**Date: 11th OCTOBER 2024**

**BOQ FOR CONSTRUCTION OF THREE WATER KISOSK AND SUPPLY AND LAYING OF 1.06 HDPE PIPE**

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| **TENDER REF NO** | **ITEM DESCRIPTION** | **DELIVERY LOCATION** |
| HFHK/ADH/06/2024 | **CONSTRUCTION OF THREE WATER KISOSK AND SUPPLY AND LAYING OF 1.06 HDPE PIPE**  **As per specifications provided on BOQ** | Project name: namaiyana kandutura pipeline distribution and water kiosks  Laikipia west sub-county, |

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| **TENTATIVE BILLS OF QUANTITIES FOR THE DEVELOPMENT OF NAMAIYANA KANDUTURA PIPELINE DISTRIBUTION AND WATER KIOSKS** | | | | | |
|  | **PIPILINE DISTRIBUTION** |  |  |  | - |
| A | General trench excavation in open ground, refill, ram and dispose. Depth not less than 0.6m and 350mm wide. | CM | 221 |  | - |
| B | General trench excavation in hard rock, refill, ram and dispose. Depth not less than 0.6m and 350mm wide. | CM | 37 |  | - |
|  | **SUPPLY OF HDPE PIPES AND LAYING IN TRENCHES. THE COST INCLUDE THE JOINERY (MANDATORY BUTT FUSION)** |  |  |  | - |
| A | HDPE 63mm dia. PN10 include for jointing (Mandatory Butt fusion/welding) | M | 650 |  | - |
| B | HDPE 50mm dia. PN10 include for jointing (Mandatory Butt fusion/welding) | M | 400 |  | - |
|  | **FITTINGS AND VALVES** |  |  |  | - |
| A | Single Acting Airvalve 63mm complete with fittings | No. | 1 |  | - |
| B | Single Acting Airvalve 50mm complete with fittings | No. | 1 |  |  |
| E | 63mm Equal Tee | No. | 3 |  |  |
| F | Construct 1200mm x1200mm x 1000mm standard valve chamber with locable cover | No. | 6 |  | - |
| I | Allow supply and fix of Reinforced marker posts 1.2m long | No. | 7 |  | - |
| J | Allow for minor fittings | LS | 1 |  | - |
| K | Peglar (England) Gate valves 2" complete with fittings | No. | 1 |  | - |
| L | Peglar (England) Gate valves 1 1/2" complete with fittings | No. | 3 |  | - |
| M | Allow for pipeline pressure testing | LS | 1 |  | - |
|  | **TOTAL COST FOR PIPELINE DISTRIBUTION** |  |  |  | **-** |
| **ESTIMATES FOR I NO.WATER KIOSK (OF UPTO 2.6M BY 2.6M AND UPTO 1 FOOT ABOVE THE GROUND LEVEL) WITH 10,000L PLASTIC WATER TANKS INSTALLED ON TOP -See design drawings attached** | | | | | |
| **1.00** | **Excavations** |  |  |  |  |
| A | General excavation to remove top soil to an average depth of 250mm | m2 | 17 |  | - |
| B | Excavation for column footing depth to a minimum depth 1200mm | m3 | 6 |  | - |
| C | Excavation for front area depth not exceeding 250mm | m3 | 5 |  | - |
| D | Cart away surplus excavated material & deposit at recommended area | m3 | 3 |  | - |
| E | 300mm thick approved hard-core, well compacted in layers not exceeding 150mm and blinded using 50mm murrum/quarry dust | m2 | 11 |  | - |
| **2** | **Masonry Work** |  |  |  | **-** |
| A | 150 x225X 450mm natural stone to walls to superstructures walling in 1:3 sand/cement mortar finished with steel finished on one side. Rate to included mild all reinforcement at every course | m2 | 16 |  | - |
| B | 150 x225 X 450 natural stone to walls to Substructures walling in 1:3 sand/cement mortar. Rate to included mild all reinforcement at every course | m2 | 18 |  | - |
| C | 150mm wide DPM to walls | m | 12 |  | - |
| **3** | **Concrete Work** |  |  |  | **-** |
| A | Concrete grade 15/20 - 400 mm thick Plinth | m3 | 0 |  | - |
| B | Concrete grade 15/20 - 100mm thick slanting front area | m3 | 1 |  | - |
| C | Reinforced concrete grade 25/20 - 125mm thick floor slab | m3 | 1 |  | - |
| D | Reinforced concrete grade 25/20 - 450 X 250mm footing | m3 | 1 |  | - |
| E | Reinforced concrete grade 25/20 - 1050 X 1050\* 300mm column footing | m3 | 1 |  | - |
| F | Reinforced concrete grade 25/20 - 300 X 200mm columns | m3 | 1 |  | - |
