

United Nations Children's Fund (UNICEF)



INSTALLATION WORKS OF THE OMNI PROCESSOR AT IAAT WWTP

VOLUME 3

GENERAL SPECIFICATIONS

Part 1 - General Requirements

Part 2 - Civil Works

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101 GENERAL REQUIREMENTS

101.1 GENERAL REQUIREMENTS AND PARTICULAR SPECIFICATION

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 ISO 9000 CERTIFICATION

Imported manufactured products and equipment shall comply with their relevant international standards. The quality assurance of all imported goods shall be granted the ISO 9000 certification.

Locally manufactured products and equipment shall comply with US or Western European Standards. ISO 9000 certification for locally manufactured goods is not essential, however these goods shall be subject to the approval of the Engineer.

101.4 DRAWINGS, RECORDS AND DOCUMENTS

101.4.1 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.

101.4.2 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.

101.4.3 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.

101.5 BOREHOLE INFORMATION

The Contractor shall satisfy himself as to the nature of the strata underlying the sites of the works. He may carry out at his own expense borings, tests and investigations as he may consider necessary and utilize the information thus gained for the preparation of his tender.

Any subsoil information and test results provided by the Employer shall be given to the Contractor for his preliminary information only. Such information shall not relieve the Contractor in any way of his obligation to inspect the sites and of his sole responsibility for carrying out the works as specified and required by the Engineer and at the rates set out in the Bill of Quantities. No claims for additional payment and/or extensions of time shall be entertained in respect of data furnished to the Contractor by the Employer or the Engineer.

101.6 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		Mountanianous zones		Bekaa Valley		Coastal zones		Mountanianous 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

101.7 BILL OF QUANTITIES

101.7.1 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.

101.7.2 Provisional Items and Quantities

Care shall be taken to distinguish between “Provisional items” which represent work they may not be required, and “Provisional Quantities” which represent work that will be required but the quantity of which cannot be closely estimated in preparing the Bill of Quantities and details of which will be given on site.

101.7.3 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.

101.8 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.

101.9 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

101.10 SURVEY AND SETTING OUT

101.10.1 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.

101.10.2 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.

101.10.3 Surveying for Measurement of Earthwork

All intermediate and final surveying necessary for the establishment of quantities of excavation and earthfill 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.

101.10.4 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.

101.11 PROGRAMME OF WORKS AND PROGRESS REPORTS

Not Used)

101.12 WORK SITES

101.12.1 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.

101.12.2 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.

101.12.3 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.

101.12.4 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 or 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. Insofar 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.

101.13 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.

101.14 BUILDING REGULATIONS

All buildings erected by the Contractor upon the Site and Work Area shall comply with all Laws and local By-laws insofar as they are applicable.

101.15 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.

101.16 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.

101.17 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.

101.18 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.

101.19 MATERIALS

101.19.1 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.

All goods and materials used in the execution of the Contract shall comply in all respects with ISO 9000 Standards or other equivalent standards approved by the Engineer.

101.19.2 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.

101.19.3 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.

101.19.4 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.

101.20 MAINTENANCE OF WORKS

During the period of maintenance, the Contractor shall maintain the Works and make all repairs, as defined in 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 authorised 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.

101.21 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 form the basis for a demand for any payment under the Contract.

101.22 RESIDENT ENGINEER'S OFFICE

(Not Used)

101.23 DAYWORKS

When Dayworks are authorized by the Engineer all equipment, labour and materials shall be paid for at the rates listed in the Schedule of Dayworks in the Bill of Quantities.

All major materials for Dayworks authorized by the Engineer but not included in the Schedule of Dayworks shall be paid for on a Prime Cost basis. The Contractor shall be paid on the basis of paid invoices showing cost of materials less any discount, paid receipts for transportation and handling charges and paid receipts for insurance on materials and delivery of materials. Before authorizing the use of materials in Dayworks the Engineer may require the Contractor to supply estimates of the costs of the materials.

The Contractor shall be compensated for his expenses, overhead, labour and profit involved in procuring and delivering the materials by an amount equal to a percentage of the actual cost of the Prime Cost Sum.

101.24 WATER SAMPLES AND ANALYSES

(Not Used)

201 - EARTHWORKS

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201 EARTHWORKS

201.1 GENERAL

201.1.1 Scope

Earthworks under this Specification include excavation and backfill for pipelines, excavation for ponds and open canals, excavation and backfill for structures, excavation from borrow areas, construction of embankments, 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 roter, 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 metre 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 metre 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 Dewatering, Supporting and Fencing of Excavations

(Not Used)

201.1.5 Use of Explosives

(Not Used)

201.1.6 Programme and Methods of Work

(Not Used)

201.1.7 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.

201.1.8 Earthworks in Urban Areas

(Not Used)

201.1.9 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.

201.1.10 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 201.3.11.

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.

201.1.11 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 programme 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.

Pneumatic Roller shall consist of pneumatic tires arranged in a manner so as to provide a satisfactory compacting unit. The roller shall have an effective rolling width of at least 150 cm. and shall give a compression of at least 130 kg. per cm. of width of tread when fully loaded. The tires shall be uniformly inflated.

Smooth Roller shall be self-propelled or power roller and shall weigh at least 10 tons and may be of the tandem or three-wheel type. The wheels of the roller shall be equipped with adjustable scrapers.

Other 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. Satisfactory equipment shall be maintained on the site at all times when embankment construction is in progress.

201.2 CLEARING AND STRIPPING

201.2.1 Clearing

The areas upon which new construction is to take place, the rights-of-way along which pipelines are to be laid and all other such areas as may be designated by the Engineer and/or indicated on drawings as required for auxiliary purposes, (site offices and workshops, transport and machinery yards, borrow pits, stockpile sites, etc.), 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

(Not Used)

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 metres, 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 EXCAVATION AND BACKFILL FOR PIPELINES

201.3.1 Surface Excavation to Reduce Levels

Where shown on the Drawings or required or approved by the Engineer, the Contractor shall execute surface excavation in advance of trench excavation, to the lines and grades shown on the Drawings or ordered by the Engineer.

Any surface excavation not shown on the drawings and not ordered by the Engineer that the Contractor may wish to execute for the convenience of his work shall be subject to the Engineer's approval, but shall be done entirely at the Contractor's expense.

Surface excavation shall be measured in cubic metres according to the dimensions, lines and levels shown on the Drawings or directed by the Engineer. The unit rate shall include also for hauling the excavated material to fill areas, at any distance, and spreading them in layers of thickness not exceeding 20 cm. after compaction and disposal of the surplus material, all in accordance with the Drawings or as directed by the Engineer.

201.3.2 Trench Excavation for Pipelines

Pipe trenches shall be excavated to the typical cross-sections shown on the Drawings, and in no case shall the trench width up to the level specified exceed that shown on the Drawings. The Contractor shall ensure that at any point the width of the pipe trench is sufficient to permit the pipeline to be laid, jointed, bedded/surrounded and backfilling to be placed and compacted around the pipeline to the Engineer's satisfaction.

The trench invert shall, at any location, be at the proper level and trench width of the proper dimensions to allow for sand and/or concrete bedding or surrounds as shown on the Drawings and directed by the Engineer. Where pipes are laid directly on the bottom of the trench, the latter shall be straight and even so as to provide a good support for the pipe over its entire length and shall be free of roots, stones, lumps and other hard objects that may injure the pipe or its coating.

Where welding or jointing of pipes and/or accessories is required to be done in the trench, the same shall be widened and/or deepened to form bell-holes of sufficient size as directed by the Engineer's Representative so as to easily permit the proper execution of all welding, connecting and fixing works in all their stages, all necessary repairs to the pipe and coating, and for the thorough inspection of all these operations.

The length of trench to be kept open at one time shall be determined by the Engineer and shall in no case be exceeded. Should there be any danger that trenches may erode, then sections shall be left unexcavated for as long as possible and the laying and backfilling of pipelines shall follow excavation as soon as possible.

The excavated material shall be placed alongside the trench in such a manner as not to interfere with the work and to prevent its falling into same.

Should any part of a trench be excavated, in error, deeper than required, the extra depth shall be filled up with concrete, solely at the Contractor's expense.

Trench formations shall be in undisturbed ground. Where in the opinion of the Engineer, the formation is unsuitable for bearing, extra excavation shall be carried out under the direction of the Engineer and the level made up again with sound soil material carefully compacted or with concrete. This work shall be paid for by the Employer provided that the unsuitability of the formation is not due to the method of working of the Contractor, in which case the Contractor shall carry out the work at his own expense.

Trench walls excavated in rock shall be as nearly vertical as possible, and the Contractor shall consolidate the walls wherever they have been loosened by blasting or other reasons, and shall remove all loosened material. If rock occurs at a level higher than the required level of the trench bottom, the clearance between the pipe and the trench sides and bottom shall, where in rock, be made to the dimensions shown on the Drawings or directed by the Engineer, to allow for sand or concrete bedding or surround.

In confined areas, where the passage of excavating equipment is impossible, or where the Engineer's Representative deems the use of such equipment impracticable or undesirable for any reason whatsoever, trench excavation shall be done by hand. All requirements specified above shall apply to trench excavation by hand. No extra payment shall be made for works in confined areas. All excavation, whether in confined or unconfined areas, shall be paid for at uniform rates as specified hereafter.

If, in the opinion of the Engineer, there is undue delay in testing the pipelines; removing surplus material; general tidying up of areas where pipes have been laid; partial restoration of maintenance of surfaces; or similar operations, then the Engineer may order that no further trenches shall be opened until the outstanding work has been carried out to his satisfaction and the Contractor shall have no ground for a claim against the Employer on this account.

No work will be started on the laying of pipes or bedding in any section of trench, until the trench formation of that particular section has been approved by the Engineer.

Once the pipeline section has been tested and the bedding and surround approved by the Engineer, the trenches shall be backfilled by layers as specified hereafter. Each layer shall be separately compacted and any subsidence resulting from insufficient compaction shall be the Contractor's liability and he shall forthwith add the necessary extra material which shall then be thoroughly compacted.

Unless otherwise specified, items for trench excavation shall apply to all kinds of soil, including rock, and the excavation will be measured for payment in linear metres measured along the centreline of the pipeline, classified by pipe diameter and for each section by average depth to invert of pipes. The average depth of a section shall be the average between adjacent manholes or as directed by the Engineer's Representative. The cost of trench excavation shall be deemed to include for excavation, drilling and blasting, to the required width and depth to underside of pipe barrel, finishing the trench bottom as specified, digging boreholes where required, removing excavated material and storing it alongside the trench for backfilling whenever permitted, removal of material that may result from land slides, removal of loosened earth or rock, removal and disposal of all excess spoil to any distance, timbering and dewatering as and where required if no specific items have been provided in the Bill of Quantities.

201.3.3 General Backfill

The excavated material or selected material which can be classified as suitable for backfilling shall be in accordance with the requirements of Section 201.5.

Where necessary, excavated material shall be sieved or sorted to remove large stones, rocks, or other particles which, in the opinion of the Engineer’s Representative, may impede compaction.

201.3.4 Type A Fill

Type A fill shall be good hard well graded material screened and crushed as necessary to lie within the grading envelope given in Table 1.1. The material shall have a CBR greater than 30%.

The liquid limit should not be more than 40% and the plasticity index should not exceed 10%.

Table 1.1: Grading Envelope for Type A Fill

Sieve Size	% by Mass Passing
75 mm	100
37.5 mm	85 - 100
10 mm	45 - 100
5 mm	20 - 65
600 microns	8 - 45
75 microns	0 -20

201.3.5 Type B Fill

Type B fill shall be clean hard fill free from deleterious material and free from stones greater than 150mm insize.

The material shall have a CBR greater than 20%.

201.3.6 Hardcore

Hardcore shall consist of broken stone or other suitable hard material. It shall be free from clay, dust or other deleterious matter, shall not contain pieces exceeding 100mm and not more than 5% of the material shall pass through a 20mm sieve.

201.3.7 Beddings and Surrounds - Sand and Granular Material

(a) Sand Bedding and Surrounds for Concrete, A.C. and Metal Pipes -

Where shown on Drawings, pipes shall be laid in sand bedding or surround.

The bedding and surrounds material shall be fine, uniformly graded sand (sand comply with BS 882 grading zone c), clean and free of stones, rubbish, clay or organic matter.

Free draining, incompressible, fine granular material may be used instead of sand, subject to written approval of the Engineer.

The beddings and surrounds up to 30 cm above the pipe shall be wetted and thoroughly compacted in layers not exceeding 15 cm in thickness after compaction. Special care shall be taken to obtain proper compaction under and around the pipe.

Sand beddings and surrounds at any depth shall be measured in linear metres of trench in which surround has been placed, classified by diameter of pipe. The unit rates inserted in the Bill of Quantities for surrounds shall include the additional excavation in trench bottom, supplying the necessary materials, spreading, levelling and compacting the materials.

(b) Granular Material Beddings and Surrounds for P.V.C. and G.R.P. Pipes

All P.V.C. and G.R.P. pipes shall be laid in suitable granular material bedding or surround. Suitable bedding and surround material shall be broken stone or gravel from 3/8" (9.5 mm) to 3/16" (4.8 mm) size, sand (as specified in Section 201.3.7(a)) or other material having a compaction factor not exceeding 0.1. The compaction factor shall be obtained by the following test:

Equipment

1. Open-ended cylinder 225 mm long and 150 mm internal diameter (a pitch fibre or P.V.C. pipe is suitable).
2. Metal rammer with striking face 40 mm diameter and weighing 0.9 to 1.1 kg.
3. Rule.

Method

Obtain a representative sample more than sufficient to fill the cylinder viz. about 11.5 kg. It is important that the moisture content of the sample should not differ materially from that of the main body of material at the time of its use in the trench.

Place the cylinder on a firm surface and gently pour the sample material into it, loosely and without tamping. Strike off the top surface level with the top of the cylinder and removal all surplus spilled material. Lift the cylinder up clear of its contents and place on a fresh area of flat surface. Place about one-quarter of the material back in the cylinder and tamp vigorously until no further compaction can be obtained. Repeat with the second quarter, tamping as before, and so on for the third and fourth quarters, tamping the final surface as level as possible.

Measure from the top of the cylinder to the surface of the compacted material. This distance divided by the height of the cylinder (255 mm) is referred to as the Compaction Factor.

Interpretation of Values

<u>Compaction Factor</u>	<u>Suitability for Use</u>
0.1 or less	Material suitable
Over 0.1	Material unsuitable

For each batch of material, three (3) Compaction Factor tests shall be made and the average value used. Material sufficient for the surround of two hundred linear metres of pipe shall be considered to comprise one batch.

The granular material bedding and surround shall be wetted and thoroughly hand-tamped in layers not exceeding 15 cm in thickness after compaction. Special care shall be taken to obtain proper compaction under and around the pipe.

Granular material beddings and surrounds for pipes, at any depth, shall be measured for payment in linear metres of pipe, classified by diameter. The rates shall include additional excavation in trench bottom, supplying the necessary material, spreading, levelling, compacting and carrying out Compaction Factor tests.

201.3.8 Beddings and Surrounds - Concrete

Where required, pipes shall be bedded on or surrounded by concrete, to the dimensions, lines and levels shown on the Drawings or determined by the Engineer. All concrete used for bedding and surround of pipelines shall comply, in all respects, with the provisions of Division 202 hereafter. Plain concrete and reinforced concrete shall be of Grade C20P.

Pipes shall be supported and jointed at the correct level, clear of the trench bottom upon two blocks of precast concrete of suitable height, each supporting one end of the pipe. Concrete shall then be poured and rammed beneath and around the pipes in one operation and finished off to the level and dimensions shown on the drawings.

The precast blocks shall first be properly set on the trench bottom and boned to the correct position and level. The pipes shall then be laid on the blocks and properly centred, socketed and finally brought to the correct gradient by the application of wooden wedges one on each side of the pipe and between the pipe and the concrete blocks. These wedges shall remain left-in whilst the pipes are jointed and tested, as herein specified and during the pouring of the concrete beneath and around the pipes. Where the concrete while being poured would otherwise cause the pipes to float, pipes shall be effectively anchored to prevent such flotation.

The Contractor may, according to his own choice, pour concrete either with or without forms. Whatever the Contractor chooses; the concrete for payments shall be measured as per Drawings and no extras shall be paid for dimensions in excess of those required according to the Drawings.

Concrete beddings and surrounds shall be measured for payment in linear metres, classified according to diameter of pipe and according to type of bedding and surround. The rates shall be valid for any depth and shall include all additional excavation in trench bottom, concrete, reinforcement, formwork, materials, labour, etc.

201.3.9 Backfilling of Pipe Trenches

Backfilling of pipe trenches (except at joints) shall be done as soon as practicable after the pipes have been satisfactorily laid in position and jointed and in no case shall more than five pipe lengths be left uncovered after laying. Where shown on Drawings, the first stage of the backfill, up to 30 cm above the crown of the pipe, shall consist of selected material. Selected material shall be granular, free from stones, rubbish, clay and organic matter. It shall be free-draining and readily compactable. This backfill shall be spread in layers not exceeding 15 cm in thickness after compaction, and compacted at least to 92% of modified A.A.S.H.T.O. density as defined in Part 2 Section 201.7.

The remainder of the pipe trench (from 30 cm above the crown of the pipe to the sub-base coarse of the road or to the top of the trench) shall be backfilled, after the completion of testing, by one of the following methods:

- (a) Where the pipeline crosses or runs underneath roads or pavements, backfilling shall be of type B, type A will be used when directed by the Engineer or shown on the Drawings, and shall be placed in layers not exceeding 15 cm after compaction, wetted as necessary and compacted at least 90% of modified A.A.S.H.T.O. and the last 60 cm below the road sub-base course shall be compacted at least 95% of modified A.A.S.H.T.O. density as defined in Section 201.7.
- (b) In open areas, where the requirements of para. (a) do not apply, the second stage backfill may be done with excavated material dumped into the trench by means of a bulldozer or similar equipment, provided that the fill material does not contain any large stones, that the trench is completely filled without leaving any voids, and the fill is finished with a neat mound raised to about 30 cm above the trench edges to allow for future subsidence.

All joints and other accessories shall be left uncovered until after the pipeline shall have passed any pressure or leakage tests that may be prescribed by the Specification.

Where the backfill cover over the pipes is less than 70 cm, the travel of the tracks or wheels of heavy equipment thereon will be strictly prohibited, and the Contractor shall use suitable small compactor, and shall be responsible for any damage caused to the pipe by non-compliance with this requirement.

The Contractor shall be responsible for any subsidence of trench backfill and shall make good any damage to road or structures caused thereby during the Period of Maintenance.

Where lengths of trench are excavated partly in rock, stony ground, or in other material unsuitable for backfilling, there may not be sufficient suitable material available from the excavation for backfilling as specified above and in such cases the Contractor shall transport suitable material from other parts of the work or from borrow areas.

The Contractor shall make arrangements for sites for tipping the spoil and shall include in his rates for excavation the cost of haulage and tipping of spoil and all expenses in connection with the obtaining of suitable backfilling material.

Backfilling of pipe trenches will be measured for payment in linear metres along the centreline of the pipeline, classified by pipe diameter and for each section by average depth to the top of surrounds material which is placed to 30 cm above the top of the pipe. The average depth of a section shall be the average between adjacent manholes in case of gravity pipelines, and the average between adjacent stations in case of pressure pipelines. The cost of trench

backfilling shall be deemed to include supplying of material and compaction in layers not exceeding 15 cm after compaction.

201.3.10 Cased Borings

Where shown on the Drawings or instructed by the Engineer, pipes shall be installed in casings inserted into horizontal borings across embankments at existing installations or in road crossings. The casing pipe shall be of sufficient strength to withstand the forces acting on it during insertion in the bore and the external pressure of the earth, and shall have a nominal diameter as shown on Drawings but at least 6” larger than that of the line pipe. Where the soil is sufficiently cohesive and stable, the casing may be pushed into a bore previously drilled through the embankment to a diameter slightly larger (by 2-3 cm) than the external diameter of the casing. Where the nature of the soil does not permit such a procedure, the casing shall be jacked through the embankment or under the road with simultaneous drilling and removing the material from the interior of the casing pipe. In both cases, the casing pipe may be inserted in successive sections welded to each other as the work proceeds. The Contractor shall choose the most suitable and efficient method for drilling and casing and shall submit the procedure proposed by him for the Engineer’s approval. Drilling and casing shall be done at the exact locations and to the lines and grades shown on the drawings or determined by the Engineer. After the casing has been installed in position and approved by the Engineer, the line pipe shall be installed therein. To protect the line pipe and especially its coating against abrasion and other injury or damage during installation and thereafter, the Contractor shall use specially designed spacers of timber or plastic or shall produce such spacers. The distances between spacers of either kind shall not exceed 3.00 m. After the line pipe has been installed in its final position, the annular space at each end of the casing shall be filled with a mixture of bitumen and sand to seal off the interior of the casing against the entry of water, mud, small animals, vermin and other foreign bodies.

Cased borings shall be measured, separately for each diameter of casing, in linear metres by the actual length of cased boring through embankment as approved by the Engineer.

The unit rates for cased borings shall include: open-cut excavation and preparation of work area at both ends of boring, drilling through embankment, supply of casing pipe, welding of casing pipe sections, inserting of casing pipe in bore, installation line pipe in casings, supply and placing of spacers and sealing of openings at the ends, supply, transport and removal from Site of boring equipment and backfill of open-cut excavation connected with boring.

201.3.11 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 tonnes mass.

201.4 EXCAVATION FOR PONDS AND CANALS

Excavation for ponds and canals shall be carried out and finished to the lines, grades and dimensions shown on the Drawings and to the tolerances specified hereafter.

Excavated material shall be used for earthfill in embankments and in other locations, as shown on Drawings, except for material rejected by the Engineer as unsuitable, which shall be run to spoil. Under this Section, suitable material shall be excavated, moved to fill areas, dumped and spread, as specified. The Engineer shall be entitled to designate the earthfill where individual loads of material shall be deposited.

The Contractor shall take all necessary precautions to prevent excavation beyond and below the lines and levels indicated on Drawings. Any damage to the work due to the Contractor's operations, including shattering of the material beyond the required depths and lines, shall be made good by the Contractor at his own expense. Any and all excess excavation for the convenience of the Contractor or any overexcavation performed by the Contractor for any purpose or reason, except as may be directed by the Engineer in writing, shall be at the expense of the Contractor. Where required to complete the work, all excess excavation and overexcavation shall be refilled, consolidated and made good with materials provided by the Contractor at his own expense, as directed by the Engineer's Representative.

Unless otherwise specified, items for excavation for ponds and canals shall equally apply to all kinds of soil, including rock, and excavation shall be measured by cubic metres of excavated material, to the lines and levels shown on the Drawings or as directed by the Engineer. The unit rate shall include for excavation, drilling and blasting, stacking, hauling excavated material in fill areas, and disposal of spoil material, all as specified in this Section.

201.5 EXCAVATION AND BACKFILL FOR STRUCTURES

All excavation for structures shall be carried out to the dimensions, lines and grades shown on the Drawings or directed by the Engineer.

Excavations on or against which concrete or compacted fill is to be placed, shall be clean and free from stones, clods, debris and other loose material. Where the bottom of an excavation does not provide a solid basis for casting concrete, it shall be consolidated by tamping and/or watering as necessary until the required density is obtained.

Any overexcavation in the bottom of the structure shall be cleaned and backfilled with concrete or selected backfill compacted to the density of the adjacent natural soil. Overexcavation in rock shall be backfilled with the concrete of the structure or with dry stone pack, as directed by the Engineer. Any and all excess excavation for the convenience of the Contractor for any purpose or reason, except as may be directed by the Engineer in writing, and all refilling of such overexcavation as specified, shall be at the expense of the Contractor.

Where possible, concrete foundations and blocks shall be cast against the undisturbed sides of the excavation. Where overexcavation beyond the lines of the structure is unavoidable due to the nature of the ground, because of the shape of the structure or for any other reason, the space between the structure and the faces of the excavation shall be backfilled to the original ground level (whether natural or reduced) as specified hereafter for backfilling.

Excavated material, to the extent that it is required and suitable, shall be put aside for use in backfill. Surplus excavated material shall be either used for backfill in other locations on the site, or shall be otherwise disposed. Wherever required, the Contractor shall obtain suitable material for compacted backfill from borrow areas.

Backfill shall be carried out to the lines and grades shown on the Drawings. The backfill material shall be placed in horizontal layers not exceeding 15 cm in thickness after compaction. The backfill material shall completely and firmly fill the spaces between the excavation lines and the structure without leaving any voids, and shall be compacted to the density of the adjacent natural earth. The sides and bottom of the excavation shall be moistened before backfilling and so shall the backfill material, in order to obtain the moisture content necessary for the required compaction. Every layer shall be compacted by pneumatic tampers approved by the Engineer.

Unless otherwise specified, items for excavation and backfill for structures shall equally apply to all kinds of soil, including rock.

Excavation shall be measured by cubic metres to the neat lines and dimensions of the structures, as shown on the Drawings or described in the Specification, with no allowance whatsoever so actual side-slopes, working space, etc. The unit rates for excavation shall include for excavation, drilling and blasting, stacking, hauling of excavated material to any distance, spreading and compacting and running surplus to spoil.

Backfill will be measured for payment by cubic metres, and the unit rates for backfill shall include for supplying of material, spreading and compaction of material in layers not exceeding 15 cm after compaction.

201.6 EXCAVATION FROM BORROW AREAS

Wherever required or directed by the Engineer, the Contractor shall obtain suitable material for compacted fill from borrow areas. Such suitable borrow material shall be excavated, moved to fill areas and spared as specified. The locations and boundaries of the borrow areas

as well as the depths and slopes of excavation therein shall be as determined or approved by the Engineer's Representative. Before commencing to extract filling material from any borrow area, the Contractor shall strip its surface as specified in Sub-Section 201.2.3 above and shall also remove therefrom all material which is, in the Engineer's opinion, unsuitable for filling. The surface of the borrow shall be left in a reasonably smooth and even condition, as approved by the Engineer's Representative.

No excess borrow material shall be brought to fill areas. Unnecessary material shall be rejected and dumped and shall not be measured for payment.

Measurement for payment of excavation in borrow areas shall be made only for excavation of borrow material actually used as fill, to the lines and dimensions prescribed by the Engineer's Representative. Measurement shall be by cubic metres and the unit rate shall include for stripping (which shall not be measured and paid for) and for removing unsuitable material, hauling to fill areas at any distance. All materials from borrow pits placed in embankments and compacted backfill will again be included for payment under the applicable rates of the Bills of Quantities for compacting such earthwork. Provided always that the cost of borrowed material has not been specified to be included in those relevant pay items for which the same borrowed material is to be supplied.

201.7 EMBANKMENTS AND COMPACTED FILL

201.7.1 General

Wherever the term "embankment" is employed it shall also mean "compacted fill", unless the distinction between those two terms is clearly emphasized.

Embankments shall be constructed to the lines and grades shown on the Drawings. Where grassing is required, a compacted fill embankment shall be constructed up to the underside of the layer of top soil, as shown on the Drawings.

No brush, roots, sod, or other perishable or unsuitable materials shall be placed in the embankments. The suitability of each part of the foundation for placing embankment materials thereon and of all materials for use in embankment construction will be determined by the Engineer. The Contractor shall maintain the embankment in an approved manner until the final completion and handing over of all the Works.

The embankment operations shall be so conducted and the various soil strata shall be placed so as to produce a soil structure as shown on the typical cross sections, or as directed by the Engineer. The slopes of the division lines between zones and/or portions of the embankment are tentative and shall be subject to variation, at any time prior to or during construction, and the Contractor shall be entitled to no additional allowance above the unit rates in the Bill of Quantities, by reason of such variations. The embankment for each portion shall be maintained approximately level throughout the entire length of each layer from abutment to abutment. All openings through the embankment required for construction purposes shall be subject to approval, and such openings shall be constructed so that the slope of the bonding surface between embankment in place and embankment to be placed is not steeper than 1:4. The bonding surface of the embankment in place shall be prepared as provided for embankment foundations.

The Contractor shall be responsible for the stability of all embankments made under the contract and shall replace any portion which, in the opinion of the Engineer, has become displaced due to carelessness or negligence on the part of the Contractor.

Where excess spoil, or other material for which compaction is not specified, is dumped and spread, the Contractor shall route his equipment, both when loaded and when empty, to travel over the entire area of the above mentioned material. No payment will be made for this operation, and its cost shall be deemed to be included by the Contractor in his unit rates for the various items in the Bill of Quantities.

When the state of the weather is such that it would adversely affect the placing of fill, all embanking shall be stopped. In particular, embanking work will not be permitted during rain nor for such time afterwards as the Engineer may judge to be necessary to allow the upper layers in the embankment to dry to their correct moisture content as directed by the Engineer.

At all times during dry weather, whether embanking is taking place or not, the surface of the embankment is to be watered everywhere as directed by the Engineer, or protected to his satisfaction to prevent undue cracking of the surface. Watering is to be done by means of tankers, sprinklers or other methods approved by the Engineer.

Any material not complying with the specified density or moisture content shall be replaced in the embankment at the Contractor's own expense notwithstanding the fact that it may be overlaid by more recently placed material.

201.7.2 Preparation of Foundation

No material shall be placed in any section of the embankment until the foundation for that section has been suitably prepared and approved by the Engineer's Representative.

All excavation made for test pits or other subsurface investigations, and all other existing cavities found within the area to be covered with earthfill which extend below the established lines of excavations for the embankment foundations shall be filled with compacted earthfill. The foundation for earthfill, where in clayey soil, shall be scarified, wetted and compacted as specified for the earthfill to be placed thereon. Where the foundation is granular material it shall be compacted by vibrating rollers to a depth of not less than 30 cm to the same density as specified by the overlaying earthfill. Surfaces upon or against which the earthfill portions of the embankment are to be placed shall be cleaned of all loose and objectionable materials in an approved manner by hand-work or other effective means immediately prior to placing the first layer of earthfill. The surfaces of each portion of the foundation, immediately prior to placing the earthfill, shall have all water removed from depressions and shall be properly moistened and sufficiently clean to obtain a suitable bond with the earthfill. Where compaction of fill is to be started, or continued after the previous layer has been in place for over 6 hours, the area shall be harrowed to a depth of 20 cms, wetted and compacted to the required degree of compaction.

201.7.3 Compaction Control

Compaction shall be controlled by field density and field moisture tests, or by such other tests as prescribed by the Engineer.

The densities of the compacted earth materials shall be defined as follows:

- (a) Modified A.A.S.H.T.O. Density shall mean the maximum dry density obtained from the compaction test in accordance with the A.A.S.H.T.O.-T-180-61 (method D) test or the (identical) A.S.T.M.-D-1557 (method D) test.

- (b) Relative Density shall be defined by the following formula (in accordance with the U.S. Bureau of Reclamation Earth Manual Designation E-12):

$$D_d = \frac{Y_d \max (Y_d - Y_d \min) \times 100}{Y_d (Y_d \max - Y_d \min)}$$

where

- D_d = Relative density
 $Y_{d\max}$ = greatest dry density obtained by laboratory
 $Y_{d\min}$ = least dry density obtained by laboratory
 Y_d = the dry density at which the soil is to be placed or the in-place dry density

The field density of compacted material in place shall be determined by the A.A.S.H.T.O.-T-191-61 method or by the identical A.S.T.M.-D-1556-64 method. Field moisture content shall be determined by the A.S.T.M.-D-2216-63-T method.

Samples of all fill materials, both before and during placement, shall be taken for testing at frequent intervals. The following tests shall be performed:

- (a) Tests to determine the maximum dry density and the optimum moisture content. The number of samples for these tests shall be as determined by the Engineer but not less than one sample per 1,000 m³ of fill shall be taken.
- (b) Field density tests. The number of samples for these tests shall be as determined by the Engineer, but not less than one sample per 1,000 m³ of compacted fill or one sample per day, whichever is larger.

For the performance of all the above-mentioned tests, the Contractor shall provide a fully-equipped field laboratory and the necessary trained personnel for sampling and testing, all subject to the Engineer's prior approval. All costs for providing the field laboratory and the necessary personnel and for sampling, testing, transportation, etc., shall be deemed to be included by the Contractor in his unit rates for the various items of earthworks in the Bill of Quantities and shall not be paid for separately.

201.7.4 Placing and Compacting - General

Embankment materials shall be deposited in horizontal layers over the entire width of the embankment and compacted to the required densities as shown on the Drawings or as specified.

Embankments shall be formed of satisfactory materials. The thickness of each layer shall not exceed the thickness shown on the Drawings or as specified. In the construction of embankments, starting layers shall be placed in the deepest portion of the fill, and as placement progresses, layers shall be constructed approximately parallel to the finished grade line.

The material in the layers shall be brought to the optimum moisture content before rolling is started to obtain the prescribed compaction. Wetting or drying of the material and manipulation to secure a uniform moisture content throughout the layer shall be required. Should the material be too wet to permit proper compaction or rolling, all work on all portions

of the embankments thus affected shall be delayed until the material has dried to the required moisture content. Sprinkling shall be done with sprinkling wagons, pressure distributors, or other approved equipment that will sufficiently distribute the water. Sufficient equipment to apply the required water shall be available at all times.

The optimum moisture content shall be determined by the Engineer and the actual content shall not vary from the required one by more than plus 4 or minus 2 percent. This optimum moisture content, determined by the Engineer as required for compaction purposes, shall be uniform throughout each layer of the earth-fill prior to and during the compacting.

The distribution of materials shall be such that the compacted fill be homogeneous and free from lenses, pockets streaks or other imperfections.

The number of successive passes of the compacting equipment over each and every point in any layer shall be not less than six (6). The overlapping of two adjacent passes shall be not less than 30 cm. The Engineer's Representative shall have the right to test every layer. However, the Contractor shall not be permitted to start work on the successive layers without the Engineer's Representative's permission, irrespective of whether tests have been made or not.

Where due to small width of required fill or any other reason, compaction of material in horizontal layers by sheeps foot rollers or pneumatic rollers will in the Engineer's opinion be impracticable, the Engineer may permit the use of other equipment and procedures such as compaction by mechanical tampers or spreading the material in small quantities in layers parallel to the slope and compacting same by cylindrical rollers applied along the slopes, or otherwise. Compaction shall be carried out to the Engineer's satisfaction and to the specified density.

After compaction has been completed as specified, all surfaces and slopes shall be trimmed and smoothed to accuracy specified hereafter. The cost of such trimming and smoothing shall be deemed to be included in the various rates for construction of embankments.

201.7.5 Compaction of Clayey and Silty Materials

Clayey and silty materials shall be deposited in horizontal layers of thickness not exceeding 15 cm, after compaction. The excavating and placing operations shall be such that the materials when compacted will be blended sufficiently to secure the best practicable degree of compaction, impermeability and stability. Prior to and during compaction, the materials shall have the optimum moisture content as determined by the Engineer, and the moisture content shall be uniform throughout each layer.

Insofar as practicable, as determined by the Engineer's Representative, moistening of the material shall be performed at the site of excavation, but if necessary shall be supplemented by sprinkling at the Site. Should the actual moisture content not be within the limits prescribed in Subsection 201.7.4 above, compacting operations shall not proceed until the layer has been brought to optimum moisture content, whether by wetting or scarifying and drying. No additional payment shall be made on account of any operation by the Contractor in drying or wetting the materials or on account of delays occasioned thereby.

When the filling material has been conditioned as specified, it shall be compacted by tamping with sheeps foot rollers having staggered and uniformly spaced knobs and of sufficient weight for proper compaction, by tyre rollers, by hand or power tampers, or by other compacting equipment approved by the Engineer. When tamping rollers are used, the tamping knobs and

cleaner bars shall be properly maintained and the space between the tamping feet shall be kept clear of anything which may impair the effectiveness of the roller. Unless otherwise specified, the dry density of the soil fraction in the compacted material shall not be less than 92 percent of the Modified A.A.S.H.T.O. Density as defined in Subsection 201.7.3 above.

201.7.6 Compaction of Cohesionless Free-Draining Materials

Cohesionless free-draining materials, such as sand and gravel, shall be deposited in horizontal layers of not more than 15 cm if compacted by tampers or rollers, not more than 30 cm if by treads of crawler-type tractors, surface vibrators or similar equipment and not more than the penetrating depth of the vibrator if compacted by internal vibrators.

Unless otherwise specified, the relative density of the compacted materials, as defined in Subsection 201.7.3 above, shall be not less than 70 percent.

201.7.7 Compaction of Intermediate Soil Types

Unless otherwise specified, in borderline cases between clayey and silty soils and those that fall under the definition of cohesionless free-draining materials, the density shall be either 92 percent of the Modified A.A.S.H.T.O. Density or 70 percent relative density, whichever value is the higher.

201.7.8 Pipelines and Structures in Embankments and in Compacted Fill

Where pipelines are to be laid in embankments or in compacted fill, the embankment or fill will first be constructed to the lines and levels shown on the Drawings, to a height of 1.5 m above the crown of the pipe or to the top of the embankment or fill. After the embankment or fill have been constructed to the height specified above, the Contractor shall excavate in the compacted fill a trench to the Typical Trench Cross Sections; shall lay, joint, etc., the pipes in it; shall backfill the trench, as specified, to the top of the embankment and shall complete all other operations of constructing and covering the pipeline. After all the above operations have been completed, the Contractor shall resume, where necessary, the construction of the embankment or fill and its compaction.

Where steel pipes are to be laid in compacted embankments, the work shall be carried out as specified above, except that the embankment shall be completed to a level of 50 cm above the crown of the pipes.

Where structures, such as manholes, chambers, channels, etc., are to be constructed in compacted embankments or fill, the embankment or fill will first be completed to the lines and levels shown on the Drawings. The required excavation for the structures shall then be made and the structures constructed in it. After the completion and testing of such structures, the excavation shall be backfilled and compacted to the specified density.

201.7.9 Methods of Measurement and Payment

The supply of fill material, including its hauling and spreading and running of surplus to spoil, shall not be paid for separately and shall be deemed to be included in the relevant pay items for excavation, whether from borrow areas or from excavations for pipelines, structures, etc.

Compaction of Embankments shall be paid for separately and measured by cubic metres of the volume of compacted fill in place. No payment shall be made for additional material required to be added due to Settlement, and the Contractor shall make due allowance for this in his rates. The unit rate shall include wetting and compacting and the performance of all field and laboratory tests as specified. The unit rate shall also cover all additional costs of scarifying, harrowing, etc., where and when needed and trimming and smoothing of surfaces.

No additional payment shall be made in case of stockpiling of excavated materials and later rehandling of such material if directed by the Engineer in order to produce the specified embankment structure and the cost thereof 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.

201.8 TOLERANCES OF FINISHED EARTHWORKS

All earthworks shall be finished to the dimensions and elevations shown on the Drawings. Unless otherwise specified, the following variations shall be acceptable:

- (a) Embankment width - not more than 20 cm over the specified widths and not more than 10 cm less than the specified widths. Embankment elevations - not more than 5 cm.
- (b) Elevations of bottoms of ponds - no more than 5 cm.
- (c) Channel invert elevations - not more than 3 cm, provided a continuous slope is maintained in the direction of flow so as to prevent the formation of puddles on bottom of channel.
- (d) Irregularities in surfaces of all earthworks - not more than 1.5 cm when checked by a straight edge.

201.9 SOIL INVESTIGATIONS

(Not Used)

CONCRETE WORKS

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202 CONCRETE WORKS

202.1 STANDARDS, GRADES, COMPOSITION AND TYPES

202.1.1 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.

202.1.2 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.

202.1.3 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	100	200	Non-Reinforced Concrete
C15P	150	200	
C20P	200	280	Reinforced Concrete
C25P	250	280	
C30P	300	280	
C40P	400	300*	Prestressed Concrete and Concrete for Special Purposes
C50P	500	300*	
C60P	600	300*	

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

Grade C40P - 375 kg per 1.0 m³
 Grade C50P, C60P - 450 kg per 1.0 m³

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/m ³)			Maximum Water/Cement Ratio
		Maximum Aggregate Size			
		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/m ³)			Maximum Water/Cement Ratio
In Soil (Total SO ₃)	In Ground Water Parts per 100,000		Maximum Aggregate Size			
			40mm	20mm	10mm	
< 0.2	< 30	OPC	NORMAL CONDITIONS			
0.2 - 0.5	30 - 120	OPC	300	330	370	0.50
		SRPC	250	280	320	0.55
0.5 - 1.0	120 - 250	OPC	Not Permitted	330	370	-
		SRPC	300			0.50
1.0 - 2.0	250 - 500	OPC	Not Permitted	370	410	-
		SRPC	340			0.45
> 2.0	> 500	SRPC	Ditto but with protective coating			0.45

202.1.4 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) Lean, Blinding and Cyclopean concrete

Concrete shall be proportioned to 200 kg of cement per 1 m³.

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) Porous Concrete

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/m².

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

– (Not Used)

f) Fibre concrete

– (Not Used)

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 ($\leq 0.315\text{mm}$). 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 ($0.4 \leq W/C \leq 0.5$), 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/m ³	25 kg/m ³	30 kg/m ³	35 kg/m ³	40 kg/m ³
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 (evenness 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 through 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/m³).

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

- (Not Used)

202.2 MATERIALS FOR CONCRETE -

202.2.1 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.

202.2.2 Water

The water used for mixing concrete shall be of potable quality, free from 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.

202.2.3 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 ascertain 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.

202.2.4 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	BS 1881	BS 1881)
	Slump	Pt 101	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.

202.3 BATCHING AND MIXING

202.3.1 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.

202.3.2 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.

202.4 PLACING AND CURING

202.4.1 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.

202.4.2 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

(Not Used)

202.4.3 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.

202.4.4 Finishing of Concrete Surfaces

Formed concrete surfaces, i.e. surfaces cast against forms, shall receive the required smoothness and texture by the use of appropriate forms as specified under Section 202.10. After removal of forms and the specified curing all fins and offsets caused by misaligned or defective form boarding shall be removed. Tie wires shall be cut back to at least 15 mm below the concrete surface and the resulting depressions as well as the holes left after the removal of tie rod fasteners shall be filled with non-shrinking cement mortar and finished flush with the surrounding areas.

Where the concrete surfaces will be permanently exposed to view, the ground and filled areas shall have the same colour, texture and degree of smoothness as the surrounding concrete surfaces. Honeycombed areas and other major defects in concrete shall be repaired as specified in Section 202.7 hereinafter, and the repaired areas given the required finish.

Unformed concrete surfaces that are to be covered shall require no other finishing than sufficient levelling and screeding to produce an even uniform surface. Unformed concrete surfaces that are to remain permanently exposed shall be given a floated surface, unless a trowelled finish as described below is required. Floated finish shall consist of levelling and screeding to even and uniform surfaces followed by floating without the addition of any topping as soon as the screeded surface has stiffened sufficiently. Floating shall be done to the minimum required to produce a surface that is free from screed marks and is uniform in texture. The finish shall be given a final touch-up with a wooden float at an appropriate time after completion of the initial floating.

Trowel finish shall be applied to unformed concrete surfaces that will be in contact with liquids and elsewhere as shown on the Drawings or ordered by the Engineer. When the surface screeded and floated as described above has hardened sufficiently to prevent excess of fine material to be drawn to the surface, steel trowelling shall be started. Steel trowelling shall be performed with firm pressure, such as will flatten the sandy texture of the floated surface and produce a dense uniform surface, free from blemishes and trowel marks. Where required, trowelling shall be done with the addition of a certain amount of cement as specified in the Particular Specification or Bill of Quantities.

Unless otherwise specified or shown on the Drawings, all exterior angles shall be chamfered to the approval of the Engineer. The cost of Floated Finish, Trowel Finish and Chamfers shall be deemed to be included in the unit rates for concrete work and shall not be paid for separately.

202.4.5 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.

202.5 CONTRACTION AND EXPANSION JOINTS

202.5.1 Contraction Joints

The position of construction joints will be as specified in the drawings by the designer. If there is a need on site to revise any specified position /or/ to have additional construction joints the proposed positions should be agreed with the Engineer.

Full structural continuity must be assumed in design at a construction joint. Reinforcement will be fully continuous across the joint, and the concrete is taken to be as nearly monolithic as possible.

The concrete at the joints should be bonded with the one subsequently placed against it, without provision for relative movement between the two.

Concrete should not be allowed to run to a feather edge, and vertical joints should be formed against a stop end. Particular care should be taken when framing the joint.

The surface of the first pour should be roughened to increase the bond strength and to provide aggregate interlock.

With horizontal joints, the joint surface should be roughened without disturbing the coarse aggregate particles, by spraying the joint surface approximately 2h to 4h after the concrete is placed, with a fine spray water and/or brushing with stiff brush.

Vertical joints can be treated similarly, if the use of a retarder on the top is authorised, to enable the joint surface to be treated after the stop end has been removed.

If the joint surface is not roughened until the concrete has hardened, the larger aggregate particles near the surface should be exposed by sand blasting or by applying a scaling hammer or other mechanical advice.

Care should be taken that the joint surface is clean immediately before the fresh concrete is placed against the old one. It may need to be dampened prior to the new concrete being placed, to prevent excessive loss of mix water into it by absorption.

Particular care should be taken in placing of new concrete close to the joint to ensure that it has adequate fines content and is fully compacted and dense.

N.B. When instructed by the Engineer in designing construction joints for retaining aqueous liquids it is necessary to incorporate waterstops in properly constructed joints.

Construction joints shall be formed only in the positions shown in the drawings or indicated by the Engineer and concreting shall be carried out continuously between and up to joints.

All intersections of construction joints, permanently exposed, shall be made absolutely straight and level or plumb and matching with adjacent members.

Construction joint shall be formed at right angles to the axis of the member concerned, by the insertion of rigid stopping-off forms in the case of horizontal or inclined members.

The upper surface of lifts of concrete in walls and columns shall be horizontal.

The surface of the stopping-off form /or/ the horizontal surface shall be indented to produce a key the old and new work.

The face of the horizontal joints brushed and roughened shall be rendered with a 1.0 to 1.5 cm thick layer of cement-sand mortar having the same relative proportions of cement and sand (without coarse aggregate) and the same water-cement ratio as the concrete to be placed upon it, and the new concrete shall then be laid immediately upon it and thoroughly punned in.

Where joints will be permanently visible, the mortar shall be kept back at least 25mm from the exposed face.

In the case of vertical joint the face shall be rendered with a coat of neat cement placed immediately before each fresh lift of new concrete.

NB : No Day Joints /or/ Stopping-off joints will be permitted in water retaining structures. Pouring operations shall be continuous between joints as shown in the drawings.

The Contractor shall have sufficient materials and standby equipment to meet these requirements.

Where due to accident or breakdown it is impossible to continue concreting, the Engineer /or/ his Representative shall be immediately notified and his verbal instructions which shall be confirmed in writing as soon as possible, regarding either the making of a construction joint /or/ the taking out of new concrete back to the last construction joints, shall be complied with immediately.

Construction joints in wall

Where the wall is designed to be monolithic with the base slab, a kicker should be cast at the same time as, and integrally with the slab.

The height of the kicker should be at least 75mm to enable the next lift of formwork to fit tightly and to avoid leakage of cement grout from the newly deposited concreted.

The joint in this position will be a construction joint, and although it is recommended that wall panels are cast in one lift, any necessary extra horizontal joints will be construction joints when approved by the Engineer on site.

Circular Structures retaining liquid

(Not Used)

Temporary open sections in rectangular tank

When structural continuity is required in the final structure (wall of a rectangular tank) the amount of reinforcement required to control early thermal effects may be reduced by the use of temporary open sections by the contractor after obtaining the agreement of the Engineer for such operation.

The width of the open section between adjacent panels should be no greater than 1000mm.

Properly formed construction joints should be provided at each end of the temporary open section with the longitudinal reinforcement from each adjacent panel, lapping in this area.

Sufficient time should be allowed for all the early thermal movement to take place before the open section is infilled by the Contractor.

The surface of the concrete first placed at a contraction joint shall be coated, before the concrete on the other side of the joint is placed, with an approved bituminous paint or with a sealing compound as specified in Subsection 202.4.5 . Where a water stop is inserted in the contraction joint, great care should be taken to prevent any paint or sealing compound from coming into contact with the half of the waterstop width protruding from the first-placed concrete. Any paint or sealing compound which will come into contact with the waterstop shall be immediately cleaned off.

202.5.2 Expansion Joints

For concrete structures retaining aqueous liquid, all eventual expansion joints are designed to accommodate repeated movement of the structure without loss of liquid.

The joint is designed to suit the characteristics of the material available and should also provide for the exclusion of grit and debris that would prevent the closing of the joint.

Detailing of places where the joint changes direction /or/ intersects with another joint should be uncomplicated.

The expansion joint:

At an expansion joint the Contractor shall provide a complete discontinuity in both reinforcement and concrete.

An initial gap should be provided between adjoining parts of the structure to accommodate the expansion /or/ contraction of the structure.

Waterstop, joint fillers and joint sealing compounds are essential.

The Joint Filler

An elastic joint filler material cut in sheets of the thickness specified and/or shown on the drawings, shall be:

- either placed in the forms before the first placed concrete is cast.
- or, may be attached to the first placed concrete surface means approved by the Engineer.

The elastic filler materials shall be of a quality approved by the Engineer and shall conform to US Federal Specification H-H-F-341 a, or to a similar approved standard.

Where the exposed sides of the joint are filled with an elastic joint sealant approved by the Engineer, sheets of foamed polystyrene may be substituted for the above described elastic filler.

The sheet of filler material, shall be cut to fit the entire contact surfaces of the complete side of the joint.

Where a waterstop is installed in the joint, the filler materials shall be placed on both sides of the waterstop so as to fit snugly about the bulb of the waterstop.

Except where a groove for joint sealant is to be formed, the edges of the filler materials shall be placed flush with the finished surface of the concrete /or/ the bottom of the chamfers.

Joints in the filler shall be made tight so that mortar from the concrete will not seep through to the opposite concrete surface.

N.B.: Joint sealing compound cannot be expected to provide a liquid-tight seal for more than a proportion of the life of the structure and waterstops should always be provided in movement joints by the Contractor and installation must follow the recommendations of the manufacturer.

202.5.3 Elastic Joint Sealant

Where shown in the Drawings, the groove formed on the exposed side of contraction or expansion joints shall be filled with an elastic joint sealant meeting the requirements of ASTM Designation D-1850. The joint sealant is supplied in two components, base and accelerator, which are mixed together only immediately before use. Flow type sealant shall be used on horizontal or nearly horizontal surfaces, and heavy type on inclined and vertical surfaces. If required by the manufacturer, a suitable primer shall be applied on the joint surfaces prior to the filling of the groove and the time elapsing between the application of the primer and the placing of the joint sealant shall not exceed the maximum prescribed by the

manufacturer. Care shall be taken that the mixed compound is used before the expiry of its pot-life as indicated by the manufacturer.

Prior to the application of the primer (if any) and the placing of the joint sealant, the groove shall be thoroughly cleaned, flushed with a jet of water and finally cleaned and dried with compressed air. The joint sealant shall be placed immediately after mixing of the two components, by means of a caulking gun so as to fill the joint groove completely and tightly, without leaving any depressions, voids or air bubbles. The joint filling shall be finished neatly and flush with the concrete surfaces by means of a spatula or similar tool.

202.5.4 Payment for Joints

Unless specific items are included in the Bill of Quantities, the cost of all work and materials for making construction, contraction and expansion joints shall be deemed to be included in the rates for the concrete work and shall not be paid for separately.

202.6 TOLERANCES FOR CONCRETE STRUCTURES

The maximum permitted variation from the design dimension shown on the Drawings or ordered by the Engineer shall be as follows :

1. Variation from the plumb :
 - a- In the lines and surfaces of columns, piers, walls and arises

In any storey or	
5 m maximum	10 mm
15 m or more	25 mm
 - b- For exposed corner columns, construction-joint grooves, and other conspicuous

	1/2 of the above amount
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2. Variation from the level or from the grades indicated on the Drawings :
 - a- In floor and beam soffits

In 3 m	5 mm
In any bay or	
5 m maximum ...	10 mm
In 10 m or more	20 mm
 - b- For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines

 1/2 of the above amount
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3. Variation of the building lines from established position in plan and related position of columns, walls and partitions

In any bay or	
5 m maximum	5 mm
In 10 m or more	20 mm
4. Variation in the size and location of sleeves, floor openings and wall openings

	10 mm
--	-------
5. Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls

Minus	5 mm
Plus	5 mm
6. Footings :

a- Variation of dimensions on plan	Minus 10 mm Plus 10 mm
b- Misplacement or eccentricity	2 percent of the footing width in the direction of misplacement but not more than 50 mm
c- Reduction in thickness	Minus 5 percent of specified thickness but not more than 50 mm
7. Placing of Reinforcement Steel :	
a- Variation of protective cover	With cover up to 8 cm 5 mm 8 cm and more 10 mm
b- Variation from indicated spacing, provided that average spacing and total quantity of steel are not affected 25 mm

202.7 REPAIR OF CONCRETE

202.7.1 General

Repair of concrete where permitted by the Engineer shall be performed. The Contractor shall correct all imperfections on the concrete to the satisfaction of the Engineer.

202.7.2 Concrete Repairs in “Rehabilitation Works”

(Not used)

202.7.3 Concrete Repairs in News Concrete Works

Any concrete which in the opinion of the Engineer fails to comply entirely with this specification shall be declared defective and shall be cut out, removed from the site and replaced, and any steelwork reinforcement or other material damaged by the cutting and shall be replaced, all at the Contractor expansion.

The Contractor will submit to the Engineer, details of his proposal for rectifying the defects, and shall comply with the Engineer’s instructions, regarding the procedure of carrying out the work.

Notwithstanding the Engineer approval, should the remedial work prove unsatisfactory, the Contractor shall make good the work and bear the whole cost occasioned by the defective work.

Immediately after the forms have been removed, all fins and projections and all timber works at joints shall be removed and rubbed smooth with a carborandum block.

All holes and honeycombing in the surface shall be cleaned out and roughened up to give a good key. These holes shall then be filled with 1:2 cement/sand mortar and after it has thoroughly hardened, the surface shall be rubbed down with a carborandum stone to an even finish.

Concrete filling shall be used for holes extending entirely through the concrete, for holes in which no reinforcement is encountered, and which are greater than 0.20 m² and deeper than 10 cm and for holes with reinforcement concrete which are in area greater than 0.05 m² and which extend beyond reinforcement.

Plastering of smooth concrete surfaces will not be permitted.

All mortar and concrete filling must be non shrinkable and shall be kept constantly moist and protected from drying due to surface temperature and natural ventilation.

All materials, procedures and operations used in the repair of concrete shall be subject to the Engineer direction. All fillings shall be bonded tightly to the surface of the holes and shall be sound and free from shrinkage cracks and drummy areas after the fillings have been cured and dried.

All repairs of concrete executed by the Contractor shall be deemed to be included in the unit rates for concrete work in the Bill of Quantities and shall not be paid separately.

202.8 TESTING OF CONCRETE

202.8.1 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.

202.8.2 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.

202.8.3 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/cm ²)	Cube strength at 28 days (kg/cm ²) **		
		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.

202.8.4 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.

202.8.5 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.

202.9 STEEL REINFORCEMENT

202.9.1 General

Reinforcement steel for concrete shall meet the requirements of the relevant British Standards listed in Subsection 202.1.2 of this Specification.

The Contractor shall supply the Engineer with certificates from the makers of the steel showing that it has complied under test with the appropriate Standard Specification, stating the process of manufacture and if required the chemical analysis, and such test sheets shall be forwarded to the Engineer one week before the dispatch of such steel to the Works.

The steel shall be stored off the ground and kept scrupulously clean and free from loose mill scale, loose rust, oil and grease or other harmful matter. Any bar adversely affected by storage or for any other reason shall be cleaned or removed from the Site and replaced by the Contractor at his own expense.

202.9.2 Bar Schedules

Where reinforcement bar schedules are shown on the Drawings to assist the Contractor in preparing and placing the steel reinforcement, the Contractor shall carefully check such bar schedules for compliance with the structural drawings and shall correct the bar schedules as necessary. Where no bar schedules are incorporated in the Drawings, the Contractor shall prepare such schedules at his own cost and responsibility. In any case, the Contractor will be

solely responsible for the correct preparation and placing of steel reinforcement in accordance with the Drawings. Any bars bent and prepared according to incorrect schedules, and not suitable for placing in the structure will be rejected and will not be paid for.

202.9.3 Bending Reinforcement

All bending shall be done cold, by an approved bending machine, in a manner that will not injure the material. Welded joints shall not be permitted in any bar. Only experienced steel benders, to the approval of the Engineer, shall be employed in bending. All bending shall be in accordance with British Standard 4466. The internal radius of all cranks and bends shall be at least three times the diameter of the bar. Heating of mild steel bars only to facilitate bending, especially of large diameter bars, will be permitted, provided the temperature of the steel does not exceed 850°C (cherry-red heat) and provided further that the cooling rate is low and uniform (normal still-air cooling). Quenching of hot-bent bars in water will not be permitted. Reinforcement bars depending on cold working for their strength, such as cold drawn or twisted bars shall not be bent hot.

202.9.4 Placing Reinforcement

The number, size, form and position of all steel bars, ties, links etc.. shall be in exact accordance with the Drawings and in the placing and fixing the function of each bar shall be borne in mind.

The greatest care shall be taken to ensure that the steel is laid out correctly in accordance with the Drawings and fixed rigidly within the forms. Sufficient temporary ties of annealed iron wire shall be provided to prevent any displacement before or during the placing of concrete and to ensure that the specified amount of cover is everywhere maintained. Concrete shall be rammed firmly with spatulas around the steel and compacted against it and against the shuttering.

No pieces of metal or blocks or wood shall be used on the bottom surface or against the sides of formwork to keep the reinforcing bars in position. For this purpose specially prepared precast concrete blocks shall be used of a thickness equal to the concrete cover specified hereafter. The use of plastic spacers is also accepted.

Unless otherwise shown on the Drawings or directed by the Engineer, the cover reinforcement, including cover stirrups and distribution bars, shall be at least equal to the diameter of the principal reinforcement bars plus

- at least 1 cm in the case of solid interior slabs, or
- at least 1.5 cm in all other cases, or
- at least 1 cm in addition to the above in the case of elements exposed to climatic influences.

In any case, all parts of a structure in direct contact with the earth or water shall have at least 3 cm cover over reinforcement, including stirrups and distribution bars.

The minimum cover stipulated above shall be increased, if necessary, up to 5 cm wherever a structure is particularly liable to danger of corrosion or abrasion, and up to 8 cm where concrete is placed directly against earth, without formwork.

Bars, generally, shall be of the required lengths and the lapping of main bars will not be permitted, except as indicated on the Drawings. Where bars are required or permitted to be

lapped, the parts along the lap shall have a clear space between them equal to 1cm or the diameter of the bar, whichever is the greater. The minimum length of overlap will be 40 times the diameter of the bars for hooked bars and at least 60 times the bar diameter for bars without hooks. Laps of adjacent parallel reinforcement bars shall be staggered. Ends of ties shall be cut back 1.5 cm from face and covered with mortar. Fabric reinforcement shall be lapped at least 40 diameters or two squares, whichever is the greater.

All laps of bars are to be tied tightly with six laps of 1.5 mm annealed iron wire at intervals of ten diameters of the bars. All crossings of steel are to be secured with three laps of wire. Splicing of bars by butt welding will be permitted, provided that the resulting joint is not inferior in strength to the rest of the bars. Bars depending for their strength on cold drawing or twisting shall not be spliced by welding. Crossings of steel bars may be secured by tack welding instead of tie-wires, provided that burning or other damage to steel at tack-welds is prevented. All welds shall be done in a thoroughly workmanlike manner by qualified welders either by the oxy-acetylene method to BS 693 or by the metal arc method to BS 5135. Splices of bars having a diameter of 26 mm and more shall be done by butt-welding only.

The Contractor shall not pour any concrete before the Engineer has inspected and approved the placement of reinforcement. Such approval shall, however, not affect the Contractor's responsibility for the correctness of the reinforcement in accordance with the Drawings, reinforcement schedules, Specifications and/or directions given by the Engineer.

202.10 FORMWORK

202.10.1 General

The Contractor shall design, supply and fix all necessary formwork, together with its attendant scaffolding, timbering, shoring, strutting, etc., required for the placing of the concrete.

The Contractor will be permitted to use timber boarding as formwork or forms lined with plywood, hardboard of approved manufacture or steel sheets. Where timber boarding is used, the formwork surfaces coming in contact with wet concrete shall be made of properly seasoned timber. Full size plywood or hardboard sheets shall be used except where otherwise required or where smaller pieces will cover the entire area. Forms shall be so placed that markings shall be symmetrical.

All formwork shall be of sufficient strength to resist movement of men or equipment and the pressure of the wet concrete while it is being placed and vibrated, without distortion. Where plywood, hardboard or steel lining is used, particular care shall be taken to ensure that the forms are adequately braced and stiffened.

The formwork for successive vertical lifts must make such perfect contact with concrete in the preceding lift that there shall be no excrescences, bulges, tears or other outward signs of faulty junction. The formwork must be constructed so that there shall be no leaked of mortar. Whenever it is unavoidable, the Contractor shall prevent leakage of any kind through open joints by means of suitable caulking.

The repeated use of forms of all descriptions will be at the discretion of the Engineer, who will require the forms to be reconditioned or surfaced from time to time. After repeated use, the old forms will be replaced with new ones at the direction of the Engineer.

All exposed concrete shall have the external angles chamfered 20 mm or as directed by means of moulding strips fixed to the formwork. Interior angles on such surfaces and edges at formed joints will not require bevelling unless requirement for bevelling is indicated on the Drawings.

The height of all erected at any one time shall be subject to the approval of the Engineer.

The surface of the forms shall be free from encrustation of mortar, grout, or other foreign material. Before the form panels or boards are erected in place, the surfaces of the forms shall be oiled with an approved commercial form oil that will effectively prevent sticking and will not stain the concrete surfaces.

202.10.2 Types of Forms

The surfaces of formwork to give a desired finish of formed concrete will be classified as follows :

- (a) Unwrought Formwork of unwrought timber will be permitted in formwork for concrete surfaces or portions thereof which will receive plaster or other facing, or which will be covered up below ground level.
- (b) Wrought Formwork (for Smooth Internal and External Surfaces) made of new plywood or new steel sheets or timberboarding planed on both sides to equal thickness, shall be used on all exposed concrete surfaces except where plaster or another facing or fairface concrete are provided for. The formwork shall ensure that a regular and smooth finish is obtained, free of excessive bulges, irregularities or unsightly markings or defects of any kind.
- (c) Fair-face Concrete Formwork shall be employed where shown on the Drawings, required in the Specification or directed by the Engineer. This type of formwork shall include use of new plywood or new steel sheets equal thickness, joined by torque and groove joints in parallel and vertical or horizontal alignment, arranged so as to achieve concrete surfaces of the textures and patterns required.

Where the surfaces formed in wrought or fair-face formwork are defective, the Engineer may order repairs to be made in accordance with Section 202.7 above and, if large surfaces should be found honeycombed or otherwise impaired, he may order all such surfaces to be plastered with cement plaster. Repairs to fair-face concrete, where required, shall be made in accordance with Section 202.7 above, but if in the Engineer's opinion such repairs would be insufficient to restore the external appearance of the surface, he shall order surfaces destroyed and cast anew.

The cost of all above-mentioned repairs to concrete surfaces, including application of cement plaster, and re-casting shall be deemed to be included in the unit rates for concrete work in the Bill of Quantities and shall not be paid for separately.

202.10.3 Form Ties

Embedded metal rods or sleeves used for holding forms shall remain embedded and shall terminate not less than 2½ cm from the face of the concrete. Embedded wire ties for holding forms will not be permitted in concrete walls which are to come into contact with liquids or where the concrete surfaces through which the ties would extend will be permanently

exposed. Wire ties may be used for concrete walls to be plastered, stone faced or covered with earth. Wire ties shall be cut back at least 1.5 cm from the face of the concrete. The holes left in the concrete surfaces after cutting back of wire ties and removal of fasteners or holding rods or sleeves, and the insides of sleeves where sleeves are used, shall be completely filled with an approved non-shrinking mortar, and the mortar shall be finished flush with the concrete surfaces. This operation will be carefully carried out. The hole formed by the cutting process will be thoroughly cleaned and wetted before filling. Time mortar will be of damp, not wet, consistency. The patch will be properly towelled smooth to match the surrounding concrete surfaces and shall be thoroughly cured by keeping it moist continuously for at least three days. After the patch has hardened, the Engineer may require the patch and the adjacent concrete surface to be ground down smooth. Any patches that are loose or hollow on completion must be re-done. Water stop tie rods shall be used for liquid retaining structures.

All costs for complying with the requirements of this Subsection shall be deemed to be included in the unit rates for formwork and shall not be paid for separately.

202.10.4 Embedded Metal Parts

Parts of metal work, such as fixtures for wall brackets, hooks and similar parts that are to be embedded in the concrete shall be attached to the forms in their proper position prior to placing of concrete.

All costs for and in connection with the installation of metal parts shall be deemed to be included in the unit rates for formwork and for concrete and shall not be paid for separately, except where specific items shall be included in the Bill of Quantities.

202.10.5 Striking of Forms

To facilitate satisfactory progress with the specified curing and to permit earliest practicable repair of surface imperfections, forms shall be struck as soon as the concrete has hardened sufficiently to prevent damage by careful form removal. Forms shall not be struck until the strength of the concrete is such that form removal will not result in perceptible cracking, breaking of surfaces, or other damage to the concrete and that the concrete can sustain the loads to be borne at the time of striking. Forms shall be struck with care so as to avoid injury to the concrete, and any concrete so damaged shall be repaired at the Contractor's expense.

No forms shall be removed without the express permission of the Engineer's Representative, but the Contractor shall, nevertheless, accept sole responsibility for the removal and consequences thereof.

In no case shall forms to soffits be struck until test cubes from the actual concrete concerned have yielded the 7 days strengths specified.

As a guide to the Contractor and subject to the foregoing requirements the followings minimum striking times, from the completion of concrete placing, may be assumed:

- | | |
|--|------------|
| - For sides of Foundations, slabs, etc. | - 24 hours |
| - For sides of Beams in suspended work, sides of walls and columns | - 48 hours |
| - For sides of Retaining Walls | - 36 hours |
| - For soffits of Beams and Slabs in suspended works (spans up to 3 meters) | - 10 days |

- For soffits of Beams and Slabs in suspended works (spans 3 to 6 meters) - 12 days
- For soffits of Beams and Slabs in suspended works (spans over 6 meters) - 14 days
- For the soffits of beams having a span of more than 5.0 m, at least one support and for those of slabs having a span exceeding 6.0 m, at least one row of supports shall be left in place for an additional period of seven days.

If the striking times stated above are not sufficient to permit the unsupported concrete to sustain superimposed loads (such as support for the shuttering of an upper floor, storing of building materials, etc..). Such loads will require special supports to sustain them.

202.11 MISCELLANEOUS CONCRETE WORKS

202.11.1 Openings and Holes in Concrete

Openings in concrete walls or slabs or reservoirs shall be predetermined and subject to the approval of the Employer. No openings shall be made after formworks removal. The Contractor shall be responsible for the co-ordination of all requirements of his sub-contractors as regards provision of openings, holes and fixings, and prepare shop drawings.

Holes left after the removal of formwork shall be filled with a compensating epoxy-based mortar or any similar product. For water retaining structures water stop tie rods shall be used when filling the holes to ensure watertightness.

Where it is impracticable, as determined by the Engineer's Representative, to install metal parts in the forms as required under Subsection 202.10.4 suitable holes or recesses shall be formed in the concrete structure into which the metal parts can be placed and grouted in. The shape and dimensions of such holes shall be as shown on the Drawings or as determined by the Engineer's Representative, and they shall be formed with wooden core boxes, fabricated in such a manner that they can be completely withdrawn or broken up and removed after the concrete has set. All such core boxes shall be set with great accuracy with the aid of templates and securely fixed to prevent displacement during concreting. The supply and installation of all such core boxes and their removal when the concrete has hardened sufficiently shall be deemed to be included in the unit rates for formwork and concrete work and shall not be paid for separately.

Where the holes or openings have not been formed in the concrete during placement, the Engineer may either order the tearing down and rebuilding of the structure or the part thereof concerned, or permit such holes or openings to be cut in the hardened concrete to the dimensions shown on the Drawings or as directed by the Engineer. Such cutting shall be kept to the minimum necessary dimensions and shall be done by drilling, chiselling or the use of a power tool, all as approved by the Engineer and in such a manner as not to cause any damage to the concrete structure.

Reinforcement bars passing through such holes or openings shall not be cut without the express written permission of the Engineer's representative.

Where the forming of the openings or holes has been omitted by the Contractor's neglect, all tearing-down and rebuilding or cutting of holes and openings in the hardened concrete as aforesaid shall be done by the Contractor at his own expense, in all other cases the cost thereof shall be borne by the Employer and shall be paid for as extra work under Clause 51 of the Conditions of Contract.

202.11.2 Manholes and Chambers

Manholes and chambers shall be constructed in the positions and to the details shown on the Drawings. The grades of concrete and types of formwork shall be as shown on the Drawings, as required in the Specification or as directed by the Engineer. The inside dimensions, unless otherwise specified, will be after plastering or to otherwise finished surfaces.

A base slab of concrete, supporting the walls, shall be cast on firm ground foundations (so as to prevent any differential settlement), on a blinding layer of Lean Concrete (Grade C10). Where shown on the Drawings, smoothly constructed U-shaped channels, to carry and direct the flow, shall be formed integrally with the concrete base, or may be constructed separately by benching. Adjacent floor areas shall slope to drain to the channel with a gradient of about 5% to 10%. All transition curves shall be smooth.

The whole of the floor areas and channel surfaces shall be finished with a smooth coat of cement mortar.

The walls of the manholes shall be made of cast-in-situ concrete or of precast concrete rings, all as shown on the Drawings. The construction of walls shall not start sooner than 24 hours after slab had been cast. Cast-in-situ concrete and precast concrete shall be Grade C30 for floors, walls; ceilings and Grade C15 for benching. Precast concrete Chamber and Shaft rings shall conform to requirements of B.S. 556, shall be of the tongue and groove type and shall be assembled with cement-mortar joints to ensure complete water tightness of the joints.

Internal surfaces of Manholes and Chambers shall be absolutely smooth. This shall be achieved by the use of wrought formwork or by plastering with cement mortar 1:1½ and steel trowel finish with the addition of cement in the proportion of 1 kg per square meter as shown on the Drawings or as directed by the Engineer.

