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101. GENERAL REQUIREMENTS

101.1 GENERAL REQUIREMENTS AND PARTICULAR SPECIFICATIONS

These General Requirements shall form an integral part of the General Specifications. In addition to these General Requirements, the Contract contains a Particular Specification, to supplement and/or modify the General Specification as may be necessary in each particular case.

The provisions of the Particular Specification for any specific section or number of sections shall prevail over those of the General Specification. Whenever the term "Specification" without further qualification is used in the Contract Documents, it shall mean this General Specification together with the Particular Specification.

101.2 REQUIREMENTS OF SPECIFICATION

The Contractor shall fulfil all requirements and obligations of all clauses of the Specification applicable to the construction work involved in the Contract. Neither the following clauses of this Specification nor the Bill of Quantities shall limit the obligations of the Contractor under the accompanying Conditions of Contract. Where items are not included in the Bill of Quantities for any such requirements or obligations the cost of such requirements or obligations shall be deemed to be spread over all the items of the Bill of Quantities unless otherwise stated.

101.3 DRAWINGS, RECORDS AND DOCUMENTS

101.3.1 Drawings

All works shall be performed in accordance with the drawings furnished with the Contract documents and any such additional drawings as may be issued by the Engineer from time to time during the progress of the work or any drawing furnished by the Contractor and approved by the Engineer. Additional drawings (if any) will be furnished to the Contractor in due time so as to enable him to perform the work shown thereon in its proper sequence and for any advance planning that may be necessary for the efficient performance of such work. The Engineer will decide in each instance whether additional drawings are required for advance planning of the works and determine the time required for same.

In all cases, detailed shop drawings for all components of the Works shall be prepared by the contractor, after the approval of all related equipment items. The design and the shop drawings shall be submitted to the Engineer who shall within 21 days approve, reject or ask the Contractor to revise or modify such documents and resubmit them for

approval. All these documents shall be approved by the Engineer prior to commencement of the work. The structural design will be in accordance to the recommendations based on soil investigations.

101.3.2 Records and "As-built" Drawings

After the work has been completed, the Contractor shall furnish "as-built" drawings prepared whilst surveying during construction, showing the Works as constructed together with all other information that may either be required or be useful for the operation and maintenance of the Works in the future, such as alignment and depth of cover of pipelines, type of soil, type, dimensions and location of structures, size of pipelines and cables encountered during excavation.

Unless specific items are included in the bill of Quantities, the cost of preparing the shop drawings, "as-built" Drawings and Records shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately. The As-built Drawings shall be submitted, if required by the Engineer, on computer diskettes.

101.3.3 Ownership of Drawings and Documents

The Drawings and documents are issued to the Contractor for the purpose of the execution of the Works under the Contract and shall remain the property of the Employer to whom they are to be returned by the Contractor after completion of the work, as a precondition for the issue of the Certificate of Completion.

101.3.4 Meteorological and Hydrological Conditions

The Contractor's attention is directed to the meteorological and hydrological conditions prevailing in the project area and its vicinity. In his planning of the work and in his unit rates, the Contractor shall take these factors into account. No increase in prices and/or extension of time shall be granted due to rains, floods and/or other adverse climatological conditions in the project area and along the roads to it.

For information, the climatic conditions in Lebanon can be summarized as follows:

	Temperature (deg C°)						Relative humidity					
	Coastal zones		Mountainous zones		Bekaa Valley		Coastal zones		Mountainous zones		Bekaa Valley	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Summer	20	35	15	25	10	35	65	85	50	60	40	65
Winter	7	15	-5	10	-1	15	60	75	55	75	55	80

101.4 BILL OF QUANTITIES

101.4.1 Rates and Prices

The rates and prices inserted by the Contractor in the Bill of Quantities are to be the full and inclusive value of the work described. They are to cover all costs, expenses and general risks which may be involved, together with all liabilities and obligations set forth or implied in the Specification and other documents on which the Tender is based. They must include all plant, tools, materials, transport of men and materials, insurance and labour of every description. They must also take into account the conditions referred to in the general Conditions, and include time lost due to weather, payment of guaranteed minimum and holidays with pay. The cost of any travelling time subsistence and incentives such as overtime etc. must be included in the rates and prices. Where any special risks, liabilities and obligations, mentioned above or otherwise, cannot be dealt within the rates, then the price thereof is to be separately stated in items provided for the purpose or added by the Tenderer.

Any item left unpriced shall be held to have had its cost included in the unit rates for other items of work.

101.4.2 Methods of Measurement and Payment

The methods of measurement and payment for each trade are normally specified in the General Specification, provided that where a different method of measurement is indicated in the Bill of Quantities or specified in the Particular Specification, the Bill of Quantities and the Particular Specification, in that order, take precedence over the General Specification.

Where no method of measurement is specified in any of the foregoing documents, the work will be measured in accordance with the latest edition of the Standard Method of Measurement of Civil Engineering Quantities, published by the Institution of Civil Engineers of London, U.K.

101.5 UNITS

In this Specification, on the Drawings and in the Bill of Quantities the S.I. (Systeme International d'Unites) metric system of dimensioning has been employed.

Where dimensions are given in metric units for materials which are only available in Imperial dimensions, the Contractor may, subject to his obtaining prior approval of the Engineer, substitute suitable sizes of materials as are available in the Imperial system. Such approval shall not unreasonably be withheld, provided that there is no difficulty in making interface connections with any other parts of the Works.

101.6 STANDARDS

For convenience and in order to establish the necessary standards of quality, reference has been made in the Contract Documents, to specifications issued by International Standards. Such specifications shall be defined and referred to hereinafter as "Standard Specifications" and shall be the latest editions of such Standard Specifications issued prior to the issue of Tender Documents together with such additions and amendments to such editions as may have been issued prior to the same date. Subject to the approval of the Engineer, any other internationally accepted Standard which specifies an equal quality of work may be used.

In reference to Standard Specifications, the following abbreviations have been employed:

B.S.	British Standard
A.S.T.M.	American Society for Testing Materials
D.I.N.	Deutsche Industrie Normen
I.S.O.	International Organization for Standardisation
A.A.S.H.T.O.	American Association of State Highway and Transport Officials
A.W.W.A.	American Water Works Association
N.F.	Normes Française
AFNOR	Association Française de Normalisation

101.7 SURVEY AND SETTING OUT

101.7.1 Engineer's Benchmarks and Survey Markers

Prior to the commencement of the work, the Contractor will receive from the Engineer a number of benchmarks and survey markers on the Site. Before starting any work, the Contractor shall check the alignment and levels of the benchmarks and markers in the presence of the Engineer's Representative and shall correct any error or mis-alignment which may be discovered during such checking with the consent of the Engineer's Representative. Thereafter, the Contractor shall establish from these corrected benchmarks and markers all levels and lines necessary for the performance of the work.

The Contractor shall be responsible for the preservation of the benchmarks and markers during the entire period of construction, and shall at his own cost repair or replace any of them that may be damaged, destroyed, or removed by any cause whatsoever.

101.7.2 Setting Out

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

Whether or not directed by the Engineer's Representative, the Contractor shall take such levels and dimensions as may be required prior to disturbance of the ground for the purpose of measurement and these shall be agreed between the Contractor and the Engineer's Representative in writing before any of the surface is disturbed or covered up.

The Contractor shall establish parallel survey lines or other points of reference at a safe distance, permitting the re-establishment of lines and points, wherever the original lines and points must inevitably be destroyed or removed during the progress of work.

101.7.3 Surveying for Measurement of Earthwork

All intermediate and final surveying necessary for the establishment of quantities of excavation and earth fill will be done by the Contractor, who shall establish elevation points and prepare cross-sections sufficient to permit an accurate calculation of the quantities of earthwork. The Contractor shall notify the Engineer's Representative at least three days in advance of his intention to perform such measurements. The cross-sections prepared by the Contractor and approved by the Engineer's Representative shall be basis for the measurement and payment of earthworks.

101.8 PAYMENT

Unless specific items are included in the Bill of Quantities, the cost of all surveying, modifications to drawings, setting out, and measuring to be done by the Contractor and all other expenses incurred by him in complying with the requirements of this section shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

101.9 PROGRAMME OF WORKS AND PROGRESS REPORTS

The time allocated for the performance and completion of all works under this Contract shall be as stated in the Appendix to Form of Tender (Volume 2 of Contract Documents).

The Contractor shall submit to the Engineer, before commencing work on site, a fully detailed programme showing the order or procedure and method by which he proposes to carry out the construction and completion of the Works, and particularly of the organization and staff proposed to direct and administer the performance of the Contract.

The information to be supplied to the Engineer shall also include drawings showing the general arrangement of his temporary offices, camps, storage sheds, building and access roads, and details of Construction Plant and Temporary Works proposed.

The Contractor when preparing his programme shall take due account of the time required for the delivery of materials.

The Engineer will check the proposed programme and will return same to the Contractor within 14 days of its receipt with his approval or comments and requirements for changes (if any). The Contractor shall make all requested corrections and changes not later than 7 days after having received the Engineer's comments. The programme as finally agreed to and approved by the Engineer will serve as the only basis for the carrying out of the Works.

After the commencement of each and any part of the Contract, the Contractor shall forward to the Engineer in triplicate, for each calendar month, a progress report and a chart showing the approved programme, the work completed to date and the progress made during the month. Such monthly progress reports and charts shall be submitted by the Contractor to the Engineer or his Representative not later than the 6th day of the month following that to which the report and chart refer.

101.10 WORK SITES

101.10.1 Right of Way and Sites of Works

The Employer will provide all the necessary rights of way, lands and sites on which the Works are to be carried out and will designate the access roads to the sites which the Contractor will be permitted to use.

In no case shall the Contractor occupy lands, right-of-ways or way-leaves without the previous written permission of the Engineer.

101.10.2 Contractor's Work Area

The location of the Contractor's work area, i.e. the area or areas where the Contractor may set up his offices, stores, workshops, yards for mechanical plant, etc., and transport depots, shall be agreed beforehand with the Engineer and shall be such as to avoid obstruction and nuisance to the public. The Contractor shall provide, within his work area, a Site Office for the use of his agent where written instructions from the Engineer may be delivered.

The Contractor shall make his own arrangements for and pay all costs incurred in the use of such areas of land as he may require for work areas for the purpose of the Contract.

101.10.3 Access and Construction Roads

The Contractor shall at his own expense construct and maintain within the right of way any temporary access roads and construction roads on the work sites that he deems necessary for the proper performance of the works, but the routes of such temporary roads and the method of their construction shall be subject to the Engineer's approval.

The Contractor will be permitted the use of existing roads on the Site provided that such use is co-ordinated with other users.

The Contractor will be permitted to use public roads as access roads to the Works only after having obtained permission in writing from the relevant Authorities and from the Engineer. The Contractor shall strictly adhere to all requirements and conditions prescribed by the relevant Authorities and set out in Clauses 29 and 30 of the Conditions of Contract.

The cost of preparation and maintenance of all access and construction roads and all

costs incurred in complying with the requirements of this subsection shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

101.10.4 Existing Services

The Contractor shall make himself acquainted with the position of all existing works and services inter alia roads, sewers, stormwater drains, cables for electricity and the telephone lines, telephone and lighting poles, and water mains, before any excavation is commenced.

The Contractor will be held responsible for damage caused in the course of the execution of the Works to such existing works and services and shall indemnify the Employer, the Engineer and their agents against any claims arising from such damage (including consequential damages). Any damage caused must be made good at the Contractor's own expense.

Where the works required the crossing of existing roads, railways, fuel pipelines and services, the Contractor shall obtain the prior permission of and shall make all necessary arrangements with the relevant authorities and/or owners of said utilities and shall obtain their consent to the time and manner of execution of all work connected with such crossings.

When crossing a road in public use the Contractor shall either leave half the width of the road free for traffic or shall construct a bypass, as may be required by the road authority. The length, width and shape of any such bypass and the mode of its construction shall be as directed by the Engineer, but shall at all times permit for the passage of traffic using the main road. The Contractor shall put up warning and traffic signs, and shall employ flagmen to direct the traffic and shall mark the road crossings and put up lights from sunset to sunrise.

The Engineer's Representative may order the Contractor to repair bypasses, strengthen any temporary structures, put up additional signs or lights and generally improve the arrangements as he may deem necessary, and the Contractor shall forthwith comply with such orders. Regardless of whether or not the Engineer's Representative orders any such repairs of improvements, the Contractor shall remain solely responsible for the proper performance of all work in connection with the erection, maintenance and subsequent removal of all temporary structures required under this Clause, to the complete satisfaction of the Engineer.

Where the Works cross existing pipes, sewers, drains, channels, telephone or power lines

and cables, the Contractor shall be responsible for the preservation of all such utilities in a good and serviceable condition during the execution of the Works and shall see to it that any damage done to any of the services be immediately repaired. Inasfar as necessary, the Contractor shall construct temporary bypasses for such pipes, channels and cables and restore them to their original position after the work at the junction or crossing has been completed.

The Contractor shall construct all bypasses and do all repairs to roads, pipes, channels and cables in accordance with the requirements of the proper authorities and/or the owners thereof or shall bear the expenses of all such work done by them.

Existing access to lands, property and all other facilities shall be maintained by the Contractor during the continuance of the Works to the Engineer's satisfaction.

Where work is being carried out in the vicinity of overhead power lines the Contractor shall take special measures to ensure that all persons working in such areas are aware of the relatively large distance that high voltage electricity can "short" to earth when cranes or other large masses of steel are in the vicinity of power lines and that adequate safety precautions are being taken. The Contractor shall ensure that none of his employees commits any act which will cause damage from, or to, overhead power lines.

Unless specific items are included in the Bill of Quantities, the cost of all works required under this section shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

101.11 WATER AND POWER FOR USE IN THE WORKS

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

The Contractor shall be responsible for the supply of all electric power to meet his obligations under the Contract and for the distribution thereof.

All costs associated with the supply of water and power shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

101.12 CONSTRUCTIONS REGULATIONS

All constructions executed by the Contractor upon the Site and Work Area shall

comply with all Laws and local By-laws insofar as they are applicable.

101.13 WORKS IN THE DRY

All parts of the Works are to be carried out in the dry, and shall be kept free at all times from surface or groundwater from whatever source it may come to the satisfaction of the Engineer. Keeping the Works dry shall include all pumping and diversion of water that may be necessary in carrying out the Works, also provision and filling-in of sump holes, installation and operation of drains, pumps, well points etc., in a manner and with equipment and materials satisfactory to the Engineer.

The Contractor shall, at his own expense, make such provision for the discharge of any water from the Works as shall be satisfactory to the Engineer and to any person having rights over the lands or watercourses over or down which such water is discharged. He shall hold the Employer indemnified against any claim that may be made through non-compliance with this section. In the event of any interference with existing land or road drains due to the construction of the Works or to the dumping of spoil, etc., within or without the limit of the Works, the Contractor shall take immediately steps to restore the drainage to the satisfaction of the Engineer and the Owners, occupiers, or Authority concerned.

Unless specific items are included in the Bill of Quantities, the cost of keeping the Works dry as specified in this section, shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

101.14 WATCHING, FENCING AND LIGHTING

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

From the time that any portion of the Works shall be commenced, until the end of the works, the Contractor shall be responsible for protecting the public and his workmen from anything dangerous to persons or property and for the safe and easy passage of pedestrian, animal and vehicular traffic.

