness over any 100-metre length shall not be less than the required thickness. The top surface of the crushed aggregate base course shall have the required shape, superelevation, levels and grades and shall be everywhere within the tolerances specified in subsection 7.2.

6. Binder and Wearing Course

6.1 Asphaltic Concrete

Unless otherwise shown in the Drawings, this work shall consist of furnishing, placing, shaping and compacting asphaltic concrete wearing course on a prepared and accepted bituminous or bitumen primed pavement courses immediately after the application of a tack coat. The materials shall be supplied in accordance with JKR Specification No.JKR 20401-0029-97 and laid in accordance with the Guidelines for The Laying of Asphaltic Concrete as described in the same Specification, and to the lines, levels, grades, dimensions and cross-sections shown in the Drawings and/or as required by the S.O.

6.2 Bituminous Macadam

Unless otherwise shown in the Drawings, this work shall consist of furnishing, placing, shaping and compacting bituminous Macadam wearing course on a prepared and accepted bituminous or bitumen primed pavement course immediately after the application of a tack coat. The materials shall be supplied in accordance with JKR Specification No.JKR 20401-0030-97 and laid in accordance with the Guidelines for The Laying of Bituminous Macadam as described in the same Specification, and to the lines, levels, grades, dimensions and cross-sections shown in the Drawings and/or as required by the S.O.

7. Horizontal Alignment, Surface Levels and Surface Regularity of Pavement Courses

7.1 Horizontal Alignment

The horizontal alignment shall be determined from the centreline of the pavement surface shown in the Drawings. The edges of the pavement as constructed and all other parallel construction lines shall be correct within a tolerance of + 50mm and **-** 0mm from the centreline. Kerbs, channel blocks and edge lines shall be laid with a smooth alignment within a tolerance of + 25mm and **-** 0mm from the centreline.

7.2 Surface Levels of Pavement Courses

The design levels of pavement courses shall be calculated from the vertical profile, cross fall and pavement course thickness shown in the Drawings. The level of any point on the

constructed surface of a pavement course shall be the design level subject to the appropriate tolerances given in Table 3.

TABLE 3 - TOLERANCES IN SURFACE LEVELS OF PAVEMENT COURSES

Pavement Course	Tolerance
Wearing Course	± 5mm
Binder	± 5mm
Road base	+ 0mm - 20mm
Subbase and Lower Subbase	+ 10mm - 20mm

The combination of permitted tolerances in the levels of different pavement courses shall not result in a pavement thickness less than that shown in the Drawings. Each pavement course shall have an average thickness not less than that shown in the Drawings.

SECTION N.2 -SURFACE WATER DRAINAGE AND CULVERTS

1. Excavation

1.1 Excavation Generally

1.1.1 Unless otherwise specified hereunder, all excavation work in this Section shall be as specified in SECTION C: EXCAVATION AND EARTHWORK. Excavation for all surface water drains and culverts shall be carried out so as not to cause any danger or obstruction to the traffic or public. It shall be carried out to the dimensions and levels as shown in the Drawings or as approved by the S.O. All excavation shall be inspected and approved by the S.O. prior to further work being carried out. The trench shall first be excavated to a depth of 150mm less than the depths intended or shown in the Drawings. The remaining excavation shall be carried out immediately prior to the placing of blinding materials. Should the bottom of the trench be inadvertently excavated below the specified level, it shall be brought back at Contractor's expense to the correct level with good selected earth or sand, carefully rammed into place.

1.2 Hard Materials**/** Rock Excavation

1.2.1 Where hard materials**/** rock is encountered in the trench excavation, it shall be removed to the approval of the S.O. Where layer of rock is encountered along the bottom of the excavation, it shall be cut and trimmed to the required level. All voids formed at bottom of the trench by the removal of rocks shall be backfilled to the required level with 1:3:6-20mm concrete or other suitable materials well rammed and compacted all to the approval of the S.O. Jagged surfaces of rocks at the bottom of the excavation due to the trimming shall be levelled and smoothened with sand blinding to the approval of the S.O.

2. Surface Water Drains

2.1 Precast Concrete Drains

All precast drain units shall be of concrete (1:2:4-19mm max. aggregate) and shall be of a dense and impermeable type, free from air holes and other defects and to the approval of the S.O. The precast drain units shall be cured for seven days before being laid. The unit shall be in 600mm lengths, true to shape, sizes and dimensions as stated and shall have smooth internal faces. Unless otherwise shown in the Drawings, the units shall be laid on 1:3:6-20mm concrete base, 75mm thick, to the proper falls and jointed straight, true to lines and levels. The joints shall be cement grouted.

2.2 Cascade Drains

Cascade drains shall be constructed from precast concrete drain units and laid stepping on a 150mm thick bed of mass concrete (1:3:6-20mm) as detailed in the Drawings or as approved by the S.O.

3. Culverts

3.1 Pipe Culverts

3.1.1 Pipes

Pipes for culverts shall be of spun reinforced concrete of approved manufacture complying with MS 881 or any equivalent alternative acceptable and approved by

the S.O. with spun concrete collars or spigot and socket type as shown in the Drawings. On each section of the pipe the following markings shall be clearly shown: -

(i) The date of manufacture
(ii) The name and trade mark of the manufacturer

The S.O. reserves the right to request for test certificates and to request for tests to be carried out on samples, all at the Contractor's own cost.

Individual sections of pipes may be rejected due to any of the following: -

(i) Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.

(ii) Defects that indicate imperfect proportioning, mixing and moulding.

(iii) Surface defects indicating honeycombed or open texture.

(iv) Damaged ends where such damage would prevent making a satisfactory joint.

3.1.2 Laying of pipes

The pipes shall be laid with collars or spigot and socket ends true to lines and grades as shown in the Drawings or as approved by the S.O. The laying of pipes and concreting for bedding and haunching shall be carried out strictly in accordance with the manufacturer's instructions.

Unless otherwise specified, the ends of the pipes shall be butts and the collar centred about the joint using wedges or other approved means. The annular gap shall then be filled with cement sand mortar (1:3) with only sufficient water added to ensure adequate workability and the wedges removed before finally fairing the joint. Special care shall be taken to see that any excess of cement mortar, etc. is neatly cleaned off while each joint is being made and any earth, cement or other material thoroughly cleaned out of the pipes by drawing a tight fitting wad through them as the work proceeds, or by any other approved means.

3.1.3 Haunching and Surround to Pipes

Bedding and haunching of pipes shall be of concrete (1:2:4-19mm) and be constructed as shown in the Drawings. The Contractor shall pack the concrete under and around the pipes to ensure an even bedding and solidity in the concrete. The concrete shall not be thrown directly onto the pipes. The upper surfaces of concrete shall be struck off with a wooden screed or template and neatly finished off.

3.1.4 Unless otherwise shown in the Drawings, concrete surrounds shall be carried up from the bed to a square section with a minimum thickness of 150mm all round the barrel of the pipes.