|  | Reinforced concrete grade 25/20 - 450 X 300mm Ground and roof beams | m3 | 3 |  | - |
| G | Reinforced concrete grade 25/20 in roof slab | m3 | 1 |  | - |
| **4** | **Concrete Ancillaries** |  |  |  | **-** |
| A | Provide, cut and fix in position sawn timber formwork and probs or equivalent for all concrete works | LS | 1 |  | - |
| **5** | **Reinforcement: Steel reinforcement cut, bend & placed in position, unit price to include cutting, bending & placing in position with binding wire and concrete seats** |  |  |  | **-** |
| A | a) Mesh 142 mild steel reinforcement mesh (0.40kg/m2) in foundation wall | m2 | 15 |  | - |
| B | b) 10mm diameter high tensile steel (0.62kg/m2) in foundation wall | m | 45 |  | - |
| C | a) 8mm diameter mild steel (0.40kg/m) in foundation wall | m | 130 |  | - |
| D | b) 12mm diameter high tensile steel in roof slab | m | 182 |  | - |
| E | c) 8mm diameter mild steel (0.40kg/m) in roof slab | m | 110 |  | - |
| F | d) 10mm diameter high tensile steel (0.89kg/m) in column footing | m | 45 |  | - |
| G | e) 12mm diameter high tensile steel (0.89kg/m) in columns | m | 40 |  | - |
| H | f) 10 mm diameter mild steel (0.40kg/m) in columns | m | 35 |  | - |
| **6** | **Fittings and Fixtures** |  |  |  | **-** |
| A | 2000 X 1000 steel door including locks and hinges to details | No | 1 |  | - |
| B | 1000 X 1000 steel swing window including locks and hinges to details | No | 1 |  | - |
| **7** | **Pipes and Fittings: All pipes to be Galvanised Iron with Screw with adequate jute hemp thread for fixation of fittings** |  |  |  | **-** |
| A | 50mm to 25mm reducing bush | No. | 1 |  | - |
| B | 25mm inlet pipe | m | 18 |  | - |
| C | 25mm dia. Elbows | No. | 4 |  | - |
| D | 75mm dia. Valve sockets | No. | 2 |  | - |
| E | 25mm dia. Gate Valve as Peglar | No. | 2 |  | - |
| F | 25 X 25 mm/Equal Reducing Tee | No. | 5 |  | - |
| G | 25mm end plug | No. | 1 |  | - |
| I | 25mm long thread nipple | No. | 2 |  | - |
| J | 25mm union | No. | 4 |  | - |
| K | 25mm short nipple | No. | 11 |  | - |
| L | 25mm heavy duty Globe Valve | No. | 3 |  | - |
| N | 25mm Peglar Water Meter | No. | 1 |  | - |
| **8** | **Finishes** |  |  |  | **-** |
| A | Pointing to all External wall surfaces with cement sand mortar 1:2 | m2 | 16 |  | - |
| B | Apply plastering to lintel surfaces | m2 | 1 |  | - |
| C | Apply plastering to all internal wall faces | m2 | 16 |  | - |
| D | Provide three coats of gloss paint to all plastered wall faces | m2 | 16 |  | - |
| E | Provide 3 coats of bituminous paint to all exposed concreted faces | m2 | 1 |  | - |
| 9 | **Drainage** |  |  |  | - |
| A | Excavate for 1200mm diameter X 2000mm soak pit as detailed | No. | 1 |  | - |
| B | 4" X 8'' X 18" lining block to the site of the catch pit | m | 2 |  | - |
| C | 100mm thick mass concrete grade 15/20 for catch pit base slab and cover | m2 | 1 |  | - |
| D | 100mm thick mass concrete grade 15/20 to the soak pit cover slab | m3 | 1 |  | - |
| E | Provide 150mm perforated waste pipe to soak pit | No | 2 |  | - |
| F | Graded approved free draining hard-core/rubble stone filling the soak pit | m3 | 2 |  | - |
| 10 | **Storage** |  |  |  | - |
| A | Allow for provision and installation of 10,000l double layered plastic water tank on top of the water kiosk inclusive of pipe fittings and fitted with a ball valve | No. | 1 |  | - |
|  | **TOTAL COST FOR PROPOSED WATER KIOSKS** |  |  |  | **-** |
| **COLLECTION SUMMARY** | | | | | |
| SN | **COMPONENT** | **Unit** | **Qty** |  | **Corrected Amount** |
| 1 | TOTAL COST FOR PIPELINE DISTRIBUTION | No | 1 |  | - |
| 2 | TOTAL COST FOR PROPOSED WATER KIOSKS | No | 3 | - | - |
| 3 | 16% VAT |  |  |  | - |
|  | **GRAND TOTAL NAMAIYANA KANDUTURA DISTRIBUTION PIPELINE AND WATER KIOSKS** |  |  |  | **-** |

