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25 SEWERAGE

25.1 SCOPE

The work covered by this section of the specifications consists in furnishing all reinforced concrete pipes, plant, labour, equipment, appliances and materials and in performing all operations required for installing and testing the sewer pipes in strict accordance with the specifications of this section and the applicable drawings and subject to the terms and conditions of the Contract.

25.2 RELATED WORKS SPECIFICATIONS

- Section 3 – Earthwork
- Section 5 – Plain & Reinforced Concrete
- Section 11 – Brickwork
- Section 27 – Tube-well & Water Supply
- Section 28 – Iron Steel & Aluminum Works

25.3 SEWER LINES

25.3.1 MATERIALS

All materials used in the manufacture of reinforced cement concrete pipes for use shall conform to ASTM Designation C-76-03 or latest revision and also with the following specifications.

a) Cement

The Portland cement to be used in the manufacture of reinforced concrete pipes shall conform to the requirement of BS-12/ASTM Designation C-150 (latest revision).

b) Aggregates

The coarse/fine aggregate to be used in the manufacture of concrete pipes to be furnished and installed shall be generally in accordance with the provisions of Section 5 – Plain & Reinforced Concrete.

c) Water

Water to be used in the manufacture of pipes shall be in accordance with the provisions of Section 5 - Plain & Reinforced Concreteapproved by the Engineer-in-Charge.

d) Steel Reinforcement

The material shall conform to the specifications contained in Section 5 – Plain & Reinforced Concrete.

e) Brick Ballast

Brick ballast shall have a maximum gauge of 1½ inch and shall be graded down to ¾ inch and shall not contain more than 10% which will pass through screen made of ¼ inch diameter bars spaced at ¾ inch centre to centre.

25.3.2 NON-REINFORCED CEMENT CONCRETE PIPES

The non-reinforced cement concrete pipes shall conform to ASTM C-14, latest revision Class II equivalent. Pipe ends shall be thus tongue and groove or bell and spigot. The physical dimensions shall be as described in applicable provisions of ASTM C-14.

25.3.3 REINFORCED CONCRETE PIPES

25.3.3.1 CLASSES OF PIPE

The reinforced cement concrete pipes to be furnished and installed shall be of the strength Class II or specified otherwise on the Drawings.

Following technical criteria shall be adhered to:

Class of Pipe	:	Class-II
Concrete Strength	:	4000 Psi (Cylinder Test)

The design requirements for these classes of reinforced cement concrete pipes shallbe as described in ASTM Designation C-76, Table 1 to 5 for the respective strength classes. Unless otherwise called for in other parts of these Technical Specifications or as ordered, all reinforced cement concrete pipes shall comply with the Wall-B design requirements as set forth in said Table 1 to 5 of ASTM Designation C-76-82 or latest revision.

For pipes smaller than 12 inches dia BSS 556, Class-L shall be strictly followed:

25.3.3.2 BASIS OF ACCEPTANCE

Acceptance of reinforced cement concrete pipes will be on the basis of three edge bearing and material tests as per ASTM Designation C-76-79 or latest revision and inspection of manufactured pipes for defects and imperfections. The Contractor shall bear the cost of such tests and pay fees etc., and also pay for the carriage of such samples and all other expenses contingent to tests.

25.3.3.3 PIPE DIMENSIONS

The internal diameters and wall thicknesses of reinforced concrete pipes under this contract shall be as set forth in ASTM Designation C-76-82 or latest revision in Tables 1 to 5 for "Wall-B" pipes as required and shown on the Drawings.