3.2 Box Culvert

3.2.1 Concrete Boxes

Reinforced concrete box culverts shall be of precast concrete of approved manufacture complying with MS 1293 or any equivalent alternative acceptable and approved by the S.O. Unless otherwise shown in the Drawings, the box shall be capable of withstanding a proof load test of 112.5 kN applied over an area of

320mm x 320mm at any position on the cover slab. The S.O. reserves the right to call for test certificates on the concrete boxes supplied.

3.2.2 Individual sections of the box may be rejected because of such defects specified hereinbefore for pipe culverts.

3.2.3 Laying of Concrete Boxes

Box culvert units shall be laid as close as possible and the maximum gap in between shall not be more than 13mm and the difference in level, not more than 3mm. The gap shall be filled with cement mortar (1:3) and finished smooth. To ensure uniform bearing, a layer of cement grout shall be spread along the top of the walls of the invert where the lid will sit.

4. Backfilling of Trench

4.1 Backfilling of trenches shall be carried out immediately after completion of drain laying or installation of culverts and as soon as the S.O. has inspected and given his approval.

4.2 In backfilling the trenches for drains, approved fill materials shall be placed evenly in layers not exceeding 150mm. To provide uniform support, loosed thickness of fill materials on both sides of the drain shall be thoroughly compacted with mechanical rammers. This procedure shall be followed for the whole depth of drain section.

4.3 In backfilling of trenches for culverts, heavy earth moving and compacting equipments shall not operate closer than 2 metres to the culvert until covered to at least one fourth of the depth of the culvert, but in no case less than 600mm. Light weight equipments may be operated within the above limitation after the embankment has been placed and compacted to give a minimum cover of 300mm over the top of the culvert.

SECTION N.3 - FENCE AND GATES

1. General

1.1 Unless otherwise shown in the Drawings, fencing shall be of chain link type as specified hereunder.

1.2 Unless otherwise stated in the Drawings, the height of the fence shall be 1500mm from the ground up to the full height of the chain link.

1.3 The fence shall be erected to the extent and location as shown in the site plan. Where fencing is to be located on the boundary of the Site, the Contractor shall ensure that its construction shall not infringe the adjoining properties.

2. Mild Steel Post and Bracings

2.1 Unless otherwise shown in the Drawings, mild steel angle posts and bracings shall be of size 57mm x 57mm x 6mm. All steel members for fencing and gates shall be free from rust, scales and other defects and shall be to the approval of the S.O. Previously used steel members shall not be used in the construction of new fencing and gates. Before delivery to the Site, the steel members for fencing and gates shall be precut and assembled at the Contractor's workshop and painted with one coat of approved metallic primer.

2.2 Where three strands of barbed wires are required, a mild steel angle arm 430mm long, of the same cross sectional dimension as the post shall be welded at the top of the post at 45 degrees inclination. Where six strands of barbed wires are required, two pieces of mild steel angle arms as specified hereinbefore shall be welded to the top of each post forming the shape 'Y' with each arm having three strands of barbed wires. The welding used shall be of continuous fillet welds. Necessary holes shall be made in the posts, arms and bracings for insertions of fixing bolts and clips.

3. Chain Link Mesh, Straining

3.1 Chain link mesh, straining wires and barbed wires shall be made of galvanized steel and of approved quality. The mesh shall be of size 64mm made up of 3.25mm (10 gauge) diameter wire. Straining wires shall be of 4.06mm (8 gauge) diameters and barbed wires shall be of 2.64mm (12 gauge) diameters.

4. Fencing

4.1 Unless otherwise shown in the Drawings, the mild steel angle posts shall be erected at 3000mm centres commencing from the gate post and the posts shall be embedded plumb in 1:3:6-25mm concrete footings of size 250mm x 250mm x 600mm deep. Mild steel angle bracings of the same cross sectional dimensions as the post shall be fixed at all corners, bends, junctions, gate posts and at every five bays of straight fencing.

4.2 The bracings shall be fixed at an inclination of 45 degrees to the horizontal with top end bolted to the post, 300mm below the top of the post and the bottom end encased in concrete footing as described hereinbefore.

4.3 The chain link mesh shall be stretched across the posts and secured in place using approved fencing clips. The end of chain link fencing abutting mild steel gate posts shall be fixed by means of 19mm x 3mm mild steel flat straps drawn through the mesh and bolted using 10mm diameter mild steel bolts to 25mm x 25mm x 6mm mild steel plates

welded to the posts at equal intervals of 300mm. Where gate posts are non metal, the termination of the fencing at the gate shall be by means of another mild steel angle post fixed to one side of the gate post and strengthened by bracing as described hereinbefore. The chain link mesh shall then be strained by three strands of 4.06mm (8 gauge) diameter galvanized steel straining wires threaded through the mesh and fixed to the posts.

4.4 Where shown in the Drawings, the bottom of the chain link mesh shall be buried in continuous 1:3:6-25mm concrete curbs. Unless otherwise detailed in the Drawings**,** the cross-sectional dimension of curbs shall be 125mm wide x 375mm high with 150mm protruding above the ground. The portion of the curb above the ground shall be rendered with 13mm thick 1:6 cement render to a wood float finish.

5. Gates

5.1 The gates shall be constructed as detailed in the Drawings.

6. Painting of Fence and Gates

6.1 The metallic primer previously applied to the steelwork at the workshop shall be touched up where necessary. Unless otherwise specified, the posts, bracings and gates shall be finished with two coats of approved aluminium paint.

SECTION N.4 - LANDSCAPING AND TURFING

1. General

1.1 All landscaping works shall be as shown in the Drawings. All turfing and tree planting shall be carried out in such a manner as to minimise risks of damage to turfs and plants, and stunted growth. Turfing on all slopes shall be carried out immediately after slopes are formed. Tree planting shall be carried out as soon as practicable.

1.2 All landscaping works shall start as early as possible so that trees and plants are well grown, and fully adapted to the new environment when the project concerned is handed over upon completion.

1.3 All landscaping works shall be furnished, installed and maintained by the Contractor as specified herein, or as shown in the Drawings, using the best horticultural management, giving special attention to planting practices, soil mixtures, and application of agricultural chemicals.

2. Classifications and Characteristics of Plants

2.1 Plants shall mean trees, palms, shrubs, ground covers, and plants of other descriptions to be provided by the Contractor, as shown in the Drawings or listed in the plant schedules.

2.1.1 Each tree shall possess characteristics of its variety and growth typical to such tree. All trees shall be well-branched, with straight trunks characteristic of the species, with well-shaped top and intact leader. The height shall be measured from the stem's earth line to the top of the tree.

2.1.2 Palms shall have vigorous root system, crown of new leaves, proper colour of leaves of adult palms, and sufficient hardlines. The height of palms shall be measured from the stem's earth line to the base of the first frond.