**TECHNICAL SPECIFICATIONS**

* **ELEVATED PRESSED STEEL WATER TANK**

1. **SCOPE OF WORK:**

The work to be performed under these specifications includes furnishing all labor, materials, tools and equipment necessary to design, fabricate, construct, inspect and test a welded steel elevated water storage tank supported on a concrete support structure, including the foundation and accessories as shown on the drawings and specified provided by the contractor and approved by project engineer.

Approvals for layouts and structural drawings to be carried out by the Client at no cost and before commencement of the tank erection.

1. **Tank Panels**

Tank panels shall be available module dimensions shall be as specified in the drawings and BOQs and shall be hydraulically cold pressed in one piece. Standard plates thickness will be as per the drawings and shall be determined by the tank sizes.

1. **Covers**

Flat steel plates will be used with a pitch at the center and suitably supported to allow for external loads including installation/maintenance crew. A standard square manhole with hinged lockable cover and vent shall be provided.

1. **Internal bracings and brackets**

Internal bracings and brackets shall be provided to ensure the strength, rigidity and absolute uniformity of the tank depending on the size.

1. **Fasteners**

All bolts used in the assembly of the pressed steel tank shall be galvanized and 4.6 and Tensile Grade 8.8 for rigid holding. They should be Zinc coated to protect against rust forming. All steel washers to be mild steel.

1. **Joint Materials**

A non-toxic strip joining material shall be used between joints of tank plates, under the internal brackets and for sealing the cover plates to make all joints completely leak proof.

1. **Surface Finish**

The TANK PANELS, COVERS, FASTENERS, INTERNAL BRACINGS AND BRACKETS SHALL be applied with:

-One coat of grey oxide primer

-Two coats of Silver aluminum paint.

1. **Testing and Commissioning**

LEAKAGE TEST SHALL BE CARRIED OUT IMMEDIATELY AFTER COMPLETION OF ERECTION AND ANY REPAIRS SHALL BE CARRIED OUT IMMEDIATELY

1. **Foundation Works**

The Contractor shall:

1. Ensure the mix ratio for to attain the strength of Fcu 25N/mm2;
2. Ensure curing of concrete is done for a minimum of 28 days;
3. The Water Mix should be to ratio of 0.5
4. Concrete mix should be to the ratio of 1:1 ½: 3
5. It is recommended to use Bamburi cement as it attains maximum strength within a shorter period;
6. Ensure water used for mixing concrete must be clean water without any natural salts;
7. Ensure use of clean sand for concrete free of any organic matter;
8. Ensure reinforcement bars meet the Engineering standards;
9. Provide a bar bending schedule before start of concrete works;
10. Provide appropriate Engineering drawings for the foundation before the start of concrete works;
11. Ensure that the cover to foundation (reinforcement bars) is as specified in the drawings
12. Ensure that the cover to columns (reinforcement bars) is as specified in the drawings
13. Ensure that the cover to beam (reinforcement bars) is as specified in the drawings.
14. Ensure that cube test is done for every batch of concrete (at KEBs) and submit results to Client
15. Ensure compacting of murram (backfill) will be in 200mm layers with proper moisture content.

* **CONCRETE WORKS**
  1. **General**
     1. Code of practice

All workmanship, materials, tests, and performances in connection with the reinforced concrete work are to be in conformity with the latest edition of British Standard Code of Practice (C.P. 8110 for “Structural Use of Concrete”) where not inconsistent with these specifications.

* + 1. Contractor’s plant

Not less than 30 days prior to the installation of the Contractor’s plant and equipment for processing, handling, transporting, storing and proportioning ingredients, and for mixing, transporting and placing concrete, the Contractor shall submit drawings for approval by the Engineer, showing proposed general plant arrangements, together with a general description of the equipment he proposes to use.

After completion of installation, the operation of the plant and equipment shall be subject to the approval of the Engineer.

* 1. **Materials**
     1. **Cement**

Cement, unless otherwise specified, shall be Portland cement of the Blue Triangle brand, or Bamburi Portland Cement brand. Any other brand must be approved by the Engineer and shall comply with the requirements of B.S. 12 with the exceptions that it may contain reactive volcanic ash (of not more than 10% of total weight) and the quantity of insoluble residue permitted in B.S. 12 may be exceeded. A manufacturer’s Certificate of Test in accordance with B.S. shall be supplied for each consignment delivered to site.

Should the Contractor require using cement of the rapid hardening variety, he shall obtain the approval of the Engineer and obtain any instructions regarding the modifications to the preambles caused thereby. Any additional cost that may be caused using the rapid hardening cement shall be at the Contractor’s expense.

Cement may be delivered to site either in bags or in bulk. If delivered in bags, each bag shall be properly sealed and marked with the manufacturer’s name and on the site is to be stored in a weather- proof shed of adequate dimensions with a raised floor. Each consignment shall be kept separate and marked so that it may be used in the sequence in which it was received. Any bag found to contain cement which has set or partly set shall be completely discarded and not used in the Works. Bags shall not be stored more than 1500 mm in height.

If delivered in bulk the cement shall be stored in a weather-proof silo either provided by the cement supplier or by the Contractor, but in either case the silo shall be to the approval of the Engineer.

* + 1. **Aggregates**

The aggregates shall conform to the requirements of B.S. 882 and the sources, and all types of all aggregates are to be approved in all respects by the Engineer before work commences.

The grading of aggregates shall be one within the limits set out in B.S. 882 and as later specified and the grading, once approved, shall be adhered to throughout the Works and not varied without the approval of the Engineer. Fine aggregate shall be clean, coarse, siliceous sand of good, sharp, hard quality and shall be free from lumps of stone, earth, loam, dust, salt, organic matter, and any other deleterious substances. It shall be graded within the limits set out in zone 1 or 2 of B.S. 882.

Coarse aggregate shall be good, hard, clean approved black trap or similar stone, free from dust, decomposed stone, clay, earthy matter, foreign substances or friable thin elongated or laminated pieces. It shall be graded within the limits of Table 1 of B.S. 882 for its respective nominal size.

