General Specifications for Building Construction

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GENERAL

1.1 General Description of the Works

1.1.1 Scope of Works

Construction of Agriculture training centre in Ramadi\ Anbar

1.2 Location of the Works

The site for the construction will be in Anbar Province.

1.3 Drawings and Documents

The drawings of the Tender Documents and any other modifications to those drawings and any other drawings that may be prepared by the Contractor and approved by the Supervisor engineer shall subsequently become the Contract Drawings.

For the purpose of carrying out the Contract, the Contractor will be provided with 2 sets of the Contract Documents and Contract Drawings.

1.4 Standard Specifications

For convenience and in order to establish the necessary standards of quality, reference has been made to specifications issued by national or other widely recognised bodies. Such specifications shall be referred to as 'Standard Specifications' and shall be the latest editions of such Standard Specifications issued prior to the issue of these Tender documents together with such additions or amendments as may have been issued prior to the same date.

In referring to Standard Specifications, the following abbreviations are used:

BS	British Standard
ISO	International Organisation for Standardisation
ASTM	American Society for Testing and Materials
ASA	American Standards Association
IGTS	Iraqi general technical specification.
NCCL	National centre for construction laboratories.

1.5 Works Designed by the Contractor

All drawings, calculations, plans, reports, instruction manuals, pamphlets, data and all other documents required to be submitted by the Contractor under the Contract shall be clear and readable.

All the drawings and calculation to substantiate the design shall be checked, signed and approved by the Contractor prior to submission.

1.6 Site Meetings

The Contractor shall be obliged to attend all meetings at the appointed time. The discussions of such meetings shall include but not be limited to the progress of work and problems having direct bearing on the immediate and long term activities (construction, procurement, transport, labour etc.).

The Supervisor engineer shall invite the Employer for such meetings.

1.7 Records

The Contractor shall take photographs of the Facility and the Depots before starting construction and keep detailed records as specified below and as directed by the Supervisor engineer, and submit them at least once a week to the Engineer for his approval.

- Daily weather conditions
- Progress of Work including photographs showing the progress
- Delivery of materials and equipment
- Labourers' time sheets at Facility and Depots
- Details of all visitors to the Facility and the Depots

1.8 Reports

The Contractor shall submit from time to time to the Supervisor engineer reports, notices and other documents as specified in the Specifications and as directed by the Supervisor engineer. The reports and notices shall include, but not be limited to the following:

1.8.01 At the Start of Construction Works

(1) Notice to Commence and Information on the Contractor's Representative and Supervisors, 1 copy to The Employer and 3 copies to the Engineer.

(2) Other documents

The following documents shall be submitted to the Supervisor engineer in a separate volume from paragraph (1) above:

- Selected Sub-Contractor's List..... 1 copy
- Manufacturer's List..... 1 copy
- General Work Schedule..... 1 copy
- Copy of the signed Contract..... 1 copy
- Priced Bill of Quantities..... 1 copy
- Invoice Schedule..... 1 copy

1.8.02 <u>During Construction Works</u>

- Monthly Progress Reports..... 1 copy
- Work Diary..... 1 copy
- Detailed Work Schedule..... 1 copy
- Invoice and Data on the Amount of Works done ..... 1 copy
- Shop Drawings and Construction Details ..... 1 copy
- Test Results ..... 1 copy
- Copy of Documents for Payment ..... 1 copy

1.8.03 During Equipment Installation Works

- Weekly Progress Report ..... 1 copy

Including but not limited to the following data:

(1) Number and classifications of labour engaged in the Works on daily basis,
(2) Erection and job site processing equipment and materials used, and
(3) Any problem and solution.

1.8.04 At the completion of Construction and Equipment Installation Works

The Contractor shall furnish to the Supervisor engineer at the completion of the Works the reports and documents as described in the Clause 1.18.

1.9 Drawings, Operation and Maintenance Instructions etc.

The project drawings shall comprise

(a) The drawings provided in the book of drawings issued for Tender

(b) Such other drawings and/or sketches as are issued from time to time by the Engineer to deal with design modifications in response to on-site conditions.

(c) Where shop drawings are to be used, the Contractor, unless otherwise specified, shall submit not later than seven (7) days before the beginning of a trade work to the Supervisor engineer for his approval three (3) copies of all shop and setting-out drawings and schedules required for its work. No work shall be commenced before approval of the Supervisor engineer for such drawings and schedules.

1.10 Level Datum

The survey control points and benchmarks shown on the drawings shall be handed over to the Contractor as basis for surveying and setting out of Works.

Before using the control points and bench marks for setting out of the Works, the Contractor shall carry out a check survey thereon and satisfy himself as to their accuracy. The Employer shall bear no responsibility for the accuracy of any control point or benchmark.

The Contractor may establish additional temporary bench marks for his own convenience but each temporary bench mark shall be of a design and in a location approved by the Supervisor engineer and shall be accurate in relation to the bench marks established by the Supervisor engineer.

The Contractor shall protect the reference points and level bench marks and in the event of any damage he shall re-survey and re-establish the points and bench marks.

1.11 Setting Out

The Contractor shall appoint and employ the necessary qualified and experienced staff to set out the Works accurately. The Contractor shall establish and locate all lines and levels and be responsible for the correct location of all Works.

Where directed by the Supervisor engineer, the Contractor shall take such levels and dimensions as may be required for the purposes of measurements prior to disturbance of the ground. These shall be agreed between the Contractor and the Supervisor engineer in writing before any surface is disturbed or covered up.

1.12 Construction and Checking of Work

The Contractor shall be solely responsible for and shall provide all labour, tools, lifting tackle and other equipment required for the construction and checking of the Works.

No operatives shall be allowed to execute any type of work, which is normally carried out by a skilled tradesman, unless the operative is thoroughly experienced and proficient in the trade concerned. Supervisors and operatives may be required to demonstrate their proficiency or produce certificate of competence to the satisfaction of the Supervisor engineer.

As each part of the work is carried out it shall be subject to the approval by the Supervisor engineer.

1.13 Supervision and Labour

The Contractor will be required to maintain a competent supervising Site Agent and staff on site throughout the construction period until completion of the Works, and thereafter as may be required during the defects liability period. The Supervisor engineer shall give prior approval to the appointment of this supervising Site Agent and key staff and shall have authority to withdraw the approval at any time in accordance with the Conditions of Contract.

All staff and labour employed on the Works shall be employed in accordance with the local labour and employment laws and regulations.

1.14 Works Executed by the Employer (GIZ) or by other Contractors

The Employer of GIZ reserves the right to execute, on the site, works not included under this Contract and to employ for this purpose either his own employees or other contractors whose contracts may be either a sub-contract under this Contract, or an entirely separate contract. The Contractor shall ensure that neither his own operations nor trespass by his employees shall interfere with the operations of the Employer, or his contractors employed on such works and the same obligations shall be imposed on the Employer or other contractors in respect of work being executed under this Contract.

1.15 Contractor's Storage and Working Areas

The Employer shall provide, free of charge, areas of land where the Contractor shall establish the store. The location of stores shall be to the approval of the Supervisor engineer.

The Employer reserves the right to allocate areas of land less than the Contractor may require. In such case, the Contractor shall make his own arrangement for obtaining the use of the additional areas that he requires.

The location of stores shall be to the approval of the Supervisor engineer.

1.16 Definition and Use of the Site

1.16.1 Definition of the Site

The Site shall include all those areas of land which, being public or private:

(a) Are being provided by the Employer for the purpose of constructing the permanent works.

(b) Are being provided by the Employer for stores.6

1.16.2 Use of the Site

The lands and other places outside the Site which are the property of or under the control of the Employer shall not be used except with the approval of the Supervisor engineer.

The Supervisor engineer shall at any time remove any vehicle or vessel or any other obstruction under his control that may be required to be removed by the Engineer for any purpose. The Contractor shall move such obstruction promptly on instruction being given.

The Supervisor engineer shall maintain access for the inspection, operation and maintenance of any of the Employer's works which lies within the Site.

The Contractor shall not use any portion of the Site for any purpose not connected with the Works unless the written permission of the Supervisor engineer has been obtained.

1.17 Possession of the Site

The Contractor shall restrict his activities to those areas of the Site adjacent to the works being executed and shall avoid any encroachment upon lands outside the areas for which possession has been given. Any trespass or damage or any claim arising from such encroachment shall be the Contractor's sole responsibility and he shall hold the Employer indemnified against all claims arising from such trespass or damage.

1.18 Interference with the Works

The Contractor shall not interfere in any way with any existing works, whether the property of the Employer or of a third party, whether or not the position of such works is indicated to the Contractor by the Engineer, except where such interference is specifically described as part of the Works, either in the Contract or in an instruction from the Supervisor engineer.

1.19 Measurement System

The measurement system for the Works shall be in metric.

1.20 Permits and Licences

The Contractor shall secure all the permits, except for the Building permission undertaken by the Employer, the licenses necessary for progress of the Works, and negotiate to obtain permission with the authorities concerned.

1.21 Material for the Works

All material shall comply with appropriate Standard Specifications unless otherwise required hereinafter.

The Contractor shall, before placing any order of materials, manufactured articles or machinery for incorporation in the Works, submit for the approval of the Supervisor engineer the names of the suppliers from whom he proposes to obtain such materials, manufactured articles or machinery, together with a list of the same, giving the origin, quality, weight, strength, description and other relevant details. No materials, manufactured articles or machinery shall be ordered or obtained from any suppliers which the Supervisor engineer has not approved in writing.

All materials shall be delivered to the Site a sufficient period of time before they are required for use in the Works, to enable the Supervisor engineer to take such samples as he may wish for testing and approval.

Notwithstanding the fact that approval has been given to the source of supply, the Supervisor engineer may forbid the use of any materials if, upon delivery, they are found to be defective, or he considers them unsuitable for incorporation in the Works. Such rejected materials shall be removed from the site forthwith.

The Contractor may propose alternative materials of equivalent quality to those specified, and subject to the approval, such materials may be used in the Works.

The Contractor shall have no claim against the Employer in respect of any financial loss which he may suffer as a result of the rejection of any such materials, and he shall also bear the cost of removing them from the Site.

The Supervisor engineer shall have the right to inspect materials and plant for the permanent works during the course of manufacture. The Contractor shall arrange for the right of access to manufacturing premises for the Supervisor engineer and his staff during normal working hours. The Supervisor engineer shall be given sufficient notice by the Contractor to allow him to observe the testing of any materials for the works at the place of manufacture. The Supervisor engineer

shall also be given the opportunity to inspect any material or plant in their completed state prior to packing for transport to the site.

If requested by the Supervisor engineer, the Contractor shall provide to the Engineer copies of orders for the supply of goods or materials required in connection with the works.

1.22 Rejected Materials and Defective Work

Materials or work which, in the opinion of the Engineer, do not comply with the Specification, shall be classified as rejected materials or defective work, and shall be cut out and removed from the Works and replaced as directed by the Supervisor engineer.

1.23 Existing Works and Services

The Contractor shall acquaint himself with the positions of all existing works and services including water mains, storm water drains, cables and service poles before any excavation is commenced.

The Contractor will be held responsible for any damage, however caused, in the course of the execution of the Works, to such existing works and services.

Such existing works and services, where exposed by the execution of the works, shall be properly shored, hung-up and supported to the satisfaction of the Supervisor engineer and of the authority concerned.

Poles supporting cables and the like adjacent to the Works shall be kept securely in place until the Works are completed and shall then be made as safe and permanent as before.

Notwithstanding the foregoing requirements and without lessening the Contractor's responsibility, the Contractor shall inform the Supervisor engineer immediately any existing works have been exposed and shall comply with any requirements of the authority concerned.

Only when and as directed by the Supervisor engineer shall the position of existing works or services be changed by the Contractor to meet the requirements of the proposed work.

The laying of pipework, ducts, drains, and the like shall be arranged so as to cause as little interference as possible with the smooth operation of existing works.

When breaking out and making good existing structures, the Contractor shall disturb the existing structures as little as possible. All structures shall be made good with materials similar to those used in the existing works, or such materials which are considered by the Supervisor engineer to be of similar appearance and suitable in all other respects.

1.24 Water and Power for Use on the Works

The Contractor shall be solely responsible for the location, procurement and maintenance of a water supply adequate in quality and quantity to meet his obligations under the Contract.