Any excavation, material dumps, soil dumps or other obstructions likely to cause injury to any person or thing shall be suitably fenced off and at night protected by red warning lights. The Contractor shall, at his own expense, and immediately upon completion of any part of the Works, fill up all holes and trenches, and level all mounds and heaps of earth which have been excavated or made in connection with the Works. The Contractor shall be responsible for the payment of all costs, charges,

damages and expenses incurred or sustained on account or in consequence of any accident which may happen by reason of holes and trenches being dug and left or placed in improper locations.

Fencing shall consist of at least three 15 mm diameter hemp ropes or 4 mm diameter wires, or more, if required, stretched tightly between poles, standards, etc., securely planted in solid ground, well clear of the excavation and enclosing the spoil from the excavation. The poles, standards, etc., shall not be more than 15 m apart. If circumstances require it, they shall be placed closer and the ropes or wires shall be stretched tight, approximately 0.40 m, 0.80 m and 1.20m, respectively, above the ground.

Banks of spoil of suitable height and form may be accepted by the Engineer in lieu of fencing.

Fences and spoil banks shall be clearly marked at the ends, all corners and along the length at intervals of not more than 15 m, by means of white lime-washed boards, discs, stones or oil drums during the day and by red lamps kept burning at night. Markers shall be freshly lime-washed at regular intervals to ensure that they are white and clean.

The Contractor shall detail a man to trim and fill the lamps during the day and they shall be lit at least one half hour before sunset and not extinguished until at least one half hour after sunrise.

If a road is closed, or partly closed, to traffic, temporary traffic signs and barricades shall be erected by the Contractor, to the satisfaction of the Engineer and the Police, to give proper warning to traffic and to the public. Road signs shall be not less than 1.20 m x 0.80 m in size, surmounted by a red circle. Lettering shall be black, on a yellow ground and shall incorporate reflective material. The signs shall be adequately illuminated at night. The Contractor shall be solely responsible for the proper control of all traffic.

The cost of watching, fencing and lighting and all other costs incurred in complying with the requirements of this section shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

101.15 PRESERVATION OF TREES

No trees shall be cut down without prior permission of the Engineer who will limit the

removal of trees to the minimum necessary to accommodate the Permanent Works.

If trees are cut down or damaged by the Contractor or his employees and without approval, then the Contractor shall replace such trees at his own expense with trees of not less than two years of age obtained from a reputable nursery and of species to be approved by the Engineer. The Contractor shall plant, water and ensure that the replacement trees are properly established all at his own expense.

All costs incurred in complying with the requirements of this section shall be deemed to be included by the Contractor in his unit rates for the various items on the Bill of Quantities and shall not be paid for separately.

101.16 WORKS EXECUTED BY THE EMPLOYER OR BY OTHER CONTRACTORS

The Employer 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 another Contractor whose contract 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 Contractor employed on such Works and the same obligations shall be imposed on the Employer or other Contractor in respect of work being executed under this Contract.

101.17 MATERIALS

101.17.1 General

All materials shall be of the best quality throughout. Materials delivered to the Works shall be equal in all respects to the samples approved by the Engineer. The methods of stocking, mixing, transporting, fixing, placing and applying all materials shall be in compliance with the specifications and to the approval of the Engineer, who shall be kept advised of any change of plan. Materials failing to comply with the Specifications shall be immediately removed from the Works, at the Contractor's expense.

101.17.2 Approval of Materials

Before entering into any sub-contract for the supply of any material or goods, the Contractor shall obtain the Engineer's approval in writing of the manufacturers and/or suppliers from whom he proposes to obtain such materials or goods. If requested, the Contractor shall submit to the Engineer samples of such materials and shall have them tested in approved laboratories. Such tests shall be carried out at least seven days prior to the inclusion of such materials in the Works. The cost of all samples and tests shall be borne by the Contractor.

Should the Engineer, at any time, be dissatisfied with such material or goods or with the methods of production or operation carried out at the manufacturer's or supplier's works or place of business, he shall be empowered to cancel his previously given approval of such supplier and to specify any other supplier whom he may choose for the supply of such material or goods. The Contractor shall then obtain such said material or goods from such other supplier and shall bear any additional costs thereof.

Materials which, in the opinion of the Engineer, do not comply with the Specification, shall be classified as rejected materials and shall be cut out and removed from the Works and replaced as directed by the Engineer, at the Contractor's own expense.

101.17.3 Alternative Materials

Where brand names or products of a specific manufacturer are specified in the Contract, the Contractor may, subject to the Engineer's approval (which shall not be unreasonably withheld) supply alternative materials, having similar characteristics and showing performance and quality at least equal to those specified.

Whenever the Contractor wishes to propose an alternative material he shall submit detailed information concerning the type of material and/or product, the Vendor's name, drawings if required, test certificate, etc. If the alternative material is not approved by the Engineer, the Contractor shall supply the material originally specified in the Contract.

If the price of the approved alternative material is in excess of the material specified in the Contract, the Contractor shall not be entitled to extra payment over the rates in the Bill of Quantities.

101.17.4 Supply by Contractor

Pursuant to Clause 36 of the Conditions of Contract, all materials required in the Works, except as otherwise provided for in the Contract, shall be supplied by the Contractor and the cost thereof shall be included by the Contractor in his rates in the Bill of Quantities.

The Contractor's Tender shall be construed as an undertaking that all the materials and equipment to be provided by the Contractor are in his possession, or readily available and will be delivered to the Site in accordance with the Time Schedule.

101.18 MAINTENANCE OF WORKS

During the period of maintenance the Contractor shall maintain the Works and make

all repairs, as defined in clauses 49 and 50 of the Conditions of Contract.

After the commencement of the Period of Maintenance, the Contractor shall do nothing which might endanger the safety of the Public and he shall carry out all instructions of the Engineer or other duly authorized person or authority in this regard. Throughout the Period of Maintenance the Contractor shall notify the Engineer what work or operations it is intended to be carried out on the Site and he shall carry out any instruction which the Engineer may give as to times and manner of working so that any inconvenience to the Public is kept to a minimum.

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

101.19 WORKS LOG BOOK

The Engineer's Representative will keep a Works Log Book on the Site.

To assist the Engineer's Representative in keeping the Log Book, the Contractor shall supply daily to him full details in writing on the following:

1. The number of workmen of the various trades and grades employed in carrying out the Works.
2. Quantities of the various materials brought to or removed from the Site.
3. Quantities of the materials incorporated by the Contractor in the Works.
4. Constructional Plants and Contractor's equipment brought to and removed from the Site.
5. The use of Constructional Plant in the Performance of the Works.
6. Other details as requested by the Engineer's Representative.

The Engineer's Representative may, if he so desires, use the above data to conduct the Log Book. However, such data shall not bind the Employer or the Engineer in any manner whatsoever.

The Log Book will be signed by the Engineer's Representative, and a signed copy of the daily entries will be handed to the Contractor or his authorized representative, who within 48 hours from the receipt of said copy, may object to any of the entries therein by written notice to the Engineer's Representative. Such objections by the Contractor

shall be recorded in the Log Book. If the Contractor or his authorized representative has not made any such objection within 48 hours as aforesaid, he shall be deemed to have confirmed the correctness of the data entered in the Log Book.

The Contractor may enter in the Log Book his remarks regarding the performance of the Works. However, such remarks shall not bind the Employer or the Engineer.

Entries in the Log Book, except those to which the Contractor has objected in writing as described above, shall serve as evidence between the parties as to facts included therein; however, they shall not in themselves from the basis for a demand for any payment under the Contract.

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101. GENERAL REQUIREMENTS

101.1 APPLICATION OF PARTICULAR SPECIFICATION

This Particular Specification is to be read and construed together with the General Specification of the Contract Documents for this Tender. In case of ambiguities or discrepancies between this Particular Specification and the General Specification, the Particular Specification shall prevail, except if and to the extent otherwise provided by the Contract or directed by the Engineer.

Whenever the term "Specification" without further qualification is used in the Contract Documents, it shall mean the General Specification together with the Particular Specification.

101.2 LOCATION OF WORKS

The Works cover the rehabilitation of Tleil road in Akkar Governate, North of Lebanon. Tleil road, known as Tarik El-Wadi/El-Shamys, starts at the point with the following coordinates X= -275979.107; Y= 48356.260 and ends at point X= -276647.667 Y= 48051.133. The road is around 800m long consisting of natural and rocky terrain, it cuts through agricultural lands and scrublands. Wastewater line, coming from Tleil village, travels for 70m in a sewer pipe located underneath the assessed road, reaching a sewer manhole from where it is discharged into a drainage line which passes side by side with road and crosses under it. Coordination was made with the Mayor which in turn had stated that the drainage line has no risk of flooding. The road intersects several storm water drains where it passes over constructed small stone bridges.

101.3 THE SITE

For work along pipelines within public roads and tracks, the limits of the Site shall be the limits of land in public ownership which shall be taken to be any boundary fence or wall or if there is no such clearly identified boundary the width shall be taken as one meter beyond the edge of the carriageway.

In some areas the width of the Site will be physically restricted by physical boundaries such as boundary wall or by natural topographic features. The Contractor shall have inspected the Site and shall have included for the provision of any additional working area that he may require outside the limits of the Site.

101.4 SCOPE OF WORK

Rehabilitation of Tleil road is highly significant since it will facilitate the access to agricultural lands and eventually develop them. In addition, it allows easier access for civil defense vehicles to fight trees or bush fires during summer season.

The scope of works includes clearing Tleil road of all vegetation, shrubs and trees as mentioned in the specifications, leveling the road from rocks, supplying of sub-base course, base course, and a final layer of ready mix concrete with rough surface (where specified in the drawings) with suitable aggregates and compact it to desired final level.

In addition, bridges and walls made from stones have to be constructed/ rehabilitated where needed.

101.5 CONDITIONS PREVAILING AT SITE OF WORKS

The Contractor's attention is drawn to his obligation to satisfy himself, before submitting his Tender, as to the conditions prevailing at the Site of Works and its surroundings and relevant sections of the General Specification for Civil Engineering Works.

101.6 PRIVATE LANDS

The Contractor shall not enter upon or occupy with men, tools, or materials of any nature, any lands other than the working areas shown on the Drawings, except after consent shall have been received by him from the proper parties and a certified copy of such consent shall have been furnished to the Engineer. Any rentals or damages paid for occupying private lands shall be at the Contractor's expense.

101.7 EXISTING SERVICES

In the course of works, the Contractor will encounter within the limits of the working areas and in the vicinity, miscellaneous above ground and underground services such as drains, pipes, cables, telephone and electric poles and lines, water supply and similar existing services. The Contractor's attention is directed to the provisions of Clause 101.10.4 of the General Specification with regard to such existing services.

101.8 ACCESS ROADS

Temporary access roads

The necessity of construction of Access Roads and/or temporary roads may arise, in which case such temporary roads shall be subject to the provisions of Clause 101.10.3 of the General Specification for Civil Engineering Works, and shall be executed at the contractor responsibility and expenses in coordination with the concerned Authorities and according to the Engineer requirements.

101.9 PROGRAM AND MONITORING

It is a primary requirement of the Employer that a comprehensive knowledge of the status of progress to date, predicted progress, costs and cash flow forecasts is available at all times. The Contractor shall be responsible of the requisite information and shall be responsible for programming the Works, preparation of cash flow estimates and measuring and reporting the progress of the works in an approved format. In order that programming, progress measurements and reporting is executed in a timely and efficient manner, the Contractor shall program the Works, monitor progress and generate cost reports and cash flow projections by utilizing a recognized industry standard approved P.C. based Project Management software package.

The Contractor's master program and cash flow estimates and subsequent updates, submitted detail the sequence of procurement, installing, testing and commissioning, and handing over for each of the works items including each item described in the Bill of Quantities.

At least 21 days prior to taking possession of any portion of the Site and starting of work, the Contractor shall submit a detailed construction program for that portion of the Site. The detailed construction program shall be to a level to adequately identify the intended sequence of working on each individual item of work. The minimum level of detail shall not be less than that needed to identify each individual payment item included in the Bill of Quantities.

The Engineer's obligation to measure the Works in accordance with Sub-Clause 56.1 of the Conditions of Contract shall be dependent on the Work being programmed and progress being monitored and reported in accordance with the requirements of the Contract.

101.10 OR EQUAL CLAUSE

Wherever reference to Standard Specifications, such as British Standards, are made they shall not be construed to restrict materials to British products. Materials from other scheduled countries will be considered provided that the producer of the material certifies its conformity to the appropriate Standard Specification.

Similarly whenever a material or article required is specified or shown in the plans by using the name of the proprietary product or of a particular manufacturer or vendor; any material or article which will perform adequately the duties imposed by the general design will be considered equal and satisfactory provided the material or article so proposed is of equal substance and function in the Engineer's opinion. It shall not be purchased or installed without his written approval.

101.11 GOVERNMENT REGULATIONS

The Contractor shall comply with all provisions of the rules, regulations and orders of Government and Municipal agencies, such as the Public Works Department.

The Contractor shall co-operate with the Employer in promptly furnishing any information that may be required by such governmental agencies. It shall be the obligation of the Contractor to keep himself informed of these governmental rules, regulations, and orders and the Contractor shall make the requirements of this article a part of any sub-contract he may enter into.

101.12 NOTICE BOARDS

The Contractor shall provide and erect sign boards at the sites where works are being executed, giving information to the public on the Project and the Employer and further details as will be prescribed by the Employer. The location and number of the sign boards at the sites will be indicated by the Engineer. The Contractor shall maintain, alter, move and adapt the sign boards from time to time as instructed by the Engineer. The display of any named Subcontractors or any other information associated with the Works shall be to the approval of the Engineer.

101.13 PRECAUTIONS AGAINST CONTAMINATION OF THE WORK

The Contractor shall at all times take every possible precaution against contamination of the works. The site and all permanent and temporary works shall be kept in a clean, tidy and sanitary condition. The Contractor shall at all times take

measures to avoid contamination of the existing water courses and drains by petrol, oil or other harmful materials.

101.14 ACCESS TO PROPERTIES

The Contractor shall not disrupt any private or public access way without first providing alternative arrangements.

101.15 DRAWINGS AND DOCUMENTS

All drawings and documents submitted by the Contractor shall have been checked, signed and be ready for issue and shall bear the title of the drawing, the scale, the date, the Contract number and name, the document number complying with an approved numbering system, the name and references of the Contractor, the name of the Employer and the Engineer, the date of approval by the Contractor and the signature of the person responsible for approval.

Unless otherwise specified the Contractor shall allow a minimum of 15 days for approval of drawings and documents by the Engineer.

101.16 MEASUREMENT AND PAYMENT

Unless otherwise provided for in the B.O.Q, all costs incurred in complying with the requirements of this Division 101 shall be deemed to be included by the Contractor in his unit rates in Bill of Quantities and shall not be paid for separately.

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201. CONCRETE WORKS

201.1 GENERAL

201.1.1 Life Span of Concrete Structure

New works are to be designed for a life of 60 years.