For Class II Pipes, the Wall Thickness for various dia pipes is as under:

12 inch dia. pipe	**:**	2.00 inch
15 inch dia. pipe	**:**	2.25 inch
18 inch dia. pipe	**:**	2.50 inch
21 inch dia. pipe	**:**	2.75 inch
24 inch dia. pipe	**:**	3.00 inch
27 inch dia. pipe	**:**	3.25 inch
30 inch dia. pipe	**:**	3.50 inch

The lengths of reinforced concrete pipes shall be as required to provide the designated laying length plus any overlap needed for the pipe joint. Pipe shall be of standard length of 8 ft. unless otherwise approved in writing by the Engineer-in-Charge. Only one laying length shallbe permitted for each size of reinforced concrete pipe and pipes not of the approved uniform laying length shall not be used in the work.

For 9 inch dia. RCC pipes following data in addition to ASTM-76 shall be applicable:

1.	Wall thickness	1 inch
2.	Reinforcement square inches per linear foot of pipe wall	0.05
3.	Concrete strength	4000 Psi (Cylinder Test)
4.	Inside diameter at the mouth of socket	12½ inch

5. Depth of socket 2¼inch

6. Longitudinal Steel As stated below

"*Each layer of circumferential reinforcement shall be assembled into a rigid case supported by 4 Nos. longitudinal bar of quarter inch diameter*".

The strength test requirements in pounds per linear foot of pipe under the three-edge-bearing method shall be either the D-Load (test load expressed in pounds per linear foot per foot of diameter) to produce 0.01 in crack, or D-loads to produce the 0.01 in crack and the ultimate load as specified below, multiplied by the internal diameter of the pipe in ft.

D-Load to produce a 0.01 in crack	=	1000 pounds
D-Load to produce the ultimate load	=	1500 pounds

Lift holes in the walls of reinforced cement concrete pipes will not be permitted for the purpose of handling and laying. Other approved lifting methods shall be employed.

25.3.3.4 CERTIFIED DRAWINGS AND DATA SHEETS

The Contractor shall submit in triplicate, for approval by the Engineer-in-Charge certified drawings and data sheets as required to provide complete information on all concrete sewer pipes, dimensions, type and dimensions of pipe ends, joint details proposed concrete design mix for each different strength class of reinforced pipe and any other information needed to demonstrate full compliance with these specifications.

No concrete sewer pipe shall be delivered to the work site until the Engineer-in-Chargehas formally approved the certified drawings and data sheets and until all test requirements called for in the respective ASTM Standard Specifications C-76 or latest revision have been met.

25.3.3.5 JOINTS FOR CONCRETE PIPE SEWERS

The joints for concrete pipes shall be as specified and could be as follows:-

a) Rubber Gaskets Joints

Rubber gasket joints shall be used for either tongue and groove or bell and spigot pipes.

Rubber gasket joints shall be made using specially designed rubber gaskets, made to fit the applicable tongue and groove or bell and spigot pipes and adequately tested under operating conditions. Special care must be taken in the selection and handling of the concrete pipes for use with rubber gasket joints, to ensure that pipe ends shall be smooth and concentric with tolerances which closely conform to the requirements of the manufacturer of the rubber gaskets. The tongue or spigot end of each pipe shall be specially designed to perform groove or offsets to fit the manufacturer's rubber gaskets design.

The rubber gasket joints shall conform to all applicable requirements of the latest revision of ASTM Designation C443, entitled "Joints for Circular Concrete Sewer and Culvert pipe, using Flexible Watertight Rubber Type Gaskets" except that the test pressure need not exceed 10 feet of head at which the complete sewers shall meet the infiltration or ex-filtration limits set forth hereinafter.

The groove end of tongue and groove pipes shall have at least one line of wire reinforcement of 8 gauge size placed in the centre of the groove.

The rubber gasket shall be installed on the pipe in accordance with the instructions of the gasket manufacturer. In general the gaskets shall be pre-assembled at the pipe manufacturing plant. The pipes shall be handled with special care at all times to prevent damage to the pipe ends. A lubricant shall be used for jointing the pipes as recommended by the rubber gasket manufacturer. Care shall be taken to avoid contamination of the gasket and lubricated surfaces with earth or other undesirable material during installation.