If in the opinion of the Engineer the aggregate meets the above requirements but is dirty or adulterated in any manner it shall be screened and/or washed with clean water if he so directs at the Contractor’s expense.

Aggregates shall be delivered to the site in their prescribed sizes or grading and shall be stockpiled on paved areas or boarded platforms in separate units to avoid intermixing.

* + 1. **Fine aggregate**

Fine aggregate shall be sand free from impurities and complying with British Standard No. 882. Grading zone 2 of Table 2.

* + 1. **Coarse aggregate**

Coarse aggregate shall be hard crushed rock free from impurities and complying with British Standard No. 882 "graded aggregate" 20 mm to 5 mm nominal size as Table 1.

* + 1. **Water**

Water for concrete shall be free from impurities, complying with BS 3148

* + 1. **Hardcore**

Hardcore for filling under floors shall be good, hard stone ballast or quarry waste, to the approval of the Engineer, broken to pass through not greater than a 150 mm ring or to be 75% of the finished thickness of the layers being compacted, whichever is the lesser. Hardcore shall be free from all weeds, roots, vegetable soil, clay, black cotton soil or other unstable materials.

It shall be graded with smaller stones and fine materials to give a dense compact mass after consolidation. Sufficient fine material shall be added to each layer to give gradation of material as necessary to obtain a solid compact mass after rolling. Hardcore filling is to be laid in layers each of a consolidated thickness not exceeding 250 mm. Each layer shall be compacted by at least 8 passes of a 10-tonne smooth-wheeled roller or a 2-tonne vibrating roller until all movement ceases. Sufficient water is to be added to obtain maximum compaction to the Engineer’s approval.

To each layer a 25 mm thick layer of sand complying with the specification of fine aggregate for concrete shall be spread over the surface and forced into the hardcore using a vibrating roller weighing not less than 2 tones. This operation should be carried out when the materials are dry and repeated whilst the sand is well watered. Should all the sand be absorbed the Engineer may require a further layer to be applied and the process repeated.

The top surface of the hardcore shall be leveled or graded to fall as required and shall then be blinded with a layer of similar material broken to 25 mm gauge and finished with a 10-tonne smooth-wheeled roller. The surface so obtained shall be to the Engineer’s approval.

* + 1. **Compacted hardcore**

The sub-grade shall be compacted by a smooth-wheeled roller of 8 to 10 tons weight or the vibrating roller of minimum 1300 Kg., or other approved plant. The number of coverages shall be at least 10 and there shall be a 50% overlap of successive coverage. If so, instructed by the Engineer, water shall be added during compaction to obtain optimum water content. Filling shall be compacted as above but in maximum 200 mm deep layers.

* + 1. **Sand**

The sand shall be as described for fine aggregate but that for plastering shall be light in color and well graded to a suitable fineness in accordance with the nature of work to obtain the finish directed.

* 1. **Finishes**
     1. **General**

The Contractor will be required from an early stage in the contract to prepare samples, for the approval of the Engineer, of the various concrete finishes specified hereafter. Samples are to be prepared using the same materials and the same methods of construction, compaction, curing, etc. as the Contractor proposes to use for executing the full quantity of the work. A record of the mix, water content, method of compaction, any additives used, etc., is to be kept for each sample prepared. When the Engineer has approved a sample, it will be kept on site in an approved location. The finishes in construction will be expected to be up to a standard equal to the approved sample. Consistency in cement color, and the color, grading and quality of aggregates must be maintained in all finished concrete work.

* + 1. **Mortars**

Cement mortar shall consist of one part of Portland cement to three parts sand by volume. The cement/lime mortar shall consist of one part of Portland cement, one part of lime and six parts of sand by volume.

The ingredients of mortar shall be measured in proper gauge boxes on a boarded platform, the ingredients being thoroughly mixed dry, and again whilst adding water. In the case of cement/lime mortar, sand and lime shall be mixed first and then the cement added.

All mortar is to be thoroughly mixed to a uniform consistency with only sufficient water to obtain a plastic condition suitable for toweling. No mortar that has commenced to set is to be used or re-mixed for use.

* + 1. **Tamped finish**

Areas so specified shall be finished at the time of casting with a tamped finish to the Engineer’s approval produced by an edge board. Board marks are to be made to a true pattern and will generally be at right angles to the traffic flow. Haphazard or diagonal tamping will not be accepted.

* + 1. **Fair face**

Fair face surfaces shall be clean, smooth, even, true to form, line and level, and free from all board marks, joint marks, and honeycombing, pitting, and other blemishes. Forms are to be provided with a smooth lining of plywood, steel, or other approved material which will achieve the required finish without any general rubbing down. Rubbing down will only be permitted to remove any projecting fins at corners or joints.

* + 1. **Fine face**

Fine face surfaces shall be for Fair face above, but to a higher standard obtained from forms provided with an impervious sheet lining of metal or plastics faced plywood in large panels arranged in an approved pattern. Rubbing down shall only be permitted after an inspection by the Engineer. The finished surfaces shall be capable of receiving a painted finish.

* + 1. **Chisel-dressed finish**

Chisel-dressed finish is to be carried out on any grade of concrete but not until it is at least 30 days old. The surfaces are to be fully chisel-dressed to remove a maximum of 12 mm (average 9 mm) of the surface by shearing and exposing the aggregate without excessive cracking of the surrounding matrix. Arises of columns, beams, etc., are pre-formed fair face with timber fillets set in the formwork and care must be taken in working up to these to preserve a clean line.