201.1.2 Codes and Standards

Complementary or new design shall as far as possible be carried out in compliance with relevant International Standards such as:

- BS Standards.
- ACI and Uniform Building code.
- BAEL 1992
- AFPS 90

Or equivalent standards

201.2 SOIL PARAMETERS

The Contractor shall carry out soil investigations to satisfy himself with the prevailing soil conditions for all sites.

201.3 MATERIALS

201.3.1 Grades of Concrete

The minimum grades of concrete for the various structures are given as follows:

Grade	Component
C30	Reinforced concrete for Structures (350 Kg cement/cu.m)
C20	Mass concrete and Blinding concrete (250 Kg cement/cu.m)

Reinforced and mass concrete must be vibrated.

Admixtures and mix design of the different Grades of concrete shall be submitted for approval prior to commencing the work.

201.3.2 Reinforcement

All reinforcing steels shall be Type 2 High Yield Bars and comply with the requirement of BS 8110 and shall have a specified characteristic strength of 420 N/mm^2.

Dowel bars and stirrups shall be Mild Steel grade 25, fy = 250 N/mm^2.

Lap lengths shall be 50 diameters. Mechanical bending for $\phi \geq 12$ mm is required.

201.3.3 Minimum Cover of Reinforcement

The concrete cover for all steel bars including stirrups shall not be less than 40 mm in structures where concrete surfaces are in contact with water.

Where concrete surfaces are in contact with soil, the cover of reinforcement shall not be less than 35 mm.

The cover of reinforcement in external surfaces of structures, and all elements of buildings shall not be less than 30 mm.

Formwork for all concrete surfaces in contact with water and/or soil and internal surface (walls and ceilings) of technical rooms shall be of form panels (marine plywood or metallic formwork) in order to obtain a regular and smooth finish.

201.3.4 Classes of Exposure and Crack Width

External and internal walls, columns and beams are to be considered as subject to severe exposure as defined in Sub-Clause 3.3.4 of BS 8110.

The faces of structures in contact with ground shall also be considered as subject to severe exposure.

Concrete surfaces in contact with water are designed for a maximum crack width of 0.2 mm.

201.3.5 Admixtures

Admixtures (retarders, mass waterproofing, silica fume, ...) are to be added to concrete in contact with liquid. Technical sheets and the mix design of concrete shall be submitted for approval.

202. CYCLOPEAN CONCRETE

Cyclopean concrete shall consist of Class C concrete, as specified, containing large embedded stones. The embedded rubble stones shall be of approved quality, sound and durable, and free from segregations, seams, cracks and other structural defects or imperfections tending to destroy its resistance to the weather. It shall be free from rounded, worn, or weathered surfaces. All weathered stone shall be rejected. The stone shall be kept free from dirt, oil, or any other injurious material which may prevent proper adhesion. The largest dimension of any rubble stone shall not exceed 20 centimeters. The distance between two adjacent rubble stones or between a rubble stone and the form shall not be less than 5 centimeters.

The stone shall be carefully placed-not dropped or cast-so as to avoid injury to the forms or to the partially set adjacent masonry. All stones shall be washed and saturated with water before placing. The total volume of the stone shall not be greater than one third of the total volume of the portion of the work in which it is placed.

203. SHOP DRAWINGS, AS-BUILT DRAWINGS

Shop Drawings and all necessary material technical specification shall be submitted to the Engineer for approval at least 21 days before starting of the work.

As-built drawings shall be prepared and submitted successively during the execution of works and shall be also submitted completely to the Engineer for approval one month maximum after the completion of the work.

It is the duty of the Contractor to undertake all the Engineer's recommendations, modifications and corrections at his own expense until complete satisfaction of the Engineer.

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201. EARTHWORKS

201.1 GENERAL

201.1.1 Scope

Earthworks under this Specification include excavation and backfill for road works, compacted fill and surfaces and other earthworks and works related thereto, as required in the Works.

201.1.2 Classification of Excavation

Unless specific items for Rock Excavation are included in the Bill of Quantities, earthwork will not be classified in accordance with the hardness of the excavated material and all excavation will be deemed to consist of Common Excavation, as defined hereafter, regardless of the actual hardness of the excavated material.

Where excavation is classified according to hardness of excavated materials, the following definitions shall apply:

- Rock excavation shall include hard and solid rock that cannot be broken up by mechanical excavating equipment, including a heavy tractor equipped with a rooter, but which necessitates the use of pneumatic tools or blasting for its loosening and removal. Rock excavation shall also include detached boulders exceeding one half of a cubic meter in volume.
- Common excavation shall include all material other than rock as defined above and also detached boulders less than one half of a cubic meter in volume.

No material, except the aforesaid, will be defined as rock and classified as such for the purpose of payment, whether actually loosened by blasting, pneumatic tools or otherwise.

The decision as to the classification of any excavation into “rock” or “common” shall be at the sole discretion of the Engineer’s Representative, subject only to Clause 2 of the General Conditions of Contract.

Where specific items for Rock Excavation are included in the Bill of Quantities, the Contractor shall not be entitled to be paid for excavation in rock unless, at the time the excavation is open and visible, the Contractor shall give notice in writing to the Engineer’s Representative that he claims to be paid for excavation in rock. After giving

such notice the Contractor shall not fill in the excavation or otherwise prevent it from being inspected by the Engineer's Representative for the purpose of classification and determination of payline in respect of same.

201.1.3 Natural Ground Levels

The natural ground levels, as marked on the Drawings, shall form the basis of measurement for payment for excavation, fill and all other works where the site levels have bearing and no field surveys will be made. Natural ground levels at intermediate points shall be checked on the field by the Contractor.

The Contractor shall check the natural ground levels before the commencement of earthworks, and such checking shall be made by the Contractor at his own expense, in the presence of the Engineer. The results, approvals in writing by the Engineer, shall thereafter prevail.

The cost of checking natural ground levels shall be borne by the Contractor alone, whether checking is carried out at the Engineer's request or at the Contractor's own request. No allowance will be made for normal bulking or shrinking of the soil and the Contractor shall make allowance for this in his rates.

201.1.4 Use of Explosives

The Contractor shall use explosives only with the written express permission of the Engineer's Representative and all blasting shall be carried out by properly licensed and qualified workmen under experienced supervision. When using explosives, the Contractor shall abide by and conform to all the Laws pertaining to the purchase, transportation, storage and handling of explosives and shall obtain all required licenses from and make all necessary arrangements with the relevant authorities prior to commencing blasting operations.

When blasting operations are in progress, all precautions shall be taken to protect all persons and livestock, the Works, and any other property from injury or damage.

The Engineer's Representative shall have the power to regulate, restrict or prohibit blasting if in his opinion it is necessary to do so for the safety of persons or property, or to safeguard the foundations or sides of the excavation, and the Contractor shall have no claim against the Employer in respect of such regulations or prohibitions. Explosives shall not be used within 20 meters or any other distance as the Engineer's Representative may direct, of concrete in permanent structures.

Notwithstanding anything said in this Sub-Section, the Contractor shall be held solely and entirely responsible for any injuries to persons and livestock and damage to public or private property.

201.1.5 Program and Methods of Work

In addition to the information furnished by the Contractor with his Tender, the Contractor shall, after award of Contract but no later than two weeks prior to commencement of Works, submit for the Engineer's approval detailed proposed methods of excavating, transporting and placing earthfill material, watering and compacting and any subsequent modifications thereof, together with a detailed list of quantities and type of plant to be used for all these operations. Amendments shall be made by the Contractor in accordance with any instructions issued by the Engineer before commencement of works and from time to time.

201.1.6 Excavated Materials - Handling and Disposal

As far as practicable and as determined by the Engineer's Representative, all suitable materials from excavations shall be used in the permanent construction required under the Contract.

The Contractor's operations in excavations shall be such as to yield the maximum of suitable materials for construction purposes, and shall be subject to the approval of the Engineer's Representative. Where practicable, and as determined by the Engineer's Representative, suitable materials shall be excavated separately from those considered unsuitable, and the suitable materials shall be segregated by loads during the excavation operations and shall be placed in the designated final locations either directly from the excavation, or shall be placed in temporary stockpiles for later placing in the designated locations, all as directed by the Engineer's Representative.

Excavated materials that are considered unsuitable or are in excess of those required for permanent construction, shall be removed from the Site. The Contractor shall be entirely responsible for the removal of all surplus excavated material from the Site to such disposal areas as he shall have obtained at his own cost and responsibility and shall keep the Employer indemnified against any claims, charges or proceedings arising out of the transportation and disposal of such surplus excavated material.

Spoil heaps shall be located where they will not interfere with the progress of the Works, or with the flow of water in natural streams or drainage courses, and where they will

neither detract from the appearance of the completed project and environment, nor interfere with access to the structures. Spoil heaps shall be levelled and trimmed to reasonable regular lines, as determined by the Engineer's Representative.

The cost of complying with all requirements of this Sub-Section shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

201.1.7 Restoration of Waterways and Pipelines

The Contractor shall clean out and restore to their original condition all waterways or pipelines which may have been cut by the excavation or in any way damaged or silted up as a result of his operations.

Unless specific items are provided in the Bill of Quantities the cost of all additional work involved in crossing under or cutting through any waterways and pipelines and reinstating to their original condition shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately.

201.1.8 Restoration of Surfaces

The Contractor shall be responsible for the temporary and permanent restoration of all surfaces of roads, fields, paths, gardens, verges etc. whether public or private which are affected by his operations.

Temporary restoration shall be carried out immediately after the excavations have been refilled by returning the excavated material to the position from which it was removed and adding such suitable materials as may be required and consolidating the various materials as the work proceeds in order to provide a surface that is adequate for the purpose that the original surface fulfilled. Temporary surfaces shall be maintained in a condition satisfactory to the Engineer and responsible Authority until the permanent reinstatement is made.

The Contractor shall be responsible for the permanent reinstatement of all surfaces already described including asphalt surfaced public roads as specified in Section 201.3.

Should, at any time, any trench become dangerous, the Engineer will be at liberty to call upon the Contractor to restore it to a proper condition at three hours' notice and, should the Contractor fail to carry out the work, have it done at the Contractor's expense.

The Contractor shall include in his rates for all materials and labour which he may have to employ in reinstating the trenches and surfaces to the satisfaction of the responsible Authority concerned.

Restoration shall be deemed to be included by the Contractor in his various unit rates for earthworks and shall not be paid for separately, except where specific items have been provided in the Bill of Quantities.

201.1.9 Equipment for Earthworks

Generally, equipment for earthworks, shall be of a modern type and of a design suited for each specific purpose. Only equipment and machinery approved by the Engineer shall be used in the Works.

Grading equipment shall be of any type of earthmoving equipment the Contractor may desire or has at his disposal, provided the equipment is in a satisfactory condition and of such capacity that the program can be maintained. The Contractor shall furnish, operate and maintain such equipment as is necessary to control uniform layers, section and smoothness of grade for compaction and drainage.

Compacting equipment shall be of a design, weight and quantity so as to obtain the required density.

Equipment, such as vibrating machines, may be used for compacting and consolidating the embankments, subgrades, and other areas, upon approval of the Engineer. Such equipment shall be routed over the area being compacted and shall be operated until the required density is obtained.

Watering shall be carried out by means of tank wagons, tank trucks, or distributors equipped with a suitable sprinkling device.

201.2 CLEARING AND STRIPPING

201.2.1 Clearing

The areas upon which new construction is to take place shall be cleared of all vegetation, shrubs and small and large trees, together with their roots, and from all other foreign and deleterious matter that may affect and interfere with the progress of the Works.

Trees and shrubs shall be cut or burnt down under strict control to ground level, the roots grubbed up to a depth of not less than 1.0m and removed from the area. All other scrub, vegetation, rubbish, etc., shall be cleared or burnt down to ground level and removed from the area to any distance.

All trees shall remain the property of the Employer and the Contractor shall collect these trees and store them until required by the Employer. All trees near to and about the Works except such as are to be removed, shall be carefully protected from damage by the Contractor during the period of maintenance and no trees shall be removed without the prior consent of the Engineer.

The Contractor shall take particular care at all times to prevent erosion on every site and elsewhere on land which may be affected by his operations and the Engineer may impose such reasonable limitations and restrictions upon the method of clearance and upon the timing and season of the year when clearance is carried out as the circumstances seem to him to warrant.

Unless otherwise specified in the Contract, clearing shall be measured by square meters. The unit rate shall include for all operations required under this Sub-Section, including removal of trees (see also Sub-Section 201.2.2 hereafter).

No clearing shall be carried out without prior written approval of the Engineer's Representative and only such areas approved or ordered to be cleared shall be measured and paid for.

201.2.2 Removal of Trees

Clearing as defined in Sub-Section 201.2.1 shall include the removal of small and of large trees. Trees of a girth of 40 cm or less when measured at a height of 1.0 m above ground shall be classified as small trees. Trees of a girth exceeding 40 cm when

measured at a height of 1.0 m above ground shall be classified as large trees and shall be removed only at the express order of the Engineer's Representative.

The removal of large trees, except where a specific item is provided in the Bill of Quantities, and the removal of small trees will be deemed to be included in Clearing and will not be paid for separately.

Where a specific item is included in the Bill of Quantities for the removal of large trees, they will be measured for payment by number.

201.2.3 Stripping

Areas on which compacted fill is to be placed and areas of excavations from which material for fill is to be extracted, including borrow areas, shall be stripped of top soil containing organic or otherwise deleterious and objectionable matter to a depth of at least 15 cm. or to such greater depth as may be determined by the Engineer. The stripped soil shall be stored in separate dumps for subsequent re-use in covering the slopes of embankments or the borrow areas after excavation therein has been finished, or shall be otherwise disposed of as directed. Under no circumstances shall such stripped material be used as compacted fill.

Stripping shall not be carried out unless the Contractor is able to proceed immediately with the further earthworks upon the stripped areas. Overstripping shall be backfilled and compacted, at the Contractor's own expense, to the satisfaction of the Engineer.

Stripping shall be measured in cubic meters, computed by multiplying the area stripped by the depth of stripping. The unit rate shall include for all excavation, stacking-re-spreading and running excess to spoil.

No stripping shall be carried out without prior written approval of the Engineer's Representative and only such areas approved or ordered to be stripped shall be measured and paid for.

Unless otherwise specified, stripping of borrow areas shall not be measured for payment and the cost of such stripping shall be deemed to be included by the Contractor in his unit rates for earthwork in the Bill of Quantities.

201.3 ROAD REINSTATEMENT

a) Cutting into Paved Areas

Where pipes have to be laid under existing paved areas such as roads or sidewalks, cutting into the pavement shall be done with appropriate tools, to ensure straight and neat cuts. The trench shall be vertical and its width across the top edges shall not exceed the following values:

MAXIMUM WIDTH OF THE TRENCHES AT THE TOP IN PAVED AREAS

(IN m)

Depth of trench from paved surface to pipe invert (m)	Maximum width of trench at the top in paved areas (m)
≤ 1.50	O.D(*) + 0.55
1.51 - 2.50	O.D(*) + 0.85
2.51 - 3.50	O.D(*) + 1.15
3.51 - 4.50	O.D(*) + 1.45
4.51 - 5.50	O.D(*) + 1.85
5.51 - 6.50	O.D(*) + 2.25
6.51 - 7.50	O.D(*) + 3.00

(*)O.D = Outer diameter of pipe barrel.