The Contractor shall make his own arrangements for power supplies and shall be solely responsible for the location, procurement and maintenance of a power supply, adequate to meet his obligations under the Contract.

The Contractor shall make his own arrangements for the supply of adequate safe drinking water, electricity and other services to the Permanent Works, Temporary Works and Contractor's equipment and shall provide and maintain all pipes, cables and fittings which may be necessary to carry such services to his operations

1.25 Inspection by Engineer during the Defects Liability Period

The Engineer will give the Contractor due notice of his intention to carry out any inspection during the defects liability period. The Contractor shall, upon receipt of such notice, arrange for a responsible representative to be present at the times and dates named by the Supervisor engineer. This representative shall render all necessary assistance and shall take note of all matters and things to which his attention is directed by the Supervisor engineer.

1.26 Toilet facilities for the time of the construction

The Contractor shall supply, erect and maintain toilets for the labours.

1.27 Survey Instruments and Chainmen for the Engineer

The Contractor shall provide and maintain in first class working order, for the sole use of the Engineer and his staff for the duration of the Contract, the minimum survey instruments complete with all accessories, tapes, poles, staves, stagings, moulds, templates, profiles, and requisites necessary for checking and setting out, and measurement of the Works. The equipment shall revert to the Contractor at the end of the Contract period.

1.28 Protection from Water

The Contractor shall keep the whole of the Works free from water and shall be deemed to have included in his Contract Sum all costs for pumping, shoring, temporary drains, sumps and other measures and provisions necessary for such purposes and for clearing away and making good to the satisfaction of the Supervisor engineer any damage caused thereby.

1.29 Protection against Fires

The Contractor is advised that, at all times, it is necessary to guard against fires starting within the Site or in the environs thereof, particularly as the result of the Works or from the actions of his employees. The Contractor shall have available, at all times; a trained fire-fighting team provided with adequate fire-fighting equipment and shall deal with all fires on the Site howsoever caused.

The Contractor shall be responsible for maintaining qualified fire fighting crew on the Site at all times as well as maintaining an efficient fire alarm system.

The Contractor shall comply with laws and regulations regarding fires and with respect to the prevention of fires. No fire may be lit in the dry season without written permission from the Supervisor engineer and/ or the relevant Authority.

1.30 Safety Precautions

The Contractor shall take all necessary precautions against risks of loss of life or of injury to any person employed on the Works or to employees of the Employer and to the Supervisor engineer or to visitors or to persons having good and sufficient reasons to be about the Works, and to this end he shall properly safeguard the Works to the satisfaction of the Engineer.

The Contractor shall at all times comply with any accident prevention regulations and any safety regulations peculiar to the various trades employed on the Works, and any safety regulations published by the Government.

The Contractor shall report promptly to the Supervisor engineer all accidents involving the death of or serious injury to any person on the Site or resulting from the Contractor's operations.

The Contractor shall, at his own expense, educate all his employees on safety precautions based on good practice on site. This shall be done in both English and the local languages. Safety instructions shall deal with all safety measures including but not be limited to the following; protective clothing, helmets and footwear, use of lifting equipment, precautions against electrical shock, welding, routine procedures in case of accidents, fires, etc., watchmen, warning notices and barriers, use of drilling equipment and dust suppression and use and storage of explosive.

1.31 Explosives and Fuels

The Contractor shall make arrangements to transport, store and handle explosives and fuels in a safe manner for protecting the public in accordance with the laws and security regulations in force.

The Contractor shall obtain all necessary licenses and shall pay all fees and charges in respect of the same as may be necessary for the purpose of moving explosives and fuels from place to place and storing the same, and shall make all applications and obtain approvals from the relevant authorities of the Government.

During thunderstorms and other electrical disturbances, no charging and firing will be permitted.

1.32 Watching, Fencing and Lighting

The Contractor shall employ competent watchmen to guard the Works both by day and night.

Any excavations, material dumps, spoil dumps or other obstructions likely to cause injury to any person or thing shall be suitably fenced off and at night marked by red warning lights.

1.33 Dust Abatement

During the performance of the work the Contractor shall carry out proper and efficient measures wherever and as often as necessary to reduce the dust nuisance resulting from his operations.

No separate payment will be made for the dust abatement measures.

All work shall be carried out without unreasonable noise. Compressors used on site shall be silenced either by using only full silenced models or fitted with effective exhaust silencers and properly lined and scaled acoustic covers all to the design of the manufacturers of the compressor or by the use of effective acoustic screens to enclose the noise source. Pneumatic percussion tools used on Site shall be fitted with silencers of a type recommended by the manufacturers of the tools. Compressors, silencers or other equipment shall be maintained in good and efficient working order.

No separate payment will be made for noise suppression measures and the costs thereof shall be included in the unit rates and the Contract Sum.

1.34 Sanitation

The toilet facilities provided at the site by the Contractor shall be made available, free of charge, to the employees of the Contractor and any of his subcontractors.

The Contractor shall warn his employees and sub-contractors that any employee found fouling the site shall be removed from the site immediately in accordance with the Conditions of Contract.

The Contractor shall remove all rubbish and to this end shall provide adequate number of covered garbage bins/containers placed at convenient points around the site establishments. The Contractor shall institute and maintain a regular garbage collection and disposal system. Garbage shall be disposed of by burial or by other means approved by the Supervisor engineer.

No separate payment will be made for such sanitary arrangements and all such costs will be deemed to be included in the unit rates and Contract Sum.

1.35 First Aid and Medical Services

The Contractor shall provide and maintain all equipment necessary to render First Aid in case of accidents, snakebites or other emergencies. The Contractor shall ensure that there are persons available to all such places with knowledge of simple First Aid procedures and able to administer snakebite treatment.

Notwithstanding the minimum requirements prescribed above, the Contractor shall be responsible for the adequacy of all the arrangements made.

1.36 Site Clearance

On completion of the Works, the Contractor shall clear the site; the whole of the site shall be left in a clean and tidy condition.

1.37 Units and Abbreviations

The units of measurement used in these Contract Documents are metric.

The following abbreviations have been used for units and for other words or phrases as indicated.

Abbreviations in the Contract Documents shall have the following meanings:

mm	millimetre

m	meter
km	kilometre
sq.m,m^2	square metre
ha	hectare
cu m,m^3	cubic metre
sec,s	second
hr	hour
min	minute
wk	week
l	litre
gm	gram
kg	kilogram
t	tonne
No	Number
nr	Number (in bill of quantities)
dia	diameter
max	maximum
min	minimum
AD	above datum (levels in metres)
ch	chainage (distance in metres)
eo	extra over
e	exceeding
ne	not exceeding
PQ	Provisional Quantity
PS	Provincial Sum
Do	Ditto
fob	free on board
cif	cost, insurance, freight
wt	weight
%	percent
mh	manhole
ic	inspection chamber
HYS	high yield steel
PCC	precast concrete
uPVC	uplasticised polyvinylchloride
GMS	galvanised mild steel
DI	ductile iron
SV	sluice valve
ISO	International Standards Organisation
KS	Kenyan Standard
BS	British Standard
KShs.	Kenya Shillings

2 EARTHWORKS

2.1 Site Clearance and Stripping

General clearance and site preparation is defined as the clearing, grubbing, removal and disposal of all vegetation, grass in outside facilities of the school, and backfilling of holes left by the removal of stumps and roots.

The widths and length over which site clearance is to be carried out shall be instructed by the Engineer. If termite moulds are excavated, the whole of the mould shall be removed.

2.2 Surface Levels

After the area of any section of the Works has been cleared and after trees have been felled, stumps removed and termite moulds excavated to the satisfaction of the Engineer, but before any other work is commenced, surface levels of the ground shall be taken. The levels shall be taken at spacing's agreed with the Supervisor engineer. Levels shall similarly be taken on the surface of the ground after the removal of unsuitable overburden prior to placing fill and at the interface between natural ground, rock or artificial hard material layers. The levels shall be agreed with the Supervisor engineer. The Contractor shall prepare plans and sections which shall, when finally, and mutually agreed, be signed by the Engineer and Contractor as truly representing the configurations of the areas in question at the commencement of excavation or fill construction.

2.3 Excavation General

Excavation shall be carried out with the allowances for working space given in the Method of Measurement to the Bill of Quantities, unless otherwise shown as lines, levels and profiles on the Drawings or to such other lines, levels and profiles as the Supervisor engineer may direct or approve in writing. The work shall be carried out by the Contractor in such a way as to avoid disturbance to the surrounding ground. Particular care shall be taken to maintain stability when excavating in close proximity to existing works.

The Contractor shall dispose of all material arising from excavations to outside of the municipalities border

The Contractor shall be responsible for keeping all excavations free from water from whatever cause arising and shall provide such pumping capacity and other measures as may be necessary for this purpose. The Contractor shall make good any damage that may result from his failure to keep the excavations free from water.

All excavation shall be carried out with care and the method and Contractor's equipment to be used in execution thereof shall be to the satisfaction of the Engineer. The Contractor shall be responsible for the safety and security of all excavations at all times during the execution of the contract

The Contractor will be permitted, subject to the approval of the Supervisor engineer, to adjust side slopes of excavations in soft materials which are to remain open temporarily in preference to shoring or strutting. However, no payment shall be made for extra excavation volume as a result of these measures.

The Contractor shall notify the Supervisor engineer without delay of any permeable strata, fissures or unusual ground encountered during excavation.

2.4 Approval of Excavation

When excavations have been taken out accurately to the profiles or dimensions required for the work the Contractor shall inform the Engineer who shall carry out an inspection of the excavation. If, after his inspection the Supervisor engineer requires additional excavation to be carried out, the Contractor shall do so to such new profiles or dimensions as the Supervisor engineer may direct.

2.5 Excavation for Structures

Open excavation to form a foundation for a structure shall be carried out to the lines necessary to permit the proper construction of the structure to the approval of the Supervisor engineer.

Where a structure is to be founded on soft ground, the excavation shall be taken down until the required formation is exposed and prepared to the approval of the Supervisor engineer. Where concrete has to be placed on a soft foundation, the Supervisor engineer may direct that a blinding layer of lean concrete be placed beneath the structural concrete immediately after completion and approval of the excavation, or require the Contractor to remove the last 100 mm of excavation immediately prior to placing the concrete. If foundation conditions are very soft the Supervisor engineer may instruct that additional material be excavated and replaced with compacted gravel or hardcore.

Where a structure is required to be founded on rock but is not required to penetrate into it, all soft overburden shall be removed and the surface of the rock cleared of any loose material by barring and wedging. Where the foundation is required to penetrate into the rock, excavation of the rock may be carried out by blasting but in such a manner as to prevent the shattering of the rock which is to remain. The Supervisor engineer may direct that the last 300 mm of rock be left and be removed by barring and wedging or by the use of approved pneumatic tools so that the exposed surface is sound.

The Contractor shall report to the Supervisor engineer whenever excavations are ready to receive concrete. No concrete shall be placed in the foundations until the Contractor has obtained the Supervisor's engineer agreement that a secure foundation has been reached and that the excavation has been carried out to the lines and levels required.

2.6 Excavation for Fill Foundation

Foundations for embankments shall be excavated to the depths or to the soil or rock grade indicated on the Drawings or described in the Specification. The suitability of each part of the foundation for placing fill thereon shall be determined by the Supervisor engineer. No fill shall be placed before acceptance of the foundation by the Supervisor engineer and recording of the geology.

Where specified in the Drawings or Specification or directed by the Supervisor engineer, seams and other defects below the general level of the foundations shall be excavated and filled or covered with materials including mortar and concrete to the satisfaction of the Supervisor engineer before fill is placed thereon.

Where embankments are to be constructed on sloping ground, and where shown on the Drawings, benches shall be e
\xcavated in the foundations to the dimensions shown on the Drawings.

Except where specifically permitted by the Supervisor engineer all foundations for fill shall be kept free of water when placing fill thereon.

Earth foundations shall have the top 150 mm sufficiently moistened and, if necessary, harrowed or scarified and compacted to at least ninety-five per cent (95%) of the maximum dry density as determined by the AASHTO T99. Material too wet to be so compacted shall, as directed by the Engineer, be allowed to dry, harrowed or scarified to reduce the moisture content to the required amount and then be re-compacted.