For vertical surfaces of walls and columns particular care must be taken to remove all sharp projections. For beam soffits this requirement is not necessary. All surfaces requiring this treatment are to have margins chisel-dressed by hand for a minimum width of 75 mm commencing from the fillet edge.

Thereafter, mechanical chisel-dressing may be used, but the Contractor must ensure that a uniform texture and even plane surface is achieved. The use of sharply pointed steel tools for both hand and mechanical chisel-dressing is essential. Upon completion the surfaces are to be thoroughly wire brushed and washed down.

* + 1. **Protection of finishes**

Wherever possible, in-situ exposed concrete finishes should be commenced at the highest level and worked progressively down the building. Precaution shall be taken to avoid staining or discoloration of previously finished concrete faces by leakage of grout from newly placed concrete. The Contractor shall, during all stages of construction, adequately protect all concrete finishes from damage by leaking grout, knocking, paint stains, falling plaster, etc. In cases of balustrade walls to staircases and members where damage is otherwise likely, concrete finishes shall be protected by cladding with timber, celotex, or other approved sheeting. All Sub-contractors shall be informed accordingly on the precautions to be taken.

* 1. **Blinding**

All blinding concrete to be 1:3:6, or as otherwise instructed by the Engineer in writing.

* 1. **Formwork**

The method and system of formwork which the Contractor proposes to use shall be approved of by the Engineer before construction commences. Formwork shall be substantially and rigidly constructed of timber or steel or pre-cast concrete or other approved material.

All timber for formwork shall be good, sound, clean, sawn, well-seasoned timber, free from warps and loose knots and of scanting sufficiently strong for their purpose.

* 1. **Construction of formwork**

All formwork shall be of sufficient thickness and with joints close enough to prevent undue leakage of liquid from the concrete and fixed to proper alignment, level and plumb and supported on sufficiently strong bearers, shores, braces, plates etc. properly held together by bolts or other fastenings to prevent displacement, vibration or movement by the weight of materials, men and plant on same and so wedged and clamped as to permit easing and removal of the formwork without jarring the concrete. Where formwork is supported on previously constructed portions of the reinforced concrete structural frame, the Contractor shall by consultation with the Engineer ensure that the supporting concrete is capable of carrying the load and/or sufficiently propped from lower floors or portions of the frame to permit the load to be temporarily carried during construction.

Soffits shall be erected with an upward camber of 5 mm for each 5 meters of horizontal span or as directed by the Engineer.

Great care shall be taken to make and maintain all joints in the formwork as tight as possible, to prevent the leakage of grout during vibration. All faulty joints shall be caulked to the Engineer’s approval before concreting. The formwork shall be sufficiently rigid to ensure that no distortion or bulging occurs under the effects of vibration. If at any time the formwork is insufficiently rigid or in any way defective the Contractor shall strengthen or improve such formwork as the Engineer may direct.

The Contractor’s attention is drawn to the various surface textures and applied finishes required and the faces of formwork next to the concrete must be of such material and construction and be sufficiently true to provide a concrete surface which will in each particular case permit the specified surface treatment or applied finish.

All surfaces which will be in contact with concrete shall be oiled or greased to prevent adhesion of mortar. Oil or grease shall be of a non-staining mineral type applied as a thin film before the reinforcement is placed. Surplus moisture shall be removed from the forms prior to placing of the concrete.

Temporary openings shall be provided at the base of columns, wall and beam forms and at any other points where necessary to facilitate cleaning and inspection immediately before the pouring of concrete. Before the concrete is placed the shuttering shall be trued-up and any water accumulated therein shall be removed. All sawdust, nails, chips and other debris shall be washed out or otherwise removed from within the formwork. The reinforcement shall then be inspected for accuracy of fixing. Immediately before placing the concrete the formwork shall be well wetted and inspection openings shall be closed. The erection, easing, striking and removing of all formwork must be done under the personal supervision of a competent foreman, and any damage occurring through faulty formwork or its incorrect removal shall be made good by the Contractor at his own expense.

After removal of formwork, all projections, fins etc., on the concrete surface shall be chipped off, and made good to the requirements of the Engineer. Any voids or honeycombing shall be treated as described in “Faulty Concrete”.

* + 1. **Stripping formwork**

All formwork shall be removed without undue vibration or shock and without damage to the concrete. No formwork shall be removed without the prior consent of the Engineer and the minimum periods that shall elapse between the placing of the concrete and the striking of the formwork will be as follows:

Beam sides, wall and columns 2 days

Slab Soffits (props left under) 3 days

Beam Soffits 7 days

Removal of props (partly subject to 7 days concrete cube strength being satisfactory) to:

Slabs 10 days

Beams 14 days

Cantilevered Beams and Slabs 28 days

If the Contractor wishes to take advantage of the shorter stripping times permitted for beams and slab soffits when props are left in place, he must so design his formwork that sufficient props are agreed with the Engineer can remain in their original positions without being moved in any way until the expiry of the minimum time for removal of props. Stripping and re-propping will not be permitted.