2.1.3 Shrubs and vines shall possess characteristics and growth habits typical of their species. All shrubs shall be well-shaped and bushy, with well-spaced branches, and not skinny. The height of shrubs or vines shall be measured from the stem's earth line to the top branches.

2.1.4 Ground cover is defined as any plant or groups of plant, other than grasses, which shall satisfactorily cover the ground, forming a compact and attractive cover.

2.2 All plants shall be in healthy growth condition, free from pests and diseases, and shall be representatives of their normal species or variety. All plants shall have well-branched heads and vigorous root systems, and shall be injury-free. Unless otherwise shown or specified in the Drawings, only nursery-grown plants shall be used. Plants which are potted or plastic-bag-grown shall not be root-bound.

3. Size of Plants

3.1 The size of plants refers to plantable size i.e. the size that is required for planting out on sites. All plants shall have the following sizes:-

3.1.1 Ground Covers

Ground cover plants can be supplied in plastic bags. If supplied in 150mm-size

bags, they shall have at least nine (9) cuttings per bag, and not less than 150mm long.

3.1.2 Shrubs

Height of shrubs shall range between 150mm and 1000mm.

3.1.3 Trees

Trees shall be either container-grown, or grown on the open ground. They shall be of the following three types:-

i. Tree Saplings

Tree saplings shall mean trees grown from seedlings or cuttings. They shall have straight main stems of not less than 1200mm in height from the soil level to the lowest branch, and a stem diameter of 12mm, and a well-branching system.

ii. Rooted Stump Cuttings

These refer to plants which can be easily grown from stem cuttings instead of from seeds. They shall have straight main stems of 2400mm to 3000mm in height, with a diameter ranging from 37mm to 50mm.

iii. Instant Trees

An instant tree is generally referred to the semi-mature tree with a minimum trunk height of 2000mm for palms (measured from earth line to first frond), and 3000mm for other trees which shall have well-spread branches.

3.1.4 Palms

Palms shall be either container-grown or grown on the open ground, and shall be of two types:-

i. Single-Stem Palms

These refer to palms with single main trunk. Their trunk height shall be not less than 1200mm measured from the earth line to the base of the first frond.

ii. Cluster Palms

The palms referred to are those which grow in clusters. They shall have a minimum of three (3) palms clustered together, measuring 750mm to 1000mm from the earth line to the base of the first frond.

4. Handling and Transplanting

4.1 Handling

Plants shall be transported, handled and stored in such a manner as to prevent deterioration, damage or contamination. All plant materials shall be carefully protected and, if necessary, wrapped with hessian or gunny cloth during lifting, transportation, unloading and storage on site.

4.2 Transplanting

4.2.1 Pits

Generally all pits for palms and trees shall not be less than 1000mm x 1000mm x 1000mm OR 1/3 size bigger than the root ball, spaced at intervals as shown in the Drawings or approved by the S.O.

For shrubs, the pit size may be reduced to 500mm x 500mm x 500mm deep (for big shrubs), or 300mm x 300mm x 300mm deep (for medium shrubs). Alternatively, continuous trench 500mm or 300mm deep respectively, shall be formed where required.

The bottom of all pits and trenches shall be forked loose to a depth of 300mm prior to backfilling with approved soil mixture before transplanting. All pits and trenches shall be soaked with water before planting.

Flower beds or trenches shall be made to the size as shown in the Drawings, and to a depth not exceeding 200mm.

4.2.2 Transplanting

Transplanting shall not be carried out in very hot, dry weather conditions which may result in initial drying out of the root system and / or scorching of leaves.

Immediately before transplanting, the plants shall be carefully removed from the nursery bags or pots. The plants shall be placed into the pits and the surround filled with approved black earth making sure that the roots are not excessively disturbed. The earth around the base of the stems shall be recessed slightly to facilitate watering.

4.2.3 Plant Supports

All newly planted plants shall be supported either by staking, tying or guying. Stakes shall be of wood, steel or plastic of an approved type, driven into the ground before planting so as not to damage the root ball or aerial parts of plants. Stakes shall be long enough to penetrate the undug soil to come flush with the lower branches of the plants and to be released during maintenance. Ties shall be nailed to the stakes, not the plants, with one (1) tie per stake set 150mm from the bottom.

5. Soil Mixture, Soil Conditioners and Chemical Fertilisers

5.1 Soil Mixture

Soil mixture for ground planting and backfill shall be in the ratio of 1:3, i.e. 1 part of soil conditioner or organic materials to 3 parts of black earth.

Planter box soil mixture shall be in the ratio of 1:2:3, i.e. 1 part of sand to 2 parts soil conditioner or organic materials to 3 parts black earth.

5.2 Black Earth

Black earth shall consist of fertile and friable topsoil obtained from a well-drained flood-free site. It shall be of medium texture and without admixture of stones, lumps, plants or roots, and other extraneous matter. It shall be delivered or used in a damp state.

5.3 Soil Conditioners

Soil conditioners shall be organic materials such as composted coconut fibre, peat or other approved materials which shall be composted in a stable condition, free from toxic impurities and containing no substance injurious to plants. The organic matter with 45%-55% moisture content and with Ph adjusted to 5.5 - 6.5 shall be used.

5.4 Chemical Fertilisers

Chemical fertilisers shall be granular slow release compound fertilisers with a minimum four (4) month release period at 32 degrees Celsius. They shall be stored in waterproof sealed bags and kept under shelter. The Contractor shall submit manufacturer's technical data on the proposed fertiliser for the S.O.'s approval prior to the application of the fertiliser.

6. Turfing

6.1 Unless otherwise shown in the Drawings, turfing shall be provided to all exposed earth surfaces throughout the site. All surfaces to be turfed shall be completely cleared of all incidental Contractor's debris, stone and other obstructions.

6.2 The ground to be turfed shall be graded to fall towards surface water discharge line as shown in the Drawings, or approved by the S.O.

On level ground, minimum gradient of 1:60 shall be provided to eliminate ponding hollows. Any undesirable vegetation, debris, stumps or roots shall be grubbed up and removed from the site.

6.3 50mm black earth shall be provided on a prepared surface, and compacted to provide a suitable tilt for the growth of the turf.

6.4 All turfs shall be of good, healthy, dense indigenous cow grass (Axonopus Compressus) from an approved source. The grass shall be of even density, vigorous growth and green in colour, forming a turf sufficiently fibrous to hold together when installed. They shall be free from lalang, mimosa, weeds or other foreign vegetation.

Each turf shall be approximately 300mm x 300mm x 50mm thick with roots still attached to the soil. They shall be kept moist and in shade, and shall be planted within 24 hours of lifting. Samples of turfs to be used shall be submitted to the S.O. for approval before any turfs are brought in for use. The sources of material shall be stated by the Contractor.