2.7 Trench Excavation

Trench excavation shall be performed by the use of hand tools and approved mechanical equipment, in such manner as to minimise disturbance of the sides and bottom of the excavation.

Trenches for pipes shall be excavated to a sufficient depth to enable the pipe and the specified joint, bedding, haunching and surround to be accommodated. Unless otherwise stated, the width of the trench shall be equal to the nominal diameter of the pipe plus 600 mm.

The Contractor shall fill any over excavation beneath the pipe or bedding at his own cost with well rammed selected general excavation material as per requirement of this Specification. The Contractor shall dispose of surplus excavated material not required for backfill to spoil tips.

The sides of trenches shall be adequately supported at all times. Alternatively, where the Contractor has to excavate the trenches in open cut the Contractor shall ensure that the side slopes of the excavation are sufficient for stability.

Where rock or boulders are present in the sides or base of a trench in which a pipe is to be installed, the trench shall be trimmed so that when the pipeline is laid, no projection of rock comes within 200 mm of the outside of the pipe at any point. The over excavated portion shall be backfilled as set out in this Specification with approved granular material at the Contractor’s expense.

The Contractor shall be entirely responsible for the sufficiency of all temporary supports and side slopes to the excavations. The excavation shall be carried out in such a way as to maintain the stability of all roads and other adjacent structures or works.

2.8 Channel Excavation

The excavation of all channels shall be executed in such a manner as to ensure that the stability of side slopes is not endangered. Should slips or undercutting occur for reasons attributable to the Contractor's negligence or method of working, the Supervisor engineer will give instructions for remedial works to be carried out by the Contractor at the expense of the Contractor.

Where channels are to be reshaped, cleared and trimmed, the width, depth, side slopes and centre line radius shall be as shown on the Drawings. The Contractor shall clear all weeds and growth from existing channels and grade the beds to required levels. The area of waterway shown is the minimum required and sides of channels shall be trimmed to the required slope so as to provide widths not less than those shown on the Drawings.

Any channels, streams, drains or pipes taking water to or from cultivated land shall be diverted so as to maintain their flow before being moved or broken into unless express permission to the contrary is given by the Supervisor engineer. All diversions and their subsequent reinstatement are to be carried out to the satisfaction of the Supervisor engineer. The Contractor shall be deemed to have included the cost of dealing with this in his rates.

Side banks of channels shall be trimmed to a neat appearance and even surface.

In the construction of channels and embankments a local balance of cut and fill shall be maintained as far as possible unless the cut is unsuitable material or is specified in the drawings that the fill should be imported. A deficiency of fill material shall be made up by bed borrow or gleaning. Surplus material, if suitable and approved by the Supervisor engineer may be used for

an increased width of embankment otherwise it may be spread at the toe of the embankment or placed on spoil tips as directed by the Supervisor engineer.

Where required the Contractor shall control the rates of filling and draw-down of water in channels so as not to endanger the stability of earthworks.

2.9 Disposal of Excavated Material

All material not suitable for embankments or other filling shall, unless otherwise directed by the Supervisor engineer, be taken to disposal outside of municipality border.

The cost of disposal of shall be deemed to be included in the respective unit rates for the excavation work and the Contract Sum.

2.10 Backfilling of Structural Excavations

Backfilling of structural excavations shall be carried out with excavated material selected or approved by the Supervisor engineer. The material shall be placed in layers not exceeding 250 mm compacted thickness or such other thickness as the Supervisor engineer may approve or direct.

When material is filled up to or over any structure, the filling shall be brought up equally on each side or as otherwise agreed by the Supervisor engineer so that no unequal pressures likely to cause damage to the structure are applied.

2.11 Filling under raised foundations

The material to be used as filling under raised foundations shall consist of suitable material obtained from adjacent excavations or approved borrow sources, and shall be placed in layers not exceeding 150 mm compacted thickness.

3 CONCRETE

3.1 Concrete General

Concrete shall consist of cement, graded aggregate and water carefully proportioned, thoroughly mixed, placed and compacted as specified.

The Contractor shall obtain formal approval from the Supervisor engineer before pouring any concrete for the permanent works. The Supervisor engineer shall allow concreting after ascertaining the required lines and levels, suitability of formwork, availability of required equipment and labour, proper fabrication and spacing of the steel bars and quality and quantity of cement and aggregates.

3.2 Cement

Cement for use in the permanent works shall be Ordinary Portland Cement from an approved manufacturer and shall be type CEM I 32,5N complying with BS EN 197-1. Where sulphate-resisting cement is specified, it shall comply with BS 4027.

All cements shall be certified by the manufacturers as complying with the requirements of the specification. Before orders are placed the Contractor shall submit details of the proposed supplier(s) together with such information on the proposed methods of transport, storage and certification so that the Supervisor engineer may satisfy himself that the quantity and quality required can be supplied and maintained throughout the construction period. Where necessary the Supervisor engineer may require representative samples of the proposed cement to be taken and forwarded to a nominated laboratory for analysis and testing before the source is approved.

No cement shall be used in the Works until deemed satisfactory by the Supervisor engineer.

3.3 Supply of Cement

Cement shall be obtained from one manufacturer unless otherwise authorised by the Engineer. Should the use of cement from different manufacturers be authorised, the different supplies of cement shall be stored separately and shall not be mixed.

The Contractor shall supply to the Engineer copies of the manufacturer's test certificates certifying that each consignment of cement has been tested and analysed, and that the results comply in all respects with the above standards. Each certificate shall state clearly the date of despatch and the number of bags despatched in each consignment.

Bagged cement shall be delivered in sealed 50 kilogrammes sacks. Each bag shall be marked with the parcel number of the cement contained. Bagged cement shall be transported so that at no time is it exposed to damp and so that moisture cannot be absorbed from the atmosphere. Cement in bulk shall be transported in totally enclosed water tight and sealed containers.

If cement is obtained from an intermediate agent, such agent's arrangements for transporting and storing cement shall be to the approval of the Supervisor engineer.

3.4 Storage of Cement

The Contractor shall provide sufficient storage capacity on Site to ensure that his anticipated programme of work is not interrupted due to lack of cement. Factors outside the Contractor's control such as transport, weather conditions, holidays and breakdowns shall be taken into account.

Cement delivered to the Site in bulk shall be stored in dry, well ventilated weather proof silos or bins which shall be self clearing. Cement delivered to the Site in bags shall be stored in dry, weather-proof sheds which shall have floors of damp proof construction raised at least 150 mm above the surrounding ground.

Cement of different consignments shall be stored separately and consignments shall be used in the same order as they are delivered to the site. No cement shall be stored on the site for longer than three months from the date of despatch by the manufacturer. If not used within that period, the cement shall be removed from the site.

Any bag of cement which is damaged or found to contain cement which has set or partly set, shall be discarded and not used in the Permanent Works.

3.5 Testing of Cement

Cement shall be tested by the manufacturer. If the manufacturer's test certificate is not made available, representative samples shall be taken from different bags or containers of each consignment. They shall be suitably packed and sent to an approved laboratory for testing to prove the cement's compliance with the specified standards.

The Supervisor engineer may require cement to be tested after its delivery to the site. Any cement which has been in store at the site for longer than one month shall be re-tested.

The Supervisor engineer may take samples of cement from cement bins or bagged cement, from a parcel of cement after its delivery to the site, or from a parcel of cement which has been stored at the site for longer than one month.

In addition to the manufacturer's tests the Supervisor engineer may require the following tests to be carried out to BS EN 196-3:

(a) Comprehensive strength;
(b) Soundness.

Any cement which fails to meet the specified requirements shall not be used in the Permanent Works.

3.6 Aggregate for Concrete

3.6.1 General

Aggregates for concrete shall comply with BS EN 12620, and shall be obtained from a source or sources approved by the Supervisor engineer and shall be transported and stored in such a manner as will prevent:

(a) Contamination of the aggregates from the ground, rubbish, vegetation, dust or any other foreign material.
(b) Segregation.
(c) Intermixing of aggregates of differing characteristics.

Before aggregates from each source are approved for use in the Permanent Works, tests shall be carried out at an approved testing laboratory on representative samples submitted by the Contractor to check that the aggregates comply with the requirements of the Specification.

During concreting operations, tests shall be carried out to check that aggregates delivered for use in the Permanent Works comply with the requirements of the Specification.

Moisture contents of aggregates shall be determined as the moisture content of the aggregate compared with that of the aggregate in the saturated surface-dry condition. Specific gravities of aggregate shall be determined on aggregate in the saturated surface-dry condition.

Aggregates shall be stored on a clean, free draining surface. The various types and sizes of aggregates shall be kept separate from each other and each stockpile shall be kept as large as possible to maintain a reasonably uniform content in the aggregate.

3.6.2 Fine Aggregates

Fine aggregates shall be clean and durable and shall be natural sand, crushed gravel sand or crushed rock sand complying with BS EN 12620. All the material shall pass through a 5 mm BS

sieve. In order to achieve an acceptable grading, it may be necessary to blend materials from more than one source.

As an alternative, fine aggregate for mortar only shall comply with BS 1199 and 1200.

The fine aggregate shall not contain iron pyrites or iron oxides. It shall not contain mica, shale, coal or other laminar, soft or porous materials unless the Contractor can show by tests on finished concrete as set out in BS EN 12390 that the presence of such materials does not adversely affect the properties of the concrete.

The proportion of clay, silt and other impurities passing a 75 microns BS sieve shall not exceed three per cent for natural or crushed gravel sand or 15 per cent for crushed rock sand. The shell content shall not exceed 15 per cent by weight.

Chlorides soluble in a 10 per cent solution by weight of nitric acid shall not exceed 0.05 per cent by weight expressed as chloride ion when tested as set out in BS 812, subject to the further restriction given in the note on total chloride content in sub-clause 3.5.5.

Soundness: After five cycles of the test set out in ASTM C88-76, the aggregate shall not show a weight loss of more than 10 per cent.

Samples taken from the fine aggregate shall pass the colour test for organic impurities described in sub-clause 3.6.4.

Tests on fine aggregates shall be carried out daily or as required by the Supervisor engineer on site during concreting operations as follows:

(a) Sieve analysis

(b) Moisture content. An approved "rapid" test may be used for this test.

(c) Percentage of material passing a 75 microns BS sieve by the Field Settling Test, checked when necessary by the Decantation Method.

(d) Test for organic impurities as described in sub-clause 3.5.4.

The Contractor shall arrange to carry out the following tests when requested by the Engineer:

(e) Specific gravity and water absorption.

(f) Bulk density.

(g) Other tests described in BS 812.

3.6.3 Coarse Aggregates

Coarse aggregates shall be clean, hard and durable crushed rock, crushed gravel or natural gravel complying with the requirements of BS EN 12620. The material shall be frost resistant and shall not contain any iron pyrites, iron oxides, flaky or laminated material, hollow shells, coals or other soft or porous material, or organic matter. The pieces shall be predominantly angular, rounded or irregular as defined in BS 812.

Coarse aggregate shall be supplied in the nominal sizes called for in the Contract and shall be graded in accordance with BS EN 12620 for each nominal size.

The proportions of clay, silt and other impurities passing a 75 microns BS sieve shall be not more than one per cent by weight.

The content of hollow and flat shells shall not be such as will adversely affect the concrete quality when tested as set out in BS 1881. The total shell content shall not be more than the following:

40 mm nominal size and above	2 per cent of dry weight
20 mm nominal size	5 per cent of dry weight
10 mm nominal size	15 per cent of dry weight

Chlorides soluble in a 10 percent solution by weight of nitric acid shall not exceed 0.03 per cent by weight, expressed as chloride ion when tested as set out in BS 812 but subject also to the further restriction on total chloride content given in sub-clause 3.5.5.

When tested in accordance with ASTM C289, the aggregate shall be non-reactive.

Soundness: After 5 cycles of the test set out in ASTM C88-76, the aggregate shall not show a weight loss of more than 12 per cent.

Flakiness Index: When tested in accordance with BS 812 shall be as set out hereunder:

40 mm nominal size and above	Not more than 40
20 mm nominal size and below	Not more than 34

If the flakiness index of the coarse aggregate varies more than five units from the average value of the aggregate used in the approved trial mix, a new set of trial mixes shall be carried out in the workability of the mixes have been adversely affected by such variation.