For either tongue and groove or bell and spigot pipes, mechanical means shall be used to pull the pipe home for all sizes of 12 inches or larger diameter in accordance with the recommendations of the rubber gasket manufacturer. Pipes of 9 inches diameter may be coupled manually using a cross member and bar. Under no circumstances will bars alone be used nor shall any motor driven equipment be used to force the pipe home.

b) Cement Mortar Joints

Cement mortar may be used where called for. This type of joint will normally be permitted only for sewers laid above the water table.Bell and spigot joints with cement mortar shall be made as follows:

The first pipe shall be in place to the established line and grade. The interior surface of the bell (socket) shall be thoroughly cleaned with a wet brush, and a sufficient layer of stiff mortar shall be applied to the lower portion of the bell. The spigot of the second pipe shall be thoroughly cleaned with a wet brush, and uniformly fitted into the bell so that the interiors of the two pipes are closely fitted and accurately aligned. The remaining annular space in the bell shall then be solidly filled with mortar in sufficient amount to form a head around the outside of the spigot. The interior surface of the pipe at the joint shall be cleaned of all surplusmortar and brushed to a smooth finish. The Contractor may at his own option, use jute firmly caulked into place for holding the bell and spigot joint in proper position.

Tongue & groove joints with cement mortar shall be made as follows:

The first pipe (downstream) shall be in place to the established line and grade with groove upstream. The groove of the first pipe shall be thoroughly cleaned with a wet brush and a layer of soft mortar shall be applied to the groove in the entire lower half of the pipe. The tongue end of the second pipe shall be thoroughly cleaned with a wet brush and, while it is in the horizontal position, a layer of soft mortar shall be applied to the entire upper half of the pipe. The tongue end of the second pipe shall then be inserted into the groove of first pipe until mortar is squeezed out on the exterior surface. The Contractor will use hamper jute gasket soaked in cement slurry, for holding the two pipes in proper position. The joints shall then be completely and solidly filled with stiff mortar on the outside of the pipe. The Interior surface of tile pipe at the Joint shall be cleaned of all surplus mortar and brushed to a smooth finish. The outside mortar joint shall be rubbed smooth with a moist rag and not trowelled.

The Portland cement mortar used for making joints shall consist of one part cement and one part clean sand, thoroughly mixed dry with sufficient water slowly added to give proper consistency. The mortar shall be promptly used after it is made. The completed joints shall be immediately protected on the outside with an initial covering of moist earth canvas or burlap.

25.3.3.6 HOUSE CONNECTIONS

House Connections shall be made through manholes as indicated in the drawing or as directed by the Engineer-in-Charge.

House connection shall be provided individually for each plot by means of a 6 inch dia. RCC sewer pipe and a dead end, laid at an average depth of 2.0 feet below NSL level and in such a manner that other services such as water supply, telephone and gas lines are not disturbed or interfered. The work of laying the sewer pipe shall conform to the specifications laid down in the relevant section of this contract.

Tile inlet of each house connection shall be plugged with brick masonry 4½ inches thick in 1:6 cement sand mortar both in the manhole and the pipe in the plot.

25.3.3.7 GULLY GRATING

Gully grating shall be made through manholes as indicated in the drawings or as directed by the Engineer-in-Charge.

Gully grating shall be provided on the road junctions on as mentioned in the drawings by means of a 9 inch dia. RCC sewer pipe connecting the nearest manhole with the chamber of size l ft. – 6 inches

x 1 ft. – 6 inches. The pipe is laid in such a manner that other services such as water supply and sewerage system are not disturbed or interfered. The work of laying RCC pipe shall conform to the specifications laid down in Sub-section 25.3.3.8. Mild steel grating shall be fixed at the top.