6.5 Unless otherwise shown in the Drawings, close turfing shall be provided to slopes, and extending two (2) metres of the platform at the top and bottom of the slope, one (1) metre to the sides of all drains, and two (2) metres wide of road shoulders, so that they cover the whole area without any space/gap between them.

Each sod shall be pegged in place with wooden/bamboo pegs 12mm diameter and 200mm long through the sod and into the soil base. These pegs shall be removed after the turfs have firmly established. On steep slopes, netting shall be laid onto the turfed areas for protection.

6.6 Unless otherwise shown in the Drawings, spot turfing shall be carried out on all level ground. The turf shall be laid at 450mm centres, embedded 25mm in the black earth.

6.7 Turfs shall be fertilised with approved slow release fertilisers high in Nitrogen content, one (1) month after planting at the rate of 60gm/sq.metre area, and evenly spread over the whole area. The turfs shall be well watered after each fertiliser application which shall be done once in every three months after grass cutting.

6.8 Grass cutting shall be done every three weeks after one (1) month growth/establishment by grass cutter/mower as often as is required to give a well trimmed sod not more than 25mm in height for flat surfaces and not less than 50mm on slope. All clippings shall be removed from the site before watering is carried out.

7. Football and Playing Fields

7.1 General

Unless otherwise specified hereinafter, turfing for football and playing fields shall be as specified hereinbefore. Turfing works shall start as soon as possible and shall be completed and fully established not later than three (3) months before the date of completion of the Works. The supply and installation of subsoil drains shall be as specified hereinafter at the locations and in accordance with the lines, levels and grades shown in the Drawings and/ or as directed by the S.O.

7.2 Materials

7.2.1 Sub-soil Drain Pipes

Subsoil drain pipes shall be of High Density Polyethylene (HDPE) peforated corrugated drainage pipe to DIN 16961 PT 1&2:1989 or equivalent, or Polyvinyl Chloride (PVC) pipes for subsoil drains complying with Australian Standard Specification 2439.1 or BS 3656 or equivalent, of diameter and lengths of pipe as shown in the Drawings.

7.2.2 Filter Materials

Filter materials shall consist of an angular, clean, hard and durable crush rock with uniformly sized particle of 14mm, free from lumps of clay or organic matter.

7.2.3 Geotextile Fabric

Geotextile fabric shall be of non-woven type thermally bonded with minimum weight of 100g/m^2, or equivalent and shall be of approved manufacture.

7.3 Site Preparation

The site area shall be completely cleared of all debris, large stones, discarded gravel and other unacceptable materials. The site shall then be graded to form a crown at the centre of the field with a minimum gradient of 1:300. The soil shall be of good texture and structure with the majority of the crumbs of size 1mm to 2mm and not contaminated with seeds, stolon or rhizomes of noxious weeds.

7.4 Trenching For Sub-soil Drain Pipes

Trenches shall be excavated and trimmed clean true to grade and alignment and the geotextile fabric shall be laid as shown in the Drawings. The fabric shall overlap the full width of the trench at the top. Where the fabric requires jointing along the trench, it shall overlap a minimum of 500mm at the joint.

7.5 Laying and Jointing Subsoil Drain Pipe

Subsoil pipe shall be laid and bedded as detailed in the Drawings. Subsoil drain pipe shall be jointed according to the manufacturer's recommendations.

7.6 Backfilling

The trench shall be backfilled with the filter material in layers not exceeding 150mm loose thickness and uniformly compacted by suitable method approved by the SO to the level as shown in the Drawings. Care shall be taken that the pipe is not damaged or displaced.

7.7 Outlets

Outlets shall be constructed as shown in the Drawings.

7.8 Laying of Sand and Turf Mixture

The prepared surface of the field shall be laid with a first layer of 100mm thick river sand or other suitable course grained granular materials, and a second layer of 100mm thick turf mixture before receiving the turf.

The Contractor shall carry out final gradient check prior to the turfing works.

Before turfing works commence, the Contractor shall submit samples of the turf mixture for the approval of the S.O. The turf mixture shall be laid to the required formation level and gradient.

The turf mixture shall have the following composition by weight of 4% - 5% organic matter, 12% - 15% clay and 81% - 85% river sand. The PH value for the root zone medium shall be 5 to 7.5.

7.9 Inspections

The Contractor shall give not less than twenty-four (24) hour notice prior to the commencement and upon completion of the under mentioned works. The Contractor shall not proceed with the next succeeding operation until specific approval has been given for the following:

a. Trench excavation.
b. Trench lining with geotextile fabric and laying of subsoil drain pipe.
c. Filter material backfill.
d. Sand laying.
e. Turf mixture.
f. Turfing works.

7.10 Levelling of Field

The turf shall be compacted with a roller weighing not more than one (1) tonne once a month. The roller shall be of sufficient weight to press the roots firmly into the soil to produce a close, well knit surface without over-compaction and binding of the soil.

7.11 Watering

The Contractor shall water the turf at least twice a day or as instructed by the S.O.

The rate of application and frequency of watering shall be sufficient to maintain the turf mixture in a moist condition to ensure proper and healthy growth of the turf even during the dry weather.

Water shall be applied as fine spray by means of suitable pumps and hose or sprinkler or any other method approved by the S.O so as not to disturb the turf mixture.

7.12 Weed Control

Weeding shall be carried out on the newly turfed area about ten (10) days after planting to get rid of foreign species and maintain a pure culture of Axonopus Compressus (Cow Grass). Weeding on a continuous basis shall be carried out to prevent weeds from growing.

7.13 Fertilisation

The first fertilisation shall be carried out two (2) weeks after planting, using mechanical spreader. Subsequently, the fertiliser shall be applied at three (3) weeks interval.

7.14 Mowing

Mowing shall be carried out using properly sharpened and adjusted machine tools so that the turf is cut cleanly and no tearing takes place.

The first cut shall be carried out when the turf reaches 50mm - 70mm in height. The turf shall be cut to 25mm - 30mm in height. Subsequently, mowing shall be done at least once in every two (2) weeks.

7.15 Top Dressing

The Contractor shall, from time to time or whenever directed by the S.O, check the flatness of the field and if found uneven, rectify by top dressing with turf mixture and followed by proper compaction.

7.16 Maintenance During Defect Liability Period

The Contractor shall be responsible for carrying out full-time intensive maintenance of the turfing works for the entire duration of the Defect Liability Period of the Works.

The maintenance includes watering, weed control, fertilisation, moving and top dressing, all as specified hereinbefore.

7.17 Handing Over of The Works

On handing over of the works, the field shall be in good playable condition with all the full line markings to the dimensions as shown on the Drawings.