The above times may be reduced in certain circumstances, at the discretion of the Engineer provided an approved method is adopted at the Contractor’s expense to ensure that the required concrete strength is attained before the forms are stripped.

Solid strips in composite slabs shall be considered as beams. The tops of retaining walls shall be adequately supported with stout raking props at intervals required by the Engineer. These props are not to be removed until 7 days after casting of the floor slab is over.

* + 1. **Supporting props to wall and beam soffits**

When directed by the Engineer, supporting props to wall and beam soffits are to be left in position until the completion of the whole of the reinforced concrete structure. The props are to be to the approval of the Engineer and the Contractor must submit the suggested method of propping to the Engineer prior to removal of formwork to the relevant surfaces.

* 1. **Concrete mixes**

Concrete to be used shall be of the classes specified in "Ministry of Works standard Specification" Section 17.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Class | Nominal mix | Trial Strength in N/mm2 | | Where used in this Contract |
| 7 day | 28 day |
| 15 | 1:3:6 | 13 | 19.5 | Not used |
| 25 | 1:2:4 | 25 | 32.5 | Not used |

* 1. **Concrete mixing and placing**

The concrete shall be mixed only in approved power-driven mixers of a type and capacity suitable for the work, and in any event not smaller than 0.04/0.28 cu.m. capacity. The mixer shall be equipped with an accurate water measuring device. All materials shall be thoroughly mixed dry before water is added and the mixing of each batch shall continue for a period of not less than two minutes after the water has been added and until there is a uniform distribution of the materials and the mass is uniform in colour.

The entire contents of the mixed drum shall be discharged before recharging. The volume of mixed material shall not exceed the rated capacity of the mixer. Whenever the mixer is started, 10% extra cement shall be added to the first batch and no extra payment will be made on this account.

As a check on concrete consistency slump tests may be carried out and shall be in accordance with B.S. 1881. The Contractor shall provide the necessary apparatus and carry out such tests as are required.

The slump of the concrete made with the specified water content, using dry materials, shall be determined and the water to be added under wet conditions shall be so reduced as to give approximately the same slump.

The concrete shall be mixed as near to the place where it is required as is practicable, and only as much as is required for a specified section of the work shall be mixed at one time, such sections being commenced and finished in one operation without delay. All concrete must be efficiently handled and used in the Works within twenty (20) minutes of mixing. It shall be discarded from the mixer direct either into receptacles or barrows and shall be distributed by approved means which do not cause separation or otherwise impair the quality of the concrete. Approved mechanical means of handling will be encouraged, but the use of chutes for placing concrete is subject to prior approval of the Engineer.

Concrete shall be placed from a height not exceeding 1,500 mm directly into its permanent position and shall not be worked along the shutters to that position. Unless otherwise approved, concrete shall be placed in a single operation to the full thickness of slabs, beams, and similar members, and shall be placed in horizontal layers not exceeding 1,500 mm deep in the walls and similar members.

Concrete in columns may be placed to a height of 4 meters with careful placing and vibration and satisfactory results. Where the height of the column exceeds 4 meters suitable openings must be left in the shutters so that this maximum lift is not exceeded.

Concrete shall be placed continuously until completion of the part of the work between construction joints as specified hereinafter or of a part of the approved extent. At the completion of a specified or approved part a construction joint of the form and in the positions hereinafter specified shall be made. If stopping of concrete be unavoidable elsewhere, a construction joint shall be made where the work is stopped. A record of all such joints shall be made by the Contractor and a copy supplied to the Engineer.

Any accumulation of set concrete on the reinforcement shall be removed by wire brushing before further concrete is placed. The Contractor shall provide runways for concreting to the satisfaction of the Engineer. Under no circumstances will the runways be allowed to rest on the reinforcement. Care shall be taken that the concrete is not disturbed or subjected to vibrations and shocks during the setting period. Mixing machines, platforms and barrows shall be clean before commencing mixing and be cleaned on every cessation of work. Where concrete is laid on hardcore or other absorbent materials, the base shall be suitable and sufficiently wetted before the concrete is deposited.

* 1. **Works cube tests**

Work cubes are to be made at intervals as required by the Engineer in accordance with C.P. 114, and the Contractor shall provide a continuous record of the concrete work. The cubes shall be made in approved 150 mm moulds in strict accordance with the Code of Practice. Three cubes shall be made on each occasion. Each cube shall be marked with a distinguishing number (numbers) to run consecutively and the date, and a record shall be kept o site giving the following particulars: -

Cube No.

Date made

Location in work

7-Day Test, Date, Strength

28-Day Test, Date, Strength

Cubes shall be forwarded, carriage paid, to an approved Testing Authority, in time to be tested two at 7 days and the remaining one at the discretion of the Engineer. No cube shall be dispatched within three days of casting. Copies of all Works Cube Tests shall be forwarded to the Engineer, and one shall be retained on site. If the strengths required above are not attained and maintained during the carrying out of the contract, the Contractor will be required to increase the proportion of cement and/or substitute better aggregates to give concrete which does comply with the requirements of the contract. The Contractor may be required to remove and replace at his own cost any concrete which fails to attain the required strength as ascertained by Works Cube Tests.