Impact Value: Not more than 45 per cent when tested in accordance with BS 812.

Ten per cent fines value: Not less than 50 kN when tested in accordance with BS 812.

Shrinkage: When mixed with other ingredients in the approved proportions for concrete and tested as set out in BS 1881, the shrinkage factor shall not exceed 0.05 per cent.

Water absorption: The aggregate shall not have a water absorption of more than 2.5 per cent when tested as described in BS 812.
Tests on coarse aggregate shall be carried out daily or as required by the Engineer on site during concreting operations as follows:

(a) Sieve analysis
(b) Moisture content: An approved "rapid" test may be used for this test.
(c) Percentage of materials passing a 75 microns BS sieve by the Field Settling Test, checked when necessary by the Decantation Method.

The Contractor shall arrange to carry out the following tests when requested by the Engineer:

(d) Determination of Flakiness Index.
(e) Specific gravity and water absorption.
(f) Determination of "ten per cent fines" and of Los Angeles Abrasion.
(g) Other tests described in BS 812.

3.6.4 Test for Organic Impurities

Aggregates shall be tested for organic impurities by means of discoloration of a sodium hydroxide solution as follows:

A 340 ml graduated prescribed bottle shall be filled to the 123 ml mark with a sample of the aggregate to be tested. A 3 per cent solution of sodium hydroxide in water shall be added until the volume of the aggregate and liquid after shaking gives a total volume of 194 ml. The bottle shall be stoppered, shaken thoroughly and allowed to stand for 24 hours. Should the liquid then be darker than the standard colour solution the aggregate shall not be used for making concrete.

The standard colour solution shall be prepared in a 340 ml prescription bottle as follows:

2.5 ml of a 2 per cent solution of tannic acid in 10 per cent alcohol shall be added to 97.5 ml of a 3 per cent solution of sodium hydroxide in water. The mixture shall be shaken and allowed to stand for 24 hours.

A glass of the standard colour may be used in place of the standard solution.

3.6.5 Total Chloride and Sulphate Contents

The total chloride content arising from all ingredients in a mix, expressed as chloride ions as a percentage of the weight of cement in a mix, shall not exceed 0.5 per cent in any one sample nor 0.3 per cent in 95 per cent of the samples tested. For pre-stressed concrete, steam cured concrete or concrete containing sulphate resisting cement or super sulphated cement, the total chloride content shall not exceed 0.5 per cent of the weight of cement in the mix.

The total sulphate content arising from all ingredients in a mix shall not exceed 0.4 per cent by weight of the aggregates or 4 per cent of the weight of cement in the mix, whichever is less. For this purpose, the sulphate contents shall be expressed as SO_3 and shall be calculated from the sulphate contents of the cement, aggregates and any admixtures. Where applicable, sulphate contents shall be determined in accordance with tests described in BS 1047 and 3892.

Pulverised fuel ash shall not be used in conjunction with a cement complying with the requirements of BS 4027 in concrete required to be resistant to sulphates.

3.7 Admixtures

Admixtures for improving workability, accelerating or retarding setting of concrete, or for any other purpose, shall comply with BS EN 934 and only be used with the Supervisor’s engineer written approval. Calcium chloride or admixture containing chlorides will, however, not be approved.

The Contractor shall submit samples of the admixtures he proposes to use to the Supervisor engineer for testing. If an admixture is approved for use it shall be obtained from an approved supplier and the Contractor's arrangement for measuring, mixing and adding the admixture to the concrete batch shall be strictly in accordance with the manufacturer's instructions or recommendations and subject to the approval of the Supervisor engineer.

The proportions of the concrete mixes and water/cement ratio shall be adjusted to the satisfaction of the Supervisor engineer so that the strength of the concrete with admixture is at least equal to the strength of the equivalent concrete without admixture.

3.8 Water for Concrete

Clean fresh water complying with BS EN 1008 is to be used for the mixing of all concrete and mortar, and is to be from a source approved by the Supervisor engineer.

3.9 Concrete Mixes

The design of concrete mixes shall be the sole responsibility of the Contractor, but may be undertaken in conjunction with the Supervisor engineer. Concrete mixes shall be designed mixes in accordance with the requirements of BS 5328 having the characteristics specified in Table 3.1 of this Specification. Concrete for use in water retaining structures shall comply with BS 8007.

Evidence shall be submitted to the Supervisor engineer, for all classes of concrete to be used, showing that at the intended workability the proposed mix proportions and production methods will produce concrete of the required quality.

The following information shall be provided before any designed mix is supplied:

(a) Nature and source of each material
(b) Full details of tests on trial mixes including workability
(c) Proposed quantities of each ingredient for one cubic metre of fully compacted concrete

No change in the approved mix design will be permitted, unless the Contractor carries out trials on the proposed mix design to show that compliance with this Specification can be maintained.

Mix design shall in all cases be subject to the approval of the Supervisor engineer, but such approval shall in no way relieve the Contractor of his responsibility for the design and production of concrete in compliance with this Specification.

3.10 Trial Mixes

At least six (6) weeks before commencing the placing of any concrete in the works, trial mixes shall be prepared for each class of concrete to be used on the works. Three (3) batches of each class of concrete shall be made using materials typical of the proposed supply and under full scale production conditions.

The workability of each of the trial batches shall be determined and three (3) cubes made from each batch for testing at 28 days. A further three (3) cubes made from each batch may be made for tests at an earlier age if required.

The trial mix proportions shall be approved if the average compressive strength of the nine (9) cubes tested at 28 days exceeds the specified characteristic strength by 3 Newtons per square millimetre, or if nine tests at an earlier age indicate that it is likely to be exceeded by this amount.

To demonstrate that the maximum free water/cement ratio is not exceeded, two batches of concrete shall be made in a laboratory with cement and surface-dry aggregate known from past records of the supplier of the material to be typical. The proposed mix proportions will not be accepted unless both batches have the cement content specified and free water/cement ratio below the maximum specified in Table 3.1.

Table 3.1 - Classes of Concrete

Class	Characteristic Compressive Strength N/mm^2	Maximum Free Water/cement Ratio	Minimum Cement Content kg/m^3	Maximum Cement Content kg/m^3	Maximum Aggregate Size mm
C25/10/A	25	0.55	360	400	10
C25/20/A	25	0.55	360	400	20
C25/20/B	25	0.55	290	400	20
C25/20/C	25	-	240	540	20
C20/20/B	20	0.55	290	400	20
C20/40/B	20	0.55	260	400	40
C20/40/C	20	-	220	540	40
C15/40/C	15	-	180	540	40
C15/20/C	15	-	180	540	20
C10/40/C	10	-	150	540	40

A, B and C denote exposure conditions for the finished concrete as defined in BS 8007.

3.11 Testing of Concrete

3.11.1 General

All concrete shall be sampled and tested in accordance with the requirements of BS EN 12350 and BS EN 12390 unless otherwise stated in this Specification or instructed by the Supervisor engineer.

The Contractor shall allow for all the necessary labour, materials, and equipment necessary for the regular sampling and testing of concrete to be placed in the Works.

3.11.2 Cement Content

Tests shall be carried out as required by the Supervisor engineer to determine the cement content of the mix. The cement content of any batch of concrete shall not be less than the specified minimum value minus 5 per cent of that value nor more than the specified maximum value plus 5 per cent of that value.

3.11.3 Workability

The workability of the concrete shall be measured as required by the Supervisor engineer by slump tests or compaction factor tests and shall be within the following limits:

Slump $\pm$ 25 mm or $\pm$ one third of required value whichever is greater.

Compacting Factor
$\pm$ 0.03 where required value is 0.90 or more
$\pm$ 0.04 where required value is 0.90 to 0.80
$\pm$ 0.05 where required value is 0.80 or less

The required value shall be that which has been accepted under Clause 3.8 of this Specification.

3.11.4 Water/Cement Ratio

The water/cement ratio shall be determined as required by the Supervisor engineer and shall not exceed the specified maximum value by more than 5 per cent of that value.

3.11.5 Compressive Strength

Samples of concrete shall be taken for compressive strength at a rate of one sample per 15 m^3 of concrete placed or 15 batches of concrete placed whichever is the lesser volume. A greater frequency of sampling may be instructed by the Supervisor engineer until compliance with specified strength requirements has been confirmed for each class of concrete used in the Works.

Two test specimens shall be prepared from each sample and shall be cured for 28 days, or by any other method approved by the Supervisor engineer that enables the prediction of 28-day strength at an earlier time.

On completion of curing, the two test specimens shall be tested. Provided the difference between the two results does not exceed 14 per cent of the mean of the two results, the mean shall be taken as the test result. Where the difference between the two results exceeds 14 per cent of their mean, the lower of the two results shall be taken as the test result.

Compliance with the specified strength may be assumed if the conditions given in both (a) and (b) below are satisfied.

(a) The average compressive strength determined from any one group of four consecutive 28-day test results exceeds the specified characteristic strength by not less than 3 N/mm^2 for classes of concrete C20, C25 and C30 and not less than 2 N/mm^2 for class C15 concrete.

(b) Each individual 28-day test results are greater than the specified characteristic strength minus 3 N/mm^2 for classes of concrete C20, C25 and C30 or 2 N/mm^2 for class C15 concrete.

If only one tests result fails to meet the second requirement, then that result may be considered to represent only the particular batch of concrete from which that sample was taken provided the average strength of the group satisfies the first requirement.

If more than one result in a group fails to meet the second requirement or if the average strength of any group of four consecutive test results fails to meet the first requirement, then all the concrete in all the batches represented by all such results shall be deemed not to comply with the strength requirements. For the purposes of this Clause, the batches of concrete represented by a group of four consecutive test results shall include the batches from which samples were taken to make the first and the last tests in the group of four, together with all the intervening batches.

3.12 Failure to Comply with Specified Requirements

Failure of concrete to comply with the specified requirements will result in it being classified as defective work. Immediately on notification by the Supervisor engineer that concrete work is defective, the Contractor shall take all measures necessary to improve concrete quality before further concrete is placed in the Works. If required by the Supervisor engineer, the rate of sampling of concrete shall be increased until adequate control is again established. Tests shall be carried out on the defective concrete or test cores taken from it to establish its in-situ strength. If the results of these tests satisfy the Supervisor engineer that the defective concrete will fulfil its design function, then it may be accepted. If not, the Contractor shall propose strengthening or remedial work where possible or shall remove the defective concrete from the Works.

3.13 Concrete Returns and Records

The Contractor shall send weekly to the Supervisor engineer a return showing the quantities of cement and the number of mixings of each class of concrete used in each section of the Works.

Records shall be kept by the Contractor of the positions in the Works of all batches of concrete, of their class and of all test cubes or other specimens taken from them. Copies of these records shall be supplied to the Supervisor engineer.

3.14 Equipment and Construction Procedure

The design, layout, installation and operation of equipment for processing, handling, transporting, storing and proportioning concrete ingredients and for mixing, transporting and placing concrete shall be to the satisfaction of the Supervisor engineer. Before the equipment is ordered or delivered to site, the Contractor shall submit to the Supervisor engineer drawings showing the proposed arrangements of the equipment together with detailed descriptions of the equipment proposed.

3.15 Batching

The aggregates and cement shall be proportioned by means of efficient weigh batching machines except when the Supervisor engineer has approved the use of volume batching. The machines shall be carefully maintained and cleaned and they shall be provided with simple and convenient means of checking the accuracy of the weighing mechanism, and they shall be checked when required by the Supervisor engineer.

For volume batching suitable gauge boxes shall be used.

3.16 Mixing Concrete by Machine

Where the concrete is to be mixed in machines, these shall be of the batch mixing or other approved type. The machines shall ensure that all the concreting materials including the water are thoroughly mixed together before any portion of the mixture is discharged. The mixing time shall not be less than thirty seconds per cubic foot (30 sec/cft) of concrete, with a minimum of three minutes (3 min) mixing time per batch. The machines must be capable of discharging their contents while running.

3.17 Mixing Concrete by Hand

Where it is not possible to employ machine mixing and approval has been obtained from the Engineer, concrete shall be mixed by hand as near as practicable to the site where it is to be deposited. Clean mixing bankers or platforms of sufficient area for the proper execution of the work shall be provided. These platforms if constructed of timber shall consist of planks closely jointed so as to avoid the loss of any grout or liquid from the wet concrete. The whole of the aggregate and cement shall be turned over on the banker in a dry state at least twice. The water shall then be added gradually through a rose head, after which the materials shall again be entirely turned over in a wet state at least three times.