8. Relocation and Protection of Existing Trees

8.1 Relocation of Trees

Where shown in the Drawings or if directed by the S.O, all existing trees having girth of 300mm and below identified and marked for relocation, shall not be cut, but shall be dug up, prepared for, and relocated by the Contractor to other areas within, or in the vicinity of the site. In the event of any such trees being accidentally cut or damaged, the same shall be replaced with trees of equivalent size and species by the Contractor. The Contractor shall protect and maintain the relocated trees by fencing to a height of 1.2meter, watering, manuring, pruning, and other necessary treatments throughout the contract period (including the Defects Liability Period) until satisfactory growth is established. Any relocated trees which are accidentally damaged, or fail to re-grow satisfactorily within the Defect Liability Period, shall be replaced accordingly at the Contractor's own cost.

8.2 Protection of Trees Retained On Site

All existing trees having girth of 800mm and above identified and marked by the S.O to

be retained on site, shall be protected and maintained by fencing to a height of 1.2meter, watering, manuring, pruning, and other necessary treatments throughout the contract (including the Defects Liability Period)so as not to jeopardise their growth. The ground around the tree spread shall be protected to prevent contamination from materials and chemicals detrimental to plant growth. Method of protection shall be to the approval of the S.O. In the event of any such trees being accidentally or otherwise cut or damaged, the same shall be replaced by the Contractor with trees of equivalent size and species at his own cost.

9. Maintenance of Plant and Turf

9.1 General

9.1.1 After planting and prior to the onset of the maintenance period, the Contractor shall be responsible for carrying out all necessary measures to ensure that all plant materials and turfing thrive and become established, and that the landscaped areas are kept in a clean and tidy condition.

9.1.2 The Contractor shall protect and maintain the plants and turfing from any damage and destruction, by way of watering, manuring and tilling, and by staking and fencing, where necessary, to support and protect the plants, until the end of the Defects Liability Period. All plants and turfs which are defective and / or fail to grow within the Defects Liability Period, shall be replaced and / or replanted accordingly, at the Contractor's own cost.

9.2 Weeding and Hoeing

9.2.1 Weeding and hoeing shall be done frequently, depending on weed growth or whenever directed to do so by the S.O. The Contractor shall be responsible for maintaining areas close to the base of trees or shrubs. Weeding shall be done manually by hoeing (cangkul) or forking at least once a month, with care taken not to wound plant stems.

9.3 Fertilisers and Application Rate

9.3.1 Feeding to plants shall be done with an approved organic manure or slow release fertilisers at regular intervals to maintain healthy growth. The S.O. reserves the right to request the Contractor to use any kind of fertiliser, let it be straight mixture, complex or slow release fertiliser, at the Contractor’s own cost.

9.3.2 Six (6) applications shall be required during the maintenance period. The first shall be carried out during the second (2nd) month after planting. The second and subsequent applications shall be worked into the soil above the roots, and lightly watered in. The fertiliser shall be applied, preferably, when the plants are in their active stage of growth.

9.3.3 Slow release fertilisers shall be applied strictly in accordance with the manufacturer’s directions and recommendations.

9.3.4 The Contractor shall take note that plant feeding shall be carried out only after all other maintenance works like weeding, hoeing and trimming or pruning have been carried out.

LIST OF STANDARDS AND CODES OF PRACTICE
REFERRED TO IN THIS SPECIFICATION

REFERENCE		TITLE
MALAYSIAN STANDARDS (MS)		
MS 26	Pt.1:1991	Methods of testing concrete - Pt.1: Methods of sampling fresh concrete
	Pt 2:1991	Methods of testing concrete - Pt.2: Methods of testing hardened concrete
	Pt.3:1992	Methods of testing concrete - Pt.3: Recommendations for use of non-destructive testing of concrete
MS 27:1996		Specification for precast concrete masonry units
MS 28:1985		Specification for test for water for making concrete (First revision)
MS 29:1995		Specification for aggregates from natural sources for concrete (First revision)
MS 30:1971		Methods of sampling and testing of mineral aggregates, sands and fillers
MS 30	Pt.1:1995	Methods of testing aggregates - Part 1: General requirements for apparatus and calibration
	Pt.2:1995	Methods of testing aggregates - Part 2: Guide to sampling and testing aggregates.
	Pt.3:1995	Methods of testing aggregates - Part 3: Methods for sampling.
	Pt.4:1995	Methods of testing aggregates - Part 4: Methods for determinations of particle size distribution (First revision).
	Pt.5:1995	Methods of testing aggregates - Part 5: Methods for determinations of particle shape (First revision).
	Pt.6:1995	Methods of testing aggregates - Part 6: Methods for determinations of shell content in course aggregates.
	Pt.7:1995	Methods of testing aggregates - Part 7: Methods for determinations of moisture content (First revision).
	Pt.8:1995	Methods of testing aggregates - Part 8: Methods for determinations of aggregates crushing value (ACV)(First revision).
	Pt.9:1995	Methods of testing aggregates - Part 9: Methods for determinations of ten per cent fines value (TFV).
	Pt.10:1995	Methods of testing aggregates - Part 10: Methods for determinations of aggregates impact value (AIV).
	Pt.11:1995	Methods of testing aggregates - Part 11: Methods for determinations of resistance to degradation or course aggregate by abrasion and impact in the Los Angeles machine (First revision).
	Pt.12:1995	Methods of testing aggregates - Part 12: Methods for determinations of polished-stone value (First revision).
	Pt.13:1995	Methods of testing aggregates - Part 13: Methods for determinations of water soluble chloride salts.
	Pt.14:1995	Methods of testing aggregates - Part 14: Methods for determinations of sulphate content.
	Pt.15:1995	Methods of testing aggregates - Part 15: Methods for determinations of acid-soluble material in fine aggregates.
	Pt.16:1995	Methods of testing aggregates - Part 16: Methods for testing and classifying shrinkage of aggregates in concrete.
	Pt.17:1995	Methods of testing aggregates - Part 17: Methods for determinations of soundness.
MS 76:1972		Specification for bricks and blocks of fired brick-earth clay or shale
MS 125:1995		Specification for gloss enamel paint
MS 134:1989		Specification for latex emulsion paint for exterior and interior use
MS 144:1987		Specification for cold reduced mild steel wire for the reinforcement of concrete (First revision)
MS 145:1987		Specification for steel fabric for the reinforcement of concrete (First revision)
MS 146:1988		Specification for hot rolled steel bars for the reinforcement of concrete (First revision)
MS 159:1994		Specification for cut-back bitumen for use in the construction and/or maintenance of pavement (First revision)