25.3.3.8 INSTALLATION

a) Handling of Pipes

Concrete sewer pipes shall be handled with special care at all times during the manufacture, while transporting to the site of work, and while installing. Each pipe shall be carefully inspected before being laid and no cracked, broken or defective pipe shall be used in the work. Chipping of the tongue and groove or bell and spigot pipe ends, which in the Engineer-in-Charge's opinion may cause defective joints, shall be sufficient cause for the rejection of any concrete pipe.

b) Excavation and Backfill

The excavation and backfill for sewer installations shall be as specified in applicable provisions ofSection 3 - Earthwork and will be paid for under separate contract items as classified.

c) Placing of Bedding

i) Brick Ballast Bedding

The brick ballast shall be clean material of 1 to 1½ inch gauge broken from first class bricks or bats, or from dense over burnt bricks. No under-burnt bricks or bats nor those which have become spongy of porous in the process of burning shall be broken up for brick ballast.

The material shall be evenly spread over the full width of the formation in 4 inches loose layers and compacted with hand or mechanical rammers until the full thickness as shown on the drawings for the particular pipe size has been built up and finished no more than ¼inch below required level. The Contractor shall note that it is essential that the material at the sides of the pipes is adequately compacted. Before the subsequent placing of pipe surrounding material, pipe joints shall be protected. Protection may take the form of a twist of yarn lightly pressed into the annular joints space or other equal protection approved by the Engineer-in-Charge.

ii) Crushed Stone Bedding

Crushed stone bedding shall be from an approved source. It shal1 be obtained from a dark colored igneous rock such as granite etc. It shall be strong durable, hard and impervious, having crystalline structure. The broken stone shall have sharp edges and clear fractured faces, shall be free from thin elongated or laminated pieces.

The crushed stone shall have a maximum gauge of 1½ inch and shall be graded down to¾ inchwhen sifted through a screen made of ¼ inch diameter bars spaced ¾ inchcenter to center, it shall yield not more than ten percent (10%) by volume of fine materials.

c) Laying of Sewers

Neither any sewer pipe nor the bedding shall be laid or placed till the alignment of the sewer and its levels and gradients have been carefully checked and tested with the trench excavation and found correct.

Each length of sewer pipe shall be checked for cracks and defects before placing in the line. Defects which in the opinion of the Engineer-in-Charge indicate imperfect placing, shall make, the pipe liable to rejection. Each pipe shall be placed carefully to line and grade and in close contact with adjoining pipe. These specifications require rejection of the work, if the sewer invert varies as much ½ inch from the proper elevation. As shown on Drawings, the bottom of the trench must be shaped to fit the pipe barrel, with holes left for the bells. If excavation has been carried below the correct grade, refilling must be done with satisfactory materials as approved by the Engineer-in-Charge at no extra cost.

The concrete pipe joints shall be of the type specified above and shall be made in accordance with the aforesaid specifications.

When laying is not in progress, the open pipe shall be closed with a tapered wooden plug to keep out foreign matter.

25.3.3.9 TESTING OF SEWER LINES

a) General

All sewer built shall be tested for infiltration or ex-filtration as specified below. The tests shall be made at times selected or approved by the Engineer-in-Charge. Sections of the completed sewer shall be isolated and measurements of the infiltration or ex-filtration shall be made by approved method. The contractor shall furnish all labor, material and equipment required for making the tests with no extra compensation over and above the agreed contract prices for the laying of sewer lines.

b) Infiltration Test

The sewers which are constructed with the ground water level above the invert level of the pipe shall be tested for infiltration after the sewers have been installed and backfilling has been substantially completed. The tests and measurement shall be performed by the Contractor in the presence of the Engineer-in-Charge as follows in accordance with ASTM C 969-02.