The Contractor shall take all necessary measures, such as shoring, bracing, etc. to keep the width of the trenches within the limits given in the table.

Cutting into paved areas will be measured for payment in linear metres of cut pavement.

b) Reinstatement of Surfaces

All surfaces whether public or private which are affected by the Works shall be reinstated in two stages, the first stage shall be carried-out in the first instance, and when the ground has consolidated fully the Contractor shall proceed with the second stage at the order of the Engineer.

First stage and second stage reinstatement of all surfaces, affected by the operations of the Contractor shall be carried out and maintained to the satisfaction of the Engineer and the responsible authority or owner.

First stage reinstatement shall be carried out immediately the trenches are backfilled.

Second stage reinstatement shall not be carried out until the ground has consolidated completely. The Contractor shall inform the Engineer before carrying out this work. In the event of further settlement occurring after the completion of the second stage reinstatement the Contractor shall forthwith make good the reinstatement to the approval of the Engineer or responsible authority.

For the purposes of first and second stage reinstatement in bitumen and surfaced roads the surface width of trenches shall be increased by recutting 15cm on each side of the trench for a depth of 8 cm to provide a solid abutment for the surfacing material.

Reinstatement of surfaced roads shall be carried out to the approval of the relevant authority.

The responsible authority shall have the right to carry out final reinstatement at the Contractors expense.

Trenches in open ground shall be reinstated to the condition in which the ground was before excavation was commenced. The final surface of the trench shall be flush with the surrounding ground.

In verges and other grass surfaces and after the backfilling has been thoroughly consolidated the topsoil shall be relaid rolled and planted with grass or other vegetation as-directed by the Engineer as may be necessary and watered until the grass has become well established. Should the planting fail it shall be replanted as required until a satisfactory growth is obtained.

If at any time any reinstatement deteriorates the Contractor, shall restore it to a proper condition immediately.

Should the Contractor not remedy the defect to the Engineer's satisfaction forthwith any remedial work considered necessary may be undertaken by the Employer and/or the responsible authority at the Contractor's expense.

All trees, shrubs and plants shall be carefully transplanted and shall be returned to their original location after the refilling of the excavations. Return of old or mature trees may be waived in cases where the age of the tree makes return impracticable.

Top soil shall be carefully set aside and replaced at the surface of the backfilling.

The trenches shall be refilled and rammed solid as specified in the Contract and shall not be topped up above the original surface level to allow for settlement.

If any trench becomes dangerous the Engineer may call upon the Contractor for its reinstatement at three hours' notice and failing this to have the work done by others at the Contractor's expense.

c) Safety of Excavation in Roads

Where the surface of the road (other than that which lies immediately above the trench) is damaged either by the concentration of traffic caused by an open trench, by subsidence or other causes arising from the operations of the Contractor, he shall permanently reinstate the whole of the surface so damaged to its original condition.

The Contractor shall ensure that trenches and reinstatement are maintained in a safe condition and shall take immediate action to remedy any deterioration which renders the works unsafe. If in the opinion of the Engineer any excavation or reinstatement is in a dangerous condition the Contractor shall immediately remedy the defect. Should the Contractor fail to carry at the reinstatement promptly the work may be carried out by others at the Contractor's expense.

d) First Stage Reinstatement

In all paved roads the trenches shall be refilled and compacted to the underside of the sub-base layer of the road at 48 cm below the road finished level.

A sub-base layer of 20 cm thick shall then be laid consisting of approved free draining granular material conforming to section 218.1.3 requirements.

A base layer of 20 cm thick shall then be laid consisting of approved crushed limestone material conforming to section 218.1.3 requirements.

Prior to application of the first stage reinstatement the surface of the road foundation shall be cleared of all dust, debris and other deleterious matter and shall then be primed with one application of prime coat MC-70 or similar approved. All joints with adjacent road surfacing shall be cut straight and vertical and primed.

The road surfacing of the first stage consists of 5 cm thick of finished asphalted concrete layer.

The surface shall be maintained with the end of the period of Maintenance or until instructions are given for the final reinstatement to be carried out.

f) Reinstatement of unmade roads

In all unmade roads the trenches shall be refilled and compacted as specified in the Contract to within 15 cm of the surface.

The trench shall be surfaced with 15 cm compacted thickness of base layer material as specified above.

The surface shall be maintained until the end of the Period of Maintenance and shall not be topped up above the level of the original surface to allow for settlement.

e) Second Stage Reinstatement

Second and final reinstatement consists of a wearing course of 4 cm compacted thickness of 14 mm nominal size dense wearing course macadam. The laying and finishing of the coated macadam shall be carried out so as to achieve a dense, smooth and even surface using a roller of not less than 12 tons mass.

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202. STONEWORKS

202.1.1 General

This chapter deals with all stone work with or without mortar bedding, constructional and/or decorative, such as retaining walls, paving, filters, rip rap, gabions, etc.., covering the supply of all specified materials as well as laying, jointing and constructing of all elements shown on the Drawings and described in the Specifications.

Stones shall come from selected quarry layers to the approval of the Engineer. They shall be homogeneous, frost resistant, flawless, free of any crack, solid, and of equal grain and shall have the required qualities to give a regular facing. They shall give out a clear sound when hit with a hammer. Those which give out a dull sound due to soft parts and crumble into sandy grains instead of breaking into sharp splinters shall be rejected.

Stones shall have a minimum density of 2.5, bear a crushing load superior to 600 kg/cm2 and conform to the approved sample submitted by the Contractor. Stones shall have sizes (length or width) reaching 20 to 50 cm. Their width shall be as shown on the drawings, and they shall have beds and joints perpendicular to the facing.

202.2 RUBBLE STONE PAVING

202.2.1 General

Rubble stone paving shall consist of layers of stone placed on a gravel blanket, to the lines and thickness shown on the Drawings or directed by the Engineer. The stones shall conform to the requirements of Subsections 202.3.2 and202.3.3 hereafter and the gravel blanket to the requirements of Section 202.4 hereafter.

202.2.2 Quality of Stone

Rubble stone for paving shall consist of clean frost resistant, hard sound and durable natural cobbles or quarried stone fragments of roughly cubic shape. The stones shall be free of cracks, seams and other defects. Elongated and flat slablike stones shall not be permitted. Not less than 75% of the stones shall have the dimensions of the faces perpendicular to the paved surface approximately equal to the nominal thickness of the paving and none shall be smaller than three quarters of the nominal thickness in the said direction. The stones shall be approved by the Engineer before laying.

202.2.3 Laying

Before laying the stone paving, earthworks shall be completed to final grades and lines, and the bedding shall be excavated and compacted to the finished slopes and levels. The gravel bedding shall then be placed and compacted as specified in Sub-section 202.3.4. The stones for rubble paving shall be placed on the gravel blanket and shall be hand packed as closely as possible to each other with their smallest side parallel to the paved surface and the exposed face flush with it. The joints shall be broken and no through joints will be allowed. The stones shall be bonded on all sides. The spaces between stones shall be filled either by a 1:3 cement-mortar or with rock chinking hammered into place. The paved surface shall be stable and reasonably flat and even, without any abrupt projections and/or depressions.

202.2.4 Gravel Blankets

Gravel blankets shall be placed as beddings under rubble stone pavements or, by themselves, as surfacing on soil areas, as shown on the Drawings or as directed by the Engineer. Material for gravel blankets and surfacings shall consist of natural river gravel or crushed stone in accordance with requirements of B.S. 882, Part 2 and to the satisfaction of the Engineer. Unless otherwise shown on the Drawings or directed by the Engineer, the size of the gravel, as specified in B.S. 882, Part 2, table 1, for single sized aggregates, shall be as follows:

a) For gravel blankets under rubble stone pavements - nominal size of 40 mm
b) For gravel surfacings on Soil areas - nominal size of 20 mm.

The gravel shall be placed in layers not exceeding 15 cm in thickness on a well-levelled and compacted subgrade. Each layer shall be thoroughly consolidated and compacted to the satisfaction of the Engineer. The finished blanket shall have a stable and even surface and be true to the lines and grades shown on the Drawings.

202.2.5 Methods of Measurement and Payment

Rubble stone pavements shall be classified by thickness of gravel blanket and stone layers and shall be measured for payment by m² of surface area of completed pavement. Unit rates for rubble stone pavements shall include for all materials and labour required for the completed pavement in place, including all excavation; supply and spreading of gravel blanket; supply and laying of stone and filling of joints with cement-mortar of rock-chinking; and all other works and materials required to make the pavement complete.

Gravel surfacing shall be classified by thickness of gravel layer and shall be measured for payment by m² of surface area of completed surfacing. The unit rates for gravel surfacing shall include for all materials and labor required for the completed surfacing in place, as specified in this Subsection, above, for rubble stone pavements.

202.3 HAND PLACED RIP-RAP

202.3.1 General

The work consists of hand placed rip-rap paving to the dimensions shown on the Drawings, laid on a graded gravel filter blanket on areas as shown on the Drawings and as directed by the Engineer.

202.3.2 Materials

Filter materials shall be supplied by the Contractor from approved sources and shall consist of natural washed sand and gravel or clean broken rock which does not break down into finer particles when it is placed. They shall be free from silt, clay and organic matter or other impurities or deleterious substances. Filter materials shall conform to the requirements of B.S. 882 - Coarse and fine aggregates from natural sources. The grading shall be as shown on the Drawings and as defined in the Particular Specification, and shall always be such that all permitted sizes are represented and there is no undue preponderance of any one fraction.

The Contractor shall furnish for testing and shall test, at his own cost, such representative samples of filter materials as may be required by the Engineer and shall have them tested in approved laboratories. The Engineer reserves the right to inspect the sites from which filter materials are obtained. The approval of materials from a particular source shall not be constructed as constituting an approval of all materials taken from that source, and the Contractor will be held responsible for the specified quality and gradation of gravel and sand delivered to the work site. If, in the Engineer's opinion, the filter material supplied by the Contractor fails to meet the requirements he shall be entitled to instruct the Contractor to take remedial steps such as washing the material, re-sieving it, etc.., or to reject it completely and have other material brought in by the Contractor, at no additional cost.

The material for the rip-rap shall consist of hard, dense, durable rock, resistant to weathering and water and wave action, with the following physical properties (to B.S. 812) :

- Minimum bulk specific gravity (dry in air) 2.6
- Maximum absorption 3%
- Maximum abrasion 25%

The rip-rap shall consist of angular fragments of quarried rock with the cobbles, flat slabs and elongated pieces shall be rejected.

The grading of the filter material and of the rip-rap stones shall be as shown on the Drawings, as specified in the Particular Specification and as directed by the Engineer to meet the gradation requirements. A quantity of gravel and stone spalls sufficient to fill the voids between the stones shall be included in the material.

202.3.3 Workmanship

The area to be paved shall be excavated to a depth equal to the combined thickness of the gravel blanket and rip-rap stone, so that the face of the stone of the completed rip-rap paving shall be flush with the neat lines of the area, as shown on the Drawings.

Rip-rap of stones or rock fragments shall be dumped on the gravel. The stone of rip-rap need not be compacted, and shall be dumped and graded off in such a manner as to ensure that when completed, it will be well interlocked and stable, without tendency to slide. The rip-rap stones are to be uniform distributed with sizes of stones increasing toward the top, and the small fragments and spalls shall serve to fill the spaces between the larger stones. The completed rip-rap shall have a reasonable even surface and the required thickness.

The rip-rap stones shall be carefully placed by hand in a definite pattern, with a minimum amount of voids and with the top surface relatively smooth. Joints shall be broken, as much as possible. Openings to underlying blanket shall be avoided by carefully arranging the various sizes of stones and filling the openings with rock chinking hammered into place.

202.3.4 Methods of Measurement and Payment

Hand placed rip-rap and gravel blankets under hand placed rip-rap shall be measured for payment and paid for under separate items in the Bill of Quantities. The rip-rap and the blanket shall be measured for payment by square meters of completed surface actually placed in position to the lines and dimensions shown on the Drawings or as

directed by the Engineer and shall be classified according to thickness of layer. The unit rates shall include for excavation and removal of surplus soil, supply, transportation, dumping and spreading of all gravel and stone, compaction of gravel blanket, and all materials and labor necessary to complete the work to the satisfaction of the Engineer.

The Contractor is warned that material for rip-rap and blanket which will comply with the grading specified may not be found in their natural state. The Contractor shall therefore make allowance in his rates for the fact that it may be necessary to sieve and make trial mixes or quarry for rock to obtain the correct grading by crushing rock with or without mixing with materials obtained from natural sources, all as directed by the Engineer, and at the Contractor's cost.

202.4 GABIONS

202.4.1 General

Gabion walls are gravity retaining walls, disregarding the role of the gabions which give them a higher safety coefficient due to their tensile stress.

Gabions retaining structures are classified in 4 categories:

1) Gravity retaining structures
2) Half gravity retaining structures
3) Embankment structures
4) Thin anchored to ground walls with hexagonal mesh structure.

Gabion-baskets are parallelepiped structures consisting of metallic double twisted hexagonal wire meshes filled with broken stones of suitable grading.

Where shown on the Drawings or directed by the Engineer, the Contractor shall erect box or mattress gabion structures, consisting of galvanized wire mesh baskets filled with rocks or stones of suitable sizes and mechanical properties.

Each unit shall be firmly tied to the others using wires so as to form a monolithic structure.

202.4.2 Materials

The baskets shall be manufactured of hot dip galvanized or galvanized and plasticized wire double twisted hexagonal mesh. Wires shall comply with B.S. 443 - "Galvanized coating on wire" - and B.S. 1052 - "Mild steel wire" and shall have the following characteristics:

- high mechanical strength
- high resistance to corrosion
- good deformation ability
- good resistance to the undoing of meshes
- good resistance to the undoing of meshes

Following are the characteristics of standard gabions:

Galvanized Gabions		
Mesh	**Wire ∅ mm**	**Thickness m**
10 x 12	2.40 2.70 3.00	0.50 1.00
8 x 10	2.40 2.70 3.00	
6 x 8	2.20 2.70	
5 x 7	2.00 2.40	

Width: 1.00 - 2.00

Length: 2.00 - 3.00 - 4.00 for 1 m. wide gabions/

3.00 - 4.00 - 5.00 for 2 m. wide gabions.

The gabions shall be provided with diaphragms to divide the boxes in compartments with a maximum dimension in any direction of 1 meter. Diaphragms shall be manufactured of the same wire as gabions and shall stiffen the structure and facilitate assembling. Gabions can be 1 or 2 meters wide.

Mechanical and quality properties of wires (breaking load, elongation at rupture, galvanization characteristics, etc...) must be consistent with the strictest standards.

Lacing and binding shall be done by means of hot dip galvanized wire of 2.2 mm minimum thickness, which will be supplied with the gabions and will have the same

characteristics of gabions wires (hot dip galvanized annealed mild steel, double twist and hot galvanized, long term corrosion and oxidation resistance.

Filling materials for gabions shall be stones or others provided their weight and characteristics meet static, operation and duration requirements of the structure.