3.18 Preparation of Surface to Receive Concrete

Foundations which are to receive concrete shall be properly drained and dewatered so that no water runs over or stands on a surface on which concrete is being placed. If required by the Engineer drains provided through or beneath concrete for the temporary conveyance of water shall afterwards be completely sealed to the Engineer's approval.

Before deposition of concrete against rock, the rock surface shall be thoroughly wetted and cleaned by the application of water, or of water and air, under pressure. No concrete shall be deposited until the surface has been cleaned and passed as satisfactory by the Supervisor engineer.

Faults or seams in the rock shall be cleaned to a depth satisfactory to the Supervisor engineer and if necessary stemmed with cement mortar of an approved mix.

Before any steel reinforcement is embedded in the concrete any loose mill scale, loose rust and any oil, grease or other deleterious matter shall be removed. Partially set concrete which may adhere to the exposed bars during concreting operations shall likewise be removed.

3.19 Authority to Commence Placing of Concrete

The Contractor shall give the Supervisor engineer at least 24 hours notice of his intention to place concrete in a particular section of the Works. Before concrete is placed the Contractor shall apply to the Supervisor engineer for approval of the cleanliness, alignment and suitability of surfaces against which the new concrete is to be placed and of the fixing of formwork, reinforcement, embedded parts and the like and he shall obtain written permission from the Supervisor engineer to proceed with concreting.

The Contractor shall carefully plan his concreting operation to ensure, where possible, that these operations are completed within the normal working day.

3.20 Dimension of Concrete Pours and Programme of Placing

Unless otherwise approved by the Supervisor engineer concrete shall be cast in one operation between external faces of concrete and joints shown on the Drawings or between construction joints or both.

The Contractor shall submit and obtain the Supervisor's engineer approval to a detailed concreting programme and his proposals for the location of construction joints.

3.21 Transport and Deposition of Concrete

Concrete shall be transported and deposited in such manner as to prevent segregation, loss of materials or contamination with foreign matter. The means of transport of concrete shall be subject to the approval of the Supervisor engineer. The containers for conveying the concrete shall be thoroughly cleaned immediately after use and sides dampened before work is started or restarted to prevent cement and fine material in the first batch adhering to the sides. Adequate precautions shall be taken to protect the concrete against wetting or drying out through exposure to the weather and to prevent segregation and consolidation of the mix due to prolonged jolting of the concrete. Concrete shall be placed in its final position and fully compacted before the onset of initial set. Wherever possible, concrete shall be

deposited vertically in the final position required and shall not be dropped through a greater height than 1.5 m. Where necessary, bins, drop chutes, downpipes or baffles shall be provided to prevent segregation of the material. Drying out of fresh concrete before deposition shall be prevented by the provision where necessary of suitable covers. Loss of slump during transport and deposition of the concrete shall not exceed 25 mm.

Concrete shall not be placed in standing or running water unless so specified. Where concrete has to be placed under water, the Contractor shall submit to the Engineer his proposals indicating the methods and equipment to be employed. The concrete shall be deposited by bottom discharging watertight containers or through funnel shaped tremies which are kept continuously full with concrete up to a level above the water and which shall have the discharging bottoms immersed in the concrete in order to reduce to a minimum the contact of the concrete with the water. Special care shall be taken to avoid segregation and additional cement of about 25% must be added.

3.22 Distribution and Spreading of Concrete

Concrete shall be placed in layers not exceeding 500 mm in depth approximately parallel to the horizontal or inclined construction joint planes. These layers shall be deposited from one face to the other until the full height of the lift is reached. Each layer shall be deposited on the previous one before the latter has taken its initial set and the exposed area of fresh concrete shall be maintained to the practical minimum. In order to accomplish this timing a new layer may be started before the previous layer is completed.

The face from which placing of concrete is to commence shall be selected so that if an emergency should occur which prevents the layer being completed the vertical construction joint will be formed in a structurally acceptable position.

Concrete shall not be placed during rain sufficiently heavy or prolonged to wash mortar form coarse aggregate on the exposed sloping faces of fresh concrete unless adequate shelter is provided.

Concrete shall not be placed against any surface (including formwork, reinforcement, embedded steelwork, adjacent concrete or rock) which during hot weather is not adequately dampened to prevent excessive absorption of water from the fresh concrete.

Once commenced, concreting shall be carried on as continuous operation between pre-arranged construction, expansion or contraction joints save only if an emergency occurs and interruption is unavoidable. The Contractor shall have readily available suitable prefabricated formwork for stop ends to form emergency vertical construction joints and, in the event of such an interruption occurring, the concrete already placed shall be properly finished up to the stop end and to a horizontal or inclined surface as directed by the Supervisor engineer. In water retaining structures the Contractor shall propose methods of making the joint watertight.

Concrete shall be placed carefully so as not to displace the formwork or reinforcement.

3.23 Protection of Concrete

Freshly placed concrete shall be protected from rainfall and from water running over the surface until it is sufficiently hard to resist damage from this cause.

No traffic shall be allowed on any concrete surface until such time as it is hard enough to resist damage by such traffic.

Concrete placed in the Permanent Works shall not be subjected to any structural loading until it has attained at least its nominal strength.

If the Contractor desires to impose structural loads on newly placed concrete, he shall make at least three test cubes and cure them in the same conditions as the concrete they represent. These cubes shall be tested singly at suitable intervals in order to estimate the time at which the nominal strength is reached.

3.24 No Partially Set Concrete Shall Be Used

All concrete must be placed and compacted in its final position within thirty minutes (30 min) of discharge from the mixer unless otherwise approved. No partially set material shall be used in this work.

3.25 Concreting in Adverse Weather

No concreting will be allowed to take place in the open during storms or heavy rains. Where strong winds are likely to be experienced additional precautions to ensure protection from driving rain and dust shall also be taken.

The Engineer may withhold approval of commencement of concreting until he is satisfied that full and adequate arrangements have been made.

3.26 Concreting at Night or in the Dark

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

3.27 Concreting in High or Low Ambient Temperature

Where the ambient temperature exceeds thirty-two degrees Celsius (32^{o}C), the Contractor shall take special measures in the mixing, placing and curing of concrete. The temperature of the concrete when deposited shall not exceed thirty degrees Celsius (30^{o}C). The Contractor shall carry out all necessary special measures to ensure that the maximum concrete temperature after placing shall not exceed fifty degrees Celsius (50^{o}C) or thirty degrees Celsius (30^{o}C) above the concrete temperature at the time of placing, whichever is lower.

During placing suitable means shall be provided to prevent premature stiffening of the concrete placed in contact with hot surfaces.

The Contractor shall not mix and place concrete when the ambient temperature falls below three degrees Celsius (3^{o}C).

3.28 Curing and Protection

Concrete shall be protected during the first stage of hardening from the harmful effects of sunshine, drying winds, cold, rain or running water. The Contractor shall pay particular attention to the need to protect concrete immediately after the finishing operation and prior to its final set and shall submit their proposals to achieve this protection for the Supervisor's engineer approval. Protection of concrete which has achieved its final set shall consist of one or more of the following:

(a) A layer of sacking, canvas, hessian, straw mats or similar absorbent material or a layer of sand, kept constantly moist by spraying with water as necessary for fourteen (14) days or such periods as may be directed by the Supervisor's engineer.

(b) After thoroughly wetting, a layer of approved waterproof paper or plastic membrane kept in contact with the concrete for fourteen (14) days or such period as may be directed by the Supervisor's engineer.

The use of saline water for curing purposes will not be permitted.

3.29 Steel Reinforcement

3.29.1 Materials

Unless otherwise directed or otherwise shown on the Drawings, hot rolled high yield reinforcement shall be used throughout the works.

Where required, mild steel reinforcement, medium tensile steel reinforcement and high tensile steel reinforcement shall comply with BS 4449. Cold twisted steel wire for the reinforcement of concrete shall comply with BS 4482.

All reinforcement shall be from an approved manufacturer and, if required by the Supervisor's engineer, the Contractor shall submit a test certificate of the rolling. The Contractor shall, when requested by the Supervisor engineer, provide sample pieces 0.6-metre-long for testing.

Tying wire shall be 1.6 mm diameter soft annealed iron wire.

Before any steel reinforcement is embedded in the concrete any loose mill scale, loose rust and any oil, grease or other deleterious matter shall be removed. Partially set concrete which may adhere to the exposed bars during concreting operations shall likewise be removed.

3.29.2 Fabricating Reinforcement

Bar reinforcements shall be bent to the shapes shown on the Drawings and bending schedules. All bars shall be bent cold, unless otherwise permitted by the Engineer. All hooks, bends, and the like, unless otherwise shown on the Drawings, shall be to BS 4666. The Contractor shall satisfy himself as to the accuracy of any bar bending schedules supplied and shall provide all reinforcement in accordance with the Drawing. Bar reinforcement shall be bundled and each bundle of steel shall be tagged with identifying tags, showing the size and mark of the bar. The bundles shall be stacked clear of the ground in easily accessible positions that do not in any way hinder the progress of work and shall be kept clean.

3.29.3 Fixing Reinforcement

When placed in the work reinforcement shall be free from coatings or dirt, detrimental scale, paint, oil or other foreign substances. When steel has on its surface rust, loose scale and dust which is easily removable, it may be cleaned by a method approved by the Supervisor engineer.

All reinforcing bars, ties, links and fabric shall be fixed in the positions shown on the Drawings within the tolerances specified in BS 8666. In no case shall the cover specified on the Drawings be increased by more than 5 mm.

Displacement of reinforcement beyond the specified tolerance shall be prevented by supporting the bars sufficiently and securely fixing them together at intersections where necessary.

The ends of all tying wires shall be turned into the body of the concrete and not allowed to project towards the surfaces of the concrete.

Spacers shall be used to maintain the cover to all steel and shall be made of dense cement mortar of one-part cement and two parts sand.

Spacers shall be triangular in section and only one acute edge shall bear against the formwork, the flat side shall bear against the steel. Wire cast into the blocks to fix them to the reinforcement shall be 1.6 mm diameter soft annealed iron. Spacers shall not be used on the wet face of water retaining or water excluding structures. Chairs, stools, etc. shall be used to maintain clearance between two or more layers of reinforcement.

Nothing shall be allowed to interfere with the specified position of reinforcement. The fixing of reinforcement shall be checked before and during concreting, and particular attention shall be given to the position of top steel in cantilever sections. During concrete placing a competent steel fixer shall be in attendance to adjust and correct the position of any reinforcement which may be displaced.

3.29.4 Splicing and Lapping

All reinforcement shall be provided in full lengths as indicated on the Drawings or bending schedules. Splicing of bars, except where shown on the Drawings, shall not be permitted without the written approval of the Supervisor engineer. Splices shall be staggered as far as possible. Bar reinforcement shall not be welded without the Engineer's written permission.

In lapped splices, the bars shall be placed in contact and wired together in such manner as to maintain a clearance between bars of not less than 50 mm.

Mesh or bar reinforcement shall overlap sufficiently to maintain a uniform strength and shall be securely fastened at ends and edges. The edge lap shall not be less than 40 diameters of the mesh reinforcement bar or two mesh widths whichever is greater.

3.30 Cover to reinforcement

The concrete cover to reinforcement shall be 50 mm unless otherwise shown on the Drawings.

The Contractor shall provide any necessary concrete pads for ensuring the cover is attained and in no case shall timber packing be used.

3.31 Formwork

3.31.1 Definitions

Forms, formwork or shuttering shall mean all temporary moulds forming the concrete to the required shape together with any special lining that may be required to produce the concrete finish specified.

False work or centring shall mean the furnishing, placing and removal of all temporary construction such as framing, props and struts required for the support of forms.

3.31.2 Materials

The formwork may be of seasoned, planed, tongued and grooved timber, plywood farefaced blackboard, tempered hardboard, steel or as specified on the Drawings.