Conduct testing from manhole to manhole or between more than two manholes. The length of main tested shall not exceed 700 ft

.

i) Stop all dewatering operation and allow the groundwater to return to its normal level. Infiltration testing shall not be used unless the groundwater level is at least 2 ft above the crown of the pipe for the entire length of the test section.

ii) Plug all pipe outlets discharging into the upstream manhole.

iii) Measure the groundwater elevation and determine the average head over the test section.

iv) Measure infiltration leakage at the outlet of the test section. Because leakage allowances are small, measurements are best made by either timing the filling of a small container of known volume, or by directing flow into a container for a specified time and measuring the content, or by using small weirs.

v) If the measured rate of leakage is less than or equal to the allowable leakage in accordance with (d) hereafter the section of sewer tested is acceptable.

vi) If the test section fails, it is not prohibited that it be repaired and retested in accordance with this practice.

vii) The allowable leakage limit including manholes is 500 gallon/ inch of internal diameter (mile of sewer) (24 h) when the average head on the test section is 6 ft or less.

viii) The average head on the test section is the head above the crown of the pipe at the upstream manhole plus the head above the crown of the pipe at the downstream manhole divided by two.

ix) When the average groundwater head on the test section is greater than 6 ft. the allowable leakage shall be increased in proportion to the ratio of the square root of the average groundwater head to the square root of the base head of 6 ft.

x) Manholes shall be tested separately and independently or with the pipeline with the allowance of 0.1 gallon (ft of diameter) (ft of head) (h). If building or house leads are connected to the main line being tested, allowance shall be made for permissible leakage in such leads.

c) Ex-filtration Test

i) Conduct testing from manhole to manhole or between or between more than two manholes. The length of main tested shall not exceed 700 ft.

ii) Determine the groundwater elevation at both ends of the test section. If the groundwater level is less than 2 ft above the crown of the pipe measured from the highest elevation of the sewer, the ex-filtration test shall be used.

iii) Plug all pipe outlets discharging into the upstream manhole and the test section outlet. Fill the sewer line with water.

iv) At the upstream manhole the test head shall be established as minimum of 2 ft above the crown of the pipe, or at least 2 ft above existing groundwater, whichever is higher.

v) Allow the pipe to remain saturated for a period long enough to allow water absorption in the pipe, a minimum of 4 h and up-to a maximum of 72 h. After the absorption period, refill the pipe to the required test head.

vi) Measure the leakage loss over a timed test period. The minimum test period shall be 15 min and the maximum shall not exceed 24 h.

vii) If the measured rate of leakage is less than or equal to the allowable leakage in accordance with (d) the section of sewer tested is acceptable.

viii) If the test section fails, it is not prohibited that it be repaired and retested in accordance with this practice. The groundwater elevation shall be re-determined prior to a second test and the test head adjusted, if necessary in accordance with (iv).

ix) For ex-filtration testing the allowable leakage limit including manholes is 500 gal. (in. of internal diameter) mile of sewer) (24 h) when the average head on the test section is 3 ft or less.

x) When the average head on the test section is greater than 3 ft. the allowable leakage shall be multiplied by the ratio of the square root of the average test head and the square root of the base head of 3 ft.

xi) Manholes shall be tested separately and independently or with the pipeline with an allowance of 0.1 gal. (ft of diameter) (ft of head) (h).

d) Allowable Infiltration or Ex-filtration

The calculated amount of infiltration or ex-filtration over a 24 hour period shall not exceed 500 gallons per inch of pipe diameter per mile of sewer which rate shall be applied to the actual sewer size and length tested to determine the allowable infiltration or ex-filtration over the 24 hour period.

If the measured infiltration or ex-filtration exceeds the specified allowable limit, then the Contractor shall locate the points of leakage and make necessary repairs so as to reduce the leakage to less than the permission maximum stated above.

e) Cleaning of Sewer Lines

The Contractor shall clean all the sewer lines at no extra cost with the method approved by the site Engineer-in-Charge prior to handing it over to the Owner.

25.4 MANHOLES

25.4.1 MATERIALS

Brick masonry, Portland cement concrete, and other materials shall meet the specified requirements of the relevant sections of the specifications, listed under clause 25.2 and elsewhere as necessary. Cast iron frame shall conform to the specifications as per B.S.S. 497, Manhole steps shall be of galvanized mild steel.