Rockfills shall consist of hard broken stones. It is advisable to use materials with a high specific gravity especially in the event of gravity retaining or submerged structures or works subject to the living force of waters. To ensure a long life time of the structure, stones should not be friable, soluble in water but frost resistant, hard dense and durable with a minimum bulk specific gravity (dry in air) of 2.6, maximum absorption 3% and maximum abrasion 25% (tests according to B.S. 812)

Dimensions of rock fills shall vary between 1 and 1.5 times the size D of the wire mesh, which prevents rock losses. The use of small-size rockfills (1-1.5xD) allows a better and a more economical filling, and therefore, a good load distribution and a high adaptability to deformation.

Boulders, rounded cables, flat slabs and elongated pieces shall be rejected.

202.4.3 Workmanship

The gabions shall be delivered to the site, folded and packed. Delivery of assembled gabions shall not be permitted. On the site, the gabions shall be opened up and laid flat on the ground, any unnecessary creases shall be straightened and the ends of diaphragms shall be lifted into a vertical position and placed together with binding wire to form the box. Adjacent arises shall be laced together and diaphragms fixed to lateral sides. The binding shall be carried out in a continuous lacing operation, the wire being passed through each mesh and around both edges which must be tied together, with two round turns after every second mesh.

Assembled gabions shall be placed in position for filling singly, or wired together in groups suitable for man-handling. All adjacent gabions shall be securely wired together at all corners and edges in the same manner as described above. Where there are more than one course of gabions, the ones in the upper course shall be laced to those below. Adjacent gabions shall be laced together afterwards.

To avoid bulging on the outside of the structure, tie wires (of the same material and thickness as building wires) shall be fitted inside the gabion compartments between

the outer and inner skins. The tie wires shall be passed around at least two meshes on each side of the compartment. Vertical ties shall be fixed to the bottom of the gabion prior to filling and tied down to the lid on completion. Two ties at least shall be used per square meter of surface. Horizontal ties shall be placed either perpendicular to the sides or diagonally across the corners.

The disposition of gabions is conditional upon adopted types and required characteristics of the structure.

Filling shall be carried out manually and mechanically, with minimum of voids. Packing of the stones shall be as tight as practicable. After filling the gabions slightly over-full to allow for subsequent settlements, the lid shall be laced down with binding wire to the tops of all the sides and diaphragms.

A design calculation note shall be submitted in terms of the type and geometry of the structure and shall determine the required properties and dimension of gabions walls, taking into account the technical constraints of each site.

202.4.4 Methods of Measurement and Payment

Gabions shall be measured for payment by cubic meters of gabions in place, to the lines and dimensions shown on the Drawings. The unit rates shall include for any necessary excavation and disposal of surplus soil, supply and erection of the gabions, the supply and filling of stone and all materials and labor, required to complete the gabions in place as specified, as shown on the Drawings, and to the satisfaction of the Engineer.

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203. ROAD WORKS

203.1 ROADS AND PAVED AREAS

203.1.1 General

Road construction under this division shall include construction of new roads and paved areas and repairs to existing roads and paved areas where such repairs are necessitated by the performance of the Works, and the term "road" as used in this division shall also include other areas on which a road surfacing is required.

All roads shall be constructed to the lines, levels and cross-sections shown on the Drawings and as detailed in the Particular specification. Road surfacing may consist of compacted local soil, gravel, laterite or similar suitable material, with or without a stabilizing spray of bitumen, or of asphalt concrete placed on a bearing course of compacted gravel, laterite or other suitable base course material.

203.1.2 Earthworks for Road Construction (Subgrade)

All excavation and fill required for road construction shall be carried out in accordance with the applicable requirements of Division 201. The materials to be used and the degree of compaction to be obtained in each layer of the road structure shall be as shown on the Drawings or as required in the Particular Specification.

203.1.3 Sub-Base and Base Courses

Sub-base preparation shall consist of the following:

- Scraping of the natural ground
- Earthworks and levelling of the surface
- Compaction with a pneumatic roller.

Unless otherwise specified, sub-base material shall consist of hard, durable particles or fragments of stone or gravel, screened and crushed to the required size and grading or an equivalent material, subject to the Engineer's approval. The material shall be free from vegetable matter, lumps or balls of clay and other objectionable matter.

The sub-base shall be levelled, watered, rolled and compacted to 96% of the Modified AASHTO Density. In case it consists of non-rock ground, the California Bearing Ratio CBR shall be greater than 30. The Material shall have a specific weight greater than 2.45 kg/dm^3.

If the bearing of the foundation soil be inadequate, the top soil shall be stripped to a 20cm depth. The stripped area shall be backfilled with material that meets the requirements and have a minimum CBR of 15 when compacted to 96% of Modified AASHTO Density. The frequency of tests shall be determined by the Engineer.

The sub-base course material layer shall conform to the following grading:

A.S.T.M.Sieve Designation	Percentage by Weight Passing Square Mesh Sieves

1"½	100%
1"	60-100
¾"	55-85
No. 4	35-60
No. 10	25-50
No. 40	15-30
No. 200	0-15

The material shall have the following properties:

- Plasticity Index (AASHTO T90) 4-8
- Plastic Limit (AASHTO T89) 25 maximum
- Sand Equivalent (AASHTO T176) 50 minimum

Unless otherwise specified, base course material shall be crushed aggregate which shall consist of hard, durable particles or fragments of stone or gravel crushed to the required size, and a filler of sand or other finely divided mineral mater. When produced from gravel, not less than 50 percent by weight of the coarse aggregate shall be particles having at least one fractured face and, if necessary to meet his requirement or to eliminate an excess of filler, the gravel shall be screened before crushing. All suitable oversize material less than 10 inches in diameter shall be crushed. The material shall be free from vegetable matter, lumps or balls of clay and other objectionable matter.

The sub-base and base courses shall consist of a minimum of 20 cm thick each course of compacted layers of screened and crushed material.

The sub-base shall be watered prior to the placing of the base course. The material shall then be laid, watered and compacted with a pneumatic roller to 98% of Modified AASHTO Density.

The last base course shall be levelled to ± 1 cm according to the levels shown on the drawings or specified by the Employer. Newly placed base courses shall not be opened to traffic.

The base course material shall have a specific weight greater than 2.45 kg/dm^3 and shall conform to one of the following gradings:

A.S.T.M.Sieve designation	Percentage by Weight Passing Square Mesh Sieves								
	A	B	B-1	C	C-1	D	D-1	E	E-1
3 inch	100	-	-	-	-	-	-	-	-
2 inch	-	100	100	-	-	-	-	-	-
1 1/2 inch	-	-	70-100	100	100	-	-	-	-
1 inch	-	-	55-85	-	70-100	100	100	-	-
3/4 inch	-	-	50-80	-	60-90	-	70-100	100	100
3/8 inch	-	-	40-70	-	45-75	-	50-80	-	-
No. 4	15-45	20-50	30-60	25-55	30-60	30-60	35-65	35-65	45-80
No. 10	-	-	20-50	-	20-50	0	25-50	-	30-60
No. 40	-	-	10-30	-	10-30	0	15-30	-	20-35
No. 200	0-10	0-10	5-15(*)	0-10	5-15(*)	0 - 10	5-15(*)	0-10	5-15(*)

(*) For gradings B-1, C-1, D-1 and E-1, the fraction passing the No. 200 sieve shall not be greater than two-thirds of the fraction passing the No. 40 sieve.

If no specific grading is specified, the grading shall comply with C above.

If fine aggregate or filler in addition to that naturally present in the base-course material is necessary in order to meet the grading requirements or for satisfactory bonding of the material, it shall be uniformly blended with the base-course material at the screening and crushing plant or on the road. The material for such purpose shall be obtained from sources approved by the engineer and shall be free from hard lumps.

That portion of the base course material passing No. 40 sieve shall be nonplastic.

The base course material shall be tested for abrasion in accordance with B.S. 812 and the following maximum values shall be acceptable.

Aggregate fraction	Maximum abrasion (%)
3/4" - 1"	40
1/2" - 3/4"	35
3/8" - 1/2"	30
1/8" - 3/16"	28

Sub-base and base courses shall be placed in layers not exceeding 15 cm in thickness, after compaction. Unless otherwise specified, base course materials shall be placed only by means of spreader boxes or equivalent equipment. Placing base course materials directly by means of trucks, shovel dozers and other loading or hauling equipment will not be permitted. Blending material, where required, shall be added by means of spreader boxes or other approved equipment and the whole base course layer shall be thoroughly mixed to its full depth by means of graders, mixers or other approved equipment.

During placing and mixing, water shall be added in the amount necessary to provide the optimum moisture content for compacting.

Compaction shall be carried out in accordance with the applicable parts of Section 201.7.

Unless otherwise specified, the following densities shall be required:

- For sub-bases: 96% of the Modified A.A.S.H.T.O. Density
- For base-courses: 98% of the Modified A.A.S.H.T.O. Density

203.2 TESTING

203.2.1 Testing on fill materials

All natural fine fills shall conform to the below listed requirements:

a) Complete Identification Tests
   - Sieve analysis and sedimentometry
   - Atterberg limits (liquid limit, plasticity index, shrinkage)

b) Test on organic soils

c) Standard Proctor tests with complete determination of compaction diagram

d) Modified Proctor tests with complete determination of compaction diagram

e) CBR tests at 95% of the maximum dry density.

The number of the aforesaid tests shall be as determined by the Engineer.

203.2.2 Tests on Backfill

Placing natural fine fill shall be controlled by the Engineer in the following manner:

Three series of the following tests shall be conducted on each backfilled layer or on every 250 m^3 of placed backfills:

Measurement of moisture content

Measurement of compactness (dry density)

203.2.3 CBR tests on natural ground

CBR tests shall be conducted according to relevant standards.

The frequency of tests shall be as determined by the Engineer.

203.2.4 Tests on crushed aggregates

The required tests on crushed aggregates to be used for roads are the following:

- Measurement of the specific gravity
- Measurement of the compressive strength on 7 cm side cube
- Los Angeles test
- Sieve analysis
- tests on organic soils according to French Standards
- Measurement of the sand equivalent.

A series of tests shall be carried out on each 500 m^3 of aggregates or as directed by the Engineer.

Following are the two density control tests to be carried out on site on each placed crushed aggregate layer:

- Either on each finished layer,
- Or on each 250 m^3 of placed aggregates,

- Or as directed by the Engineer.

203.3 ROADS - METHODS OF MEASUREMENT AND PAYMENT

Unless otherwise specified, roads constructed in accordance with the Drawings or on specific instructions of the Engineer, shall be measured for payment. Access and construction roads for the Contractor's own use and reinstatement of paved areas are referred to in Subsection 201.1.8 respectively, and shall not be paid for under this division.

Unless otherwise specified, roads, shoulders and sidewalks shall be measured for payment - each separately - by m^2 of completed road shoulder or sidewalk, classified by type of surface and/or by cross-section. The unit rates shall include for all necessary earthwork; supply, hauling, spreading and compaction of all sub-base and base materials, bituminous coatings, chippings and asphalt concrete; and for all materials, equipment and labor necessary for completing roads, shoulders or sidewalks, in accordance with the Drawings and the Specification, and to the satisfaction of the Engineer.

Concrete curbstones, channels etc. shall be measured for payment in linear meters of curbstone etc. in place, classified by type and size. The unit rates shall include for supply of units and all necessary materials for bedding and support, laying and jointing. The same unit rates shall be paid for both straight and curved alignment.

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204 CONCRETE WORKS

204.1 STANDARDS, GRADES, COMPOSITION AND TYPES

204.1.1 General

This division describes the quality of materials and workmanship of concrete and reinforced concrete works cast in situ in all parts of structures below or above ground in all site locations.

The Specification shall apply to concrete prepared on site as well as ready mixed concrete and small precast concrete elements. Generally, it is based on CP 110 Part I 1972 and on BS 4881, 5328 and 5337.

In case of discrepancy or contradiction, the requirements of this Specification shall rule over any standard.

204.1.2 Standards and Codes

The current ruling Standards and Codes of Practice, detailed below, are made by reference part of this Specification.

BS	12	Portland Cement (ordinary and rapid hardening)
BS	146	Portland - Blastfurnace Cement
BS	410, 1796	Test Sieves and Test Sieving
BS	882, 1201	Aggregates from Natural Sources
BS	1305	Batch Type Concrete Mixers
BS	1370	Low Heat Portland Cement
BS	1881	Methods of Testing Concrete
BS	1926	Ready-Mixed Concrete
BS	3148	Tests for Water for Making Concrete
	4027	Sulphate Resisting Portland Cement
BS	4251	Truck Type Concrete Mixers
BS	4449	Hot Rolled Steel Bars for the Reinforcement of Concrete
BS	4461	Cold Worked Steel Bars for the Reinforcement of Concrete
BS	4466	Bending Dimensions and Scheduling of Bars for the Reinforcement of Concrete (Plain round mild steel or high yield steel)
BS	4482	Hard Drawn Mild Steel Wire for the Reinforcement of Concrete
BS	4483	Steel Fabric for the Reinforcement of Concrete
BS	5075	Concrete Admixtures
BS	5135	Metal Arc Welding of Carbon and Carbon-Manganese Steels
BS	5328	Methods for Specifying Concrete Part 1 to Part 4
PD	6440	Accuracy in Building
BS	6588	Portland Pulverised - Fuel Ash cement
BS	8007	Design of Concrete Structures for Retaining Aqueous Liquids
BS	8102	Protection of Structures against Water from the Ground
BS	8110	CP 110 Part 1 and Part 2 Structural use of Concrete
ASTM Standard C309		Liquid Membrane Forming Compound for Curing Concrete

ASTM Standard C260 Air Entraining Admixtures for Concrete

In case of discrepancy or contradiction, the requirements of this Specification shall overrule any standard.

204.1.3 Classification and Composition

Concrete of all grades shall consist of coarse and fine aggregate, cement, water and additives. Generally, the grades of concrete shall be detailed as described in the following table. However, other grades may be required in the Particular Specification.

Table 2.1 Concrete grades and Classifications

Grade/Class of Concrete Per B.S. 5328	Characteristic Compressive Strength (Kg/cm^2)	Minimum Cement Content (Kg per m^3) of Ready Concrete	Characteristic Use
C 7P	70	150	Lean Concrete
C10P C15P	100 150	200 200	Non-Reinforced Concrete
C20P C25P C30P	200 250 300	280 280 280	Reinforced Concrete
C40P C50P C60P	400 500 600	300* 300* 300*	Prestressed Concrete and Concrete for Special Purposes

* For prestressed concrete the following maximum cement contents shall not be exceeded:

Grade C40P - 375 kg per 1.0 m^3
Grade C50P, C60P - 450 kg per 1.0 m^3

The relationship between grade of the concrete and its characteristic strength shall be as given in BS 5328. The grade of concrete to be used in particular locations shall be as given in Table 2.2 unless noted otherwise on the Drawings.

Table 2.2 Concrete strength requirements

Location	Maximum Coarse Aggregate Size (mm)	Grade of Concrete (BS 5328)
Blinding Concrete - General Structures - Liquid Structures	 20 or 40 20	 C15P C20P
Blinding concrete - Sulphate Condition	 20	 C25P
Substructures thickness less than 400 mm	20	C25D
Substructures, walls and slabs more than 400 mm	20	C25D
Superstructures normal concrete	20	C25D
Liquid retaining structures	20	C35D
Fine concrete	10	C25D
Precast concrete	10 or 20	C30D

In the above table suffix P means a prescribed mix, D means a designed mix and A means a design mix complying with the requirements of BS 8007.