Aluminium or galvanized steel steps, or a ladder if so shown on the Drawings, shall be provided in all manholes 1.25 m deep and over. The steps shall be staggered and spaced at about 25 cm vertically, or as shown on the Drawings. They shall be solidly embedded in the walls prior to the plastering. The top step shall always be located to accommodate the right foot. Step irons for manholes shall comply with B.S. 1247 type A and shall be hot-dip galvanized. All steps shall be built in as the work proceeds. Cutting out completed work for inserting steps or other fittings shall only be permitted where it is impossible to built them in as the concrete is being cast. Unless otherwise specified, in manholes with depths greater than 5.25 m, ladders shall be installed instead of steps. The ladders shall comply with the Drawings or shall be as specified or directed by the Engineer.

Where shown on the Drawings or directed by the Engineer, pipe stubs for future connections shall be installed. The stubs shall extend at least 50 cm beyond the outside of the walls of the manhole and shall be plugged watertightly. Appropriate channels for the future connections shall also be prepared in the benching.

Unless otherwise indicated, manhole and chamber covers shall be suitable for heavy duty and shall be made of cast-iron to B.S. EN124 or concrete with cast-iron frames, of a type approved by the Engineer. Suitable lifting keys of mild steel shall be provided with the covers at a rate of 1 set of keys for each 10 covers. After the completion of the work, cast iron parts of the covers and the frames shall be thoroughly cleaned and painted with bitumen paint.

Manholes shall be watertight. The Contractor shall, if so required, test them in the presence of the Engineer. The Contractor shall provide all water labour, drains, stoppers, bends and other

needful appliances for carrying out tests and no manholes or other work must be covered up until they have been seen and passed by the Engineer. The test to be applied to manholes and chambers shall be their filling with water to 10 cm below the slab or to finished ground level and after allowing due time for saturation of the concrete, by topping up to the original level. Thereafter the loss of water shall not be greater than the equivalent of 2 cm over the whole area of the chamber in 24 hours.

202.11.3 Thrust and Anchor Blocks

Concrete thrust and anchor blocks shall be formed at bends, tees and valves in accordance with the details shown on the Drawings or as directed by the Engineer. Excavation shall be made after pipelaying, and the blocks concreted immediately after excavation. The back of supports and blocks shall abut on to solid ground with all loose material being removed before concreting.

No pressure shall be applied in any section of main until the concrete has achieved adequate strength and at least three day's curing.

Flexible joints shall not normally be cast in. Where the size of the block does not make this possible, additional flexible joints shall be provided no greater than half a pipe diameter beyond each face of the block.

202.11.4 Concrete Surround to Pipes

Where pipelines pass under streams and rivers or where directed by the Engineer, the pipeline shall be surrounded with concrete as shown on the Drawings.

Concrete surround shall be broken at all pipe joints to retain flexibility in the pipeline. No joints shall be concreted in without the prior approval of the Engineer.

202.11.5 Precast Concrete

All precast concrete members to be used in the works, such as covers, lintels, sills, slabs, stairs, etc., shall be manufactured on site or obtained from approved manufacturer. In either case casting shall be done under the supervision of the Engineer, whose approval of the place and method of casting must be obtained before starting work. If casting is done on the site, the Contractor shall prepare a suitable area near the structure for which the precast parts are intended, and samples of the precast work shall be submitted to the Engineer for approval before proceeding with the manufacture on site. Casting of the precast parts shall be completed in due time so as not to delay the completion of the structures and everything connected therewith.

Unless otherwise directed, precast elements shall be of concrete Grade C30P. All precast elements shall be true to dimensions and shapes as shown on the Drawings. Concrete surfaces shall be smooth and all corners square or chamfered, as shown on the Drawings or directed by the Engineer. Lifting lugs and similar metal parts, whether part of the reinforcement steel or not, shall be incorporated in the elements during manufacture. Precast elements shall not be transported or otherwise handled until the end of the curing period, which shall be at least 14 days.

Any precast concrete element becoming defective during casting or placing or from any other cause, and rejected by the Engineer, shall be removed from the Site by the Contractor who shall cast new elements to replace the rejected ones, and all expenses in connection therewith shall be borne by the Contractor.

202.11.6 Cast-in-situ Reinforced Concrete piles

(Not used)

202.11.7 Hourdis Slabs

A Hourdis slab is a monolithical reinforced concrete slab consisting of embedded beams and ribs separated by rows of hollow blocks (Hourdis blocks).

The reinforcement bars of the beams and ribs as well as the hourdis blocks shall be placed on the formwork prior to start concreting.

The hourdis slabs shall be carried out in accordance with the details and dimensions shown on the Drawings.

202.12 JOINT SEALS WITH ELASTOMERIC SEALANTS

202.12.1 Major Components

The major components of a good joint seal are:

- The substrate,
- The joint filler,
- The bond breaker, and
- The sealant.

a) The substrate:

The more common substrates are masonry concrete, metal, and glass; these are generally classified as porous /or/ non porous.

- Some substrate may not be suitable for achieving a bond unless, treated mechanically, chemically, or both.
- When the substrate has a coating, this coating must be compatible with the sealant and its bond to the substrate and sealant must be adequate.
- The Contractor must consult both substrate and sealant manufacturers for suitable joint preparation methods and primers to be used before applying joint materials.
- Adhesion testing of trial applications in the site is recommended.
- Surface laitance and incompatible or bond-inhibiting form release agents on concrete surfaces, must be removed.

- Substrates must be clean, dry, sound, and free of loose particles, contaminants, foreign matter, water-soluble material, and frost.
- Joints in masonry and concrete should be sealed before cleaning exposed surfaces and applying required protective barriers.

b) Primer:

The purpose of a primer is to improve the adhesion of a sealant to a substrate. Many sealant require primers on all substrate; some on only certain substrate or on none at all. Most require a primer for maximum adhesion to concrete and masonry surfaces.

c) Joint Fillers:

A joint filler is used to control the depth of sealant in the joint and permit full wetting of the intended interface when tooled.

Some joints fillers may be incompatible with the substrate and sealant, causing stains, on either one of them or both. Some may be factory coated with a suitable material that provides a barrier to staining.

The Contractor must confirm this suitability, i.e. that the barrier coating must be acceptable to both, the sealant and the joint filler manufacturers.

Joint filler for vertical application may be flexible, compatible, closed cell plastic foam /or/ sponge rubber rod stock, and elastomeric tubing of such materials as:

- neoprene,
- butyl, and
- E.P.D.M.

They should resist permanent deformation before and during sealant application, be non absorbent to water or gas, and resist flowing upon mild heating since this can cause bubbling of the sealant.

- Open cell sponge type materials such as urethane foam may be satisfactory, provided that their water absorption characteristics are recognised. The sealant should be applied immediately after joint filler placement to prevent water absorption from rain.
- Elastomeric tubing of neoprene, butyl, or EPDM may be applied immediately as a temporary seal until the primary sealant is put in place, after which they serve to a limited degree as a secondary water barrier.

Joint filler for horizontal application (for floors, pavements, sidewalks, patios and other light-traffic areas may be compatible, extruded, closed cell, high density flexible foams, corkboard, resin-impregnated fiber board /or/ elastomeric tubing /or/ rods).

- These joint fillers should remain resilient in cold temperature, exhibit good recovery, not cause the sealant to bubble in the joint because of heat, and be capable of supporting the sealant in traffic areas.
- They should not exude liquids under compression, which could hydraulically cause sealant failure by forcing the sealant from the joint.

- Combination of joint filler may be used to form a joint in concrete and an additional filler material may be installed under compression across the width and to the proper depth just before the sealant is applied to provide a clean, dry, compatible backup.

d) Bond breaker:

A bond breaker may be necessary to prevent adhesion of the sealant to any surface or material where such adhesion would be detrimental to the performance of the sealant.

- The use of a joint filler to which the sealant will not adhere may preclude the need for a bond breaker.
- The bond breaker may be a polyethylene tape with pressure-sensitive adhesive on one side /or/ various liquid applied compounds, as recommended by the sealant manufacturer.

e) Sealant

Sealants are classified as:

- single component /or/ multicomponent
- non sag /or/ self leveling,
- traffic /or/ non traffic use

as well as according to movement capability.

- Characteristics of common elastic sealants are listed in the following Table 2.5:

Table 2.5

CHARACTERISTICS OF COMMON ELASTOMERIC SEALANTS

	ACRYLIC (SOLVENT RELEASES)	POLYSULFIDE		POLYURETHANE		SILICONE
	(ONE PART)	TWO-PART	ONE-PART	TWO-PART	ONE-PART	(ONE PART)
Chief ingredients	Acrylic terpolymer, inert pigments, stabilizer, and selected fillers	Polysulfide polymers, activators, pigments, plasticizers, inert fillers, gelling, and curing agents		Polyurethane prepolymer, inert fillers, pigments, plasticizers, accelerators, activators, and extenders	Polyurethane prepolymer, inert fillers, pigment, and plasticizers,	Siloxane polymer pigment, and selected fillers
Percent solids	85-95	95-100	95-100	95-100	95-100	95-100
Curing process	Solvent release and very slow chemical cure	Chemical reaction with curing agent	Chemical reaction with moisture in the air	Chemical reaction with curing agent	Chemical reaction with moisture in all, also oxygen	Chemical reaction with moisture in all
Curing characteristics	Skins on exposed surface; interior remains soft and tacky	Cures uniformly throughout; rate affected by temperature and humidity	Skins over, cures progressively inward; final cure uniform throughout	Cures uniformity throughout; rate affected by temperature and humidity	Skins over, cures progressively inward; final cure uniform throughout	Cures progressively inward; final cure uniform throughout
Primer	Generally not required	Manufacturer's approved primer required for porous surfaces, sometimes for other surfaces		Manufacturer's approved primer required for most surfaces		Required for most surfaces
Application temperature (°F)	40-120	40-100	60-100	40-120	40-120	0-120
Tackfree time	1-7 days	6-24 hr	6-72 hr	1-24 hr	Slightly tacky until weathered	1 hr or less
Hardness, Shore A Cured 1 to 6 months Aged 5 years	0-25 45-55	15-45 30-60	25-35 40-50	20-40 35-55	25-45 30-50	20-40 35-55
Toxicity	Nontoxic	Curing agent is toxic	Contains toxic ingredients	Toxic; gloves recommended for handling		Nontoxic
Cure time (days)	14	7	14-21	3-5	14	5
Joint movement capability (max.)	± 12.5%	± 25%	± 15%	± 25%	± 15%	± 25% high modulus ± 50% low modulus
Ultraviolet resistance (direct)	Very good	Poor to good	Good	Poor to good	Poor to good	Excellent
Dirt resistance cured	Good	Good	Good	Good	Good	Poor
Use characteristics	Excellent adhesion; poor low-temperature flexibility; not usable in traffic areas; unpleasant odor 5-12 days	Wide range of appropriate applications; curing time depends on temperature and humidity	Unpleasant odor; broad range of cured hardnesses available	Sets very fast; broad range of cured hardnesses; excellent for concrete joints and traffic areas	Excellent for concrete joints and traffic areas, but substrate must be absolutely dry; short package stability	Requires contact with air for curing; low abrasion resistance; not tough enough for use in traffic areas

202.12.2 Joint Design

The design geometry of a joint seal is related to numerous factors including:

- desired appearance,
- spacing of joints,
- anticipated movement in joint,
- movement capability of sealant to be used,

- required sealant width to accommodate anticipated movement,
- and tooling methods.

a) Sealant width

The required sealant width relative to thermal movement is determined by:

- the application temperature range of the sealant
 - the temperature extremes anticipated at the site location
 - the temperature at the time of sealant application, and
 - the movement capability of the sealant to be used.
- 1) In the absence of specific application temperature knowledge, an ambient application temperature from 4°C to 38°C (40° to 100°F) should be assumed in determining the anticipated amount of joint movement in the design of joints.
 - 2) Although affected by ambient temperatures, anticipated joint movement must be determined from anticipated building material temperature extremes, rather than ambient temperature extremes.
 - 3) Many other factors can be involved in building joint movement including but not limited to:
 - a) material mass
 - b) color
 - c) insulation
 - d) differential thermal stress (bowing)
 - e) residual growth or shrinkage of materials
 - f) building sway and
 - g) seismic forces
 - 4) The design joint width should be calculated taking all possible movement and tolerance factors into consideration.
 - 5) A simplified method (but no as accurate) is to use the accompanying graph.

b) Joint depth:

The sealant depth, when applied, depends on the sealant width; the following guidelines are normally accepted practice

- 1) For a recommended minimum width of ¼ in, the depth should be ¼ in
- 2) For joints in concrete, masonry, or stone, the depth of the sealant may be equal to the sealant width in joint up to ½ in
 - a) for joints ½ in to 1 in wide, the sealant depth should be one-half of the width.
 - b) for joints 1 to 2 in wide, the sealant depth should not be greater than ½ in.
 - c) for widths exceeding 2 in, the depth should be determined by the sealant manufacturer.

- 3) For sealant widths over $\frac{1}{4}$ in and up to $\frac{1}{2}$ in in metal, glass and other nonporous surface joints the minimum of $\frac{1}{4}$ in in depth applies, and over $\frac{1}{2}$ in in width the sealant depth should be one-half the sealant width and should in no case exceed $\frac{1}{2}$ in.

When determining the location of the joint filler in the joint, consideration should be given to the reduction in sealant depth with concave and recessed tooled joints, and the joint should be designed accordingly.

202.12.3 Application

To obtain proper adhesion, it is essential that:

- the sealant comes in direct contact with the substrate,
 - the sealant wets the surface of the substrate
 - the substrate is strong enough to provide a firm anchor for the sealant.
- If any of these conditions is not met, poor adherence will usually result.
- The sealant should be installed in such manner as to completely fill the recess provided in the joint.

Against a porous material, the sealant must enter the pores if good adhesion is to be obtained. Sealants used for this application are thixotropic and will resist flow into the pores unless an external force is applied. Proper filling of the recess accomplishes this, in part, and proper tooling ensures it.

a) Joint preparation:

For a joint to receive sealant it must be cleaned out and raked to full width and depth required for installation of joint seal materials. Thoroughly cleaning all joints is by removing all foreign matter such as: dust, paint (unless it is a permanent protective coating), oil, grease, water proofing or water-repellent treatments, water, surface dirt and frost.

- Clean porous materials such as: concrete, masonry and unglazed surfaces of ceramic tile, by brushing, grinding blast cleaning, mechanical abrading, acid washing or a combination of these methods to provide a clean, sound substrate for optimum sealant adhesion.
- The surface of concrete may be cut back to remove contaminants and expose & clean surface when acceptable to the purchaser.
- Remove laitance from concrete by:
 - Acid washing
 - grinding or
 - mechanical abrading
- remove all form of oils from concrete by blast cleaning.
- remove loose particles originally present or resulting from
 - grinding abrading or
 - blast cleaning

- by blowing out joints with oil free compressed air (or vacuuming) prior to application of primer or sealant.
- Clean nonporous surfaces, such as metal, glass, porcelain enamel and glazed surfaces of ceramic tile chemically or by other means that are not harmful to the substrate and are acceptable to the substrate manufacturer.
- Remove temporary coatings on metallic surfaces by a solvent that leaves no residue. Apply the solvent with clean oil free cloths or lintless paper towels. Do not dip cleaning cloth in the solvent. Always pour the solvent on the cloth to eliminate the possibility of contaminating the solvent. Do not allow the solvent to air-dry without wiping. Wipe dry with a clean dry cloth or lintless paper towels. Permanent coatings that are to be remain must not be removed or damaged.

b) Masquing Tape:

Install masquing tape at joint edges when necessary to avoid undesirable sealant smears on exposed visible surfaces. Use a non staining, non-absorbent, compatible type.

c) Primer and Joint Filler:

Install primer when and as recommended by the sealant manufacturer for optimum adhesion.

Install compatible joint filler uniformly to proper depth without twisting and braiding.

d) Sealant:

Install sealant in strict accordance with the manufacturer's recommendations and precautions. Completely fill the recess provided in the joint. Sealants are more safely applied at temperature above 40°F (≈ 5°C)

e) Tooling:

- Tooling nonsag sealants is essential to force the sealant into the joint and eliminate air pockets and should be done as soon as possible after application and before skinning or curing begins. Tooling also ensures contact of the sealant to the sides of the joint.
- Plastic or metal tools can be used. Most applicators use dry tools but they may be surface-treated to prevent adhesion to the sealant and may be shaped as desired to produce the desired joint profile. Dipping tools in certain liquids decreases the adhesion of the sealant to the tool. All liquids should be first tested and accepted for by the manufacturer. The use of some liquids may result in surface discoloration. In using tooling liquids, care should be taken to ensure that the liquid does not contact joint surfaces prior to the sealant contacting the joint surface. If the sealant overlap the area contaminated with the liquid, the sealant bond may be adversely affected.
- Tool sealant so as to force it into the joint, eliminating air pockets and ensuring contact of the sealant with the sides of the joint. Use appropriate tool to provide a concave, flush, or recessed joint as required.
- Immediately after tooling the joint, remove masking tape carefully if used, without disturbing the sealant.

f) Field testing

In case where the building joints are ready to receive sealant and the question of adhesion of the sealant to novel or untried surfaces arises, it is advisable to install the sealant in a 1.5m (5 feet) length of joint as a test.

- It would be good practice to do this as a matter of standard procedure on all sites even though unusual conditions are not suspected.
- Following instructions of the sealant manufacturer and using primer as and when recommended, the Contractor will install the sealant in the joint and examine for adhesion after cure to determine whether proper adhesion has been obtained.

202.12.4 Bituminous sealant to waterproof horizontal joints

Once the joint sealant are approved by the Engineer, the Contractor shall submit for approval the application procedures.

Application conditions

- 1) Prior to filling the joints, the Contractor shall:
 - a) make good damaged joints,
 - b) grind or saw joints which are narrower than required,
 - c) clean by grinding and brushing joint sides,
 - d) clean with compressed air.
- 2) Bituminous sealants are hot applied under temperature ranging from 100°C to 130°C, and with a caulking gum. The nozzles shall be kept at the bottom of the joint to ensure a complete and tight filling.
- 3) In the event of a mastic creep in horizontal joints, the Contractor shall re-fill tightly the surface.

202.12.5 Surface strip joint seal (combiflex type or similar)

Surface strip joint seal, is applied, where shown on the drawings or indicated by the Engineer.

- 1) Many joints can be reliably and durably sealed with a system based on an elastomeric strip bridging the joint and bond on both sides of the joints with a special epoxy adhesive.
 - a) This is a flexible water proof seal for joints. The strip is highly flexible and fully weather-resistant elastomeric membrane (neoprene, hypalon or E.P.D.M)
 - b) The width of the strip varies from 100mm minimum to more than 500mm.
 - c) The thickness varies from 1 to 3mm.
 - d) In some cases the strip must be protected.

- 2) The Contractor shall apply the whole system in accordance with the manufacturer technical data sheet.

202.13 ELASTOMERIC SUPPORT

(Not Used)

202.14 METHODS OF MEASUREMENTS

202.14.1 General

Except where otherwise specified, cast-in-situ concrete will be measured and paid for by volume. Separate payment will be made for reinforcement steel (by weight) and formwork (by area).

The following items shall be measured and paid for as specified hereafter :

- Manholes and chambers - by completed units.
- Precast concrete elements - by completed units, or by length or area.
- Cast-in-situ reinforced concrete piles - by linear meters.

A detailed description of the methods of measurements and payment for the different concrete works is given in the following subsections.

202.14.2 Cast-in-situ Concrete

Concrete will be classified for payment in accordance with grades, structural elements and location in the structure.

Except as otherwise specified, all cast-in-situ concrete will be measured by volume to the neat lines and dimensions shown on the Drawings or determined by the Engineer. The volume of all openings, holes and shown on the Drawings or determined by the Engineer. The volume of all openings, holes and recesses not actually filled by concrete will be deducted, but no deduction will be made for the volume of reinforcing steel or small openings (less than 0.1 sq.m. in surface area) and metal parts embedded in the concrete. No payment will be made for concrete that has been rejected or for concrete used to fill over-excavations.

Floors and intermediate and roof slabs will be measured over the external walls. Columns will be measured from top of foundation to first floor soffit and between floor slabs. Beams will be measured between columns or walls in length, and to floor soffits in height.

The unit rates for concrete shall include for : supply and transport of all materials to the site; batching, mixing, placing, vibrating and curing of concrete; testing of concrete; finishing of concrete, except as otherwise paid for under specially provided items in the Bill of Quantities.

Binding layers of lean concrete will be measured by square meters to a stated thickness. Cyclopean concrete will be measured by cubic meters including stones.

The shotcrete concrete will be measured by cubic meters including all means of application.

The Fiber concrete will be measured by cubic meters including all necessary metallic fibers.

202.14.3 Reinforcement Steel

Reinforcement steel will be classified for payment in accordance with the type of bars or fabric.

Measurement for payment of reinforcement bars will be made only of the weight of the bars placed in the concrete, on the basis of the net lengths and sizes, in accordance with the Drawings or as directed. Overlaps not shown on the Drawings will not be measured for payment. Payment for reinforcement bars will be made at the unit rates per kilogram (or ton) bid therefore in the Bill of Quantities, which unit rates shall include the cost of furnishing the reinforcement bars, furnishing and attaching tie rods and fasteners, wire ties and metal supports, if used, and of delivering, unloading, hauling, storing, sorting, cutting, bending, cleaning, welding if necessary, placing, and securing and maintaining in position all reinforcement bars, as shown on the Drawings or as directed, as well as waste and overlaps not shown on the Drawings.

Fabric reinforcement, required, will be measured on the basis of the area of work covered and will be paid for at the unit rates per kilogram (or ton) bid therefore in the Bill of Quantities, which unit rates shall include the cost of furnishing the fabric, cutting it to the required sizes, bending, placing, binding, supplying and placing all supports that are required, as well as the cost of all laps and waste.

202.14.4 Formwork

Formwork shall be measured for payment in m², classified by type (unwrought, wrought and for fairface concrete). Measurement for payment shall be of the net area of contact of concrete with the forms, after deduction of all openings and gaps exceeding 0.25 m² in area. The unit rates shall include for the use and waste of timber and of other materials and the supply of nails, tie-wires and fasteners; erection of forms, including scaffolding, shoring and shuttering; forming of levels, fillets, rebates, recesses, openings, etc.; removal of forms and for all materials (including waste), labour and equipment necessary for obtaining the required finish of the surfaces. It will also include temporary structures necessary for execution of all structure works.

Where no specific items for formwork are inserted in the Bill of Quantities, the cost of formwork as above shall be deemed to be included by the Contractor in his unit rates for the various items for concrete work and shall not be paid for separately.

202.14.5 Manholes and Chambers

Chambers shall be measured and paid for as defined in the Particular Specification.

Sewer manholes shall be measured by the number of complete units, classified according to type and depth as defined in the Bill of Quantities. For this purpose the depth shall be taken as the difference between the level of the manhole cover and the invert of the lowest pipe where it leaves the manhole. The unit rates of manholes shall each include : the cost of the required excavation in all kinds of soil; the blinding layer under the concrete floor; construction of the floor, walls, and ceiling, inclusive of reinforcement, all in accordance with the Drawings and as specified in the Bill of Quantities; supply and fixing of hooks, step irons and/or ladders; the construction of inlets and outlets; benching of the floor as shown on the Drawings; applying the specified finish to all internal surfaces including lastering where required; supply and installation of frames and covers; supply and fixing of pipe stubs for future connections;

compacted backfill around the structure and removal of all surplus spoil, and all ancillary works required to complete the manholes in accordance with the Drawings and specifications and to the Engineer's satisfaction.

The unit rates for manholes will not include for external drops, which will be measured and paid for as an extra over the rates of manholes and chambers. They will be measured by number and classified by diameter only, irrespective of depth. The unit rates shall include for the supply of all materials and all work necessary in the construction of the external drop to the details shown on the Drawings.

202.14.6 Thrust and Anchor Blocks

The thrust and anchor blocks shall be measured and paid for per cubic metre of concrete to the dimensions shown on the Drawings. The unit rate per cubic metre shall include excavation, erecting formwork, placing steel reinforcement, pouring concrete, backfilling works and all other related works.

202.14.7 Precast Concrete Elements

Precast concrete elements will be measured by number, length or area as detailed in the Bill of Quantities. The unit rates shall include for the costs involved in complying with all requirements of Section 202.11.3 and in addition all material, labour and equipment required in the manufacture, transport and placing the precast units in the structure, including also reinforcement steel and other metal parts that are part of the precast element.

202.14.8 Cast-in-situ Reinforced Concrete Piles

Cast-in-situ reinforced concrete piles will be measured by linear meters of concrete piles cast in boreholes, classified according to the depth and diameter of the borehole as specified in the Bill of Quantities.

The length of the pile will be measured from the bottom of the borehole to the bottom of the beam or column. The bottom of the borehole shall be taken as shown on the Drawings and/or determined by the Engineer. Lengths exceeding those shown on the Drawings or required by the Engineer shall not be measured.

The unit rates inserted in the Bill of Quantities shall include for : boring the hole for the pile and removal of the excavated material, protection of the borehole against caving in by installation and use of steel sheet casings and/or bentonite suspensions, supply of all materials for concrete, mixing and placing of concrete and all other works required according to the specifications.

Supply and placing of reinforcement cages will be measured and paid for separately according to Subsection 202.14.3 above.

202.14.9 Joint Seals

Joint seals will be measured by length, and will be paid per linear metre.

The unit rates for joint seals shall include the cost of supplied materials and all necessary works to complete the joint sealing.

202.14.10 Elastomeric Support

Elastomeric supports will be measured by units and will be paid separately for each specified support as shown on the drawings.

202.14.11 Hourdis Slabs

Hourdis slabs shall be measured and paid for per cubic metre of finished monolithical slab measured to the dimensions shown on the Drawings.

The unit rate per cubic metre shall include for formwork, steel bars, hourdis blocks placing concrete and all related works unless otherwise specified in the bill of Quantities.

BRICKWORK AND BLOCKWORK

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203 BRICKWORK AND BLOCKWORK

203.1 GENERAL

All brickwork and blockwork to be constructed under the Contract shall comply with the provisions of this chapter. The use of the terms “brick” or “block” and their compounds shall not be limiting and the use of one term or both in the specification shall, where applicable, be interchangeable.

203.2 MATERIALS

203.2.1 Bricks and Blocks

Bricks and blocks shall comply with the provisions of the following standards and codes of practice :

Concrete Bricks and Fixing Bricks	B.S. 1180
Precast Concrete Blocks	B.S. 2028 and 1364
Brick and Block Masonry	C.P. 121 Part 1

All bricks and blocks shall be new and unused, free from any defects, and entirely in conformity with samples submitted to and approved by the Engineer. Where no specific instruction is given as to grade of block, the Contractor shall supply blocks of the highest quality.

Blocks and bricks used in fair-faced walls (“neat” brickwork) shall be specially chosen by the Contractor, to ensure uniformity of aggregate size, colour, shape and freedom from defects, and the block manufacturer shall be advised of their intended use.

Special decorative blocks shall conform in all respects with approved samples as submitted to the Engineer prior to commencement of the work.

Hollow or blind concrete blocks shall be of first grade quality manufactured in an approved factory, made of vibrated and compressed concrete and thoroughly watered.

Hollow concrete blocks shall be mechanically manufactured on site or in an approved factory by means of moulds.

Mix proportion : 50 kg of cement
 120 l of stone chippings
 90 l of sand

Characteristics : Weight : 1500 to 2000 kg/m³

Concrete blocks shall be left to dry for nearly one month in a well ventilated shelter. They shall have the thickness specified on the drawings.

Concrete blocks shall be 40 days old minimum and show, after 28 days, a crushing strength (measured on the whole block surface) equal to 40 kg/cm².

203.2.2 Sand for Mortar

The sand shall be natural sand, or sand from crushed stone, which in respect of quality and classification, shall comply with the provisions of B.S. 1200.

203.2.3 Water

The water for mortar shall be of potable quality in accordance with B.S. 3148.

203.2.4 Cement

The cement shall be Portland Cement complying with B.S. 12.

203.3 MORTAR FOR BRICKWORK

203.3.1 Proportions for Mortar

The different types of mortar shall be proportioned by volume as follows, unless otherwise specified :

Cement Mortar, 1:3 - One part cement, and three parts sand or other fine aggregate.

The type of mortar to be used shall be as specified hereafter and as directed by the Engineer. For the purpose of proportioning by volume, a sack of cement shall be assumed to be 37 litres in volume (50 kg in weight).

203.3.2 Mixing of Mortar

The dry ingredients shall be measured in suitable containers and mixed by hand or by mechanical mixer and then the required quantity of water shall be added in the form of a spray. Mixing by hand shall be done in special boxes. Mixing shall not be done on the bare earth. Cement mortar shall be used within one hour of mixing.

203.4 BRICKLAYING WORKMANSHIP

203.4.1 General

All bricks and blocks shall be thoroughly wetted before use, except where the capacity of absorption of concrete bricks or blocks is less than 5% by weight, and the Engineer is so informed in advance.

A perfectly rectilinear wooden ruler, a plumb line and an air level shall be permanently kept on site for verification of masonry. The Contractor shall demolish and re-build at his own expense every wall that is not in accordance with the stipulated requirements.

According to the used material, and whether masonry will be rendered or kept exposed, surface evenness tabulated hereinafter shall be measured by means of:

- 10 m long line
- 2 m ruler
- 0.20 m ruler

203.4.2 Workmanship

Bricklaying shall progress upwards in an orderly and continuous manner, and so that no portion will rise more than one meter above adjacent sections, unless special considerations rule otherwise. Should it be necessary to stop work without the courses being completed, courses shall be racked back at an angle of 45°. On resumption of work, the top course shall be cleaned and wetted prior to laying of additional brickwork. All courses shall be horizontal, and vertical joints shall be staggered, alternate joints being in one vertical line. The use of broken blocks will not be permitted, but half-blocks, specially prepared will be used when and as required. Wherever a closing piece not to standard dimensions is required, the closing shall be done by neatly casting concrete. The bond will be as shown on the Drawings; where not shown, English Bond shall be used unless otherwise approved by the Engineer.

Masonry using exposed concrete blocks

Exposed surfaces shall meet the following tolerances:

- Total evenness measured with a 10.00 m line : 2 cm
- Alignment of horizontal joints lines (over 10.00m) : 1 cm

Masonry with concrete blocks to be rendered

There are two types of masonry:

- ordinary workmanship
- wrought workmanship

Ordinary workmanship shall be reserved to walls which do not require any wrought finish or those which shall receive either a traditional thick rendering or a finish applied indirectly to the surface.

The wrought workmanship shall have the same application as the ordinary one but its workmanlike quality limits eventual coating works.

Type of workmanship	Overall evenness under 2.00 m ruler (cm)	Out of flush and local evenness under a 0.20 m ruler (cm)	Appearance
Ordinary	1.5	1	Levelled joints Repair of scratches or accidental lack of material that cannot be concealed with traditional rendering works After repair, residual local imperfections that can be concealed with normal rendering works shall not exceed 10% of placed blocks.
Wrought	1	0.7	Idem, but the percentage of defective blocks equals 5

203.4.3 Joints

All joints shall be filled with mortar to a thickness of 10 mm over their entire surface of contact. The thickness of the mortar shall be even throughout the joint. The variation in thickness of any joint from the determined thickness shall not be greater than 2 mm. The overall height of any four courses shall be equal to the nominal height of four building elements (blocks or bricks), plus four times the specified thickness of the joint, ± 2 mm.

During the laying of bricks (or blocks) the joints shall be wiped flush with the face of the wall. Racking out of joints in preparation for pointing, or for forming special facing joints, shall be done after partial setting of the mortar. Special facing joints shall be formed at the time of racking out.

203.4.4 Scaffolding

Scaffolding shall be stable and conform entirely with all requirements of the law. No building work at a height of more than 2 meters shall be carried out without scaffolding. Scaffolds shall be secured to the wall through holes left in it by omission of blocks. These holes shall be carefully filled with blocks after the scaffolds have been removed.

203.4.5 Blockwork Filled with Concrete

Hollow or channel blocks intended to be filled with concrete so as to serve as pillars or beams shall be accurately laid to allow easy placing of reinforcement steel. The bars be tied to the reinforcement of the building framework. Joints shall be made in accordance with Subsection 203.4.3.

203.4.6 Cavity Walls

Cavity walls shall be built in cement mortar or cement-lime-mortar, in accordance with the Drawings. Walls of less than one brick thickness shall be constructed in stretcher bond. During construction precautions shall be taken to prevent course for cleaning purposes, shall not be filled in until the completion of the wall.

In the absence of any special detail for the drainage and ventilation of the cavity, every third vertical joint in the bottom course of the outer wall shall be left open. Precautions shall be taken that these joints remain open plastering.

The ties between the walls shall be made in accordance with details shown on the Drawings or approved by the Engineer. Where ties consist of bricks or blocks, their ends projecting into the inner wall shall be covered with bitumen to prevent the passage of moisture from the outer leaf. Metal ties shall be of non-rusting material, or shall be protected against corrosion.

203.4.7 Fair Face Work

Fair-face brickwork shall be built of specially selected bricks or blocks. Only straight, clean flawless blocks shall be chosen. The blocks shall be inspected again immediately prior to laying and any damaged blocks shall be rejected.

Joints in fair-face blockwork or brickwork shall be pointed according to the details shown on the Drawings or to the Engineer's instructions. Pointing shall be done with an approved special tool using a special cement mortar (2: 3) made with white or coloured cement and with added pigments as required or directed by the Engineer. Pointing of joints shall commence at the top of the wall, shall proceed downwards and shall be carried out immediately prior to the removal of the scaffolding. As the pointing progress the wall shall be thoroughly cleaned of all excess mortar. All joints shall receive the same treatment and final shape and colour in order to present a neat uniform appearance.

203.4.8 Chases

Pipe chases shall not be cut in lime-sand brick partitions of half brick thickness or less and shall not be cut in walls until the mortar in the joints has hardened sufficiently. The chases shall be filled with 1:3 cement mortar, after the pipes have been fixed in them.

203.5 BUILDING JUNCTIONS

203.5.1 Junctions Between Walls and Partitions

Unless otherwise specified, corners and junctions between walls and/or partitions with courses of the same height shall be built in continuity in proper bond across the corner or junction.

When the walls and/or partitions meeting at the corner or junction are not built in continuity or if their courses are of different heights, the junction shall be formed by a concrete column, jointed to the walls by tothing the blockwork in accordance with the detailed Drawings. The concrete junction column shall be cast in sections as the walls progress in height.

203.5.2 Junctions Between Brickwork Walls and Concrete Columns

Where the column is to be cast after the wall has been built, a suitable gap shall be left in the wall which shall be finished in tooth formation on both sides of the gap. The column shall be cast between formboards fixed to either side of the wall. The gap in the wall shall be such as will leave the minimum required width of the column between protruding teeth. The depth of the socket between teeth shall be at least 10 cm. Where the wall is to be built after the

concrete column has been cast, especially if the depth of the column is larger than the thickness of the wall, the junction shall be effected in accordance with the details shown on the Drawings, either by leaving a groove in the side face of the column into which the bricks or blocks are built, or by casting a small connecting column between the main column and the toothed end of the wall as described in Subsection 203.5.1 above.

203.5.3 Junctions Between Walls and Concrete Soffits

The gap at the joint between the top of the top most course and the concrete soffit shall not be greater than 1.5 cm and shall be filled with 1:3 cement mortar. The wall shall be secured to the joint. The filling of the joint and the wedging shall be done after the mortar in the wall has properly set and hardened and, preferably, just before plastering.

203.6 MISCELLANEOUS BRICKLAYING WORK

203.6.1 Brick facing on walls

Bricks and blocks for wall facing (remaining exposed to view) shall be selected as required under Subsection 203.4.7 for fair face walls. The mortar used for laying facing bricks shall be cement lime mortar 1:2:6 or cement mortar 1:3. Making and pointing of joints shall be done as required in Subsection 203.4.7. Bricks or blocks used in facing shall be fixed to the wall by means of mortar having as dry a consistency as possible. Where anchors are shown on the Drawings they shall be of non-corrosive metal and shall penetrate at least 3 cm into the wall.

203.6.2 Composite Walls

Walls consisting of brickwork or blockwork with a concrete backing, shall be built as required in Section 203.4, except that they shall be constructed in lifts not exceeding 5 courses of blocks or 10 courses of bricks. Bricklaying in any lift shall not begin until the backing concrete in the lift below it has been allowed to set. Unless otherwise specified, the backing concrete shall be Class C15P in accordance with Division 204.

203.7 PREFABRICATED AND PRECAST ELEMENTS

203.7.1 General

This section shall apply only to those prefabricated and precast elements which have no structural function and are not part of the load-bearing structure. Included are those elements of concrete, asbestos-cement and similar materials, used as ventilating louvers, light partitions in bathrooms, banisters to stair-ways and balconies, etc..

203.7.2 Supply and Erection

The Contractor shall supply the required elements only after samples submitted by him to the Engineer have been approved.

Elements such as ventilation louvers shall be supplied and built in during building of the wall. All elements supplied shall be clean, free from flaws and complete in all details in accordance with the Drawings or instructions and shall include anchor damage during the course of the work.

203.7.3 Concrete Elements

Concrete for precast elements shall be Class C15P at least, unless specifically stated otherwise. Reinforcement shall be included as required, in order to facilitate safe haulage, erection and use.

203.8 METHODS OF MEASUREMENT AND PAYMENT

203.8.1 Walls and partitions

Brick and block walls and partitions will be measured by m² or built area according to the Drawings and classified by type and thickness of wall, all openings, beams, columns, precast elements etc.. being deducted from the area measured; however, tooth work as required under Section 203.5 will not be deducted. The cost of making all openings in the brick or blockwork shall be deemed to be included in the rates for the brickwork and shall not be paid for separately.

Unit rates shall be deemed to include for supply of all building materials such as blocks, bricks, cement, sand, etc.. and the waste involved in their use, the erection and removal of scaffolding, the cost of making all openings and connections to the walls, partitions and concrete structures. Where connection of blockwork wall to an existing building (i.e., one not built under this Contract) is required, payment will be made for the connection measured in accordance with the net length of the connection between one old and the new structures.

203.8.2 Columns and Beams

Columns and beams of hollow blockwork filled with concrete will be measured and paid for extra over the prices for blockwork. Measurement will be in accordance with the net lengths of the columns or beam and the unit rate shall cover all costs of special blocks, concrete work, steel reinforcement, etc..

203.8.3 Fair face

Neat work (fair face) will be measured separately by area, in m², extra over the unit rates for brick or blockwork; neat work on both faces will be paid for at the same unit rate, for each face separately.

203.8.4 Precast Elements

Precast elements will be paid for separately in accordance with size and type of complete elements. The unit rate will include for the supply of the elements and all accessories required for building-in as well as the actual erection of the element. The unit rate for precast units shall allow for cement wash rendering should the Engineer request it, in order to obtain a more uniform and harmonious appearance to the wall in which the element is built.

PLASTERING

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205 PLASTERING

205.1 GENERAL

205.1.1 Miscellaneous Requirements

Surfaces

i) Nature of surfaces

Plasterworks specified in this Section shall be applied to the following surfaces:

- traditional masonry made of stones, bricks, concrete blocks, traditional floors or with precast small girders.
- ordinary aggregate concrete or lightweight concrete.
- plaster tiles and plates including cellular plaster tiles.
- Plaster plates and perforated cardboard.
- metal lathing.

ii) Condition of Surfaces

All surfaces to be plastered shall be dry, clean, free from soot, efflorescence, dust and oil. They shall be rough and unevenness of joints shall not exceed one third the plastering thickness.

Plastering frozen surfaces is not permitted.

Plastering work shall be classified into internal and external work, each of which may be applied in one-coat or two-coat work as indicated on the Drawings and/or in the Particular Specification or as directed by the Engineer.

The Contractor shall not carry out any plastering on days of extremely dry weather without the prior approval of the Engineer, who may require special precautions to be taken by the Contractor to prevent the early drying out of the plaster. Each layer of plaster shall be wetted prior to placing the next layer and at least 24 hours shall elapse before an additional layer is placed. All corners, whether internal or external, shall be neat and true, special care being taken to ensure a true, straight line at the junction of walls to the ceilings. All finished plastered surfaces shall be even, smooth, straight, plumb, with true angles (except where curved surfaces are shown on the Drawings) and free from trowel marks, cracks and other blemishes. Plane surfaces shall contact a 3 m straight edge with not over 3 mm deviation either way. Plaster showing cracks, blisters, pits or discoloration will not be accepted. It shall be removed by the Contractor and made up again at his own expense to the complete satisfaction of the Engineer.

205.1.2 Samples

Samples of each type of plaster to be used in the Works shall be prepared, each sample covering at least 1 square meter. Each sample shall be subject to approval by the Engineer, prior to actual commencement of plastering.

205.1.3 Scaffolding

Scaffolding shall be of sturdy and stable construction. Where a decorative spray or thrown finish is required to the plaster, the scaffolding shall not be connected to the wall to be plastered.

205.1.4 Repairs to Finished Plaster

Repairs of plaster, at skirting and elsewhere, as for instance around pipework, passages and channels, after the completion of other trades, shall be done in a neat manner so that all repairs will have a uniform appearance, indistinguishable from the general area of the plaster.

205.1.5 Levelling Course

A levelling Course shall be applied under all plasterwork and where called for on the Drawings and/or in the Particular Specification or directed by the Engineer, in order to straighten or correct imperfections in the base (brickwork, concrete, etc.). The levelling course shall consist of a cement-sand mix containing not less than 400 kg cement per meter cube of material. The course shall be applied as a thick paste with the aid of trowels, the minimum thickness being not less than 3 mm. Should the thickness be 10 mm or more, reinforcing wire mesh shall be used.

205.2 MATERIALS

Lime shall comply with the requirements of BS 890.

Lime shall be stored in a dry place protected from excessive temperature and wind.

Water shall be of potable quality, clean, fresh, free of salts, chemicals and impurities.

Sand shall be natural sand or quarry sand, free from dust, dirt and organic and foreign matter, complying with B.S. 1198 and 1199. Quarry sand shall not contain fines passing a No. 200 sieve in a quantity exceeding 6% - 8%. The sand for the first coat in two-coat work shall be coarse and graded. For the top-coat the sand shall be fine and well-screened, except where a special plaster made of coarse sand is required. Dune sand shall only be used for the top-coat of smooth internal plaster. The sand shall be supplied to the Site and stored according to type, each type separately. Sand in storage shall be placed on a layer of suitable material or any other stable surface in order to prevent contact and mixing with earth. The use of siliceous sand instead of calcareous sand is advisable.

Additives to control the workability or setting time of plaster may be used only with the prior approval of the Engineer, and shall be suited, in quality and quantity, to the type of cement used. No additional payment will be made to the Contractor for the use of any additive.

Coloured plaster shall be obtained by adding pigmenting powders to white or gray cement or by using coloured cement. Such cement shall comply in all respects with the requirements of the standards for ordinary Portland cement. Pigmenting powders shall be mineral oxide of metals. The use of compounds of organic origin will not be permitted. The pigmenting powders shall be obtained from approved manufacturers. They shall be thoroughly mixed with the dry cement before being introduced into the mixing machine.

Metal Lathing for plastering on false ceilings and partitions shall be expanded metal (XPM), at least 0.6 mm thick, with mesh size openings of at least 12 mm and the opened mesh weighing at least 1 kg per square meter. Wire Mesh used for plastering chases in brick or block work shall be XPM as above or chicken wire with a thickness of 0.7 mm and a mesh of at least 12 mm.

205.3 WORKMANSHIP

205.3.1 Preparation of Surfaces

Plastering shall be done only after all other finishing works such as window sills, terrazzo work, electrical work, drain pipes, etc., has been completed. Only with the Engineer's consent in writing will the Contractor be allowed to carry out plaster, prior to the completion of all other works. In exterior plasterwork, care shall be taken to avoid staining or damaging any completed elements of the building.

No plastering shall be done until at least two weeks have passed since completion of the brickwork or concrete on which the plaster is to be placed. All surfaces to be plastered shall be thoroughly brushed down with stiff brushes to remove any efflorescence and all loose and flaky particles. Grease and oil patches must be removed.

Prior to commencement of plastering, all necessary repairs shall be made to the base, protrusions shall be removed and any exposed steel reinforcement shall be covered with a 1:3 cement-sand mortar.

Considerable holes or local unevenness shall be patched with mortar, plaster mortar or plaster. Where holes or local unevenness exceed 5cm, they shall be filled with parts of brick and hollow blocks, as well as, with lime mortar or plaster mortar.

Patching on plaster masonry shall be carried out with plaster or plaster mortar.

Junctions between two different materials (e.g., concrete and blockwork) shall be covered with 15 cm wide strips of XPM mesh. No mesh will, however, be required where junction between brickwork and concrete is toothstepped.

Pipe chases containing two or more pipes shall be covered with wire mesh, the mesh being stretched across the chase with a 5 cm minimum overlap on each side, and fastened down with galvanized nails. The mesh shall be covered with a 1:3 cement-sand mortar. Minor chases, holes, etc., need not be covered with wire mesh, but shall be carefully filled with a 1:3 cement-sand mortar, the face of which shall be slightly roughened.

All repairs shall be thoroughly cured and allowed to dry, and moistened prior to commencing the plastering.

All smooth surfaces, such as concrete, shall be scarified in order to increase the bond of the plaster to the wall or ceiling. In blockwork the joints shall be raked out to a depth of 1 cm and all exterior surfaces shall be spatterdashed in 1:2 cement sand mortar to provide a key for the plastering. The spatterdash shall be wetted an hour or two after application to ensure adequate hydration and shall be allowed to harden thoroughly for 3 days during which time it shall be covered up for protection against the sun and kept moist by watering.

Surfaces to be plastered shall be cleaned and moistened, prior to application of plaster. Where necessary, ingrained dirt and other foreign materials shall be removed by wire brushing. Twenty-four hours prior to application of plaster the surface shall be soaked with a light spray of water, but not to an excess causing water to flow down the face of the wall to be plastered. During warm, dry weather the area shall be lightly wetted for a second time immediately before commencing the plastering.

205.3.2 Plastering

a) General

It is not allowed to re-mix plastering having began to dry out with or without adding fresh plaster.

Plaster mix shall consist of the following:

- cement mortar: 300 to 350 kg of cement per cubic meter of dry sand
- lime mortar: 350 kg of mix (one part of lime to two parts of cement) per cubic meter of dry sand
- plaster mortar: 300 to 350 kg of plaster per cubic meter of dry sand.

Smooth surfaces shall be roughened and cleaned from loose particles or treated with a sand cement or plaster sand mix to which an admixture is added to increase the bond (acetate or vinyl propionate).

b) Type of Plastering

Plastering shall be applied and smoothed by hand in two coats to a metal lathing.

c) Application of fine structural plaster or coarse structural plaster rendering

Plastering shall be applied in two coats, the first is a coarse structural plaster. The mix contains at least 100 kg of plaster per 100 liters of water.

The base coat shall be applied to the levelling course with a trowel but not smoothed. As soon as this coat hardens it shall be scarified with a special tool and the top coat applied.

The mix of the second layer shall be at least equal to that of the first applied. The total thickness shall reach 12mm with a tolerance of 2mm. Where a metal lathing is to be placed plastering shall be 6mm thick.

205.3.3 Condition of surfaces

After the surface preparation (wire brushing and removal of loose particles) plastered surfaces shall show no cracks, holes flakes nor streaks of more than 1mm deep. Moreover, the number of holes and streaks of less than one mm deep shall also be limited. Surface unevenness shall be repaired by traditional surface preparation work taken into account the type of paint to be applied and the required finishing quality.

The deflection under a 0.20m long ruler drawn over the surface in all directions shall not exceed 1mm (local evenness). A two meters long ruler drawn over the surface shall not show a deflection exceeding 5mm (general evenness).

The tolerance on verticality shall be 5mm maximum for one floor.

205.3.4 Reinforcement of Corners

External corners at intersections of plastered surfaces shall be reinforced by means of special approved angle beads of galvanized steel, aluminium or plastic, all as specified or shown on the Drawings. The height of the angle beads shall be not less than 1.8 m measured above the top of the skirting. The angle beads shall be securely fastened to the base wall under the plaster by use of galvanized nails. Plaster of the type used on the wall shall be carefully filled under and around the angle bead. The apex of the angle shall coincide exactly with the edge of the corner with regard to position and plumb.

205.4 METHODS OF MEASUREMENT AND PAYMENT

205.4.1 General

The unit rates for plastering shall include for the use of all tools scaffolding, labour and materials, including supply, processing and use of cement lime - slaked or otherwise - sands, gravels, additives and colouring pigments, mica flakes, and including for metal lath, all as specified and as applicable. Unless otherwise specified, the unit rates shall include for the use of ordinary Portland cement. The unit rates shall also include for all cleaning and wetting of all surfaces prior to plastering and the protection and curing of the plaster, inclusive of all surface treatments required.

205.4.2 Measurement

Measurement will be in all cases be net in square meters, as measured on the Drawings, all openings, tiling, skirtings and other areas not covered by plaster being deducted with no allowance for waste, overlap, etc. Reveals, jambs, and rebates to openings (doors, windows, etc.) will be measured for payment together with the general area of the plaster and no special rates will be paid for them.

For purposes of measuring external plaster, the bottom edge will be taken as being 10 cm below final external ground level, unless otherwise shown on the Drawings.

205.4.3 Payment

Samples, making good to other trades and repairs will not be paid for separately and the cost thereof shall be included in the unit rates for plastering, which shall also allow for the supply of wire mesh for covering pipe chases, etc., where required.

Internal or external plaster will be paid under the same item in the Bill of Quantities.

RENDERING

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206 RENDERING

206.1 GENERAL

Rendering with hydraulic binders mortars shall be governed by related B.S. Standards. Rendering shall only be carried out on completed masonry works. It shall be made sure that rain and water have no pernicious action on the good hold of the rendering. It is advisable to render only on elements that have completed the major part of their shrinkage.

Rendering works shall not be started prior to the installation of electric and sanitary equipment, woodwork, metalwork, and all metal fittings. Works include, in addition to rendering, the fill-in of holes caused by the installation of electric and sanitary equipments, metal fittings, etc.. Fill-in shall be carried out with a mortar proportioned at 350 kg of cement per cubic meter of sand.

All finished surfaces shall be even and to the thickness required by the Engineer. They shall be, where specified, straight, plumb with true angles. Rendering showing defects shall be removed by the Contractor and made up again at his own expense to the complete satisfaction of the Engineer.

Samples of rendering to be used in the works shall be prepared, each sample covering at least 1 square meter. They shall be subject to the prior approval of the Engineer. Samples shall be kept on site until the completion of works. All finished rendered surfaces shall comply with the samples.

Markers shall be placed at the rate of one marker by square meter of wall to be coated. Rendering shall be carried out using a plumb line and a ruler.

Unless stated otherwise, rendered surfaces shall be brought even and smooth by using a felt. No rough patches, ridges, nor any imperfections shall be accepted. Connection with woodwork, skirtings, or metallic structures etc... shall be neatly finished and flawless.

Rendering shall be conducted and low-angled light will used so that any flaw such as undulations, ridges, blusters be detected and repaired.

Edges, salient angles, etc... shall be sized and rectified by means of straight wooden or metallic rulers.

Should several elements be set out at a stretch, they must be, after rendering, perfectly aligned and their dimensions rigourously unchanged.

A straight wooden ruler, a plumb line, an air level, a square, and an electric lamp shall be kept continuously on site.

The Contractor shall provide and install at his own expense all scaffoldings and ramps necessary for an easy and safe access to all surfaces to be rendered.

Prior to application of rendering and finishes, surfaces should be thoroughly cleaned and wetted for several hours.

Rendered surfaces shall be wetted after application to ensure adequate hydration and shall be allowed to harden thoroughly for 3 days during which time it shall be kept moist by watering.

Construction joints in rendering works shall be done in a neat manner so that the surface will have a uniform appearance, after having dried and shrunk, indistinguishable from the general area of the rendering.

206.2 MIXING OF MORTAR

Mortar can be mixed either manually or by means of mechanical mixers. Should mixing be done by hand, the dry solid constituents shall be mixed first, before water is added, in a very clean area to prevent contact and mixing with earth or other materials. Sand shall be measured in volumes by means of gauge boxes, in such a manner that each batch requires a whole number of 50 Kgs cement bags. Mortar shall be used half an hour maximum following its preparation.

206.3 RENDERING

Prior to the commencement of rendering, surfaces should be duly prepared.

Rendering generally includes:

- a roughcasting
- an intermediary coat
- a top coat which contributes partially to the structure waterproofing, and could be replaced or covered with a decorative plaster.

206.3.1 Roughcasting

External and concrete surfaces, especially if they are smooth, shall be roughcast. Internal rough surfaces shall not be roughcast (e.g. masonry with concrete blocks). This coat shall consist of a cement-sand mix containing 550 kg Portland cement per cubic meter of sand or one part of Portland cement for three parts of sand.

Grading of sand shall be 0.25/3.15 mm and shall contain 10% of fines maximum. Mortar shall be watered to obtain a good workability, and spatterdashed by means of a broom or a mechanical tool. The surface shall be rough and shall not undergo any other process whatsoever. The roughcast shall cover uniformly the surface. It shall be kept moist by watering for three days at least and shall adhere strongly to the surface. Any roughcast which did not harden thoroughly during the three day time and disintegrates, shall be entirely removed and replaced at the expense of the Contractor. Intermediary and top coats shall be applied, in principle, in two distinct coats.

206.3.2 Intermediary coat

The intermediary coat shall give rendering its final shape, the required evenness and waterproofness. It shall be homogenous and compact and consists of lesser quantities of binders than in the roughcasting coat in order to limit its fissurability. Grading of sand shall be 0.1/3.15mm, contain 5% min. of fines < 0.089 mm and be graded.

Intermediary coat shall consist of 450 kg cement per cubic metre of dry sand graded 0.1/3.1 mm. Moisture expansion of sand which is conditional upon the water content and grading

shall be taken into account when preparing the mix. This coat shall be applied only after the roughcasting coat has partially shrunk.

The intermediary coat shall not be applied until three days at least have passed since completion of the last coat. However, this period is conditional upon the atmospheric conditions.

Mortar shall be proportioned to a thick workable paste. This coat shall be applied either by hand or mechanically on a moistened roughcasting, in two or more passes depending on the thickness. The surface shall be finished with a float to an even and compact surface.

Smoothing the surface with a trowel is not permitted. It shall be roughened by using a ruler and meet the requirements of finished rendering (evenness, straight angles, round grooves etc...).

Average thickness of both roughcasting and intermediary coats shall range between 15mm and 20mm according to the tolerances on the substrate in such a way as to cover the entire surface by 10mm at least.

206.3.3 Top coat

Top coat or finishing coat is decorative but also protects the intermediary coat and preserves its waterproofness.

Since the colour of grey content is not always uniform, it is advisable, to provide cement from the same source and date of manufacture in order to improve the uniformity of shades. The same applies to sand.

This coat shall be made with an ordinary or decorative hydraulic binders mortar.

Grading of sand shall be 0.1/2mm and contains fines in considerable quantities and free from impurities (clay, gypsum, coal, organic matters, etc...)

The coat shall consist of 350 kg or 400kg of binder per cubic meter of dry sand graded 0.1/2mm.

The top coat shall not be applied until eight to fifteen days have passed since completion of the intermediary coat (average atmospheric conditions).

top coat shall cover the surface uniformly and, in no case, improve the evenness. Troweling, as well as powdering with lime or cement shall not be permitted.

The thickness of the top coat will be 5 to 7 mm.

206.3.4 Rendering on metal lathing

The metal lath shall be well blasted 24 hours at the latest after application of the roughcasting coat and securely fastened using rustproof staples or other suitable fasteners. The metal lath shall be a rustproof wire mesh with square openings of at least 30mm x 30mm.

206.4 INTERIOR RENDERING

Interior rendering shall comply with previous clause requirements and consist of 350 kg of cement per cubic meter of sand.

It consists of two-coat rendering applied as follows; roughcasting and top coat.

206.5 EXTERIOR RENDERING

It consists of three coat rendering applied as follows; roughcasting - intermediary coat-top coat.

206.6 EXTERIOR ADMIXED RENDERING

It shall have the same characteristics and specifications as those of the ordinary rendering coat (see rendering) and shall consist of 450 kgs of cement per cubic meter of sand and an additive to control plasticity and waterproofness according to a technical sheet and a technical certificate submitted for approval prior to commencing the works.

This coat shall mainly protect external walls subject to infiltrations and run-offs.

206.7 COLOURED CEMENT RENDERING

Coloured cement rendering shall consist of:

- a roughcasting coat
- a first coat, 10 mm thick, containing 400 kg of white cement per cubic meter of sand, scratched in both directions.
- a second coat, 8mm thick maximum, containing 400 kg of white cement per cubic meter of chippings, powder and pigments where called for on the Drawings and as directed by the Engineer.

Mix proportions, quality and colours of chippings, powder and pigments shall be determined subsequently by the Employer. Rendered surfaces shall be smooth and even as shown on the Drawings and as specified by the Employer.

The second coat shall be wetted three days after application to ensure adequate hydration.

Any rendered surface showing imperfections such as: unevenness, cracks, disintegration of white cement mortar, scratches (especially along arises) etc... shall be removed and re-rendered at the expense of the Contractor and under his responsibility. Repair or rendering shall be done in a neat manner so that all repairs have a uniform appearance, indistinguishable from the general area of the rendering.

Coloured white cement rendering shall be consistent with the approved sample kept on site until completion of the works.

206.8 DECORATIVE SPATTER MORTAR (TYROLEAN)

Top coat of mortar shall be applied by hand (Tyrolean brush) or mechanically. The top coat shall be applied in two or three layers, having an average thickness of 3 to 5mm. The finished surface is conditional upon the water content, the number of layers, the spatter angle and any eventual finishing treatment. Top coat shall have the same mix proportion as that used in a coloured or white cement top coat, and be applied as follows:

- a roughcasting coat
- a second coat
- a third coat with decorative mortar

Mix proportions are as mentioned previously.

206.9 RENDERING OF BASEMENT WALLS

N.B: Rendering applied to basement walls shall take into account the destination of the premises delimited by the walls, the soil nature and shape, as well as climatic conditions, the nature of support surfaces and the structure design.

Rendering of buried surfaces

General

Rendering applied to external facing of buried basement walls shall comply with the following paragraph.

Technical Specifications for exterior rendering

Minimum layers:

Rendering shall consist of at least:

- a roughcasting coat
- an intermediary coat

Minimum thickness:

Each coat shall be 8 to 15mm thick. The average thickness of both coats shall be 20 to 25mm according to the tolerances of each type of surface so as to ensure a uniform covering of at least 15mm.

Rendering

Rendering shall be applied by hand or mechanically. It shall consist of 450 to 550 kg of cement per cubic meter of dry sand. A waterproofing admixture shall be used according to the manufacturer specifications. Rendering applied to buried structures shall extend to about 20 cm above ground level.

Specifications for interior rendering

Interior rendering shall be ruled by the same conditions specified for 3 or 2 layer-rendering.

Rendering of non-buried surfaces

Rendering non-buried surfaces of basement walls shall comply with the conditions set for rendering exposed surfaces.

206.10 RESPONSIBILITY OF THE CONTRACTOR

All rendering which have started to set before application shall be removed from site. Those falling, cracking or suffering any damage whatsoever in the year following the taking over shall be removed and made up again at the expense of the Contractor. He shall take all necessary measures during surface preparation, rendering and setting time so as to ensure quality work, namely, by protecting rendered surfaces with dampened hessian coverings if need be.

These constraints are included in the incidental expenses of the Contractor.

N.B: The use of lime as a plasticizer shall only be permitted upon the written approval of the Employer.

206.11 CHARACTERISTICS

Tolerance

Tolerance is checked by measuring deviation under a 2.00m ruler or a 0.20m ruler. The deviation shall not exceed the following values.

	Under 2.00 m ruler	Under 0.20 m ruler
Spatter rendering	1 cm	-
Between wall lines	0.5 cm	0.2 cm

Plumb

Rendering applied to vertical surfaces shall have a maximum tolerance of 0.01m for each three meters.

This tolerance is only applicable to renderings between wall lines.

Bond

Rendering shall bond to the surface and shall not give a hollow sound when hammered. The rate of bond shall be equal to 0.3 megapascal (3 bars) after 28 days of application.

Three core samples crossing the whole rendering thickness shall be taken randomly from surfaces 50m² at least. The rate of bond shall be the arithmetic average of rates of bond measured in the various points. (The rate of bond shall never be less than 0.2 megapascal (2 bars)).

206.12 METHODS OF MEASUREMENT AND PAYMENT

206.12.1 General

The unit rates for rendering shall include for the use of all tools scaffolding, labour and materials, including supply, processing and use of cement, or otherwise - sands, gravels, additives and colouring pigments, mica flakes, and including for metal lath, all as specified and as applicable. Unless otherwise specified, the unit rates shall include for the use of ordinary Portland cement. The unit rates shall also include for all cleaning and wetting of all surfaces prior to rendering and the protection and curing of the render, inclusive of all surface treatments required.

Measurement

Measurement will be separate for the various types of render, and in all cases be net in square meters, as measured on the Drawings, all openings, tiling, skirtings and other areas not covered by render being deducted with no allowance for waste, overlap, etc. Reveals, jambs, and rebates to openings (doors, windows, etc.) will be measured for payment together with the general area of the plaster and no special rates will be paid for them.

For purposes of measuring external plaster, the bottom edge will be taken as being 10 cm below final external ground level, unless otherwise shown on the Drawings.

206.12.2 Payment

Samples, making good to other trades and repairs will not be paid for separately and the cost thereof shall be included in the unit rates for rendering, which shall also allow for the supply of wire mesh for covering, etc., where required.

Types of render will be itemized separately in the Bill of Quantities. The types will be further subdivided into render on plane surfaces and on curved surfaces.

Types of render to be paid for under separate items include (but are not limited to):

- a) Interior rendering
- b) Exterior rendering
- c) Exterior admixed rendering
- d) Coloured cement rendering
- e) Decorative spatter mortar
- f) Basement wall rendering.

PAINTING

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207 PAINTING

207.1 MATERIAL & APPLICATION

The following subsections deal with paint work on all exposed surfaces such as walls, ceiling, woodwork or metalwork both indoor and outdoor. The term “paint” as used herein shall include:

- Stains,
- Varnishes,
- Emulsions,
- Enamels,
- Pain washes,

and all materials as:

- Oils,
- Putties,
- etc..

All paint materials shall meet the requirements of the relevant British Standards and shall be of an approved manufacturer.

- a) The entire paint system used for painting a structure shall be of the same manufacturer. Mixing of paints of different manufacturers on the same structure shall not be permitted.
- b) All paints used shall be subject to prior approval of the Engineer’s Representative.
- c) The Contractor shall submit for the Engineer’s approval a detailed list of the paints he intends to use on the job, stating:
 - the name of the manufacturer
 - the type of paint
 - full specification of manufacturer including directions for handling and use, instructions for thinning (if any) and minimum drying time.

All paints shall be kept on the job site in the original unopened factory containers and shall be protected against the entry of air, water, dirt, or any other foreign matter.

- Paint shall be stored at shaded locations. Storage of paints, their mixing, thinning, etc., shall be carried out in a special paint shed provided by the Contractor for this purpose; on no account will the building under construction be used as paint store.

All paint work shall be performed by experienced and qualified painters, in accordance with the standards of practice.

- Prior to commencement of painting the Contractor shall clean the area and its surroundings and remove all waste building materials, cement bags and dirt. Care will be taken to avoid dropping paint on floors, sanitary installations, and other areas or objects not intended to be painted. All such areas and objects shall be covered for this purpose with sacking or other suitable protective material. Freshly painted surfaces of metal and woodwork shall be suitably protected.

Ironmongery, fittings and other attached fixtures such as:

- doors knobs,
- fasteners,
- locks,
- electric fittings,
- signs,
- etc.,

will be removed whenever possible from all windows, doors, walls, etc., and suitably stored until completion of the paint work and then be properly re-attached to their original positions.

Application of final coats of paint shall be done only after completion of all other building works. No work will be undertaken under adverse weather conditions, in heavy mist, during dust storms, or in case of external paint work, during or immediately following rain.

The choice of every type of paint material shall be in conformity with the specific recommendations of the manufacturer specially concerning the different finishing conditions requested and nature of substrate.

207.1.1 General conditions of intervention

Norms applicable are the relevant British Standards requirements, the paintworks include but limited to the following works:

- the preparation of surfaces,
- the material supply needed for the paint work execution
- the supply of the necessary stock of tools, ladders and scaffoldings etc.,
- the paint application on reference surfaces and sample specimen.
- the application of paint on all prepared substrates in conformity with BS, and the prescriptions of these specifications.
- obtaining of the required quality, the finishing aspect, the degree of brilliance, the coloring and the necessary set off colors as prescribed in the specifications.
- the cleaning of all dirt, caused by the painter intervention.
- etc.

207.1.2 General co-ordination

The Contractor is instructed to maintain a perfect co-ordination between his paintworks and the other concerned works, in particular the woodworks and glazery works etc., aiming to execute in the right time all necessary scheduled works.

- All supply and application constraints shall be due for a complete finishing as defined in the specifications.
- It is strictly forbidden to the Contractor to start the paintworks before the execution of the tile-flooring and the first passage of the pouncing machine being executed and before all having dried perfectly. Final painting works must be done after the completion of exterior woodworks and glazery works.

- Only the wall preparation and the first paint coats (primer) can be executed before the pouncing machine passage be done. The Contractor can achieve the ceiling paints and wall paints leaving the last coat (only on walls) to be achieved once the polishing of tile-flooring is done.
- A perfect co-ordination must be achieved between all involved parties.

207.1.3 General execution conditions

The Contractor must insure a perfect execution of all paintworks

- All paint material and products used and their application procedures must be of such quality to satisfy the Engineer requirements.
- In particular the Contractor must present to the Engineer approval and before any commencement of paintwork a sample of each approved material to use. The Engineer preserve for himself the right to proceed to testing and analysing of the materials at the reception and in the course of execution.
- If the controls operated reveal defects in the quality of products used or in the procedures of application, the Contractor must proceed to the complete reparation at his own cost and responsibility of all the disapproved works.
- The Contractor must bear all execution costs of such works as necessary sampling to determine on the job site the tint to be chosen after agreement of the Engineer.

207.1.4 Particular execution conditions

The application of paints, varnishes, emulsions, mastics etc., shall start only when surface to be painted has thoroughly dried out, provided that at least one dry (or summer) month and two wet (or winter) months have elapsed since plaster or concrete have been placed.

- Ambient temperature of application must be higher than 18°C and the ambient atmosphere must not be too humid favouring condensation or too dusty.
- The substrate must not be overheated or frozen.

Cement renders and concrete shall not be painted before at least one week after the execution.

Ceilings in particular, receivant oil paint must receive previously a layer of isolation product necessary to avoid absorption difference in the render substrate and uneven discoloration in careful finishing.

All ironmongery works must be chemically clean before painting with no trace of calamine, rust, humidity, grease and dirt, etc.,

- Decalamination must be obtained by natural oxidation, it must be later on followed by hammering and rubbing down.
- Calcium deposit shall be removed by hammer or abrasive disc if necessary.

- Rust must be cleared of by dry rubbing with a metal brush, by hammering, by rotative brush or by glass-paper.
- Mortar dirt must be cleaned by rubbing down with a metal bross.
- Grease will be removed by cleaning with “white spirit”.
- Pouncing will be done with pouncing stone, so that it does not subsist on the surface no grain or roughness.
- No painting will be applied unless on a surface perfectly brushed, and all sandy particles or any non adherent mortar or any trace of dust has been removed.
- During painting works, the Contractor must ensure a suitable and complete protection of the soil, woodworks, glazery, piping system, etc., and the gradual cleaning of all finished works.
- When instructed by the Engineer and for carefully finished surface, the paint will be applied on these surfaces with special preparation such as:
 - refitting,
 - filling up of all cracks, holes, pits or other surface imperfections,
 - cleaning all dirt and concrete traces,
 - etc.,

207.1.5 Cleaning after painting

At the end of painting works, and when reception of these works is made possible, the contractor must proceed to the complete and perfect cleaning of all construction elements such as:

- floors
 - glazery
 - walls
 - woodworks
 - plinth
 - pipes
 - etc...
- All precautions must be taken by the Contractor to avoid damaging the places, using procedures or products nonadapted to a perfect execution of the cleaning works. If the cleaning is not realised as instructed, detailed and approved, the Engineer will reserve for himself the right to undertake new cleaning works by another special enterprise of his choice, all expenses for these operations being beared by the Contractor.

207.1.6 Selection of paint materials

All paints to be used shall comply with the requirements of the relevant British Standards, or where specified in any other standard or specification, and shall be subject to prior approval of the Engineer's Representative.

- The Contractor shall attach to his approval request a detailed list of the paints he intends to use on the site. This list shall contain the following informations:
 - name of manufacturer
 - type of paint
 - full manufacturer original specification, including directions for handling and use, instructions for thinning (if any) and minimum drying time.
 - full original catalogue of the whole products form the manufacturer.
 - etc.,
- All paints shall be kept on the job site in the original unopened factory containers and shall be protected against the entry of air, water dirt, or any other foreign matter.
- Paints shall be stored in shaded locations.
- Thinning of paints will not be permitted except to manufacturer's instructions, if any.

Manufacturer's instructions as to storage, handling, thinning and application of paints shall be strictly adhered to.

- The entire paint system used for painting accessories of the same installation unit or structure shall be of the same manufacture.

Choice of product by the Contractor must take in account:

- the aptitude of the product to fulfil its function,
- the kind of protection needed,
- the finishing surface projected,
- all prescriptions of the specifications.

The following requirements shall apply to the different types of paints: (steel pipe installations and steel structures)

No.	Type of paint	Standard	Drying time
1	Oil-based red lead primer	/BS/2521 and /B.S./2523	24 hours minimum
2	Synthetic red lead primer	Federal specification: TT-P-86G type II	24 hours
3	Iron oxide paints	B.S./2524	12 hours minimum between coats
4	Aluminium paints for cover-coats	M/69	24 hours minimum
5	Cover-coats paints, (other than Aluminium paint)	These paints shall be synthetic paints for steel structures, and shall meet the requirements of the relevant B.S. standard and shall be of an approved manufacturer	As specified in Particular Specification and/or directed by the Engineer

N.B.: When more than one coat is specified (of primer or of the same paint) successive coats shall be of different, easy distinguishable tints.

Generally all surfaces to be painted shall be:

- clean,
 - dry,
 - smooth and
 - free from dust, grit, and other foreign matter
- All nails shall be countersunk and stopped with putty, prior to painting.

Concrete and plaster surfaces: concrete and plaster surfaces receiving paint finishes shall be thoroughly cleaned of:

- dirt
 - laitance
 - incrustations, and
 - foreign matters
 - etc...
- Cracks, holes pits or other surface imperfections shall be neatly and smoothly filled.