25.4.2 CONSTRUCTION REQUIREMENTS

Manholes shall be constructed with brick masonry laid in 1:3 cement sand mortar, built on 1:2:4 concrete base slab and as specified. The cover slab shall be 1:2:4 reinforced cement concrete, fitted with cast iron frame which shall have reinforced cement concrete cover as shown in the drawing.

Reinforcement and concrete shall conform to the requirements or Section 5 – Plain & Reinforced Concrete. The outside and inside of the walls shall be plastered (½ inch thick) with 1:3 cement sand mortar and two coats of hot PB-4 bitumen shall be applied outside. At the bottom of manholes for sewers, a proper channel as per Drawings, shall be constructed in the whole length of the manhole along the centerline of the sewers, to lead the sewage from one sewer to the other. Galvanized mild steel steps shall be installed at 12 inches interval inside the manhole during the construction of the manhole walls. Cutting holes into the wall for the steps after construction will not be permitted. Top rung shall be 18 inches below the manhole cover and the lowest not more than 12 inches above the benching (floor).

Depth of manhole shall be from invert level of sewer to the top of manhole.

Where specified cast iron manhole covers conforming to the dimensions and weights as shown on drawings shall be used.

25.4.3 DROP MANHOLE

The Contractor shall construct drop manholes wherever shown in the drawings or ordered by Engineer-in-Charge. The Contractor shall make the drop connection as shown on the drawings or ordered by the Engineer-in-Charge.

25.5 CAST IRON VENTILATING SHAFTS

Cast Iron Pipes & specials shall conform to BS-78 for spigot and sockets vertically cast pipes; BS-1211 for spigot and socket spun iron pipes and BS-2035 for flanged.

The work shall carried as specified shown on drawings and approved by the Engineer-in-Charge in accordance with applicable specifications.

25.6 CLEANING OF LINES

The lines shall be cleared of silt and other clogged material in the pipeline as directed by the Engineer-in-Charge.

25.7 PAVEMENT RESTORATION

The paved surfaces which are cut shall be restored to the original condition according to drawings and as approved by the Engineer-in-Charge.

25.8 MEASUREMENT AND PAYMENT

25.8.1 COMPOSITE RATE

The measurement and payment for the items of the work of Sewerage hereof shall be made corresponding to the applicable CSR item as provided in Contract Agreement and shall constitute full compensation, for procurements, transportations, performance in all respect and completion of work as specified including the site clearance as approved by the Engineer-in-Charge.

25.8.2 LABOUR RATE

The measurement and payment for the items of the work of Sewerage hereof shall be made corresponding to applicable CSR item as provided in Contract Agreement and shall constitute full compensation for procurements transportations, performance in all respect and completion of work as specified including site clearance, as approved by the Engineer-in-Charge except the cost of materials to be provided by Department at designated location as defined in the Contract Agreement.

25.8.3 QUANTIFICATION

The unit of measurement shall be measured as mentioned below in accordance with corresponding CSR items.

1. For Volumetric items, the unit of measurement shall be cubic meter or cubic foot. Following item of CSR are measured in the above mentioned criteria;

Item No.:25-17

2. For surface area items, the quantity of work shall be measured by surface area. The unit of measurement shall be Square meter or Square foot. Following item of CSR are measured according to this criteria;
   Item No.: 25-9 to 25-11
3. For linear items, the quantity of work shall be measured linearly along centre line of structure. The unit of measurement shall be running meter or running foot. Following items of CSR are measured according to this criteria;
   Item No.: 25-1 and 25-19
4. For linear items, the quantum of work shall be measured linearly along centre line of structure. The unit of measurement shall be running Centimeter or running Inch. Following items of CSR are measured according to this criteria
   25-4(b), 25-5(b), 25-6(b) and 25-7(b& c)
5. The following items of CSR shall be measured as Each Unit
   Item No.: 25-2 to 25-4(a), 25-5(a&c), 25-6, 25-7(a&d) and 25-12 to 25-16