All timber used for formwork shall be sound wood, well seasoned and free from loose knots, shakes, large checks, warping and other defects. Before use on the work, it shall be properly stacked and protected from injury from any source. Any timber which becomes badly warped or cracked, prior to the placing of concrete shall be rejected. All formwork for outside surfaces before final ground level shall be either tongued and grooved or provided with a suitable lining to produce a smooth surface finish.

3.31.3 Forms

All forms shall be of wood or metal and shall be built grout-tight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other loads incidental to the construction operations. Forms shall be constructed and maintained so as to prevent warping and the openings of joints due to shrinkage of the timber.

The forms shall be substantial and unyielding and shall be so designed that the finished concrete will conform to the proper dimensions and contours. The design of the forms shall take into account the effect of vibration of concrete as it is placed.

All formwork shall, unless otherwise directed, be provided with 25 mm by 25 mm angle fillets (chamfers) so as to form splays on internal and external angles.

A grout check formed from 25 mm square hardwood timber shall be incorporated in the formwork to provide a clean, level, horizontal joint on exposed concrete surfaces at the top of each lift.

All joints in the formwork shall be either horizontal or vertical. End formwork shall be square across the mass of concrete.

Where concrete is to be deposited to a slope steeper than 20 degrees to the horizontal, top formwork shall be used to enable the concrete to be properly compacted unless the Supervisor engineer agrees otherwise.

Openings for the inspection and cleaning of the inside of formwork for walls, piers and columns shall be formed in such a way that they can be closed conveniently before commencing to place concrete.

Form clamps, tie bolts and anchors shall be used to fasten forms. The use of wire ties to hold forms in position during placing of concrete will not be permitted. Tie bolts and clamps shall be positive in action and of sufficient strength and number to prevent spreading or springing of the forms. They shall be of such type that no metal part shall be left within the specified concrete cover. For water retaining sections, methods of fixing the forms which result in holes through the concrete section when the formwork is removed shall not be used and built-in wall ties shall be fitted with water baffles.

All forms for outside surfaces shall be constructed with stiff wales at right angles to the studs and all form clamps shall extend through and fasten such wales.

The shape, strength, rigidity, grout tightness and surface smoothness of forms which are re-used shall be maintained at all times. Any warped, bulged or otherwise damaged timber shall be replaced. Forms which are unsatisfactory shall not be re-used. If the surface finish on the formed concrete deteriorates as a result of deterioration of the faces of the forms, the Supervisor engineer shall instruct that forms be resurfaced, or discarded.

All forms shall be treated with approved mould or similar oil or be soaked with water immediately before placing concrete to prevent adherence of concrete. Any materials which adhere to or discolour concrete shall not be used.

All forms shall be set and maintained true to the line designated until the concrete is sufficiently hardened. Forms shall remain in place for periods which shall be as specified in

Clause 3.26. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the Engineer shall order the work stopped until the defects have been corrected.

All formwork shall be approved by the Supervisor engineer before concrete is placed within it. The Contractor shall, if required by the Supervisor engineer, provide copies of calculations of the strength and stability of the formwork and falsework. Notwithstanding the Supervisor's engineer approval of these calculations, the Contractor shall be held responsible for the safety and adequacy of formwork.

3.31.4 Falsework and Centering

Detailed plans for a falsework or centering shall be supplied by the Contractor to the Supervisor engineer at least 14 days in advance of the time the Contractor begins construction of the falsework. Notwithstanding the approval of the Supervisor engineer of any designs for falsework submitted by the Contractor, the Contractor shall be solely responsible for the strength, safety and adequacy of the falsework or centering.

All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads from the weight of green concrete and shuttering and incidental construction loads.

Falsework or centering shall be founded upon a solid footing safe against undermining and protected from softening. Falsework which cannot be founded on satisfactory footings shall be supported on piling which shall be spaced, driven and removed in a manner approved by the Engineer. The Supervisor engineer may require the Contractor to employ screw jacks, or hard wood wedges to take up any settlement in the formwork either before or during the placing of concrete.

Falsework shall be set to give the finished structure the required grade and camber shown on the Drawings.

3.31.5 Forms for Joints

Where permanent or temporary joints are to be made in horizontal or inclined members, stout stopping off boards shall be securely fixed across the mould to form a water-tight joint. The form of the permanent joint shall be as shown on the Drawings.

Where reinforcement or waterstops pass through the face of a joint the stopping off board shall be drilled so that the bars or waterstop can pass through, or the board shall be made in sections with a half round indentation in the joint faces for each bar so that when placed the board is neat and accurate fit and no grout leaks from the concrete through the bar holes, joints or around the waterstop.

3.31.6 Release Agents

Only approved chemical release agents, mould creams (emulsions of water in oil) or oils containing a proportion of surfactant not exceeding 2 percent will be permitted. Water soluble emulsions and oils without surfactant shall not be used. Oil based release agents shall be applied at a rate of 7 square metres per litre one day in advance of concreting, preferably by spray or roller. Chemical release agents shall be applied in accordance with the manufacturer's recommendations.

New timber face work shall be given three coats of release agent before use on the work to ensure uniformity of porosity on the surface.

On no account shall the release agent come into contact with the reinforcement.

3.32 Removal of Formwork

Formwork shall be carefully removed without shock or disturbance to the concrete. No formwork shall be removed until the concrete has gained sufficient strength to withstand safely any stresses to which it may thereby be subjected.

The minimum periods which shall elapse between completion of placing concrete and removal of forms are given in the following Table 3.2, and apply to ambient temperatures higher than 10°C. At lower temperatures or if cements other than ordinary Portland are involved, the Supervisor engineer may instruct longer periods.

Compliance with these requirements shall not relieve the Contractor of his obligation to delay removal of formwork until such removal can be completed without damage to the concrete.

Table 3.2 – Formwork striking time

Position of formwork	Striking Time
Beam sides, walls and columns	1 to 2 day
Slab soffits - props remain undisturbed	4 days
Beam soffits - props remain undisturbed	7 days
Removal of slab props	14 days
Removal of beam props	21 days

3.33 Surface Finishes

3.33.1 General

After removal of the formwork no treatment of any kind other than that required for curing the concrete shall be applied to the concrete faces until after inspection by the Supervisor engineer. All honeycombed areas, deformed surfaces or other defective surfaces shall then be repaired at the direction of the Supervisor engineer. Immediately following the Supervisor's engineer inspection of surface finish, all tie bolt cavities shall be filled with sand cement mortar and the surface left smooth, sound, even and uniform in colour.

Should the finishes surface either as-stuck or after repair exhibit a non uniform colour or texture, the Engineer shall have the right to order that the surface be given a skim coat and then painted.

3.33.2 Formed Surfaces

All joints between panels shall be vertical and horizontal unless otherwise directed. Suitable joints shall be provided between sheets to maintain accurate alignment in the plane of the sheets.

For warped surfaces, facings shall be built up of laminated splines cut to make a tight surface which shall then be dressed and sanded to the required curvature.

Type F1: This finish is for surfaces against which backfill or further concrete will be placed. Formwork shall consist of sawn boards, sheet metal or any other suitable material which will prevent the loss of grout when the concrete is being placed.

Type F2: This finish is for surfaces which are permanently exposed to view but where the highest standard of finish is not required. Forms to provide a Type F2 finish shall be faced with wrought thicknesses tongued and grooved boards with square edges arranged in a uniform pattern and close jointed or with suitable sheet material. The thickness of boards or sheets shall be such that there shall be no visible deflection under the pressure exerted by the concrete placed against them. Joints between boards or panels shall be horizontal and vertical unless otherwise directed. This finish shall be such as to require no general filling of surface pitting, but fins, surface discoloration and other minor defects shall be remedied by methods agreed by the Engineer.

Type F3: This finish is for surfaces which will be in contact with water flowing at high velocity and for surfaces permanently exposed to view where good appearance and alignment are of importance. To achieve this finish, which shall be free of boardmarks, the formwork shall be faced with plywood complying with BS 1088 or equivalent material in large sheets. The sheets shall be arranged in an approved, uniform pattern. Wherever possible, joints between sheets shall be arranged to coincide with architectural features or changes in direction of the surface. Suitable joints shall be provided between sheets to maintain accurate alignment in the place of the sheets. Unfaced wrought boarding or standard steel panels will not be permitted for Type F3 finish. The Contractor shall ensure that the surface is protected from rust marks, spillages and stains of all kinds.

Type F4: This finish is similar to that required for type F3 but is used in places where a first class alignment and a dense surface free from airholes and other defects is required, suitable for the application of decorative finishes, in very high velocity water channels and in other similar circumstances.

3.33.3 Unformed Surfaces

Type U1: This is screed finish for surfaces of roads of foundations, beds, slabs, and structural members to be covered by backfill, subsequent stages of construction, bonded concrete topping or cement mortar beds to receive pavings, and on exposed surfaces of paving where a superior finish is not required. It is also the first stage of Type U2 and U3 finishes. The finishing operations shall consist of levelling and screeding the concrete to produce a uniform, plane or ridged surface, surplus concrete being struck off by a straight edge immediately after compaction.

Type U2: This is a floated finish for exposed surfaces where a hard smooth steel trowelled surface is not required. Floating shall be done only after the concrete has hardened sufficiently, and may be by hand or machine. Care should be taken that the concrete is worked no more than is necessary to produce a uniform surface free from float marks.

Type U3: This is a hard smooth steel trowelled finish for surfaces exposed to water flowing at high velocity. Trowelling shall not commence until the moisture film has disappeared and the concrete has hardened sufficiently to prevent excess laitance from being worked to the surface. The surface shall be trowelled under firm pressure and left free from trowel marks.

Type U4: This finish is similar to Type U3 finish but the permissible tolerances are smaller.

3.33.4 Surface Tolerances

All parts of concrete surfaces shall be in the positions shown on the Drawings within the tolerances set out in Table 3.3 or Table 3.4.

In cases where the Drawings call for tolerances other than those given in Table 3.3 or Table 3.4, the Drawings shall rule.

Where precast units have been set to a specified tolerance, further adjustments shall be made as necessary to provide a satisfactory straight or curved line. When the Supervisor engineer has approved the alignment, the Contractor shall fix the units so that there is no possibility of further movement.

Table 3.3 - Surface Tolerances for Formed Surfaces

Type of Finish	Tolerance in mm (See Note 1)		
	A	B	C
FI	10	10	+25 to -10
F2	5	10	+15 to -15
F3	2	5	+10 to -10
F4	See Note 2	2	+5 to -5

Note 1:

The tolerances, A, B and C given in the table are defined as follows:

A is an abrupt irregularity in the surface due to misaligned formwork or defects in the face of the formwork.

B is a gradual deviation from a plane surface as indicated by a straight edge 3 metres long. In the case of curved surfaces, the straight edge shall be replaced by a correctly shaped template.

C is the amount by which the whole or part of a concrete face is displaced from the correct position shown on the Drawings.

Note 2:

Abrupt irregularities are not permitted in a Type F4 finish. Any residual irregularities which remain after removal of formwork shall be removed by grinding to achieve a transition of 1 in 50 between the surfaces adjacent to the irregularity.

Table 3.4 - Surface Tolerances for Unformed Surfaces

Type of Finish	Tolerance in mm (See Note 1)		
	D	E	F
U1	-	10	+20 to -10
U2	Nil	10	+20 to -10
U3	Nil	5	+12.5 to -7.5
U4	Nil	2	+6 to -4

Notes:

D is the maximum allowable value of any sudden change of level in the surface.

E is the maximum allowable value of any gradual irregularity of the surface, as indicated by the gap between the surface and a 3 m long straight edge or correctly shaped template placed on the surface.

F is the maximum allowable value of the difference in level or position between a straight edge or correctly shaped template placed on the surface and the specified level or position of that surface.

3.34 Conduits, Box-outs and Apertures

The layout of conduits, box-outs, grooves, apertures and the like shall be as shown on the Drawings or as directed by the Supervisor engineer, and shall be subject to inspection and approval by the Engineer before commencing concreting.

Conduits shall be placed as near the centres of members as possible and sufficient space shall be provided between adjacent conduits to prevent difficulties in the placing of concrete.

Box-outs, holes, grooves, apertures and the like shall be accurately set out in the formwork prior to placing the concrete. Fixing blocks, ends of brackets, bolts and, where possible, built in parts shall be cast into the concrete at the time of placing. No part of the concrete works shall be cut out for any such item, or for any other reason, without the Supervisor's engineer permission.