* 1. **Compaction**

At all times during which the concrete is being placed, the Contractor shall provide adequately trained and experienced labour to ensure that the concrete is compacted in the forms to the satisfaction of the Engineer. Concrete shall not be placed at a rate greater than will permit satisfactory compaction or to a depth greater than 400 mm before it is compacted.

During and immediately after placing, the concrete shall be thoroughly compacted by means of continuous tamping, spading, slicing and vibration. Vibration is required for all concrete of classes 40, 35, 25, and 20. Care shall be taken to fill every part of the forms, to work the concrete under and around the reinforcement without displacing it to avoid disturbing recently placed concrete which has begun to set. Any water accumulating on the surface of newly placed concrete shall be removed and no further concrete shall be placed thereon until such water is removed.

Internal vibrators shall be of a frequency not less than 7000 cycles per minute and shall have a rotating eccentric weight of at least 0.05 Kg. with an eccentricity of not more than 12 mm. Such vibrators shall visibly affect the concrete within a radius of 250 mm from the vibrator. Internal vibrators shall not be inserted between layers of reinforcement less than one- and one-half times the diameter of the vibrators apart. Contact between the vibrators and reinforcement, and vibrators and formwork shall be avoided. Internal vibrators shall be inserted vertically into the concrete at not more than 500 mm centers and shall be moved constantly from place to place. No internal vibrator shall be permitted to remain in any one position for more than ten seconds and it shall be withdrawn very slowly from the concrete.

In consolidating each layer of concrete, the vibrating head shall be allowed to penetrate and re-vibrate the concrete in the upper portion of the underlying layer. In the area where newly placed concrete in each layer joins previously placed concrete more than usual vibration shall be performed, the vibrator penetrating deeply at close intervals along these contacts. Layers of concrete shall not be placed until layers previously placed have been vibrated thoroughly as specified. Vibrators shall not be used to move concrete from place to place in the formwork.

At least one internal vibrator shall be of the high frequency, low amplitude type applied with the principal direction of vibration in the horizontal plane. They shall be attached directly to the forms at no more than 1200 mm centers. In addition to internal and external vibration the upper surface of suspended floor slabs shall be leveled by tamping or vibrating to receive finishes. Vibrating elements shall be of the low frequency high amplitude type operating at a speed of not less than 3000 r.p.m.

* 1. **Curing and protection**

Care must be taken that no concrete is allowed to become prematurely dry and the fresh concrete must be carefully protected, within two hours of placing, from rain, sun and wind by means of Hessian sacking, polythene sheeting, or other approved means. This protective layer and the concrete itself must be kept continuously wet for at least 7 days after the concrete has been placed. The contractor will be required to provide complete coverage of all fresh concrete for a period of 7 days. Hessian or polythene sheeting shall be in the maximum widths obtainable and shall be secured against wind. The Contractor will not be permitted to use old cement bags, Hessian or other materials in small pieces.

Concrete in foundations and other underground work shall be protected from admixture with falling earth during and after placing. Traffic or loading must not be allowed on the concrete until the concrete is sufficiently matured, and in no case shall traffic or loading be of such magnitude as to cause deflection or other movement in the formwork or damage to the concrete members. Where directed by the Engineer props may be required to be left in position under slabs and other members for greater periods than those specified hereafter.

* 1. **Faulty concrete**

Any concrete which fails to comply with these specifications, or which shows signs of setting before it is placed shall be taken out and removed from site. Where concrete is found to be defective after it has set, the concrete shall be cut out and replaced in accordance with the Engineer’s instructions. On no account shall any faulty, honeycombed, or otherwise defective concrete be repaired or patched until the Engineer has made an inspection and issued instructions for the repair. The whole cost whatsoever, which might be occasioned by the need to remove faulty concrete, shall be borne by the Contractor.

* 1. **Pre-cast units**

Pre-cast reinforced concrete slabs to be made to sizes as shown in the Drawings. Slabs to be cast with Grade 25 concrete in approved formwork, suitably vibrated and cured for 28 days before use.

* **REINFORCEMENT**
  1. **Material**

Reinforcement shall be as specified by the Engineer.

* + 1. **Bending and placing reinforcement**

Reinforcement shall be cleaned before placing and secured with space blocks in the correct position. It shall be bound with suitable wire and have such cover as shown on the drawings.

* + 1. **Strength of reinforcement**

Characteristic strengths of reinforcement are as given in B.S. 4449, 4461, and 4483.

* + 1. **Rod reinforcement**

The steel reinforcement shall comply with the latest requirements of the following British Standards: - Hot Rolled bars for the Reinforcement of concrete to B.S. 4449 (metric units)

Cold worked steel for the reinforcement of concrete to B.S. 4461 (metric units)

The Contractor will be required to submit a test certificate of the rollings. Reinforcement shall be stored on racks above ground level. All reinforcement shall be free from loose mill scale or rust, grease, paint or other substances likely to reduce the bond between the steel and the concrete.

* 1. **BRC**

The BRC should be electrically cross-welded steel wire mesh reinforcement to B.S. 4483: 1969, or as directed by the Engineer, and of the size and weight specified in the Drawings.

The fabric shall be free from scale, dust, rust, grease or other substance likely to reduce the bond between the steel and the concrete and shall be laid with a minimum 300 mm laps and bound with No. 18 S.W.G. annealed iron wire.