Timber works:

(Not Used)

Metalwork: preliminary substrate preparation shall be done in accordance with Section 207.8 of these Specifications.

The primer coat shall be applied to cleaned surfaces within four hours from the completion of the cleaning.

207.1.7 Preparation of Surfaces

a) General

All surfaces to be painted shall be clean, dry, smooth, and free from dust, grit and other foreign matter. All nails shall be countersunk and stopped with putty prior to painting.

b) Concrete and Plaster Surfaces

Concrete and plaster surfaces receiving paint finishes shall be thoroughly cleaned of dirt, laitance, instructions and foreign matter. Cracks, holes, pits or other surface imperfections shall be neatly and smoothly filled.

c) Metalwork

Preparation of steel work at the works shall be either:

- Hot dip galvanised to BS 729 with a median thickness of 85 microns (0.0034”) or
- Grit blasted to BS 7079 Grade SA 2.5 and zinc sprayed within 4 hours to BS 2569 Part 1 to a thickness of 125 microns (0.005”) followed by one coat of approved etch primer.

Typical finishes (with compatible primers) based on BS 5493 are given below.

- Steel work and ferrous castings exposed above water/sewage level

Either high build micaceous iron oxide or chlorinated rubber to give a minimum total dry film thickness of 300 microns or, one coat of two pack epoxy primer and further coats of epoxy paint to give a total dry film thickness of 270 microns.

- Steelwork below water/sewage level

Either epoxy system as above or coal tar epoxy paint system to give a minimum total dry film thickness of 450 microns.

- Ferrous castings and fittings without substrate below water level.

Coal tar epoxy paint system to give a minimum total dry film thickness of 450 microns. These coatings shall be subject to the Holiday test.

the surface of all non-ferrous parts usually painted shall be cleaned, rubbed down, stopped, filled and given one priming coat of paint.

Anti-corrosion coatings for any steel or iron used in pipework, pumps, valves, etc. in contact with potable water, shall be either a compatible bitumen material to BS 3416 or a polymeric anti-corrosion coating complying with Water Industry Specification WIS 4-52-01.

Any damage occurring to any part of a painting scheme shall be made good to the same standard of corrosion protection and appearance as that originally employed. Any finish coat applied on site shall be considered for decorative purposes only.

Manufactured articles to be galvanised shall be hot dip galvanised after complete fabrication and no bending, cutting, drilling, riveting or threading shall be permitted after galvanising.

The care of galvanised articles when transporting, storing and erecting them shall be in accordance with the recommendations of BS 729. The renovation of small areas of damaged coating not exceeding 40mm² shall be in accordance with Appendix D of BS 729 and subject to the Engineer’s approval.

207.2 PAINTING APPLICATION

207.2.1 General

All paint application shall meet the requirements of the relevant British Standards and shall be applied in conformity with the manufacturer's recommendations.

- All paint cans must not be open before application, the product homogeneity must be insured by extended mixing with appropriated tools.
- In case the product is transferred to another can, it must be mixed before utilisation and it must to remain any deposit in the original can.
- Products shall be delivered with sufficient fluidity to permit normal application.
- Solvent additional or dilution of the product is forbidden unless approved by the Engineer.
- A detailed technical leaflet will be submitted to the approval of the Engineer before any application.
- A quality control of the surface will proceed any paint or primer application.
- All surfaces must be dry and drying time between coats must be respected by the Contractor.

207.2.2 Primer or undercoat application

See preparation of surfaces.

207.2.3 Intermediate coats

These layers aim to constitute a lining which thickness and resistance can insure an effective protection system.

- Mode of application of the intermediate coat is left to the Contractor choice (Brush, roll, gun)
- In the case of several intermediate coats, each coat must be of different color easy to check and the product must ensure good adhesion to the finishing paint coats.

207.2.4 Finishing paint coats

The finishing coat(s) must answer:

By the nature of the applied lining, to the particular conditions of the ambient in which the protected surface exist.

In particular, the immersed surface must be protected against parasitic attaques from animals or vegetals.

By the choice of conventional colors, to the relevant existing security prescriptions. colors fixtily is then required so as to satisfy imposed visibility conditions.

207.3 INTERIOR PAINTS: LATEX BASE CONCRETE AND MORTAR SUBSTRATE

All interior paints must conform to the relevant British Standards.

- The interior room partitions will be covered by a washable LATEX -BASE paints, wherever indicated in the Drawings or ordered by the Engineer.
- The Contractor shall submit samples of the paints he intends to use to the Engineer's approval.
- Paints shall be washable, of a perfect solidity and shall allow a flawless application.
- A perfect resistance of the color so the effect of light is also required.
- Surfaces to be painted shall first be cleaned, and sand papered before the application of the first coat or sealer. A second sanding shall be followed by the application of a primer coat.
- Then two (2) paint coats shall be applied in conformity with the color and sample approved by the Engineer.

207.4 EXTERIOR PAINTS

For exterior surfaces a plastic paint ready to use under the form of a unctuous thixotropic paste will be used.

- This product is composed of vinylmaleate resins or similar, in water dispersion of noble pigment (Titane rutile, or similar), and siliceous charges, and fungicide agents.
- Tints area obtained with pigments resistant to the effects of exterior light (U.V. specify).
- The product must adhere perfectly and be totally waterproof offering a perfect resistance to chemical agents, to heat and fire.
- The Engineer reserve for himself, the right to proceed to any chemical analysis of his choice to insure the quality of all components. All costs to be beard by the Contractor.

Exterior surfaces must be: neat and clean, without grease dustless after brushing.

- Before any commencement of application of the paint, the Contractor shall apply a primer coat (undercoat) acting as substrate surface regulator insuring an homogenous substrate which is extremely important when applying a plastic paint on these surfaces.
- The Contractor shall use in preference an alxeol roll that it soaks in the product paste garnishing all the cells of the roll.

Application must be in thick layer and always starting from down toward upper zones.

The product must be applied in important quantities but not spread.

- A compressor can be used for application of not less than 2.2 kg/m².

A technical detailed leaflet must be submitted by the Contractor to the Engineer approval.

Intermediate coat remains a facultative one when dealing with new works, but the durability of the paint will be improved by the application of:

- One (1) layer when new works are involved.
- Two (2) layers when dealing with rehabilitation works.

The finishing exterior layer aspect will be as approved by the Engineer:

- mat, poach, in elementary finishing
- mat, satinated, poached in current finishing
- mat, satinated or shinning in careful finishing,
- etc.

N.B.: for exterior works, quality criteria for protection and durability will prevale on finishing aspect criteria.

207.5 INTERIOR PAINT - LATEX BASED WITH PUTTYING

This type of paint shall be used in specially neat surfaces and where indicated on the Drawings, the specifications, and where ordered by the Engineer.

- The paints to use shall be of the same type and shall have the same specifications as those in Section 207.3.
- The mastic shall be of a quality approved by the Engineer. It shall be delivered to the site in closed boxes, or composed on the basis of 60 to 70% of zinc and linseed oil.
- After cleaning and sanding the surfaces to be painted a first coat of sealer shall be applied. The mastic shall then be applied in two coats along two perpendicular directions. Once dry the first coat shall be sanded and rubbed with sand paper. Then an undercoat shall be applied, followed by the latex based paint coats as specified in Section 207.3.

207.6 SPECIAL PAINTS

These paints shall be used in places that are exposed to knocks and dirt. They shall be washable, resistant to sand jet No. 1 at a pressure of 125 kg. Their colors shall be permanent and inorganic pigment based, the support being a polyester based synthetic resin without an evaporative solvent or alcoholized or toxic matters, and hardener by polymerisation.

They shall be applied by means of a spray gun or by roller and shall have a granular texture obtained by application of a fiber glass reinforcement. The application shall be in accordance with the manufacturer's instructions. At least two coats shall be applied, not counting the fiber glass reinforcement.

207.7 VARNISHING ON WOOD

(Not Used)

207.8 OIL PAINT ON WOOD OR PLASTER

(Not Used)

207.9 OIL PAINT ON METAL

Metal works to receive oil paint shall be shown on the Drawings, specified herein, or where indicated by the Engineer. They shall include but not limited to sheet metal doors, gratings, metal chassis, balustrades.

- Surface preliminary works shall include:
 - removing the rust
 - degreasing
 - dusting
 - etc.
- Surface preparatory works shall include: two protective coats either of red paint or zinc chromate.

Then, two oil paint coats shall be applied. The shades shall be selected by the Engineer from samples submitted by the Contractor on site.

207.10 LIQUID EPOXY COATING

This coating shall be based on liquid, chemically cured epoxies. The curing agent may be an amine, amine-adduct, or polyamide. Materials used in both the primer and finish coats shall be products of one manufacturer.

The coating shall be suitable for use in irrigation water. It shall be used for:

- steel sluice gates,
- pipes,
- mechanical couplings,
- flanges,
- similar appurtenances for steel pipe fittings, nuts, bolts
- and other items used in conjunction with connections and attachments.

Surface preliminary works

- The surfaces shall be first cleaned to remove:
 - oil
 - grease, or
 - other foreign matters.

- Only approved procedures and solvents (that do not leave a residue) shall be used.
- The surface shall be abrasive blast-cleaned with sand, steel shot or grit to achieve a near white metal surface.

Application of epoxy coating system.

- The coating system shall be applied as recommended by the manufacturer. It shall consist of at least:
 - a two part chemically cured epoxy primer as a preparatory surface coat.
 - two coats of a different two components, chemically cured epoxy top coat.

207.11 PAINTING - MEASUREMENT AND PAYMENT

Painting shall be measured for payment by m² of net area of surface which has actually been painted, after the deduction of all openings and areas which have not been painted. Painting shall be classified according to the types of paints and number of coats. Each unit rate shall include for the supply of all paints and materials, cleaning and preparation of all surfaces, application of all necessary painting and all extra work on corners and edges, and for all materials, equipment and labour necessary for the completion of painting in accordance with the Specification and Drawings and to the satisfaction of the Engineer.

Unless otherwise specified, painting of all steel structures, and structural elements, exposed steel pipe installations, non-structural metalwork and wood joinery in buildings shall not be paid for separately and the cost thereof shall be deemed to be included by the Contractor in his unit rates for the supply, installation, erection and fixing of these items.

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209 METALWORK

209.1 GENERAL

209.1.1 Scope

The work required under this Chapter includes doors and windows in buildings, gratings, hand-railings and miscellaneous non-structural metalwork and shall be in accordance with British Standards.

The Contractor shall supply all the metal, ironmongery, paints and auxiliary materials required, shall manufacture the metalwork and shall install them in the required positions and paint them - all in accordance with the Drawings and the Specification, or as directed by the Engineer.

Alternatively, the Contractor shall supply and install standard factory-made elements, approved by the Engineer. Such elements shall also meet all requirements of this Division.

Steel for doors, windows and other metalwork shall be new, first-grade quality mild steel, without mill defects, cracks, grooves or rough surfaces and shall comply with all requirements specified on the Drawings and/or in the Particular Specification.

Hardware, metal fittings and accessories

These elements shall comply with standards and be of first grade quality and approved manufacture. They shall be carefully installed, all notches having the required sizes and depths so as not to impair the solidity of rolled sections.

209.1.2 Metalwork

All shapes, bars and plates shall be cut, drilled, bent and otherwise worked to the exact lines and dimensions shown on the Drawings. All burrs resulting from cutting and drilling shall be neatly removed. Where cutting is done by oxyacetylene torch, cut surfaces shall be clean and smooth.

Hinges and locks shall be secured by means of metal-screws for any eventual unmaking. Other accessories may be welded. Unless otherwise specified, bolts, casement bolts, locks, etc, shall be mortised. Hinges shall be solid and of quantity corresponding to door leaves size and weight. They shall have the exact required sizes and allow an easy setting and replacement. Locking devices such as locks, buttons, crutch handles, bolts, etc.. shall immobilize totally the door leaves in closed positions.

Metal fittings are integral parts of each door or hatch even when not explicitly stated in the work description.

The Contractor shall take on site all dimensions deemed necessary for metalwork and remain wholly responsible for their good adaptation to the concrete and masonry works in the building.

Jointings shall be notched and angles mitred. Electric welding shall be as continuous as possible along the joint after filing the metal elements.

After soldering, burrs and slags shall be trimmed completely. Holes shall be drilled by means of an electric drill fitted with a bit having a smaller diameter than the hole, then with another having the same diameter as the hole.

Distances between holes shall be as follows:

- Distance between hole edge and section edge \geq hole diameter
- Distance between axes of two consecutive holes $\geq 3 \times$ hole diameter
- Axes of aligned holes : a size margin equal to one tenth the hole diameter
- Irregularities in distance between holes $\leq \frac{1}{10} \times$ hole diameter.

The Contractor shall supply and install any material whether specified or not on the Drawings, but necessary for the good execution of the works.

Surface finishing

Surface finishing of works shall be in strict accordance with the General Technical Specification and shall include the protection of materials and the surface treatment.

Exposed surfaces shall have no unevenness, burrs, or metal run-out. Salient angles and projecting parts shall be rounded off. Welds shall be carefully ground. Screws shall be inserted and then painted. Accessible bolts shall be covered. Element showing appearance or assembly defects shall be rejected. It is expressly forbidden to cover and hide these defects.

Protection of metals against corrosion

No metal part shall be accepted on site unless previously protected against corrosion. Elements shall be in-factory protected according to relevant applicable standards. Unprotected iron parts shall be painted after removal of calamine, rust, and oil, with a rust proof zinc chromate paint, 60 microns thick, compatible with the top coat specified in the relevant Section (or eventually with two coats of red lead). Immediately after installation, any painted surface showing imperfections due to impacts or handling shall be wire brushed and repainted.

Contact between different metals

All measures shall be taken to avoid electrolytic corrosion caused by the contact between metal parts and accessories (screws, bolts, washers, etc ...) of various natures.

Greasing

Upon the completion of works, the Contractor shall grease all mobile metal fittings such as hinges, locks, etc ...

209.2 WORKMANSHIP

209.2.1 Manufacture

Details and profiles shown on the Drawings constitute the basic Drawings. Works shall be solid, rigid and have a perfect finish. The components shall be one-piece. Connections shall be right-angled in such a manner as to resist, without deformation nor rupture, mechanical tests and the efforts imparted to them.

Jointings shall be notched and angles mitred so that sections join at right angles without overlapping. Welding shall be continuous along the joint after bevelling the metal. Holes shall be drilled by means of a drill fitted with a bit having the same diameter of the hole. Elements shall be cleaned of all slag and burrs.

209.2.2 Assembly

Metalworks shall be fixed to their support (concrete and masonry works, partitions) by welded inserted plates, holdfasts, screws and expansion bolts or any other approved system. The use of a stud gun SPIT is prohibited. Anchor bolts shall only be used in concrete works or hollow blocks masonry; only traditional anchoring means are permitted for other surfaces. Anchors shall be screwed, bolted or welded on locks. Their section, shape, length and number are conditional upon the element sizes and installation conditions.

Fixing devices proposed by the Contractor shall be shown on shop Drawings. Fixing devices shall be placed close to hinges in order to diminish stresses.

All welding shall be done by the shielded electric-arc method by experienced welders, to the highest standards of workmanship and to the satisfaction of the Engineer. Electrodes for steel welding shall be of a kind and class approved by the Engineer. All surfaces of parts to be welded shall be well cleaned of dirt, rust, slag, and paint. All slag and splatter adhering to metal shall also be removed.

209.2.3 Installation

Prior to installation, the Contractor shall wedge and adjust the different elements so as to ensure perfect plumb, alignment and levelling.

He shall ensure all required sealings and caulking for fixing the works. He shall set out all his works and verify the location of openings left in the structure.

209.2.4 Tolerances

a) Tolerance on setting out

Maximal variation between the real position of each axis of metalwork and each axis of an opening in a wall shall not exceed 1 cm.

b) Tolerance on installation

Rectitude and plumb errors in door frames, stiles, and posts shall not entail a deviation exceeding 2 mm, provided that stiles and posts be parallel to ± 2 mm in all points and planes.

Rectitude and levelling errors in crosspieces shall not exceed 2 mm for the first meter and 1 mm for each additional meter with a maximum of 4 mm.

c) Tolerances on leaves play

The play between leaves and the finished ground shall vary between 5 and 10 mm regardless of the opening position.

d) Sealing

Air and watertightness between the structure and the metalworks shall be ensured by stable and 10 year guaranteed sealants. They shall be easily replaced. The unit rates of metalwork shall include the cost of all sealants.

209.2.5 Handling and storage

Unloading and handling of elements shall be done without causing any permanent deformation or defect that might impair the good functioning of mobile parts, or their resistance to corrosion.

Elements shall be stored in dry premises on appropriate horizontal and vertical devices avoiding any deformation whatsoever.

209.2.6 Samples and mock-ups

Samples of hardware to be used shall be as shown on Drawings.

Prior to any serial manufacture, a mock-up of each type of work shall be submitted for approval, namely:

- Ventilation grilles
- Handrails
- Guard-rails
- Protection bars
- Etc ...

The Contractor shall submit to the satisfaction of the Employer all varnish samples.

209.2.7 Locks

Locks shall be supplied with 3 keys bearing each a permanent label indicating the premises they are intended for. The loss of a key on the day of taking over entails the changing of the relevant lock at the cost of the Contractor. Prior to installation, all types of locks shall be submitted to the Employer for approval. The outside locks shall be resistant to atmospheric conditions.

209.2.8 Sections, painted wrought iron

Hatches, balustrades, guard-rails, angle-irons for antennas, handrails, stiles, posts and crosspieces, rungs, ladders, etc, ... shall be made of sectional irons, flats, pipes, etc ... and have the dimensions shown on the Drawings. Works shall be carried out according to the above-mentioned specifications. Paint shall be consistent with the specifications mentioned in the relevant Section.

209.2.9 Ladders

Ladders shall be of galvanized tubes or sections to the dimensions shown on the Drawings. They shall be painted according to the relevant Section.

Ladders shall be fixed to the upper platform and to the floor taking into account all works to be performed under other Sections (ex: waterproofing works, ...) as well as all above-mentioned conditions. Where specified, ladders shall be fitted with safety hoops.

209.2.10 Metal shutters

Rolling shutters with fastened metal blades shall be of cold-rolled and galvanized steel, with a minimum thickness of 7/10 mm, with lateral bolting of each blade. The steel curtain should withstand without deformation a load of 400 kg/m².

Scroll axes, gears, winches, etc ... shall be of stainless metals or metals that are especially treated against rust by galvanization or any other approved process.

Guide bars shall be hot-rolled and galvanized channel irons of 30 mm minimum depth and embedded in the masonry or the concrete.

Operation shall be by winch and built-in crank, with a lock system constituted of six-turn brass lock with 35 cm cylinder. The scroll axis shall be fitted with springs that balance the curtain at any height.

The shutter case shall be of galvanized sections and 7/10 mm sheets with all necessary reinforcement to ensure a perfect rigidity and easy dismantling and maintenance. Components shall be galvanized, coated with an epoxy primer and painted, as specified in the relevant Section.

209.2.11 Glazing

(Not Used)

209.3 MISCELLANEOUS METALWORK

Miscellaneous metalwork shall comprise grating, handrailing, hatches and other metal parts as shown on the Drawings or directed in the Particular Specification. The work shall be carried out to the exact details shown on the Drawings, to the highest standards of workmanship and to the satisfaction of the Engineer.

209.4 METHODS OF MEASUREMENT AND PAYMENT

Metalwork shall be measured either by number, according to type, size, etc. or by square meter, or by kilogram, all as shown on the Drawings and/or as specified. Each unit rate shall include for the manufacture, supply, transport, handling, fixing, glazing ironmongery, painting, and anodizing, and for all materials, equipment and labour necessary for the completion and installation of all metalwork item in accordance with the Drawings and the Specification and to the Engineer's satisfaction.

DAMP-PROOFING

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213 DAMP-PROOFING

213.1 GENERAL

The provisions of this division shall apply only to the:

- damp-proofing of new or existing building basements, protecting these structures against water infiltration from the ground.
- damp-proofing of back filled new concrete retaining walls against infiltrated water.
- damp-proofing below slab and over walls of concrete structures retaining aqueous liquids against infiltrated water.
- damp-proofing of cut-off walls and tunnels in catchment structures.

N.B.: Damp-proofing under water table pressure (tanking) is not included in this division.

213.2 DAMP-PROOFING MATERIALS

Damp-proofing materials are intended to provide a resistance against water and sometimes against humidity and water vapor.

213.2.1 Bituminous Coating

This material is recommended for use on the exterior wall basement of plant rooms (excluding electrical equipment) in some workshops and retaining walls where water infiltration pressure is low (permeable earth foundation) and where the performance level of protection tolerates some damp patches.

Ground water should be checked previously by the Contractor for chemicals which may have a deleterious effect on the structure or internal finishes.

The Contractor must obtain the previous approval of the Engineer on the support as well on the type of material proposed.

(Type B for reinforced concrete design in accordance with B.S. 8110).

The bitumenous coating for damp-proofing should be cold applied emulsion in two coats (of at least 0.750 kg/m² each) and cross applied.

Bitumen primer should be of the same cold bitumen emulsion compound diluted to 50% with water and applied at a minimum rate of 0,400 kg/m². The damp-proof bitumenous coat shall be applied around 24 hours after the primer application.

213.2.2 Preformed Bitumen Sheeting (SBS or APP bitumenous membranes)

This type of membranes is intended to provide no water penetration and no moisture vapour in basement of workshops and in plant rooms requiring drier or totally dry environment (working areas, archives, stores requiring a controlled environment) etc.

The form of construction must be conformed to type A structure (BS 8102, 1990) or type B reinforced concrete design (in accordance with BS 8007).

The Contractor shall previously obtain the Engineer agreement on the support (type A or B) and the kind of membrane proposed.

213.2.3 Cement Based Waterproof Render

This material is recommended to be applied on the inner side of existing structures or on the external side of the new structures to stop any infiltration or seepage or damp patches.

Cement based damp-proof renders consist of fresh cement, well graded sharp sand, water and a waterproof admixture.

Generally these renders are applied in multi-coats when seepage is widespread, but they can allow some vapour penetration.

213.2.4 New Materials

The Contractor may propose to the Engineer's approval other materials and systems of damp-proofing below ground structures, which are not included in this division.

The Engineer will contemplate then to recommend that inquiries be made regarding the following:

- Certification by the British Board Agreement (BBA)
- Performance characteristics compared with established BBA criteria.
- Certification from overseas national bodies,
- Results from independent test houses,
- Established performance in the U.K. and overseas.

213.2.5 Flexible Sheet

(Not Used)

213.2.6 Geotextile

a) Non woven

1-General

The geotextile shall be of the nonwoven type, needle punched or needle entangled and shall consist of long chain polymeric filaments of polypropylene, polyester or nylon. The fabric shall be a stable network of fibers which retain their position relative to each other. Heat bonding on one side is acceptable.

2- Physical properties

The geotextile shall meet the following physical properties:

Property	:	Value	Test reference
Grab strength *	:	113	ASTM D4632
Kg., Min.			
Elongation, Minimum	:	50	ASTM D4632
(at peak load) % Min.			
Puncture strength	:	52	ASTM D3787
Kg., Min.			
Permitivity Sec ⁻¹ , Min.	:	0.7	ASTM D4491
Burst strength	:	25	ASTM D3786
Kg/cm ² , Min.			
Ultraviolet resist	:	70	ASTM D4355
% strength retained @ 500			
Weatherometer hours			

* Minimum roll average in the weakest principal direction

3- Identification

Geotextile shall be furnished in rolls wrapped with protective covering to protect them against ultraviolet radiation and abrasion. Torn wrappers shall be repaired within 48 hours, using an approved protective covering.

Each roll of fabric shall be marked or tagged to identify the manufacturer, type, length, width and production identification number.

b) Woven

1- General

Woven geotextile shall consist of long chain polymeric monofilaments, slitfilm tapes, or multifilaments of tape and nonwoven yarn of polypropylene, polyester or nylon. The fabric shall be woven into a stable network and the edges of the fabric shall be selvedged or surged in such a way that fabric will not unravel or fray during installation or usage.

2- Physical Properties

The geotextile shall meet the following physical properties:

Property		Test reference
Grab strength *	: 123	ASTM D4632
Kg., Min.		
Elongation, Minimum	: 25	ASTM D4632
(at peak load) % Min.		
Puncture strength	: 50	ASTM D3787
Kg., Min.		
Permittivity Sec ⁻¹ , Min.	: 0.02	ASTM D4491
Burst strength	: 35	ASTM D3786
Kg/cm ² , Min.		
Ultraviolet resist	: 70	ASTM D4355
% strength retained @ 500		
Weatherometer hours		

* Minimum roll average in each direction

3- Identification

Geotextile shall be furnished in rolls wrapped with protective covering to protect them against ultraviolet radiation and abrasion. Torn wrappers shall be repaired within 48 hours, using an approved protective covering.

Each roll of fabric shall be marked or tagged to identify the manufacturer, type, length, width and production identification number.

213.2.7 Bituminous Putty

The putty is furnished either in tins or as ovolos. It shall be elasto-plastic conforming to the following requirements:

- Black color
- Temperature for use : 100°C to 130°C
- Stable at : -30°C to 60°C
- Penetration at 25°C : around 55
- Softening temperature : around 145°C
- Practical elongation : 10%
- Non-toxic

a. Application of the sealant:

Before proceeding with filling the joint, the Contractor shall complete the following works:

- Widening the joint by grinding or sawing when the joint width is less than required.
- Cleaning by grinding and brushing the sides of the joint all along its length.
- Final cleaning shall be done by blowing air immediately before starting the filling.

The putty is applied at a temperature ranging between 100°C and 130°C. It shall be filled in the joint from the bottom up. In case the putty spreads slowly when applied, especially in horizontal joints, more material is immediately added until the joint is completely filled.

213.3 DAMP-PROOFING OF BUILDINGS (WALLS & SLABS)

All external building wall bases are to be provided with damp-proof course (d.p.c.) made of special material strip (P.V.C. or bitumenous membrane) of width equal to the total thickness of the wall and any external rendering.

- The d.p.c. is to be lapped with the damp-proof membrane of the substructure and bedded in the mortar specified for the type of block used.
- The greater lengths possible are to be used for the d.p.c. but any end laps required are to be at least 200mm long and made dry without intervening mortar.
- Piers are to have complete d.p.c.'s lapped with the wall d.p.c.

Damp-proof membranes shall be laid, as directed by the Engineer beneath all floor slabs resting on the ground. They shall be composed of single sheets of minimum thickness 0.300mm black polythene sheet film of an approved manufacturer specially made for use as damp-proof membrane.

- The film shall be laid on a sand-course and turned up around all edges of the slab and with 150mm margin above the top of the slab to be tucked into the perimeter wall of the building.
- Where the building size is too large as to exceed the maximum sheet size available, several sheets shall be used and the joints shall be lapped 150mm and fused together using a welding tool designed for that purpose.
- Every care shall be taken by the following trades to prevent perforation of the membrane but in the event of puncture, the perforation shall be covered by a patch of similar material of dimensions exceeding the area of the puncture by 300mm and the two sheets welded together as described above.

213.4 DAMP PROOFING BELOW WATER RETAINING RESERVOIR SLABS

A polythene sheet film of an approved manufacture will be laid over the blinding concrete.

- Damp proof membrane, shall be approved and laid as directed by the Engineer beneath all floor reservoir slabs.
- Damp proof membranes composed of single polythene sheets of minimum thickness 0.3mm shall be laid as specified in Section 213.3

213.5 DAMP PROOFING FOR UNDERGROUND CATCHMENT STRUCTURE

A flexible waterproofing membrane will be placed between two layers of a non woven geotextile in order to achieve the cut-off walls and this before concreting.

Technical sheets must be submitted, all technical points and fixing must be clearly stated. Specifications of the flexible membrane and geotextile shall be determined in preamble to bill of quantities according to drawings.

213.6 MEASUREMENT AND PAYMENT

Damp-proofing shall be measured to payment by m² of net area of surface on which damp-proofing has actually been applied, after deduction of all openings and areas which have not been damp-proofed.

Damp-proofing shall be classified according to destination regardless of the inclination of the damp-proof surface (whether vertical, inclined or horizontal).

Each unit rate shall include for the supply of all materials, cleaning and preparation of all surfaces, application of primer, bitumenous coating or membrane including overlaps and all extra works on corners and edges and for all materials, equipments and labour necessary for the completion of damp-proofing in accordance with the Specification and Drawings and to the satisfaction of the Engineer.

Damp-proofing of catchment structures shall be measured to payment by m² of flexible membrane and geotextile placed and fixed for the cut-off walls.

WATER PROOFING

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214 WATER PROOFING, THERMAL INSULATION AND DISINFECTION

214.1 GENERAL

The provisions of this division shall apply to the:

- a) Waterproofing of the inside surfaces of the new water retaining structures (reservoirs)
- b) Waterproofing of old reservoirs under rehabilitation.
- c) Waterproofing “old or new treatment plants” namely:
 - the decanters,
 - the filtering system
 - the retention basin after filtering.
- d) Waterproofing and eventual thermal insulation of all reservoir covers and building roofs.
- e) Testing and disinfection of liquid retaining structures and roofs.

214.2 WATERPROOFING MATERIALS AND APPLICATION

214.2.1 New Reservoirs

The type of concrete for new reservoirs, is required to be waterproof as well as load bearing.

The inner surface of drinking water reservoirs (slab, walls and under roof) shall receive a surface waterproofing coating based on chemical treatment by crystallization or mineralisation and which will improve the waterproofness of the watertight concrete reservoir.

This surface coating shall be applied after concrete has almost complete shrinkage.

- This coating is applied in liquid and/or sludge form and will penetrate the concrete down to a variable depth depending upon the products, the porosity of concrete, the period of time elapsed since application, etc..
- The penetration develops in a naturally humid or moisturized concrete a chemical reaction between the impregnation compound and concrete free lime and forms insoluble crystals that seal the capillary system.

These products are constituted generally of a mixture of:

- siliceous products,
- active chemical products,
- Portland cement.

These products known under the name of crystallization or mineralization products have a long permanent action specially on concrete from artificial Portland cement C.P.A. which generate a large quantity of free lime during the hydration cycle.

The non-soluble crystals shall be activated to a depth of more than 20mm, depending on concrete compactness.

The Contractor shall contact the manufacturer to obtain all conditions of use and specifications concerning the product and specially:

- the methods for surface preparation,
- the number of vertical and horizontal coats,
- the treatment of all singular points,
- etc...

The products and applications shall be guaranteed for a period of ten (10) years from both the furnisher for the products and the Contractor for the good execution.

The advantages and limits of use of these products can be resumed as follows:

- The coat can be applied on a humid surface,
- Additional or repeated applications are possible,
- Singular points can be coated with special techniques stated in the technical sheet.
- These coats may be applied only on surfaces showing micro-cracks; existing cracks or those which appear after filling the reservoir shall be treated as specified in the technical specifications.
- These coats are deemed to improve the waterproofness of the concrete surface as well as its resistance to chemical actions (condensated water, etc.)

There is a wide range of surface waterproofing products, efficiency of which, must be checked.

Only products which have been subject to satisfactory test by a Control Bureau, shall be proposed by the Contractor to the approval of the Engineer for coating the inner surfaces of the new reservoirs.

The application of the surface waterproofing coats must be done on a duly prepared and sound concrete surface. The products penetrate to the necessary depth that is in relation with several conditions of concrete substrate and water pressure; the development of non soluble crystals (crystallization or mineralisation) allows the concrete to reach a degree of waterproofness that varies with the homogeneity of the concrete (compactness) and the size and pore's structure (capillary).

It is recommended, if approved by the Engineer, that the Contractor eventually backfills the external surfaces of the reservoir before application of the coats to insure a more constant temperature of the inner surface to be coated.

The concrete surface shall be cleaned with a strong water blasting or wet sand blasting to remove all loose particules and open all surface pores, thus facilitating the penetration of the product during application.

The Contractor shall reduce the inside high relative humidity by natural or forced ventilation to obtain a dryer inner condition avoiding eventual condensation (generally 3 days

dehydration are deemed necessary before and after application). The condensation effects often cause water rivulets to seep on reservoir vertical walls washing away the unset coating.

No application must take place when extreme high humidity exist in the inside of the reservoir (> 90%) because this will prevents the adhesion of the coats on a humid substrate.

Condensated water is very soft and adversely affects the cement curing process, and in extreme cases it can prevent the coating material from quick setting and causes it to disintegrate later.

The Contractor is asked to dehumidify the interior of the reservoir before and after placing the inner final coating to prevent condensed water from running down incurred surfaces.

The surface waterproofing coating must provide on the concrete a smooth and homogeneous surface.

That is why qualified personnel under the supervision of an expert from the manufacturer must insure that the products are applied in conformity with the manufacturer's technical specifications.

Special attention shall be paid to coating singular points such as:

- eventual construction joints, and specially,
- pipe penetration, location and treatment of which must be previously agreed with the Engineer.

The Contractor shall follow all the steps and the several phases of application in conformity with the technical specifications of the manufacturer as well as with the site instructions of the Engineer.

In some cases the inner surfaces of potable water reservoirs shall receive a flexible protective and waterproofing slurry. The product shall be composed of a cement based two component polymer modified waterproofing slurry (liquid and powder) and shall be applied to concrete to prevent water infiltrations. The product shall be suitable for external and internal waterproofing. Concrete surfaces must be clean-free from grease, oil and loosely adhering particles and as flat as possible. Application on saturated surfaces of two coats minimum. is always required. Mixing, application, curing and cleaning must be in conformity of technical data sheet of approved material.

214.2.2 Existing Reservoirs Under Rehabilitation

(Not Used)

214.2.3 Water Treatment Plants

(Not Used)

214.2.4 Reservoir roof covers and Building roof terraces, Waterproofing and eventual thermal insulation

The provisions here below shall apply to the materials, products and execution procedures concerning the waterproofing of the reservoir roof covers and the building roof terraces.

The Engineer criteria will determine which reservoir cover or roof terrace are to be thermally insulated or not.

Waterproofing approved membranes (for both reservoir covers and roof building terraces) will be one layer of 4mm minimum thickness (minimum 4.7 kg/m² with protection):

- Elastomeric (styrene-butadiene styrene = SBS) (for altitude above 300m) or
- Plastomeric (Atactic Polypropylene = APP) (for altitude below 300m).

The assembly of manufactured sheets will be by torch welding.

These membranes will generally be self-protected from the factory (mineral self-protection).

The general characteristics of the membranes are as follows: (non limited list)

- Elongation at break (for reinforced membrane $\geq 50\%$).

The Contractor shall comply with the technical certificate of SBS and APP membranes defined by the UEAtc tests and requirements.

In case of special architectural designed roof (dome) the waterproofing coat could be constituted by a liquid elastomeric bitumen which characteristics must be proposed by the Contractor for the approval of the Engineer. Anyhow a U.V. radiations resistance shall be required in any case.

The particular characteristics of the SBS and APP membranes are resumed here below (non limited list)

- a) SBS elastomeric membranes are classified according to the type of reinforcement.
 - Rolls reinforced with polyester (PY = 180 to 350 g/m²)
- b) APP Polymeric membranes are modified bitumen base sheet with APP polymers.
 - 4mm thick reinforced with polyester min weight 180 g/m² non woven polyester (PY)

The Contractor must in his offer enumerate all the characteristics of the membranes, namely: (non limited list):

- their dimensions (rolls) (1 m x 10m)
- their thickness or their weight (minimum thickness 4mm, minimum weight 4.7 kg/m²)
- the type of bitumen
- the kind and weight of reinforcement (g/m²)
- the surface protection
- their mechanical characteristics
- the overlapping size (overlapping waterproofing membrane shall be not less than 10 cm).
- etc.

SBS and APP membranes shall be applied by the Contractor on site according to the technical sheets specifications of each product and to the manufacturer's prescriptions.

All reservoir roof covers and roof building terraces are deemed to be not accessible unless to repairs necessity.

- Horizontal and vertical exposed membrane will be mineral self-protected.

214.3 WATER PROOFING FOR WASTEWATER BEARING STRUCTURES

214.3.1 General

Special performance criteria in sewage treatment is to be achieved by the contractor by the simultaneous use of:

- A high performance concrete, and
- A high performance protection, applied to the concrete substrate

214.3.2 High Performance Concrete in Sewage Treatment Applications

The concrete used in the construction of sewage treatment plants and related structures has to meet a very different set of performance criteria from those that apply in normal civil engineering works. It is usual for the mix-design to be generally determined by the need for strength and specific loading properties. The principal requirements for concrete in sewage treatment industry are more extensive and are as follows:

- a) Resistance to aggressive effluents and sludge.
- b) A dense and unpermeable concrete free from cracks (to protect steel reinforcement against corrosion).
- c) Resistance to wear and abrasion, particularly with regard to overflows energy conversion areas and the bearing surfaces for sludge scrapers, etc...
- d) Smooth and crack-free surfaces (to minimise routine cleaning and maintenance).

The aggressive effect of water-borne waste on concrete depends not only on its chemical constituents and the concentrations in which these are present, but also on such factors as:

- The pH value
- Temperature
- Oxygen supply
- etc...

- Acids with a pH value below 4.5 have a particularly aggressive effect on concrete due to the fact that they interact with the components of the set cement to form salts, which for the most part are soluble.

- However concrete may be attacked by certain alkaline solutions, salts and organic substances (especially vegetable and animal fats and oils).

The speed of the chemical reaction increases dramatically with the rise in ambient temperature.

In the absence of an adequate supply of oxygen (in long enclosed pipe runs, pits, tanks, etc.) fermentation processes may be set up that decisively alter the aggressiveness of the effluent (formation of hydrogen sulphide, sulphurous acid, etc.).

(A) Durability of Concrete is largely determined by its resistance to the ingress of liquid or gaseous substances

- Since nearly all the attack mechanisms to which concrete is subject (including chemical and physical attack, corrosion of the steel reinforcement, etc.) are associated with the transport of moisture, the following may be stated as a general principle: “The more dense and impermeable the set cement, the greater the resistance of the concrete to chemical attack.” It is generally recognised that this is also associated with an increase in compressive strength and improved resistance to wear and abrasion: hence the fact that high compressive strength is frequently equated in civil engineering practice with outstanding durability.

The inference is only valid, of course, if the increase in compressive strength results from a minimization of the capillary porosity of the set cement and a reduction in the diameter of the remaining pores.

- Damage to concrete or the underlying reinforcement via chemical attack is usually caused by the ingress of aggressive substances or water into the capillary pore system of the set cement (or into the contact zones between the set cement and aggregate). The aggressive medium may occur in liquid or gaseous form.
- The transport mechanism is activated by the following:
 - a) An unbalance of pressures (permeation), as in the exerted by water on the wall of a tank or basin.
 - b) Movements of molecules or ions resulting from differences in concentration (diffusion), as in the penetration of carbon dioxide from the air (carbonation).
 - c) The absorption of wetting liquids through porous substances (capillary action), as in the case of rising groundwater in a concrete foundation.
- The principal factors influencing the rate of transport are:
 - the presence of cracks in the concrete
 - its capillary porosity and
 - the size of the pores
- An additional factor in the case of gazes is the moisture content of the concrete (the higher the moisture content, the more difficult the transport of gaz).

214.3.3 Design and production of High-Performance Concrete

The pore structure of the concrete is largely determined by:

- the degree of compaction,
- the entrained air content
- the water content of the fresh concrete, and
- the degree of hydration in the set concrete

In order to maximize the density of the set concrete matrix and thereby achieve a high degree of chemical resistance. The well-compacted concrete must exhibit the following properties:

- a) A proper distribution of aggregate gradings, including a sufficient proportion of fines (particle diameter < 0,125 mm: approximative 350-400 kg/m³)
 - b) Low water/cement ration around 0.40 - 0.45
 - c) High degree of hydration
 - d) Absence of cracks.
- To insure that the concrete remains workable at low W/C ratios and to minimize the entrainment of air bubbles during compaction, the contractor is asked to use a super plasticizer.

The best way to maximise hydration and avoid cracks is that contractor follow the correct curing procedures (keeping the concrete damp for an extended period of time using a suitable curing compound).

- The insistence on a proper distribution of aggregate grading and an adequate fines content has to do with the attempt to maximise the density and uniformity of the internal structure of the set concrete. At the same time correct granulometric also improve the workability of the fresh concrete and greatly reduces its tendency to bleed. Bleeding produces a localized increase in the water/cement ratio and a corresponding enlargement of the pore structure in the set cement matrix close to the surface of the concrete, thus rendering it specially vulnerable to chemical attack. Many of the sands used have a low fines content (particle size < 0.125 mm) but a relatively high proportion of particles in the 0.125 - 0.25 mm grading zone. Since these require a relatively large amount of water to achieve thorough wetting, but possess only a limited capacity to retain water themselves, the contractor will make mistake to try and make up the deficiency in fines content by overdosing the mix with sand (result: bleeding of the fresh concrete). Instead the contractor's mix needs to be supplemented by a suitable alternative fines content which must be particularly effective.

(A) The use of Silica Fume Products in High Performance Concrete

The Contractor is invited to use a silica fume product (minimum 90% pure latently reactive silicone dioxide) to enhance the performance of structural concrete in a number of significant ways:

- a) Reduction in porosity: silica fume is finer than cement, mineral fillers, (powdered quartz) or commercially available fly ash.

Since the mean particle size of silicate fume is approximately 100 times smaller than a normal grain of cement, it is able to lodge in the interstices between the finest particles in the set cement matrix. The super plasticiser allows low water/cement ratios whilst maintaining good workability. This ensures a dense, tightly packed particle structure even at the micro capillary system.

- b) Increased strength: A pozzolanic reaction takes place between the silica fume and the free lime that is present in the set cement in the form of calcium hydroxide, a natural by-product of cement hydration. As a result of this reaction the weakest and most readily soluble component of the set cement is transformed into solid calcium silicate hydrate, this combined with the low water/cement ration produces significant gains in concrete strength.

As mentioned in 214.3.2(A) the chief requirement for concrete in sewage treatment applications is not so much for compressive strength in the core zone, but rather for a high degree of density and strength in the surface zone: This is the critical factor affecting the durability of structural components under these conditions.

- c) Retarding the process of carbonation : The high alkalinity of the cement provides a measure of natural protection to the reinforcement steel. The pH value of the cement paste is around 12.5 which is sufficient to passivate the steel and prevent it from rusting even in the event of the ingress of oxygen and moisture. However exposure to carbon dioxide from the atmosphere means that the alkalinity is being constantly reduced as the lime content is neutralised. If the carbonated zone reaches the steel reinforcement, the

latter begins to rust. The use of silica fume significantly retards the process of carbonation in concrete.

- d) Increased resistance to abrasion: the use of silica fume products (silica fume/plasticiser technology) in concrete can also effect a marked improvement in its resistance to abrasion. Tests carried out at the French CEBTP in Paris on mortar samples incorporating silica fume demonstrate this very clearly.
- e) Improved workability of fresh concrete: The addition of silica fume products to the mix produces a fresh concrete of outstanding stability and cohesion, with no loss of workability. Bleeding, segregation and sedimentation during transport are effectively prevented even with mixes of very plastic consistency.

(B) Curing procedures for High-Performance Concrete

The chemical reaction of silica fume with the free lime in the set cement generates the same hardening product that is produced during the hardening of cement. The reaction proceeds somewhat more slowly than in the case of cement but is more or less complete after 28 days. In order to achieve a concrete surface offering the maximum resistance to chemical attack, thorough and careful curing of the concrete is an essential requirement and the contractor must take in account the curing time in his construction schedule. At the end of the curing period the strength of the concrete in the surface zone should be at least 50% of the specified cube strength. This normally requires a curing period of at least 3-5 days; under unfavorable conditions (strong winds and sunlight or low relative humidity) the curing period should be extended by an addition 2-3 days in order to prevent premature drying-out of the concrete.

N.B. Concrete that will be exposed to “very severe” chemical attack (as defined, for example, in DIN 4030) for long periods during its service life should be finished with a suitable coating material designed to afford additional protection against the aggressive medium. However the application of such a coating is no substitute for a well-made concrete not least because a high-quality coating material needs a high quality concrete substrate in order to perform effectively. The contractor must in practice furnish a concrete capable to withstand “severe” chemical attack without taking in account the additional protection.

214.3.4 Protection of the Concrete Surface

a) Substrate preparation

Before applying the protection on the concrete, the concrete surface must receive a preparation to enable this substrate to be ideal for the application of the protective coating. High pressure water jet, pressure stream clearing or wet blast cleaning will be used by the contractor after reception of the concrete surface by the Engineer.

Any joint sealing must be done by the Contractor usually before the application of the protection coating.

Any joint sealing material must receive the early approval of the Engineer.

Any joint sealing will be purchased from the same furnisher than the protective coating.

b) Pore sealing :

The pore seal is necessary and must allow a rapid application of the coating protection - the pore sealing must be compatible with all the applied products

(superplasticizer, silica fume, water stop....) and purchased from the same furnisher it must fill all blowholes and act as a vapour - release intermediate coat.

c) The protective coating :

The known causes of damage to structures in the sewage industry show that the best concrete is still affected by some substances, which should be separated from its surface by suitable coating, or surface protection systems.

Often the concrete cover on the reinforcement does not comply with the standards.

Concrete for sewage must be coated to meet certain long term standards and the surface protection is also required to meet these standards long term.

The protection is also designed for the relevant mechanical constraints and withstand the interaction between concrete substrate and the protection system and also the mechanical, chemical, thermal and other stresses...

The Coating material requirements are:

- Chemical resistance
 - Abrasion resistance
 - Aging and weather resistance
 - Alkali and water resistance
 - Water vapour diffusion or vapour barrier qualities.
 - Impermeability to gase (carbon dioxide, sulphur dioxide)
 - Specific strength properties
 - Adhesion to surface to be coated
 - Crack bridging or sealing function
-
- The protective coating will generally be applied in two or three coats.

As all coating material properties listed above can be influenced by the system and formulation used, the contractor is asked to submit to the Engineer's approval all the coating materials and furnisher specifications concerning the protective coating and glass fabric reinforcement.

- All details arising additional difficulties (pipe connection, openings, angles etc), must receive adequate solutions from the contractor to be submitted to the Engineer's approval before any application.
- The protective system, covers usually:
 - Epoxy resin
 - Epoxy / Tar modified systems
 - Epoxy / polyurethane coating system
 - etc....

Apart from general protection, the protective coat system has to fulfil two functions.

- Restoration and levelling of the concrete surface which may be extremely rough after preparation.
- The formation of a non-porous protective film with possibility to work directly on the damp concrete surface without long waiting times while the structure is drying out.

A very important feature which should not be ignored by the contractor, is the prevention of heating in the structure in areas not in contact with water. This reduces the stresses in the coating system, the concrete and (even more important) at the coating system/concrete interface. Damage can also be avoided by the contractor by choosing the right colour.

The contractor technology must offer the maximum advantages to permit execution of the protection directly on the damp concrete surface without long waiting times while the structure is drying out.

The durability of a correctly applied coating varies considerably. The longest life span can be expected in the underwater section since the protective system is in a constant environment and not exposed to the UV and thermal shock i.e. it can remain in a low stress state.

The durability of coatings is affected by maximum stresses due to several loading, since there are exposed (in addition to high mechanical stress) to additional thermal shock caused by de-icing salts and weather and are used at the most susceptible construction points (areas at risk from cracking).

Systems which are exposed to abrasion and constant water turbulence and are used in water line zone are said to be subject to average stress.

Protective systems in digested tanks suffer the highest stresses.

The contractor is deemed to choose the protection system taken in account the importance of the stresses applied and the water covering situation.

214.3.5 Concrete Additives

The contractor is deemed having made all necessary contacts with the various furnisher of materials related with the project in order to select the best adequate materials such as:

- Superplasticiser
- The water proofing mass additive
- The waterstops
- The silica fume
- The curing material
- etc..

The superplasticiser, waterstop and waterproofing will give high impermeability to the concrete structure.

The superplasticiser and silica fume will insure reduction of porosity, increase in the surface strength, resistance to abrasion, improved workability of the fresh concrete with low water/cement ration.

The curing procedures will achieve a concrete surface offering the maximum resistance to chemical attack.

214.3.6 Sealing Joints in Concrete Construction in Sewage Installation

Although flexible sealant have an important part to play in sealing structural joints in sewage installations, they cannot seal structures containing water without additional measures. Concrete constructed with integral or surface mounted waterstop systems are obviously essential.

The Contractor will submit to the Engineer's approval all joints sealing material and waterstops which specifications must meet the Drawings Specifications.

- a) Flexible Joint Sealant: of the various raw materials normally used in the production of joint sealant (polyurethane, acrylic, silicone and polysulphide) the two-part polyurethane sealant (often containing tar) have proved most effective in sewage treatment applications.

Pouring grade is used for horizontal joints and thixotropic grade for vertical joints.

- b) Flexible Elastomeric Strip: Joints liable to greater movement and construction joints may be sealed with a flexible elastomeric strip (hypalon or butyl rubber) kept in place with a compatible epoxy adhesive. Strip thickness varies from 1 to 3 mm; standard width are : 100 mm, 150 mm, and 200 mm.

The Contractor is asked to submit his solution for sealing the various joints to the approval of the Engineer before any application.

214.3.7 Later Repairs

Effective concrete protection gives long-term security to all structural members, even if the effluent composition changes over time. High performance coatings greatly assist the prevention of damage from a number of sources. That is why detailed advance planning of concrete coating in sewage plants is to be seriously taken into account by the Contractor. If repairs are necessary later, this will be an expensive operation because of costly cleaning and re-preparation of contaminated substrate...

The Contractor must be aware that sewage plants cannot be shutdown and that later repairs and costs are out of proportion to the cost of providing good and effective protective coating on concrete initially.

The cost of all later repairs must be borne by the Contractor.

214.4 WATERPROOFING OF PLANTED ZONES

(Not Used)

214.5 WATERPROOFING WORKS ON BURIED WALLS

214.5.1 General

Prior to backfilling, all buried walls shall be waterproofed. The waterproofing product shall be applied to the vertical surface of walls down to the footing of the foundation.

The waterproofing of the foundation walls is conditional upon several parameters, namely:

Nature of the foundation ground (pervious, impervious)

- Nature of the backfilling material
- Existence of a drainage system
- Existence of waterproof structures near the buildings (slabs, sidewalks, ...) or protection of the surroundings of the foundation peripheral wall by protruding structures (protection slabs, protruding roofs, ...)
- Importance of run-offs eventually in contact with the peripheral walls of the building
- Eventual existence of an aquifer

After the excavation of trenches, all measures that bind the Contractor alone shall be consulted beforehand with the Engineer.

214.5.2 Selection of the waterproofing coating

- The specifications given in this Section are applicable only when water is not likely to be in contact with the peripheral walls for a long time, or when no differential settling of the building is expected.
- The choice of the wall coating shall be efficient only if:
 - a drainage system is unnecessary (pervious ground)
 - or, a drainage system is necessary and provided for.

In fact, should the drainage system be necessary but not provided for, the application of the coating shall not be sufficient because water may infiltrate from beneath the foundation or through any crack in the wall. In this case, tanking will be the best solution.

a) No drainage system is required (pervious foundation ground)

Buried walls shall be waterproofed by applying a rendering to the external facing of the wall. Rendering shall consist of:

- A traditional rendering consistent with standards specifications.
- A hydraulic binders based waterproofing coat having a technical certificate that proves its suitability to the type of buried masonry.

In both cases, the coating shall only be applied to the external facing of the buried wall; the waterproofing of the inner side would prevent the capillary rise.

In some cases a bitumen coating shall be applied for walls protection.

b) A drainage system is required (impervious or slightly pervious foundation ground)

The waterproofing system shall be reinforced and shall consist of:

- An SBS or APP elasto-plastic membrane applied directly to the substrate or to a rendering and consisting of:
 - Cold-applied primer : 350 kg/m²
 - Hot welded SBS or APP elasto-plastic membrane as specified in 214.4.1.
 - * non-woven polyester (180 kg/m² minimum)
 - * separation layer.

It is advisable to protect the membranes from shocks, especially during backfilling, as well as from any eventual settling of the backfill material. Should the Engineer disapprove the quality of the backfilling material and the workmanship, a 10 cm thick concrete blocks protection shall be obligatorily provided for, with non woven thermally bounded textile separation layer or by 3.2mm thick semi rigid bituminous board.

The application of waterproofing membranes to singular points especially to the footings, etc.. shall be carefully studied (details to be provided by the Contractor).

Prior to any backfilling, the Contractor shall submit to the Engineer's approval the method of laying the drainage system in the bottom of the trench, the quality of filtering material, the size and location of the trench with regard to the building and the foundations, the diameter and length of drains as well as the eventual protection of the drainage layer with a non-woven textile.

214.5.3 Manholes (a drainage system is required)

Manholes shall be constructed:

- At the upstream of the drain
- At each change of direction
- At the connection of two drains.

The manholes shall have such diameters as to allow eventual cleaning operations. The Contractor shall submit for approval the shop drawing of the manhole which is equipped with a cover preventing the intrusion of earth, gravels or any foreign matters.

The Contractor shall submit for approval waterproofing works of buried parts:

- Samples of waterproofing products
- Samples of the drains

as well as all shop drawings of waterproofing and drainage works.

214.6 TESTING AND DISINFECTION

214.6.1 Testing

The Contractor shall perform all cleaning, flushing, testing of all liquid retaining structures, reservoirs and buildings roofs, including conveyance of test water to point of use, and including all disposal thereof, complete and acceptable, all in accordance with the requirements of the BS 8007 and the contract documents.

All testing operations shall be done in the presence of the Engineer.

a) Roofs

The roofs of liquid retaining structures and buildings should be watertight and be tested by flooding the roof with water. The roof should be considered satisfactory if no leaks or damp patches shown on the soffit. The roof insulation, covering and waterproofing should be completed only, and as soon as possible, after remedial work if needed is done and satisfactory testing.

b) Liquid retaining structures

After construction is completed, the interior of the liquid retaining structures shall be completely hosed and cleaned of all dirt and loose material. Testing shall be done prior to backfilling if any, and shall not be sooner than 14 days after all portions of structure walls and associated roof systems have been completed.

The structure shall be filled to the normal maximum level with the specified liquid at a uniform rate of not greater than 2m in 24 h. The liquid level should be maintained by the addition of further liquid for a stabilizing period which may vary between 7 and 21 days according to the maximum design cracks.

After the stabilizing period and during a 7 days test period the total permissible drop in level, after allowing for evaporation and rainfall should not exceed 1/500th of the average water depth of the full tank or 10mm.

In case of seepage of the liquid or leakage, necessary remedial treatment of the concrete, or joints, holes or cracks shall be carried out from the liquid face (pumped and sealed with a two part water-insensitive epoxy, nontoxic for potable water reservoirs). Retesting after the completion of remedial work shall be carried out according to this clause.

Interior waterproofing if required, shall be applied after satisfactory results.

214.6.2 Disinfection

The Contractor shall perform disinfection of reservoirs and appurtenant piping for potable water. Disinfection shall be accomplished by chlorination and performed in accordance with the relative requirements after completing all repairs and waterproofing works if any. All chlorinating operations shall be done in the presence of the Engineer. Disinfection operations shall be scheduled by the Contractor as late as possible during the Contract time period so as to assure the maximum degree of sterility of the facilities at the time the work is accepted by the Engineer.

Bacteriological analyses shall be performed by a certified testing laboratory acceptable to the Engineer.

a) Chlorination

A strong chlorine solution (about 200 mg/l) shall be sprayed on all interior surfaces of the structure, including the underside of the roof areas. Following this, the structure shall be partially filled with water to depth of approximately 30 cm. During the partial filling operation, a chlorine-water mixture shall be injected by means of a solution-feed chlorinating device in such a way as to give a uniform chlorine concentration during the entire filling operation. The point of application shall be such that the chlorine solution will mix readily with the inflaming water. The dosage applied to the water shall be sufficient to provide a chlorine residual of at least 50 mg/l upon completion of the partial filling operation. Precaution shall be taken to prevent the strong chlorine solution from flowing back into the lines supplying the water. After the partial filling has been completed, sufficient water shall be drained from the lower ends of appurtenant piping to ensure filling the lines with the heavily chlorinated water.

b) Retention Period

Chlorinated water shall be retained in the partially filled structure and appurtenant piping long enough to destroy all non-spore-forming bacteria, and in any event, for at least 24 hours. After the chlorine-treated water has been retained for the required time, the free chlorine residual in the structure and appurtenant piping shall be at least 25 mg/l. All valves shall be operated while the lines are filled with the heavily chlorinated water.

c) Final Filling of Structure

After the free chlorine residual has been checked, and has been found to satisfy the above requirements, the reservoir shall be filled in approximately 2m increments every 24 hours by addition of potable water. The existing chlorinated water, may not be used as part of the final filling. Final filling water, when the water level is raised to its final elevation, shall produce a free chlorine residual of between 1 and 2 mg/l. If the free chlorine residual is less than one mg/l, an additional dosage shall be applied to the water in the structure. If the free chlorine residual is greater than 2 mg/l, the structure shall be partially emptied and additional potable water added. In no case shall water be released prior to the expiration of the required retention period (24 hours).

214.6.3 Bacteriological Analyses

The Contractor shall have a laboratory certified by the Engineer to take samples of water from the tank in order to perform bacteriological analyses according to the relevant section.

If the volatile organic or coliform bacteria levels exceed those allowed, the tank content, shall be drained to waste. The tank shall be refilled at the Contractor's expense, soaked and retested for coliform bacteria and volatile organic until satisfactory test results are obtained. Failure of the reservoir to attain acceptable levels shall be the responsibility of the Contractor and remedial measures shall be at his expense.

214.7 MEASUREMENT AND PAYMENT

214.7.1 Inner Waterproofing of new reservoir, new or existing treatment plants, etc...

Waterproofing shall be measured for payment by square meters (m²) of net area of surfaces to which waterproofing has been applied, after the deduction of all openings and areas which have not been waterproofed.

The unit rates shall include:

- The supply of material,
- Cleaning and preparation of the surfaces as specified,
- Treatment of all singular points,
- Application of the inner coating as specified, to horizontal, vertical and under roof surfaces including all overlaps and extra work on corners, edges and around drain outlet and other structures in walls and slab, and including all materials, equipment and workmanship necessary for the completion of the inner waterproofing of the reservoir in accordance with the Specifications and Drawings, and to the satisfaction of the Engineer.

214.7.2 Existing reservoirs under rehabilitation

- (Not Used)

214.7.3 Waterproofing of roof covers, Building terraces and Eventual Thermal Insulation

Waterproofing shall be measured for payment by square meters (m²) of net area of surfaces on which waterproofing has actually been applied, after deduction of all openings and areas which have not been waterproofed.

The unit rates shall include :

- For the supply of all approval materials.
- Cleaning and preparation of substrates, including the execution of the necessary concrete slopping towards the outlets,
- Application of primer,
- Heating and application by torch welding of the elastomeric or plastomeric membrane 4 mm thick (~ 6 kg/m²) including the overlaps and upstanding extending over the parapet wall, and any reinforcement on the Detailed Drawings approval by the Engineer,

- Any circulating concrete pads necessary for repairs installed over the waterproofing (pads 500 x 500 x 40 mm) as ordered by the Engineer,
- All drain outlets and any extra works around them and around any existing opening or penetration throughout the roof,
- All necessary protection of the waterproofing, and all materials and equipment and labour necessary for the completion of waterproofing of roofs and reservoir covers in accordance with the Specification and Drawings and to the satisfaction of the Engineer.

N.B. Normal or inversed extruded polystyrene thermal insulation shall be installed when directed by the Engineer Thermal insulation ≥ 50 mm thick will be paid for as separate item and will be measured by square meters (m^2) of net area of surfaces where thermal insulation is applied.

Normal thermal insulation unit rate is deemed to comprise the cost of furnishing and applying a vapor barrier approved by the Engineer.

214.7.4 Waterproofing Protection for Wastewater Bearing Structures

Waterproofing of external surface of the concrete substrate (Protection of the concrete surface by applying a protective coating) shall be measured for payment by square meters (m^2) of net area of surfaces on which waterproofing has actually been laid, after deduction of all openings and areas which have not been waterproofed. The unit rates shall include for :

- The supply of all the approved material,
- Cleaning and preparation of the concrete substrate as specified,
- Supply and execution of all joint sealing,
- The pore sealing as specified,
- The application of the approved protective coating in two or three coats reinforced with the glass fabric material, as specified,
- The treatment of eventual defects encountered throughout the works according to the Engineer's instructions,
- All extra works required for extending the protective layer over all kind of pitched surfaces, around drains, over parapets etc...,
- All furniture for materials, equipment and workmanship necessary for the completion of the protection coating over the total substrate surfaces in accordance with the Specifications and Drawings and to the satisfaction of the Engineer.

214.7.5 Waterproofing of planted zones

(Not Used)

214.7.6 Waterproofing works on buried walls

a) No drainage system is required

The waterproofing shall be measured for payment by square meters (m^2) of net area of rendered surfaces.

The unit rates shall include:

The rendering, hydraulic binders based waterproofing coat and eventually two coats of asphalt. It also includes scaffolding, workmanship, expenses, supply, transport, equipment, and all works required for waterproofing.

In case a bituminous coating is required, no extra payment shall be done. The price must be included in concrete works or in backfilling materials.

b) A drainage system is required

The waterproofing shall be measured for payment by square meters (m²) of net area of surfaces where the waterproofing system is applied.

The unit rates shall include:

- The elasto-plastic membranes (primer, membranes, fibreglass and non-woven polyester)
- The membranes protection.
- Singular points and drainage system required (pipes, manholes, gravels, geotextile,...)

All necessary materials, equipment, workmanship, and expenses in order to achieve the waterproofing work.

214.7.7 Testing

All water used in testing the liquid retaining structure and roofs including that used for retesting which requires disposal following such testing, retesting shall be provided and disposed by the Contractor at his hole expense. The price of such work are deemed to be included in concrete works unless otherwise noted and shall include all expenses to reach satisfactory result.

214.7.8 Disinfection and Bacteriological Analyses

All water used in disinfecting the reservoir including that used for retesting and disinfecting shall be provided and disposed by the Contractor at his hole expense. Fees for all laboratory analysis shall be borne by the Contractor.

The disinfection and analyses shall be paid on the basis of a lump sum price unless noted otherwise, and shall include all expenses to reach satisfactory results.

STEEL STRUCTURES

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216 STEEL STRUCTURES

216.1 GENERAL

The work required under this Chapter includes the fabrication and erection of structural steelwork such as steel columns, beams, trusses, platforms and the like. Non-structural metalwork such as doors, windows, gratings, handrails, etc. is treated in Divisions 209 and 210.

All steel structures shall be fabricated and erected or installed in strict accordance with the dimensions and details shown on the Drawings or determined by the Engineer and shall comply with the best accepted standards of workmanship to the complete satisfaction of the Engineer.

The Contractor shall supply all required materials, shall fabricate the steel parts, shall transport them to the Site of Works and shall erect and install them in their proper position and paint them.

216.2 MATERIALS

All materials used in fabrication, erection and painting of structural steelworks shall be new, of first-grade quality without rolling defects, cracks, grooves or rough surfaces and shall comply with the requirements specified on the Drawings and/or in the Particular Specification, and with the requirements of B.S. 4360 Grade 40, B.S. 4848 and other relevant British Standards.

216.3 WORKMANSHIP

216.3.1 Preparation of Members

All steel shapes, bars, plates, pipes, etc. shall be cut, drilled, bent and otherwise worked to the exact lines and dimensions shown on the Drawings. All burrs resulting from cutting and drilling shall be neatly removed. Where cutting is done by oxyacetylene torch, cut surfaces shall be clean and smooth.

Steel shall be worked either cold or red-hot, but not at medium (blue) temperature. Bolt holes shall be made by drilling only, and shall be accurately positioned so that bolts can be easily inserted.

Parts requiring machining shall be worked to the exact required dimensions in accordance with the Drawings and the finish shall be as marked on them, or, in the absence of such markings, shall be suitable to the purpose for which that parts are intended.

216.3.2 Weld Connections

All welding shall be done by the shielded metal-arc method by experienced welders qualified in accordance with B.S. 4871 to the highest standards of workmanship and to the satisfaction of the Engineer. The electrodes for steel welding shall be of a kind and class approved by the Engineer. The electrodes shall be stored in the original unopened containers. Electrodes in open containers shall be protected from dirt and moisture. The surfaces of the parts to be

welded shall be well cleaned of dirt, rust, slag, and paint. All slag and splatter adhering to the metal shall also be removed.

All metal parts and the electrodes shall be completely dry during welding. In case of rain or wind, all outdoor welding shall be stopped unless the metal parts are suitably protected to the satisfaction of the Engineer. Welding shall be carried out to ensure full penetration to the root of the joint in case of butt joints and in all events complete fusion of the weld metal with the base metal and with other layers of weld metal. In case of multi-layer welding, each completed layer shall be cleaned of all slag and dirt before applying the next layer.

Special care shall be taken in cleaning the root bead of butt welds. The completed welds shall be free of defects, such as gas pockets, slag inclusions, undercuts, incomplete penetration or incomplete fusion. The shape and dimensions of the welding shall be as shown on the Drawings.

No quenching of welds by means of immersion in water or flushing or other means shall be permitted, but the welds shall be allowed to cool off gradually to the ambient temperature. Where required, welded elements shall be stress relieved.

216.3.3 Bolt Connections

All holes in parts for bolt connections shall be accurately matched in order to permit easy insertion of the bolts. In case of small inaccuracies reaming with a suitable reamer will be permitted.

Before making the connection, burrs shall be removed from the hole edges and the areas of contact cleaned. Fitting together parts by force or insertion of bolts by hammer blows will not be permitted. The bolts used for connection of the parts shall be of a standard whitworth or metric thread, with hexagonal head and nut. Suitable washers shall be used, and bolt ends shall protrude about 5 mm. from the nuts. The length of thread inside the connected part shall not exceed 3 mm. Tightening up of the bolts shall be done so as to ensure a rigid and permanent connection between the connected parts, without exceeding the permissible stresses. The contact surfaces of the parts to be connected by bolts shall be painted with red lead before the connection is made.

216.3.4 Assembly

The parts of the structural steel work shall be completely shop assembled unless otherwise marked on the Drawings or directed by the Engineer in consideration of traffic needs. In such cases, site assembly will be permitted and the Contractor shall prepare in the workshop all holes, bolts, welding bevels, etc., required for the assembly on site. All parts subject to site assembly shall be marked and matchmarked in black paint, and shall be trial assembled at the shop before shipment.

The Engineer will check the parts after their assembly, but before their final connection, and will accept them if found satisfactory and conforming to the requirements of the Specification and Drawings. The Contractor shall not connect the parts together and shall not embed them in concrete until the receipt of the Engineer's approval to do so.

216.3.5 Erection

All structural steelwork shall be erected and installed to the exact lines and positions shown on the Drawings or directed by the Engineer and shall be well anchored to the concrete structures.

After the Contractor has presented the parts of structural steelwork for the Engineer's inspection and obtained his approval, he shall transport them to the Site and set them in the required positions. When transporting such parts, the Contractor shall take care to prevent any damage or distortion to the frames or to the primary coat of paint already applied at the place of fabrication. Embedding into concrete, setting into position, etc. shall be exact and correct in accordance with the best accepted standards of workmanship. Setting the parts of the structure in position and their adjustment shall be first checked by water level and plumbline and the final setting shall be checked by surveyor's level.

The cranes, derricks, scaffolds, temporary supports and temporary connections used in the erection of the structural elements shall be such as will ensure the stability of the structure and safety of persons and prevent any damage, distortion, dislocation or undesirable stresses being caused to the structural elements. Temporary supports and connections shall not be removed until the final connections have been made and approved by the Engineer, but such approval shall not relieve the Contractor of his responsibility for the correct erection, stability and safety of the structure.

Unless installation by grouting-in anchor bolts or use of expansion anchors in previously prepared recesses is approved, anchor bolts and metal parts to be embedded in concrete shall be placed in position before casting of concrete and shall be held firmly and accurately in position while the concrete is being placed.

216.3.6 Painting

Painting of metal parts shall be in accordance with Subsections 207.1.7(d) and 207.9 above.

Cleaning and priming of metal parts shall be done at the workshop prior to transporting to the Site. Parts intended to be welded on the Site during erection may be painted with a weldable primer approved by the Engineer.

The application of specific paints, such as epoxy or rubber base shall be according to the Particular Specification and/or the Engineer's instructions.

216.3.7 Glass Coated Steel Tanks

- i) Tanks shall be constructed of glass-coated steel panels erected on a concrete base or of other approved construction. The structural design, materials and construction of the tanks is to be in accordance with all British (or foreign) Standards and Codes of Practice current at the date of Tender.
- ii) Imposed loads due to snow and wind shall be in accordance with BS 6399. The tank walls shall be designed to support any roof structure, bridges, scrapers or other appurtenances to be fitted to the tanks.

- iii) The installed glass coatings shall have the following properties:
- adhesion bond strength of at least 34500 kN/m²
 - thickness between 0.18mm and 0.28mm each side
 - no permeability and zero moisture absorption
 - resistance to pH solutions in the range 3 to 9
 - ability to flex with the steel substrate without sapling or cracking
 - the ability to be repaired on site.
- iv) All holes and openings in panels greater than 25mm shall be made before glass coating, and non-destructive testing shall be carried out for dry film thickness and porosity before leaving the factory. Test certificates shall be supplied before delivery.
- v) Panels shall be jointed with suitably protected bolts and shall be sealed with polyurethane or other approved sealant which shall be applied to all joints and edges of plates.
- vi) Each tank shall be provided with all necessary factory made pipework and instrumentation connections as shown in the Drawings or specified.

216.4 METHODS OF MEASUREMENT AND PAYMENT

Measurement of structural steel for payment shall be per unit of measurements shown in the Bill of Quantities such as: weight, unit, length etc.

The unit rates for the fabrication and erection of steel structures shall include for the cost of all labour and materials, including but not being limited to: supply of all steel and auxiliary materials, transport to workshop, fabrication of parts, workshop painting as specified, transport to Site, storage, and erection according to Drawings and Specification or as directed by the Engineer and final painting of erected structure.

PIPELINES AND PIPEWORKS

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217 PIPELINES AND PIPEWORKS

217.1 SCOPE

This part of the specification shall apply to the supply, delivery, laying, jointing and testing of all pipes, fittings and accessories, and includes:

Concrete pipes (Not Used)
Asbestos-Cement pipes (Not Used)
Steel pipes (Not Used)
Cast Iron and ductile Iron pipes
G.R.P. pipes (Not Used)
P.V.C. pipes (Not Used)
HDPE pipes (Not Used)

217.2 CONCRETE PIPES

(Not Used)

217.3 ASBESTOS CEMENT PIPES AND FITTINGS

(Not Used)

217.4 STEEL PIPES AND FITTINGS

(Not Used)

217.5 CAST IRON AND DUCTILE IRON PIPES AND FITTINGS

217.5.1 Quality Requirements

All cast iron and ductile iron pipes and fittings to be supplied under this Specification shall be obtained from approved manufacturers. They shall be of the class and shall have joint ends as shown on the Drawings or as specified and shall otherwise comply in all respects with B.S. 4622 - Grey Iron Pipes and Fittings, and B.S. 4772 - Ductile Iron Pipes and Fittings.