REFERENCE	TITLE
MS 161:1994	Specification for cationic bitumen emulsions for use in pavement application
MS 228:1991	Specification for plywood
MS 360:1991	Specification for treatment of timber with copper chrome/arsenic preservatives
MS 522 Pt.1:1989	Specification for portland cement (ordinary and rapid hardening) Pt.1: Standard specification
Pt.2:1989	Specification for portland cement (ordinary and rapid hardening) Pt.2: Physical tests
Pt.3:1989	Specification for portland cement (ordinary and rapid hardening) Pt.3: Chemical analysis
Pt.4:1989	Specification for portland cement (ordinary and rapid hardening Pt.4: Spectropphotometric analysis of cement.
MS 523 Pt.1:1993	Specification for concrete, including ready-mixed concrete Pt.1: Guide to specifying concrete
Pt.2:1993	Specification for concrete, including ready-mixed concrete Pt.2: Methods for specifying concrete mixes
Pt.3:1993	Specification for concrete, including ready-mixed concrete Pt.3: Procedures to be used in producing and transporting concrete
Pt.4:1993	Specification for concrete, including ready-mixed concrete Pt.3: Procedures to be used in sampling, testing and assessing compliance of concrete
MS 544:1978	Code of practice for the structural use of timber
MS 544: Pt. 4:Sec. 1	Code of practice for structural use of timber
Sec. 2	Permissible stress design of solid timber (first revision)
Sec. 3	Permissible stress design of glued laminated timber
Pt. 6	Workmanship, inspection and maintenance (first revision)
MS 602:1979	Specification for flexible, unsupported thick PVC sheeting
MS 622:1986	Specification for vitrified clay pipes and fittings with rigid joints (first revision)
MS 628:1982	Specification for unplasticised PVC pipe for cold water services
MS 628:1999 Pt.1 2.1, 2.2 &	Specification for unplasticised PVC (uPVC) pipe for water supply
MS 672:1999	Specification for elastomeric seals for water works purposes
MS 701	Specification for commercial sand
MS 733:1992	Specification for copper/chrome/arsenic wood preservatives (first revision)
MS 734:1981	Specification for wood preservation by means of pressure creosoting
MS 740:1981	Specification for hot-dip galvanised coatings on iron and steel articles
MS 794 :1982	Specification for masonry cement
MS 797 Pt.1:1982	Specification for concrete interlocking roofing tiles
Pt.2:1982	Code of recommended practice for the installation of concrete interlocking roofing tiles
MS 832:1984	Specification for aluminium alloy windows
MS 837:1995	Method for the determination of moisture content for timber
MS 858:1983	Specification for glazed ceramic tiles for internal walls
MS 881 Pt.1:1991	Specification for precast concrete pipes and fittings for drainage and sewerage Pt.1: Specification for pipes and fittings with flexible joints and manholes
Pt.2:1991	Specification for precast pipes and fittings for drainage and sewerage: Part 2: Specification for Inspection Chambers and gullies
Pt.3:1991	Specification for precast concrete pipes and fittings for drainage and sewerage Pt.3: Specification for pipes and fittings with ogee joints
MS 922 Pt.1:1984	Specification for concrete admixture Pt.1: Accelerating admixtures, retarding admixtures and water reducing admixtures

REFERENCE	TITLE
MS 934:1986	Specification for wood cement board
MS 978:1985	Specification for plastics waste pipe and fittings
MS 979 Pt.1:1985	Specification for unplasticised pvc under ground, sewerage pipe and fittings Pt.1: Pipes of diameter 100 millimeter and 155 millimeter
MS 979 Pt.2	Specification for unplasticised pvc under ground, sewerage pipe and fittings Pt.2: Pipes of diameter 200 millimeter and above
MS 1020:1986	Specification for mineral fibre thermal insulation material
MS 1022:1986	Specification for stop valves for water services (screw down pattern)
MS 1036:1986	Specification for wood chipboard and method of test for particle board
MS 1037	Specification for sulphate-resisting portland cement
MS 1058	Specification for polyethelene (PE) piping system for water supply
MS 1059:1986	Specification for asbestos cement sewer pipes joints and fitting
MS 1061	Specification for vitrified clay pipes and fittings and pipe joints for drains and sewers
MS 1063:1986	Specification for unplasticised PVC soil and ventilating pipes, fittings and accessories
MS 1088:1987	Specification for dust pressed ceramic floor tiles
MS 1089:1987	Specification for extruded ceramic floor tiles
MS 1090:1987	Method of sampling ceramic tiles
MS 1091 Pt.1-12:1987	Methods of test for ceramic tiles
MS 1123:1988	Specification for blockboard and laminboard
MS 1135:1989	Specification for float and polished plate glasses
MS 119 Pt.1:1991	Code of practice for structural use of concrete. Pt.1: Design and construction
Pt.2:1991	Code of practice for structural use of concrete. Pt.2: Special circumstances
Pt.3:1991	Code of practice for structural use of concrete. Pt.3: Design charts for singly reinforced beams, doubly reinforced beam and rectangular columns
MS 1225:1991	Specification for cold water storage and feed expansions cistern (Polyolefin and olefin copolymer) and cistern lids
MS 1226 Pt.1:1991	Pulverised-fuel Ash Pt.1: Specification for pulverised-fuel ash for use as cementitious in structural concrete.
MS 1227:1991	Specification for portland pulverised-fuel ash cement.
MS 1228:1991	Code of practice for design and insulation of sewerage system
MS 1241:1991	Specification for fibreglass water tanks - effective capacity of less than 2000 litres
MS 1293 Pt.1:1992	Specification for precast concrete box culverts Pt.1: Small culverts.
MS 1304 Pt.1:1993	Specification for treatment of construction timber components with copper/chrome/ arsenic preservatives .Part 1: Timber for roof and ceiling construction
MS 1314 Pt.1:1993	Specification for precast concrete piles Pt.1: Standard design precast concrete pipes.
MS 1302:1993	Specification for light organic solvent preservative treatment of timber
MS 1387:1995	Specification for ground granulated blastfurnace slag for use with portland cement.
MS 1389	Specification for portland blastfurnace cement
MS 1390:1995	Specification for glass reinforced polyester panels and panel water tanks.
MS 1419: Pt.1, 2, 3 & 4	Specification for acrylonitrile butadiene (ABS) pipes and fittings for pressure application

REFERENCE	TITLE
MS 1506:2000	Specification for wooden door
MS 1522:2001	Specification for vitreous china water closet pans (first revision)

JKR SPECIFICATION

JKR-20709-0539-95	Standard specification for precast concrete piles smaller than 200mm for building projects
No.2-95(BN) JKR 20709-0347-95	Standard specification for prepainted galvanised steel sheets for roofing and wall cladding
JKR 20401-0029-97	Standard specification for asphaltic concrete for road pavement
JKR 20401-0030-97	Standard specification for bituminous macadam for road pavement
JKR 20600-0020-99	Standard specification for prefabricated timber roof truss
JKR 20600-0019-99	Standard specification for structural steel work
JKR 20600-0022-2001	Standard specification for prefabricated cold formed steel roof trusses
JKR 20200-0110-01	Standard specification for vitreous china water closet pan
JKR 20200-0041-99	Standard specification for stainless steel water tanks
JKR 20200-0083-00	Standard specification for ductile iron type 3 gate valves for water works purposes (DN 50 to DN 600)
JKR 20200-0114-01	Standard specification for ductile iron automatic control values for water works purposes (DN 15 to DN 1000)
JKR 20200-0131-01	Standard specification for urinals
JKR 20200-0160-03	Standard specification for WC flushing systems (including (dual flushing system) and flush pipes (revised edition 2003)
JKR 20200-0136-02	Standard specification for flushing cistern for water closets and urinals