The specific grades of concrete to be employed in the different structures or parts of structures shall be as shown on the Drawings or indicated in the Specification Bill of Quantities. The quantity of cement in the ready concrete shall in no case be less than the minimum quantities detailed in the above table.

The Contractor shall have trial mixes for the various structures designed by an approved laboratory. The mixes shall be designed with the objective of producing concrete having suitable workability, density, impermeability and required strength.

Proportions shall be determined in accordance with the "Design of Normal Concrete Mixes" published by the United Kingdom Department of The Environment and obtainable from:

Building Research Establishment and Bookshop
Garston
Watford
WD2 7JR
ENGLAND

or other approved methods, for the requirements set out in this Specifications.

The amount of water used in the concrete shall be changed as required to secure concrete of the proper consistency and to adjust for any variation in the moisture content or grading of the aggregates as they enter the mixer. Addition of water to compensate for stiffening of the concrete before placing will not be permitted. The mix to be used in every part of the Work shall be subject to the Engineer's approval and the Engineer shall have the right to demand the mix proportions and water-cement ratio to be changed during the progress of the work if in his opinion such changes shall be necessary to secure the required quality of the concrete as detailed above.

The mix proportions shall be selected to ensure that the workability of the fresh concrete is suitable for the conditions of handling and placing, having regard to the structural element being constructed, the disposition of reinforcement, and taking full account of the environment to which it will be subjected.

The minimum cement contents and maximum water/cement ratios of designed mixes shall be as given in Table 2.3. In the event of sulphate exposure precautions requiring lower cement content than those required for normal conditions the latter requirements shall prevail.

Table 2.3 Minimum cement contents
Normal Conditions

Type of Structural Element	Exposure Conditions (BS 8110)	Minimum Cement Content (kg/m³) Maximum Aggregate Six			Maximum Water/Cement Ratio
		40 mm	20 mm	10 mm	
Liquid Retaining Structures, Shafts and Tunnel Linings	Severe	295	325	356	0.55
All Foundations and Buried Structures	Moderate	270	300	340	0.60
Building Super-Structure	Moderate	270	300	340	0.60

Additional requirements when exposed to sulphate conditions (all structural concrete)

Concentration of Sulphates		Type of Cement	Minimum Cement Content (kg/m3) Maximum Aggregate Size			Maximum Water/Cement Ratio
In Soil (Total SO_3)	In Ground Water Parts per 100,000		40mm	20mm	10mm	
< 0.2	< 30	OPC	NORMAL CONDITIONS			
0.2 - 0.5	30 - 120	OPC SRPC	300 250	330 280	370 320	0.50 0.55
0.5 - 1.0	120 - 250	OPC SRPC	Not Permitted 300	330	370	- 0.50
1.0 - 2.0	250 - 500	OPC SRPC	Not Permitted 340	370	410	- 0.45
> 2.0	> 500	SRPC	Ditto but with protective coating			0.45

204.1.4 Types of Concrete

a) Ready-Mixed Concrete

The use of ready-mixed concrete will be permitted provided the production, transportation, sampling and testing of the ready-mixed concrete shall conform to the requirements of B.S. 1926 and that the concrete meets the requirements of this Specification as to strength, cement content, impermeability and other properties. The methods and equipment used and the speed required for transporting concrete shall be such that concrete having the required composition and consistency will be delivered into the work, without objectionable segregation, loss of slump, and delay.

The Contractor shall notify the Engineer of the supplier from whom he intends to purchase the ready-mixed concrete and shall obtain the Engineer's approval in writing of such supplier. Prior to the commencement of concrete production, the Engineer shall be given notice to enable him to check the composition and cement content of the concrete about to be produced at the supplier's plant. However, the Engineer's approval of the supplier and his inspection of the concrete production shall not relieve the Contractor of his sole responsibility for the quality concrete, and the Contractor shall make good any damage and shall indemnify the Employer against losses caused by concrete not meeting the requirements of the Specification. The Engineer may at any time and at his own discretion prohibit the use of any ready-mixed concrete which in his opinion does not meet the requirements of the Specification, and in such an event the Contractor shall discontinue the use of such ready-mixed concrete and shall at no extra cost to the Employer supply concrete mixed on the site, or ready-mixed concrete from another source meeting the Engineer's approval.

b) <u>Lean, Blinding and Cyclopean concrete</u>

Concrete shall be proportioned to 200 kg of cement per 1 m^3.

Stones for cyclopean concrete shall be wetted and cleaned from any deleterious matter prior to batching. Stones with a maximum size of 20 cm and covered with concrete shall be added to fresh concrete.

The proportion of concrete shall not be less than 60% of the total volume. Stones shall not be in contact with one another, nor with the formworks or trenches sides. The minimum distance between two stones or between one stone and the side of the formwork is 5 cm. Aggregates shall not form honeycombing in the surface of concrete. Should such defect be found after the removal of formworks, the concerned parts shall be demolished and cast anew at the expense of the Contractor. Cyclopean concrete surfaces shall be thoroughly finished. The location of these types of concrete shall be indicated on the drawings. In all cases the Engineer must give his written approval for concreting.

c) <u>Porous Concrete</u>

Porous concrete is made of single-core coarse aggregates and practically no-fines. It produces a low slump and has a low water/cement ratio; just enough cement is used to bind the aggregates into a mass resembling popcorn. The ratio of aggregate to cement shall be 8:1 by volume or 10:1 by mass.

It is characterized by 20% to 35% of voids, and a high permeability allowing a free water flow.

Porous concrete will be used in hydraulic structures where drainage is desired. It is also used to allow the recharge of groundwater by water penetration through concrete.

To maintain the required permeability properties, concrete surfaces should not be stopped nor sealed. No finishing work even with a trowel shall be required. The

compressive strength of the various mix proportions vary from 3.5 to 27.5 Mpa. Drainage velocity ranges between 100 and 900 liters/mn/m^2.

The concrete shall be mixed by machine or by hand to a uniform color and consistency before placing. The quantity of water used shall not exceed that required to coat all of the aggregate particles without forming excess grout.

d) Shotcrete concrete

Shotcrete concrete shall be mortar or concrete conveyed through a hose and pneumatically applied using either the dry mix process or the wet mix process.

The dry mix process shall consist of thoroughly mixing a proportional combination of dry fine aggregate and portland cement; conveying the mixture through a delivery hose to a special nozzle where water is added and mixed with the other materials immediately prior to its discharge from the nozzle. The wet mix process shall consist of premixing by mechanical methods a proportional combination of portland cement, aggregate, and water required to produce mortar or concrete; conveying the mortar or concrete through the delivery hose to the special nozzle where additional compressed air is added at the nozzle prior to discharge.

Shotcrete proportions shall be selected that allow suitable placement procedures using the delivery equipment selected and shall result in finished in place hardened shotcrete meeting the required strength.

The surfaces on which shotcrete is to be placed shall be finely graded to the lines and grades shown on the drawings. The surfaces shall be thoroughly compacted and shall be uniformly moistened so that water will not be drawn from the freshly placed shotcrete.

e) Chuted concrete

Chuted concrete is a plain concrete to which is added at the end of mixing a superplasticizer giving it a flowing consistency (slump at Abram's cone test = 20 to 24 cm). This concrete is especially used for heavily reinforced reservoirs or those having complex shapes. However, the following precautions should be taken:

- Check beforehand the efficiency of the superplasticizer (plasticity modification, effect on strength, duration,...)
- Mix concrete as close as possible to its final position, since this type is more prone to segregation than plain concrete.
- Use resistant formworks because chuted concrete transmits pressures (height of concrete in formworks) better than plain concrete (reduced internal friction).

f) Fibre concrete

General

Fibre concrete contain appropriate quantities of metallic fibres as to form a composite and homogeneous mixture and shall be designed according to British Standard.

The main characteristics of metallic fibre concrete are:

- Strong cohesion which gives a high strength to shocks.
- Important ductility with small cracks (< 8mm) which reduces construction cracks.
- Resistance to rupture.

Materials

Metallic fibres are machined directly from the steel slab. They are triangular, twisted, curved and have a smooth side and a rough side.

Fibres shall be stored in a dry place.

The percentage of fibres shall vary between 20 and 40 kg per cubic meter of concrete.

Cement shall be chosen according to BS 12.

Granular materials shall comply with BS 882.

Sand shall be graded 0 to 3mm or 0 to 5mm and contain 15% of fines (≤ 0.315mm). Grading shall be continuous as far as practicable with a maximum grain size of 25mm.

The water shall comply with BS 3148.

Addition of water on site shall not be permitted.

The admixtures permitted to be used with fibre concrete are:

Super Plasticizer
Super Plasticizer are used to increase the workability of fibre concrete, at the time of placing without addition of water.

Plasticizers-water reducers
They are used to increase the plasticity of concrete (especially pumped concrete) at a constant quantity.

Prior to adding fibres, concrete shall have an ultimate bending-tensile strength equal to 3.4 MPa, in order to allow the good anchoring and performance of fibre.

Concrete fluidity shall be measured by the Abram's cone (slump test).

Fibres decrease greatly the workability of concrete. Therefore, fluidizers shall be added directly on site in the truck mixer in order to facilitate placing while the water/cement ratio is kept constant.

Two types of concrete may be used:

1) Chuted concrete

This is the best solution.
Slump:

a)	Prior to adding fluidizers	:	4 to 6 cm
b)	After adding fluidizers	:	15 to 18 cm
c)	After adding fluidizers and fibres:		10 to 14 cm

Chuted concrete allows to decrease the quantity of water (0.4 ≤ W/C ≤ 0.5), and, therefore, develops good mechanical resistances and ensures a considerable workability.

Fluidizers shall be added on site.

2) Plasticized concrete

Slump:
a) Prior to adding fibres : 9 to 12 cm
b) After adding fibres : 6 to 8 cm

Plasticized concrete requires no addition of water on site. Given its low workability, it is difficult to place this type of concrete.

The performance of metallic fibre concrete is measured by the ultimate tensile bending strength test after 28 days. The average common performances are tabulated hereunder:

Proportion	20 kg/m³	25 kg/m³	30 kg/m³	35 kg/m³	40 kg/m³
Performance MPa (maximum stress)	4	4.5	4.9	5.2	5.5

Placing

Fibres shall be mixed directly with concreted without forming "urchins".

No "dosing-untangling" device shall be needed.

Placing shall be done:

- either, in the truck mixer on site, with an additional mixing of 6mm at 14 r.p.m.
- or, at concrete factory with aggregates or, at the end with an additional mixing of 4mm.
- or, in the concrete mixer on site, with an additional mixing of 6mm.

The concrete should be adequately consolidated. The vibration method is conditional upon the type of concrete.

- Chuted concrete requires almost no vibration. It is placed by means of vibrating rulers or even without any external vibration (eveness is controlled by a laser level).

Chuted concrete allows concreting large surfaces without any construction joints.

- Plasticized concrete or admixtures free concrete shall be consolidated by means of a vibrating ruler.

In the event of fair-faced concrete surfaces, fibres shall be properly integrated in concrete though adequate mechanical or manual troweling.

No particular precautions are required for other traditional finishings (sprinkling, incorporated or added finish). A curing product shall be applied to the finished surface of concrete slab to prevent rapid desiccation.

Should surfaces be painted, concrete may be cured by sprinkling with water.

Joints shall be formed in fibre concrete. However, given the plasticity and coherence of this type of concrete, it is preferable to place it continuously and, then, form contraction joints by sawing.

Joints are formed each 8m x 8m outdoors or in non covered surfaces (at the time of execution) or each 10m x 10m, and even 12m x 12m indoors. In the latter case, the proportion of fibres shall be 30 kg/m^3).

1. Construction joints
   They shall be either keyed or dowelled, with or without angle iron. However, chuted concrete allows the concreting of large surfaces without needing to form construction joints.

2. Contraction joints
   Joints are sawn over ¼ of the thickness minimum.

3. Separation joints
   Joints shall be formed around hard zones: stringers, footings, columns.

4. Expansion joints
   Expansion joints shall be avoided, as far as practicable, in covered slabs where no major temperature variations are observed.

Design of concrete pavement

According to each case, the Engineer shall determine the sizing of works.

- Westergaard modulus of subgrade reaction
- Exact definition and location of applied loads.

The maximum strengths used for calculation of concrete are conditional upon the proportion of reinforcing fibres and tabulated hereunder:

Proportion	20 kg/m^3	25 kg/m^3	30 kg/m^3	35 kg/m^3	40 kg/m^3
Allowable σ (MPa)	2.8	3.2	3.5	3.7	3.9

Controls

The user of metallic fibre concrete shall establish a self-control procedure concerning the following:

1) Taking over of support ground

The user shall take over the foundation ground in order to make sure that the slab is homogeneous and true to the adopted assumptions.

(Westergaard modules > 30 MPa/m = 3 bar/cm)

A membrane may be placed to prevent contamination with fine particles especially in silty soils or saturated with water.

It may be necessary to insert a polyethylene sheet (150 microns minimum thick) between the foundation ground and the slab to:

a) separate the slab from the foundation ground and facilitate sliding
b) avoid infiltration of water or laitance into the foundation ground.
c) avoid rising of underground water

2) Concrete quality

The user shall check the composition of concrete at the time of manufacture in the batching-mixing plant or when delivered on site, and make sure that grading curves are consistent with the present technical specifications document.

The user shall check the workability of the various types of concrete mentioned above through a slump test prior to and after placing of fibres.

According to the placement method, the user shall carry out a self control on the quantity of used fibres with regard to the volume of placed concrete, and verify that concrete is free of "urchins".

3) Mechanical strengths

Verifications shall be performed according to "the Professional Rules for Pavement Works". The user shall namely verify:

- Quality of plain concrete (tensile bending strength ≥ 3.4 MPa)
- Mechanical strength of concrete; the performances level defined above being checked out.
- Tests shall be carried out on prismatic samples 4cm x 14cm x 56cm
- Such verifications shall be carried out:
- at the concrete factory during the self control. The proportion of added fibres shall be determined on the delivery notes.
- and, on site, by the Contractor, prior to placing concrete as per the Technical Specifications.

Workmanship

The works shall be carried out by the Contractor. The Contractor shall comply with the technical specifications and the Special Specifications provided by the manufacturer.

The pavement slab shall not be used before:

48 hours after placing concrete for light pedestrian traffic
7 days after placing concrete for light traffic
28 days after placing concrete for normal traffic.

All workmanship details shall be in accordance with the requirements of all concrete sections mentioned in these specifications.

204.2 MATERIALS FOR CONCRETE

202.1.1 Cement

Cement shall comply with one of the following sub-Clauses (i) to (iv) below:

(i) BS 12 (Ordinary and rapid-hardening Portland cement).

(ii) BS 146 (Portland-blastfurnace cement).

(iii) BS 4027 (Sulphate resisting Portland cement).

(iv) BS 6588 (Portland pulverised-fuel ash cement) provided that sub-Clause (vii) below is complied with.

(v) A mixture of BS 12 (Portland cement) and BS 3892: Part 1 (Pulverised-fuel ash for use in structural concrete) provided that the amount of pulverised-fuel ash is not less than 15% nor more than 35% by weight of the total cement and sub-Clause (vii) below is complied with.

(vi) A mixture of BS 12 (Portland cement) and BS 6699 (Ground granulated blastfurnace slag for use with Portland cement) provided that the amount of slag is not more than 65% by weight of the total cement.