- External Coating: pipes and fittings shall be given an external coating of zinc in accordance with ISO 8179 or BS 4772 and a finishing coating of either cold applied bitumen complying with the performance requirements of BS 3416 Type II material, or hot applied bitumen to BS 4147 Type I Grade C.
- Internal Lining: All pipes and fittings shall be lined internally with cement mortar and shall comply with ISO 4179 or BS 4772. The inside of the sockets shall be coated with bitumen as used for the finishing coating to the pipes.

While the pipes are still suspended over the trench before lowering or before mounting, they shall be inspected for defects and rung with a light hammer to detect cracks. Defective pipes shall be dismantled, removed from the site and replaced by flawless pipes. Only pipes inspected and accepted on the site by the Engineer shall be incorporated into the works.

217.5.2 Hauling and Handling of Pipes

The Contractor shall check each pipe before loading and shall reject all damaged or defective pipes. The Contractor shall load and properly secure the pipes on the vehicles and take all necessary measures to prevent any damage to the pipes during transport. The Contractor shall be responsible for the quality of the pipes and for their condition upon and after delivery to the site, and shall immediately remove from the site any damaged or defective pipes and replace them at his own expense.

No pipes or fittings shall be allowed to drop, roll freely or strike objects which are likely to damage them. Special care shall be taken not to spoil the tar or bitumen coating.

217.5.3 Laying and Jointing

- (a) Laying - Before C.I. or Ductile pipes are laid, all dirt and foreign matter shall be removed from inside and all lumps blisters, excess coal tar, oil, grease and moisture shall be eliminated from the surfaces of the joints. After the pipe is laid and mounted, care shall be taken to avoid entrance of dirt, water and foreign matter from the trench or from elsewhere by the use of tight bulkheads.
- (b) Jointing of cast iron pipes and fittings - Joints shall be flanged; or mechanical joints; or rubber gasket "push-in" flexible joints, all as specified and/or shown on Drawings.
- (c) Jointing of ductile iron pipes and fittings - Joints in ductile iron pipes and fittings shall be of one of the following types according to the Drawing and the Particular Specification:
- Spigot and socket joint with rubber gasket
 - Flanged joints
 - Mechanical joints

All joints shall conform to B.S. 4772.

217.5.4 Testing

Testing instructions and requirements for Cast Iron and Ductile Iron pipelines shall be as specified in Subsection 217.4.12 for steel pipelines.

217.5.5 Methods of Measurement and Payment

Cast Iron pipes and Ductile Iron pipes and fittings shall be classified for payment according to type, diameter and class and shall be measured in linear meters of completed pipeline in place, measured along the crown of the pipeline. The length measured for payment shall include the lengths of all fittings, valves and specials installed in the line.

The price for fittings, bends, junctions, specials, detachable joints, flanges (when not integral part of pipe or fitting) etc. shall be considered as included in the cost of pipes, unless otherwise specified in the particular specifications or the B.O.Q.

Alternatively, if so stated in the Particular Specification and/or in the Bill of Quantities, C.I. and Ductile Iron pipes and fittings may be measured by number of pipes of defined net lengths and by number of fittings.

The payment for C.I. and Ductile Iron pipes and (under separate items) for fittings, bends, junctions etc. shall include:

- Supply, hauling, unloading and stacking of pipes and fittings including all necessary joints and jointing materials.
- Removal from stacks, hauling and stringing alongside the trench, laying and jointing of pipes and fittings at any depth of trench, connections to manholes and/or chambers and final cleaning and flushing of pipeline. The unit rates for this item for each type, class and diameter of pipe and fitting shall be the same for all depths of trench in which the pipes and fittings are to be installed.
- Testing of completed pipeline
 - For pressure and gravity pipelines shall be paid for under a separate item in the Bill of Quantities, by linear meters of pipe tested.

Only pipes, fittings, junctions, bends etc. actually laid, jointed and tested and accepted by the Engineer shall be taken into account for payment under items and no allowance whatsoever will be made for any breakage, loss, etc.

Excavation and backfill, special beddings, surrounds and manholes and chambers shall be paid for under separate items in the Bill of Quantities, unless otherwise noted.

217.6 G.R.P. PIPES

(Not Used)

217.7 P.V.C. PIPES

(Not Used)

217.8 HIGH DENSITY POLYETHYLENE PIPES (HDPE)

(Not Used)

217.9 WATER SERVICE CONNECTIONS

(Not Used)

217.9.1 Microtunneling System and Machines

(Not Used)

ROAD WORKS

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218 ROAD WORKS

218.1 ROADS AND PAVED AREAS

218.1.1 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.

All roads shall be fitted with a stormwater drainage system, sidewalks, etc.

218.1.2 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.

218.1.3 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/dm³.

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/dm³ 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.

<u>Aggregate fraction</u>	<u>Maximum abrasion (%)</u>
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

218.1.4 Bituminous Prime Coat and Tack Coat

Unless otherwise specified, a prime coat of medium curing cut-back bitumen of grade MC-70 shall be applied on top of finished base course, at the rate of 1.0 kg/m², and a tack coat of rapid curing cut-back bitumen of grade RC-250 shall be applied between asphalt concrete layers (where more than one wearing course is specified), at the rate of 0.25 kg/m².

Bituminous coats shall be applied one day before the next layer is placed on top of them. Prior to applying bituminous coats, the road surface shall be thoroughly cleaned of all dirt, oil, grease and other objectionable matter, to the satisfaction of the Engineer. The bitumen shall be heated in boilers of an approved type and spreading shall be carried out by means of mechanical pressure distributors.

218.1.5 Asphalt Concrete Wearing Courses

The number of asphalt concrete layers to be placed in the road surfacing and the thickness of each of them shall be as shown on the Drawings and/or required in the Particular Specification.

All aggregates and bituminous materials to be used in asphalt concrete shall be subject to approval by the Engineer. Samples of the materials shall be submitted to the Engineer at least 30 days prior to their use.

All aggregates, except natural sand, shall be obtained by crushing natural quarry stone, and the use of river gravel, whether crushed or not, will not be permitted. Coarse aggregate shall be of uniform quality, with the particles as nearly cubiform as possible, clean of dust or foreign matter, and shall comply with the requirements of Subsection 218.1.3 above for base course aggregate. Quarry sand shall be clean and free of clay, silt or other deleterious matter; it shall all pass sieve No. 10 and not more than 10 percent of it shall pass sieve 200. The grading of the aggregates shall be if not specified in the Particular Specification as follows:

A.S.T.M.Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
3/4"	100%
1/2"	80-100
No. 4	50-70
No. 10	32-47
No. 40	16-26
No. 80	10-18
No. 200	4-10

Mix design shall be carried out as follows. The proposed aggregate mixture shall be mixed with 5.5% bitumen (if no other percentage is required in the Particular Specification). This sample shall be subjected to a set of Marshall tests (A.S.T.M.-D-1559 and A.S.T.M.-D-1188) at a laboratory in order to determine the optimum bitumen content. The Engineer may change the grading of the aggregates and the bitumen content according to the results of laboratory tests conducted on samples of materials supplied from time to time by the Contractor at the request of the Engineer.

Placing of asphalt concrete, unless otherwise specified, shall be carried out by means of paving finishers, specially designed for that purpose. The asphalt concrete layers shall be compacted by tandem rollers, heavy pneumatic rollers and three-wheeled rollers, in that order to reach a density not less than 97% of the Marshall density. Parts of the layers inaccessible to heavy mechanical rollers shall be compacted by small vibratory tampers. Rolling shall proceed from the outer edges towards the centre of the road and the whole area shall receive a uniform compaction throughout and shall be finished accurately to the required lines and levels. When asphalt concrete is placed in more than one layer, longitudinal joints shall be staggered by 30 cm and transversal joints by 60 cm between layers. The permissible variations of the top surface from the design levels shall be $-0 + 15$ mm. The permissible variations from the plane in the top surface shall be 5 mm over a length of 5 m.

Newly paved asphalt concrete surfaces shall be opened to traffic only after permission to do so is given in writing by the Engineer.

Placing of asphalted concrete shall ensure an inclination for drainage of stormwaters in accordance with the drawings and as specified by the Engineer.

218.1.6 Bituminous Surface Treatment

Where shown on the Drawings or required in the Particular Specification, a surface treatment shall be applied to the base course by spraying cut-back bitumen followed by a rolled blinding layer of stone chippings. Unless otherwise specified, bituminous surface treatment shall consist of the following two layers:

- Cut-back bitumen MC-3000 at the rate of 2.8 kg/m^2 , followed immediately by stone chippings of 3/4" - 1" size at the rate of 27 kg/m^2 .
- Cut-back bitumen MC-3000 at the rate of 1.35 kg/m^2 , followed immediately by stone chippings of No. 4 - 1/2" size at the rate of 22 kg/m^2 .

The second layer shall be placed after the first layer has been rolled.

Prior to application of bituminous spray the base course surface shall be checked for accuracy and any irregularities shall be repaired. The surface shall then be swept clean of all loose material, foreign matter, dust and dirt. Areas contaminated by kerosene or diesel oil shall be removed and made good with clean and stable base course material.

The bitumen shall be heated in kettles of an approved type equipped with enclosed thermometers, the heat being conducted by oil or steam. Heating of bitumen in the barrels will not be permitted.

The entire area of the base course shall be sprayed uniformly at the prescribed rate by means of approved mechanical spraying equipment. Pools of excess liquid bitumen shall be sprinkled with fine sand which shall be swept off after it has absorbed the surplus bitumen.

The stone chippings shall be uniformly applied upon the entire sprayed surface. Trucks or other equipment for spreading the chippings shall be operated backwards so that the bituminous spray will be covered before wheels or workmen pass over it. Supplementary spreading and smoothing, where necessary, shall be done manually.

Following spreading and smoothing of chippings, each layer shall be rolled, to the satisfaction of the Engineer.

The completed road surface shall not be opened to traffic until permitted by the Engineer.

218.2 DRAINAGE SYSTEM

(Not Used)

218.3 SIDEWALKS

Where specified on Drawings and required by the Engineer, sidewalks shall be executed.

Prior to the construction of sidewalks, the base course shall be prepared as determined in the previous articles. The Contractor shall be held liable for any future settlement of such layer.

Pavement works shall start upon the approval of the Engineer, and as shown on shop drawings.

For concrete paving, the flags shall be of an approved colour and laid in compliance with the requirements of the division 208, and in strict accordance with the lines and levels shown on shop drawings.

218.4 CONCRETE KERB-STONES

(Not Used)

218.5 TESTING

218.5.1 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.

218.5.2 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 m³ of placed backfills:

Measurement of moisture content
Measurement of compactness (dry density)

218.5.3 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.

218.5.4 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 m³ 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 m³ of placed aggregates,
- Or as directed by the Engineer.

218.5.5 Tests on concrete asphalt aggregates

Following are the required tests to be carried out on concrete asphalt aggregates:

- Los Angeles Test
- Specific gravity
- Sieve analysis
- Loss in weight
- Sand equivalent
- Any other test as specified by standard ASTM D 693-54.

Three series of tests shall be conducted on each 500 m³ of furnished material or on any volume exceeding by 50% this number, as required in writing by the Engineer.

218.5.6 Tests on bitumen

- Penetration at 25° C
- Penetration at 163° C
- Ductility at 25° C
- Flash point
- Solubility in carbon sulphide at 20° C
- Paraffin content.

Whenever required in writing by the Engineer, the tests above shall be carried out on each furnished bitumen volume prior to manufacture of asphalt concrete, or on bitumen that is being used.

218.5.7 Tests on asphalt concrete mixture

The Contractor shall conduct:

- 1) Tests to determine the grading of aggregates and the bitumen content
- 2) Marshall tests to determine the stability and density of bitumen-covered aggregates.

These tests shall be carried out before the commencement of works and repeated to the satisfaction of the Engineer.

218.5.8 Quality Control Tests

- Control of grading
- Control of moisture content and temperature
- Control of bituminous mixture, 2 samples to be tested daily/mixing plant
- Control of mixing plant.

Grading control shall be conducted once a day on 10 kg of samples of aggregates before putting them in the mixing plant, and whenever required by the Engineer.

Control of moisture content and temperature shall be carried out twice a day; moisture content shall not exceed 0.5% and temperature variations $\pm 5^{\circ}$ C.

The control of bituminous mixture shall be carried out on the bitumen content and grading. Each tested sample consisting of four distinct samplings shall be taken from the mixing plant at short intervals as to ascertain that the proportioning remains unchanged.

The tolerance on bitumen content is relatively $\pm 5\%$ of the measurements daily average.

Permissible tolerances are:

- $\pm 5\%$ of the percentage fixed for the average bitumen content
- $\pm 10\%$ of the percentage fixed for the corrector filler content.

218.5.9 Control of placing asphalt concrete

Throughout placing and compacting aggregates works, the temperature shall be controlled permanently in order to be $\geq 135^{\circ}$ C.

After compaction, density shall be equal to 98% of the Marshall density; one core sample shall be taken of each 1000 m² of finished layer. These samples shall also be used to control the layer thickness.

Where specifically called for, the level and regularity of the surfacing shall be controlled.

No layer shall be executed by the Contractor unless the underlying one has been duly taken over by the Engineer.

218.6 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 201.1.10 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 m² 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 labour necessary for completing roads, shoulders or sidewalks, in accordance with the Drawings and the Specification, and to the satisfaction of the Engineer.

Concrete kerbstones, channels etc. shall be measured for payment in linear meters of kerbstone 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.

MISCELLANEOUS SITE WORKS

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220 MISCELLANEOUS SITE WORKS

220.1 SCOPE

The provisions of this Chapter shall apply to the following kinds of site works:

- Fencing, including gates and wickets,
- Grassing (Not Used),
- Roads and paved areas.

Other kinds of site works, if required, will be detailed in the Particular Specification.

220.2 FENCING, GATES AND WICKETS

Wherever shown on the Drawings or directed by the Engineer, the Contractor shall erect fences, gates and wickets. All fences, gates and wickets shall be in accordance with the layout and details shown on the Drawings and/or described in the Particular Specification.

The ground along the fence alignment shall be levelled so as to provide an even gap between the bottom wire and the ground surface.

All main and tie wires, all barbed wires and all other metal parts shall be hot-dip galvanized, unless otherwise specified or directed. The fence shall be stretched and fastened by means of approved fasteners, to the satisfaction of the Engineer. Stretching shall not be commenced until the concrete foundations have sufficiently hardened and in no case before 14 days from the pouring of the foundations.

Unless otherwise specified or directed, the entrance gates shall be double leaf and wickets single leaf, to the widths and heights shown on the Drawings, fabricated from standard galvanized water pipe and fittings including bracing, and covered with 5 x 5 cm wire mesh made of 3 mm diameter galvanized and plastic coated wire. The gates shall be hinged to gateposts and shall be complete with locks and stops. All wires and metal parts shall be hot-dip galvanized, unless otherwise specified or directed.

Wherever called for on the Drawings or in the Particular Specification, painting shall be carried out in accordance with Subsection 207.1.5.

Fences shall be measured for payment in linear meters of finished fence, as shown on the Drawings. Gates and wickets shall be paid for per unit. The rates under this Section shall include for all materials, equipment and labour required to complete the fences, gates and wickets in place, in accordance with the Drawings and Specification, and to the satisfaction of the Engineer.

220.3 GRASSING

(Not Used)

United Nations Children's Fund (UNICEF)



INSTALLATION WORKS OF THE OMNI PROCESSOR AT IAAT WWTP

VOLUME 4

PARTICULAR SPECIFICATIONS

Part 1 - General Requirements

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MARCH 2021

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PART 1

GENERAL REQUIREMENTS

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PART 1

101. GENERAL REQUIREMENTS

101.1 APPLICATION OF PARTICULAR SPECIFICATION

This Particular Specification is to be read and construed together with the General Specification contained in Volume 3 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. In addition, Health, safety and environmental requirements including precautions for Covid-19 are to be included in the contract.

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 construction of the waste water treatment plant located at IAAT Lebanon.

101.3 THE SITE

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

The works covered by this contract are limited to the construction of the waste water treatment plant 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.

101.5 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.

101.6 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 Well, 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 101.12.4 of the General Specification with regard to such existing services.

101.7 ACCESS ROADS

101.7.1 Temporary access roads

There is no necessity of construction of Access Roads and/or temporary roads, the site is accessible by an existing road.

In case such temporary roads is needed, it shall be subject to the provisions of Clause 101.12.3 of the General Specification for Civil Engineering Works, and shall be executed at the contractor's responsibility and expenses in coordination with the concerned Authorities and according to the project's requirements with the approval of the Engineer.

101.8 PLANNING 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 planning 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 plan 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 shall, as a minimum, 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.

101.9 LIST OF ABBREVIATIONS

In the Contract Documents, the following abbreviations have been employed:

uPVC	- Unplasticized Polyvinyl Chloride
D.I.	- Ductile Iron
R.C.	- Reinforced Concrete
C.I.	- Cast Iron
G.S.	- General Specification

C.O.C.	- Conditions of Contract
B.O.Q.	- Bill of Quantity
PN	- Nominal Pressure
DN	- Nominal Diameter
ID	- Inner Diameter
OD	- Outer Diameter

101.10 OR EQUAL CLAUSE

Wherever references 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 required material or article 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, Electricity of Lebanon, and Telecommunications Authority.

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 FACILITIES FOR THE ENGINEER'S REPRESENTATIVE

The Contractor shall provide any necessary protective clothing and safety equipment for the use of authorized visitors to the site including the Employer and his staff and Representatives and those of any relevant authority who have reason to visit the site.

101.13 ACCESS TO WORK

The Engineer and his duly appointed representatives and the Employer or his representatives or agents may at any time and for any purpose whatsoever enter into and upon the work and the premises used by the Contractor. The Contractor shall provide free, proper, and safe facilities therefore.

101.14 SURVEY AND SETTING OUT

All levels used for construction shall be referred to the National Height Datum. The Contractor shall be responsible for obtaining the location and values of the permanent bench Marks. In cases where such bench Marks do not exist, a site datum shall be agreed with the Engineer.

Prior to the commencement of the work the Engineer shall approve all plans showing benchmarks, limits of plot and auxiliary baselines. The Contractor, under the supervision of the Engineer, shall set out on-site and erect appropriate permanent markers where instructed by the Engineer.

The Contractor shall employ an experienced licensed Surveyor for the duration of the Contract. He shall furnish the Engineer with a duly signed map showing the various centerlines, baselines, reference points permitting the renewal of markers and boundaries of parcels and blocks, if destroyed. Before starting and during earthwork on the site, the Contractor shall set out a net of square coordinates at distances not exceeding 10 m in each direction. A peg shall be driven at each intersection and at other relevant points and levels of peg tops and of ground at the same spot shall be measured.

The levels of the ground and the levels and dimensions of existing features shown on the Drawings are not guaranteed to be correct.

Wherever dimensions or levels are marked on the Drawings such dimensions or levels shall take precedence over dimensions scaled from the Drawings. Where no dimensions or levels are shown on the Drawings, instructions shall be obtained from the Engineer. Large scale drawings shall be taken in preference to drawings of smaller scale.

101.15 GEOTECHNICAL INVESTIGATION CAMPAIGN

The Contractor shall employ an experienced licensed Geotechnical company in order to conduct geotechnical investigation campaign and to confirm design criteria set in tender documents.

Prior to the commencement of the works, the Engineer shall approve and advise on geotechnical investigation report in order to insure foundations dimensions and levels.

The Contractor, under the supervision of the Engineer, shall perform required boreholes as approved by the Engineer, at least one borehole under each facility of treatment plant.

Boreholes location and depth shall be submitted to the Engineer for approval before commencement of geotechnical campaign.

101.16 NOTICE BOARDS

The Contractor shall provide and erect a sign board at the site 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.

101.17 MANUFACTURE'S CERTIFICATES

The Contractor shall furnish the Engineer with a manufacture's certificate confirming compliance to the specification in respect of all items of equipment.

The original and one copy of the manufacturer's certificate shall be delivered to the Engineer not later than 14 days prior to the intended date of delivery of the Item to site.

101.18 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.

In addition, special measures related to health, safety and environmental requirements including precautions for Covid-19 are to be implemented and respected on site by all Contractor's staff members during all execution phases of the project.

101.19 ACCESS TO PROPERTIES

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

101.20 TOPOGRAPHIC SURVEY

All control points, and heights shall be related to the National Height Datum in meters. Station Descriptions with distances to reference objects and a list of coordinates and heights shall be submitted to the Engineer.

Permanent bench marks shall be constructed from steel pins, road nails or painted marks on existing stable features. A minimum of two site bench marks shall be established on existing stable features.

All man-made hand detail features, road edges, curbs, existing manholes, inspection covers, culverts, and underground service pipeline shall be surveyed in their true position and shown by conventional symbols. The detection of the existing services will be paid separately and must be approved by the Engineer.

Any surveyor who will subcontract topographical works from the Contractor shall be approved of by the Engineer. However, the Contractor will still be held responsible for the accuracy of the survey until it gets approved by the Engineer.

101.21 DRAWINGS AND DOCUMENTS

All drawings and documents submitted by the Contractor shall have been checked and signed, shall 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 the approval.

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

101.22 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 the Bill of Quantities and shall not be paid for separately.

101.23 POST-INSTALLATION DOCUMENT

Documentation shall include, but not limited to, the following:

- As-built drawings.
- Operation and maintenance
- Test, commissioning and calibration reports.
- Acceptance certificates.
- Warranty-conditions, start dates, end dates.

101.24 TRAINING, TESTING AND COMMISSIONING

101.24.1 TRAINING THE EMPLOYER PERSONNEL

During the period of assembling and especially during the period of pre-commissioning operation, the Contractor shall train the personnel assigned by the Employer. The training shall be carried out at 3 principal levels:

- a) Engineers
- b) Control and maintenance technicians (assistant engineers)
- c) Skilled workers

The instruction of levels b) and c) shall be carried out with the collaboration of level a) already trained.

The training program, as well as the number of persons participating in the training shall be established by mutual agreement with the Employer, and upon his approval.

At the end of the training, the trainee shall receive a training certificate issued by the contractor and approved by the engineer.

During the period of pre-commissioning, the Contractor shall hand over to the Employer's personnel the respective operating and maintenance manuals of the equipment.

101.24.2 TESTING

101.24.21. GENERAL

Pump testings shall be determined according to the pump tests carried out by an international control organisation, i.e. EUROPUMP.

Equipment manufactured in large quantities shall not undergo in-factory tests.

The manufacturer shall produce, for the manufacture criteria and their justifications, the characteristic curves of each pump ordered by the Contractor :

- Flow curve
- Efficiency curve
- Power curve
- Suction curve (NPSH)

The complete control of operation conditions shall be carried out as soon as the equipment is installed on site.

101.24.22. TESTING ELECTRICAL PANELS IN WORKSHOPS

Tests of each electrical panel must include at least the following verifications :

- Verification of the aspect, accessibility of mechanical equipment, as well as strength and operation of mobile elements, precautions taken to prevent corrosion and protect paint, wires and cable runs, and marking operations, etc...
- Verification of the good functioning of mechanical and electrical control devices as well as efficiency of locking mechanisms.
- Verification of the electrical insulation.
- Verification of the continuation of sheathings.
- Verification of Earthing connections.

Moreover, all electrical equipment constituting the panels should have undergone in-factory tests determined by the relevant standards.

101.24.3 COMMISSIONING

At the end of the satisfactory pre-commissioning operation, and if the Contractor has started training the Employer's personnel, the commissioning of the equipment shall start. It shall be deemed started and a report shall be drawn thereof provided that the Contractor has submitted to the Engineer a written request, along with a copy of the drawings, notices and documents necessary to the operation and maintenance of the equipment.

Starting from the commissioning operation, the Employer's personnel takes over the operation and the maintenance of the equipment under the supervision of a sufficient number of qualified technicians assigned by the Contractor.

These technicians shall supervise the personnel till the end of the commissioning.

The commissioning period is fixed to a minimum continuous duration of twenty eight days, during which the equipment shall function satisfactorily and require only minor secondary setting up or adjustment entailing no stops and revealing no systematic defect.

In case any setting up, adjustment or defect entails the stopping of the equipment during the commissioning period, the minimum period of twenty-eight days mentioned above should compulsorily restart as from the resumption of the normal commissioning operation.

During the commissioning period set above, the Contractor's supervising technicians shall continue training the personnel assigned by the Employer.

Until the taking over, and provided the operation requirements permit it, the Contractor shall carry out, at his own costs, all necessary replacements, modifications, setting up and adjustments.

101.25 DEFECTS LIABILITY PERIOD

The Contractor guarantees that all the supplies delivered according to the terms of the Contract are new, have never been used, are of the latest pattern put into service and have undergone all necessary improvements relating to design and materials.

Moreover, the Contractor guarantees that all the delivered supplies have no defects owing to their design, to the constituent material or to their use.

The Defects Liability Period remains valid for 12 months as from the date of Taking Over.

During the Defects Liability Period the Contractor shall supervise the maintenance of the installations.

During the Defects Liability Period, the Contractor is bound to carry out all modifications, setting up, adjustments required for the replacement of the defective parts, so that the equipment meet the conditions set out in the Contract.

If during the Defects Liability Period an equipment is stopped due to defects attributable to the Contractor, especially in the case of abnormal wear, deterioration or malfunction of a main component, the Defects Liability Period for this equipment is extended to cover the period of time during which the equipment was out of order.

If during the Defects Liability Period, it is necessary to replace a component due to an abnormal wear, deterioration or malfunction, the Defects Liability Period of this component is counted from the moment the replacing parts are put into service. In this case, the Engineer can, at the end of the Defects Liability Period retain an amount of money equal to twice the price of the component determined at the moment of the

replacement. This amount shall not be fully paid up until the end of the Defects Liability Period proper to this component, provided that the latter was proved consistent with the clauses of the Contract.

The Contractor affords all the expenses resulting from the above-mentioned operations including the cost of transportation, on site disassembling and reassembling and customs dues, etc...

Are excluded, expenses resulting from a deterioration owing to a negligence or an operation error and attributable to the Employer, or due to operation conditions that are not consistent with the instructions of operation and maintenance given by the Contractor. After having examined these defects not attributable to him, the Contractor shall inform the Engineer within a period of ten working days only, under a penalty of foreclosure.

The Contractor is not responsible for the components supplied, repaired, modified or replaced by the Employer or his representative without the written approval of the Contractor.

However, this does not include the cases where the Employer carries out urgent repairs or replacements in the event of non-compliance by the Contractor to the conditions mentioned hereinafter.

If it has been proved that the noticed defect is caused by a systematic error of design of equipment, the Contractor should replace or modify all identical parts used on the other equipment mentioned in the Contract, even though they did not give rise to any accident.

All works incumbent on the Contractor during the Defects Liability Period should be executed as soon as possible, taking into consideration the operation requirements.

The Contractor should, however, afford all provisional repairs to meet to the best these requirements, while reducing to the minimum the time during which equipment is partially or totally not operational.

The end of the Defects Liability Period will be declared following satisfactory Test On Completion results.

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CIVIL WORKS

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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.
 - Eurocode
 - AFPS 90
- or equivalent standards

201.2 SOIL PARAMETERS

The Contractor is not required to carry out soil investigations, since a complete geotechnical study was conducted during the design phase.

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 Reservoirs (400 Kg cement/cu.m)
C30	Reinforced concrete for other Parts and Structures (350 Kg cement/cu.m)
C25	Reinforced concrete for thrust blocks (350 Kg cement/cu.m)
C20	Mass concrete and Blinding concrete (250 Kg cement/cu.m)

Reinforced and mass concrete must be vibrated. Cement used for structures in contact with wastewater and buried surfaces in contact with underground water shall be sulfate resisting Portland cement (BS 4027). Cement for all other structures shall be ordinary or/and rapid hardening Portland cement (BS12).

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/mm².

Dowel bars and stirrups shall be Mild Steel grade 25, $f_y = 250$ N/mm².

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 50 mm in structures where concrete surfaces are in contact with water and for the cover slab of reservoir.

The concrete cover for all steel shall not be less than 50 mm in foundations poured directly on blinding concrete.

Where concrete surfaces are directly poured in contact with soil, the cover of reinforcement shall not be less than 70 mm.

Formwork for all concrete surfaces in contact with water and/or soil and internal surface (walls and ceilings) 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 0.1 mm.

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

In addition, concrete environmental class exposure is based on BS EN 206 Concrete Specifications. As shown below (table 1 – exposure classes - BS EN 206) , XA2 classes are adopted for concrete elements.

Minimum required concrete compressive strength is adopted according to annex F - BS EN 206. ($f^c = 30$ MPa for XA2 with minimum cement content of 320 kg/m³)

Class designation	Description of the environment	Informative examples where exposure classes may occur
1 No risk of corrosion or attack		
X0	For concrete without reinforcement or embedded metal: All exposures except where there is freeze/thaw, abrasion or chemical attack. For concrete with reinforcement or embedded metal: Very dry	Concrete inside buildings with very low air humidity
2 Corrosion induced by carbonation		
Where concrete containing reinforcement or other embedded metal is exposed to air and moisture, the exposure shall be classified as follows:		
XC1	Dry or permanently wet	Concrete inside buildings with low air humidity; Concrete permanently submerged in water
XC2	Wet, rarely dry	Concrete surfaces subject to long-term water contact; Many foundations
XC3	Moderate humidity	Concrete inside buildings with moderate or high air humidity; External concrete sheltered from rain
XC4	Cyclic wet and dry	Concrete surfaces subject to water contact, not within exposure class XC2

Class designation	Description of the environment	Informative examples where exposure classes may occur
3 Corrosion induced by chlorides other than from sea water		
Where concrete containing reinforcement or other embedded metal is subject to contact with water containing chlorides, including de-icing salts, from sources other than from sea water, the exposure shall be classified as follows:		
XD1	Moderate humidity	Concrete surfaces exposed to airborne chlorides
XD2	Wet, rarely dry	Swimming pools; Concrete exposed to industrial waters containing chlorides
XD3	Cyclic wet and dry	Parts of bridges exposed to spray containing chlorides. Pavements, Car park slabs
4 Corrosion induced by chlorides from sea water		
Where concrete containing reinforcement or other embedded metal is subject to contact with chlorides from sea water or air carrying salt originating from sea water, the exposure shall be classified as follows:		
XS1	Exposed to airborne salt but not in direct contact with sea water	Structures near to or on the coast
XS2	Permanently submerged	Parts of marine structures
XS3	Tidal, splash and spray zones	Parts of marine structures
5 Freeze/thaw attack with or without de-icing agents		
Where concrete is exposed to significant attack by freeze/thaw cycles whilst wet, the exposure shall be classified as follows:		
XF1	Moderate water saturation, without de-icing agent	Vertical concrete surfaces exposed to rain and freezing
XF2	Moderate water saturation, with de-icing agent	Vertical concrete surfaces of road structures exposed to freezing and airborne de-icing agents
XF3	High water saturation, without de-icing agent	Horizontal concrete surfaces exposed to rain and freezing
XF4	High water saturation, with de-icing agent or sea water	Road and bridge decks exposed to de-icing agents; Concrete surfaces exposed to direct spray containing de-icing agents and freezing Splash zones of marine structures exposed to freezing
6 Chemical attack		
Where concrete is exposed to chemical attack from natural soils and ground water, the exposure shall be classified as follows:		
XA1	Slightly aggressive chemical environment	Concrete exposed to natural soil and ground water according to Table 2
XA2	Moderately aggressive chemical environment	Concrete exposed to natural soil and ground water according to Table 2
XA3	Highly aggressive chemical environment	Concrete exposed to natural soil and ground water according to Table 2

Table F.1 — Recommended limiting values for composition and properties of concrete

	Exposure classes																	
	No risk of corrosion or attack	Carbonation-induced corrosion				Chloride-induced corrosion				Freeze/thaw attack								
		Sea water				Chloride other than from sea water				XF 1		XF 2		XF 3		XF 4		
	XC 0	XC 1	XC 2	XC 3	XC 4	XS 1	XS 2	XS 3	XD 1	XD 2	XD 3	XF 1	XF 2	XF 3	XF 4	XA 1	XA 2	XA 3
Maximum w/c	-	0,65	0,60	0,55	0,50	0,50	0,45	0,45	0,55	0,55	0,45	0,55	0,55	0,50	0,45	0,55	0,50	0,45
Minimum strength class	C12/15	C20/25	C25/30	C30/37	C30/37	C30/37	C35/45	C35/45	C30/37	C30/37	C35/45	C30/37	C25/30	C30/37	C30/37	C30/37	C30/37	C35/45
Minimum cement content ^a (kg/m ³)	-	280	280	280	300	300	320	340	300	300	320	300	300	320	340	300	320	360
Minimum air content (%)	-	-	-	-	-	-	-	-	-	-	-	-	4,0 ^b	4,0 ^b	4,0 ^b	-	-	-
Other requirements	-	-	-	-	-	-	-	-	-	-	-	Aggregate in accordance with EN 12620 with sufficient freeze/thaw resistance				Sulfate-resisting cement ^d		

^a Where the concrete is not air entrained, the performance of concrete should be tested according to an appropriate test method in comparison with a concrete for which freeze/thaw resistance for the relevant exposure class is proven.

^b Where sulfate in the environment leads to exposure classes XS2 and XS3, it is essential to use sulfate-resisting cement conforming to EN 197-1 or complementary national standards.

^c Where the i-value concept is applied the maximum w/c ratio and the minimum cement content are modified in accordance with 5.2.5.2.

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. COMMON REQUIREMENTS

All metal sheets shall be 6mm thick minimum. All metal works shall be epoxy painted over a primer. Openings for ventilation or other shall be taken into consideration.

Aluminum works shall be of first quality and glazing shall be 8mm thick.

All hardware shall be water resistant.

Buried walls shall receive a bituminous coating for protection.

Washable paint, acid resistant shall be applied elsewhere (Primer and two coats over a double layer of mastic). A tyrolean render shall be applied on external surfaces of Elevated Water Tank.

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.

All the modifications to the design drawings coming out during execution of the works, or after ordering the relating materials should be done by the contractor and approved by the Engineer.

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MASONRY UNIT

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301. UNIT MASONRY

301.1 PART 1 - GENERAL

301.1.1 DESCRIPTION

This section specifies requirements for construction of masonry unit walls.

301.1.2 SUBMITTALS

- A. Submit in accordance with Section 01340, SAMPLES AND SHOP DRAWINGS.
- B. Samples:
 - 1. Concrete masonry units, when exposed in finish work.
 - 2. Anchors, and ties, one each and joint reinforcing 1200 mm (48 inches) long.
- C. Shop Drawings:
 - 1. Special masonry shapes.
 - 2. Drawings, showing reinforcement, applicable dimensions and methods of hanging soffit or lintel masonry and reinforcing masonry for embedment of anchors for hung fixtures.

301.1.3 SAMPLE PANEL

- A. Use sample panels approved by Resident Engineer for standard of workmanship of new masonry work.
- B. Use sample panel to test cleaning methods.

301.2 PART 2 - PRODUCTS

301.2.1 CONCRETE MASONRY UNITS

Hollow and Solid Load-Bearing Concrete Masonry Units: ASTM C90.

- 1. Unit Weight: // Normal weight // medium weight // lightweight //
- 2. Fire rated units for fire rated partitions.
- 3. Sizes: Modular

301.2.2 ANCHORS, TIES, AND REINFORCEMENT

- A. Joint Reinforcement:
- B. Wall Ties, (Mesh or Wire):
 - 1. Mesh wall ties formed of ASTM A82, W0.5, 2 mm, (16 gage) galvanized steel wire 13 mm by 13 mm (1/2 inch by 1/2 inch) mesh, 75 mm (3 inches) wide by 200 mm (8 inches) long.
 - 2. Rectangular wire wall ties formed of W1.4, 3 mm, (10 gage) galvanized steel wire 50 mm (2 inches) wide by 200 mm (8 inches) long.

301.3 PART 3 - EXECUTION

301.3.1 JOB CONDITIONS

- A. Protection:
1. Cover tops of walls with nonstaining waterproof covering, when work is not in progress. Secure to prevent wind blow off.
 2. On new work protect base of wall from mud, dirt, mortar droppings, and other materials that will stain face, until final landscaping or other site work is completed.
- B. Cold Weather Protection:
1. Masonry may be laid in freezing weather when methods of protection are utilized.
 2. Comply with MSJC and “Hot and Cold Weather Masonry Construction Manual”.

301.3.2 CONSTRUCTION TOLERANCES

- A. Lay masonry units plumb, level and true to line within the tolerances as per MSJC requirements and as follows:
- B. Maximum variation from plumb:
1. In 3000 mm (10 feet) - 6 mm (1/4 inch).
 2. In 6000 mm (20 feet) - 10 mm (3/8 inch).
 3. In 12 000 mm (40 feet) or more - 13 mm (1/2 inch).
- C. Maximum variation from level:
1. In any bay or up to 6000 mm (20 feet) - 6 mm (1/4 inch).
 2. In 12 000 mm (40 feet) or more - 13 mm (1/2 inch).
- D. Maximum variation from linear building lines:
1. In any bay or up to 6000 mm (20 feet) - 13 mm (1/2 inch).
 2. In 12 000 mm (40 feet) or more - 19 mm (3/4 inch).
- E. Maximum variation in cross-sectional dimensions of columns and thickness of walls from dimensions shown:
1. Minus 6 mm (1/4 inch).
 2. Plus 13 mm (1/2 inch).
- F. Maximum variation in prepared opening dimensions:
1. Accurate to minus 0 mm (0 inch).
 2. Plus 6 mm (1/4 inch).

301.3.3 INSTALLATION GENERAL

- A. Keep finish work free from mortar smears or spatters, and leave neat and clean.
- B. Anchor masonry as specified in Paragraph, ANCHORAGE.
- C. Wall Openings:
1. Fill hollow metal frames built into masonry walls and partitions solid with mortar as laying of masonry progresses.
 2. If items are not available when walls are built, prepare openings for subsequent installation.
- D. Tooling Joints:
1. Do not tool until mortar has stiffened enough to retain thumb print when thumb is pressed against mortar.

2. Tool while mortar is soft enough to be compressed into joints and not raked out.
 3. Finish joints in exterior face brick work with a jointing tool, and provide smooth, water-tight concave joint unless specified otherwise.
 4. Tool Exposed interior joints in finish work concave unless specified otherwise.
- E. Partition Height:
1. Extend partitions at least 100 mm (four inches) above suspended ceiling or to overhead construction where no ceiling occurs.
 2. Extend following partitions to overhead construction.
 - a. Where noted smoke partitions, FHP (full height partition), and FP (fire partition) and smoke partitions (SP) on drawings.
 - b. Both walls at expansion joints.
 - c. Corridor walls.
 - d. Walls at stairway and stair halls, elevators, dumbwaiters, trash and laundry chute shafts, and other vertical shafts.
 - e. Walls at refrigerator space.
 - f. Reinforced masonry partitions
 3. Extend finish masonry partitions at least four-inches above suspended ceiling and continue with concrete masonry units or structural clay tile to overhead construction:
- F. Lintels:
1. Lintels are not required for openings less than 1000 mm (3 feet 4 inches) wide that have hollow metal frames.
 2. Openings 1025 mm (3 feet 5 inches) wide to 1600 m (5 feet 4 inches) wide with no structural steel lintel or frames, require a lintel formed of concrete masonry lintel or bond beam units // or structural facing tile lintel units // filled with 25 MPa (3000 psi) concrete and reinforced with 1- #15m (1-#5) rod top and bottom for each 100 mm (4 inches) of nominal thickness unless shown otherwise.
 3. Precast lintels of 25 Mpa (3000 psi) concrete, of same thickness as partition, and with one Number 5 deformed bar top and bottom for each 100 mm (4 inches) of nominal thickness, may be used in lieu of reinforced CMU masonry lintels.
 4. Doors having overhead concealed door closers require a steel lintel, and a pocket for closer box.

POINTING

- A. Fill joints with pointing mortar using rubber float trowel to rub mortar solidly into raked joints.
- B. Wipe off excess mortar from joints of glazed masonry units with dry cloth.
- C. Finish exposed joints in finish work with a jointing tool to provide a smooth concave joint unless specified otherwise.
- D. At joints with existing work match existing joint.

301.3.4 GROUTING

- A. Preparation:
1. Clean grout space of mortar droppings before placing grout.
 2. Close cleanouts with masonry units.
 3. Install vertical solid masonry dams across grout space for full height of wall at intervals of not more than 9000 mm (30 feet). Do not bond dam units into wythes as masonry headers.
 4. Verify reinforcing bars are in cells of units or between wythes as shown.
- B. Placing:
1. Place grout by hand bucket, concrete hopper, or grout pump.
 2. Consolidate each lift of grout after free water has disappeared but before plasticity is lost.
 3. Do not slush with mortar or use mortar with grout.

301.3.5 CLEANING AND REPAIR

General:

1. Clean exposed masonry surfaces on completion.
2. Protect adjoining construction materials and landscaping during cleaning operations.
3. Cut out defective exposed new joints to depth of approximately 19 mm (3/4 inch) and repoint.
4. Remove mortar droppings and other foreign substances from wall surfaces.
5. Immediately following setting, brush exposed surfaces free of mortar or other foreign matter.

301.3.6 WATER PENETRATION TESTING

- A. Seven days before plastering or painting, in the presence of Resident Engineer, test solid exterior masonry walls for water penetration.
- B. Direct water on masonry for a period of one hour at a time when wind velocity is less than five miles per hour.
- C. Should moisture appear on inside of walls tested, make additional tests at other areas as directed by Resident Engineer.
- D. Correct the areas showing moisture on inside of walls, and repeat test at repaired areas, to insure that moisture penetration has been stopped.

PART 2
CIVIL WORKS

PLASTERING WORKS

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401. LATHING AND CEMENT PLASTERING

401.1.1 DESCRIPTION

This section specifies lathing and Portland cement based plaster.

401.1.2 RELATED WORK

- A. Steel framing members for attachment of plaster bases
- B. Room finish schedule and color
- C. Gypsum plaster: Section 09200

401.1.3 PROJECT CONDITIONS

- A. Maintain work areas for interior work at a temperature of not less than 4°C (40°F) for not less than 48 hours prior to application of plaster, during application of plaster and until plaster is completely dry.
- B. Exterior plaster shall not be applied when the ambient temperature is less than 4°C (40°F).
- C. Plaster shall not be applied to frozen surfaces or surfaces containing frost.
- D. Frozen materials shall not be used in the mix.
- E. Plaster coats shall be protected against freezing for a period of not less than 24 hours after application.

401.2 PART 2 - PRODUCTS

401.2.1 METAL PLASTERING BASES

- A. Expanded Metal Lath:
 - 1. ASTM C847, zinc-coated (galvanized) except as modified by ASTM C841 and this specification. Self furring where applied over solid backing.
 - 2. Flat diamond mesh weighing not less than 1.8 kg/m² (3.4 pounds per square yard).
 - 3. Stucco Mesh: Flat expanded diamond mesh pattern, with openings approximately 38 by 75 mm (1-1/2 by 3 inches), weighing not less than 1.9 kg/ m² (3.6 pounds per square yard), with backing as specified.
- B. Wire Lath:
 - 1. Zinc coated (Galvanized).
 - 2. Welded Wire Lath: ASTM C933, with backing as specified.
 - 3. Self furring where applied over solid backing.
- C. Building Paper Backing for Metal Plastering Bases:
 - 1. Backing attached to lath as specified in ASTM C933.
 - 2. Vapor Permeable Backing: Fed. Spec. UU-B-790, Type I, Grade D.
 - 3. Water Resistant Backing: Fed. Spec. UU-B-790, Type I, Grade B.

401.2.2 ACCESSORIES FOR CEMENT PLASTER

- A. ASTM C841, except fabricate from 0.69 mm (0.027 inch) thick zinc alloy.
- B. Control Joints: ASTM C841, 0.69 mm (0.027-inch) thick zinc.

401.2.3 FASTENERS

- A. Tie, wire, screws, clips, and other fasteners ASTM C841, except as otherwise specified.
- B. Fasteners for securing metal plastering bases shall have heads, or be through washers large enough to engage two strands of the metal plastering base.
- C. For fire rated construction; type and size as used in fire rated test.
- D. Screws: ASTM C1002.
- E. Expansion Shields: Fed Spec. FF-S-325, Group I, II, or III, of the Type and Class applicable.
- F. Toggle Bolts Fed. Spec. FF-B-588, Type and Class best suited for the purpose.
- G. Power Actuated Drive Pins:
 - 1. Fed. Spec. FF-P-395.
 - 2. Fastener length and Class as required to resist twice the imposed loads.
 - 3. Style PC for concrete; Style PS for steel.
 - 4. Eye Pin: Style SC for concrete; Style SS for steel.

401.2.4 CEMENT

- A. Portland: ASTM C150, Type I.
- B. Masonry: ASTM C91. Lime where added, ASTM C207, Type S.
- C. White where required for white finish coat.

401.2.5 LIME

- A. ASTM C206, Type S.
- B. ASTM C207, Type S.

401.2.6 AGGREGATES (Sand)

- A. ASTM C897, graded as required to suit texture of finish specified.
- B. White where white finish coat is specified.

401.2.7 BONDING AGENT

ASTM C932.

401.2.8 FACTORY PREPARED FINISH COAT FOR CEMENT PLASTER(STUCCO)

- A. Factory prepared dry blend of materials, integrally colored, designed for exterior finish coat application.
- B. Pigments: ASTM C979, lime proof mineral oxide.
- C. Not more than 35 percent, by weight of all ingredients (cement, aggregate, hydrated lime, admixture and coloring pigment) shall pass a number 100 sieve.

401.2.9 ADMIXTURES

Air Entrainment: ASTM C260.

401.3 PART 3 - EXECUTION

401.3.1 INSTALLING PLASTERING ACCESSORIES

- A. Install accessories in accordance with ASTM C841, except as otherwise specified.
 - 1. Set plastering accessories plumb, level and true to line, neatly mitered at corners and intersections, and securely attach to supporting surfaces as specified for metal lath.
 - 2. Install in one piece, within the limits of the longest commercially available lengths.
- B. Corner Beads: Install at all vertical and horizontal external plaster corners, as required to establish grounds, and where shown.
- C. Strip Lath:
 - 1. Install metal lath strips centered over joints between dissimilar materials, such as hollow tile, brick, concrete masonry units, concrete, and joints with metal lath on framing or furring, where both such surfaces are required to be plastered and are in contact 88 with each other in same plane, except where expansion joints and casing beads are required.

2. Wire tie or fasten strip lath to base along both edges at not over 150 mm (six inches) on centers.
- D. Casing Beads:
1. Install casing beads where shown and at following locations where plaster terminates to provide finish trim:
 2. Where plaster terminates against non-plastered surfaces such as masonry, concrete, and wood.
 3. Where plaster terminates against trim of steel frames and trim of other materials and equipment, except where trim overlaps plaster.
 4. Around perimeter of openings except where edge is covered by flanges. Locate to conform to dimensions shown on shop drawings.
 5. Where plaster for new walls or furring (vertical or horizontal) terminates against existing construction.
 6. Both sides of expansion and control joints unless shown otherwise.
 7. Install casing bead at perimeter angles between walls and ceilings so as to provide floating angle (unrestrained) construction in accordance with ASTM C841.
- E. Cornerites:
1. Install at interior corners of walls, partitions, and other vertical surfaces to be plastered, except where metal lath is carried around angle.
 2. Fasten only as necessary to retain position during plastering.
 3. Omit cornerites at junction of new plastered walls with existing plastered walls at locations where casing beads are specified.
- F. Control Joints:
1. Where control joints are placed parallel to framing members, install joints within 100 mm (four inches) of the framing member.
 2. Install control joints only to the edges of abutting sheets of lath so that the lath is not continuous or tied across the joint.
 3. Joints shall extend the full width and height of the wall or length of soffit/ceiling plaster membrane.

401.3.2 SURFACE PREPARATION OF SOLID BASES

- A. Surfaces that are to receive plaster shall be prepared and conditioned in accordance with ASTM C926, except as otherwise specified.
- B. New surfaces of masonry and concrete:
 - 1. Remove projections and clean concrete surface of form oil.
 - 2. Fill depressions, holes, cracks and similar voids flush with Portland cement plaster to provide substrate within the tolerance specified in ASTM C926.
 - 3. Use bonding agent.
 - 4. Cover with self furring lath where required to keep the total plaster thickness as specified in Table 4 of ASTM C926.
- C. Existing surfaces of concrete and masonry:
 - 1. Clean surface of dirt and other foreign matter which will prevent bond.
 - 2. Apply dash bond coat or bonding agent as specified herein.
 - 3. Where existing surfaces have a coating such as paint or bituminous waterproofing apply metal plastering base as specified herein.

401.3.3 PORTLAND CEMENT BASED PLASTER

- A. Provide portland cement based plaster where cement plaster is shown and specified, and as follows:
 - 1. Two coat work may only be used over solid bases meeting the requirements of Paragraph, SURFACE PREPARATION OF SOLID BASES.
- B. Proportion, mix and apply plaster in accordance with ASTM C926, except as otherwise specified.
 - 1. Use air entrained plaster for all exterior work.
 - 2. Use coloring pigments for finish coat when integral color other than white is specified.
 - 3. Use white cement with white sand when white finish coat is specified.
 - 4. Factory prepared finish coat: Add water, mix, and apply as specified by manufacturer.
 - 5. Color:
 - a. Color of finish coat shall be natural cement color when painted or other coating is specified.
 - b. Other colors as specified in Section, INTERIOR/EXTERIOR FINISHES, MATERIALS, AND FINISH SCHEDULES.
 - 6. Finish coat shall be // smooth troweled // sand float // machine dash // texture.

PART 2
CIVIL WORKS

PAINTING WORKS

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501. PAINTING WORKS

501.1.1 DESCRIPTION

- A. Section specifies field painting.
- B. Section specifies prime coats which may be applied in shop under other sections.
- C. Painting includes shellacs, stains, varnishes, coatings specified, and striping or markers and identity markings.

501.1.2 SUBMITTALS

- A. Submit SAMPLES AND SHOP DRAWINGS.
- B. Manufacturer's Literature and Data:
Before work is started, or sample panels are prepared, submit manufacturer's literature, indicating brand names, product type color, gloss level, coating composition, Federal Specification Number or manufacturer's name or product number where applicable, and certificates as specified.
- C. Sample Panels:
 - 1. After painters' materials have been approved and before work is started submit sample panels showing each type of finish and color specified.

501.1.3 DELIVERY, AND STORAGE

- A. Deliver materials to site in manufacturer's sealed container marked to show following:
 - 1. Name of manufacturer
 - 2. Product type
 - 3. Batch number
 - 4. Instructions for use
 - 5. Safety precautions
- B. Maintain space for storage, and handling of painting materials and equipment in a neat and orderly condition to prevent spontaneous combustion from occurring or igniting adjacent items.
- D. Store materials at site at least 24 hours before using, at a temperature between 18 and 30 °K (65 and 85 °F).

501.1.4 MOCK-UP PANEL

- A. Before starting application of water paint mixtures, // cementitious paint // _____ //, apply paint as specified to an area, not to exceed 9 m² (100 sf), selected by Resident Engineer.
- B. Finish and texture approved by Resident Engineer will be used as a standard of quality for remainder of work.

501.2 PART 2 - PRODUCTS

501.2.1 PAINT PROPERTIES

- A. Use ready-mixed (including colors), except two component polyesters, paints having metallic powders packaged separately and paints requiring specified additives.
- B. Materials finely ground, uniform in consistency and readily dispersed to form a smooth and homogeneous fluid.
- C. Where no requirements are given in the referenced specifications for primers, use primers with pigment and vehicle, compatible with substrate and finish coats specified.

501.2.2 REGULATORY REQUIREMENTS

- A. Paint materials shall conform to the restrictions of the local Environmental and Toxic Control jurisdiction.
 - 1. Volatile Organic Compounds (VOC): VOC content of paint materials shall not exceed local, state or district requirements.
 - 2. Lead-Base Paint:
 - a. Comply with Section 410 of the Lead-Based Paint Poisoning Prevention Act, as amended, and with implementing regulations promulgated by Secretary of Housing and Urban Development.
 - b. Regulations concerning prohibition against use of lead-based paint in federal and federally assisted construction, or rehabilitation of residential structures are set forth in Subpart F, Title 24, Code of Federal Regulations, Department of Housing and Urban Development.
 - c. For lead-paint removal, see Section 02090.
 - 3. Asbestos: Materials shall not contain asbestos.
 - 4. Chromate, Cadmium, Mercury, Silica: Materials shall not contain zinc-chromate, strontium-chromate, Cadmium, mercury or mercury compounds or silica sand.
 - 5. Human Carcinogens: Materials shall not contain any of the ACGIH-BKLT and ACGHI-DOC confirmed or suspected human carcinogens.

501.3 PART 3 – EXECUTION

501.3.1 JOB CONDITIONS

- A. Safety: Observe required safety regulations and manufacturer's warning and instructions for storage, handling and application of painting materials.
 - 1. Take necessary precautions to protect personnel and property from hazards due to falls, injuries, toxic fumes, fire, explosion, or other harm.
 - 2. Deposit soiled cleaning rags and waste materials in metal containers approved for that purpose. Dispose of such items off the site at end of each days work.
- B. Atmospheric and Surface Conditions:
 - 1. Do no exterior or interior painting in foggy, damp or rainy weather. When building is completely enclosed, interior work may be painted.
 - 2. Paint exterior and interior surfaces when ambient temperature is between 10 and 32 degrees C (50 and 90 degrees F), except when

- otherwise designated in manufacturer's printed instructions. Maintain interior temperatures until paint dries hard.
3. Do no exterior painting when it is windy and dusty.
 4. Do no painting in direct sunlight or on surfaces which will soon be warmed by the sun.
 5. Apply only on clean, dry and frost free surfaces except as follows:
 - a. Apply water thinned acrylic and cementitious paints to damp (not wet) surfaces where allowed by manufacturer's printed instructions.
 - b. Dampened with a fine mist of water on hot dry days concrete and masonry surfaces to which water thinned acrylic and cementitious paints are applied to prevent excessive suction and to cool surface.
 6. Varnishing:
 - a. Apply in clean areas and in still air.
 - b. Before varnishing vacuum and dust area.
 - c. Immediately before varnishing wipe down surfaces with a tack rag.

501.3.2 SURFACE PREPARATION

- A. Method of surface preparation is optional, provided results of finish painting produce solid even color and texture specified with no overlays.
- B. General:
 1. Remove prefinished items not to be painted such as lighting fixtures, escutcheon plates, hardware, trim, and similar items for reinstallation after paint is dried.
 2. Remove items for reinstallation and complete painting of such items and adjacent areas when item or adjacent surface is not accessible or finish is different.
 3. See other sections of specifications for specified surface conditions and prime coat.
 4. Clean surfaces for painting with materials and methods compatible with substrate and specified finish. Remove any residue remaining from cleaning agents used. Do not use solvents, acid, or steam on concrete and masonry.
- C. Ferrous Metals:
 1. Remove oil, grease, soil, drawing and cutting compounds, flux and other detrimental foreign matter by use of solvents, emulsions, cleaning compounds, or by steam cleaning, as defined in SSPC-SP 1.
 2. Remove loose mill scale, rust, and paint, by hand or power tool cleaning, as defined in SSPC-SP 2 and SSPC-SP 3, except where high temperature aluminum paint is used, prepare surface in accordance with paint manufacturer's instructions.
 3. Fill dents, holes and similar voids and depressions in flat exposed surfaces of hollow steel doors and frames, access panels, roll-up steel doors and similar items specified to have semi-gloss or gloss finish with metal filler compound. Finish flush with adjacent surfaces.
 - a. This includes flat head countersunk screws used for permanent anchors
 - b. Do not fill screws of item intended for removal such as glazing beads.

4. Spot prime abraded and damaged areas in shop prime coat which expose bare metal with same type of paint used for prime coat. Feather edge of spot prime to produce smooth finish coat.
 5. Spot prime abraded and damaged areas which expose bare metal of factory finished items with paint as recommended by manufacturer of item.
- D. Zinc-Coated (Galvanized) Metal, // Zinc, // Aluminum //, // Copper and Copper Alloys // Surfaces Specified Painted:
1. Clean surfaces to remove grease, oil and other deterrents to paint adhesion, with toluene, xylene or similar solvents in accordance with SSPC-SP 1.
 2. Spot coat abraded and damaged areas of zinc-coating which expose base metal, using zinc rich paint MIL Spec MIL -P-21035, on hot-dip zinc-coated items and spot prime with zinc dust primer, Fed Spec. TT-P-641.
- E. Masonry, Concrete, Cement Board, Cement Plaster and Stucco:
1. Clean and remove dust, dirt, oil, grease efflorescence, form release agents, laitance, and other deterrents to paint adhesion.
 2. Use emulsion type cleaning agents to remove oil, grease, paint and similar products. Use of solvents, acid, or steam is not permitted.
 3. Remove loose mortar in masonry work.
 4. Replace mortar and fill open joints, holes, cracks and depressions with new mortar specified in Section MORTAR AND GROUTS. Do not fill weep holes. Finish to match adjacent surface.
 5. Neutralize Concrete floors to be painted by washing with a solution of 1.4 Kg (3 pounds) of zinc sulfate crystals to 3.8 L (1 gallon) of water, allow to dry three days and brush thoroughly free of crystals.
 6. Repair broken and spalled concrete edges with concrete patching compound to match adjacent surfaces as specified in CONCRETE Sections. Remove projections to level of adjacent surface by grinding or similar methods.

501.3.3 PAINT PREPARATION

- A. Thoroughly mix painting materials to ensure uniformity of color, complete dispersion of pigment and uniform composition.
- B. Do not thin unless necessary for application and when finish paint is used for body and prime coats. Use materials and quantities for thinning as specified in manufacturer's printed instructions.
- C. Remove paint skins, then strain paint through commercial paint strainer to remove lumps and other particles.
- D. Mix two component and two part paint and those requiring additives in such a manner as to uniformly blend as specified in manufacturer's printed instructions unless specified otherwise.
- E. For tinting required to produce exact shades specified, use color pigment recommended by the paint manufacturer.

501.3.4 APPLICATION

- A. Start of surface preparation or painting will be construed as acceptance of the surface as satisfactory for the application of materials.
- B. Unless otherwise specified, apply paint in three coats; prime, body, and finish. When two coats applied to prime coat are the same, first coat applied over primer is body coat and second coat is finish coat.
- C. Apply each coat evenly and cover substrate completely.
 - D. Allow not less than 48 hours between applications of succeeding coats, except as allowed by manufacturer's printed instructions, and approved by Resident Engineer.
- E. Finish surfaces to show solid even color, free from runs, lumps, brushmarks, laps, holidays, or other defects.
- F. Apply by brush, roller or spray, except as otherwise specified.
- H. Do not spray paint in existing occupied spaces unless approved by Resident Engineer, except in spaces sealed from existing occupied spaces.
 - 1. Apply painting materials specifically required by manufacturer to be applied by spraying,
 - 2. In areas, where paint is applied by spray, mask or enclose with polyethylene, or similar air tight material with edges and seams continuously sealed including items specified in WORK NOT PAINTED, motors, controls, telephone, and electrical equipment, fronts of sterilizes and other recessed equipment and similar prefinished items.
- I. Do not paint in closed position operable items such as access doors and panels, window sashes, overhead doors, and similar items except overhead roll-up doors and shutters.

501.3.5 PRIME PAINTING

- A. After surface preparation prime surfaces before application of body and finish coats, except as otherwise specified.
- B. Spot prime and apply body coat to damaged and abraded painted surfaces before applying succeeding coats.
- C. Additional field applied prime coats over shop or factory applied prime coats are not required, except for exterior exposed steel apply an additional prime coat.
- D. Prime rebates for stop and face glazing of wood, and for face glazing of steel.
- E. Metals except boilers, incinerator stacks, and engine exhaust pipes:
 - 1. Steel and iron: Ferrous metal primer. Use epoxy coating where finish of epoxy coating is specified.
 - 2. Zinc-coated steel and iron: Zinc dust primer.
 - 3. Aluminum scheduled to be painted: Zinc molybdate primer.
 - 4. Terne metal: Ferrous metal primer.
 - 5. Copper and copper alloys scheduled to be painted: Zinc molybdate primer.
 - 6. Machinery not factory finished: Enamel, Alkyd, Gloss Low VOC content.
 - 7. Asphalt coated metal: Aluminum paint.
 - 8. Metal over 94 degrees C. (200 degrees F), Boilers, Incinerator Stacks, and Engine Exhaust Pipes: Heat Resistant Paint, 650 degrees C (1200 degrees F),.

- F. Concrete Masonry Units except glazed or integrally colored and decorative units:
 - 1. Concrete Masonry Unit Filler on interior surfaces.
 - 2. Prime exterior surface as specified for exterior finishes.
- G. Cement Plaster or stucco // Concrete Masonry, Brick Masonry // and Cement board // Interior Surfaces of Ceilings and Walls:
 - 1. Latex emulsion, except use two coats where substrate has aged less than six months for latex emulsion finish coat.
 - 2. Use acrylic emulsion finish coats of cementitious paint or epoxy or water paint as scheduled.
- H. Concrete Floors: Floor Enamel.
- I. Barrier coat to separate epoxy paint from existing oil or alkyd paint:
Two coats latex emulsion or rubber paint.
- J. Rubber paint when rubber paint finish is specified over prime coats to surfaces.

501.3.6 EXTERIOR FINISHES

- A. Apply following finish coats where specified in Section 09050.
- B. Steel and Ferrous Metal, // Including Tern //.
 - 1. Two coat of exterior oil paint on exposed surfaces, except on surfaces over 94 degrees C (200 degrees F).
 - 2. One coat of heat resistant paint on surfaces over 94 degrees K (200 degrees F) and on surfaces of boiler // incinerator // stacks // engine exhaust pipes.
- C. Machinery without factory finish except for primer: One coat Enamel, Alkyd, Gloss Low VOC content.
 - 1. Use water paint without additions only interior surfaces.
- D. Concrete Masonry Units // Brick // Cement Plaster // Concrete //:
 - 1. General:
 - a. Mix as specified in manufacturer's printed directions.
 - b. Do not mix more paint at one time than can be used within four hours after mixing. Discard paint that has started to set.
 - c. Dampened warm surfaces above 24 degrees C (75 degrees F) with fine mist of water before application of paint. Do not leave free water on surface.
 - d. Cure paint with a fine mist of water as specified in manufacturer's printed instructions.
 - 2. Use one of the following unless specified otherwise.
 - a. Two coats of water paint mixed with additives specified (CEP).
 - 1) Water paint mixed with water and liquid acrylic resin.
 - a) Allow 24 hours minimum drying time between coats.
 - b) Apply paint with stiff fiber brush and thoroughly work into surface with rubbing motion to seal pores, cracks and voids.
 - c) Apply first coat with brush strokes horizontal or vertical, and second coat brush strokes perpendicular to first.
 - d) After the second coat has set so it will not roll or lift, float surface to uniform texture with a

- sponge float to match finish of mock-up panel.
- 2) Water paint mixed with water, liquid acrylic resin and sand aggregate grades for application by plasterer's type spray gun.
 - a) Prepare paint powder for spraying by mixing with a liquid consisting of one part of liquid acrylic resin to three parts of water unless specified otherwise in manufacturer's printed instructions.
 - b) Spray first coat evenly distributed.
 - c) Float or brush out first spray coat before starting second spray application to fill holes, pores, and imperfections.
 - d) Spray second coat after first coat has set, and air and water bubbles have broken, double back over surface with an even spray application, or additional applications to provide a uniform texture and to match finish of mock-up panel.
- b. Two coats of cementitious paint.

501.3.7 INTERIOR FINISHES

- A. Apply following finish coats over prime coats in spaces or on surfaces.
- B. Metal Work:
 - 1. Apply to exposed surfaces.
 - 2. Omit body and finish coats on surfaces concealed after installation except electrical conduit containing conductors over 600 volts.
 - 3. Ferrous Metal, Galvanized Metal, and Other Metals Scheduled:
 - a. Apply two coats of Alkyd Semigloss (SG) unless specified otherwise.
 - b. Two coats of // alkyd flat or (AK) // alkyd gloss (G) //.
 - c. One coat of enamel undercoat plus one coat of alkyd semigloss on exposed interior surfaces of alkyd-amine enamel prime finished windows.
 - d. Machinery: One coat Enamel, Alkyd Gloss, Low VOC content.
 - e. Asphalt Coated Metal: One coat Aluminum paint (AP).
 - f. Ferrous Metal over 94 degrees K (200 degrees F:), Boilers, Incinerator Stacks, and Engine Exhaust Pipes: One coat Heat Resisting Paint, 650 degrees K (1200 degrees F). (HR).
- C. Plaster:
 - 1. One coat of enamel undercoat plus one coat of low-luster (LL).
 - 2. Two coats of water-based acrylic emulsion paint.
 - 3. One coat of enamel undercoat plus one coat of latex semigloss (SG) or latex gloss (G).
 - 4. One coat epoxy coating (EC).
 - 5. One coat rubber paint (RP).
- D. Masonry and Concrete Walls:
 - 1. Over filler on CMU surfaces.

2. Two coats of water-based acrylic emulsion paint.
3. Two coats of latex flat (AK), low-luster (LL), latex semigloss (SG), or latex gloss (LG).
4. One coat rubber paint. (RP).
5. Two coats water paint (WPC).

501.3.8 PROTECTION CLEAN UP, AND TOUCH-UP

- A. Protect work from paint droppings and spattering by use of masking, drop cloths, removal of items or by other approved methods.
- B. Upon completion, clean paint from hardware, glass and other surfaces and items not required to be painted of paint drops or smears.
- C. Before final inspection, touch-up or refinished in a manner to produce solid even color and finish texture, free from defects in work which was damaged or discolored.

PART 2
CIVIL WORKS

METAL WORKS

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601. METAL WORKS

601.1 PART 1 - GENERAL

601.1.1 DESCRIPTION

- A. Section specifies steel awning supported on steel columns.
- B. Types:
Industrial / Metal

601.1.2 SUBMITTALS

Shop Drawings: Show design, fabrication details, installation, connections, material, and size of members.

601.2 PART 2 - PRODUCTS

601.2.1 DESIGN CRITERIA

- A. Design of unaccessible roof to support a live load of 80 kg/m² and superimposed dead load of 50 kg/m²
- B. Structural design, fabrication and assembly in accordance with requirements of NAAMM Metal Stairs Manual, except as otherwise specified or shown.
- C. Snow load is assumed to be equal to 300 kg/m²
- D. Wind load calculation is based on basic wind speed on 35 m/s

601.2.2 MATERIALS

- A. Steel Pipe: ASTM A53, Standard Weight, zinc coated.
- B. Steel Grating: Metal bar type grating NAAMM BG.
- C. Sheet Steel: ASTM A366.
- D. Structural Steel: ASTM A36.
- E. Steel Floor Plate: ASTM 786.
- F. Steel Decking: Form from zinc coated steel conforming to ASTM A446, with properties conforming to AISI Specification for the Design of Cold-Formed Steel Structural Members.
- G. Steel Plate: ASTM A570.
- H. Iron Castings: ASTM A48, Class 30.
- I. Malleable Iron Castings: ASTM A47.

601.2.3 FABRICATION GENERAL

- A. Fasteners:
 - 1. Conceal bolts and screws wherever possible.
 - 2. Use countersunk heads on exposed bolts and screws with ends of bolts and screws dressed flush after nuts are set.
- B. Welding:
 - 1. Structural steel, AWS D1.1 and sheet steel, AWS D1.3.
 - 2. Where possible, locate welds on unexposed side.
 - 3. Grind exposed welds smooth and true to contour of welded member.
 - 4. Remove welding splatter.

- C. Remove sharp edges and burrs.
- D. Fit stringers to head channel and close ends with steel plates welded in place where shown.
- E. Fit face stringer to newel post by tenoning into newel post, or by notching and fitting face stringer to side of newel where shown.
- F. Shop Prime Painting: Prepare surface and apply primer as specified for ferrous metals in Section, PAINTING.

601.2.4 RAILINGS

- A. Fabricate railings, including handrails, from steel pipe with flush.
 - 1. Connections may be standard fittings designed for welding, or coped or mitered pipe with full welds.
 - 2. Wall handrails are provided under Section, METAL FABRICATIONS.
- B. Return ends of handrail to wall and close free end.
- C. Provide standard terminal castings where fastened to newel.
- D. Space intermediate posts not over six feet on center between end post // or newel post //.
- E. Fabricate handrail brackets from cast malleable iron.
- F. Provide standard terminal fittings at ends of post and rails.

601.2.5 INDUSTRIAL STAIRS / Ladders

- A. Provide treads, platforms, railings, stringers and other supporting members as shown.
- B. Treads and platforms of checkered steel floor plate:
 - 1. Turn floor plate down to form nosing on treads and edge of platform at head of stairs.
 - 2. Support tread and platforms with angles welded to plate.
 - 3. Do not leave exposed fasteners on top of treads or platform surfaces.
 - 4. Provide flat sheet steel risers for stairs with steel plate treads where shown //.
- C. Treads and platforms of steel grating:
 - 1. Fabricate steel grating treads and platforms in accordance with requirements of NAAMM Metal Bar Grating Manuals.
 - 2. Provide end banding bars, except where carrier angle are used at tread ends.
 - 3. Support treads by use of carrier plates or carrier angle. Use carrier plate end banding bars on exterior stairs.
 - 4. Provide abrasive nosing on treads and edge of platforms at head of stairs.
 - 5. Provide toe plates on platforms where shown.

601.3 PART 3 - EXECUTION

601.3.1 STAIR INSTALLATION

- A. Provide lateral bracing required to support the imposed lateral wind loads.
- B. Perform job site welding and bolting as specified for shop fabrication.
- C. Set all structural members in position and secure to existing structure as shown.
- D. Install plumb, level and true to line verification.

601.3.2 RAILING INSTALLATION

- A. Install standard terminal fittings at ends of posts and rails.
- B. Secure brackets, posts and rails to steel by welds, and to masonry or concrete with expansion sleeves and bolts, except secure posts at concrete by setting in sleeves filled with commercial non-shrink grout.
- C. Set rails horizontal or parallel to rake of stairs to within 3 mm in 3650 mm (1/8-inch in 12 feet).
- D. Set posts plumb and aligned to within 3 mm in 3650 mm (1/8-inch in 12 feet).