The Contractor shall ensure that all sub-contractors are informed of his programme for the structural works at the commencement of the Contract and that such sub-contractor's requirements relating to concrete members are approved well in advance. The Contractor shall obtain from all such sub-contractors complete information of their requirements regarding conduits, pipes, fixing blocks, ducts, holes and any other items to be cast into or formed in the concrete members. Failure of a sub-contractor to sub-contractor to supply such information shall not be allowed to delay the progress of the Works.

3.35 Construction joints

Concreting shall be carried out continuously up to construction joints, the position and arrangement of which shall be as indicated on the Drawings or as previously approved by the Engineer. The Contractor is to allow for working beyond the ordinary working hours where necessary in order that each section of concrete may be completed without any lapse while the work is in hand. All construction joints are to be formed square to the work.

Where vertical construction joints are required, the joint face of the first stage concrete shall be finished against a stopping-off board, or vertical end shutter, suitably notched to pass the reinforcement. When the concrete is hard and the shutter is removed, the whole joint surface shall be thoroughly hacked and roughened or scabbled with suitable tools so that no smooth skin of concrete is visible and that all aggregates and solid matrix around them is exposed.

For horizontal or slightly inclined construction joints, the surfaces shall preferably be prepared when the concrete has set but not hardened by jetting with a fine spray of water and brushing with a stiff brush to remove the smooth skin and expose the aggregate without disturbing it. Where this treatment is impractical and work is resumed after the concrete surface has hardened, a similar procedure shall be adopted as on vertical joints.

If, in the opinion of the Supervisor engineer, any deleterious material has come into contact with the concrete of the construction joint or if the concrete is honeycombed or unsound for any reason, the concrete shall be cut back to such a depth as the Supervisor engineer shall order and the roughened surfaces shall be thoroughly cleaned by compressed air and water jets or other approved means.

Immediately before concreting is resumed, the roughened joint surface shall be thoroughly cleaned with compressed air and water jets and slightly wetted and cement grout placed The Contractor shall take precaution to avoid segregation of the concrete along the joint plane and to obtain thorough compaction.

3.36 Precast Concrete Units

Precast concrete units shall be provided by an approved specialist supplier or may, subject to the Engineer's written approval, be manufactured by the Contractor. The Supervisor engineer may require the Contractor to supply samples of precast concrete units for testing prior to the approval of the proposed supply for each type of unit and such samples shall be supplied and tested as directed by the Supervisor engineer.

Precast concrete units shall be made in accordance with the provisions of this Specification covering concrete work. Precast concrete units shall be manufactured under shed roofs and protected from the weather. The units shall remain in the moulds for seven days and shall remain protected for a further seven days, during which periods the concrete shall be shielded by sacking or other approved material which shall be kept wet. The units shall then be moved from the sheds and stacked in the open for at least a further seven days to season before being set in position.

Precast concrete work shall be tested as directed by the Supervisor engineer and work failing to meet the requirements of the Specification shall be rejected. Precast units that become damaged during handling shall likewise be rejected.

The Contractor shall, when required, make arrangements with his supplier for access to the supplier's work for the Supervisor engineer to inspect and carry out tests on precast concrete units.

All precast units shall be marked with individual identification. Lifting hooks are to be attached only to those positions shown on the Drawings or detailed by the Supervisor engineer. The Contractor shall be deemed to have included in their rates for all measures required to handle and stack units safely and without undue stressing.

3.37 Breaking out Existing Concrete or Blockwork

Well in advance of the commencement of the work the Contractor shall seek the approval of the Engineer regarding the proposed method of breaking out existing concrete or blockwork in the positions shown on the Drawings or as directed by the Supervisor engineer.

3.38 Cement Grout

Cement grout for general purposes shall consist of Portland cement and water mixed in the proportion of one (1) part by volume of cement and one and a half (1.5) parts by volume of water. The grout shall be used within one hour (1hr) of mixing.

3.39 Cement Mortar

Cement mortar shall be machine mixed and unless otherwise specified, consist of three (3) parts of sand to one (1) part of Ordinary Portland cement mixed and thoroughly incorporated together. Just enough water will be added to give a workability appropriate to its use. The above proportions are by volume. Mortar shall be used whilst freshly mixed and no softening or retempering will be allowed.

3.40 Rendering Work

3.40.1 Material

Cement, water and fine aggregate shall conform to the requirements specified in the concrete works. Mesh reinforcement shall be plain diamond expanded steel lathing to BS 1369 where specified. Lime shall be to BS 980 and shall be mixed with water and allowed to stand prior to use according to the manufacturer's recommendations.

The mix proportion of the cement mortar by volume shall be as follows:

- For rendering coat, Cement: Sand = 1:5
- For finishing coat, Cement: Sand = 1:3

Lime putty may be mixed in mortar for finishing coat at 10% of sand by volume.

3.40.2 Waterproof cement mortar

Waterproof mortar shall be made by mixing a waterproof agent into ordinary cement mortar. The Contractor shall be responsible for selection and quality of the waterproof agent and this shall be approved by the Engineer before use. The mixing and application shall be in accordance with the manufacturer's instructions.

3.40.3 Application

The surface which are to receive a rendering coat shall be free from all laitance, scum, loose carbonate scale, loose aggregate dirt and other foreign matters. Concrete block, brick or stone surfaces shall be sufficiently and uniformly damped immediately before application of mortar. Concrete surfaces shall be kept thoroughly wet for 24 hours prior to the application of mortar.

Where shown on the drawings or directed by the Supervisor engineer, steel wire lath shall be fixed to the brick, concrete block or concrete walls before applying cement mortar plaster.

Cement mortar shall be used within 30 minutes from the time of mixing. Retempering shall not be permitted.

The total thickness of rendering plus finishing coat shall be 30 mm for the floors and 20 mm for wall. Cement mortar finish shall be trowel finished unless otherwise specified. When the finishing coat is applied, the entire surface of floor or wall shall be finished in one operation in order to minimise joint marks.

When expansion and control joints exist in the base structure, provision shall be made to prevent cracking of the mortar by inserting metal expansion beads within the coating thickness in a manner approved by the Supervisor engineer.

The finished surface shall be perfectly plumb or level as the case may be except where otherwise specified without any bulging, runs, bruises or stains.

After application of the finishing coat, the surfaces shall be kept continuously damp for not less than 48 hours and then allowed to become thoroughly dry. Moistening shall be started as soon as the surface has hardened sufficiently not to cause displacement or damage.

3.41 In Situ Concrete Chambers

In situ concrete chambers shall be constructed generally in accordance with Section 3 of this Specification.

3.42 Chamber Covers and Slabs

Covers and slabs shall be the type, size and weight shown in the drawings. Care shall be taken to see that slabs are even so that the cover can seat without rocking.

Covers and frames shall be provided as shown on the drawings. The tops of the covers shall be flush at all points with the surrounding surface of paved areas or as directed in unpaved areas. Any slight adjustment of the slab level which may be necessary to accomplish this shall be effected by topping the side walls with concrete.

4 STONEWORK

4.1 Stone Masonry

Masonry shall be built to the lines and levels shown on the Drawings.

For face work the stones shall show a face of not less than 0.025 m^2 and not more than 0.1 m^2 in area and none shall be less than 100 mm in depth; they shall be laid to give a uniformly random appearance and shall be selected in laying so as to present an even distribution of large and small stones on the face.

For the arises, stones shall be roughly squared, quarry split and of a size to give outbands varying from 300 mm to 500 mm in length and inbands from 150 mm to 250 mm. The alignment of arises shall be set true to the required lines.

The stones shall be set in mortar with their natural bedding plane (if any) as near normal as possible to the face or normal to the line of thrust in the case of load bearing structures. Particular care must be given to obtaining a sound bond both longitudinally and transversely and there shall be at least one bonder, or length not less than two-thirds of the wall thickness, in each square yard of wall face.

The mortar, unless otherwise specified, shall be machine mixed cement and sand in the proportion of one part to three (1:3) parts generally as described in the specification. Mortar shall completely fill all interstices between the stones.

The face joints in rubble masonry may vary in thickness from 10 mm to 20 mm. They shall be finished as a neat weathered joint with mortar while the work proceeds where the masonry is specified to be "unpointed". Where pointing is specified, the joints in each day's work shall be raked out to a depth of not less than 25 mm before the mortar has set. Subsequently the joint shall be filled with mortar and finished in accordance with Clause 4.6. The face of the masonry is to be kept wet while the pointing is proceeding. Provision shall be made to clean all exposed faces both as work proceeds and on completion so that they are left in a neat, tidy and clean condition.

Building of masonry will not be allowed in heavy rain without the written consent of the Supervisor engineer. Building shall only proceed when suitable precautions to the satisfaction of the Engineer shall be taken against the action of rain on newly placed mortar. If for any reason of urgency, the consent of the Supervisor engineer should be desired to a departure from these provisions, the Contractor shall submit to the Engineer for approval their proposals for protecting the materials and work from the weather.

4.2 Types of Masonry

The arrangement of the stones on the exposed face or faces of the masonry shall be as described below according to which type is called for on the Drawings.

(a) Random rubble uncoursed masonry shall be built with stones of irregular shapes taken generally as they come from the quarry, preparation being limited to the removal of inconvenient corners and excrescences. They shall be selected as the work proceeds to give a uniformly random appearance and no attempt shall be made to form courses.

(b) Random rubble masonry brought to courses shall be generally as the preceding type except that it shall be levelled up to courses between 300 mm to 400 mm in depth and coinciding with the quoin stones.

(c) Squared rubble coursed masonry shall be built in courses between 100 mm to 250 mm in depth of stones squared to rectangular shapes and selected so that all stones in one course are of approximately the same height.

4.3 Bedding of Stone Masonry

Unless otherwise directed by the Supervisor engineer, all masonry stones, when incorporated in the Works shall be laid on its natural bed, except in the case of arches where the natural bed shall be radial.

4.4 Special Stonework

Special stonework shall consist of approved stones dressed to the shapes and dimensions and with the faces tooled, all as shown on the Drawings. All stones shall be laid true to line and centre with mortar joints as shown on the Drawings.

4.5 Pointing of Joints in Masonry

Unless otherwise shown on the Drawings, pointing to masonry joints shall be flush and shall be formed by raking the joint clean and then filling it with pointing consistency mortar which shall be given a flush face with a steel trowel.

4.6 Hand Placed Rubble Filling

Hand placed rubble filling shall consist of stones individually selected and placed by hand firmly in place in bearing contact with each other or with the sides of the space to be filled; the voids shall be carefully filled with small rocks and spalls wedged together to form a compact mass. The sides of stones shall be roughly trimmed if necessary with a spalling hammer to obtain a reasonably close fit. On the exposed face the stones shall be placed with their flattened sides uppermost and in the plane of the face.

5 BUILDING WORKS

5.1 Masonry

Building stone for masonry walls shall be cut to true rectangular shape 225 mm x 225 mm and be of minimum length from a source approved by the Engineer.

Dressed stone for masonry tanks shall not exceed 300 mm in length and shall be soaked in water for 24 hours, prior to being laid.

5.2 Precast concrete blocks

Precast concrete blocks shall conform to B.S.6073 Parts 1 and 2. Blocks shall be solid or hollow, of the sizes required and shall be made in approved moulds of metal construction of sufficient strength to ensure the manufacture of dead square blocks of even size and shape.

Concrete blocks for general walling shall be 450 mm x 200 mm. Purpose-made half or three-quarter length blocks shall be used where required for bonding, and cutting of blocks to obtain bond will only be permitted where expressly allowed by the Engineer.

5.3 Blockwork

The blocks for walling shall be properly bonded together in such a manner that no vertical joint in any one course shall be within 100 mm of a similar vertical joint in the course immediately above or below.

Alternative courses of walling at all angles and intersections shall be carried through the full thickness of the adjoining wall. All perpends, reveals and other angles of walling shall be built strictly true and square.

The blocks shall be bedded and jointed in cement mortar 1:3 with beds and joints not more than 20 mm or less than 12 mm thick, all flushed up and grouted solid as the work proceeds. All walling shall be properly protected as the mortar is setting.

Ends of lintels, cills, joints, roof trusses etc., are to be pinned up to the under side of concrete beams and slabs with cement mortar.