(vii) The pulverised-fuel ash used shall have a maximum colour index of 6 (Colour Comparator disc reference No. 296570) when measured using the Lovibond Colour Comparator system as recommended in BS 3892: Part 1 Appendix H, Clause H8.

The Concrete Cement used for Concrete Structure in contact with wastewater shall be Sulphate resisting Portland Cement and in accordance with BS 4027.

Consignments of any cement shall be used in the order in which they are received. Any cement stored on the site over three months may be rejected by the Engineer. Should the quality of the cement be adversely affected by dampness or any other cause the cement shall be removed from the site.

Each shipment of cement shall be stored so that it may readily be distinguished from other shipments. The cement shall be free form lumps and shall be otherwise undamaged when used in concrete.

Sacked cement shall be delivered to the Site in the sound original bags of the manufacturer and shall be stored in a watertight and weatherproof shed on a floor raised at least 15 cm from the ground. Stacking cement bags to excessive heights they may cause damage to cement or is otherwise undesirable, as determined by the Engineer, will not be permitted.

Bulk cement shall be stored in weatherproof bins or silos to be approved by the Engineer. The bins shall be emptied and cleaned at reasonable intervals as directed by the Engineer.

The quality of each consignment of cement shall be verified by manufacturers' certificates showing the results of tests, as per B.S. 12, appropriate for cement to be used in tropical climates. Where the Engineer so orders, the Contractor shall perform at his own cost additional tests on samples selected by the Engineer, all in accordance with B.S.12.

202.1.2 Water

The water used for mixing concrete shall be of potable quality, free form harmful materials such as clay, loam, acids or trade effluent. River water may be used after its suitability is ascertained beyond doubt by tests according to B.S. 3148. Periodic tests shall be carried out to keep a continuous check on the suitability of such water. The source of the water shall be subject to the Engineer's approval.

202.1.3 Admixtures

Usually the water proof concrete specifications are written aiming to achieve a watertight concrete structures.
But practically the concrete can sometime be very difficult to place.

If agreed by the Engineer, the contractor will be permitted to use concrete with more plastic consistency helping to produce a smoother and denser floor and wall finishes requirements.

In heavy reinforced structures, a good and long workability is also important.

It is impossible to meet the water/cement ration > 0.5 and a good workability requirements at the same time unless concrete admixtures are used.

Contractor may use admixtures and shall use if required by the Engineer admixtures such as:

- Retarder
- Accelerator
- Plasticizer or super plasticizer
- air entraining agent
- water proofing admixtures
- Fluid admixtures
- Anti freeze admixtures

Plasticizer and super plasticizer gives good workability and correct consistency (even for pumped concrete with extended working times) to enable the concrete to be compacted as fully as possible in as short a time as possible with a high reduction in the water/cement ratio.

Retarder

- By the use of suitable retarder the Contractor must obtain that the start of the setting process be delayed from a few hours to a day or more.
- This will permit to fresh concrete to be transported, poured and vibrated over longer periods of time.
- The controlled retardation of the initial set, must not be in no way slow down the subsequent hardening process.
- The period of time during which the concrete can still be vibrated is known as the retardation time.
- The choice of retarder dosage will be made by referring to the dosage chart of the furnisher, preliminary trials may be asked by the Engineer to acertain the correct dosage for planned retardation.
- Dosage can varies with the type of structure (foundation slab or walls...) and with temperature (ambient air and/or concrete) the Contractor must consult with the

Engineer to either avoid construction joints (cold joints) or to work out a concreting schedule where entire mass of concrete is required to set simultaneously.

Water proofing concrete admixture
A concrete admixture in liquid or powder form can be used by the Contractor as highly efficient water proofing principal agent with a secondary function as plasticizer.

The dosage will correspond to % of the weight of cement.

The admixture must be compatible with the type of cement.

The admixture will be dispensed directly into the mixing water (liquid admixture) prior to its addition to the aggregates /or/ added directly to the dry mixed aggregates.

Other Admixtures
The Contractor will relate to the technical specifications of the admixtures Supplier. Admixtures that contain chlorine will be forbidden.

Admixtures used shall be furnished by the Contractor and the cost of the materials and all costs incidental to their use shall be deemed to be included by the Contractor in his unit rates for concrete and shall not be paid for separately.

202.1.4 Aggregates

Fine and coarse aggregates shall be as defined by and be of the quality and nature required by BS 882 and BS 1201 whichever is applicable. In addition they shall be chemically inert to alkali reaction.

Prior to acceptance of an aggregate as inert to alkali reaction the report of a qualified geologist, appointed by the Engineer on the suitability or otherwise of materials shall be obtained following examination of all types of material that the proposed sources will yield during the course of the contract. The Engineer may require that samples be taken from boreholes and for large contracts or contracts extending over a long period then more than one report is to be obtained.

Aggregates shall conform to the requirements of the "Acceptance Standards" of Table 2.4.

Table 2.4 Sampling, Testing and Acceptance Standards

Materials	Test	Site Sampling	Testing	Accepted Standards	Remarks
1	2	3	4	5	6
CEMENT	Ordinary Portland Rapid Hardening Sulphate Resisting		 BS 4550	BS 12 BS 12 BS 4027	Manufacturer's Test Certificates
AGGREGATES	Description and Classification		BS 812 Section 2	BS 882	Whichever is applicable
	Particle size	BS 812 Sec.1	BS 812 Sec.3	BS 882	)
	Particle Shape	BS 812 Sec.1	Visual & BS 812 Sec.3		)) Mix Design
	Sp. Gravity	BS 812 Sec.1	BS 812 Sec.3		) Requirements
	Density	BS 812 Sec.1	BS 812 Sec.3		)
	Voids	BS 812 Sec.1	BS 812 Sec.4		)
	Absorption	BS 812 Sec.1	BS 812 Sec.4	BS 8007 Cl. 6.2.2.	See Freeze-thaw Test in this Table
	Organic Impurities	BS 812 Sec.5			
	Moisture Content	BS 812 Sec.5			For adjustment of added water for concrete making
	Mechanical Properties	BS 812 Sec.6	BS 882		Ten per cent fines value
WATER	Suitability	BS 3148	BS 3148	BS 2138	Not required for potable water
CONCRETE	Compacting Factor Slump	BS 1881 Pt 101	BS 1881 Pt 103 BS 1881 Pt 102		)) Workability Test))
	Crushing		BS 1881	BS 5328, BS 8110	Cube test
	Water Absorption		BS 1881 Pt 122	BS 340 Para 19 (b)	Precast concrete Cl. 3.8
	Freeze-thaw	BS 1881			Durability test for aggregate not complying with moisture absorption requirements of BS 5337 Cl, 21.2
	Electrolytic Efflorescence				As required for salt containing aggregate or saline water
	Cores	BS 1881 Pt 6 BS 1881	BS 1881 Pt 6 BS 1881	BS 1881 Pt 120 with strength specified on drawings	
ADMIXES with cement	Compatibility by Laboratory	As required			Tests to be carried out by independent Laboratory as required.

(a) General:

Aggregates for concrete shall be fine aggregate and coarse aggregate and shall be supplied by the contractor from approved sources, but the approval of any source by the Engineer shall not be construed as approval of all materials taken from that source, and the Contractor will be held responsible for the specified quality of all materials used in the work and for their being equal to the approved samples.

The Engineer, at the Contractor's expense, will test the aggregates and the Contractor shall provide such facilities as may be necessary for procuring representative test samples. The Contractor shall submit, for preliminary tests and approval, representative samples of 100 kg each of fine aggregate and of each

size of coarse aggregate proposed for use in the work at least 30 days before the aggregates are required for use.

Should the Engineer reject any sample furnished by the Contractor, the Contractor shall immediately supply a sample or samples from some other source until all samples are approved by the Engineer.

Those samples which have been finally approved by the Engineer as meeting the requirements of the Specification shall be kept on the Site until the completion of all concrete work and all aggregates brought to the Site shall be compared with such approved samples.

Any aggregate rejected by the Engineer shall be immediately removed from the Site, unless the Engineer shall permit its use after undergoing further treatment by washing and or screening in order to bring it up to standard.

The aggregates shall be brought to the Site in separate loads, each containing aggregates of one size. The aggregates shall be stored in such a way as to prevent aggregates of different sizes from being mixed together in storage. Aggregates mixed either in transport or on Site will be rejected.

(b) Fine Aggregate:
Fine aggregate for concrete shall be natural sand (but not beach sand) or a mixture of natural sand and fine crushed stone. It shall meet the requirements of B.S. 882 and its grading shall be within the limits of one of grading zones 1, 2 or 3 given in Table 2 of B.S.882. In addition, it shall have a specific gravity of not less than 2.5, shall not contain more than 5 percent by volume of shells or shell fragments. The fine aggregate delivered to the batching plant shall have a uniform and stable moisture content.

When necessary, or when required by the Engineer, all fine aggregate shall be washed in clean water, before being incorporated in the Works.

(c) Coarse Aggregate:
The coarse aggregate for concrete shall be natural gravel or crushed stone. It shall consist of hard, dense, durable uncoated rock fragments and shall meet the requirements of B.S. 882.

Coarse aggregate for reinforced concrete shall be either graded aggregate or made up of a number of single size aggregates, with the largest particles not exceeding the following sizes:

(a)40mm, or
(b)1/3 of the smallest thickness of concrete members, or
(c)3/4 of the smallest space between reinforcement bars, whichever is the smallest.

Coarse aggregate for non-reinforced concrete may contain particles up to 3"

The grading of coarse shall lie within the limits given in Table 1 of B.S. 882. The exact sizes of the coarse aggregate and the grading to be used shall be determined as part of the mix design in accordance with Subsection 202.1.3.
All aggregates shall be approved by the Engineer.

204.3 BATCHING AND MIXING

204.3.1 Batching

The Contractor shall provide equipment and shall maintain and operate the equipment as required to accurately determine and control the amount of each separate ingredient entering the concrete. For concrete Class C20P and higher, the amounts of sand, bulk cement and each size of coarse aggregate entering each batch of concrete shall be determined by weighing, and the amount of water shall be determined by weighing or volumetric measurement. Where sacked cement is used, the amount of cement entering the mixture shall be determined on the basis of integral sacks of cement and the use of cement from torn bags shall not be permitted.

For concrete Class C15P and lower, the Engineer may permit volumetric measurement of aggregates.

All weighing equipment shall be subject to the Engineer's approval. An accuracy to within 0.4 percent of the scale capacity will be satisfactory, and the equipment shall be capable of ready adjustment for compensating for the varying weight of any moisture contained in the aggregates and for effecting changes in concrete mix proportions. The Contractor shall make such adjustments, repairs, or replacements as may be necessary to meet the specified requirements for accuracy of measurement. Each dial, indicator and other measuring device shall be in full view of the operator.

Where batching by volume is permitted by the Engineer, only precisely dimensioned gauge boxes approved by the Engineer shall be used for the sand and different sizes of aggregates. After filling the box the aggregate shall be struck off level with the brim. Sand shall be poured or shovelled into the gauge boxes without compacting. All gauge boxes shall bear marks in red oil paint showing the kind and size of aggregate for which each box is to be used. No boxes similar in shape and appearance but different in volume from the approved gauge boxes shall be kept on the Site.

204.3.2 Mixing

The materials shall, unless otherwise directed by the Engineer, be mixed in approved mechanical batch mixers. In each case, the number and capacity of mixers employed shall be sufficient for the concreting operations being undertaken, shall allow for sufficient reserve capacity at all times and shall be subject to the approval of the Engineer.

The mixing shall continue until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall the mixing be for less than 2 minutes after all the ingredients are in the mixer. Water shall be added prior to, during and following the mixer-charging operations. Overmixing requiring the addition of water to preserve the required concrete consistency will not be permitted.

No dry material shall be introduced into a mixer until all material from the previous batch has been removed and the interior of the mixing drum has been cleaned of encrustations of concrete or mortar. Remixing of concrete or the addition of water to a mixture that has already begun to set or that is otherwise unsuitable for casting shall not be permitted and such concrete shall be wasted. When a concrete mixer has been out of use for more than 20 minutes, or when the type of cement is changed, the mixer shall be thoroughly cleaned before a fresh batch of concrete is made in it.

The Engineer may in exceptional cases permit hand mixing of lean and other non-reinforced concrete. No hand mixing shall be done unless authorised in writing by the Engineer. The batches in hand mixing shall not exceed 1/6 of a cu.m. Hand mixed concrete shall not be used until the mixing of the whole batch has been completed and the concrete is of uniform colour and consistency. Hand mixing shall be done twice on dry aggregate, and at least twice wet, on a clean and even surface, which will prevent the loss of water during mixing. The water added shall be measured in order to prevent the use of an excessive quantity of water.

When mixing by hand, the quantity of cement shall be increased by 10% above that specified above in Section 202.3.

204.4 PLACING AND CURING

204.4.1 Preparations for Placing

No concrete shall be placed until the Engineer has approved the formwork and reinforcement. The Contractor shall give at least 48 hours notice to the Engineer of the times he proposes to concrete and no concreting shall take place unless either the Engineer or his Representative is present.

Concrete shall be placed only in the presence of the Engineer or his duly authorized Representative, unless written permission has been given by the Engineer to place concrete without himself being present or represented. The Contractor shall give the Engineer not less than 48 hours notice before the day on which he intends to commence placement of concrete in any structure or substantial part thereof.

No concrete shall be placed until all reinforcement, formwork, parts to be embedded, and preparation of surfaces involved in the placing have been approved.

All surfaces of forms and embedded materials shall be clean and free from dried mortar which may have encrusted them from previously placed concrete.

All surfaces of foundations and areas upon or against which concrete is to be placed shall be free from standing water (except for concrete required to be placed under water), mud, debris, oil, objectionable coatings and loose, semi-detached or unsound fragments. Absorptive surfaces shall be moistened thoroughly so that moisture will not be drawn from the freshly placed concrete. On surfaces of rock upon or against which concrete is to be placed, a 2 cm layer of 1:3 cement mortar shall be spread immediately prior to placing concrete and shall be well worked into the surface with the aid of brushes. Care shall be taken that the mortar does in no case set before concrete is placed on it. The cost of such mortar and its spreading shall be deemed to be included in the rates for concrete.

204.4.2 Transporting and Placing

The methods and equipment used and the speed required for transporting concrete shall be such that concrete having the required composition and constancy will be delivered into the work, without objectionable segregation, loss of slump, and delay. Except as otherwise specified for ready-mixed concrete, the time elapsed between the first wetting of concrete ingredients and the completion of placing the concrete in the work shall in no instance exceed 30 minutes. Retempering of concrete will not be

permitted. Any concrete which has become so stiff that proper placing cannot be assured shall be wasted.

Concrete shall be deposited as far as practicable directly in its final position and shall not be placed in a manner permitting or causing segregation. The Contractor shall provide suitable openings in the formwork and/or drop chutes and baffles to confirm and control the falling of concrete, and to limit its free drop to a maximum of 1.50 meters.

Except as intersected by joints, all formed concrete shall be placed in continuous approximately horizontal layers, the depths of which shall not exceed 60 cm, in such a manner that no layer of concrete will begin setting before the next layer is placed on top of it. In no case shall the delay between the placing of any two adjacent layers be such that the vibrating unit will not readily penetrate of its own weight the concrete placed before the delay.