601.3.3 FIELD PRIME PAINTING

- A. When installation is complete, clean field welds and surrounding areas to bright metal, and coat with same primer paint used for shop priming.
- B. Touch-up abraded areas with same primer paint used for shop priming.
- C. Touch up abraded galvanized areas with zinc rich paint as specified in section PAINTING.

602. EXPANSION JOINT COVER ASSEMBLIES

602.1 PART 1 - GENERAL

602.1.1 DESCRIPTION

- A. Section specifies floor, wall and ceiling // seismic and // building expansion joint assemblies.
- B. Types of assemblies:
 - Metal Plate Cover
 - Elastomeric Joint Covers
 - Preformed Elastomeric Sealant Joint

602.1.2 RELATED WORK

- A. Sheet Metal Expansion Joint Seals
- B. Roof Expansion Joint Cover Assemblies
- C. Color of Elastomer Inserts, Filler Strips, Exterior Wall Seals and Metal Finishes
- D. Steel Plate Expansion Joint Covers

602.1.3 QUALITY ASSURANCE

- A. Project Conditions:
 - 1. Check actual locations of walls and other construction, to which work must fit, by accurate field measurements before fabrication.
 - 2. Show recorded measurements on final shop drawings.
- B. Fire tests performed by Factory or other approved independent testing laboratory.

602.1.4 DELIVERY STORAGE AND HANDLING

- A. Take care in handling of materials so as not to injure finished surface and components.
- B. Store materials under cover in a dry and clean location off the ground.
- C. Remove materials which are damaged or otherwise not suitable for installation from job site and replace with acceptable materials.

602.1.5 SUBMITTALS

- A. Submit SAMPLES AND SHOP DRAWINGS.
- B. Manufacturer's Literature and Data:
 - 1. Submit copies of manufacturer's current literature and data for each item specified.
 - 2. Clearly indicate movement capability of cover assemblies // and suitability of material used in exterior seals for ultraviolet exposure //.
- C. Certificates: Material test reports from approved independent testing laboratory indicating and interpreting test results relative to compliance of fire-rated expansion joint assemblies with requirements specified.
- D. Shop Drawings:
 - 1. Showing full extent of expansion joint cover assemblies; include large-scale details indicating profiles of each type of expansion joint cover assembly, splice joints between sections, joiners with other type assemblies, special end conditions, anchorages, fasteners, and relationship to adjoining work and finishes.
 - 2. Include description of materials and finishes and installation instructions.
- E. Samples:
 - 1. Samples of each type and color of metal finish on metal of same thickness and alloy used in work.
 - 2. Samples of each type and color of flexible seal used in work //.

602.2 PART 2 - PRODUCTS

602.2.1 MATERIALS

- A. Stainless Steel: ASTM A167, Type 302 or 304.
- B. Structural Steel Shapes: ASTM A36.
- C. Steel Plate: ASTM A283, Grade C.
- D. Rolled Steel Floor Plate: ASTM A786.
- E. Aluminum:
 - 1. Extruded: ASTM B221, alloy 6063-T5.
 - 2. Plate and Sheet: ASTM B209, alloy 6061-T6.

- F. Bronze:
 - 1. Extruded: ASTM B455.
 - 2. Plate: ASTM B121.
- G. Brass: ASTM B36.
- H. Elastomeric Sealant:
 - 1. ASTM C920, polyurethane.
 - 2. Type.
 - 3. Class 25.
 - 4. Grade P or NS.
 - 5. Shore A hardness 25, unless specified otherwise.
- I. Thermoplastic Rubber:
 - 1. ASTM C864.
 - 2. Dense Neoprene or other material standard with expansion joint manufacturers having the same physical properties.
- J. Vinyl Invertor Sealant Waterstops: Manufacturers' standard shapes and grade.
- K. Fire Barrier:
 - 1. Designed for indicated or required dynamic structural movement without material degradation or fatigue.
 - 2. Tested in maximum joint width condition as a component of an expansion joint cover assembly in accordance with UL 263 NFPA 251, or ASTM E119 and E814, including hose steam test at full-rated period.
- L. Zinc-Molybdate Primer: Fed. Spec. TT-P-645.
- M. Accessories:
 - 1. Manufacturer's standard anchors, fasteners, set screws, spacers, flexible secondary water stops or seals and filler materials, drain tubes, adhesive and other accessories as indicated or required for complete installations.
 - 2. Compatible with materials in contact.
 - 3. Water stops.

602.2.2 FABRICATION

- A. General:
 - 1. Use ceiling and wall expansion joint cover assemblies of same design as floor to wall and floor to floor expansion joint cover assemblies. Unless shown otherwise.
 - 2. Provide expansion joint cover assemblies of design, basic profile, materials and operation indicated required to accommodate joint size variations in adjacent surfaces, and as required for anticipated structural movement.
 - 3. Deliver to job site ready for use and fabricated in as large sections and assemblies as practical. Assemblies identical to submitted and reviewed shop drawings, samples and certificates.
 - 4. Furnish units in longest practicable lengths to minimize number of end joints. Provide hairline metered corners where joint changes directions or abuts other materials.
 - 5. Include closure materials and transition pieces, tee-joints, corners, curbs, cross-connections and other assemblies.
 - 6. Fire Performance Characteristics:
 - a. Provide expansion joint cover assemblies identical to those of assemblies whose fire resistance has been determined per ASTM E119 and E814, NFPA 251, or UL 263 including hose stream test at full-rated period.
 - b. Fire rating: Not less than rating of adjacent floor or wall construction.
 - 7. Fire Barrier Systems:

- a. Material to carry label of approved independent testing laboratory, and be subject to follow-up system for quality assurance.
 - b. Include thermal insulation where necessary, in accordance with above tests, with factory cut miters and transitions.
 - c. For joint widths up to and including 150 mm (six inches), supply barrier in lengths up to 15000 mm (50 feet) to eliminate field splicing.
 - d. For joint widths of seven inches and wider, supply barrier 3000 mm (10-foot) modules with overlapping ends for field splicing.
 - e. For joints within enclosed spaces such as chase walls, include 1 mm (0.032-inch) thick galvanized steel cover where conventional expansion joint cover is not used.
8. Seal Strip factory - formed and bonded to metal frames and anchor members.
 9. Compression Seals: Prefabricate from thermoplastic rubber or dense neoprene to sizes and approximate profiles shown.
- B. Floor-to-Floor Metal Plate Joints:
1. Frames on each side of joint designed to support cover plate of design shown.
 - a. Continuous frame designed to finish flush with adjacent floor of profile indicated with seating surface and raised floor rim to accommodate flooring.
 - b. Provide concealed bolt and steel anchors for embedment in concrete.
 - c. Designed for filler materials between raised rim of frame and edge of cover plate where shown.
 - d. Frame and cover plates of some metal where exposed.
 - 1) Design cover plates to support 90 Kg (200 lbs) per 0.3 square meters (1-square foot).
 - 2) Cover plates free of rattle due to traffic.
 - 3) No gaps or budes occur on filler material during design movement of joint.
 - 4) Provide manufacturer's continuous standard flexible vinyl water stop under floor joint cover assemblies.
- C. Floor-to-Wall Metal Plate Joints:
1. Provide one frame on floor side of joint only. Provide wall side frame where required by manufacturer's design.
 2. Angle Cover Plates: Provide angle cover plates for joints to wall with countersunk flat-head exposed fasteners for securing to wall unless shown otherwise.
 3. Space fasteners as recommended by manufacturer.
 4. Match cover of adjacent floor to floor cover.
- D. Interior Wall Joint Cover Assemblies:
1. Surface Mounted Metal Cover Plates:
 - a. Concealed frame for fastening to wall on one sides of joint.
 - b. Extend cover to lap each side of joint and to permit free movement on one side.
 - c. Provide concealed attachment of cover t frame cover in close contact with adjacent finish wall surfaces.
 - d. Use angle cover plates at intersection of walls.
 - e. Use smooth surface cover plates matching floor plates.
 - f. Use expansion fire inserts in fire rated walls, rated same as hour rating of wall.
- E. Exterior Wall Joint Assemblies:
1. Variable movement with seal designed to prevent water and air infiltration.
 2. Use vinyl seal strip as secondary seal behind primary seal.
 3. Cover Plate Assemblies:
 - a. Surface mounted cover plate.

- b. Concealed frame for fastening to wall on one side of joint.
- c. Extend cover to lap each side of joint and to permit free movement on one side.
- d. Provide concealed attachment of cover to frame for cover with cover in close contact with adjacent finish surfaces.
- e. Use angle cover plate of intersection of walls.
- 4. Extruded thermoplastic rubber joint assemblies.
 - a. Aluminum frames both sides of joint.
 - 1) Designed to receive flexible rubber primary seal on exposed face after installation of frame.
 - 2) Designed to receive continuous secondary vinyl sheet seal.
 - 3) Anchor spaced at ends and not over 600 mm (24-inches).
 - b. Variable movement extruded rubber primary seal designed to remain in aluminum frame, throughout movement of joint.
 - 1) Flush mounted seal minimum 3 mm (0.125-inch) thick with dual movement grooves designed for plus or minus 50 percent, movement of joint width. //
 - 2) Seismic seal minimum 3 mm (0.125-inch) thick with multi-movement grooves designed for plus or minus 100 percent movement of joint width //.
 - 3) Recessed front face seal minimum 3 mm (0.125-inch) thick with no movement grooves, designed for plus or minus 50 percent movement of joint width. //
 - c. Provide factory heat welded transitions where directional changes occur to ensure a watertight system.
 - d. Provide pantographic wind load supports, maximum 2400 mm (8 feet) on center to support seal systems of 300 mm (12-inches) and wider.
- F. Ceiling and Soffit Assemblies:
 - 1. Variable movement vinyl insert in metal frame on both sides of joint.
 - 2. Designed for flush mounting with no exposed fasteners.
 - 3. Vinyl insert locked into metal frame.
 - 4. Vinyl and metal finish as specified in INTERIOR/EXTERIOR FINISHES, MATERIALS, AND FINISH SCHEDULE.
 - 5. Vinyl insert semi rigid either flush face or accordion shape as showed to span joint width without sagging.
- G. Preformed Sealant Joint: Factory installed elastomeric sealant between extruded aluminum angle frame both sides.
 - 1. Elastomeric Sealant: Two part polyurethane sealant with movement capability of +/- 25% of joint width per ASTM-C-920, Type M, Grade P, Class 25, Shore A hardness of 25+/-5.
 - a. Color:
 - 2. Frame: Extruded Aluminum: Clear // Bronze // anodized.
 - 3. Anticipated movement: (+/- ____).

602.2.3 METAL FINISHES

- A. General:
 - 1. Apply finishes in factory after products are fabricated.
 - 2. Protect finishes on exposed surfaces with protective covering before shipment.
- B. Aluminum Finishes:
 - 1. Finish letters and numbers for anodized aluminum are in accordance with the NAAMM AMP 501, Aluminum Association's Designation System).

- a. Clear anodized finish: AA-C22A41 Chemically etched medium matte, clear anodic coating, Class I Architectural, 0.7 - mil thick.
- b. Color anodized finish: // AA-C22A42, // Chemically etched medium matte, integrally colored anodic coating, Class I Architectural, 0.7-mil thick //; or // AA-C22A44 //

Chemically etched medium matte, electrolytically deposited metallic compound, Class I Architectural, 0.7-mil thick finish. Dyes not accepted.

2. Fluorocarbon Finish: NAAMM AMP 503 AAMA 605.2, high performance organic coating.
 3. Factory-Primed Concealed Surface: NAAMM AMP 505 Protect concealed aluminum surfaces that will be in contact with plaster, concrete or masonry surfaces when installed by applying a shop coat of zinc-molybdate primer to contact surfaces. Provide minimum dry film thickness of 2.0 mils.
- C. Bronze Finish: NAAMM-AMP 502-M32, mechanical finish, directional textured, natural medium satin.
- D. Stainless Steel: NAAMM AMP 503, finish No. 2B.
- E. Carbon Steel: NAAMM AMP 504, Galvanized 690.

602.3 PART 3 EXECUTION

602.3.1 EXAMINATION

- A. Manufacturer's representative shall make a thorough examination of surfaces receiving work of this section.
- B. Before starting installation, notify prime contractor of defects which would affect satisfactory completion of work.

602.3.2 PREPARATION

- A. Verify measurements and dimensions at job site and cooperate in coordination and scheduling of work with work of related trades.
- B. Give particular attention to installation of items embedded in concrete and masonry so as not to delay job progress.
- C. Provide templates to related trade for location of support and anchorage items.

602.3.3 INSTALLATION

- A. Install in accordance with manufacturers installation instructions unless specified otherwise.
- B. Provide anchorage devices and fasteners for securing expansion joint assemblies to in-place construction including threaded fasteners with drilled-in fasteners for masonry and concrete where anchoring members are not embedded in concrete. Provide metal fasteners of type and size to suit type of construction indicated and provide for secure attachment of expansion joint cover assemblies.
- C. Perform cutting, drilling and fitting required for installation of expansion joint cover assemblies.
- D. Install joint cover assemblies in true alignment and proper relationship to expansion joint opening and adjoining finished surfaces measured from established lines and levels.
- E. Allow for thermal expansion and contraction of metal to avoid buckling.
- F. Set floor covers at elevations flush with adjacent finished floor materials unless shown otherwise.

- G. Material and method of grouting floor frames set in prepared recesses in accordance with manufacturer's instructions.
- H. Locate wall, ceiling and soffit covers in continuous contact with adjacent surfaces. Securely attach in place with required accessories.
- I. Locate anchors at interval recommended by manufacturer, but not less than 75 mm (3-inches) from each ends, and, not more than 600 mm (24-inches) on centers.
- J. Maintain continuity of expansion joint cover assemblies with end joints held to a minimum and metal members aligned mechanically using splice joints.
- K. Cut and fit ends to produce joints that will accommodate thermal expansion and contraction of metal to avoid buckling of frames or plates.
- L. Flush Metal Cover Plates:
 - 1. Secure flexible filler between frames so that it will compress and expand.
 - 2. Adhere flexible filler materials to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.
- M. Waterstops:
 - 1. Install in conjunction with floor joints and where shown, run continuously to prevent water damage to finish spaces.
 - 2. Provide seal with frame to prevent water leakage.
 - 3. Provide outlet tubes from waterstops to drain to prevent damage to finish spaces.
- N. Fire Barriers:
 - 1. Install in compliance with tested assembly.
 - 2. Install in floors and in fire rated walls.
 - 3. Use fire barrier sealant or caulk supplied with system.
- O. Sealants: Install to prevent water and air infiltration.
- P. Vertical Exterior Extruded Thermoplastic Rubber.
 - 1. Install side frames mounted on sealant or butyl caulk tape with appropriate anchors 600 mm (24 inches) on center complete with independent continuous PVC back seal.
 - 2. Install primary seals retained in extruded aluminum side frames.
- Q. Installation of Extruded Thermoplastic Rubber or Seals:
 - 1. For straight sections, provide preformed seals in continuous lengths.
 - 2. Vulcanize or heat-seal field splice joints to provide watertight joints using manufacturer's recommended procedures.
- R. Installation of Preformed Elastomeric Sealant Joint:
 - 1. Locate joint directly over joints in wall or floor substrates.
 - 2. Full length shall be fastened to substrate using a construction adhesive.
 - 3. Install flush or slightly below finish material.

602.3.4 PROTECTION

- A. Take proper precautions to protect the expansion joint covers from damage after they are in place.
- B. Cover floor joints with plywood where wheel traffic occurs.

603. STEEL DOORS AND FRAMES

603.1 PART 1 - GENERAL

603.1.1 DESCRIPTION

- A. This section specifies steel doors, steel frames and related components.
- B. Terms relating to steel doors and frames as defined in ANSI A123.1 and as specified.

603.1.2 WORK

Frames fabricated of structural steel: Section 05500, METAL FABRICATIONS.

603.1.3 TESTING

Performed by an independent testing laboratory.

603.1.4 SUBMITTALS

- A. Submit SAMPLES AND SHOP DRAWINGS.
- B. Manufacturers Literature and Data:
 - 1. Fire rated doors and frames, showing conformance with NFPA 80 and Underwriters Laboratory, Inc., or Inchcape Testing Services or Factory Mutual fire rating requirements // and temperature rise rating for stairwell doors. Submit proof of temperature rating //.
 - 2. Sound rated doors, including test report from Testing Laboratory.

603.1.5 STORAGE AND HANDLING

- A. Store doors and frames at the site under cover.
- B. Protect from rust and damage during storage and erection until completion.

603.2 PART 2 - PRODUCTS

603.2.1 MATERIALS

- A. Stainless Steel: ASTM A167, Type 302 or 304; finish, NAAMM Number 4.
- B. Sheet Steel: ASTM A366, cold-rolled, stretcher leveled degree of flatness for panels (face sheets) of doors and panels.
- C. Anchors, Fastenings and Accessories: Fastenings anchors, clips connecting members and sleeves from zinc coated steel.
- D. Insect Screening: ASTM D3656, 18 by 18 regular mesh.
- E. Prime Paint: Paint that meets or exceeds the requirements of A250.8.

603.2.2 FABRICATION GENERAL

- A. GENERAL:
 - 1. Follow SDI A250.8 for fabrication of standard steel doors, except as specified otherwise. Doors to receive hardware specified in Section 08710, Door Hardware. Tolerances as per SDI A250.8. Thickness, 44 mm (1-3/4 inches), unless otherwise shown.
 - 2. Close top edge of exterior doors flush and seal to prevent water intrusion.
 - 3. When vertical steel stiffeners are used for core construction, fill spaces between stiffeners with mineral fiber insulation.
- B. Custom Metal Hollow Doors:
Provide custom hollow metal doors where nonstandard steel doors are indicated. At the Contractor's option, custom hollow metal doors may be provided in lieu of standard steel doors. Door size(s), design, materials, construction, gages and finish shall be as specified for of standard steel doors.
- C. Tubular Steel Doors:

1. Industrial type.
2. Stiles and rails minimum of 125 mm (5 inches) by 44 mm (1-3/4 inches), formed of 1.3 mm (0.053 inch) thick steel tubular design, with locked seam. Bottom rail be 250 mm (10 inches) wide.
3. Louver and glazed opening sizes as shown.
4. Door panels; consist of two sheets of 1 mm (0.042 inch) thick steel with a resilient separator, nominally 9 mm (3/8 inch) thick, interlocked into the stiles and rails.

603.2.3 METAL FRAMES

A. General:

1. SDI A250.8, 1.3 mm (0.053 inch) thick sheet steel, types and styles as shown or scheduled.
2. Frames for exterior doors: Fabricate from 1.7 mm (0.067 inch) thick galvanized steel conforming to ASTM A525.
3. Frames for labeled fire rated doors // and windows //.
 - a. Comply with NFPA 80. Test by Underwriters Laboratories, Inc., Inchcape Testing Services, or Factory Mutual.
 - b. Fire rated labels of approving laboratory permanently attached to frames as evidence of conformance with these requirements. Provide labels of metal, with raised or incised markings.
4. Frames for lead-lined doors.
 - a. Frames for doors 900 mm (3 feet) or less in width and having lead lining of 1 mm or less in thickness, and not shown to have structural steel supports: Minimum 1.7 mm (0.067 inch) thick.
 - b. Frames for doors over 900 mm (3 feet) in width or having lead-lining more than 1 mm in thickness shown to be supported by and attached to structural steel subframes: Minimum 1.3 mm (0.053 inch) thick.
 - c. Lead-lining and its application is specified in Section 13091, LEAD RADIATION SHIELDING.
5. Frames for detention door (Type 22): Minimum 2 mm (0.093 inch) thick.
6. Frames for doors specified to have automatic door operators; Security doors (Type 36); service window: minimum 1.7 mm (0.067 inch) thick.
7. Knocked-down frames are not acceptable.

B. Reinforcement and Covers:

1. SDI A250.8 for, minimum thickness of steel reinforcement welded to back of frames.
2. Provide mortar guards securely fastened to back of hardware reinforcements except on lead-lined frames.

C. Terminated Stops: SDI A250.8.

D. Glazed Openings // and // Panel Opening //:

- a. Integral stop on exterior, corridor, or security side.
- b. Design rabbet width and depth to receive glazing material or panel shown or specified.

E. Two piece frames:

- a. One piece unequal leg finished rough buck sub-frames as shown, drilled for anchor bolts.
- b. Unequal leg finished frames formed to fit subframes and secured to subframe legs with countersunk, flat head screws, spaced 300 mm (12 inches) on center at head and jambs on each side.
- c. Preassemble at factory for alignment.

F. Frame Anchors:

1. Floor anchors:

- a. Where floor fills occur, provide extension type floor anchors to compensate for depth of fill.
 - b. At bottom of jamb use 1.3 mm (0.053 inch) thick steel clip angles welded to jamb and drilled to receive two 6 mm (1/4 inch) floor bolts. Use 50 mm x 50 mm (2 inch by 2 inch) 9 mm by (3/8 inch) clip angle for lead lined frames, drilled for 9 mm (3/8 inch) floor bolts.
 - c. Where mullions occur, provide 2.3 mm (0.093 inch) thick steel channel anchors, drilled for two 6 mm (1/4 inch) floor bolts and frame anchor screws.
 - d. Where sill sections occur, provide continuous 1 mm (0.042 inch) thick steel rough bucks drilled for 6 mm (1/4 inch) floor bolts and frame anchor screws. Space floor bolts at 50 mm (24 inches) on center.
2. Jamb anchors:
- a. Locate anchors on jambs near top and bottom of each frame, and at intermediate points not over 600 mm (24 inches) apart, // except for fire rated frames space anchors as required by labeling authority //.
 - b. Form jamb anchors of not less than 1 mm (0.042 inch) thick steel unless otherwise specified.
 - c. Anchors set in masonry: Use adjustable anchors designed for friction fit against the frame and for extension into the masonry not less than 250 mm (10 inches). Use one of following type:
 - 1) Wire loop type of 5 mm (3/16 inch) diameter wire.
 - 2) T-shape or strap and stirrup type of corrugated or perforated sheet steel.
 - d. Anchors for stud partitions: Either weld to frame or use lock-in snap-in type. Provide tabs for securing anchor to the sides of the studs.
 - e. Anchors for frames set in prepared openings:
 - 1) Steel pipe spacers with 6 mm (1/4 inch) inside diameter welded to plate reinforcing at jamb stops or hat shaped formed strap spacers, 50 mm (2 inches) wide, welded to jamb near stop.
 - 2) Drill jamb stop and strap spacers for 6 mm (1/4 inch) flat head bolts to pass thru frame and spacers.
 - 3) Two piece frames: Subframe or rough buck drilled for 6 mm (1/4 inch) bolts.
 - f. Anchors for observation windows and other continuous frames set in stud partitions.
 - 1) In addition to jamb anchors, weld clip anchors to sills and heads of continuous frames over 1200 mm (4 feet) long.
 - 2) Anchors spaced 600 mm (24 inches) on centers maximum.
 - g. Modify frame anchors to fit special frame and wall construction and provide special anchors where shown or required.

603.2.4 TRANSOM PANELS

- A. Fabricate panels as specified for flush doors.
- B. Fabricate bottom edge with rabbet stop to fit top of door where no transom bar occurs.

603.2.5 LOUVERS

- A. General:
 1. Sight proof type with stationary blades the full thickness of the door.

2. Design lightproof louvers to exclude passage of light but permit free ventilation.
 3. Provide insect screen and wire guards at exterior doors, except where doors are located below completely enclosed areaways, the wire guard is not required.
- B. Fabrication:
1. Steel louvers 0.8 mm (0.032 inch) thick for interior doors, and 1.3 mm (0.053 inch) inch thick for exterior doors.
 2. Fabricate louvers as complete units Install in prepared cutouts in doors.
 3. Weld stationary blades to frames. Weld louvers into door openings.
- C. Screen frames:
1. Frame of either extruded aluminum or tubular aluminum.
 2. Fabricate frame to hold wire fabric in a channel with a retaining bar anchor and to mount on surface of door with screws.
 3. Do not lap frame over louver opening.
 4. Miter corners of frame members and join by concealed mechanical fastenings extending about 57 mm (2-1/4 inches) into ends of each member.
 5. Drill frame and doors for screw attachment. Space screws 50 mm (2 inches) from end of each leg of frame and not over 300 mm (12 inches) on center between end screws.
 6. Finish: Clear anodized finish, 0.4 mils thick.
 7. Insect screens: Fasten insect screens to interior side of doors with retaining bar against door and not exposed to view.
 8. Wire guards:
 - a. Wire fabric shall be wire guard screen as specified.
 - b. Fasten wire guard to exterior side of door with retaining bar against door and not exposed to view.

603.2.6 SHOP PAINTING

SDI A250.8.

603.3 PART 3 - EXECUTION

603.3.1 INSTALLATION

- A. Plumb, align and brace frames securely until permanent anchors are set.
1. Use triangular bracing near each corner on both sides of frames with temporary wood spreaders at midpoint.
 2. Use wood spreaders at bottom of frame if the shipping spreader is removed.
 3. Protect frame from accidental abuse.
 4. Where construction will permit concealment, leave the shipping spreaders in place after installation, otherwise remove the spreaders after the frames are set and anchored.
 5. Remove wood spreaders and braces only after the walls are built and jamb anchors are secured.
- B. Floor Anchors:
1. Anchor the bottom of door frames to floor with two 6 mm (1/4 inch) diameter expansion bolts. Use 9 mm (3/8 inch) bolts on lead lined frames.
 2. Power actuated drive pins may be used to secure frame anchors to concrete floors.
- C. Jamb Anchors:

1. Anchors in masonry walls: Embed anchors in mortar. Fill space between frame and masonry wall with grout or mortar as walls are built.
 2. Coat frame back with a bituminous coating prior to lining of grout filling in masonry walls.
 3. Secure anchors to sides of studs with two fasteners through anchor tabs. Use steel drill screws to steel studs.
 4. Frames set in prepared openings of masonry or concrete: Expansion bolt to wall with 6 mm (1/4 inch) expansion bolts through spacers. Where subframes or rough bucks are used, 6 mm (1/4 inch) expansion bolts on 600 mm (24 inch) centers or power activated drive pins 600 mm (24 inches) on centers. Secure two piece frames to subframe or rough buck with machine screws on both faces.
- D. Install anchors for labeled fire rated doors to provide rating as required.
- E. Frames for Sound Rated Doors:
1. Coordinate to line frames for sound rated doors with insulation.
- F. Overhead Bracing (Lead Lined Frames): Where jamb extensions extend to structure above, anchor clip angles with not less than two, 9 mm (3/8 inch) expansion bolts or power actuated drive pins to concrete slab. Weld to steel overhead members.

603.3.2 INSTALLATION OF DOORS AND APPLICATION OF HARDWARE

Install doors and hardware as specified in Section, INSTALLATION OF DOORS AND HARDWARE.

PART 2
CIVIL WORKS
WATERPROOFING

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701. WATERPROOFING

701.1 PART 1 - GENERAL

701.1.1 DESCRIPTION DESCRIPTION:

This section specifies impervious built-up membranes of bituminous materials used for waterproofing, bituminous coating for buried concrete and cementitious waterproofing for internal side of underground walls.

701.1.2 SUBMITTALS:

- A. Submit SAMPLES AND SHOP DRAWINGS.
- B. Manufacturer's Literature and Data: Fiberboard, asphalt primer, felts and fabrics (each type to be used)
- C. Certificates: Indicating materials conform to contract specifications.

701.1.3 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver materials to job in manufacturer's original unopened containers with brand name marked thereon.
- B. Before proceeding with work, protect surfaces from excessive changes in temperature and protect piping, conduits and installed equipment and materials.

701.2 PART 2 – PRODUCTS:

701.2.1 BITUMEN:

- A. Asphalt: ASTM D449, Type II, for exterior work below grade, Type III for work above grade.
- B. Coal-Tar: ASTM D450, Type II.

701.2.2 BITUMEN:

Bituminous Dampproofing for Below Grade Applications (DAMP-1): Fiber reinforced (non-asbestos), solvent-base, non-sag asphaltic coating designed for troweled application and conforming to the following.

- A. ASTM D-2822, Type 1.
- B. Fed. Spec. SS-C-153C, Type 1, Class A and B.

701.2.3 FELTS AND FABRICS (FOR USE WITH ASPHALT):

- A. Cotton Fabric Asphalt-Saturated: ASTM D173.
- B. Organic Felt Asphalt-Saturated: ASTM D226, Type I.
- C. Glass Mat (Fabric) Asphalt-impregnated: ASTM D2178, Type III.

701.2.4 FELTS AND FABRICS (FOR USE WITH COAL-TAR):

- A. Cotton Fabric Coal-Tar Saturated: ASTM D173.

- B. Organic Felt Coal-Tar Saturated: ASTM D227.
- C. Burlap (Fabric) Coal-Tar Saturated: ASTM D1327.
- D. Glass Fabric, Coal-Tar Treated: ASTM D1668.

701.2.5 PRIMER:

- A. Use ASTM D41 for asphalt products.
- B. Use ASTM D43 for coal-tar products.

701.2.6 FIBERBOARD:

ASTM C208, Type V, Class C, 13 mm (1/2-inch) thick.

701.2.7 EPOXY RESIN COATING:

Protective high build epoxy resin waterproof coating to floors, walls of underground tanks.

701.3 PART 3 – EXECUTION:

701.3.1 PREPARATION:

- A. Do not apply waterproofing when ambient temperature is 4.4°C (40°F) or lower.
- B. Cleaning and Filling:
 - 1. Before applying waterproofing materials, clean surfaces smooth, firm and dry.
 - 2. Remove high spots, depressions, loose and foreign particles; and fill all voids, joints and cracks with portland cement mortar.
 - 3. Surface shall be approved by Resident Engineer before waterproofing is started.

701.3.2 GENERAL:

- A. Ventilation: Provide adequate ventilation for waterproofing installed in enclosed spaces.
- B. Compatibility of Materials: Use coal-tar pitch with coal-tar-saturated felts and fabric. Use asphalt with asphalt-saturated felts and fabrics.
- C. Temperature of Bitumen: Heat bitumen to flow freely when applied, but not above 190°C (375°F) for coal-tar, and not above 230°C (450°F) for asphalt.
- D. Rate of Application: Apply primers at the rate of 0.4 L/m² (one gallon per 100 square feet) over concrete and parging. Apply coal-tar at the rate of 1.9 kg/m² (40 pounds per 100 square feet) and asphalt at the rate of 1.5 kg/m² (30 pounds per 100 square feet), for each mopping.
- E. Number of Plies:
 - 1. Membrane waterproofing shall consist of four plies of felt or fabric.
 - 2. Install membrane by lapping each ply approximately three-quarters over the preceding ply.
 - 3. Use appropriate width starting strips of felt or fabric at the starting line to provide four plies at the edge.

701.3.3 APPLICATION

- A. Exterior Vertical Surfaces:
1. Start each ply at the bottom, placed vertically, in hot bitumen and complete prior to applying the next ply.
 2. Overlap plies downward.
 3. Lap each ply 100 mm (4 inches) at the end. Stagger end laps not less than 450 mm (18 inches) in relation to preceding layer.
 4. Bitumen shall be applied to exterior vertical surfaces with cotton roller mops or other approved application devices.
 5. Waterproofing membranes shall be installed vertically, shingle fashion, in the manner specified herein.
 6. The membrane shall extend 50 mm (2 inches) from the outer edge of footing, across the top of the footing, and up foundation wall to approximately 100 mm (4 inches) below the finished grade.
 7. Tops of the membranes shall be // secured and protected as indicated // nailed to treated wood nailers set flush with the face of the wall and covered with two piles of fabric reinforcement. // Nailing shall be 200 mm (8 inches) on centers on a line 38 mm (1-1/2 inches) below the top of the membranes.
- B. Horizontal Surfaces:
1. Apply waterproofing membranes for floor slabs to a primed, smooth surface base slab.
 2. Apply felts shingle fashion in moppings of hot bitumen.
 3. Carry membranes up abutting vertical surfaces to the level approximately 150 mm (six inches) above the finish floor unless otherwise shown.
 4. Extend felts to intersections with interior surfaces of foundation walls.
 5. Where membranes pass over interior footings for load-bearing partitions, they shall be reinforced with two plies of fabric membrane in moppings of hot bitumen applied at the rate specified.
 6. The fabric plies shall extend a minimum of 150 mm and 200 mm (6 and 8 inches), respectively, beyond the edges of the footing.
 7. After all reinforcing membranes have been installed, the entire surface shall be covered uniformly with hot bitumen applied at the rate specified.
- C. Fabric Membrane Reinforcement:
1. Provide fabric membranes to reinforce felts at intersections.
 2. Reinforcement shall consist of two plies of fabric membrane cemented in place and to each other with roofing cement not less than 2 mm (1/16 inch) thick for each coating.
 3. At the intersection of slabs and vertical surfaces, extend the first ply at least 150 mm (6 inches) on the slab and 100 mm (4 inches) up the vertical surface.
 4. At Intersections of two vertical surfaces, extend the first ply at least 250 mm (10 inches) on each side of the intersection.
 5. The second ply shall lap the first by not less than 50 mm (two inches).
- D. Keyed Joint Footings:
1. Provide an asphaltic-coated 454 g (16-ounce) cold-rolled copper flashing sheet with joints soldered and neatly formed to the contours of keyed joints in foundation wall footings.
 2. The flashing sheet shall extend a minimum of 250 mm (10 inches) beyond the inside edge of the footing and shall be bent down 100 mm (4 inches) on the outside of the footing.
 3. Protect the flashing sheet until it is lapped by the waterproofing membranes for the subsurface floor slabs and foundation walls.
- E. Flashing Flanges:

1. Prime flashing flanges of the sleeves of pipe and ducts penetrating the waterproofing membrane.
 2. Allow primer to dry and strip flanges in with two fabric membrane collars cemented in place and to each other with bituminous plastic cement. The collars shall extend 100 mm and 150 mm (four and six inches), respectively, beyond the edge of the flanges, cover the flanges, and fit tight against the sleeve.
 3. Waterproofing connecting with work exposed to the weather shall extend back of same, or be counter-flashed to form a watertight connection.
- F. Clamping Devices:
At floor drains and elsewhere as indicated, extend membrane into clamping device set in heavy coating of bituminous roof cement and clamp securely.
- G. Reglets:
1. Where indicated, install continuous reglets as specified in Section, FLASHING AND SHEET METAL, to receive the exposed edges of membrane waterproofing.
 2. After placement of waterproofing, completely fill reglets with bitumen.
- H. Wood Nailers:
1. Where indicated, upper edges of membrane waterproofing shall be nailed to wood nailers and covered with two plies of fabric reinforcement.
 2. Wood nailers are specified in Section, ROUGH CARPENTRY.
- I. Epoxy resing
1. Install materials in accordance with the manufacturers instructions and prime surfaces accordance with manufacturer's instructions.
 2. Apply to walls in internal wet areas full height after corner reinforcement.
 5. Apply to all bottom floor area after corner reinforcement.
 4. Fill depressions, holes, and cracks with a material compatible with the epoxy coating, same material: epoxy putty

701.3.4 PROTECTIVE COVERING FOR ROOF MENBRANE

- B. Horizontal Surfaces: As soon as the application has thoroughly dried, apply protective cement removable floor tiling topping.

701.3.5 INSPECTION

Do not cover waterproofed surfaces by other materials or backfill until the work is approved by Resident Engineer.

PART 2

CIVIL WORKS

ROADS

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801 ROAD WORKS

801.1 ROADS AND PAVED AREAS

801.1.1 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.

All roads shall be fitted with a storm water drainage system, sidewalks, etc.

801.1.2 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.

801.1.3 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/dm³.

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/dm³ 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.

<u>Aggregate fraction</u>	<u>Maximum abrasion (%)</u>
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

801.1.4 Bituminous Prime Coat and Tack Coat

Unless otherwise specified, a prime coat of medium curing cut-back bitumen of grade MC-70 shall be applied on top of finished base course, at the rate of 1.0 kg/m², and a tack coat of rapid curing cut-back bitumen of grade RC-250 shall be applied between asphalt concrete layers (where more than one wearing course is specified), at the rate of 0.25 kg/m².

Bituminous coats shall be applied one day before the next layer is placed on top of them. Prior to applying bituminous coats, the road surface shall be thoroughly cleaned of all dirt, oil, grease and other objectionable matter, to the satisfaction of the Engineer. The bitumen shall be heated in boilers of an approved type and spreading shall be carried out by means of mechanical pressure distributors.

801.1.5 Asphalt Concrete Wearing Courses

The number of asphalt concrete layers to be placed in the road surfacing and the thickness of each of them shall be as shown on the Drawings and/or required in the Particular Specification.

All aggregates and bituminous materials to be used in asphalt concrete shall be subject to approval by the Engineer. Samples of the materials shall be submitted to the Engineer at least 30 days prior to their use.

All aggregates, except natural sand, shall be obtained by crushing natural quarry stone, and the use of river gravel, whether crushed or not, will not be permitted. Coarse aggregate shall be of uniform quality, with the particles as nearly cubiform as possible, clean of dust or foreign matter, and shall comply with the requirements of Subsection 218.1.3 above for base course aggregate. Quarry sand shall be clean and free of clay, silt or other deleterious matter; it shall all pass sieve No. 10 and not more than 10 percent of it shall pass sieve 200. The grading of the aggregates shall be if not specified in the Particular Specification as follows:

A.S.T.M.Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
3/4"	100%
1/2"	80-100
No. 4	50-70
No. 10	32-47
No. 40	16-26
No. 80	10-18
No. 200	4-10

Mix design shall be carried out as follows. The proposed aggregate mixture shall be mixed with 5.5% bitumen (if no other percentage is required in the Particular Specification). This sample shall be subjected to a set of Marshall Tests (A.S.T.M.-D-1559 and A.S.T.M.-D-1188) at a laboratory in order to determine the optimum bitumen content. The Engineer may change the grading of the aggregates and the bitumen content according to the results of

laboratory tests conducted on samples of materials supplied from time to time by the Contractor at the request of the Engineer.

Placing of asphalt concrete, unless otherwise specified, shall be carried out by means of paving finishers, specially designed for that purpose. The asphalt concrete layers shall be compacted by tandem rollers, heavy pneumatic rollers and three-wheeled rollers, in that order to reach a density not less than 97% of the Marshall density. Parts of the layers inaccessible to heavy mechanical rollers shall be compacted by small vibratory tampers. Rolling shall proceed from the outer edges towards the centre of the road and the whole area shall receive a uniform compaction throughout and shall be finished accurately to the required lines and levels. When asphalt concrete is placed in more than one layer, longitudinal joints shall be staggered by 30 cm and transversal joints by 60 cm between layers. The permissible variations of the top surface from the design levels shall be $-0 + 15$ mm. The permissible variations from the plane in the top surface shall be 5 mm over a length of 5 m.

Newly paved asphalt concrete surfaces shall be opened to traffic only after permission to do so is given in writing by the Engineer.

Placing of asphalted concrete shall ensure an inclination for drainage of stormwaters in accordance with the drawings and as specified by the Engineer.

801.1.6 Bituminous Surface Treatment

Where shown on the Drawings or required in the Particular Specification, a surface treatment shall be applied to the base course by spraying cut-back bitumen followed by a rolled blinding layer of stone chippings. Unless otherwise specified, bituminous surface treatment shall consist of the following two layers:

- Cut-back bitumen MC-3000 at the rate of 2.8 kg/m^2 , followed immediately by stone chippings of 3/4" - 1" size at the rate of 27 kg/m^2 .
- Cut-back bitumen MC-3000 at the rate of 1.35 kg/m^2 , followed immediately by stone chippings of No. 4 - 1/2" size at the rate of 22 kg/m^2 .

The second layer shall be placed after the first layer has been rolled.

Prior to application of bituminous spray, the base course surface shall be checked for accuracy and any irregularities shall be repaired. The surface shall then be swept clean of all loose material, foreign matter, dust and dirt. Areas contaminated by kerosene or diesel oil shall be removed and made good with clean and stable base course material.

The bitumen shall be heated in kettles of an approved type equipped with enclosed thermometers, the heat being conducted by oil or steam. Heating of bitumen in the barrels will not be permitted.

The entire area of the base course shall be sprayed uniformly at the prescribed rate by means of approved mechanical spraying equipment. Pools of excess liquid bitumen shall be sprinkled with fine sand which shall be swept off after it has absorbed the surplus bitumen.

The stone chippings shall be uniformly applied upon the entire sprayed surface. Trucks or other equipment for spreading the chippings shall be operated backwards so that the

bituminous spray will be covered before wheels or workmen pass over it. Supplementary spreading and smoothing, where necessary, shall be done manually.

Following spreading and smoothing of chippings, each layer shall be rolled, to the satisfaction of the Engineer.

The completed road surface shall not be opened to traffic until permitted by the Engineer.

801.2 DRAINAGE SYSTEM

Stormwater discharge channels and drainage systems shall be installed as shown on the drawings.

Excavation limits of channels and pipes as shown on the drawings shall be extended by 10 cm at the bottom and 30 cm on either sides.

Such over excavations shall be backfilled with graded fills and compacted to the satisfaction of the Engineer.

Excavations shall have a longitudinal slope as specified by the Engineer to facilitate water discharge.

The concrete drainage channels shall be either of precast or of cast-in-place concrete complying with the requirements of division 202.

Where specified, construction and expansion joints shall be performed to the details shown on the drawings and as directed by the Engineer.

A collector fitted with a metallic grid shall be mounted on channels and pipes as shown on shop drawings.

801.3 SIDEWALKS

NOT USED

801.4 CONCRETE KERB-STONES

NOT USED

801.5 TESTING

801.5.1 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.

801.5.2 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 m³ of placed backfills:

Measurement of moisture content
Measurement of compactness (dry density)

801.5.3 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.

801.5.4 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 m³ 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 m³ of placed aggregates,
- Or as directed by the Engineer.

801.5.5 Tests on concrete asphalt aggregates

Following are the required tests to be carried out on concrete asphalt aggregates:

- Los Angeles Test
- Specific gravity
- Sieve analysis
- Loss in weight
- Sand equivalent
- Any other test as specified by standard ASTM D 693-54.

Three series of tests shall be conducted on each 500 m³ of furnished material or on any volume exceeding by 50% this number, as required in writing by the Engineer.

801.5.6 Tests on bitumen

- Penetration at 25° C
- Penetration at 163° C
- Ductility at 25° C
- Flash point
- Solubility in carbon sulphide at 20° C
- Paraffin content.

Whenever required in writing by the Engineer, the tests above shall be carried out on each furnished bitumen volume prior to manufacture of asphalt concrete, or on bitumen that is being used.

801.5.7 Tests on asphalt concrete mixture

The Contractor shall conduct:

- 1) Tests to determine the grading of aggregates and the bitumen content
- 2) Marshall tests to determine the stability and density of bitumen-covered aggregates.

These tests shall be carried out before the commencement of works and repeated to the satisfaction of the Engineer.

801.5.8 Quality Control Tests

- Control of grading
- Control of moisture content and temperature
- Control of bituminous mixture, 2 samples to be tested daily/mixing plant
- Control of mixing plant.

Grading control shall be conducted once a day on 10 kg of samples of aggregates before putting them in the mixing plant, and whenever required by the Engineer.

Control of moisture content and temperature shall be carried out twice a day; moisture content shall not exceed 0.5% and temperature variations $\pm 5^{\circ}$ C.

The control of bituminous mixture shall be carried out on the bitumen content and grading. Each tested sample consisting of four distinct samplings shall be taken from the mixing plant at short intervals as to ascertain that the proportioning remains unchanged.

The tolerance on bitumen content is relatively $\pm 5\%$ of the measurements daily average.

Permissible tolerances are:

- $\pm 5\%$ of the percentage fixed for the average bitumen content
- $\pm 10\%$ of the percentage fixed for the corrector filler content.

801.5.9 Control of placing asphalt concrete

Throughout placing and compacting aggregates works, the temperature shall be controlled permanently in order to be $\geq 135^{\circ}$ C.

After compaction, density shall be equal to 98% of the Marshall density; one core sample shall be taken of each 1000 m² of finished layer. These samples shall also be used to control the layer thickness.

Where specifically called for, the level and regularity of the surfacing shall be controlled.

No layer shall be executed by the Contractor unless the underlaying one has been duly taken over by the Engineer.

801.5.10 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 shall not be paid for under this division.

Unless otherwise specified, roads, shoulders and sidewalks shall be measured for payment - each separately - by m² 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 labour necessary for completing roads, shoulders or sidewalks, in accordance with the Drawings and the Specification, and to the satisfaction of the Engineer.

Concrete kerbstones, channels etc. shall be measured for payment in linear meters of kerbstone 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.

PART 3

ELECTRO-MECHANICAL WORKS

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400. ELECTRO-MECHANICAL EQUIPMENT AND ACCESSORIES: IAAT WASTEWATER TREATMENT PLANT – OMNI PROCESSOR

400.1 GENERAL WORKS

400.1.1 General Standards for Electrical Equipment

All equipment supplied shall be in accordance with the standards VDE, NEMA, DIN, ISO, EN, NEC, IEC or JIS.

The Contractor shall make the standards available to the Employer or the Employer's Representatives on request.

All equipment shall be new and shall be suitable for the duty concerned and of first-class commercial quality, free from imperfections and selected for long life and minimum maintenance.

Where the following abbreviations are used, they shall have the following meanings:

- AIEE American Institute of Electrical Engineers
- API American Petroleum Institute
- ASA American Standards Association
- ASTM American Society of Testing Materials
- BS British Standards Institution
- DIN Deutsche Industries Norm
- EN European Norm
- IEC International Electrical Commissions
- ISO International Standard Organization
- JIS Japanese Industrial Standard
- NEC US National Electrical Code
- NEMA National Electrical Manufacturer's Association
- UL Underwriters Laboratory, Inc.
- JEC Standard of the Japanese Electro Technical Committee
- JEM The Standard of Japan Electrical Manufacturers Association

The following list represents the most important DIN VDE specifications which shall be used in their latest current edition under this contract. Specifications available in English translation are marked (Engl.). The other titles are translated here for information only. The numbers of corresponding IEC Publications are stated wherever possible.

Power Installations

DIN VDE No.	IEC Publ.	Title
0100/05.73	364	Erection of power installations with nominal voltages up to 1,000 V, Pads 100, 300, 410, 420, 430, 510, 523, 540, 559, 560, 701, 720, 721, 724, 726, 728, 730 and 736 (Engl.)
0101/05.89	694, 621	Erection of power installations with rated voltages above 1 kV (Engl.)
0102/01.90	909	Calculation of short-circuit currents in three-phase AC systems (Engl.)
0103/04.88	865	Mechanical and thermal short-circuit strength of electric power installations (Engl.)
0104/10.89		Erection and operation of electrical test equipment for voltages above 1 kV (Engl.)
0105		Operation of power installations
Part 1/07.83		General requirements (Engl.)
Part 9/05.86		Supplementary requirements for hazardous areas (Engl.)
0106		Protection against electric shock
Part 1/05.82		Classification of electrical and electronic equipment
Part 100/03.83		Actuating members positioned close to parts liable to shock (Engl.)
0108/10.89		Power installations and safety power supply in communal facilities (Engl.)
0109	664	Insulation co-ordination within low-voltage systems
Part 11/10.90	28A(C0)24	including clearances and creepage distances for equipment (Engl.)
0110/01.89	664	Specification for clearances and creepage distances in electrical equipment (Engl.)
0111	71	Insulation co-ordination for equipment in three-phase
Part 1/1 0.79		AC systems above 1kV (Engl.)
0113	204	Electrical equipment of industrial machines (Engl.)
Part 1/02.86		
0132/11.89		Measures to be taken in the case of fire in and near electrical installations
VDE 0134/07.71		First aid guide for accidents (VDE Publication)
0141/07.89	364-5-54	Earthing systems for power installations with rated voltages above 1 kV (Engl.)

143/10.84		Live-line washing systems for power installations with rated voltages above 1 kV
0150/04.83		Protection against corrosion due to stray currents of DC installation (Engl.)
0151/06.86		Materials and minimum dimensions of earth electrodes with respect of corrosion
0160/05.88	204-3	Electronic equipment for use in electrical power installations and their assembly into electrical power installations (Engl.)
0165/02.91		Installation of electrical apparatus in hazardous areas (Engl.)
0185		Lightning protection system
Part 1/11.82		General with regard to installation (Engl.)
Part 2/11.82		Erection of special structures (Engl.)
0190/05.86		Inclusion of gas and water pipes in the main equipotential bonding system of electrical installations, technical regulations of DVGW (superseded by DIN VDE 0100 Part 540/11.91)
0199/03.88	73	Colours of indicator lights and push-buttons (Engl.)

Power Guides

DIN VDE No.	IEC Publ.	Title
DIN 40500 ¹⁾	28	Copper for electrical engineering, technical terms of delivery. ¹⁾ DIN Standard, not part of DIN VDE Group 2
Parts 1-3/04.80		Sheet, tube, sections
Part 4/09.73		Wire
Part 5/06.83		Tinned wire
DIN 40501 ¹⁾	105	Aluminium for electrical engineering, technical terms of delivery. ¹⁾ DIN Standard, not part of DIN VDE Group 2
Parts 1-3/06.85		Sheet, tube, sections
Part 4/08.73		Wire
Part 5/05.80		Continuous-cast wire rod
0206/06.64	304	Recommendations on the colour of plastic or rubber protective sheaths or coverings for cable and insulated wires (Engl.)

0207/06.86		Insulating and sheathing compounds for cables and flexible cords, series DIN 57207 (Engl.)
0210/12.85	826	Construction of overhead power lines with rated voltages above 1 kV (Engl.)
0211/12.85		Construction of overhead power lines with rated voltages up to 1,000 V (Engl.)
0212		Fittings for overhead lines and switchgear
Part 50/04.85		Static-mechanical behaviour (Engl.)
Part 51/07.86		Dynamic-mech. behaviour of antivibration fittings (Engl.)
Part 52/07.86		Electrical contact behaviour of current-carrying fittings under normal operating conditions (Engl.)
Part 53/04.85		Partial discharge characteristics test
Part 54/09.86		Hot galvanization
0220		Specification for detachable cable clamps to be used in
Part 1/1 1.71		Power cable installations up to 1,000 V (Engl.)
Part 2/11.71		Specification for pressed connectors to be used in power cable installations (Engl.)
Part 3/10.77		VDE Specification for single and multiple cable clamps with insulating parts in electrical power cable installations up to 1,000 V (Engl.)
0228		Proceedings in the case of interference on telecommunication installations by electric power installations
Part 1/12.87		General (Engl.)
Part 2/12.87		Interference by three-phase installations (Engl.)
0250/P1/10.81	227,502	Specification for cables and flexible cords for electric power and lighting (Engl.)
0255/11.72	55	Specification for mass-impregnated paper-insulated metal-sheathed cables for electricity supply (except external gas-pressure and oil-filled cables) (Engl.)
0256/12.87	141-1	Low-pressure oil-filled cables and their accessories for nominal voltages up to 220/3800 kV (Engl.)
0257/11.67	141-3	Specifications for external gas-pressure cables (compression cables) in steel pipes and their accessories to be used in single and three-phase installations with rated voltages up to 275 kV (Engl.)
0257 A2/10.81		Amendment 2 to 0257/11.67

0258/09.72	141-2	Specification for internal gas-pressure cables and their accessories to be used in single and three-phase installations with rated voltages up to 275 kV (Engl.)
0258A2/10.81		Amendment 2 to 0258/9.72
0265/04.75	228	VDE Specification for thermoplastic-insulated lead-sheathed cables for electricity supply (Engl.)
0266/02.85		Halogen-free cables with improved characteristics in the case of fire; nominal voltages U_0/U 0.6/1 kV (Engl.)
0271/06.86	502,504	PVC-insulated cables with nominal voltages up to and including 6/10 kV (Engl.)
0272/09.89	502	Cross-linked polyethylene insulated cables; nominal voltage: U_0/U 0.6/1 kV (Engl.)
0273/12.87	502	Cross-linked polyethylene insulated cables, nominal voltages: U_0/U 6/10, 12/20, 18/30 kV (Engl.)
0274/02.87		Cross-linked polyethylene insulated conductors for overhead transmission lines, nominal voltage: U_0/U 0.6/1 kV (Engl.)
0278		Power cable accessories with rated voltages up to 30 kV
Part 1/02.91		Requirements and test methods (Engl.)
Part 2/02.91		Joints above 1 kV (Engl.)
Part 3/02.91		Joints 1 kV (Engl.)
Part 4/02.91		Sealing ends for indoor installations above 1 kV (Engl.)
Part 5/02.91		Sealing ends for outdoor installations above 1 kV (Engl.)
0281		PVC cables, wires and flexible cords for power
Part 1/04.85		Installation, general requirements (Engl.)
0282	245	Rubber cables and flexible cords for power installation,
Part 1/04.85		General requirements (Engl.)
0284/04.85	702	Mineral-insulated cables with nominal voltages up to 750 V
0291		Specification for filling compounds for cable accessories
Part 1/02.72		and for scalding compounds (Engl.)
Part 1 a/07.73		Amendment to 0291 Part 1
Part 2/11.79		Casting compounds for use in cable fittings
0293/01.90	304,757	Identification of cores in cables and flexible cord used in power installations with nominal voltages up to 1,000 V (Engl.)

0295/05.86	228	Conductors of cables, wires, and flexible cords for power installation (Engl.)
0298		Application of cables and flexible cords in power installations
Part 1/11.82		General for cables with rated voltages U_0/U upto 18/30 kV (Engl.)
Part 2/11.79	287	Recommended values for current-carrying capacity of cables for fixed installation with rated voltages U_0/U up to 18/30 kV (Engl.)
Part 3/08.83		General for cables (Engl.)
Part 4/02.88	364-5-523	Recommended values for current-carrying capacity for sheathed and non-sheathed cables for fixed wiring, flexible cables, and cords (Engl.)

Insulating Materials

DIN VDE No.	IEC Publ.	Title
0302		Insulation systems of electrical equipment
Part 1/09.86	505	Evaluation and identification (Engl.)
Part 2/09.86	610	Functional evaluation; ageing mechanisms and diagnostics procedures (Engl.)
Part 3/09.86	611	Thermal endurance characteristics; fundamentals for test procedures (Engl.)
0303	112	Method for determining the comparative and the proof
Part 1/06.84		Tracking indices of solid insulating materials under moist conditions (Engl.)
0303	234-1	Determination of the electrical breakdown voltage and
Part 2/11.74		electric strength (Engl.)
0303		
Part 6/03.68	426	Determination of electrolytic corrosive effects (Engl.)
Part 10/06.83	587	Test method for evaluating resistance to tracking at high voltage (Engl.)
0304		
Part 3/09.85	707	Thermal properties of electrical insulating materials (Engl.)
0370	296	Insulating oils
Part 1/1 2.78		New insulating oils for transformers and switchgear (Engl.)

Part 2/12.78		Insulating oils in service in transformers and switchgear (Engl.)
Part 3/02.80	475	Method of sampling liquid dielectrics (Engl.)
0373		Requirements and acceptance of new sulphur
Part 1/04.80	376	Hexafluoride (Engl.)
Part 2/04.80	480	Guide to the checking of sulphur hexafluoride (SF6) taken from electrical equipment (Engl.)

Measurement, Control, Testing

DIN VDE No.	IEC Publ.	Title
0410/10.76	414	VDE Specification for electrical measuring instruments; safety requirements for indicating and recording instruments and their accessories (Engl.)
0411	348	VDE Specifications for electronic measuring instruments and automatic controls
Part 1/10.73		Protective measures for electronic measuring instruments (Engl.)
Part 1a/02.80		Amendment to DIN 57411 Sheet 1
Part 2/12.69		Safety requirements for electronic automatic controls (Engl.)
0412	405	Measurement and control Electronic measuring instruments used in conjunction with ionizing radiation in the occupational sphere
Part 1/03.83		Protective measures
0413		Measurement and control Appliances for testing the protecting devices in power installations
Part 1/09.80		Insulation meters (Engl.)
Part 2/01.73		Insulation monitoring devices for monitoring AC networks by means of impressed DC voltage
Part 3/07.77		Loop impedance measuring instruments
Part 4/07.77		Ohmmeters
Part 5/07.77		Earth testers (Engl.)
Part 6/08.87		Measuring instruments for testing the efficiency of fault-current and fault-voltage operated protection devices in TN and TT systems (Engl.)
Part 7/07.82		Earth testers according to the voltmeter-ammeter method (Engl.)

Part 8/02.84		Earth-leakage monitoring devices intended for supervision of DC and AC voltage systems with metallicly connected DC circuits (Engl.)
Part 9/02.84		Phase sequence indicator (Engl.)
0414	44	Specification for instrument transformers
Part 1/1 2.91		General requirements (Engl.)
Part 1 A/02.78		Amendment
Part 2/12.70	185	Special requirements for inductive current transformers
Part 3/12.70	186	Special requirements for inductive voltage transformers
	358	
Part 4/08.73	186	Special requirements for capacitive voltage transformers
Part 10/05.85	44-4	Measurement of partial discharge (Engl.)
	0418	
Part 1/07.82	521	Electric integrating meters (Engl.)
0419/07.66	1038	Specifications for tariff switching clocks
0420/07.84	1037	Ripple control receivers
	0432	High-voltage test techniques
Part 1/10.78	60-1	Definitions and general test requirements (Engl.)
Part 2/10.78	60-2	Test procedures (Engl.)
Part 3/10.78	60-3	Measuring devices
	0433	
Part 2/08.61	52	Generation and measurement of high voltages (Engl.)
0434/05.83	270	High-voltage testing methods, measurement of partial discharges
0435/09.62	255	Rules for electrical relays in power plants
	0435A/09.72	Amendment to VDE 0435/9.62 (Engl.)
Part 120/10.81	255-0-20	Contact performance of electrical relays (Engl.)
Part 201/05.83	255-1-00	All-or-nothing electrical relays (Engl.)
Part 303/09.84	255-3,4,6,11	Static measuring relays
	0441	Testing of plastic insulators for AC service voltages above 1 kV
Part 1/07.85		Testing of materials for outdoor insulators
Part 2/10.82		Testing of outdoor insulator strings with glass-fibre reinforced core

Part 3/06.84	660	Tests on indoor post insulators of organic material for systems with nominal voltages greater than 1,000 V up to but not including 300 kV (Engl.)
0446	83	Insulators for overhead lines, contact wires and tele-
Part 1/04.82		Communications lines for service voltages above 1 kV
0448	507	Testing of insulators for AC service voltages above 1 kV under pollution
Part 1/1 0.75		Test method with polluted surfaces
Part 2/09.77		Salt-fog method
0470		Test equipment and testing methods
Part 1/11.92	529	Testing of protection against contact
0471		
Part 1-1/04.86	695-1-1	Fire hazard testing (Engl.)
0472/06.87	811	Recommendations for testing insulated cables and flexible cords (Engl.)
Supplement 1 to 0472/06.87		Index to parts of Standard DIN VDE 0472

Machines, Transducers

DIN VDE No.	IEC Publ.	Title
0510/01.77		VDE Specification for electric storage batteries and battery plants (Engl.)
Part 2/07.86		Stationary batteries (Engl.)
0530/10.86	34	Rotating electrical machines (several parts in English)
0532	76, 289	Specifications for transformers and reactors,
Part 1/03.82		General (Engl.)
0558	146	Specification for semiconductor converters
Part 1/07.87		
0560		Specification for capacitors
Part 1/1 2.69		General requirements (Engl.)
Part 2/05.70		Coupling capacitors for voltages up to 1,000 V (Engl.)
Part 4/04.73	70	Specification for capacitors for power systems (Engl.)

Installation Material, Switchgear

DIN VDE No.	IEC Publ.	Title
0603/10.91		Consumer units and meter panels AC 400 V

0604		Electrical trunking for walls and ceilings
Part 1/05.86		General requirements (Engl.)
Part 2/05.86		Trunking for appliances (Engl.)
Part 3/05.86		Skirting board ducts (Engl.)
0605/04.82	614	Specification for conduits for electrical installations (Engl.)
0606/02.76		VDE Specifications for connecting material up to 750 V
Part 1/11.84		Connection material up to 660 V
0607/11.74		VDE Specification for clamps of screwless terminals for connecting or joining copper conductors from 0.5 mm ² up to 60 mm ² (Engl.)
0609		Screw terminal clamping units for connection of copper
Part 1/06.83		Conductors up to 240 mm ² (Engl.)
0611	947-7-1	Terminal blocks for copper conductors up to 1,000 V
Part 1/08.92		AC and 1,200 V DC (Engl.)
0630/06.92	1058-1	Switches for appliances up to 500 V and up to 63 A (Engl.)
0632/04.91	669	Switches for household and similar fixed electrical installations (Engl.)
0635/02.84		Low-voltage fuses (Engl.)
0641/08.92	898	Miniature circuit-breakers
Supplement 1	947	Low-voltage switchgear and controlgear
to 0660/09.82		Specifications, synopsis (Engl.)
Supplement 2		Quoted and further standards in the series of DIN
to 0660/12.85		VDE 0660 (Engl.)
0660		
Part 100/07.92	947-1	Low-voltage switchgear, general specification
Part 101/07.92	947-2	Low-voltage switchgear, circuit-breakers (Engl.)
Part 102/07.92	947-4-1	Contactors and motor-starters (Engl.)
Part 103/03.84	470	AC contactors from 1,000 V to 1,200 V
Part 105/03.84	632-1	AC motor starters from 1,000 V to 12,000 V
Part 107/09.82	947-3	Switches, disconnectors, switch disconnectors and fuse assemblies
Part 108/09 82		DC circuit-breakers from 1,200 V to 3,000 V
Part 109/10.86	158-2	Semiconductor contactors (Engl.)
Part 200/07.92	947-5-1	Control switches (Engl.)

Part 500/04.91	439-1	Low-voltage switchgear and control gear assemblies
Part 501/02.92	439-4	Low-voltage switchgear, particular requirements for construction site assemblies
0664	1008	Residual current-operated circuit-breakers rated up to 500 V AC and up to 63 A (Engl.)
Part 1/1 0.85		
Part 2/08.88	1009	Residual-current-operated circuit-breakers with over-current trip (r.c.c.b.)
Part 3/10.88		Residual-current-operated circuit-breakers, system-dependent
0670	694	Specifications for AC switchgear for voltages above 1 kV
Part 2/10.91	129	Disconnectors and earthing switches
Part 4/07.90	282-1	High-voltage fuses, Part 1
Part 6/12.84	298	Metal-enclosed high-voltage switchgear for voltages up to 72.5 kV, factory-assembled, type-tested
Part 7/03.78	466	Insulation-enclosed high-voltage switchgear for voltages up to 36 kV, factory-assembled, type-tested
Part 8/09.88	517	Gas-insulated metal-enclosed high-voltage switchgear for rated voltages of 72 kV and above
Part 101/12.92	56	High-voltage AC circuit-breakers
Part 104/10.92	56	High-voltage AC circuit-breakers; type and routine tests
Part 106/10.92	56	High-voltage AC circuit-breakers; information and rules
Part 301/12.92	265-1	High-voltage switches
Part 302/12.92	265-2	High-voltage switches of 52 kV and above
Part 1000/08.84	694	Common clauses for high-voltage switchgear (Engl.)
0674/10.62		Rules for insulating bodies and insulators to be used in AC equipment and installations with rated voltages above 1 kV (Engl.)
Part 1/12.84	168, 383	Tests on indoor and outdoor post insulators of ceramic material or glass for system voltages above 1 kV (Engl.)
Part 2/12.84	233	Tests on hollow insulators for use in electrical equipment (Engl.)
0675		Recommendations for over-voltage protection devices
Part 1/05.72	99-1	Valve-type lightning arresters for AC networks
Part 2/08.75	99-1A	Application of valve-type lightning arresters in AC networks
0675		

Part 102/09.86		Testing of valve-type lightning arresters under contamination condition
0680		Personnel protective equipment, protective devices and apparatus for work on electrically energized systems up to 1,000 V (Engl.)
Part 1/01.83		
0681		Devices for actuating, testing and guarding live parts with rated voltages above 1 kV
Part 1/1 0.86		
Part 2/03.77		Actuating rods
Part 3/03.77		Fuse tongs
Part 4/10.86		AC voltage testers
Part 211/11.92	832	Insulating rods
0683		Portable earthing and short-circuiting apparatus
Part 1/03.88		Freely guided devices

Information Technology

DIN VDE No.	IEC Publ.	Title
0800		Telecommunications
Part 1/05.89		Requirements and tests for the safety of facilities (Engl.)
Part 2/07.85		Earthing and equipotential bonding (Engl.)
Part 3/06.83		Telecommunications systems with remote power supply
Part 4/03.86		Installation of telecommunications lines
0804/05.89		Telecommunication; Additional requirements of construction and testing of apparatus (Engl.)
0805/05.90	950	Safety of data processing equipment (Engl.)
0815/09.85		Wiring cables for telecommunication and data processing systems (Engl.)
0818/02.83		Self-supporting telecommunication aerial cables on overhead power lines above 1 kV
0833		
Part 2/07.92		Requirements for fire alarm systems (Engl.)
0843/09.87	801	Electromagnetic compatibility
0845/10.87		Protection of telecommunication systems against lightning, electrostatic discharges and over-voltages (Engl.)
Part 1/08.85	0846	Measuring devices for assessing electromagnetic compatibility

Part 1/1 1.81	0847	Procedure of measurements for the electromagnetic compatibility (Engl.)
	0848	Hazards presented by electromagnetic fields
Part 1/02.82		
0850/03.80	481	Coupling devices for PLC transmission systems
0851/04.73	953	Specifications for PLC wave traps
0875/12.88		Radio-interference suppression of electrical appliances and systems (Engl.)
	0888	Fibre optic cables for telecommunications purposes
Part 1/06.88	0891	Application of cables and insulated wires for telecom-
Part 1/05.90		medications and information processing systems

400.1.2 Definitions

For the purpose of this Specification, the electrical definitions as given in the IEE Regulations for Electrical Installations, 18th Edition shall apply.

As applied to enclosures the words 'shall be constructed to give IP**' or 'to give a degree of protection of IP**' shall have the meaning as defined in the latest IEC standards.

400.1.3 Operating Voltages and Frequencies

Unless otherwise indicated all apparatus and wiring shall be suitable for use with a 3 phase, 4 wire, 380/220V, 50 Hz earthed neutral supply.

The supply wave form shall be a sine wave in accordance with the appropriate standard.

Control circuit supply voltage shall be single phase 220V, 50 Hz via double wound transformer.

400.1.4 Size of Equipment

The Contractor shall investigate each space in the building through which equipment must pass to reach its final location.

If necessary, the manufacturer shall be required to ship his material in sections sized to permit passing through such restricted areas in the building.

400.1.5 Equipment Marking

The Contractor shall provide nameplates of laminated plastic with engraved white letters on black background, secured to the equipment in a permanent manner.

All markings shall be as approved by the Employer's Representative and shall be applied to all pieces of equipment such as switches, circuit breakers, panel boards, motor starters, etc. will be in Arabic and English language.

400.1.6 Rating Plates, Name Plates and Labels

Each main and auxiliary item of Plant shall have permanently attached to it in a conspicuous position a nameplate and rating plate.

Upon these shall be engraved, in Arabic and English, the manufacturer's name, direction of rotation, type and serial number of plant, details of the loading and duty at which the item of Plant has been designed to operate, and such diagrams as deemed necessary.

All indicating and operating devices shall have securely attached to them or marked upon them designations as to their function and proper manner of use.

Provision shall be made to incorporate descriptive numbering codes as indicated on the construction documents.

400.1.7 Materials

The materials used in all systems shall be new, unused, and as hereinafter specified.

All materials where not specified shall be of the very best of their respective kinds. Samples of materials or manufacturer's specifications shall be submitted for approval.

Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by water.

400.1.8 Waterproofing

All equipment which will be installed outdoors or installed in machinery rooms of the buildings shall be waterproof type, and designed and manufactured in accordance with internationally acceptable standards such as JIS C 0920, "Tests to Prove Protection against Ingress of Water for Electrical Equipment, Grade 5", or equivalent.

400.1.9 Explosion-proofing

400.1.9.1 The explosion-proof type shall be manufactured in accordance with the following standards or equivalent.

- JIS C 0903: Electrical Apparatus for Explosive Atmospheres
- JIS C 0904: Test Methods on Electrical Apparatus for Explosive Gas Atmospheres in General Industry
- JIS C 0905: Supplementary Requirements for Construction of Electrical Apparatus for Explosive Atmosphere in General Industry

400.1.10 Electroplating, Galvanizing and Sherardizing

Electroplating or galvanizing will be acceptable as an alternative to painting for small ferrous component.

Hot dip galvanizing shall be carried out in accordance with BS 729 with a deposition rate of at least 460 g/m².

After galvanizing all parts shall be passivated to minimize discoloration.

400.1.11 Enclosures and Protections

Cubicles and enclosures for outdoor locations shall be fitted with lockable outside doors and a housing so designed that all controls, instruments and such like are fully enclosed with the whole assembly weatherproof and vandal-proof.

The doors shall be fitted with stays arranged to prevent overstraining of the hinge fixings and allow fixing of the doors in the open position.

The internal cubicles shall also be weatherproof to allow operation of the controls when the outside doors are open during inclement weather.

Unless otherwise stated enclosures shall give a minimum degree of protection as follows:

- Indoor installation:
 - substation or switch room IP43
 - plant room IP54
- Outdoor installation:
 - under cover IP55
 - exposed IP65
- Submersible: IP67

400.1.12 Electrical Tools and Appliances

All tools provided shall be of good quality. All wrenches and spanners shall be made from hardened steel forgings with bright finished heads and with work faces dressed to fit accurately.

The tools shall be boxed in steel or steel bound wooden boxes marked or labelled with their contents and fitted with locks.

Where specified tools and test equipment are provided for internally sited plant they shall be mounted in suitable cabinets with lockable doors. Racks or clips shall be provided for individual items with outline markings and labels showing tools or equipment are missing.

A schedule is included to cover all special tools necessary for the proper maintenance of the plant. The Employer's Representative will notify the Contractor which tools shall be included in the contract. These tools shall not be used for the purpose of erecting the works.

The Employer's Representative may inspect the tools and packaging before dispatch and the Contractor shall hold them at his works and not allow them to be sent by suppliers direct to site.

400.1.13 Protection Packing and Shipment

All plant shall only be dispatched and packed in accordance with the approved standard. In addition, the plant shall be so protected as to be safe from spoilage and corrosion for 12 months after delivery to site.

Items of plant which are finished painted at the manufacturer's works such as switchboard, shall be suitably encased in wood (such as hardboard secured by screws to a wood framework) for their protection before dispatch.

Particular care shall be taken in the packing of electrical apparatus. It shall be packed separately in sealed polythene or similar approved bags (including a liberal supply of desiccant) taking all precautions to exclude moisture.