BRITISH STANDARDS (BS)

BS 4	Structural steel section
BS 4 Pt.1:1993	Specification for hot rolled sections
BS 78	Specification for cast iron spigot and socket pipes (vertically cast) and spigot and socket fitting
BS 143	Specification for malleable cast iron and cast copper alloy threaded pipe fittings
BS 402	Clay roofing tiles and fittings
BS 410	Specification for test sieves
BS 416	Discharged and ventilating pipes and fittings, sand-cast or spun in cast iron
BS 417 Pt.2:1987	Metric units
BS 437:1978	Specification for cast iron spigot and socket drain pipes and fittings
BS 476	Fire test on building materials and structures
BS 544:1969 (1994)	Specification for linseed oil putty for use in wooden frame
BS 638	Arc welding power sources, equipment and accessories
BS 638 Pt.4:1996	Specification for welding cables
Pt.7:1984	Specification for safety requirements for installation and use
BS 709:1983	Methods of destructive testing fusion welded joints and weld metal in steel

REFERENCE	TITLE
BS 864 Pt.2:1983	Specification for capillary and compression fittings for copper tubes
BS 1052:1980(1986)	Specification for mild steel wire for general engineering purposes
BS 1091:1963(1980)	Specification for pressed steel gutters, rain water pipes, fittings and accessories
BS 1142:1989	Specification for fibre building board
BS 1191	Specification for gypsum building plaster
BS 1212	Float operated valves
BS 1224:1970	British standard specification for electroplated coating of nickel and chromium
BS 1230 Pt.1:1985 (1994)	Specification for plasterboard excluding materials submitted to secondary operations
BS 1305	Specification for batch type concrete mixers
BS 1369	Steel lathing for internal plastering and external rendering
BS 1370:1979	Specification for low heat portland cement
BS 1377	Methods of test for soil for civil engineering purposes
BS 1387:1985 (1990)	Specification for screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads
BS 1449 Pt.2:1983	Specification for stainless and heat-resisting steel plate, sheet and strip
BS 1452:1990	Specification for flake graphite cast iron
BS 1474:1987	Specification for wrot aluminium and aluminium alloys for general purposes: bars, extruded round tubes and sections
BS 1552:1995	Specification for open bottomed taper plug valves for 1st, 2nd and 3rd family gases up to 200 mbar
BS 1564:1975(1983)	Specification for pressed steel sectional rectangular tanks
BS 1615:1987(1994)	Method for specifying anodic oxidation coatings on aluminium
BS 1881 Pt.101:1983	Method of sampling fresh concrete on site
Pt.102:1983	Method of determination of slump
Pt.103:1983	Method of determination of compacting factor
Pt.104:1983	Method of determination of vebe time
Pt.106:1983	Method of determination of air content of fresh concrete
Pt.107:1983	Method of determination of density of compacted fresh water
Pt.108:1983	Method for making test cubes from fresh concrete
Pt.111:1983	Method of normal curing test specimen (20EC)
Pt.116:1983	Method of determination of compressive strength of concrete cube
Pt.124:1988	Methods for analysis of hardened concrete
Pt.125:1986	Method of mixing and sampling fresh concrete in the laboratory
Pt.201:1986	Guide to the use of non-destructive methods of test for hardened concrete
BS 2494:1990	Specification for elastomeric seals for joints in pipework and pipelines
BS 2499	Hot-applied joint sealant systems for concrete pavements
BS 2499 Pt.1:1993	Specification for joint sealants.
Pt.2:1992	Code of practice for the application and use of joint sealants.

REFERENCE	TITLE
BS 2600	Radiographic examination of fusion welded butt joints in steel
BS 2872:1989	British standard specification for copper and copper alloy forging stock and forgings
BS 2874:1986	British standard specification for copper and copper alloy rods and sections (other than forging stock)
BS 2910:1986	Methods for radiographic examination of fusion welded circumferential butt joints in steel pipes
BS 2989:1991	Specification for continuously hot-dip zinc coated and iron-zinc alloy coated steel of structural qualities: wide strip, sheet/plate and slit wide strip
BS 3100:1991	Specification for steel casting for general engineering purposes
BS 3260:1969(1996)	Specification for semi-flexible PVC floor
BS 3416:1991	Specification for bitumen-based coating for cold application suitable for use in contact with portable water
BS 3923 Pt.1:1986	Method for manual examination of fusion welds in ferritic steels
Pt.2:1972	Automatic examination of fusion welded butt joints in ferritic steels
BS 3987:1991(1997)	Specification for anodic oxidation coatings on wrought aluminium for external architectural applications
BS 4027:1996	Specification for sulphate-resisting portland cement
BS 4127:1994	Specification for light gauge stainless steel tubes, primarily for water application
BS 4190	Specification for ISO Metric Black Hexagon Bolts, Screws & Nuts
BS 4254:1983(1991)	Specification for two part polysulphide-based sealants
BS 4320:1968	Specification for metal washers for general engineering purposes, Metric series
BS 4360:1986	Specification for weldable structural steel
BS 4368 Pt.4:1984	Specification for compression coupling for tubes Pt.4: Specification for type test requirements
BS 4395	Specification for high strength friction grip bolts and associated nuts and washers for structural engineering
BS 4449:1988	Specification for carbon steel bars for the reinforcement of concrete
BS 4461	Specification for cold worked steel bars for the reinforcement of concrete
BS 4466:1989	Specification for scheduling, dimensioning, bending and cutting of steel reinforcement for concrete
BS 4570:1985	Specification for fusion welding of steel castings
BS 4576 Pt.1:1970	Specification for unplasticised pvc rain water goods Pt.1: Half round gutters and circular pipe
BS 4604	Specification for the use of high strength friction grip bolts in structural steelwork. Metric series
BS 4848	Hot-rolled structural steel sections
BS 4848 Pt.2:1991	Specification for hot-finish hollow sections
BS 4872 Pt.1:1982	Specification for approval testing of welders when welding procedure approval is not (1995) required
BS 5082:1993	Specification for water-borne priming paints for woodwork
BS 5135:1984	Specification for arc welding of carbon and carbon manganese steels
BS 5154:1983	Specification for copper alloy globe, globe stop and check, check and gate valves
BS 5268	Specification for structural use of timber
BS 5268 Pt.2:1991	Code of practice for permissible stress, design, materials and workmanship
Pt.3:1985	Code of practice for trussed rafter roofs
BS 5292	Specification for jointing materials and compounds for installation using water, low pressure steam or 1st2 & 3 family gases
BS 5328 Pt.1:1990	Guide to specifying concrete