Timber frames are to be built in with holdfasts and bedded solid and pointed both sides in cement mortar. Lugs of window, door and louvre frames are to be built in or cut and pinned to blockwork. Frames are to be bedded solid in mortar and pointed in approved mastic applied externally.

5.4 Precast concrete products

Paving Slabs shall not be less than 50 mm thick and shall be of precast concrete with basalt or phonolite aggregate. They shall comply in all respects with: -

B.S. 368 for "Precast Concrete Flags". They shall have minimum side dimensions of 600 mm and shall be hydraulically pressed during manufacture.

Sills to windows shall comply with B.S. 5642 Part 1. They shall measure 105 mm deep, showing 70 mm at the front edge, by 175 mm wide and be of appropriate length as indicated on the Drawings. All sills shall be cast with a recessed throating under the front edge and shall bear 150 mm on supports.

Lintels to windows, louvre and door openings where these are separate from the reinforced concrete ring beam shall be of precast concrete complying in all respects with B.S.1239. They shall bear 300 mm on supports and shall be cast with a recessed throating under the front edge. Design calculations for lintels shall be submitted to the Supervisor engineer for approval before casting is commenced.

5.5 Airbricks/Ventilation bricks

Airbricks shall be as shown on the drawings and be of an approved type and manufacture. They shall be supplied complete with a fine copper mesh woven wire fly proof screening fixed to the back face. Openings through walls shall be formed to the net size required and rendered smooth in cement mortar. Where openings occur in cavity walls the walls shall be built solid all round the openings.

5.6 Wall finishing

a) Plastering

Internal plastering is to be carried out in accordance with B.S. Code of Practice C.P.211 or equivalent approved.

All joints in walling, etc., are to be raked clean for not less than 10 mm deep before any plaster or rendering is applied.

All concrete surfaces which are to be plastered are to be hacked or otherwise suitably roughened to provide a key.

All surfaces to receive plaster are to have the suction correctly adjusted by the application of clean water.

All arises shall be finished true and slightly rounded except where otherwise stated.

No partially set or wholly set plaster shall be used or remixed.

The Contractor shall cut out and make good all cracks blisters and other defects and leave the whole of the plaster work perfect on completion. On no account shall plaster of paris be used to effect repairs.

Where plastering or rendering is applied over a joint between block walling and concrete, the plaster or render is to be vee grooved 10 mm deep to coincide with the joint.

b) Cement Rendering

Cement rendering shall be applied in one coat of 10 mm thickness and shall be in the ratio of 1 part of cement to 3 parts of sand, finished with a wood float, with use of SBR of 200 gr per M2.

c) Roughcast Finish

Roughcast finish, where ordered, shall be to the same consistency as cement rendering, and shall be applied by means of an approved paddle-gun onto a partly set base coat of cement rendering. Roughcast finish shall terminate in well defined and straight vertical and horizontal edges, and shall stand proud of any surrounding rendered finish by at least 5 mm.

5.7 Building paper

Water proof paper shall comply in all respects with B.S. 1521 for Waterproof Building Paper, Class B, and shall contain fibrous reinforcement.

5.8 Polythene sheeting

Polythene sheeting shall comply with B.S.4646 "High Density polythene sheet for general purposes".

5.8.1 Steel doors, door frames, holdfasts and bonding ties

Steel door frames are to be fixed in accordance with the manufacturers recommendations.

Steel doors and frames shall comply with the requirements of BS 6510

Timber door frames are to be fixed with holdfasts screwed to the frames one end and built into blockwork or concrete at the other end. Door frames shall have three holdfasts at each side.

The holdfasts shall be of 6 mm x 25 mm galvanised wrought iron 200 mm long, one end turned up, twice drilled and countersunk for screwing to frames with stout screws and other end formed swallowtail for building into brickwork etc.

5.9 Timber - general

All timber is to be sound, straight, of matured growth, square edge and free from whitewood, shakes, large loose or dead knots, cracks, waves edges or other defects and blemishes except to the extent to which the Engineer considers that the timber is not rendered unsuitable for its intended use.

5.10 Paint

All paint used in the Works shall be of approved manufacture, type and colour delivered to the Site in sealed containers from the manufacturers.

All materials are to be supplied in containers clearly marked with the manufacturer's name or trademark and a description of the contents. All materials for multiple coat work, e.g. priming, under coat and finishing coat shall be supplied by the same manufacturer and are to be those recommended by the manufacturer as suitable for using together. Undercoats are to be tinted

different shades, to suit the finishing coat, and are to be readily distinguishable. Samples of paint to be used shall be supplied to the Supervisor engineer for his approval.

Door, and door frames, shall be knotted, stopped, primed and painted with three coats of paint as directed by the Supervisor engineer.

5.11 Painting

The type of paint, etc., to be used, the number of coats applied and any special process or treatment required shall be as specified herein.

Paint may be applied by paint rollers on concrete or over surfaces where a light stipple is required with the permission of the Supervisor engineer.

Rubbing down prior to final coat shall be done by the wet process with pumice stone or waterproof glass paper. Preliminary coats of paint shall be lightly rubbed down with fine sandpaper before the next coat is applied.

No external paintwork shall be carried out during wet weather, or upon surfaces that are not thoroughly dry.

Primed or undercoated work shall not be left in an exposed or unsuitable situation for an undue period before completing the painting process.

All metal fittings and fastenings are to be removed before the preparatory processes are commenced, and shall not be refixed in position until after the finishing coat has hardened.

Except for the application of first coat priming, spray painting with approved machines shall be permitted only with the consent of the Supervisor engineer and must be carried out in accordance with directions to be supplied by the manufacturers of the material which shall be specially prepared for this method of application.

All paintwork shall be cleaned down on completion and all marks due to spill removed. All painted finishes shall be left to the complete satisfaction of the Supervisor engineer.

All undercoating and finishing used on the same work are to be those recommended by the manufacturer for using together.

Where directed by the Supervisor engineer, the Contractor is to prepare panels showing the colour schemes proposed for the work for final approval of the Supervisor engineer.

All brushes, tools, pots, kettles etc., used in carrying out the work shall be clean and free from foreign matter, and are to be thoroughly cleaned out before being used for a different type of class or material.

Before painting, lacquering, varnishing or enamelling is started, every possible precaution must be taken to keep down dust.

An ample supply of clean dust sheets to protect the work during its progress are to be at hand.

No dilution of painting materials shall be allowed except strictly as detailed by the Manufacturer in directions to be supplied or by special permission of the Supervisor engineer. The mixing of paints of different types shall not be permitted.

All materials are to be thoroughly stirred and mixed when the containers, etc. are opened and when transferring to painters' kettles. Where necessary the paints are to be strained to remove all skin, etc. before application. All containers shall be kept securely covered with tight fitting lids when not in use.

Primers and subsequent coats shall be applied by brush and allowed a minimum period in which to dry and thoroughly harden in accordance with directions to be supplied by the manufacturer of the materials.

No paint shall be applied to surfaces structurally or superficially damp and all surfaces must be ascertained to be free from condensation, dust, oil, etc., before the application of each coat.

5.12 Paint systems

a) Concrete, Fair Face Brickwork and Plaster

Preparation: clean down with a stiff brush to remove loose dust, efflorescence, etc. and leave work to dry out thoroughly. The surface shall be left as long as possible to ensure that no further efflorescence will appear.

Finish: apply two coats plastic emulsion paint by brush, roller or other means, as directed by the Engineer.

b) Iron and Steelwork

Preparation: Metal work delivered unprimed shall be chipped, scraped and wire brushed to remove all rust and loose scale and cleaned to remove all dirt and grease.

Metal work delivered primed shall be thoroughly washed down to remove all dirt and grease. All defective paint, blistered, crazed or not firmly adhering, etc., shall be removed by scraping back to a firm edge or, if necessary, the surface shall be completely stripped back to clean metal.

Priming:

i) Surfaces which after assembly or erection on site become permanently inaccessible: 2 coats approved red lead primer. Surfaces buried in concrete shall be unpainted.

ii) Surfaces exposed and which are to be painted with finishing coats: 1 coat approved red lead primer.

Finish

i) 2 coats exterior or interior undercoating.

ii) 1 coat exterior or interior high gloss finish.

c) Woodwork

Preparation: All timber used for grounds or battens or any purpose which precludes inspection and maintenance is to be treated with one coat of aluminium wood primer.

If woodwork is delivered to site primed, the work shall be ascertained to be of good quality and in good condition. Bare places shall be rubbed down and touched up with one coat of wood primer.

All new and unprimed woodwork is to be free from dirt and grease and to be examined for defects. Any large or loose knots are to be cut out and neatly plugged. Smaller knots are to be treated with two thin coats of knotting.

Woodwork to be painted shall be well rubbed down and primed with aluminium wood primer well brushed into the wood. All knots shall be covered with good shellac knotting before priming and all defects shall be filled with hard stopping after priming. Plywood shall be filled over the entire surface with an approved brush filler.

Finish: Two coats of exterior grade undercoat shall be applied followed by one coat of exterior or interior grade high gloss finish as appropriate.

5.13 Rainwater goods

These shall be of galvanised steel complying with B.S. 1091.

Downpipes shall be 100 mm diameter as shown in the drawings.

Gutters shall be laid to falls as directed.

The general arrangement of the drainage system shall be to the Supervisor's engineer approval.

5.14 Bituminous roofing felt

Bituminous roofing felt shall be in accordance with CP 144, type 2E, suitable for tropical conditions. Each layer shall be applied to the roof surface strictly in accordance to the manufacturers instructions. A protective layer of light coloured chippings shall be applied to the finished surface with an approved adhesive.

6.0 Specifications for Tile work

6.1 GENERAL

SAMPLES
The sample needs the approval of the Supervisor engineer

PREPARATION
EXISTING BACKGROUNDS/BASES GENERALLY:
Efflorescence, laitance, dirt and other loose material: Remove.
Deposits of oil, grease and other materials incompatible with the bedding: Remove.
Tile, paint and other nonporous surfaces: Clean.
Wet backgrounds: Dry before tiling.

NEW PLASTER
Plaster: Dry, solidly bedded, free from dust and friable matter.
Plaster primer: Apply if recommended by adhesive manufacturer.

HACKING FOR KEY
Keying: Roughen backgrounds thoroughly and evenly to a depth of 3 mm.

SPATTERDASHING FOR KEY
Spatterdash mix:
Sand: Clean coarse.
Proportions (cement:sand): 1-1.5:2.
Thickness: 3-5 mm.
Curing/ drying: Keep damp until hardened. Dry out to provide securely bonded finish.

6.2 FIXING

FIXING GENERALLY
Colour/ shade: Unintended variations within tiles for use in each area/ room are not permitted.
Variegated tiles: Mix thoroughly.
Adhesive: Compatible with background/ base. Prime if recommended by adhesive manufacturer.
Use of admixtures with cementitious adhesives: Only admixtures approved by adhesive manufacturer.
Cut tiles: Neat and accurate.
Fixing: Provide adhesion over entire background/ base and tile backs.
Final appearance: Before bedding material sets, make adjustments necessary to give true, regular appearance to tiles and joints when viewed under final lighting conditions.
Surplus bedding material: Clean from joints and face of tiles without disturbing tiles

SETTING OUT
Joints: True to line, continuous and without steps.
Joints on walls: Horizontal, vertical and aligned round corners.
Joints in floors: Parallel to the main axis of the space or specified features.
Cut tiles: Minimize number, maximize size and locate unobtrusively.
Joints in adjoining floors and walls: Align.
Joints in adjoining floors and skirtings: Align.
Movement joints: Where locations are not indicated, submit proposals.

FLATNESS/ REGULARITY OF TILING
Sudden irregularities: Not permitted.

Deviation of surface: Measure from underside of a 2 m straightedge with 3 mm thick feet placed anywhere on surface. The straightedge should not be obstructed by the tiles and no gap should be greater than 6 mm, i.e. a tolerance of + 3 mm.

GROUTING
Sequence: Grout when bed/adhesive has set sufficient to prevent disturbance of tiles.
Joints: 6 mm deep (or depth of tile if less). Free from dust and debris.
Grouting: Fill joints completely, tool to profile, clean off surface. Leave free from blemishes.
Profile: Flush.
Polishing: When grout is hard, polish tiling with a dry cloth.