Packing cases shall be strongly constructed using tongued and grooved boards with internal and external battens. Each packing case shall be durably marked with the contract number and site address and such other marking as may be directed.

The contractor shall make good to the satisfaction of the Employer's Representative any deterioration of the protective coatings, paintwork, etc. which may occur during transportation.

400.1.14 Precautions Against Damp

Special precautions shall be taken to prevent corrosion due to the high humidity and heavy rainfall in the area.

All wall mounted equipment shall be fitted with spacers to provide a minimum gap of 5 mm. All holes in equipment shall be effectively sealed against the ingress of water. All items exposed to the weather, or water shall be free of water traps and where necessary drain holes shall be provided to prevent the accumulation of water.

All fixing, fastenings and spaces shall be galvanized, sherardized, or otherwise protected against corrosion.

400.1.15 Circuit Breakers

For AC circuits, circuit breakers shall be triple pole of the air break type as specified, suitable for the short circuit fault duty.

Low voltage breakers shall incorporate a neutral link, unless in special cases a neutral pole is called for on the breaker under the specific requirements. Air brake circuit breakers shall be 'trip-free' and the whole of the operating mechanism shall be suitable for such conditions of operation.

The whole equipment shall be robust and be capable of withstanding repeated closing and opening impacts satisfactorily.

Each breaker shall be provided with the following:

- Mechanical 'flag' indicator giving clear indication that it is either Off (open) or On (closed)
- Means of isolation so that the breaker may be maintained with busbars alive
- An operating handle that can be concealed when not required, to ensure a flush fronted appearance
- An adequate number of auxiliary switches with the addition of one normally open and one normally closed spare switches, all to be wired to a terminal board of approved design in the fixed portion of the switchgear and arranged in the same sequence on all equipment
- Protection relays and tripping devices as specified

- Facilities for connection of appropriate auxiliary circuits when the circuit breaker is in the isolated position to permit operation of the breaker for test and indication purposes
- Key operated interlocks between breakers as specified

Where withdrawable circuit breaker units are used, the housing shall accurately locate the movable portion prior to engagement and accommodate automatic safety shutters.

Each group of busbar and circuit spout orifices shall be fitted with an individual automatically operated safety shutter. The appropriate shutters shall positively open or close when the circuit breaker is racked in or out.

When closed, the shutters shall prevent any contact with either the busbar or circuit connections and seal the spouts against the ingress of dust. The shutters shall be painted in bold characters 'BUSBARS' or 'CIRCUIT' as appropriate; the busbar shutter shall be colored red and the circuit shutter shall be colored yellow.

For testing and inspection, each shutter shall be separately hand operated, from the front of the unit, and latched in the open position. Any movement of the circuit breakers either in or out of the housing shall automatically restore the automatic feature.

Provision shall be made for each shutter to be locked only in the closed position.

Each circuit breaker unit shall be provided with mechanical interlocks to prevent incorrect operation, accidental contact with live metal and to protect the equipment and operator from the danger of mal operation. The design shall prevent the following where relevant:

- The circuit breaker being closed unless it is in the fully engaged or fully-withdrawn position
- The circuit-breaker being engaged and plugged into the busbar and circuit spouts unless the tank is bolted to the top-plate
- The circuit-breaker being engaged or withdrawn unless the main contacts are open
- The circuit-breaker unit being withdrawn from or pushed into the unit housing unless the breaker is in the fully withdrawn position
- The circuit-breaker being positioned in the unit in any positioned other than that indicated on the locator

400.1.16 Electrical Building Services, Lighting

400.1.16.1 Electrical Building Services

Lighting shall be provided in each building. The type of luminaire shall be selected with regard to the height of the building area and the purpose and environment thereof. Due consideration shall be given to high efficiency, low energy consumption lamps, fittings and circuitry. Distribution to luminaires shall provide a high level of security. Switching shall allow economy of usage.

Plant areas, switch rooms, kiosks, control rooms and other areas with control equipment within and offices, shall have a level of illumination as mentioned in section 400.1.17

Self-contained battery/charger LED emergency luminaires of the non-maintained type shall be provided in all buildings. They shall be positioned to provide emergency lighting to illuminate essential equipment items and to illuminate the exit routes within buildings to allow safe evacuation.

The Contractor shall provide lighting and small power comprising of interior, exterior lightning and indoor small power installations as appropriate.

All associated civil work, fixings, trays, clips, etc. as required shall be assumed to be included.

The entire works shall be in accordance with the IEE Regulations for Electrical Installations, 18th Edition or local equivalent regulations unless otherwise specified.

Cable trays shall be perforated, galvanized and not less than 2.0 mm thickness. Fixings shall be located at intervals not exceeding 1 meter.

Alternative fittings to those shown on the drawings shall be to the approval of the Employer's Representative.

Control gear for discharge lamps shall incorporate power factor correction and interference suppression capacitors.

Conduits shall be of the heavy gauge screwed galvanized steel type and of adequate diameter for the cables to be carried to avoid excessive bunching and be within space-factor regulations.

Switches for lighting circuits shall be mounted approximately 1,200 mm above finished floor level (ffl) and socket outlets shall be mounted 500 mm above (ffl).

Sockets above benches shall be 150 mm clear of the working surface.

Earth continuity shall be maintained throughout the entire wiring installation using separate earth conductors ultimately connected to a common earth terminal at the respective distribution board.

Cable tray and trunking, where applicable, shall be bonded across all joints with external copper bonding links.

Metal to metal joints in conduits shall not be used for earth continuity.

Distribution boards, earthing bars and electrical equipment will be grounded to the earth mat.

Wiring for emergency lighting shall be fire resistant.

XLPE/CSP cable would be acceptable.

The location of the lighting and small power items as shown on the drawings shall be reviewed on site to ensure co-ordination with pipe work, cables and other plant as satisfactory. Any adjustments necessary shall be deemed to be included in the contract price.

400.1.16.2 Lighting Indoor Application

All lighting fixtures must comply with the electrical specifications and will be as follows:

- Robust, mechanically steel with mounting brackets included

- Manufactured from steel minimum thickness being 1.5 mm, painted and gloss enamelled to specifications standards (white)
- Ballast and power factor correction capacitor terminal blocks, internal wiring, be-pin holders starters etc. shall all be inspected by the Employer's Representative
- All fixtures are to be complete with reflectors and transparent hard plastic covers to specification

A sample of intended fixtures shall be submitted to the Employer's Representative for his approval.

400.1.16.3 Lighting Outdoor Application

The following types of floodlight fixtures shall be utilized on this project and will be to specification and be from an approved manufacturer.

Description	Wattage	Rating
• Height pressure sodium	250 W 220 V, 50 Hz	
• Mercury vapour	80 W 220 V, 50 Hz	
• Spotlights (Quartz halogen)	250 W 220 V, 50 Hz	
• LED	80 W 220 V 50 Hz	

All internal components shall be to specification and a sample of each individual light fixture shall be submitted to the Employer's Representative for his approval.

Particular attention will be focused on the internal components namely ballast, capacitors, holders and wiring with regard to class, temperature, rating, protection and specification.

400.1.16.4 Illumination Levels

Minimum illumination levels shall be as follows:

• Machinery space, stores and equipment areas	300 lx
• Changes-areas, shower toilet areas, wash areas	100 lx
• Office and laboratory	500 lx
• Passage ways	150 lx
• Service building	200 lx

400.1.16.5 Lighting Types and Outlets

Lamps:

- Lamps shall be provided for all luminaries and shall be suitable for the fitting design and be of the correct rated voltage and power specified
- LED lamps shall be 'Warm White' colour

Luminaries:

- All LED fittings shall have metal bodies and reflectors treated with an anti-rust finish, the reflectors shall be finished white
- Any covers shall be of the injection moulded, polycarbonate prismatic type
- Internal wiring shall be terminated at a three-way fused terminal block for the mains connection

Maintenance Lighting:

- External lighting shall be provided at strategic points where maintenance or inspection is likely to be carried out on external plant

Emergency Lighting:

- Self-contained luminaries to provide emergency lighting shall incorporate a maintenance-free nickel cadmium battery, capable of preserving the light output for a period of 3 hours without mains supply, together with an automatic recharging circuit with a monitoring indicator, to restore the charge within 24 hours of total discharge

The luminaries shall be of the:

- Maintained form, normally lit from the mains and automatically switched from mains to battery during mains failure
- Non-maintained form, energised automatically from the battery supply only when the mains fails
- Sustained form, having two lamps, one of which is mains fed only, the other operating from the battery supply during mains failure

Lighting Switches:

- All switches for lighting circuits shall be 250 V rated, dolly operated with dished protective cast cover plates and housed in surface mounting metal clad boxes
- All boxes and covers shall be galvanised
- Where switches are mounted out of doors, weather-proof switchboxes shall be provided
- All switches for lighting circuits shall be mounted approximately 1.4 m above the associated operating floor level
- Any switch that is fixed out of sight of the lamps it controls shall be provided with a label immediately above the switch indicating the position of or otherwise describing, such lamp or lamps. Labels, engraved with approximately 2.5 mm lettering on white ground, shall be fixed by two brass screws. Abbreviations of lettering will not be permitted. Labels shall be non-flammable.

400.1.17 Lightning Protection System

400.1.17.1 General

The lightning protection system shall be installed to protect the plant against damage caused by lightning strokes. A distinction is made between external and internal lightning protection.

External lightning protection comprises all devices provided and existing outside, at and in the protected installation for the purpose of intercepting and diverting the lightning stroke current to the earthing system.

Internal lightning protection comprises the measures taken to counteract the effects of the lightning stroke current and its electrical and magnetic fields on assemblies and electrical apparatus included in the structures of the installation.

The earthing facilities necessary for lightning protection must conform to DIN VDE 0141, with particular attention paid to the requirements for lightning protection in outdoor switching stations (e.g. back flashover).

The design of lightning protection systems shall be according to one of the following methods:

- The lightning sphere method
- The method of DIN VDE 0185
- Linck's universal method
- The method of DIN VDE 0101

Reinforced concrete electrode test and inspection chambers are to be provided for each earth electrode.

Each earth pit shall comprise copper clad steel rod earth rods of minimum 25 mm diameter and minimum 4.5 m long.

The minimum depth to the top of each earth rod assembly shall be 6 meters.

Earth pits shall not be located near areas where people may walk and shall not be less than 4 meters from the building foundations.

The measured value of resistance to earth shall not exceed 3 Ω .

Buried earthing conductors shall be by means of a copper conductor not less than 50 mm² in cross-sectional area.

400.1.17.2 Air Terminal Lightning Protection System

The lightning protection system at the Treatment Plant will comprise of the following:

- Air Terminals being the EF type or equivalent mounted regulation height above ground level utilising galvanised pipe in tapered sections and supported on a steel baseplate with a concrete base.
- This terminal shall generate a current of free primary electrons coming from the Air Natural Gradient, the potential of which rises in proportion with the approach of lightning and its change.

- It shall not use any radio-element, nor shall it be electrically supplied by batteries or solar cells, nor shall it include capacitors, diodes or electric resistance.
- It shall not be designed to prevent the corona development; therefore, it shall not be of spherical shape.
- It shall be made of highly dielectric materials so that, as soon as lightning strikes its tip, it enters into a sealed hole down to earth.

400.1.17.3 Lightning Protection Down Conductor (EF)

The down conductor will be a special coaxial cable which can convey lightning currents while eliminating side-flashing risks and cutting waves which propagate dangerous over voltages to electronic equipment.

It shall be manufactured of two concentric copper conductors (2x35 mm²) which are strongly insulated from each other and from the structure.

Approximate Diameter shall be 32 mm with a 1,5 kg/m weight.

With installation it shall not be subject to bends of less than 365 mm in radius.

400.1.17.4 Earth Terminal (EF)

The earthing shall not exceed 3 Ω of static impedance.

The earthing shall be achieved by buried copper strips or copper clad steel rods or a combination of both.

The bonding to the earthing of structures to be protected is acceptable but the resistance shall be measured before making this bonding.

400.1.17.5 System Protection Radii

The design shall adopt a fished breakdown distance of 90 m which corresponds to a lightning current amplitude of 25 kA.

As the striking distance between lightning and the terminal of a lightning protection system depends on the height of the structure and intensity of the discharge, the table below identifies the protection radius (meters) to structure height (meters).

Structure Height in metres	Protection Radius in metres
5	95
10	100
20	110
30	120
40	130
50	140
60	150
70	160
80	170
90	180
100	190

400.1.18 Overvoltage protection

Electrical and electronic equipment shall be protected against surges or transients generated by switching operations, electrostatic discharges and induction, etc... by the use of graded lightning and overvoltage arresters.

Other grounding systems such as that for building, plumbing, power supplies, information processing etc... shall be taken into consideration upon designing the complete protection system.

Compatible overvoltage devices for 'line-side' protection that includes basic, medium level and detailed protection, shall be installed and shall be of the same brand.

These overvoltage devices shall be installed according to the manufacturer's recommendations and shall have the following characteristics:

- Modular design
- Visual fault indication
- Remote signaling module
- Replacement of active module (varistor) without interrupting the power supply
- Negligible leakage current
- High discharge capacity
- No follow current when the surge voltage has died down
- Short response time

Telecommunication systems, data interfaces, electronic networks, etc... shall be protected with adequate overvoltage protection devices.

400.1.19 Earthing

A system of earthing and bonding shall be provided to minimize danger to life and equipment arising from:

- Faults between energised conductors and non-current carrying metal works
- Atmospheric discharges
- Accumulation of static charges

To provide protection against the above, a protective earth network shall be established consisting of an earthing grid of buried conductors and earth rods to which will be connected:

- Plant structural steelworks
- Protective earth conductors
- Cable armouring
- Vessels
- Electrical equipment panels, motors, switchboards, MCC's; and
- Supply neutral

All main items of electrical plant shall have a minimum of two direct connections to this protective earth network.

Each connection being of sufficient size to carry the prospective fault current and shall not be less than 70 mm².

The physical position of earth connections per equipment is diagonally opposite.

All structural steel works is to be bonded together and connected to the earth system, with copper conductors not less than 70 mm² cross-sectional area.

Crane tracks shall be earthed at both ends to the earth system with copper conductors, not less than 70 mm².

For smaller items of plant, the minimum size of earth continuity conductors shall be as follows:

Cable Conductors	Earth Continuity Conductors
• up to 16 mm ²	6 mm ²
• to 50 mm ²	35 mm ²
• and above	70 mm ² and greater

Earth rods and buried earth conductors shall be of low resistance and highly resistant to corrosion.

Reinforced concrete electrode test and inspection chambers are to be provided.

Earthing electrodes are to be interconnected with each other and an earth grid is to be established to which all electrical plant and metalwork shall not exceed.

The combined resistance of the earth electrodes shall not exceed two ohms.

The short time rating of the installation shall be at least equal to the prospective short circuit current and maximum possible duration.

The Contractor shall ensure that dangerous touch voltages cannot arise.

Transformer neutrals shall be connected to the earthing system.

Holes drilled for earth rods where applicable shall be injected with bentonite to ensure good contact with the surrounding area.

Demonstration identifying the final ohmic value of the earth system will be required by the site Employer's Representative.

400.1.20 Inspection & Testing

Tests specified below shall be carried out at the manufacturers works witnessed by the Buyer and/or their representative.

Abbreviated Tests:

- Measurement of winding resistance (cold)
- Measurement of no-load losses
- Measurement to allow calculation of locked rotor current and torque
- High voltage test plus insulation resistance tests
- Inspection (at no-load) of bearings and mechanical operation of motor
- Vibration

- High voltage and continuity tests on built in temperature detectors

Complete Tests:

- Measurement of winding resistance (cold and hot)
- Measurement of no-load losses
- Measurement to allow calculation of locked rotor current and torque
- High voltage test after heat run and insulation resistance before and after heat run
- Inspection (at full load) of bearings and mechanical operation of motor
- Full load heat run
- Measurement of slip at full load
- Measurement to allow calculation of pull-out torque
- Measurement to allow calculation of starting torque
- Measurement to allow calculation of efficiency at full, three quarter and half load
- Measurement to allow calculation of power factor at full, three quarter and half load
- Vibration
- Noise

High voltage and continuity tests on built-in temperature detectors, together with tests to demonstrate satisfactory operation and compliance with stated characteristics.

Motors up to and including 150 kW:

- Complete tests will not normally be required if evidence of type tests on identical machines is produced at the time of tender. Abbreviated tests shall be made on every motor and certified Test Reports shall be provided.

Motors above 150 kW:

- Complete tests shall be made on at least one motor of each group of identical motors being supplied and these will be witnessed at the discretion of the purchaser's inspector. Certified Test Reports of these complete tests, and of abbreviated tests on the remaining motors in each batch, shall be provided.

400.1.21 General Works and Safety

- Supply and installation of CCTV complete room with IP83-AFO-4.0MP INVO Outdoor camera, INVO cabinet, HDD 4TB/64MB/ WD Purple, Installation and configuration with one-year warranty on hardware parts without cabling.
- Supply and installation of Self Standing fire detection devices and alarms which shall be connected to the SCADA system
- Supply and installation of emergency alarm system (automatic and manual)
- Supply and Installation of a new Grounding System - Lightning and Surge Protections

400.1.22 CCTV and fire alarms

The CCTV and fire alarms system shall have the following specifications:

- 8 IP83-AFO-4.0MP INVO Outdoor camera 2.8~12mm Motor Zoom & Auto focus lens 4.0MP 1/3" OVCMOS sensor,Hisilicon Hi3516D+OV OV4689 with POE
- N6508POE INVO 8CH POE NVR HD 8CH POE NVR, Main processor: Hi3535, Support : ONVIF, Video input model: 8CH*3M/8CH*1080P/16CH*720P, Decode:4*3M Real-time, Playback:4*3M/8*1080P/16*720P, 2 USB interface, Hard disk:2*6T, Video out: 1CH VGA, 1CH HDMI, 1 Rs485, Net Interface:1*RJ-45 10M/100M, 8 POE ports support POE power supply
- INVO cabinet 6U Width 60cm, Depth 45cm, Height37cm
- UTP Cat 6 Cable - Invo - 305 meters
- HDD 4TB/64MB/ WD Purple
- Installation and configuration with one year warranty on hardware parts without cabling
- Self-Standing fire detection devices and alarms shall be connected to the SCADA system

400.1.23 Electrical Installation for Buildings

As mentioned in the general section clause 400.1.16

400.1.24 Grounding System - Lightning and Surge Protections

As mentioned in the general section clause 400.1.17

400.1.25 Portable Fire Extinguishers

Location \ Type	“Gas”	“Powder”
Administration building	2x12 kg	2x12 kg

**United Nations Children's
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**INSTALLATION WORKS OF THE OMNI
PROCESSOR AT IAAT WWTP**

VOLUME 5

PREAMBLE AND BILL OF QUANTITIES

Part A - Preamble to Bill of Quantities

Part B - Bill of Quantities

MARCH 2021

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PART A

PREAMBLE TO BILL OF QUANTITIES

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1 INTRODUCTION

1.1 GENERAL

The Bill of Quantities is not and does not purport to be either exhaustive or explanatory of all the obligations and duties of the Contractor who shall be deemed to have satisfied himself as to the correctness and sufficiency of the rates and prices entered by him in the Bill of Quantities all of which shall cover all his obligations under the Contract (including those in respect of the supply of goods, materials, plant or services or of contingencies, etc.) and all matters and things necessary for the proper execution and completion of the Works and the remedying of any defects therein and which may reasonably be inferred to be necessary for the Works as described in the Contract whether expressly mentioned therein or not.

1.2 ITEMS DESCRIPTION

A detailed description of the items and of the conditions under which and the manner in which the work is to be done and measured is not set out in each item of the Bill of Quantities. Reference should be made to this Preamble and all other documents forming the Contract.

1.3 DEFINITIONS OF BILL OF QUANTITY CATEGORIES

The Bill of Quantities is divided into two categories, listed below, to group the prices under the following:

- A) Civil Works
- B) Electro-mechanical Works

1.3.1 CIVIL WORKS

The Civil Works shall include, but not be limited to, concrete works, waterproofing, metal works, painting, fencing, and all necessary works not mentioned above and needed for a good finishing and exploitation of the structure.

1.3.2 ELECTRO-MECHANICAL WORKS

The Mechanical, Electrical, and Control Equipment and works category of the BOQ shall include all the prices to supply and install the specified equipment including factory cost, factory tests, Engineer fees for factory tests and inspection, reports, packaging, shipping, handling, delivery on site, storage, trenching, backfilling, interconnections, connection to power supply, operation and maintenance manuals, testing and commissioning according to specifications and design drawings.

1.4 RATES AND PRICES

The Contractor shall be deemed to have inserted against each item in the Bills such rates and prices as he may deem necessary to cover the requirements of the Contract. Where neither price nor rate is entered against an item or if the term "included" or any such similar term is used it shall be deemed to have been included in the other priced items in the BOQ and measured accordingly. All rates and prices entered against any item in the BOQ shall be deemed to include all the detailed requirements of the General and Particular Specifications.

Rates and prices shall be inserted in the unit rate column of the Bill of Quantities. Each part of the Bill of Quantities shall be totaled and the totals carried to the Summary and Grand Summary.

1.5 MEASUREMENT

The Bill of Quantities includes items as lump sum and others as measured quantities.

1.6 LUMP SUM

The lump sum items shall not be subject to re-measurement, and shall include the prices for all necessary equipment, construction, installation, testing and commissioning among others. The lump sum entered in the Bills shall include the price for a complete installation as described in the specifications.

The prices shall include all work necessary for completion of the Works and shall include the prices for all necessary building work such as forming box outs, supports plinths, cable trenches, and all necessary safety and access works including guards, handrails, firefighting equipment, etc...

1.7 MEASURED QUANTITIES

All measurements in the Bill of Quantities are taken strictly net. The principle of net measurements shall apply to all Works executed. All quantities measured for payment shall be measured by the Contractor and checked and approved by the Supervisor on the basis of actual net quantities of Work fixed in position. Item not used shall neither be measured nor included by the Contractor in his statements.

The quantities given in the Bill are the estimated quantities. In no sense shall such quantities be considered as limiting or extending the amount of the work to be done by the Contractor and of the materials to be supplied by him. The Contractor shall be responsible for checking quantities and for making any necessary surveys and investigations prior to placing any order for materials.

1.8 DEFINITIONS

The following definitions shall apply to items in the Bill of Quantities.

- Extra - Over

Any “Extra-Over” (EO) item shall be measured and paid for in addition to the measurement of the basic item to which it relates.

- Included

Where the term included is used in the Preamble or in the Bills any items stated to be included within another item shall not be subject to measurement and their costs shall be deemed to be included within the rates of the billed item.

1.9 DEALING WITH WATER

Unit rates of items in the Bills of Quantities especially excavation items or excavation works shall be deemed to include the prices for dealing with water flows (especially for water courses crossing, or excavation along a water course) and keeping the Works free of water, and shall include prices for dewatering and supporting of trenches and excavation limits for pipeline works and structure works (for reservoirs, pumping stations, etc...) the above-mentioned works shall not be measured and shall not be paid separately.

1.10 WATER AND POWER

Unless otherwise explicitly stated in the Contract, water and power for the purpose of constructing, cleaning, and testing the Works shall be provided by the Contractor at his own expense, and shall not be measured separately.

1.11 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 type of soil, dimensions and location of structures, size of existing pipelines and cables encountered during excavation, in addition to all mechanical, electrical and control equipment and works.

The cost of preparing the shop 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 Supervisor, three hard copies of all the drawings and 3 soft copies on CD/DVD and shall be paid for separately.

1.12 TRAFFIC REGULATION CONTROL AND SAFETY PROVISION

The provision of traffic control, safety equipment, signs, diversions, control systems including obtaining approvals and liaison with third parties for work in public roads and streets or in private sector will not be measured separately but shall be deemed to be included in his unit rates for the various items in the Bill of Quantities and shall not be paid for separately, and shall include but not by way of limitation:

- Preparing all necessary plans, details and schedules and submission to the contracting authority/supervisor to obtain all necessary approvals.
- Liaison with third parties.
- Erecting, maintaining, moving and removal of safety barriers, signs and traffic control equipment.
- Establishment and management of road diversions.
- Watching and lighting.
- Maintaining roads and streets clean and free from construction debris.

2 BILL A - CIVIL WORKS

2.1 TOPOGRAPHIC SURVEY AND SITE DELIMITATION

The price per site of the topographical surveys shall include checking, completing and/or performing land surveying based on approved benchmarks, the existing ground elevation, property lines, northing and easting coordinates, topographical maps, layouts, delimitation of plots (official delimitation from the concerned authorities), implantation of foundations and reservoirs, the measurement of earthworks etc.... as well as all other additional tasks imposed by the site and/or the Supervisor. It also includes all necessary topographical works, official delimitation certificate and approved plan, labor expenses, transport costs as well as all expenses resulting from calculations and data transfer on drawings and/or on technical sheets that will accelerate the progress of works.

The site survey shall be supplied as digital data suitable for automated plotting.

2.2 SITE CLEARANCE

The lump sum price shall include cleaning the entire site and clearing it from any obstacle (material or equipment) located within the area of works, it shall also include the demolition of existing unused structures, labour, necessary equipment, transport of soil or wastes to environmentally approved public dumps (after obtaining a permit from the concerned authorities) and all tasks to deliver the site for excavation.

2.3 SITE REARRANGEMENT AFTER CONSTRUCTION

The lump sum price shall include the reinstatement of the site after completion of the works according to the drawings and to the Supervisor's instructions. It also includes backfilling all around the structures and foundations with selected materials and/or backfill to deliver the site in a good condition and prepared for the proposed improvements.

2.4 AS-BUILT DRAWINGS

As-built drawings shall be paid as lump sum and shall include formwork details, metal works, reinforcement drawings and bar bending schedule. Plans view shall be presented on scale 1/50 and details on scale 1/20.

Payment shall only be made for as-built drawings approved by the Supervisor and submitted on paper and AutoCAD files which shall be submitted via email.

2.5 GEOTECHNICAL INVESTIGATION REPORT

Geotechnical investigation report shall be paid as lump sum and shall include all boreholes execution recommended and approved by Engineer and laboratory tests conducted on boreholes samples and geotechnical report analysis.

2.7 EXCAVATION AND TRANSPORT OF UNSUITABLE BACKFILLING MATERIALS

The price per cubic meter of excavation shall include but not be limited to the excavation in all kinds of soils and rocks for structures and for access roads, use of all adequate equipment, transport of soil to environmentally approved disposal sites accepted by the Supervisor, labour, dewatering, temporary and/or final retaining structures for trenches or open digs. The volume of excavations shall be measured from the geometric dimensions of structures and levels determined according to the site layout and drawings. No excess excavations or earthworks shall be paid for unless otherwise stated by the Supervisor.

2.8 PREPARATION OF FORMATION TO REACH FINISH GROUND LEVEL

The price shall be measured in cubic meter for preparation of formation under the construction's foundation or slabs on grade and shall include compacted gravels, sand, polyethylene sheet (250µ), compaction equipment, labour and all material and equipment necessary to achieve the sub-base and base to receive the concrete. The volume shall be measured according to geometric dimensions shown on the drawings.

2.9 BACKFILLING AND COMPACTION

The price of cubic meter of backfilling shall include backfilling layers (25 cm thickness each before compaction) placed and compacted inside the fences, around the pump room as ordered by written instructions from the Supervisor or shown on the drawings. It shall also include geotextile sheets and drainage system if needed (minimum thickness 1.2mm, mass $\geq 300 \text{ g/m}^2$), bituminous coating.

The volume of backfill materials shall be computed according to the dimensions shown on the drawings and the site layout and shall be composed of selected material for each case.

The price shall also include material, equipment, labour and all necessary tasks to achieve the work in perfect conditions.

2.10 ASPHALTING

The price per square meter of asphaltting for structures and access roads layout shall include earthwork, sub-base preparation (scraping, levelling, compaction,...), sub-base material layer (hard stones, gravel, ...), base course material (hard crushed aggregate,...) bituminous tack coats, asphalt and all material, equipment, supply, transport, labor, expenses, drainage system, testing, quality control, hauling, spreading and compaction, and all necessary tasks for laying, jointing and a perfect execution and shall include, but not be limited to:

- Base course: supply, and transport of materials, earth work, scraping, levelling, compaction, labor, final thickness after compaction 20 cm, testing, quality control and all necessary tasks for a perfect execution.
- Asphalt: supply and transport of materials, bituminous, tack coat, asphalt and all necessary materials, labor, expenses, testing, quality, control, hauling, spreading and compaction and all necessary tasks for laying, jointing and a perfect execution.

2.11 DRAIN TRENCH

The price per linear meter of drain trench at the edge of asphalted road shall include excavation earthwork, sub-base preparation (scraping, levelling, compaction,...), drain material layer (hard stones, gravel,...), and geotextile filter separation including all material, equipment, transport labour, expenses, testing, quality control, hauling, spreading and all necessary tasks for laying, jointing and a perfect execution.

2.12 EXCAVATION FOR EMBEDDED PIPES

The price of excavation , backfilling and compaction of required embedded underground pipes shall include earthwork, sub-base preparation (scraping, levelling, compaction,...), drain material layer (hard stones, gravel,...), and geotextile filter separation including all material, equipment, transport labour, expenses, testing, quality control, hauling, spreading and all necessary tasks for laying, jointing and a perfect execution.

2.13 BLINDING, MASS CONCRETE C20 AND CYCLOPEAN CONCRETE

The price per cubic meter shall include all material, equipment, labour, transport, blinding and/or mass concrete, cyclopean concrete (40 % stone ; 60 % concrete) and shall be composed of at least 250 kg of cement per cubic meter of concrete and shall be measured according to the geometric shapes shown on the layout drawings and/or Standard Drawings. Any quantity executed in excess of the indicated dimensions shall not be paid for. Any quantity less than that required in the Contract drawings and according to the specification documents shall be deducted or completed according to the instructions given by the Supervisor.

2.14 REINFORCED CONCRETE GRADE C30/37

The price per cubic meter shall include all material, equipment, labor, transport, admixtures (retarders, plasticizers, waterproofing materials) batching, mixing, placing, vibrating, curing, testing, finishing, scaffolding, reservations for equipment, formwork, wrought formwork (fair face), surface levelling with mechanical float, etc. Dosage of cement shall be 400 kg/cu.m. All joints or sealing systems shall be included in the price. Measurement shall be determined according to the geometric shapes indicated on the layout drawings and/or buildings drawings; any quantity executed in excess of the indicated dimensions shall not be paid for. Any quantity less than that required in the Contract drawings and according to the specification documents shall be deducted or completed according to the instructions given by the Engineer.

The price per cubic meter includes levelling of horizontal surfaces of large areas of slabs on grade (reservoirs and/or technical trench) by a mechanical trowel.

The price shall also include all materials, equipment, labour, transport, storage, placing, bending, of reinforcing steel supplied, placed, bended, with all needed materials, accessories and tasks to achieve the works in perfect conditions. Detailed bar bending schedules and sheets should be submitted for approval before placing and installation.

The price shall also include all needed works, labour, material, transport, formwork, to execute a fair faced concrete for interior and exterior walls and grade beams and cover slabs.

2.15 REINFORCED CONCRETE GRADE C30/C37 (FOR CONCRETE UPSTANDS AND PARAPETS)

The price per linear meter shall include all material, equipment, labour, transport, admixtures (retarders, plasticizers, waterproofing materials) batching, mixing, placing, vibrating, curing, testing, finishing, scaffolding, reservations for equipment, formwork, wrought formwork (fair face), surface levelling. Dosage of cement shall be 400 kg/cu.m. Measurement shall be determined according to the geometric shapes indicated on the layout drawings and/or buildings drawings; any quantity executed in excess of the indicated dimensions shall not be paid for.

Any quantity less than that required in the Contract drawings and according to the specification documents shall be deducted or completed according to the instructions given by the Engineer.

The price shall also include steel reinforcement, all materials, equipment, labor, transport, storage, placing, bending, scaffolding, etc. of reinforcing steel supplied, placed, bended, etc. with all needed materials, accessories and tasks to achieve the works in perfect conditions. Detailed bar bending schedules and sheets should be submitted for approval before placing and installation.

The price shall also include all needed works, labor, material, transport, formwork, etc., to execute a fair faced concrete for interior and exterior of parapets and technical trench.

2.16 METAL WORKS

The price per kilogram of metalwork (grating, railings, trap doors, ...) shall include all material, equipment, transport, labor, expenses, epoxy paint, supply, installation, anchoring, locking system, reinstatement of support, finishing and all tasks and accessories necessary to a perfect execution.

2.17 EXTERIOR STEEL DOOR AND WINDOWS INCLUDING PAINTING

The price of exterior steel door and windows of WC room is lump sum price and shall include all material, equipment, transport, labor, expenses, water-resistant hardware, ventilation, mechanical protections, epoxy paint, louvers, openings, locking system, supply, installation, anchoring, reinstatement of support, finishing and all tasks and accessories, necessary to a perfect execution. Metal sheets shall be 3mm thick minimum.

2.18 FENCE

The price per linear meter of fence shall include all excavation, reinforced concrete, metalwork, epoxy paint, finishing, material, labor, equipment, supply, transport, anchor bolts, reinstatement of property line, and all tasks necessary for a perfect execution. The price shall also include fixing the fence to the concrete support.

2.19 ACCESS GATE

The lump sum price of the access gate per site shall include all excavation, reinforced concrete, steel access gate, locking system, epoxy paint, water resistant hardware, anchors, finishing material, labour, equipment, formwork, scaffolding, supply, transport, reinstatement of property line and all tasks necessary for a perfect execution. For access gate width refer to site layout.

2.20 PROTECTIVE COATING FOR UNDERGROUND RESERVOIR AND UNDERGROUND BURRIED CONCRETE ELEMENTS

The price per square meter of bituminous coating for the underground RC elements and epoxy resin coating for underground tanks shall include preparation of the surface (sand blasting, water blasting), treatment of singular points (pipe penetration, ...) material, transport, scaffolding, application in several layers, labor, expenses, ... in conformity with the technical sheet of approved material, quality tests, structures test, before and after application, warranty. Epoxy resin products shall be applied on underground walls and bottom slab of tanks.

All products used shall resist to an aggressive environment (wastewater).

2.21 WATERPROOFING OF ROOF SLABS

The price per square meter of waterproofing without thermal insulation shall include material, transport, equipment, labor, supply, installation, preparation of support, treatment of singular point, scaffolding and shall be composed of two layers of a liquid electrometric bitumen (aluminum color) in order to assure a protective waterproofing. Supply and installation work of necessary roof drains are deemed to be included in this item and shall not be paid for separately.

The price shall also include the supply and installation of removable concrete protective tiles in layer of 4cm thick.

The membranes shall be measured only for horizontal surfaces and no measurements or excess shall be paid for vertical surfaces.

2.22 HOLLOW CONCRETE BLOCK WALLS

The price per square meter of built areas at WC of hollow concrete blocks (10 cm and 20 cm thick) shall include concrete blocks, sand and cement for mortar, all materials, equipment, labor, expenses, scaffolding, placing, junctions, concrete lintels, openings, ... and shall be measured according to net areas built from one side.

2.23 RENDERING OR PLASTERING OF INTERIOR OR EXTERIOR SURFACES

The price of rendering per square meter shall include all materials: cement, sand, water, equipment, labor, scaffolding, expenses, supply, transport, placing mortars and shall be measured according to geometric shapes of rendered areas, no excess and no measurement shall be paid for re-entrant or salient angles of openings, chamfered angles or others. The rendering shall be executed according to specifications.

2.24 INTERNAL PAINT COATING

The price per square meter of paint includes all materials, equipment, transport, labor, expenses, scaffolding, surface preparation, application, preparation of support, finishing cleaning, singular points, and shall be composed of external putty, primer and a minimum of two coats of paint.

The surfaces shall be measured according to geometric shapes of painted area, no measurement and no excess shall be paid for re-entrant or salient angles of openings.

2.25 TILING OF FLOOR SURFACE

The price of floor tiling per square meter shall include all materials: cement, sand, water, equipment, labor, expenses, supply, transport, placing mortars and shall be measured according to geometric shapes of floor, no excess and no measurement shall be paid for skirting or others tillable elements. The tiling shall be executed according to specifications.

3 BILL B - ELECTROMECHANICAL WORKS

3.1 LUMP SUM

The lump sum items shall not be subject to remeasurement, and shall include the prices for all necessary equipment. The lump sum entered in the Bills shall include all equipment necessary for a complete installation as described in the specifications.

3.2 ELECTROMECHANICAL EQUIPMENT AND WORKS

The Mechanical, Electrical, and Control Equipment and works category of the BOQ shall include all the prices to supply and install the specified equipment including factory cost, factory tests, Engineer fees for factory tests and inspection, reports, packaging, shipping, handling, delivery on site, storage, trenching, backfilling, interconnections, connection to power supply, operation and maintenance manuals, testing and commissioning according to specifications and design drawings.

3.2.1 HYDRAULIC ACCESSORIES

The price of the hydraulic accessories item shall include, but not be limited to, the rehabilitation of the existing hydraulic system and/or the supply of new hydraulic equipment and accessories including packaging, shipping and handling customs fees, delivery on site, storage, and any other item and accessory necessary for the complete installation and trouble-free operation.

3.2.2 ELECTRICAL CONTROL PANELS

The price of the electrical control panels item shall include, but not be limited to, the rehabilitation of the existing electrical control panel including cables and replacement of damaged items, and/or the supply of a new electrical control panel with all electrical wires. The price shall include packaging, shipping and handling customs fees, delivery on site, storage, and any other item and accessory necessary for the complete installation and trouble-free operation of the electrical system.

3.2.3 DOMESTIC LIGHTING AND ELECTRICAL SYSTEM

The lump sum price for the domestic lighting and electrical installation item shall include, but not be limited to, the rehabilitation and/or the supply and installation of the electrical panel boards along with their accessories, cables, conduits, junction boxes and their accessories, all lighting fixtures, switches, sockets, plugs and their accessories, necessary electric connections for the proper operation of the complete installation, and connection to the electric power system. The price also includes the preparation of O&M manuals, testing and commissioning and any other item and accessory deemed necessary for the complete installation and trouble-free operation of the domestic lighting and electrical system.

3.2.4 GROUNDING SYSTEM - LIGHTNING AND SURGE PROTECTIONS

The lump sum item for the Grounding system – lighting and surge protections item shall include, but not be limited to, the rehabilitation and/or the supply and installation of the ground rods, the lightning rod and pole, the ground rod clamps, the ground plate, the grounding electrode conductor and any other grounding elements required to successfully protect the station. Furthermore, the price includes packaging, shipping and handling, customs fees, delivery to the site and its storage.

3.2.5 FIRE EXTINGUISHERS

The lump sum price of the Fire Extinguishers item shall include, but not be limited to, the supply and installation of fire extinguishers as well as the supply of all furniture, packaging, shipping and handling, customs fees, delivery on site, spare parts, storage and any other items and accessories deemed necessary for the complete installation and trouble-free operation of the mechanical system.

3.2.6 TRAINING, TESTING AND COMMISSIONING

The lump sum price for training, testing and commissioning item shall include, but not be limited to, on site tests for all electromechanical works and performance tests on equipment and systems, all measurements, equipment, apparatus, materials, power supply, and labor, tests reports, necessary training sessions, training material and documentation, as well as transportation, accommodation and expenses of trainers and commissioners, and any other item and accessory deemed necessary for the comprehensive training of the water authority appointed personnel, and necessary for the on-site testing and commissioning of the plant.

PART B

BILL OF QUANTITIES

**INSTALLATION WORKS OF THE OMNI PROCESSOR AT IAAT WWTP
VOLUME 5 - BILL OF QUANTITIES**

**IAAT WWTP - OMNI PROCESSOR
BILL A - CIVIL WORKS**

ITEM Nb.	DESCRIPTION	UNIT	QUANTITY	UNIT RATE USD	TOTAL AMOUNT USD
1,0000	General				
1.0010	Checking, completing, and/or performing topographic survey and site delimitation	L.S.	1		
1.0020	Site clearance	L.S.	1		
1.0030	Site rearrangement after construction including removal of all construction debris	L.S.	1		
1.0040	As-built drawings after completion of works including site photos of executed treatment plant	L.S.	1		
1.0050	Conduct geotechnical investigation campaign. Geotechnical report to be submitted for approval. Boreholes location and depth to be coordinated and approved by Engineer.	L.S.	1		
	Sub-Total 1,0000				
TOTAL OF DIV 1 - GENERAL REQUIREMENTS					
2.1000	Earthworks				
2,1100	Excavation				
2.1110	General excavation in all types of soils and rocks and transport of unsuitable backfilling material to disposal sites of all construction site area to insure 50 cm depth for execution of base and sub-base execution.	cu.m	518		
	Sub-Total 2,1110				
2.1120	Excavation in all types of soils and rocks and transport of unsuitable backfilling material to disposal sites of underground water tanks structures.	cu.m	165		
	Sub-Total 2,1120				
2.2200	Backfilling				
2.2210	Backfilling and compaction around underground excavated underground structure in order to reach 50 cm below road level	cu.m	132.00		
	Sub-Total 2,2210				

**INSTALLATION WORKS OF THE OMNI PROCESSOR AT IAAT WWTP
VOLUME 5 - BILL OF QUANTITIES**

**IAAT WWTP - OMNI PROCESSOR
BILL A - CIVIL WORKS**

ITEM Nb.	DESCRIPTION	UNIT	QUANTITY	UNIT RATE USD	TOTAL AMOUNT USD
2.2220	Backfilling and compaction of subgrade base and sub-base below concrete slab on grade at different facility of OMNI plant. Price to include polyethylene sheet before concrete pouring	cu.m	67.50		
	Sub-Total 2,2220				
	Sub-Total 2,2000				
2.3000	Asphalting				
2,3100	Subgrade compaction, sub-base and base preparation, and asphalting	sq.m	750		
	Sub-Total 2,3000				
2.4000	Drain trench				
2,4100	Supply and apply drain trench materials 50 cm depth along all sides of the project as shown on drawings including required excavation and geotextile filter separation	lm	54.0		
	Sub-Total 2,4000				
2.5000	Excavation for underground embedded pipes				
2,5100	Excavation for all embedded pipes in any type of soil to reach invert levels as indicated on mechanical drawings including all required compaction and backfilling above pipes as specified.	L.S.	1.0		
	Sub-Total 2,5000				
	TOTAL OF SITE CONSTRUCTION WORKS				

**INSTALLATION WORKS OF THE OMNI PROCESSOR AT IAAT WWTP
VOLUME 5 - BILL OF QUANTITIES**

**IAAT WWTP - OMNI PROCESSOR
BILL A - CIVIL WORKS**

ITEM Nb.	DESCRIPTION	UNIT	QUANTITY	UNIT RATE USD	TOTAL AMOUNT USD
3.0000	Concrete works				
3,100	Blinding and Mass Concrete Strength Class C20/25 , for raft foundation and tie beams				
3,210	Blinding concrete under raft foundation 10 cm thick	m3	5.00		
3,220	Blinding concrete under tie beams and concrete electrical trench	m3	6.00		
3,230	Cyclopean concrete behind underground basement wall at axis 5	m3	40.00		
3,240	Pedestal concrete foundation support for steel stair columns fixation 500 mm height	unit	5.00		
	Sub-Total 3,100				
3,200	Execution of Reinforced Concrete Strength Class C30/37 for structural underground concrete elements in contact with water and backfilling materials including all RC concrete materials and accessories				
3,210	Raft foundation for pump station	cu.m	12.00		
3,211	Underground tanks peripheral walls including smooth finish concrete	cu.m	22.50		
3,212	Under tanks internal walls including smooth finish concrete	cu.m	5.00		
3,213	Underground tanks cover slab	cu.m	10.00		
3,214	Electrical trench base anchored in underground walls of water tanks including smooth finish concrete	cu.m	2.10		
3,215	Electrical trench upstands anchored in underground walls of water tanks including smooth finish concrete	lm	21.00		
3,216	Electrical trench near plant building including base and 2 sides upstands including smooth finish concrete	lm	16.00		
3,217	Peripheral edge beam of Storage material shed including smooth finish concrete sides	cu.m	6.00		
3,218	Slab on grade at storage materials shed including power floating for smooth finish and execution of saw cut crack control joints	cu.m	9.00		
3,219	Peripheral edge beam at waste water treatment facility including smooth finish concrete sides	cu.m	4.00		
3,220	Slab on grade at waste water treatment facility including power floating for smooth finish and execution of saw cut crack control joints	cu.m	3.50		
3,221	Peripheral edge beam at plant building including smooth finish concrete sides	cu.m	4.00		
3,222	Slab on grade at plant building including power floating for smooth finish and execution of saw cut crack control joints	cu.m	4.50		

**INSTALLATION WORKS OF THE OMNI PROCESSOR AT IAAT WWTP
VOLUME 5 - BILL OF QUANTITIES**

**IAAT WWTP - OMNI PROCESSOR
BILL A - CIVIL WORKS**

ITEM Nb.	DESCRIPTION	UNIT	QUANTITY	UNIT RATE USD	TOTAL AMOUNT USD
3,223	Peripheral edge beam below office container including smooth finish concrete sides	cu.m	4.00		
3,224	Slab on grade at office container including power floating for smooth finish and execution of saw cut crack control joints	cu.m	3.25		
3,225	Peripheral edge beam for WC area including smooth finish concrete sides	cu.m	2.00		
3,226	Slab on grade at WC area including power floating for smooth finish and execution of saw cut crack control joints	cu.m	1.50		
3,227	Roof cover slab at WC area including power floating for smooth finish and execution of saw cut crack control joints	cu.m	1.50		
3,228	Roof cover slab parapets at WC area including smooth finish concrete 30 cm height , 15 cm width	lm	10.10		
3,229	Concrete columns for WC area supporting roof slab	unit	4.00		
3,230	Slab on grade at external plant building platform including power floating for smooth finish and execution of saw cut crack control joints	cu.m	10.00		
3,231	Peripheral edge beam at external plant building platform area including smooth finish concrete sides	cu.m	8.00		
3,232	Concrete underground tie beam separation between asphalt area and green plantation area.	lm	160.00		
3,233	Concrete up stand above underground tank wall at treatment tanks area	cum	4.00		
Sub-Total 3,200					
TOTAL OF CONCRETE WORKS					
4,0000	Metal Works				
4.1000	Execution Shop drawings Prepare all necessary shop drawings for steel structures erection with related calculation notes for approval.				
4.1100	Steel shop drawings and as built drawings with related calculation notes to be submitted for approval	L.S.	1		
Sub-Total 4,1000					

**INSTALLATION WORKS OF THE OMNI PROCESSOR AT IAAT WWTP
VOLUME 5 - BILL OF QUANTITIES**

**IAAT WWTP - OMNI PROCESSOR
BILL A - CIVIL WORKS**

ITEM Nb.	DESCRIPTION	UNIT	QUANTITY	UNIT RATE USD	TOTAL AMOUNT USD
4.2000	Metal Windows for WC area Supply and install galvanized steel windows, installed complete including frame, sub frame, transoms, sills, infill panels, accessories, iron monger, gaskets, sealants, anchors and protective coating.				
4.2100	WS01 overall size 400 mm wide x 400 mm high.	No.	2		
	Sub-Total 4,2000				
4.3000	Galvanized Steel Door at WC area Supply and installation of galvanized steel doors with protective coating and adequate support , including all necessary fixing devices, accessories, fasteners complete all as specified and shown on drawings.				
4.3100	DS01 overall size 750 wide x 2200 mm high.	No.	1		
	Sub-Total 4,3000				
4.4000	Metal steel stair and walkway Supply and installation of a colored epoxy coated metal steel stair structure with epoxy coating steel adequate support , including all necessary fixing devices, accessories, fasteners complete including galvanized steps and walkway checker plates with steel railing balustrade.				
4.4100	Stair steel structure and accessories	kg	1,500		
4.4200	Steps and walkway gratings plates including railing balustrade	L.S.	1		
	Sub-Total 4,4000				

**INSTALLATION WORKS OF THE OMNI PROCESSOR AT IAAT WWTP
VOLUME 5 - BILL OF QUANTITIES**

**IAAT WWTP - OMNI PROCESSOR
BILL A - CIVIL WORKS**

ITEM Nb.	DESCRIPTION	UNIT	QUANTITY	UNIT RATE USD	TOTAL AMOUNT USD
4.5000	External peripheral steel fence Supply and installation of galvanized steel columns with protective coating for external fence including galvanized steel wire mesh , with all necessary fixing accessories, all as specified and shown on drawings.				
4.5100	External fence supply and install including the following and as shown on drawings: - excavation - foundations - beams on grade - columns - hollow concrete blocks (Th. 20cm) - metallic fence - Protective Paint finishing	lm	125		
4.5200	Main access steel gates with protective layer including all necessary fixing devices, accessories, fasteners with sliding rail.	sq. m	45		
	Sub-Total 4,5000				
4.6000	Steel structure for Material storage shed area Supply and installation of steel structure of storage materials shed with epoxy coating protective layer , including all necessary fixing devices, accessories, fasteners complete all as specified and shown on drawings.				
4.6100	Steel columns and Roof cover beams	kg	3,000.0		
4.6200	Galvanized steel roof sheeting	kg	1,000.0		
	Sub-Total 4,6000				

**INSTALLATION WORKS OF THE OMNI PROCESSOR AT IAAT WWTP
VOLUME 5 - BILL OF QUANTITIES**

**IAAT WWTP - OMNI PROCESSOR
BILL A - CIVIL WORKS**

ITEM Nb.	DESCRIPTION	UNIT	QUANTITY	UNIT RATE USD	TOTAL AMOUNT USD
4.7000	Checker plates covering water tanks pit opening Supply and installation galvanized steel checker plates with all supporting steel structures and with embedded steel angles installation , including all necessary fixing devices, accessories, fasteners complete all as specified and shown on drawings.				
4.7100	Galvanized checker plates 4 mm thick	m2	4.0		
4.7200	Steel angles 60x60x4 mm embedded in concrete	lm	64.0		
	Sub-Total 4,7000				
4.8000	Filter screen steel structure Supply and installation steel filter screens steel structure with epoxy coating protective layer with steel angle embedded in concrete including all necessary fixing devices, accessories, fasteners complete all as specified and shown on drawings.				
4.8100	Steel structure filter screens at underground water tank cover slab 30 mm thick	L.S.	1.0		
4.8200	Steel angles 50x50x3 mm embedded in concrete	lm	5.6		
	Sub-Total 4,8000				
	TOTAL OF METAL WORKS				
5,0000	Moisture Protection				
5.1000	Waterproofing membrane on WC roof Waterproofing membrane installed on prepared substrates including dressing up against parapets, working around pipes and openings and necessary laps, complete all as specified on roof slab including concrete tiles 40x40 protective laver				
5.1100	Torch applied roofing membrane including prime coat, minimum thickness 4 mm at roofs.	L.S.	1		
5.1200	Mastic sealant at edge of membrane applied in concrete parapet groove	lm	10.1		
	Sub-Total 5,1000				

**INSTALLATION WORKS OF THE OMNI PROCESSOR AT IAAT WWTP
VOLUME 5 - BILL OF QUANTITIES**

**IAAT WWTP - OMNI PROCESSOR
BILL A - CIVIL WORKS**

ITEM Nb.	DESCRIPTION	UNIT	QUANTITY	UNIT RATE USD	TOTAL AMOUNT USD
5.2000	Aluminum Flashing on WC roof Anodized aluminum flashing installed, anchored and well sealed and turned into strips, sealants, anchors and protective coating, complete as specified at roof slabs.				
5.2100	Aluminum flashing 200mm	lm	10.1		
	Sub-Total 5,2000				
5.3000	Epoxy resin protective coating for internal underground walls Supply and apply epoxy resin protective coating including surface preparation, primer and double coats; with special treatment on angles and cracks; as per specifications				
5.3100	protective coating to tank ground and walls	sq.m	112		
5.3200	special treatment at corner with fiber mesh reinforcement	lm	76.0		
	Sub-Total 5,3000				
5.4000	Bituminious waterproofing coating Supply and apply double bituminous protective layer on exposed basement walls and foundation and grade beams sides including surface preparation, primer and double bituminous coats as per specifications				
5.4100	Bituminious coating for external tank underground walls	sq.m	70		
5.4200	Bituminious coating for burried grade beams sides in contact with soil	sq.m	120.0		
5.4300	Bituminious coating for electrical trench concrete in contact with soil	sq.m	20.0		
5.4400	PVC water stop for base of underground tanks walls	lm	27.5		
	Sub-Total 5,4000				
	TOTAL OF MOISTURE AND WATERPROOFING WORKS				

**INSTALLATION WORKS OF THE OMNI PROCESSOR AT IAAT WWTP
VOLUME 5 - BILL OF QUANTITIES**

**IAAT WWTP - OMNI PROCESSOR
BILL A - CIVIL WORKS**

ITEM Nb.	DESCRIPTION	UNIT	QUANTITY	UNIT RATE USD	TOTAL AMOUNT USD
6,0000	FINISHES WC AREA				
6.1000	WC MASONRY WALLS Apply and supply masonry walls for external walls and internal WC partitions with all related grouting materials and accessories				
6.1100	20 cm external walls	sq.m	26		
6.1200	10 cm internal partition walls	sq.m	7		
	Sub-Total 6,1000				
6.2000	WC RENDERING				
6.2100	Plastering Preparation and application of two coats of cement plaster finish Internal plastering External plastering	L.S. L.S.	1 1		
6.2200	Painting Internal Enamel paint over smooth finish concrete Acrylic external paint over plastered smooth finished walls	L.S. L.S.	1 1		
	Sub-Total 6,2000				
6.3000	WC FLOOR TILING Apply and supply ceramic floor tiles with all related filling materials and accessories				
6.3100	Ceramic floor tiling	L.S.	1		
	Sub-Total 6,3000				
	TOTAL OF FINISHING WORKS				
	TOTAL OF CIVIL WORKS				

**INSTALLATION WORKS OF THE OMNI PROCESSOR AT IAAT WWTP
VOLUME 5 - BILL OF QUANTITIES**

**IAAT WWTP - OMNI PROCESSOR
BILL B - ELECTRO-MECHANICAL WORKS**

ITEM Nb.	DESCRIPTION	UNIT	QUANTITY	UNIT RATE USD	TOTAL AMOUNT USD
7.1000	WC EQUIPPING				
7.1001	Supply and installation of complete WC (Toilet) equipment including taps, sink, latrine, etc... as per drawing number EM01	L.S.	1		
7.1002	Supply and installation of complete water and sanitation system including piping, valves, 1 m3 plastic water tank, along with all equipment necessary for the proper functioning of the system.as per drawing number EM02	L.S.	1		
7.2000	ELECTRICAL SYSTEM				
7.2001	Supply and installation of complete lightning and protection system along with all equipment necessary for the proper functioning of the system. as per drawing number EM04	L.S.	1		
7.2002	Supply and installation of complete domestic lighting system including internal and external lighting fixtures, sockets, switches, etc...as per drawing number EM03	L.S.	1		
7.2003	Supply and installation of Low voltage Armoured cable 1x(3x95+50) mm ² including trench excavation, cable laying, backfilling, compaction, asphaltting (where necessary), and connection to the main electrical panel of IAAT WWTP.	lin.m	450		
7.2004	Supply and installation of three phase (4 Poles) 65 A circuit breaker	nb.	2		
7.2005	Supply and installation of solar street lighting, including 6 m poles, solar panels, batteries, lamps, etc... along with all equipment necessary for the proper functioning of the system.	nb.	4		
7.3000	Supply and Installation of fire alarms				
7.3001	Supply and installation of Self Standing fire detection devices and alarms	nb	4		
7.3002	Supply and installation of emergency alarm system (automatic and manual)	LS	1		
7.3003	Supply of Personal Protective Equipment necessary in a WWTP.	LS	1		
7.3004	Fire extinguishers	LS	1		

**INSTALLATION WORKS OF THE OMNI PROCESSOR AT IAAT WWTP
VOLUME 5 - BILL OF QUANTITIES**

**IAAT WWTP - OMNI PROCESSOR
BILL B - ELECTRO-MECHANICAL WORKS**

ITEM Nb.	DESCRIPTION	UNIT	QUANTITY	UNIT RATE USD	TOTAL AMOUNT USD
7.4000	Preparation of full As-built drawings of the OMNI processor Plant, including civil, electrical, mechanical, control and hydraulic layouts and sections, along with full O&M Manual for all installed equipment. In addition to the supply and installation of project panel board which all shall be to the satisfaction of the engineer.	LS	1		
7.5000	Supply and installation of 1 Air conditioning unit of 12,000 BTU capacity for the general office.	LS	1		
7.6000	Landscaping and Walking Space				
7.6001	Supply and apply 15 cm thick layer of gravel (30 to 50mm) to be spread between treatment plant structures	sq.m	500		
7.7000	Supply and planting of trees				
7.7001	Populus trees (Trees trunk shall have a minimum height of 2.00 m above the planting level)	unit	25		
7.7002	Leyland's trees (Trees trunk shall have a minimum height of 2.00 m above the planting level)	unit	25		
7.8000	Suplpy and installation of complete irrigation system including pumps, piping, fittings and all necessary equipment for the proper functioning of the system	L.S.	1		
	TOTAL OF ELECTRO-MECHANICAL WORKS				

**INSTALLATION WORKS OF THE OMNI PROCESSOR AT IAAT WWTP
VOLUME 5 - BILL OF QUANTITIES**

**IAAT WWTP - OMNI PROCESSOR
SUMMARY TABLE**

DIVISION Nb.	DESCRIPTION	AMOUNT USD
DIV 1	GENERAL REQUIREMENTS	
DIV 2	SITE CONSTRUCTION	
DIV 3	CONCRETE WORKS	
DIV 4	METAL WORKS	
DIV 5	THERMAL AND MOISTURE PROTECTION	
DIV 6	FINISHES	
DIV 7	ELECTRO-MECHANICAL WORKS	
	TOTAL OF WORKS	

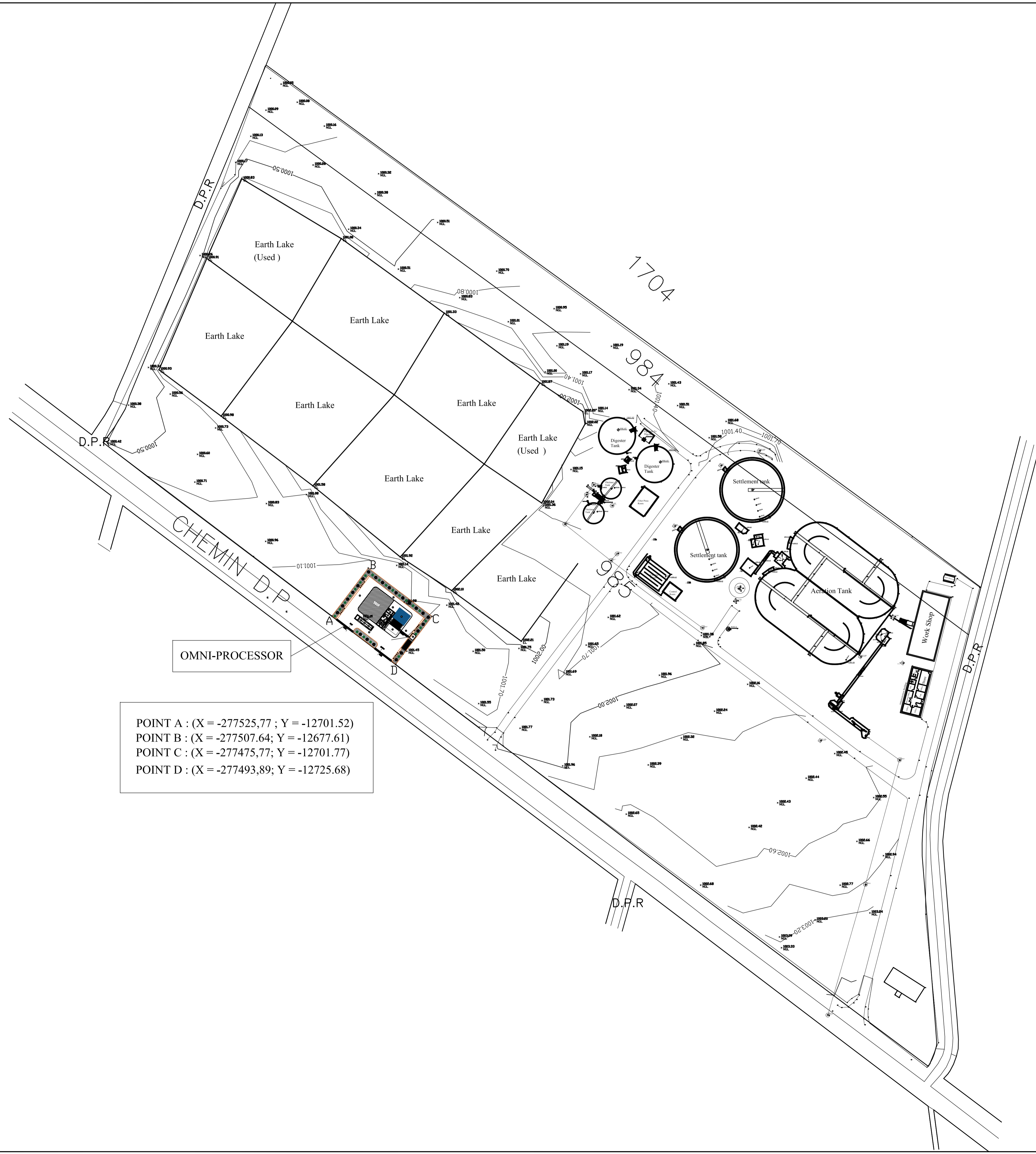


United Nations Children's Fund
(UNICEF)

INSTALLATION WORKS FOR THE OMNI PROCESSOR AT IAAT WWTP

TENDER DOCUMENTS DRAWINGS

MARCH 2021



POINT A : (X = -277525.77 ; Y = -12701.52)
 POINT B : (X = -277507.64; Y = -12677.61)
 POINT C : (X = -277475.77; Y = -12701.77)
 POINT D : (X = -277493.89; Y = -12725.68)

OMNI-PROCESSOR

Rev.	Date	Dsgn	Drwn	Chk'd	Appr'd

REPUBLIC OF LEBANON



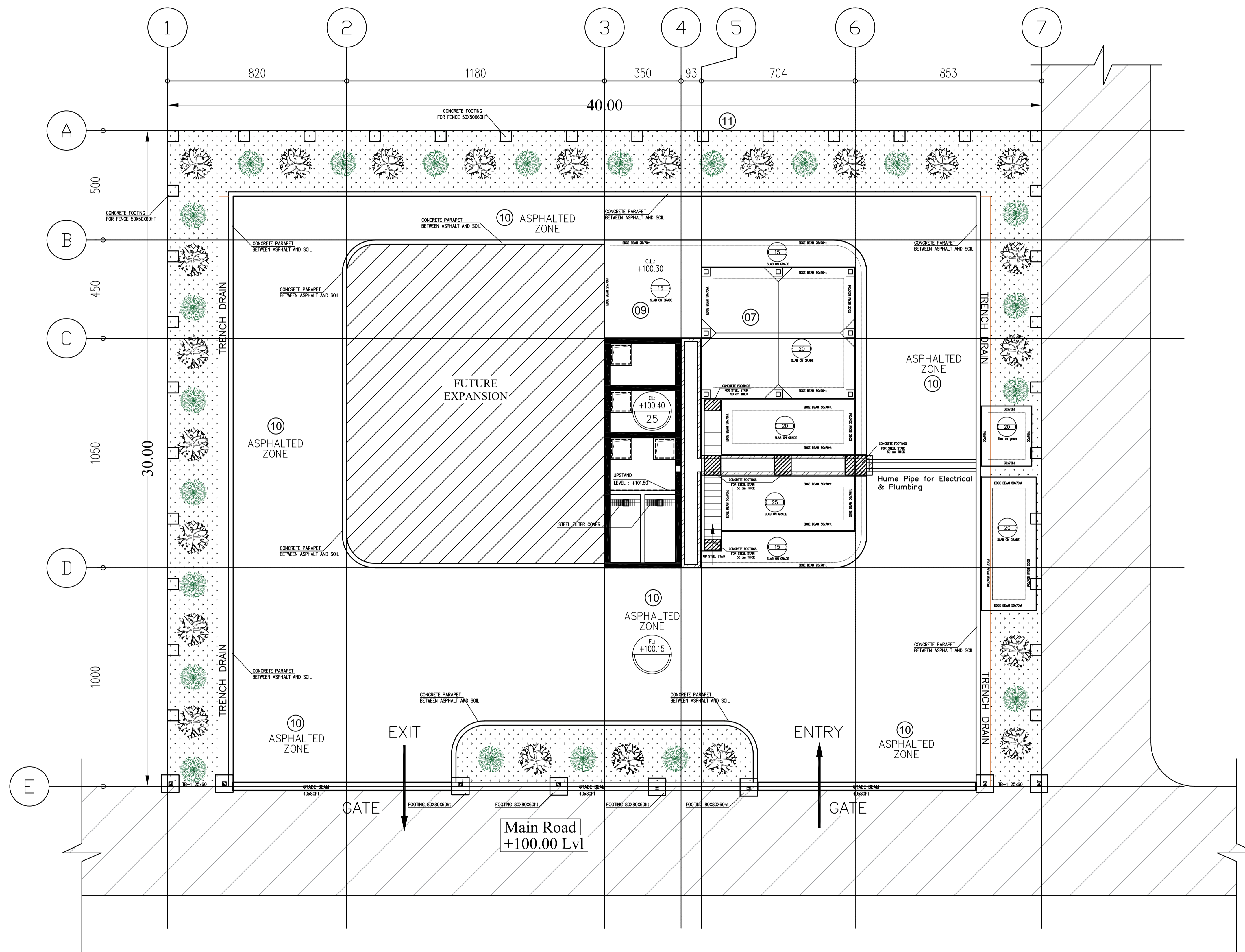
United Nations Children's Fund
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INSTALLATION WORKS OF THE
OMNI PROCESSOR AT IAAT WWTP

IAAT WASTEWATER TREATMENT PLANT	SITE LOCATION
---------------------------------------	---------------

FILE	DESIGNED BY	DRAWN BY	CHECKED BY
STR01	-	-	-

DATE	SCALE	SHEET No.	DRAWING No.
FEBRUARY 2021	NTS	1/1	1/17



LIST OF COMPONENTS:-

1	Septage Receiving Station
2	Holding Tank 45kl Capacity
3	Filtrate Tank
4	Treated Water Tank
5	Plant Building (G+1)
6	Waste Water Treatment
7	Material Storage Shed
8	Office Container
9	Plant Building Platform
10	Road
11	Compound Wall
12	Toilet

Rev.	Date	Dsgn	Drwn	Chk'd	Appr'd

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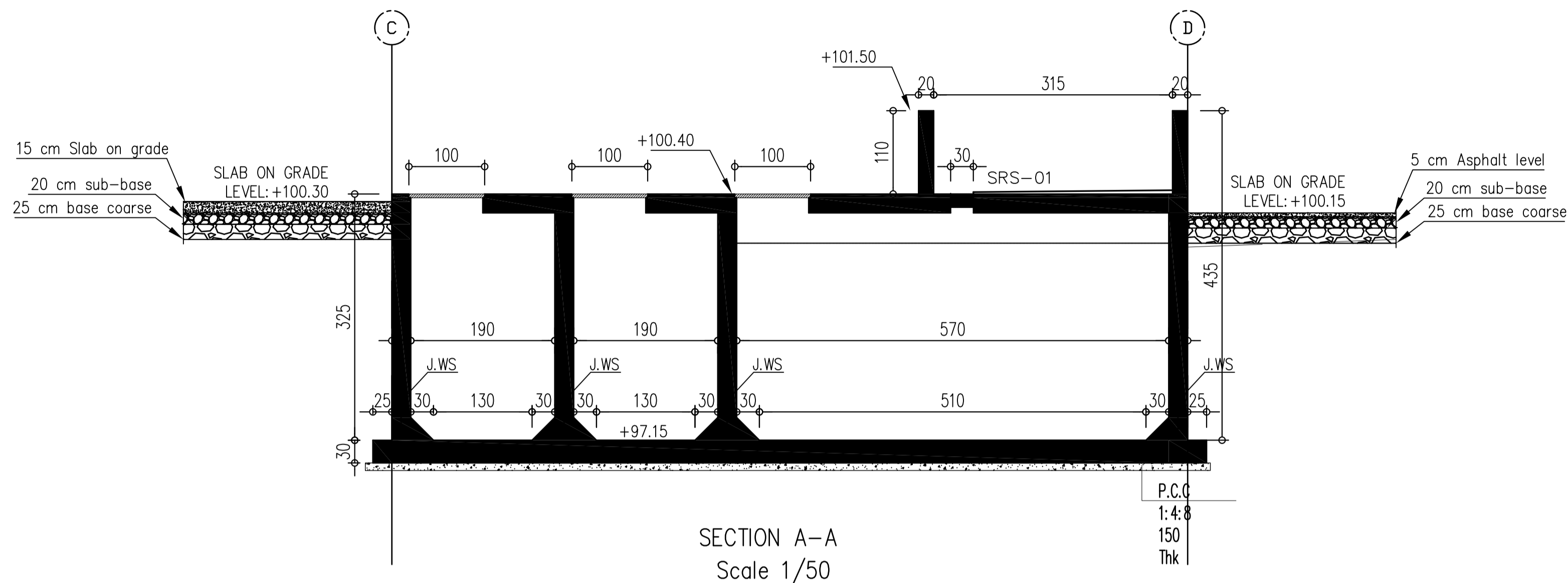
United Nations Children's Fund
(UNICEF)