Concreting shall be carried out continuously between and up to joints, the position and arrangement of which shall be predetermined and no interruption of placing other than at these joints will be permitted. To this end, the Contractor shall take all necessary measures, such as preparing a sufficient stock of materials, stand-by equipment, shift-work, lighting for night-work, etc.

In the event of unavoidable stoppage in positions not predetermined, the concrete shall be terminated on horizontal planes and against vertical surfaces and construction joints shall be prepared according to Subsection 202.5.1. Where required the Contractor shall also provide keyways, dowels, and/or waterstops to ensure a perfect bond and/or watertightness at the joint.

Where the concrete abuts against earth or any other material liable to become loose, the greatest possible care shall be taken to avoid falls or run of such or other materials upon the surface of the concrete, and if any such falls or runs occur the surface of the work soiled thereby shall be removed until a new and clean surface shall have been obtained, and all spaces left by such falls or runs beyond the prescribed dimensions of the work, or caused by the negligence or for the convenience of the Contractor, shall be built up with concrete at the dimensions of the work, or caused by the negligence or for the convenience of the Contractor, shall be built up with concrete at the discretion of the Engineer, and the additional cost so incurred shall be held to be included in the Contractor's rates in the Bill of Quantities for work within the original Contract limits.

No concrete shall be placed in water, except with the written permission of the Engineer, and the method of depositing the concrete shall be subject to his approval. Concrete shall not be placed in running water and shall not be subjected to the action of running water until after the concrete has hardened.

Surfaces of rock upon or against which concrete is to be placed, shall be prepared and cleaned as specified and placing of concrete shall be carried out as detailed below for construction joints.

No concrete shall be placed when the ambient temperature at the time of placing and/or 2 hours thereafter is expected to be below 4°C. The temperature of the concrete when being placed shall not exceed 32°C.

In hot weather when the temperature of the concrete is liable, in the opinion of the Engineer, to rise above 32°C, the Contractor shall, at his own expense, employ effective means, to the satisfaction of the Engineer, for reducing the temperature in

the mix, such as sprinkling of water on the aggregate, protection of the water lines from the sun, painting of mixers and water tanks with light-reflecting paint and/or placing them in shadow, or by adding crushed ice to the water in a proportion not exceeding 50% of the water. The addition of ice will be permitted only if it has been proved to the satisfaction of the Engineer's Representative that all other means for the reduction of temperature are insufficient.

1) Hot weather concreting

Heat accelerates the hydration reaction of cements, thus it increases the heat of hydration and accordingly, shrinkage and cracks are likely to occur. It is necessary to abide by the following measures:

a) Use concrete as compact as possible.
b) Use cement of low heat of hydration.
c) Reduce the cement dosage as far as practicable according to the requested characteristics of concrete.
d) Use a water reducing plasticizer in order to reduce the quantity of mixing water (0.5 to 0.75 in weight of cement).
e) Use a setting retarder which increases the heat of hydration time.
f) Cool concrete constituents. This is an expensive method, but gives the best results.
g) moisturize the hardened concrete on which fresh concrete shall be placed in order to avoid loss of water.
h) Cover the structures after concreting, in order to prevent water evaporation from fresh concrete.
i) Use Antisol-E which protects concrete from desiccation (suppress the use of damp coverings, watering, etc...).

2) Cold weather concreting

When concreting in cold weather, and in order to prevent having a frozen and porous concrete, plasticizers and water reducing admixtures shall be used to reduce the quantity of mixing water, while preserving the workability of fresh concrete at an acceptable degree.

Low temperature slows down the reaction of hydration of cement and therefore, delays formworks removal. The following precautions shall be taken:

a) Use a quick setting cement
b) Increase the C/W ration (plasticizer - water reducer)
c) Heat the materials (water + aggregates). However, the temperature of concrete shall not exceed 30°C.
d) Use isolating formworks (wood, panels coated with expanded polystyrene, etc..)
e) Protect fresh concrete with thick dry covers.
f) Heat concrete eventually (hot formworks).
g) Use antifrost products (1% in weight of cement).

No concrete shall be placed when the ambient temperature is -0°C.

Placing concrete at a temperature below + 5°C is allowed provided that the above mentioned precautions are respected and upon the prior approval of the Engineer.

3) Concreting under water

When fresh concrete is to be placed under a water in motion (currents, waves,...) adequate measures shall be taken to prevent the washing out of concrete and carrying away of mortar.

Concrete shall be conveyed via a tight chute avoiding the contact of concrete with water and placed inside an underwater formwork. In this way, only the upper section of concrete shall be wasted out and it is removed once hardened by a pneumatic drill.

While concreting, the Contractor shall control the height of concrete at the bottom of the formwork and in the chute as well as the length of chute entering in the poured concrete mass in order to prevent any sudden depositing of concrete which might cause water intrusion and stoppage of work. Throughout concreting works, the chute shall be raised progressively.

4) Concreting under sea water

Sea water has two major effects on works:

a) Dynamic effect of waves
b) corrosive effect of salt on concrete and reinforcing bars.

Structures shall be oversized and designed to have high strength. Massive elements shall be concreted. Thin walls and frail beams are to be avoided. A thick sufficient cover of a compact concrete shall be provided around reinforcement in such a way as to ensure waterproofness and avoid capillary attraction.

The cover shall be at least equal to 4 cm, and may be increased if this minimum distance cannot be ensured in all points. Concrete shall be richly batched with a minimum cement proportion of $c \geq \frac{700}{\sqrt[5]{D}}$

Sulfate in sea water reacts with tricalcic aluminate in cement and form Candlot salt which attacks concrete. Therefore, a sea water concrete containing a high proportion of clinker cement shall be used in lieu of Portland cement.

Sharp arises and peaks which are attacked easily by sea water shall be bevelled and their angles rounded off. While placing, segregation and excess water which increase porosity and contraction shall be avoided. A plasticized concrete shall be preferably used provided it does not have a too high slump and can be adequately consolidated by a proper vibration.

The external surface of concrete shall not receive any further treatment like roughening, sandblasting, washing... As far as practicable, concreting shall not be interrupted. Should stoppages be unavoidable, the surfaces of joints shall be rendered with an epoxy based mortar or Thiokol.

The cost of all work described in this Subsection shall be deemed to be included by the Contractor in his unit rates for the various items of concrete work in the Bill of Quantities and shall not be paid for separately. The Contractor shall not be entitled to any additional payment over the rates bid for concrete by reason of any limitations in the placing and concreting required in this Subsection.

204.4.3 Consolidation of Concrete (Vibration)

Each layer of concrete shall be consolidated to the maximum practicable density, so that it is free from pockets of coarse aggregate and closes snugly against all surfaces of forms and embedded materials.

Concrete Class C15P and less may be consolidated by spading, hand-tamping, or by mechanical vibration as described below. All concrete Class C20P and higher shall be consolidated by power-driven immersion ("needle") type vibrators having a frequency of not less than 9000 oscillations per minute. The vibrators shall be inserted into the concrete at intervals not exceeding 50 cm and shall be allowed to penetrate and revibrate the concrete in the upper portion of the underlying layer.

On slabs not exceeding 25 cm in thickness the use of flat surface tamping vibrators with a frequency of not less than 5000 oscillations per minute will be permitted, provided that it is supplemented by immersion vibrators adjacent to the forms and to concentrations of reinforcement bars.

On walls not exceeding 20 cm in thickness external vibrators, fixed to the forms, will be permitted. External vibrators shall be raised in lifts as the filling of the forms proceeds each lift being not more than the height of concrete visibly affected by the vibration. They shall be placed horizontally, at distances not greater apart than the radius through which the concrete is visibly affected.

The types, sizes and numbers of vibrators shall be subject to the approval of the Engineer.

At least one stand-by unit of each vibrator type and ample spare parts for all types employed shall be available on Site during placing of concrete to ensure continuous placing with no stoppage due to breakdowns.

The vibrators shall be applied in each position for as long as required for the concrete to become uniformly plastic and shall be withdrawn as soon as water appears on the surface. Systematic spacing of insertion of the vibrators in the concrete shall be established to ensure that no concrete remains unvibrated. Care shall be exercised to avoid contact of the vibrating heads with the surfaces of the forms and the reinforcing bars or other embedded material. The vibration shall everywhere be supplemented by hand spading. Vibration shall never be used to cause concrete to flow in a lateral direction, as this will lead to segregation.

The cost of all consolidation shall be deemed to be included in the Contractor's rates for concrete.

204.4.4 Curing of Concrete

From casting until the end of the specified minimum curing period, the concrete shall be kept constantly moist and adequately protected against damage due to fluctuation in surface temperatures. Immediately after casting, the exposed surface of the concrete shall be covered to prevent drying and to minimize temperature variations, until the commencement of curing at an age of not more than 20 hours. Curing of formed surfaces shall commence as soon as the formwork is removed. During curing the concrete shall be kept suitably moist by:

1. Direct application of water at ambient temperature, e.g. by spray or by ponding, or,
2. Covering with absorptive material, e.g. sand or hessian, kept constantly damp. Ventilation of any gap between the material and the concrete should be prevented so as to maintain near saturated conditions in the air within the gap, or
3. When specifically permitted in writing by the Engineer, by sealing the surface of the concrete, before it has lost any of its original water by evaporation, by means of a sealing membrane which will effectively prevent any loss of water from the concrete. The sealing compound shall be white-pigmented and shall conform to Standard Specification for Liquid Membrane forming Compound for Curing Concrete, ASTM Designation C309 latest edition, or to another standard acceptable to the Engineer. The type and make of sealing compound and its form of application and use shall be subject to the approval of the Engineer. Membrane curing shall not be used on surfaces upon or against which concrete is to be cast or which are to be plastered or painted.

The cost of curing shall be deemed to be included by the Contractor in his unit rates for concrete and shall not be paid for separately.

204.5 TESTING OF CONCRETE

204.5.1 General

Prior to the commencement of work, trial mixes shall be prepared and preliminary tests for workability, compressive strength and impermeability (where required) will be made at an authorized laboratory. The results of these tests will be used in specifying the mix design to be used by the Contractor. During the progress of work, daily slump tests will be made to ensure that the concrete is dense and of an adequate workability.

With the commencement of concrete placement and on each day concreting, samples shall be taken for testing for compressive strength at the ages and frequencies as prescribed hereafter. Where required, samples shall be taken for impermeability tests. The Engineer shall determine the elements from which concrete samples shall be taken for testing.

204.5.2 Slump Tests

The slump measured in accordance with B.S. 1881 shall not exceed 5 cm in concrete for foundations and horizontal or inclined slabs and shall not exceed 10 cm in other parts of the structures, unless otherwise specified or directed by the Engineer. Slump tests shall be made as directed by the Engineer.

204.5.3 Compressive Strength Tests

For testing the compressive strength of concrete, samples of fresh concrete shall be taken and used for preparing test cubes. The cubes shall be tested for compressive strength after 7 days and 28 days. The dimensions of the cubes and the methods of sampling and testing shall be in accordance with B.S. 1881. The cubes shall be marked and dispatched to the laboratory according to the instructions of the Engineer and at such intervals as may be specified by him.

Unless otherwise specified or directed by the Engineer, at least three samples shall be taken from different batches on the same day of casting. Out of every sample, at least two test cubes shall be prepared for testing at 7 and 28 days, respectively. The number of samples taken from hardened concrete which for any reason was not taken while the concrete was fresh or of which the strength obtained did not meet the requirements, and taking and testing of such samples shall be in accordance with B.S. 1881.

The average strength of the cubes or more tested at each age may be taken as the works cube strength of the concrete. This works cube strength may be accepted as complying with the specified requirement for works cube strength, if none of the compressive strengths of any of the cubes is below the specified works cube strength, or if the average strength is not less than the specified works cube strength and the strength of the weakest cube is not less than that listed in the following table. The table details the required cube strengths of work cubes and trial mixes for the various grades of concrete.

Compressive Strength Requirements (for all types of Concrete)

Grade	Characteristics compressive strength (kg/cm²)	Cube strength at 28 days (kg/cm²) **		
		Works cubes *		Trial mixes *
		Average	Weakest Cube	Average
C10	100	133	85	
C15	150	200	128	215
C20	200	275	170	315
C25	250	325	213	365
C30	300	375	255	415
C40	400	475	340	515
C50	500	575	425	615

* Strength requirements may be adjusted in accordance with CP110, if and as detailed in the Particular Specification.

** Concrete may be provisionally accepted on the basis of the days' cube strength, provided the average strength is at least 70% of the required 28 days strength and provided 28 days' cubes will be tested and will meet the requirements.

If for any part of a structure the works cube strength does not reach the required values at the age of 28 days, or if the concrete has hardened and samples have not been taken while the concrete was still fresh, the Engineer may permit the cutting of at least six cylinders out of the same part of the structure, and the cylinders shall be tested in accordance with the requirements of B.S. 1881. The concrete shall be deemed to comply with the specification if its strength, as deduced from the cylinder tests, meets the compressive strength requirements detailed in the above table and the results of the previous samples shall not be taken into account. Should the concrete also fail to meet the requirements in the testing of the cylinders as above, all the concrete from which the samples have been tested will be considered defective. In such a case, the Engineer may at his own sole discretion, order the carrying out of additional tests by any method he may deem fit, and if such additional tests show the concrete meeting the requirements he may accept it. Should the concrete not meet the strength requirements in the test of samples as above, or in the additional tests that the Engineer may have permitted, then it shall be dealt with according to one of the following two methods, chosen at the sole discretion of the Engineer.

(a) The Contractor shall demolish and re-construct the part of the structure made of the defective concrete.

(b) The Engineer will accept the defective concrete but reduce its price as defined hereinafter. This provision shall apply only to concrete in which the average compressive strength of the samples taken is not less than the Characteristic Compressive Strength listed in the table. In such an event, the Engineer may accept the concrete, but reduce 2% of the unit rate per cubic meter of the defective concrete for every kg/cm² of the difference between the required strength and the average strength. (For example: C130 concrete was required. The strengths of all samples were above 255 kg/cm² but the average strength of the samples was 367.5 kg/cm² instead of 375 kg/cm². In this case the Engineer may, at his sole discretion, accept the concrete and reduce its unit rate by 15%).

Concrete that has not met the requirements as stated above and concrete that the average compressive strength of the samples of which is below the nominal strength shall be rejected in every case. The part of the structure made of the rejected concrete shall be demolished and re-built by the Contractor at his own cost.

204.5.4 Impermeability Tests

Where required on the Drawings or the Specification, or where directed by the Engineer, the concrete shall be tested for impermeability. Samples for the impermeability tests shall be in the form of 20x12 cm plates and shall be prepared, cured and tested in accordance with DIN 1048. Unless otherwise stated in the Particular Specification or elsewhere in the Contract, the requirement for impermeability shall be that, when a water pressure of 2 kg/cm² is applied to one side of the test specimen, no moisture shall appear on the other side.

204.5.5 Payment for Tests

The costs of sampling and performing the tests in accordance with this Section, including all labour, equipment, transportation and ancillary works, shall be deemed to be included by the Contractor in his unit rates for concrete and shall not be paid for separately, unless specific items for testing are included in the Bill of Quantities.