REFERENCE		TITLE
	Pt.2:1990	Methods for specifying concrete mixes.
	Pt.3:1990	Specification for the procedures to be use in producing and transporting concrete.
	Pt.4:1990	Specification for the procedures to be use in sampling, testing and assessing compliance of concrete.
BS 5358:1993		Specification for solvent-borne priming paint for woodwork
BS 5606:1978		Code of practice for accuracy in building.
BS 5606:1990		Guide to accuracy in building
BS 5629	Pt.2:1979	Test methods
	Pt.3:1979	Method for specifying requirements for individual materials
BS 5950		Structural use of steelwork in building
BS 5950	Pt.1:1990	Codes of practice for design in simple and continuous construction: hot rolled sections
	Pt.2:1992	Specification for materials, fabrication and erection: hot rolled section
Pt.3: Section 3.1:1990		Code of practice for design of simple and continuous composite beams
	Pt.4:1994	Code of practice for design of composite slab with profiled steel sheeting
	Pt.5:1987	Code of practice for design of cold formed sections
	Pt.6:1995	Code of practice for design of light gauge profiled steel sheeting
	Pt.7:1992	Specification for materials and workmanship: cold formed section
	Pt.8:1990	Code of practice for fire resistant design
	Pt.9:1994	Code of practice for stressed skin design
BS 5975		Code of practice for falsework
BS 5979:1993		Code of practice for remote centres for alarm systems
BS 6089:1981		Guide to assessment of concrete strength in existing structures
BS 6363:1983		Specification for welded cold formed steel structural hollow sections
BS 6431		Ceramic floor and wall tiles
BS 6477:1992		Specification for water repellents for masonry surfaces
BS 6510:1984		Specification for steel windows, sills, window boards and doors
BS 6675:1986		Specification for servicing valves (copper alloy) for water services
BS 6699:1992		Specification for ground granulated blast-furnace slug for use with portland cement
BS 6920		Suitability of non-metallic product for use in contact with water intended for human consumption with regard to their effect on the quality of water
BS 7668:1994		Specification for weldable structural steel. Hot finished structural hollow section in weather resistant steels
BS 8004:1986		Code of practice for foundation
BS 8007:1987		Code of practice for design of concrete structures for retaining aqueous liquids
BS 8110		Structural use of concrete
BS 8110	Pt.1:1985	Code of practice for design and construction
BS 8215:1991		Code of practice for design and installation of damp-proof courses in masonry construction
BS EN 499:1995		Welding consumables. covered electrodes for manual metal arc welding of non alloy and fine grain steels. Classification
BS EN 875:1995		Destructive tests on welds in metallic materials. Impact tests. Test specimen location, notch orientation and examination

REFERENCE	TITLE
BS EN 876:1995	Destructive tests on welds in metallic materials. Longitudinal tensile test on weld metal in fusion welded joints
BS EN 895:1995	Destructive tests on welds in metallic materials. Transverse tensile test
BS EN 910:1996	Destructive tests on welds in metallic materials. Bend tests
BS EN 10029	Specification for tolerances on dimensions, shape and mass for hot rolled steel plates 3mm thick or above
BS EN 10143	Continuously hot-dip metal coated steel sheet and strip. Tolerances on dimensions and shape
BS EN 10147	Continuously hot-dip zinc coated structural steel sheet and strip-technical delivery conditions
BS EN 1043-1:1996	Hardness test on arc welded joints
BS EN 10051:1992	Specification for continuously hot-rolled un-coated plate. sheet and strip of non-alloy and alloy and alloy steels. Tolerances on dimensions and shape
BS EN 1057:1996	Specification for copper pipes
BS EN 10025:1995	Hot rolled products of non-alloy structural steel. Technical delivery conditions
BS EN 10113:1991	Hot-rolled products in weldable fine grain structural steels
Pt.1:1993	General delivery condition
Pt.2:1993	Delivery conditions for normalized/normalized rolled steels
Pt.3:1993	Delivery conditions for thermomechanical rolled steels
BS EN 10137-1:1996	General delivery conditions
-2:1996	Delivery conditions for quenched and tempered steels
-3:1996	Delivery conditions for precipitation hardened steels
BS EN 10155:1993	Structural steel with improved atmospheric corrosion resistance. Technical delivery conditions
BS EN 10210-1:1994	Technical delivery requirements
BS EN 50078:1994	Torches and guns for arc welding
BS EN 60974-11:1996	Electrode holders
EN 10113	Hot-rolled products in weldable fine grain structural steels.
EN 10155	Structural steels with improved atmospheric corrosion resistance. Technical delivery conditions
EN 12201	Specification for polyethelene (PE) piping system for water supply
EN 12319 Pt.1, 2, 3 , 5 & 7	Specification for plastic piping systems for hot and cold water - polybutylene (PB)
EN 15493	Specification for acrylonitrile butadiene (ABS) pipes and fittings for pressure application

REFERENCE	TITLE

OTHER STANDARDS

American Standard

ASTM A 312/A312M-87a	Standard specification for seamless and welded austenitic stainless steel pipe
ASTM A 351/A351M-86	Standard specification for steel casting austenitic for high temperature service
ASTM A 403/A403M-86	Standard specification for wrought austenitic stainless steel piping fittings
ASTM C88	Test method for soundness of aggregates by use of sodium sulfate or magnesium sulfate
ASTM A 312	Standard specification for seamless and welded austenitic stainless steel pipes
ASTM A351/A351M-86	Standard specification for steel castings, austenitic for high temperatures service
AS 3982:1996	Australian/New Zealand Standard for urinals

Japanese Standard

JIS 304	Specification for the properties of hot-rolled stainless steel sheets
JIS G3192	Dimensions, mass and permissible variation of hot-rolled steel section year 2000
JIS A5526	Japanese Industrial Standard Steel H Piles

Australian / New Zealand Standard

AS/NZS2642 Pt.1, 2 & 3	Specification for plastic piping systems for hot and cold water - polybutylene (PB)
ASSE 1037:1990	Performance requirements for pressurized flushing devices (flush meters) for plumbing fixtures

China Standard

CNS 9443:1982	China National Standard (Taiwan) specification for stainless steel tank
AWWA C210	Specification for liquid epoxy coating systems for the interior and exterior of steel water pipelines
AWWA C210-84	Specification for liquid epoxy coating systems for the interior and exterior of steel water pipelines
AWWA C210:1994	Specification for liquid epoxy coating systems for the interior and exterior of steel water pipelines
DIN 8077:1997	Polypropylene (PP) pipes (Dimension)
DIN 8078:1996	Types 1, 2 and 3 Polypropylene (PP) pipes (General quality requirements & testing)
DIN 16962 Pt.5 – 8	Pipe joint assemblies & fittings for polypropylene (PP) pipes
DIN 16962 Pt.5 - 9	Pipe joint assemblies & fittings for Polypropylene (PP) pipes