INSTALLATION WORKS OF THE
OMNI PROCESSOR AT IAAT WWTP

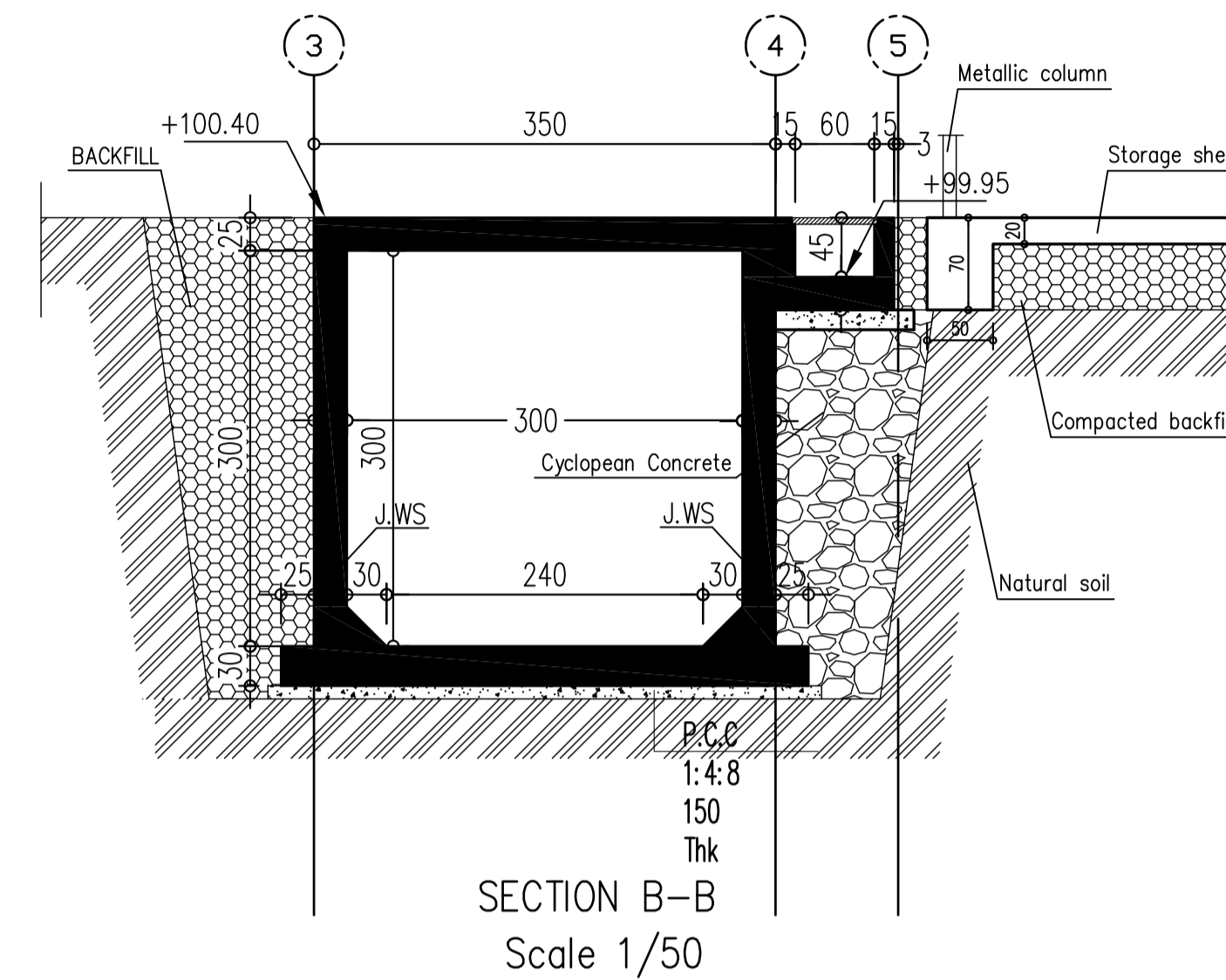
IAAT WASTEWATER PLANT	KEY PLAN
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FILE	DESIGNED BY	DRAWN BY	CHECKED BY
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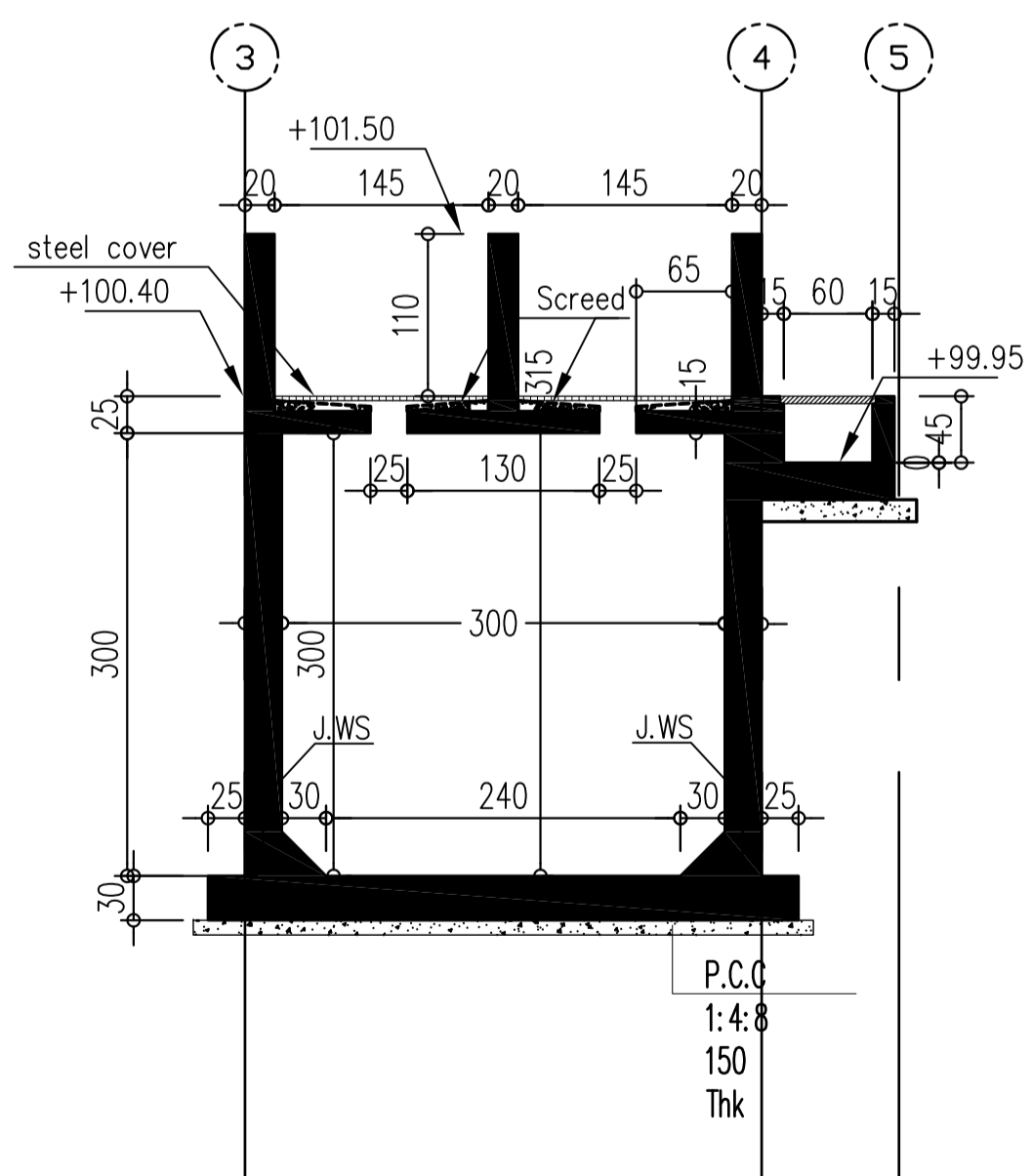
DATE	SCALE	SHEET No.	DRAWING No.
FEBRUARY 2021	1/250	1/1	2/17



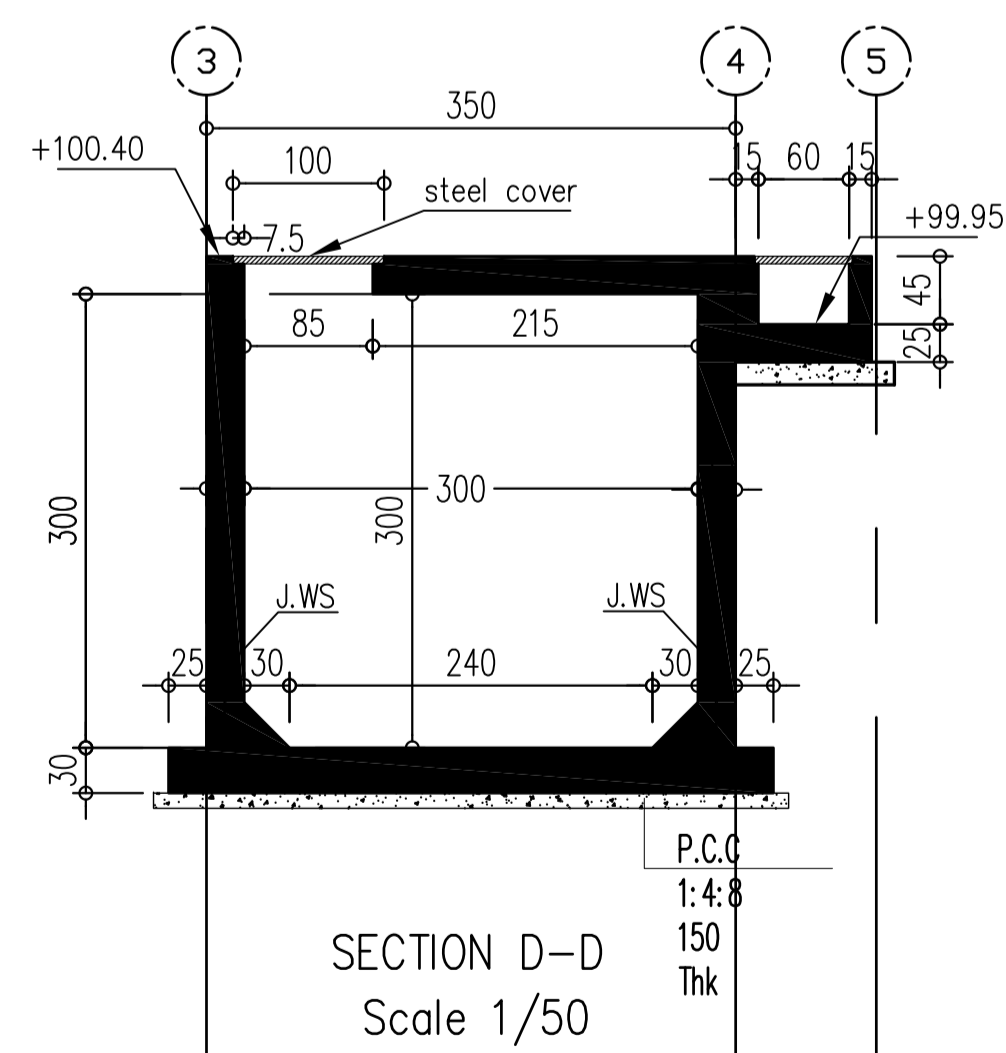
SECTION A-A
Scale 1/50



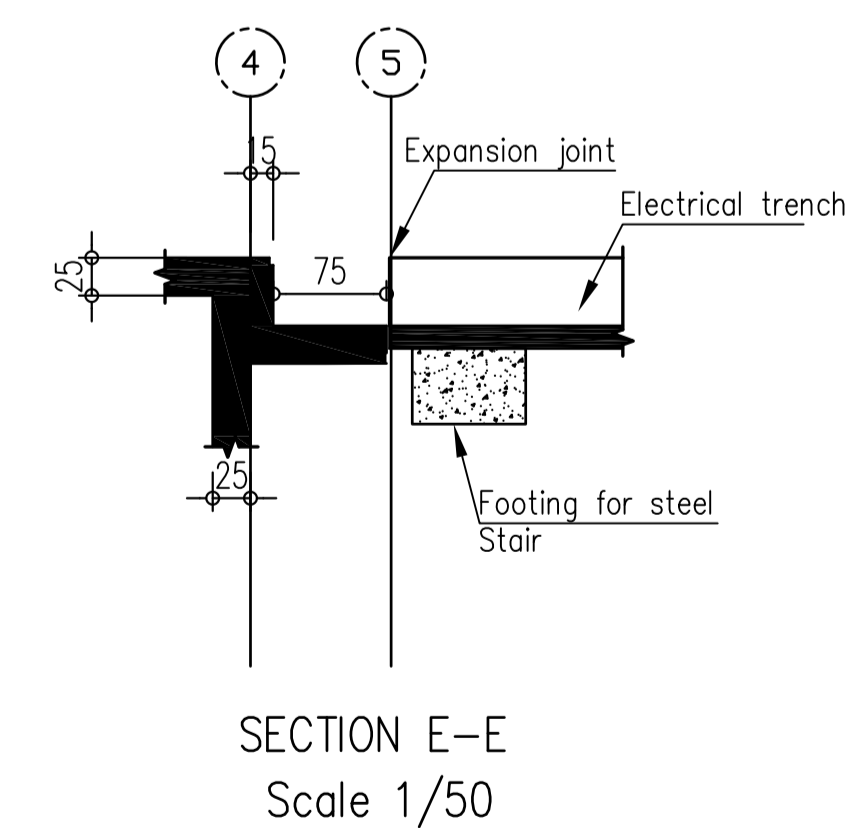
SECTION B-B
Scale 1/50



SECTION C-C
Scale 1/50



SECTION D-D
Scale 1/50



SECTION E-E
Scale 1/50

NOTES:

REINFORCED CONCRETE:
SULFATE RESISTING PORTLAND CEMENT.
Grade C30 : DOSING 400 Kg/m³ FOR CONCRETE
Grade C20 : DOSING 250 Kg/m³ FOR MASS CONCRETE/LEAN CONCRETE

STRESSES:
SEVERE CONTROL.
CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS:
- ON A CUBE, a= 150mm :37N/mm²
- ON A CYLINDER φ=150mm, h=300mm :30N/mm²

COVER:
THE CONCRETE COVER FOR ALL STEEL BARS INCLUDING STIRRUPS SHALL NOT BE LESS THAN:
50MM FOR ALL THE STRUCTURE

FORMWORK:
ALL CONCRETE FORMWORK IS SMOOTH FINISH FAIR-FACED.
THE USE OF φ6mm BARS AS TIE-RODS IS NOT ALLOWED.
HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.

WATERPROOFING:
- BITUMINOUS WATERPROOFING PAINT TO ALL UNDERGROUND CONCRETE SURFACES IN CONTACT WITH SOIL.
- INTERNAL TANK WALLS:
CEMENTITIOUS WATERPROOFING COMPOSED OF FLEXIBLE HIGH-PERFORMANCE CEMENT-BASED MESH-REINFORCED WATERPROOFING SYSTEM IN TWO COATS.
- BITUMINOUS MEMBRANE WATERPROOFING FOR ROOF SLAB.

EXCAVATION AND BEARING CAPACITY:
- THE ALLOWABLE BEARING CAPACITY IS 1 Kg/cm².
- THE DESIGN IS BASED ON THE BELOW ASSUMPTIONS:
- FOUNDATIONS ARE ANTICIPATED TO BE IN DRY AND NON-AGGRESSIVE CONDITIONS.
- THE FOUNDATIONS ARE RESTING ON THE MARL FORMATION, HAVING A MINIMUM MODULUS OF ELASTICITY OF 40,000 KPa.
- THE ABOVE ASSUMPTIONS ARE MADE WITHOUT A SITE SPECIFIC INVESTIGATION. THE CONTRACTOR SHALL ASSIGN AT HIS EXPENSES A GEOTECHNICIAN TO CARRY OUT SOIL INVESTIGATION AND VERIFY THE FOUNDATION DESIGN BASED ON THE SOIL REPORT PRIOR TO ANY CONSTRUCTION ACTIVITY AND RECTIFY THE DESIGN ACCORDINGLY. THE CONTRACTOR SHALL SUBMIT THE VERIFICATION/RECTIFICATION FOR THE FOUNDATION DESIGN ALONG WITH THE RELEVANT DOCUMENTS FOR EMPLOYER'S APPROVAL BEFORE CONSTRUCTION.

- EXCAVATION SUPPORTS AND PROTECTION SYSTEMS CAPABLE OF SAFELY RESISTING SOIL AND GROUNDWATER PRESSURE (IF APPLICABLE), SHALL BE DESIGNED, PROVIDED, INSTALLED, MONITORED AND MAINTAINED WHERE NEEDED FOR SUPPORTING THE SIDES OF THE EXCAVATION IN A MANNER ACCEPTED TO THE ENGINEER AT THE CONTRACTOR'S SOLE RISK AND RESPONSIBILITY. THE CONTRACTOR IS ALSO HELD RESPONSIBLE FOR REMOVING THE EXCAVATION SUPPORTS AND PROTECTION SYSTEMS WHEN NO LONGER NEEDED WITHOUT DISTURBING THE UNDERLYING UTILITIES, PAVEMENTS, ADJACENT STRUCTURES OR OTHER FACILITIES.

Rev.	Date	Dsgn	Drwn	Chk'd	Appr'd

REPUBLIC OF LEBANON



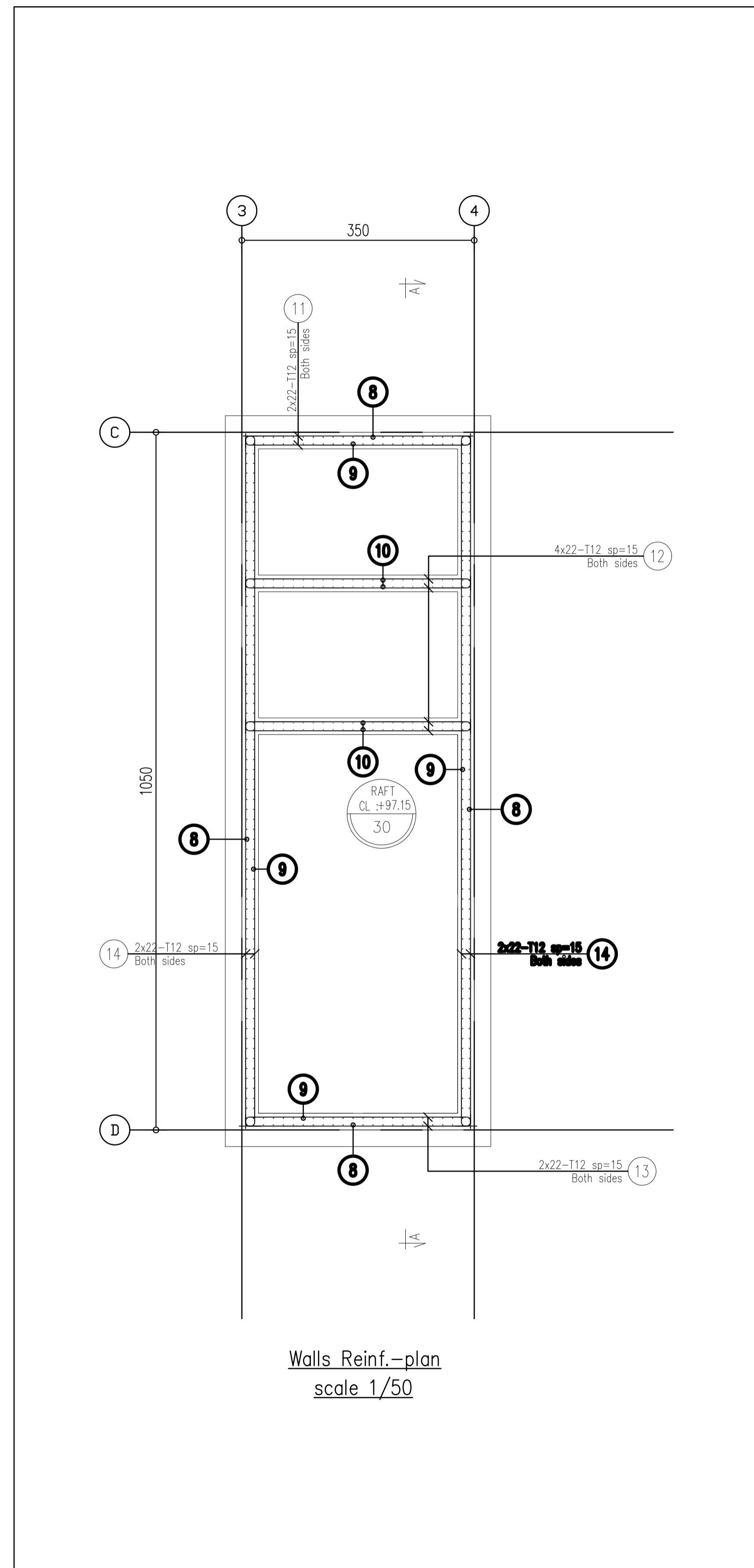
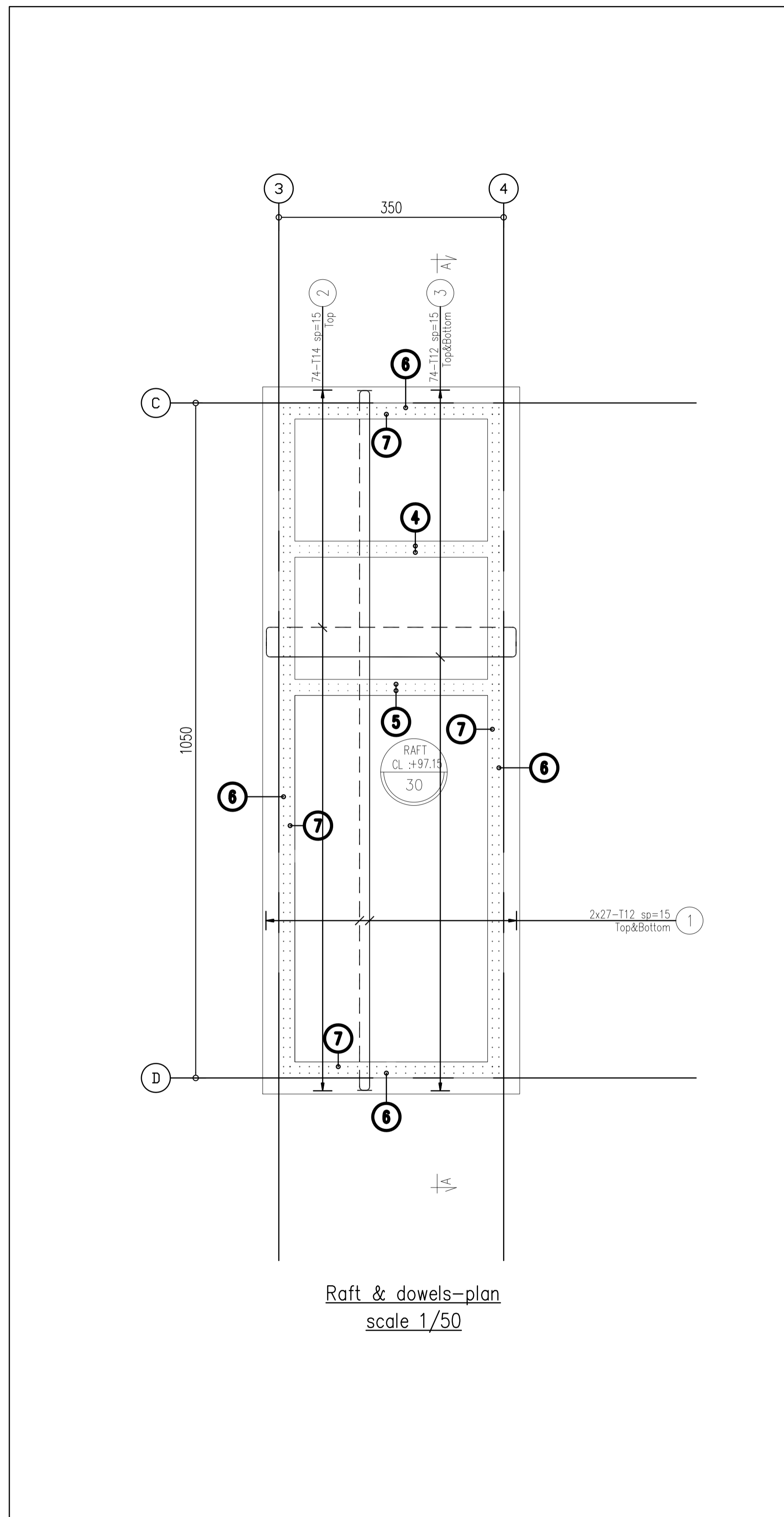
United Nations Children's Fund
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INSTALLATION WORKS OF THE
OMNI PROCESSOR AT IAAT WWTP

IAAT WASTEWATER PLANT	UNDERGROUND TANK SECTIONS FORMWORK
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FILE	DESIGNED BY	DRAWN BY	CHECKED BY
STR04	-	-	-

DATE	SCALE	SHEET No.	DRAWING No.
FEBRUARY 2021	1/50	1/1	4/17



- NOTES:**
- REINFORCED CONCRETE:
 - SULFATE RESISTING PORTLAND CEMENT.
 - Grade C30 : DOSING 400 Kg/m³ FOR CONCRETE
 - Grade C20 : DOSING 250 Kg/m³ FOR MASS CONCRETE/LEAN CONCRETE
 - STRESSES:
 - SEVERE CONTROL.
 - CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS:
 - ON A CUBE, $\sigma_c = 150\text{mm}$
 - ON A CYLINDER $\phi=150\text{mm}$, $h=300\text{mm}$:30N/mm²
 - COVER:
 - THE CONCRETE COVER FOR ALL STEEL BARS INCLUDING STIRRUPS SHALL NOT BE LESS THAN:
 - 50MM FOR ALL THE STRUCTURE
 - FORMWORK:
 - ALL CONCRETE FORMWORK IS SMOOTH FINISH FAIR-FACED.
 - THE USE OF $\phi 6\text{mm}$ BARS AS TIE-RODS IS NOT ALLOWED.
 - HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.
 - WATERPROOFING:
 - BITUMIOUS WATERPROOFING PAINT TO ALL UNDERGROUND CONCRETE SURFACES IN CONTACT WITH SOIL
 - INTERNAL TANK WALLS:
 - CEMENTITIOUS WATERPROOFING COMPOSED OF FLEXIBLE HIGH-PERFORMANCE CEMENT-BASED MESH-REINFORCED WATERPROOFING SYSTEM IN TWO COATS.
 - BITUMINOUS MEMBRANE WATERPROOFING FOR ROOF SLAB.
 - EXCAVATION AND BEARING CAPACITY:
 - THE ALLOWABLE BEARING CAPACITY IS 1 Kg/cm².
 - THE DESIGN IS BASED ON THE BELOW ASSUMPTIONS:
 - FOUNDATIONS ARE ANTICIPATED TO BE IN DRY AND NON-AGGRESSIVE CONDITIONS.
 - THE FOUNDATIONS ARE RESTING ON THE MARL FORMATION, HAVING A MINIMUM MODULUS OF ELASTICITY OF 40,000 KPa.
 - THE ABOVE ASSUMPTIONS ARE MADE WITHOUT A SITE SPECIFIC INVESTIGATION. THE CONTRACTOR SHALL ASSIGN AT HIS EXPENSES A GEOTECHNICIAN TO CARRY OUT SOIL INVESTIGATION AND VERIFY THE FOUNDATION DESIGN BASED ON THE SOIL REPORT PRIOR TO ANY CONSTRUCTION ACTIVITY AND RECTIFY THE DESIGN ACCORDINGLY. THE CONTRACTOR SHALL SUBMIT THE VERIFICATION/RECTIFICATION FOR THE FOUNDATION DESIGN ALONG WITH THE RELEVANT DOCUMENTS FOR EMPLOYER'S APPROVAL BEFORE CONSTRUCTION.
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Rev.	Date	Dsgn	Drwn	Chk'd	Appr'd

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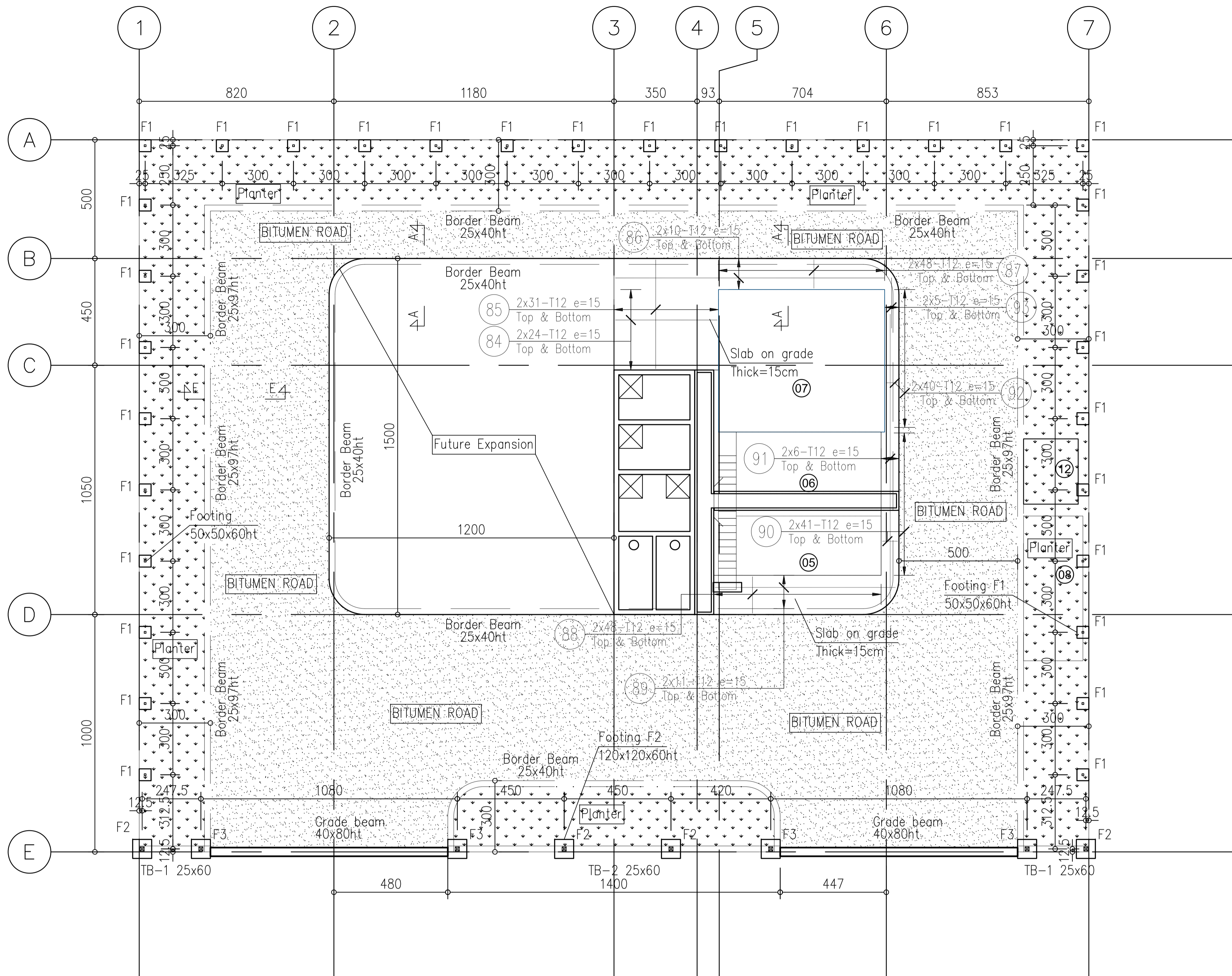
United Nations Children's Fund
(UNICEF)

INSTALLATION WORKS OF THE
OMNI PROCESSOR AT IAAT WWTP

IAAT WASTEWATER TREATMENT PLANT	UNDERGROUND TANK REINFORCEMENT (1)
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FILE	DESIGNED BY	DRAWN BY	CHECKED BY
STR05	-	-	-

DATE	SCALE	SHEET No.	DRAWING No.
FEBRUARY 2021	1/50	1/1	5/17



NOTES:

REINFORCED CONCRETE:
 SULFATE RESISTING PORTLAND CEMENT.
 Grade C30 : DOSING 400 Kg/m³ FOR CONCRETE
 Grade C20 : DOSING 250 Kg/m³ FOR MASS CONCRETE/LEAN CONCRETE

STRESSES:
 SEVERE CONTROL.
 CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS:
 - ON A CUBE, $\phi = 150\text{mm}$
 - ON A CYLINDER $\phi = 150\text{mm}$, $h = 300\text{mm}$:30N/mm²

COVER:
 THE CONCRETE COVER FOR ALL STEEL BARS INCLUDING STIRRUPS SHALL NOT BE LESS THAN:
 50MM FOR ALL THE STRUCTURE

FORMWORK:
 ALL CONCRETE FORMWORK IS SMOOTH FINISH FAIR-FACED.
 THE USE OF $\phi 6\text{mm}$ BARS AS TIE-RODS IS NOT ALLOWED.
 HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.

WATERPROOFING:
 - BITUMINOUS WATERPROOFING PAINT TO ALL UNDERGROUND CONCRETE SURFACES IN CONTACT WITH SOIL
 - INTERNAL TANK WALLS:
 CEMENTITIOUS WATERPROOFING COMPOSED OF FLEXIBLE HIGH-PERFORMANCE CEMENT-BASED MESH-REINFORCED WATERPROOFING SYSTEM IN TWO COATS.
 - BITUMINOUS MEMBRANE WATERPROOFING FOR ROOF SLAB.

EXCAVATION AND BEARING CAPACITY:
 - THE ALLOWABLE BEARING CAPACITY IS 1 Kg/cm².
 - THE DESIGN IS BASED ON THE BELOW ASSUMPTIONS:
 - FOUNDATIONS ARE ANTICIPATED TO BE IN DRY AND NON-AGGRESSIVE CONDITIONS.
 - THE FOUNDATIONS ARE RESTING ON THE MARL FORMATION, HAVING A MINIMUM MODULUS OF ELASTICITY OF 40,000 KPa.
 - THE ABOVE ASSUMPTIONS ARE MADE WITHOUT A SITE SPECIFIC INVESTIGATION. THE CONTRACTOR SHALL ASSIGN AT HIS EXPENSES A GEOTECHNICIAN TO CARRY OUT SOIL INVESTIGATION AND VERIFY THE FOUNDATION DESIGN BASED ON THE SOIL REPORT PRIOR TO ANY CONSTRUCTION ACTIVITY AND RECTIFY THE DESIGN ACCORDINGLY. THE CONTRACTOR SHALL SUBMIT THE VERIFICATION/RECTIFICATION FOR THE FOUNDATION DESIGN ALONG WITH THE RELEVANT DOCUMENTS FOR EMPLOYER'S APPROVAL BEFORE CONSTRUCTION.

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Rev.	Date	Dsgn	Drwn	Chk'd	Appr'd

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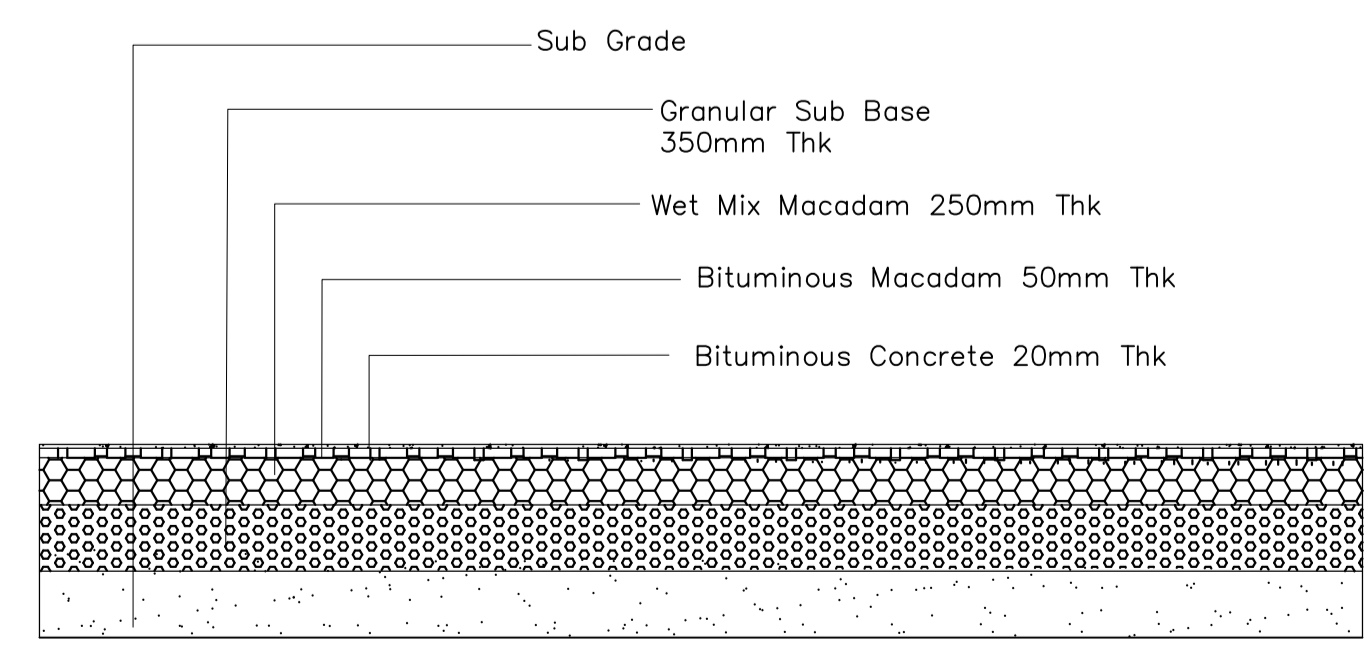
United Nations Children's Fund
(UNICEF)

INSTALLATION WORKS OF THE
OMNI PROCESSOR AT IAAT WWTP

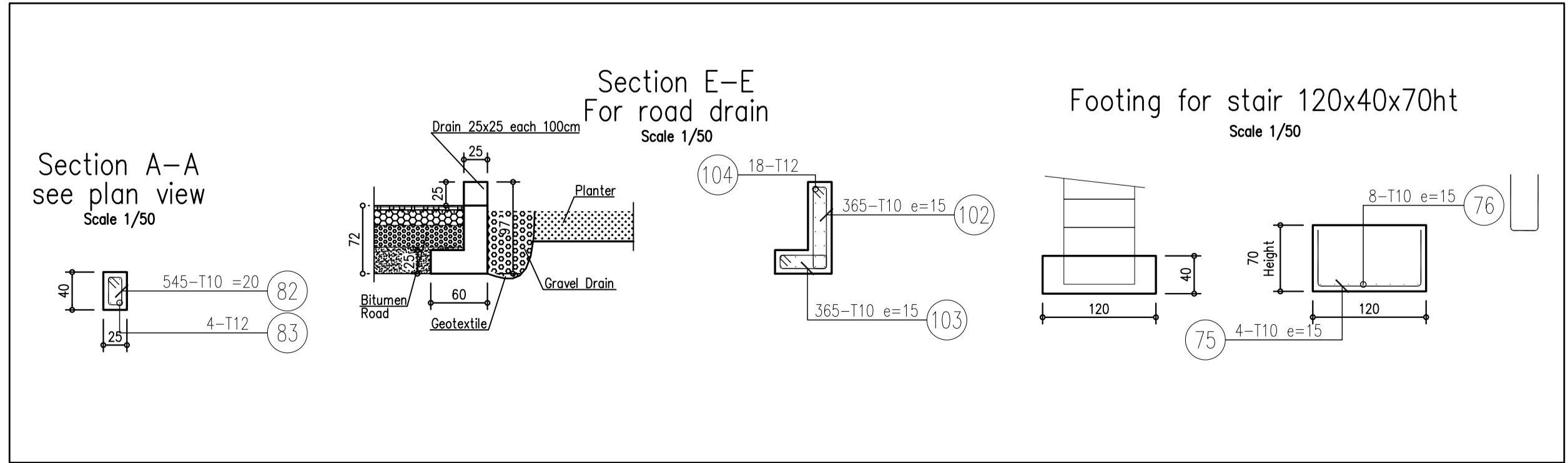
IAAT WASTEWATER TREATMENT PLANT	SLAB ON GRADE REINFORCEMENT
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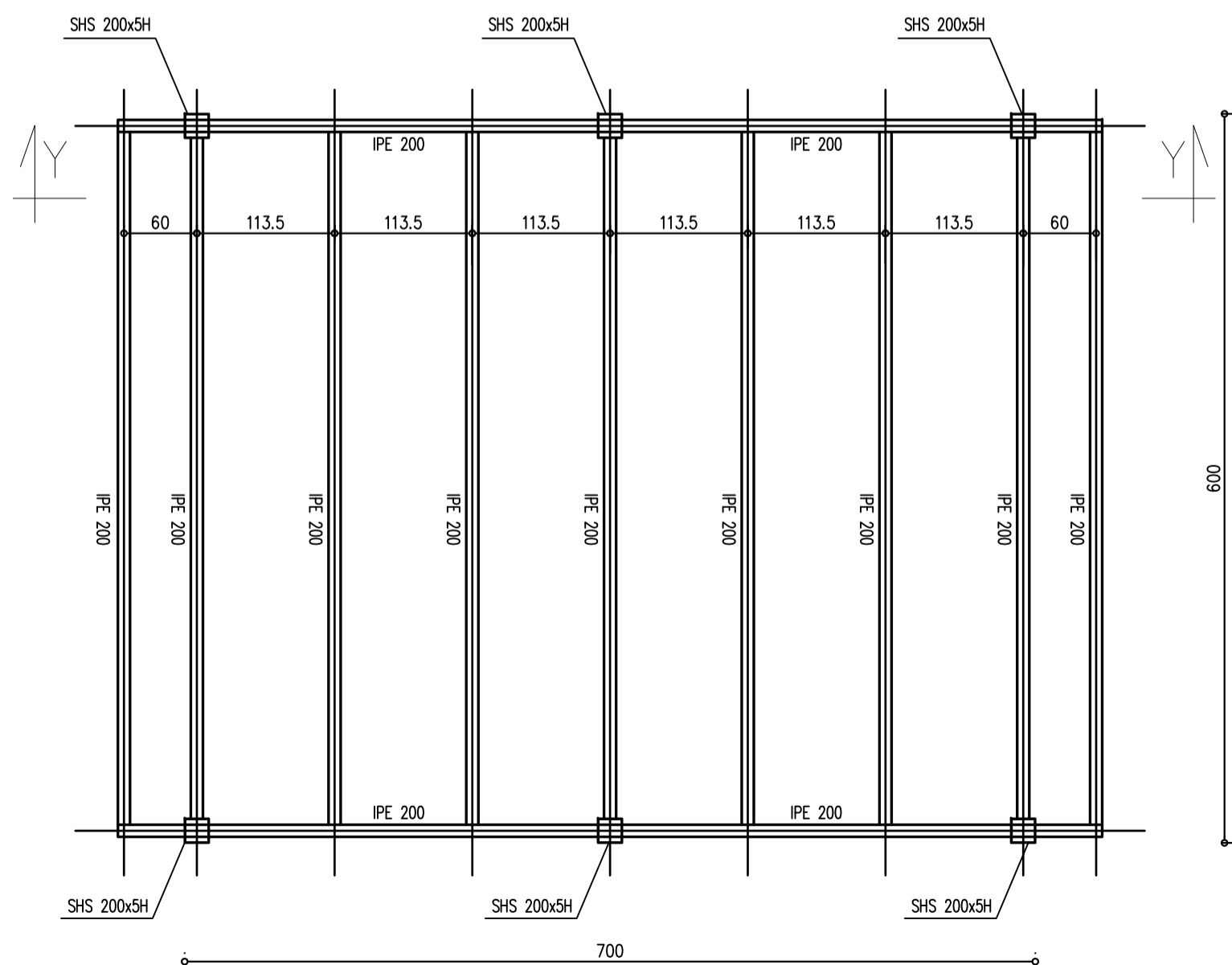
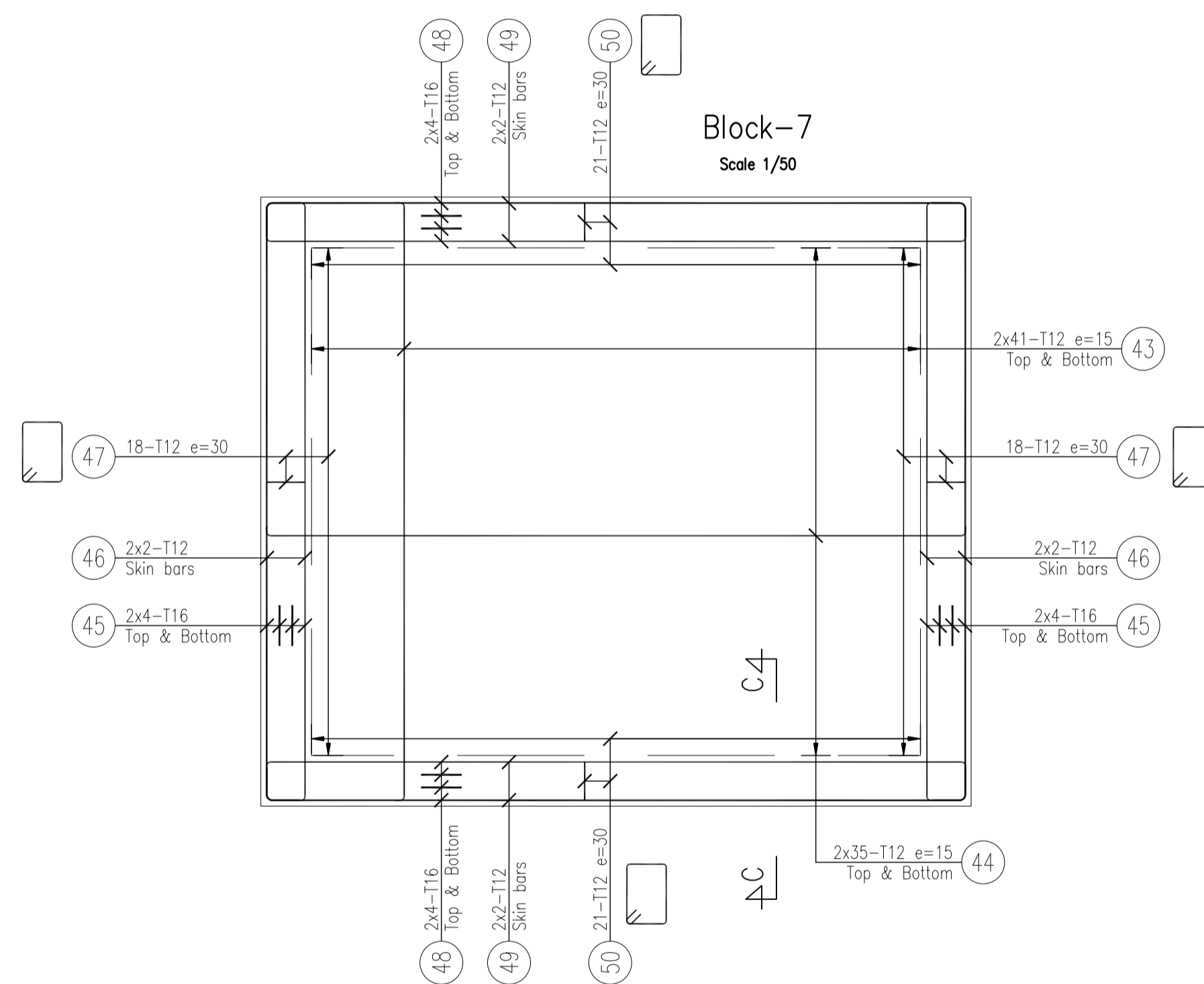
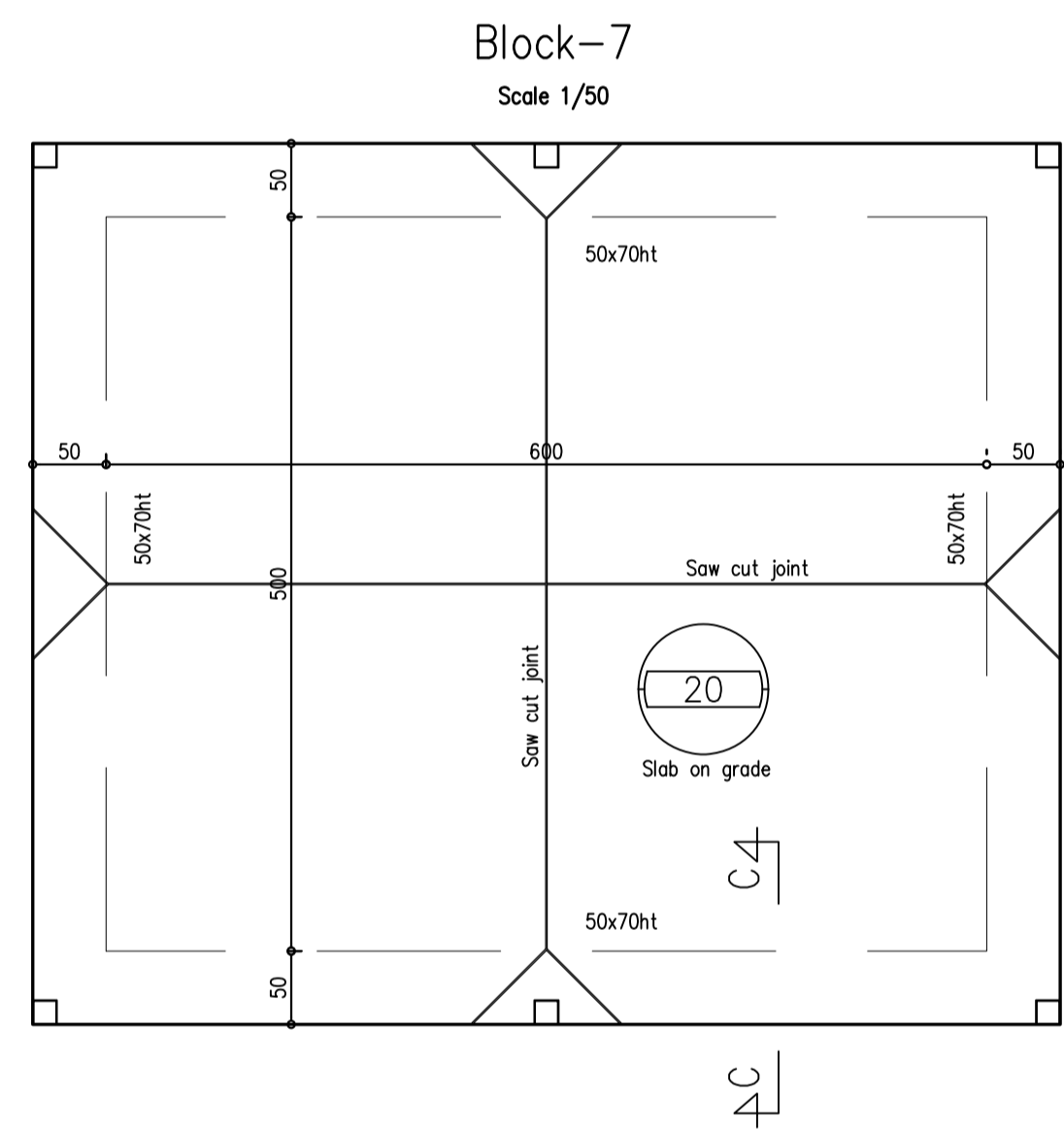
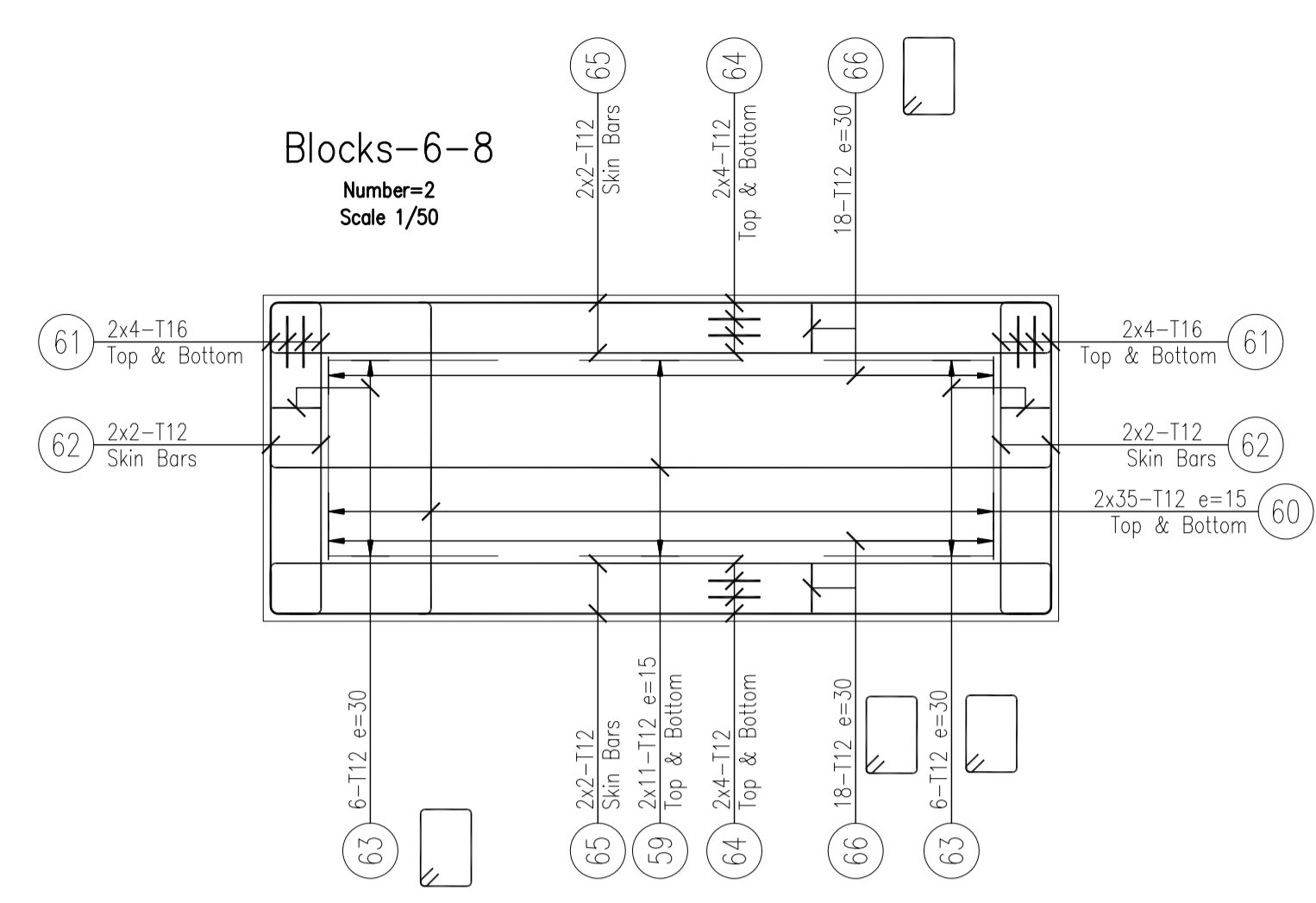
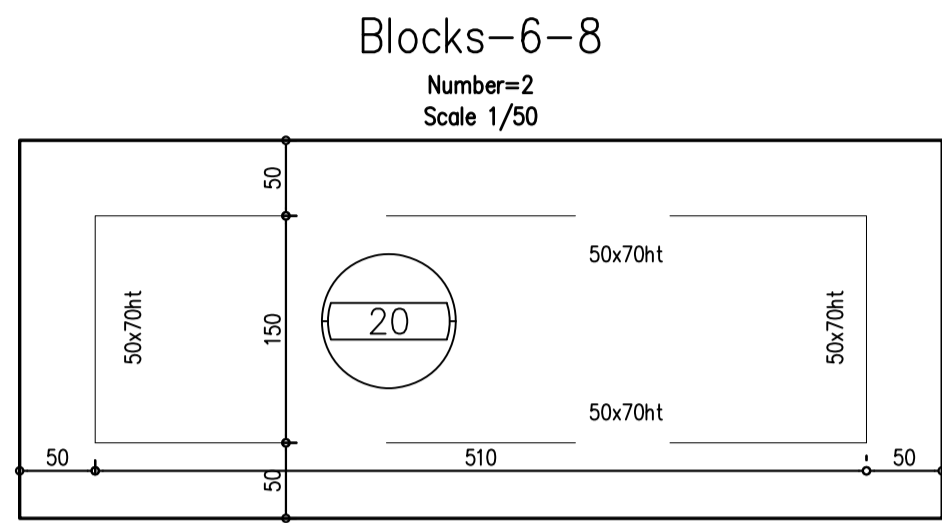
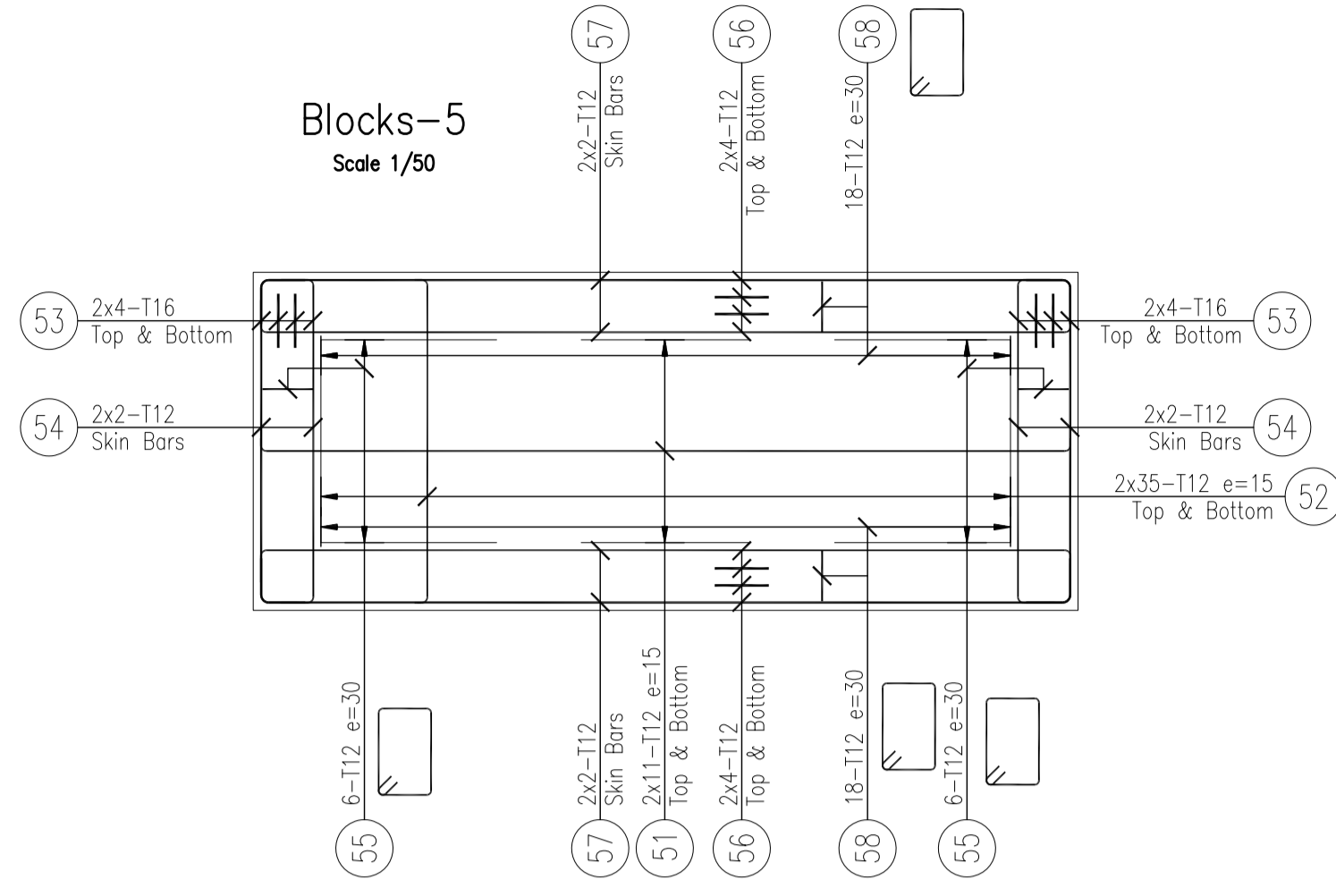
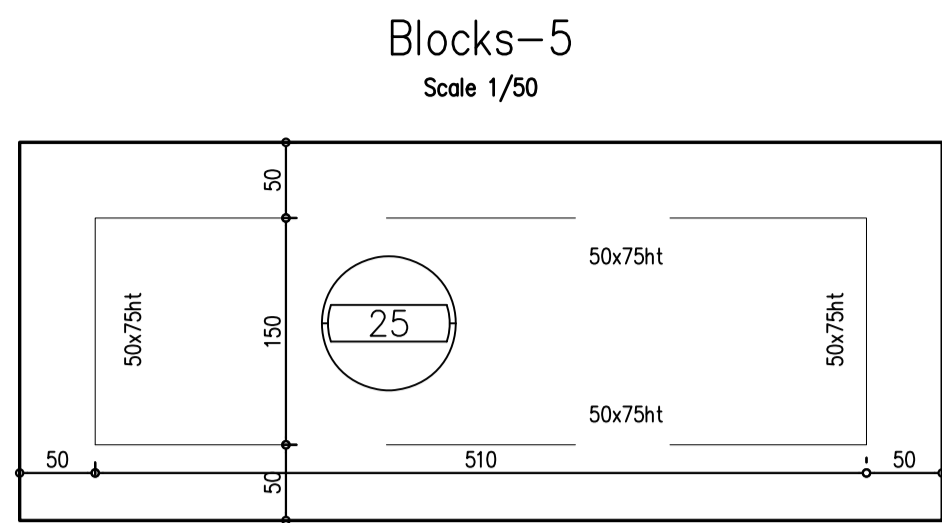
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STR08	-	-	-

DATE	SCALE	SHEET No.	DRAWING No.
FEBRUARY 2021	1/100	1/1	08/17

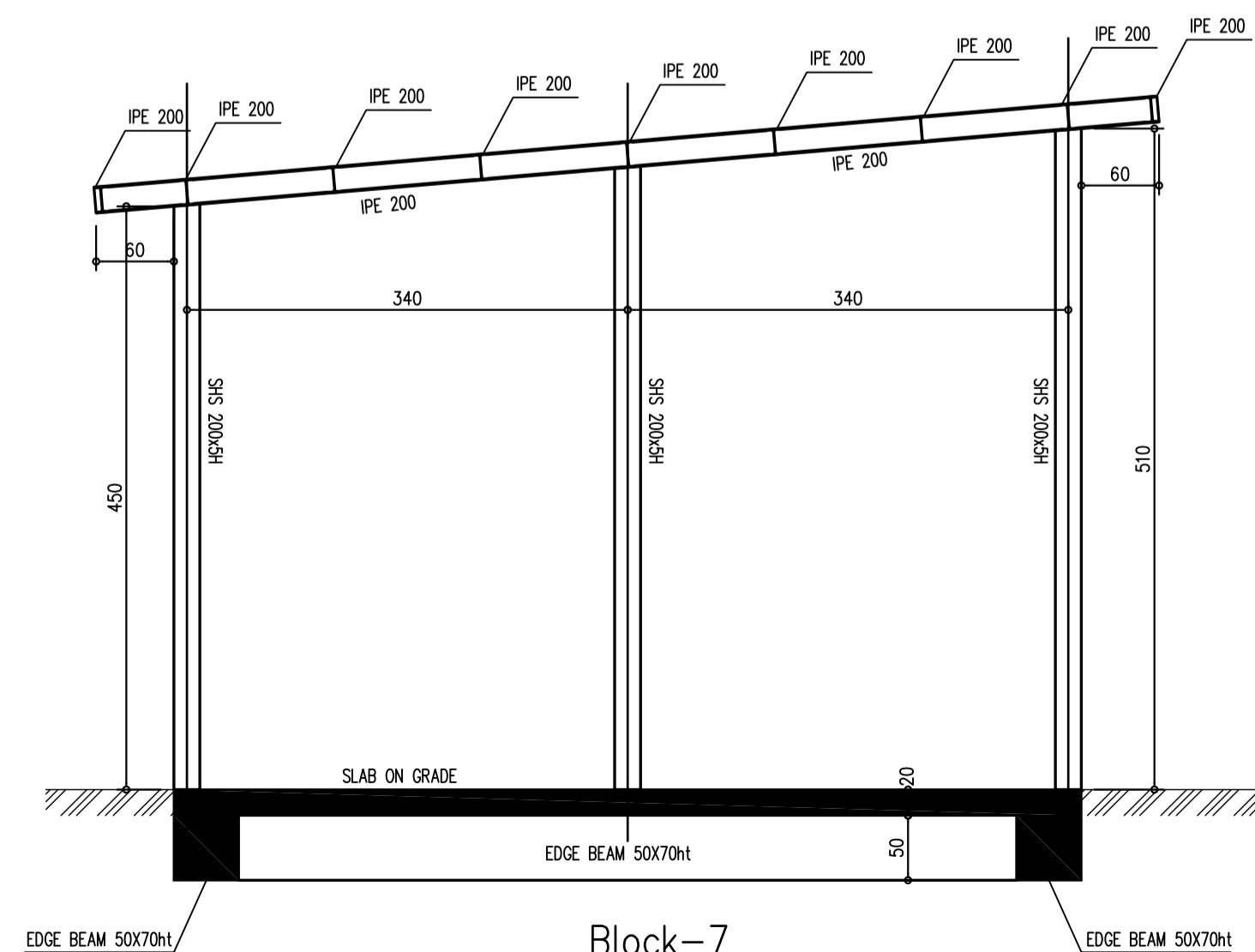


TYPICAL CROSS SECTION OF BITUMEN ROAD

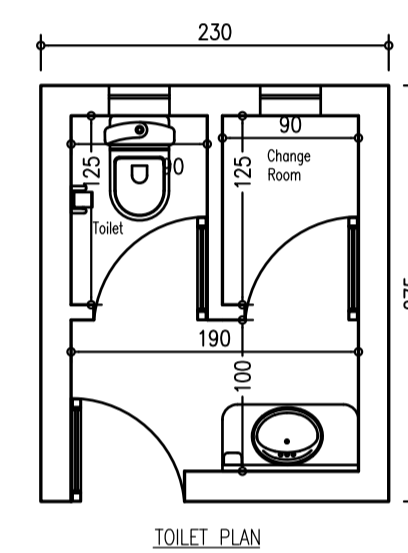




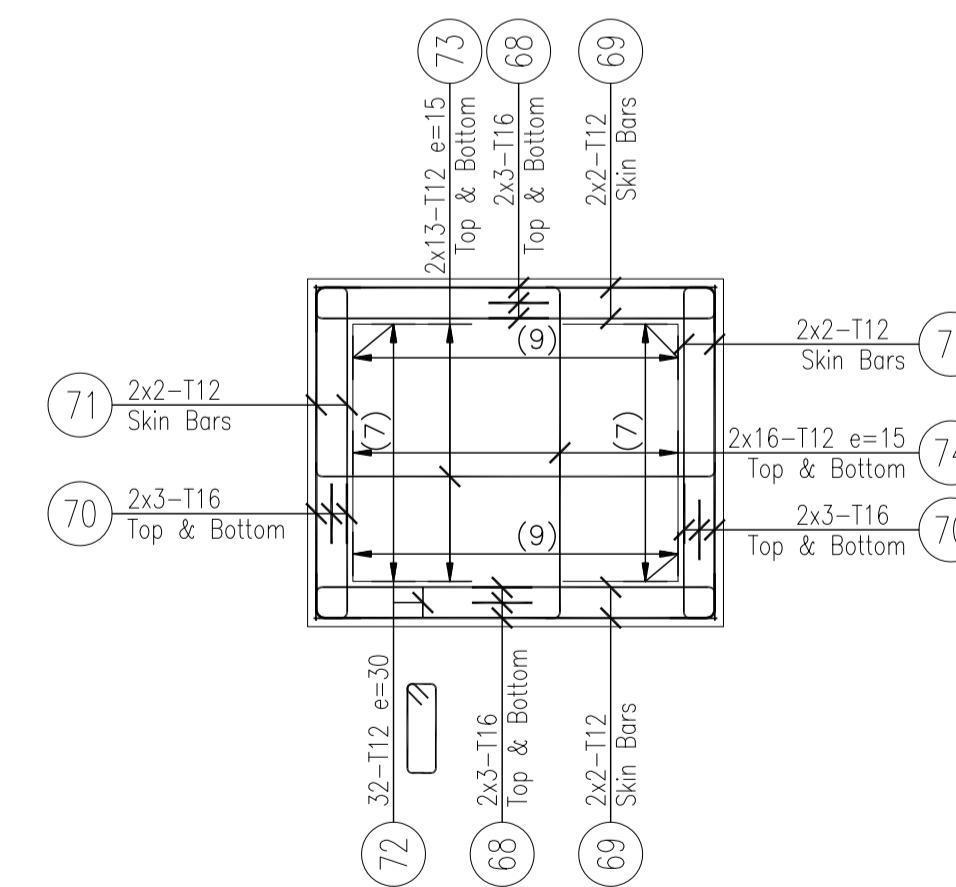
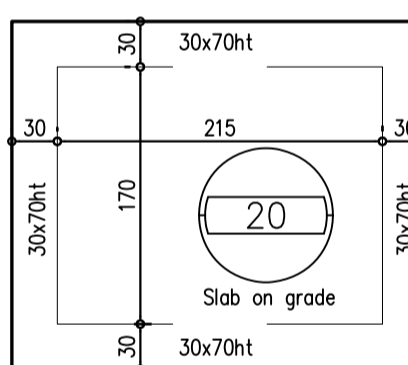
Block-7
MATERIAL STORAGE SHED
Scale 1/50



Block-7
SECTION Y-Y
Scale 1/50



Block-12 et Toilet
Number=2
Scale 1/50



NOTES:

REINFORCED CONCRETE:
SULFATE RESISTING PORTLAND CEMENT.
Grade C30 : DOSING 400 Kg/m³ FOR CONCRETE
Grade C20 : DOSING 250 Kg/m³ FOR MASS CONCRETE/LEAN CONCRETE

STRESSES:

SEVERE CONTROL.
CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS:
- ON A CUBE, $\phi = 150\text{mm}$
- ON A CYLINDER $\phi = 150\text{mm}$, $h = 300\text{mm}$: 37N/mm²

COVER:

THE CONCRETE COVER FOR ALL STEEL BARS INCLUDING STIRRUPS SHALL NOT BE LESS THAN:
50MM FOR ALL THE STRUCTURE

FORMWORK:

ALL CONCRETE FORMWORK IS SMOOTH FINISH FAIR-FACED.
THE USE OF $\phi 6\text{mm}$ BARS AS TIE-RODS IS NOT ALLOWED.
HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.

WATERPROOFING:

- BITUMINOUS WATERPROOFING PAINT TO ALL UNDERGROUND CONCRETE SURFACES IN CONTACT WITH SOIL
- INTERNAL TANK WALLS:
CEMENTITIOUS WATERPROOFING COMPOSED OF FLEXIBLE HIGH-PERFORMANCE CEMENT-BASED MESH-REINFORCED WATERPROOFING SYSTEM IN TWO COATS.
- BITUMINOUS MEMBRANE WATERPROOFING FOR ROOF SLAB.

EXCAVATION AND BEARING CAPACITY:

- THE ALLOWABLE BEARING CAPACITY IS 1 Kg/cm².
- THE DESIGN IS BASED ON THE BELOW ASSUMPTIONS:
- FOUNDATIONS ARE ANTICIPATED TO BE IN DRY AND NON-AGGRESSIVE CONDITIONS.
- THE FOUNDATIONS ARE RESTING ON THE MARL FORMATION, HAVING A MINIMUM MODULUS OF ELASTICITY OF 40,000 KPa.

- THE ABOVE ASSUMPTIONS ARE MADE WITHOUT A SITE SPECIFIC INVESTIGATION. THE CONTRACTOR SHALL ASSIGN AT HIS EXPENSES A GEOTECHNICIAN TO CARRY OUT SOIL INVESTIGATION AND VERIFY THE FOUNDATION DESIGN BASED ON THE SOIL REPORT PRIOR TO ANY CONSTRUCTION ACTIVITY AND RECTIFY THE DESIGN ACCORDINGLY. THE CONTRACTOR SHALL SUBMIT THE VERIFICATION/RECTIFICATION FOR THE FOUNDATION DESIGN ALONG WITH THE RELEVANT DOCUMENTS FOR EMPLOYER'S APPROVAL BEFORE CONSTRUCTION.

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Rev.	Date	Dsgn	Drawn	Chk'd	Appr'd

REPUBLIC OF LEBANON



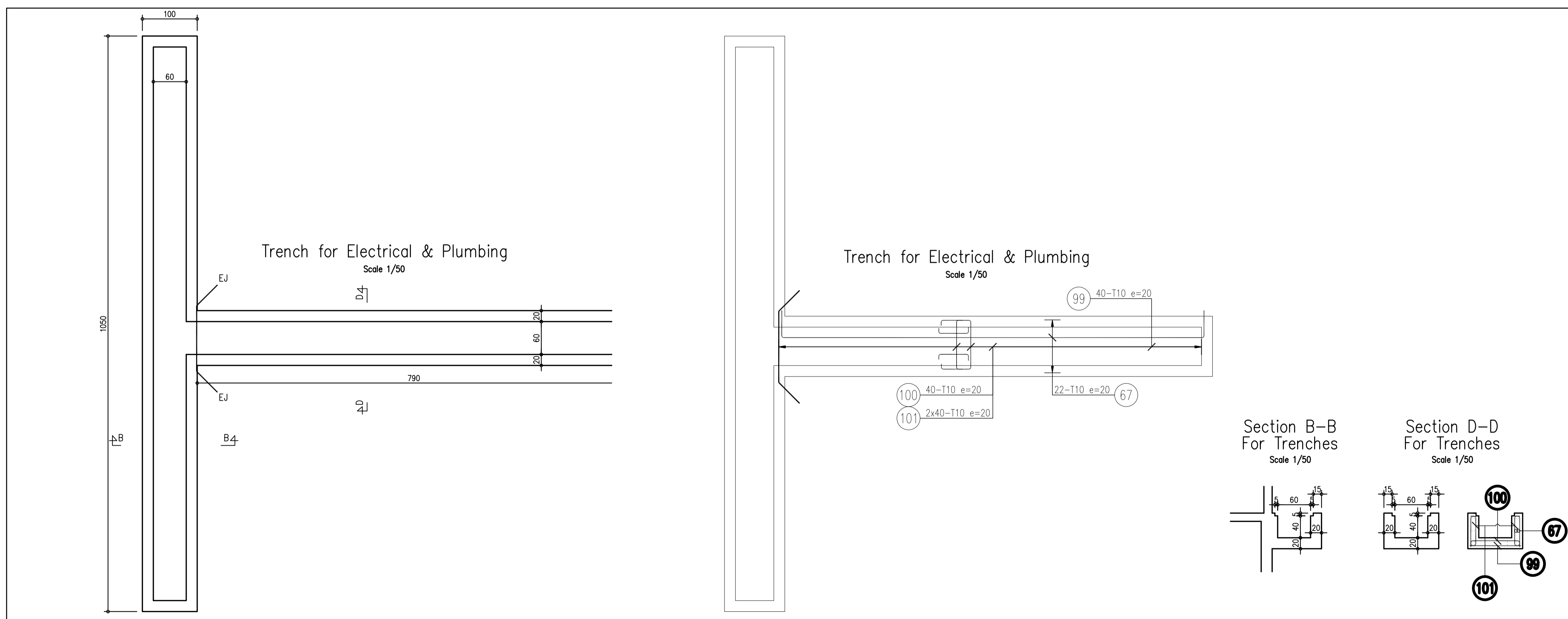
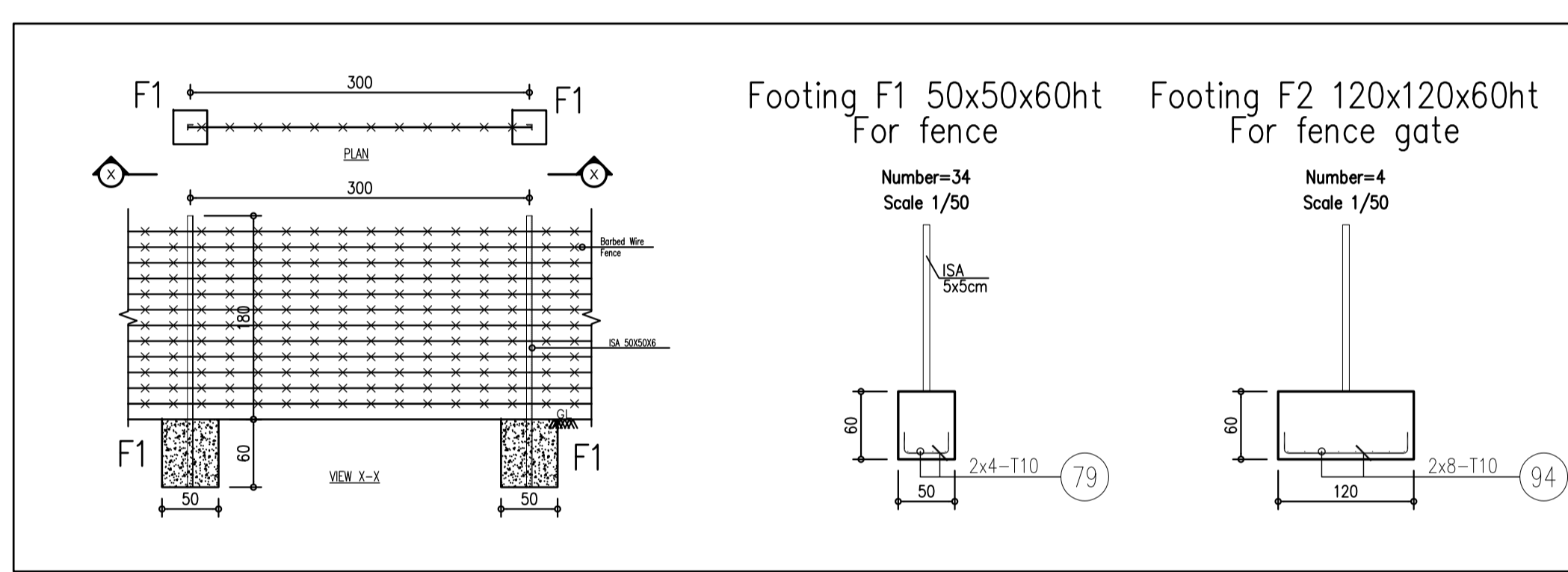
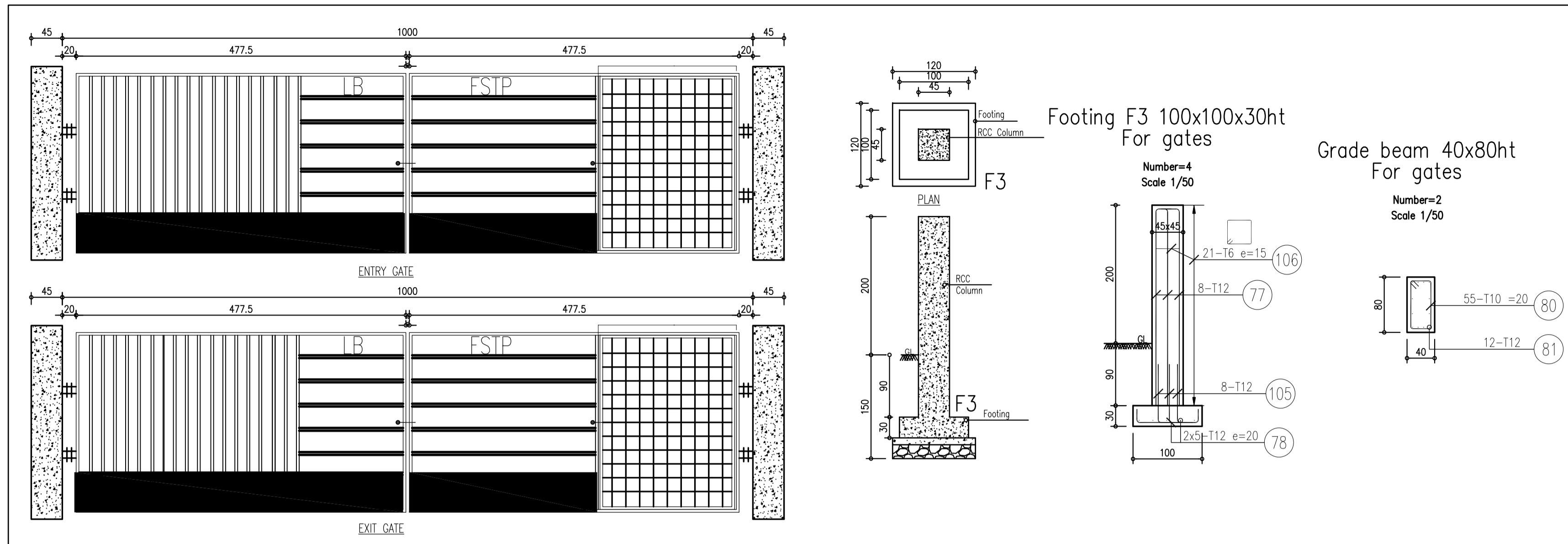
United Nations Children's Fund
(UNICEF)

INSTALLATION WORKS OF THE
OMNI PROCESSOR AT IAAT WWTP

IAAT WASTEWATER TREATMENT PLANT	BLOCKS 5, 6, 7, 8, 12 AND TOILET FORMWORK & REINFORCEMENT
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FILE	DESIGNED BY	DRAWN BY	CHECKED BY
STR09	-	-	-

DATE	SCALE	SHEET No.	DRAWING No.
FEBRUARY 2021	1/50	1/1	09/17



NOTES:

REINFORCED CONCRETE:
 SULFATE RESISTING PORTLAND CEMENT.
 Grade C30 : DOSING 400 Kg/m³ FOR CONCRETE
 Grade C20 : DOSING 250 Kg/m³ FOR MASS CONCRETE/LEAN CONCRETE

STRESSES:
 SEVERE CONTROL.
 CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS:
 - ON A CUBE, $\sigma_c = 150\text{N/mm}^2$
 - ON A CYLINDER $\sigma_c = 100\text{N/mm}^2$

COVER:
 THE CONCRETE COVER FOR ALL STEEL BARS INCLUDING STIRRUPS SHALL NOT BE LESS THAN:
 50MM FOR ALL THE STRUCTURE

FORMWORK:
 ALL CONCRETE FORMWORK IS SMOOTH FINISH FAIR-FACED.
 THE USE OF $\phi 6\text{mm}$ BARS AS TIE-RODS IS NOT ALLOWED.
 HOLES MADE BY TIE-RODS SHALL BE FILLED WITH A NON SHRINK GROUT BY MEANS OF SPECIAL INJECTION METHODS.

WATERPROOFING:
 - BITUMINOUS WATERPROOFING PAINT TO ALL UNDERGROUND CONCRETE SURFACES IN CONTACT WITH SOIL
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 - BITUMINOUS MEMBRANE WATERPROOFING FOR ROOF SLAB.

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Rev.	Date	Dsgn	Drwn	Chk'd	Appr'd

REPUBLIC OF LEBANON



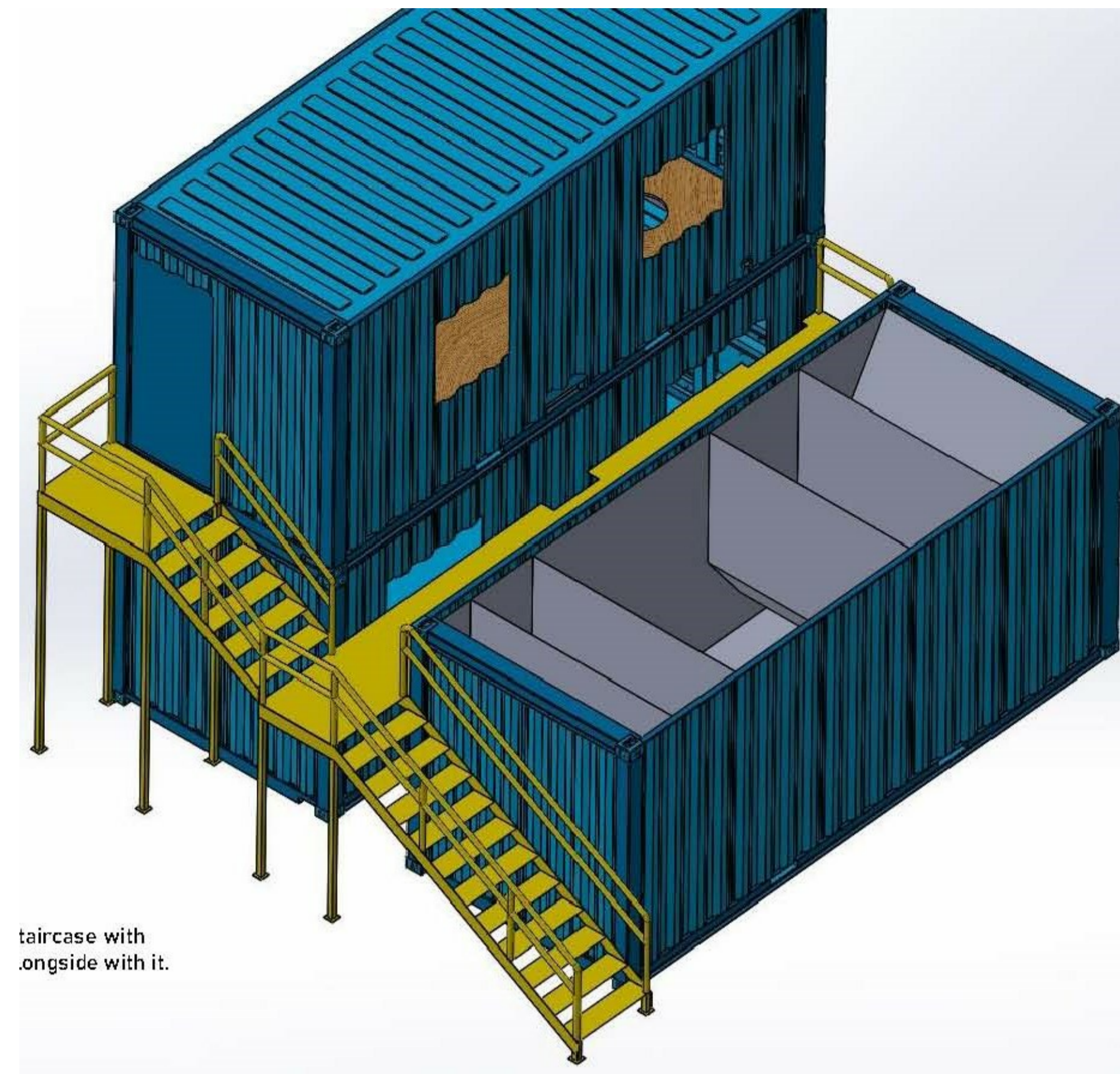
United Nations Children's Fund
(UNICEF)

INSTALLATION WORKS OF THE
OMNI PROCESSOR AT IAAT WWTP

IAAT WASTEWATER TREATMENT PLANT	FENCE, FOOTINGS, GRADE BEAM AND TRENCH REINFORCEMENT
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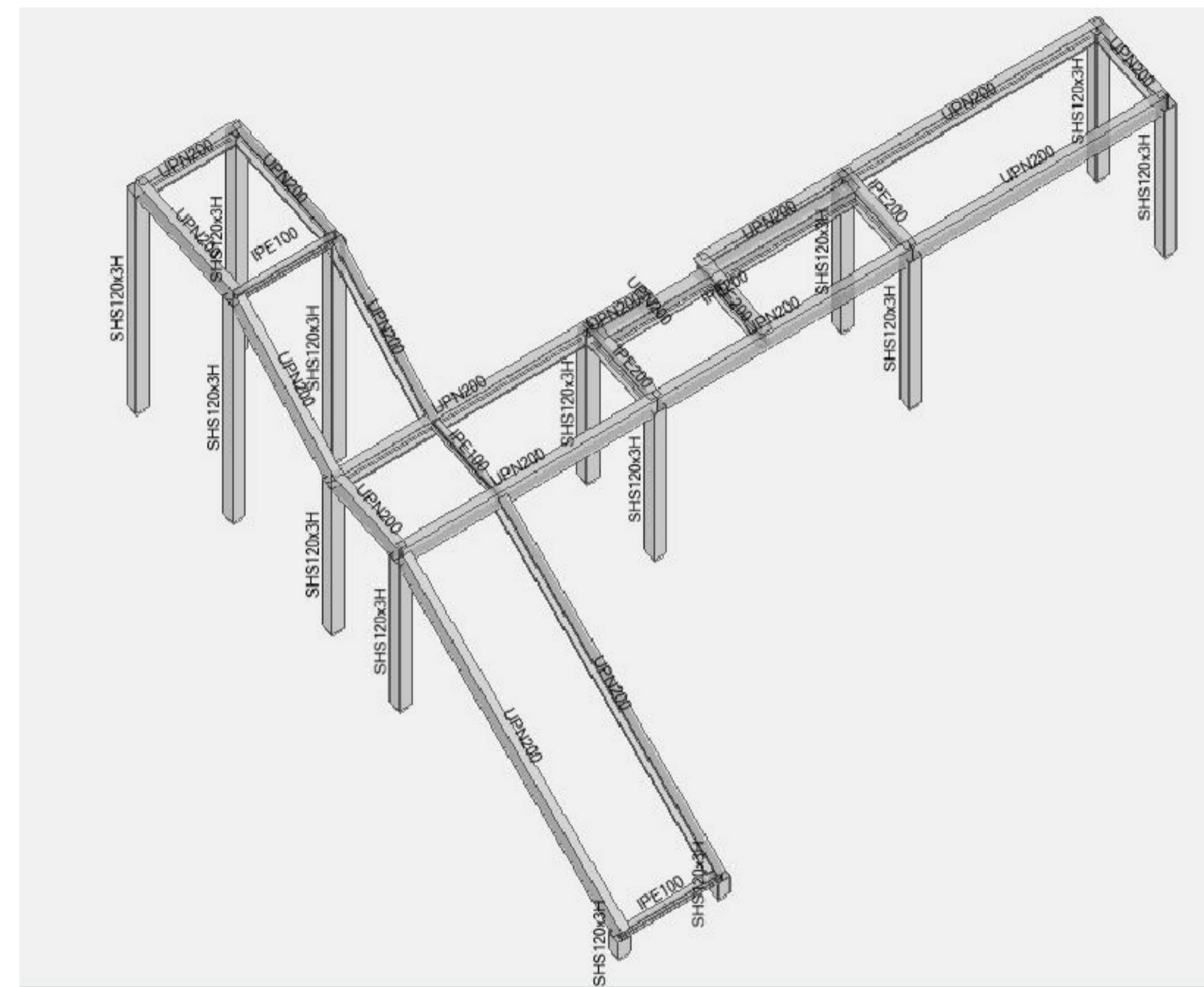
FILE	DESIGNED BY	DRAWN BY	CHECKED BY
STR10	-	-	-

DATE	SCALE	SHEET No.	DRAWING No.
FEBRUARY 2021	1/50	1/1	10/17



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STEEL STAIRCASE 3D VIEW



STEEL STAIRCASE STRUCTURE

NOTES:

REINFORCED CONCRETE:
SULFATE RESISTING PORTLAND CEMENT.
Grade C30 : DOSING 400 Kg/m³ FOR CONCRETE
Grade C20 : DOSING 250 Kg/m³ FOR MASS CONCRETE/LEAN CONCRETE

STRESSES:
SEVERE CONTROL.
CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS:
- ON A CUBE, $\phi=150\text{mm}$: 37N/mm^2
- ON A CYLINDER $\phi=150\text{mm}$, $h=300\text{mm}$: 30N/mm^2

COVER:
THE CONCRETE COVER FOR ALL STEEL BARS INCLUDING STIRRUPS SHALL NOT BE LESS THAN:
50MM FOR ALL THE STRUCTURE

FORMWORK:
ALL CONCRETE FORMWORK IS SMOOTH FINISH FAIR-FACED.
THE USE OF $\phi 6\text{mm}$ BARS AS TIE-RODS IS NOT ALLOWED.
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WATERPROOFING:
- BITUMIOUS WATERPROOFING PAINT TO ALL UNDERGROUND CONCRETE SURFACES IN CONTACT WITH SOIL
- INTERNAL TANK WALLS:
CEMENTITIOUS WATERPROOFING COMPOSED OF FLEXIBLE HIGH-PERFORMANCE CEMENT-BASED MESH-REINFORCED WATERPROOFING SYSTEM IN TWO COATS.
- BITUMINOUS MEMBRANE WATERPROOFING FOR ROOF SLAB.

EXCAVATION AND BEARING CAPACITY:
- THE ALLOWABLE BEARING CAPACITY IS 1 Kg/cm².
- THE DESIGN IS BASED ON THE BELOW ASSUMPTIONS:
- FOUNDATIONS ARE ANTICIPATED TO BE IN DRY AND NON-AGGRESSIVE CONDITIONS.
- THE FOUNDATIONS ARE RESTING ON THE MARL FORMATION, HAVING A MINIMUM MODULUS OF ELASTICITY OF 40,000 KPa.

- THE ABOVE ASSUMPTIONS ARE MADE WITHOUT A SITE SPECIFIC INVESTIGATION. THE CONTRACTOR SHALL ASSIGN AT HIS EXPENSES A GEOTECHNICIAN TO CARRY OUT SOIL INVESTIGATION AND VERIFY THE FOUNDATION DESIGN BASED ON THE SOIL REPORT PRIOR TO ANY CONSTRUCTION ACTIVITY AND RECTIFY THE DESIGN ACCORDINGLY. THE CONTRACTOR SHALL SUBMIT THE VERIFICATION/RECTIFICATION FOR THE FOUNDATION DESIGN ALONG WITH THE RELEVANT DOCUMENTS FOR EMPLOYER'S APPROVAL BEFORE CONSTRUCTION.

- EXCAVATION SUPPORTS AND PROTECTION SYSTEMS CAPABLE OF SAFELY RESISTING SOIL AND GROUNDWATER PRESSURE (IF APPLICABLE), SHALL BE DESIGNED, PROVIDED, INSTALLED, MONITORED AND MAINTAINED WHERE NEEDED FOR SUPPORTING THE SIDES OF THE EXCAVATION IN A MANNER ACCEPTED TO THE ENGINEER AT THE CONTRACTOR'S SOLE RISK AND RESPONSIBILITY. THE CONTRACTOR IS ALSO HELD RESPONSIBLE FOR REMOVING THE EXCAVATION SUPPORTS AND PROTECTION SYSTEMS WHEN NO LONGER NEEDED WITHOUT DISTURBING THE UNDERLYING UTILITIES, PAVEMENTS, ADJACENT STRUCTURES OR OTHER FACILITIES.

Rev.	Date	Dsgn	Drwn	Chk'd	Appr'd

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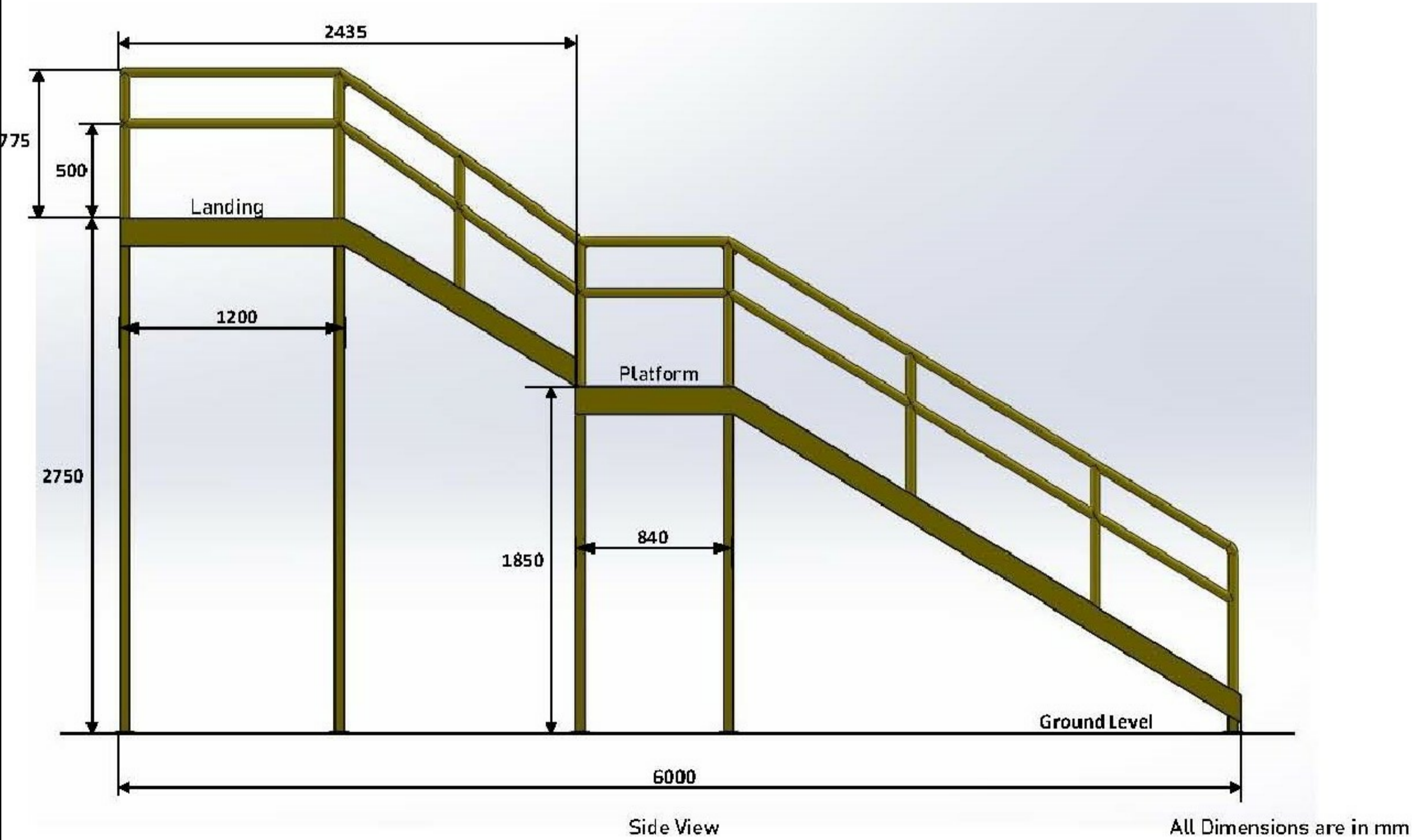
United Nations Children's Fund
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INSTALLATION WORKS OF THE
OMNI PROCESSOR AT IAAT WWTP

IAAT WASTEWATER TREATMENT PLANT	STEEL STAIRCASE
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FILE	DESIGNED BY	DRAWN BY	CHECKED BY
STR12	-	-	-

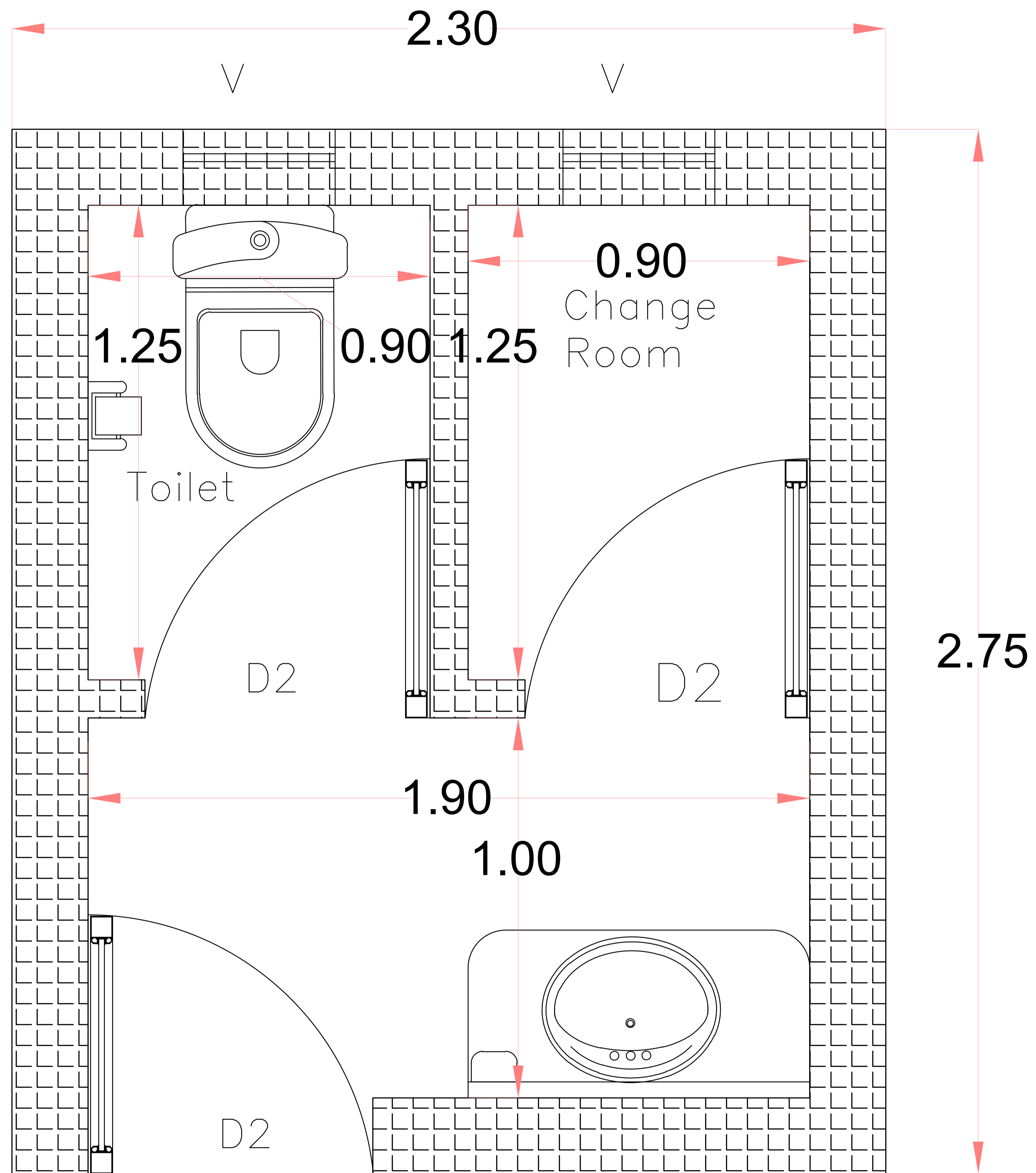
DATE	SCALE	SHEET No.	DRAWING No.
FEBRUARY 2021	NTS	1/1	12/17



Side View
STEEL STAIRCASE SIDE VIEW
All Dimensions are in mm



STEEL STAIRCASE BRACING SYSTEM
(L50x50x6)



TOILET PLAN

LIST OF COMPONENTS:-

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INSTALLATION WORKS OF THE
OMNI PROCESSOR AT IAAT WWTP

IAAT WASTEWATER TREATMENT PLANT	WC LAYOUT
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FILE	DESIGNED BY	DRAWN BY	CHECKED BY
EM01	-	-	-

DATE	SCALE	SHEET No.	DRAWING No.
FEBRUARY 2021	N.T.S	1/5	13/17

LIST OF COMPONENTS:-

SYMBOL	DESCRIPTION
	Ø 2" CPVC Septage Line
	Ø 4" UPVC Septage Overflow Line
	Ø 4" UPVC Filtrate Line
	Ø 1.5" CPVC Treated Water Line
	Ø 1" CPVC Fresh Water Line
	Ø 6" Hume Pipe
	0.6x0.45m Trench
	Ball Valve
	Non Return Valve
	Union
	Water points
	Pump
	Elbow Up
	Elbow Down

Rev.	Date	Dsgn	Drwn	Chk'd	Appr'd

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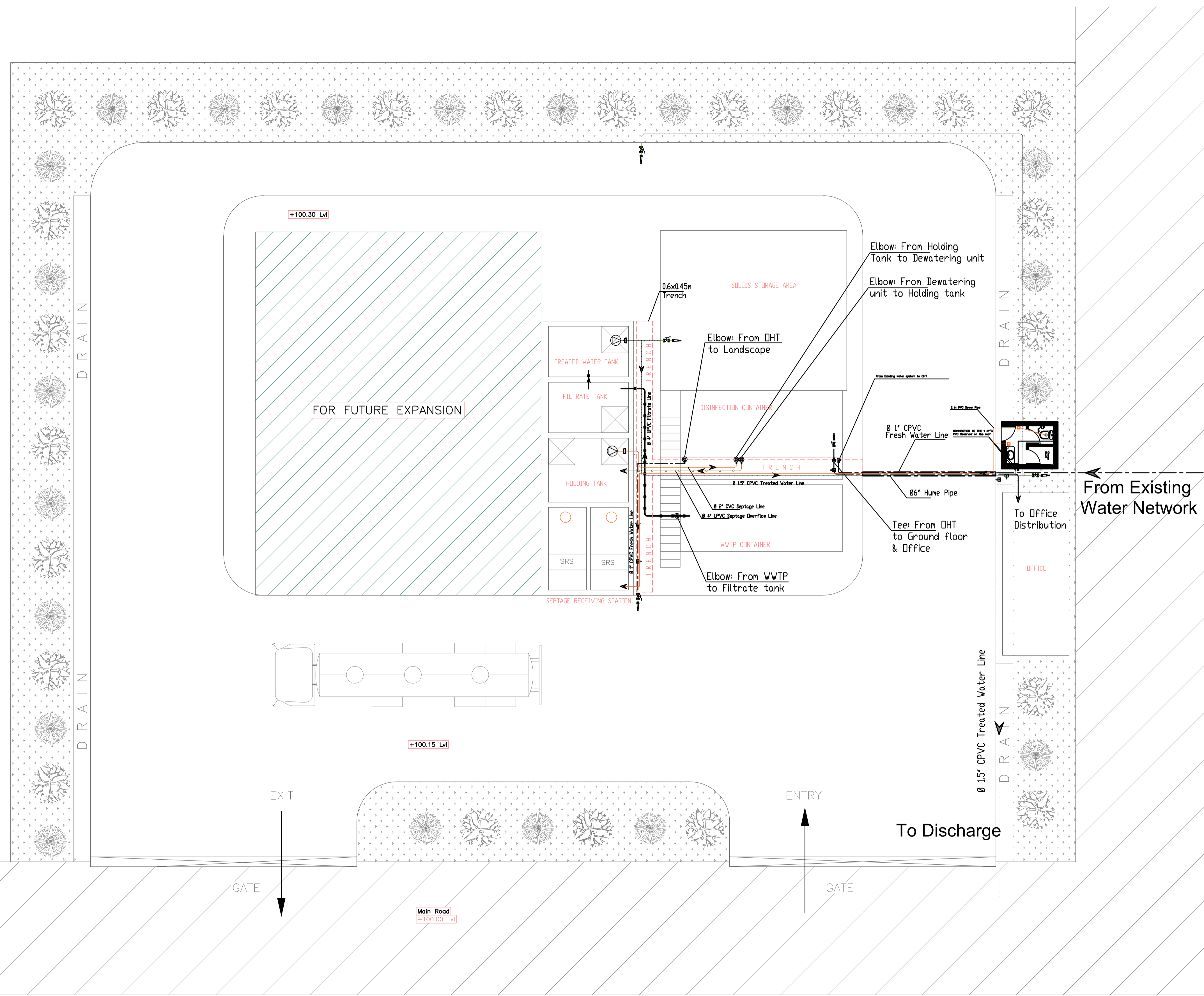
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INSTALLATION WORKS OF THE
OMNI PROCESSOR AT IAAT WWTP

IAAT WASTEWATER TREATMENT PLANT	PIPING LAYOUT
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FILE	DESIGNED BY	DRAWN BY	CHECKED BY
EM02	-	-	-

DATE	SCALE	SHEET No.	DRAWING No.
FEBRUARY 2021	N.T.S	2/5	14/17



LIST OF COMPONENTS:-

SYMBOL	DESCRIPTION
	CONTROL PANEL
	24 WATT LED TUBE LIGHT
	6A SINGLE POLE SWITCH
	20W LED STREET LIGHT
	6A 2/3PIN SOCKET OUTLET WITH 6A SWITCH
	16A 3PIN SOCKET OUTLET WITH SWITCH
	AC POINT
	SOLAR STREET LIGHT
	CONDUIT

Note:

- 1sqmm single core copper cable for 6A wiring.
- 1.5sqmm single core copper cable for 16A wiring
- 20mm 2mm Thick PVC FRLS Conduits to be used for all cables.

Rev.	Date	Dsgn	Drwn	Chk'd	Appr'd

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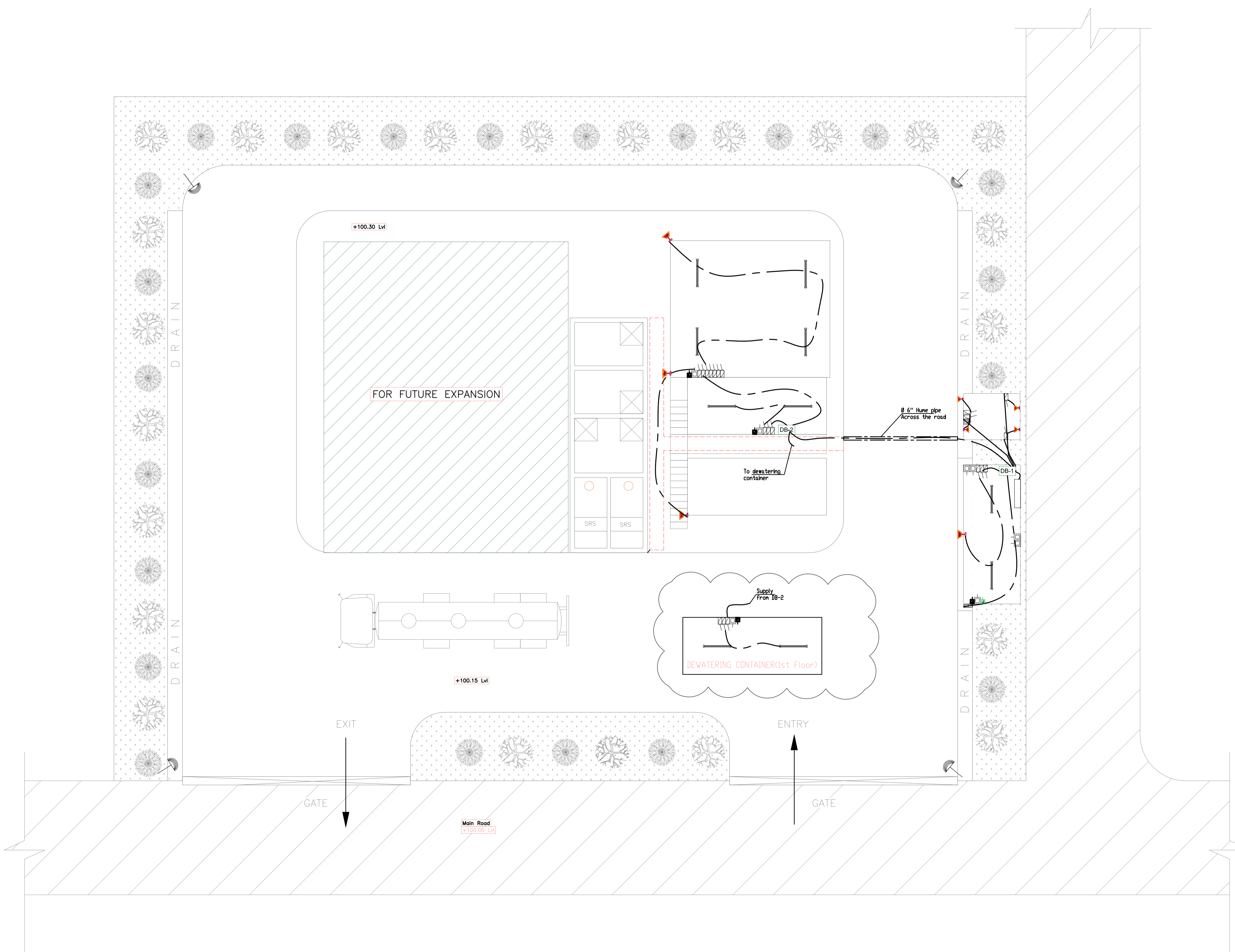
United Nations Children's Fund
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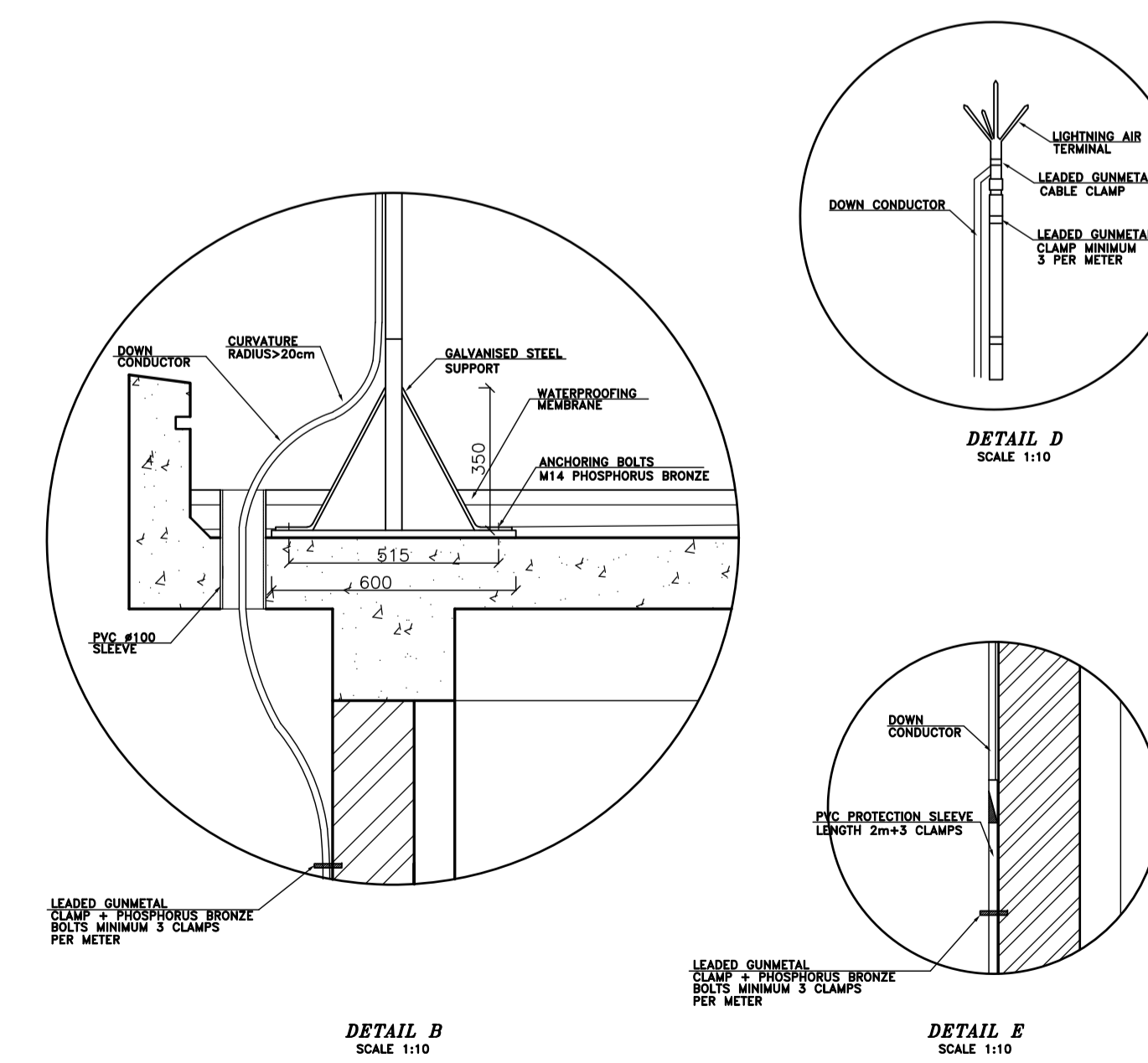
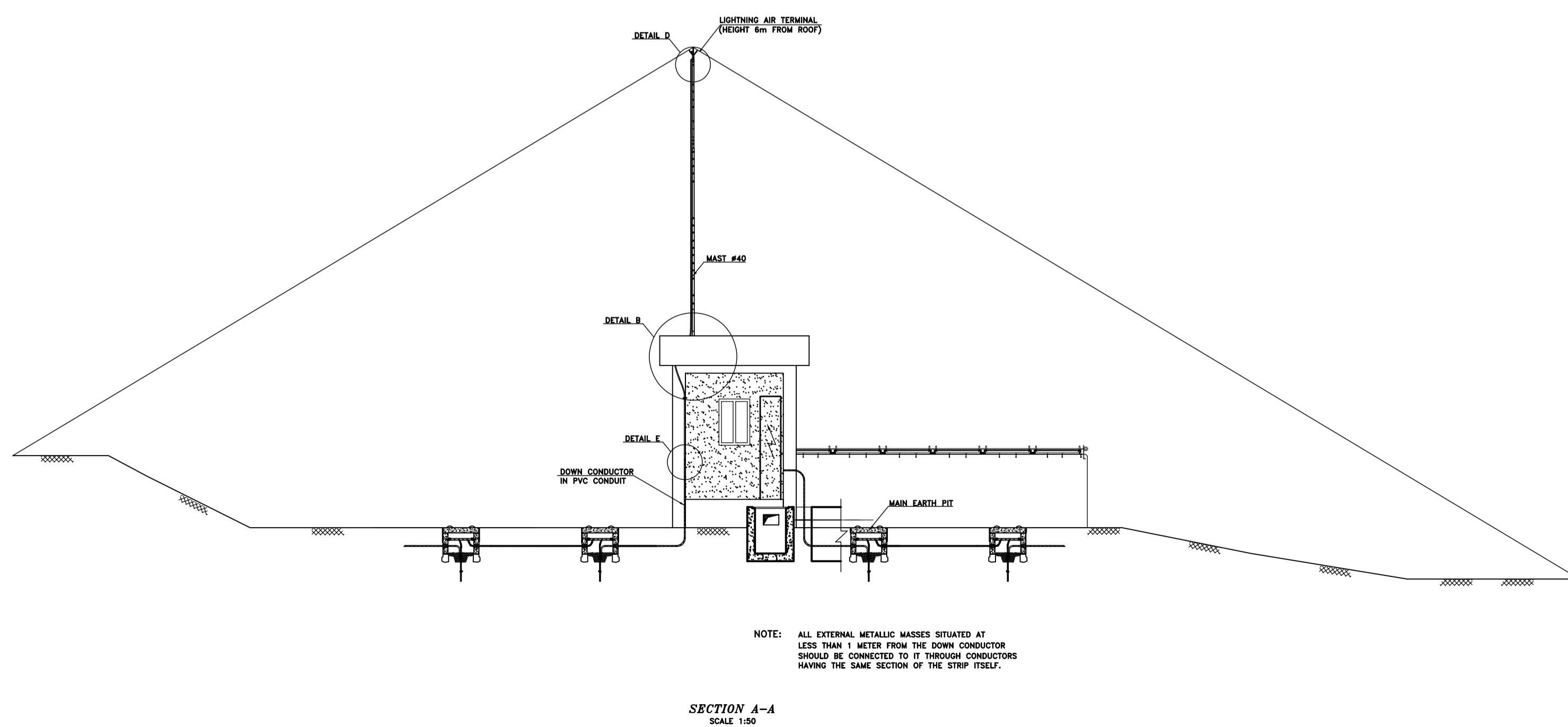
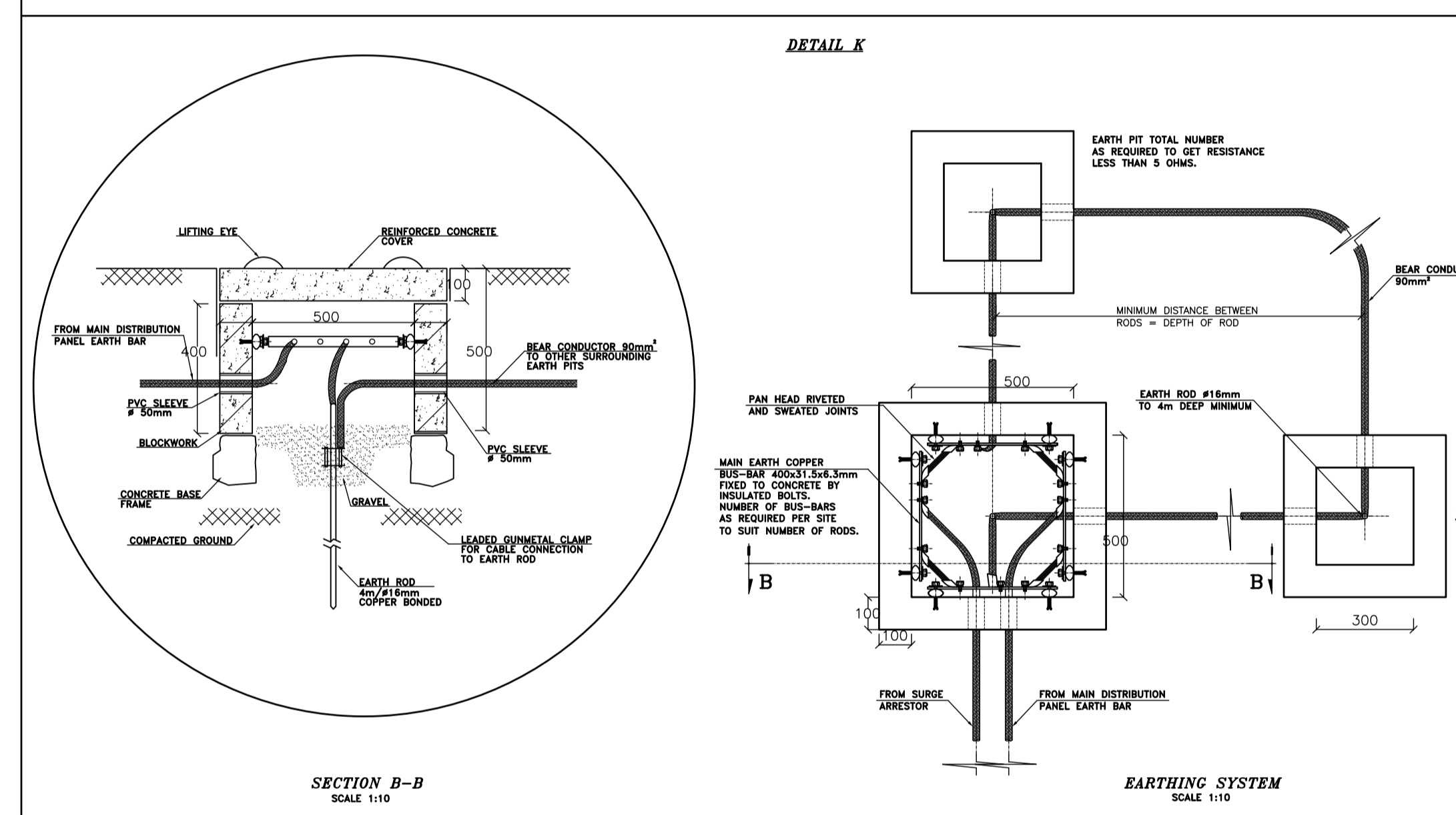
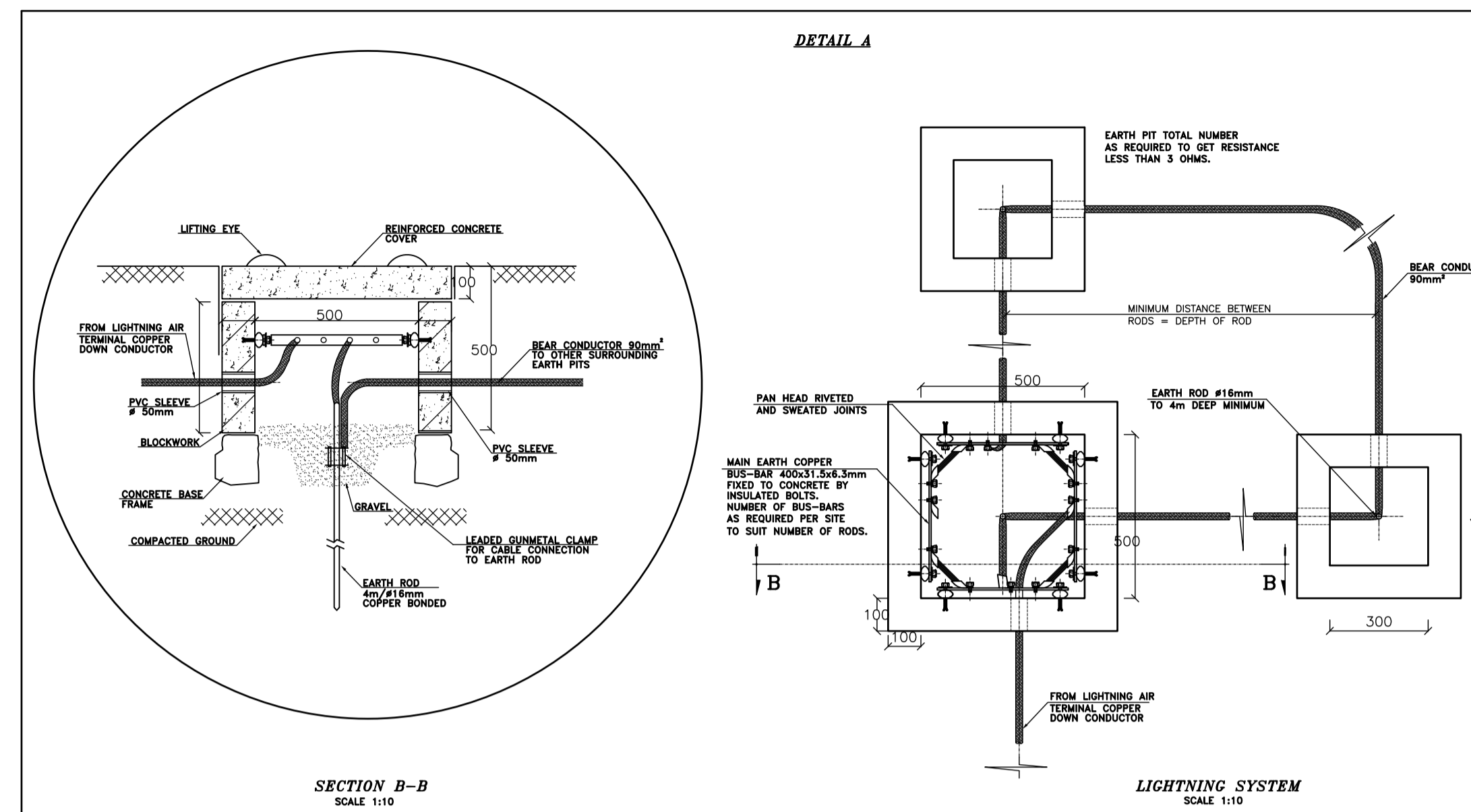
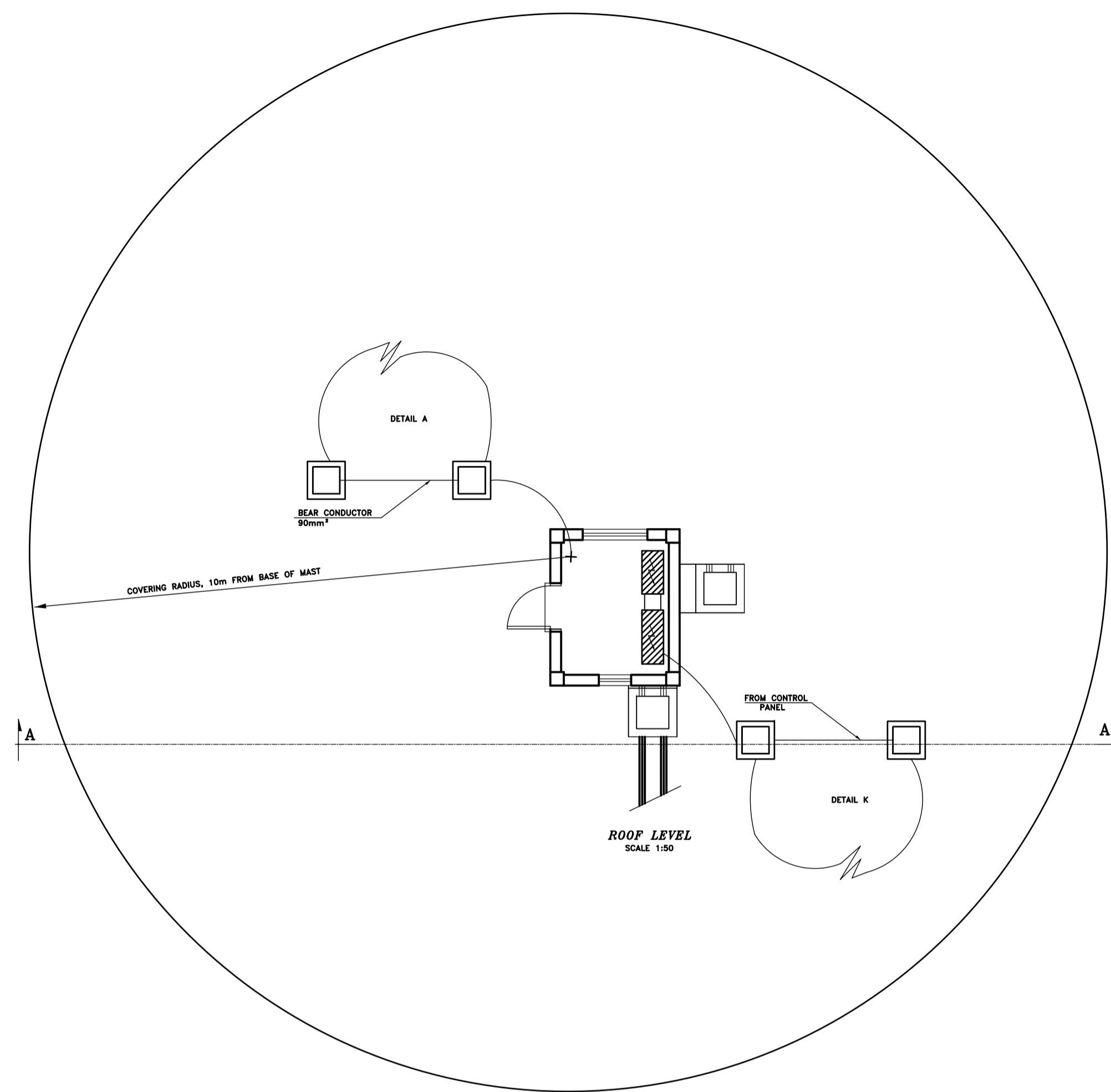
INSTALLATION WORKS OF THE
OMNI PROCESSOR AT IAAT WWTP

IAAT WASTEWATER TREATMENT PLANT	DOMESTIC ELECTRICAL SYSTEM
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FILE	DESIGNED BY	DRAWN BY	CHECKED BY
EM03	-	-	-

DATE	SCALE	SHEET No.	DRAWING No.
FEBRUARY 2021	N.T.S	3/5	15/17





LIST OF COMPONENTS:-

Rev.	Date	Dsgn	Drwn	Chk'd	Appr'd

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INSTALLATION WORKS OF THE
OMNI PROCESSOR AT IAAT WWTP

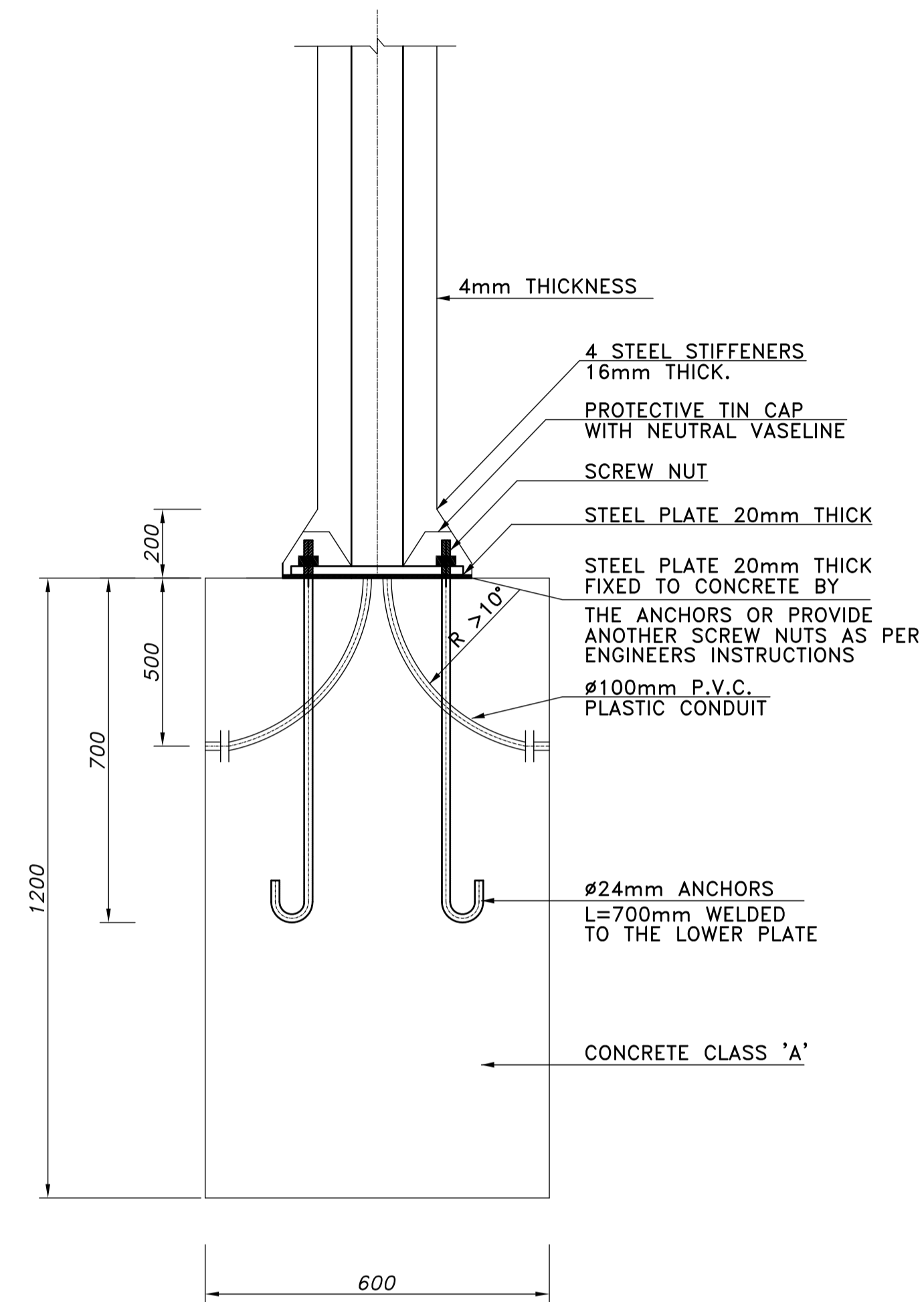
IAAT
WASTEWATER TREATMENT
PLANT

EARTHING, LIGHTNING AND
SURGE PROTECTION SYSTEM

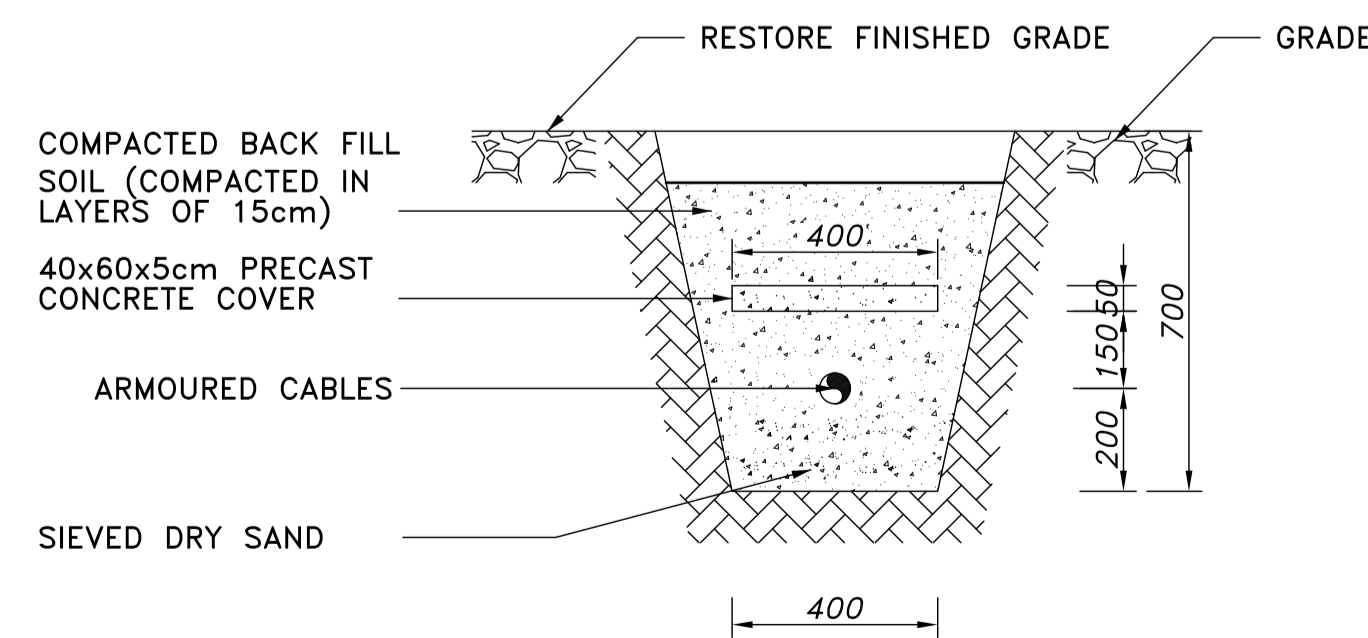
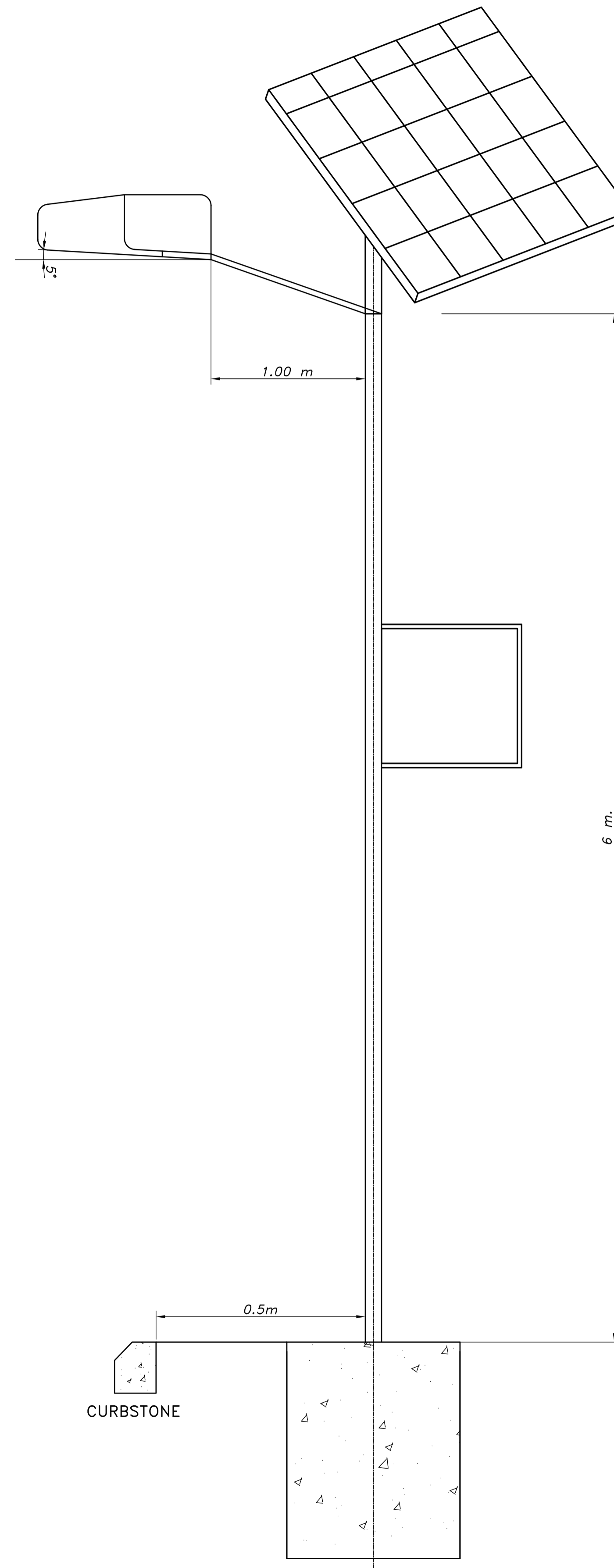
FILE	DESIGNED BY	DRAWN BY	CHECKED BY
EM04	-	-	-

DATE	SCALE	SHEET No.	DRAWING No.
FEBRUARY 2021	N.T.S	4/5	16/17

CONCRETE BASE FOR STREET LIGHTING
POLE 6m HEIGHT



TYPICAL CROSS SECTION OF LIGHT



CABLE TRENCH
FOR ELECTRICAL POWER CABLE

LIST OF COMPONENTS:-

Rev.	Date	Dsgn	Drwn	Chk'd	Appr'd

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INSTALLATION WORKS OF THE
OMNI PROCESSOR AT IAAT WWTP

IAAT WASTEWATER TREATMENT PLANT	SOLAR LIGHTING POLES AND TRENCH SECTION FOR POWER CABLE
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FILE	DESIGNED BY	DRAWN BY	CHECKED BY
EM05	-	-	-

DATE	SCALE	SHEET No.	DRAWING No.
FEBRUARY 2021	N.T.S	5/5	17/17