* 1. **Fixing reinforcement**

Reinforcement shall be accurately bent to the shapes and dimensions shown on the Drawings and in accordance with B.S. 4466 (1969). Reinforcement must be cut and bent cold and no welded joints will be permitted, unless so detailed. Reinforcement shall be accurately placed as shown on the Drawings, and before and during concreting, shall be secured against displacement by using No. 18 S.W.G. annealed binding wire or suitable clips at intersections, and shall be supported by concrete or metal supports, spacers or metal hangers to ensure the correct position. No concreting shall be commenced until the Engineer has inspected the reinforcement in position and until his approval has been obtained and Contractor has given two clear days‟ notice of intention to concrete.

The Contractor is responsible for maintaining the reinforcement in its correct position, according to the drawings, before and during concreting. During concreting, a competent steel fixer must be in attendance to adjust and correct the position of any reinforcement which may be displaced. The vibrators are not to meet the reinforcement.

* 1. **Position and correctness of reinforcement**

Irrespective of whether any inspection and/or approval of the fixing of the reinforcement has been carried out as in C above, it shall be the Contractor’s sole responsibility to ensure that the reinforcement complies with the details on the Drawings and is fixed exactly in the positions shown therein and, in the positions, to give the prescribed cover. The Contractor will be held entirely responsible for any failure or defect in any portion of the reinforced concrete structure and including any consequent delay, claims, third party claims. etc., where it is shown that the reinforcement has been incorrectly positioned or is incorrect in size or quantity with respect to the detailed Drawings.

* 1. **Concrete cover to reinforcement**

Unless otherwise directed, the concrete cover to rod reinforcement over main bars in any face shall be:-

Foundations against blinding 50 mm

Strip foundations 40 mm

Columns/Floor slab/Walls 40 mm

Beams 25 mm

* 1. **Projecting reinforcement**

Where reinforcement projects from a concreted section of the structure and this reinforcement is expected to remain exposed for some time, it is to be coated with a cement grout to prevent rust staining on the finished concrete. This grout is to be brushed off the reinforcement prior to the continuation of concreting.

* 1. **Fixtures**

No openings, chases, holes or other voids shall be formed in the concrete without the prior approval of the Engineer. Details of any fixtures to be permanently built into the concrete including the proposed position of all electrical conduits 25 mm and over in diameter shall be submitted to the Engineer for his approval before being placed.

* 1. **Chases, holes, etc., in concrete**

The Contractor shall be responsible for the co-ordination with the Electrical and other Sub-Contractors for incorporating electrical conduits, pipes, fixing blocks, chases and holes in concrete members as required and must ensure that adequate notice is given to such Sub-Contractors informing them when concrete members incorporating the above are to be poured. The Contractor shall submit full details of these items to the Engineer for approval before the work is put in hand. All fixing blocks, chases, holes, etc., to be left in the concrete shall be accurately set out and cast with the concrete. Unless otherwise instructed by the Engineer, all electrical conduit to be positioned within the reinforced concrete shall be fixed inside the steel cages of beams and columns and between the top and bottom steel layers in the slabs and similar members.

The proposed position of all electrical conduits 25 mm and over in diameter which are to be enclose in the concrete shall be shown accurately on a plan to be submitted to the Engineer, whose approval shall be obtained before any such conduit is placed.

* **PIPEWORK**
  1. **GI. pipes and fittings**

All pipework is to be HDPE pipe PN16.

All jointing and lying of PVC pipes and fittings shall be carried out strictly in accordance with the manufacturer’s instructions.

* 1. **Sluice valves**

Valves shall confirm to BS 1218

Sluice valves shall have heads for key operation unless otherwise stated.

Valves shall be securely fixed with the spindle in vertical position, unless otherwise stated. They shall be checked for ease of operation and water tightness. Valve glands shall be repacked if necessary.

Unless otherwise stated, sluice valves should be able to withstand the working pressure of the class of pipe adjoining the valve.

* 1. **Air valves**

Air valves shall be of cast iron conforming to BS 1452, grade 14. They shall be suitable for working pressures not less than the specified for the class of pipe specified. To which they are connected.

* 1. **Manufacturer’s instructions.**

The contractor shall be responsible for obtaining copies of any manufacturer’s instructions for pipes jointing and shall familiarizes himself and his employees with these instructions.

All necessary tools and equipment required for the laying, jointing and testing of pipes and joints shall be provided by the contractor at no extra costs.

* 1. **Step Irons**

Step irons shall be galvanized malleable iron and shall comply with B.S 1247.

* 1. **Surface Boxes**

Surface boxes shall confirm to B.S 1426.

* 1. **Trench excavation.**

Excavated material shall be placed tidily and compactly at the sides of the trench so as to occupy as little space as possible and to create as little nuisance as possible.

The bottom of the trench shall be absolutely smooth and completely free from stones and sharp objects so as to ensure that the pipes rests uniformly upon original ground throughout its length.

Backfilling with excavated material beneath the pipe at low spots will not be permitted. Excavation below the bottom of the trench at pipe joints must be kept to a minimum.

If the bottom of the trench materials that is unsuitable for pipe laying, the Engineer may instruct the contractor to excavate below formation level and backfill to formation with suitable approved material properly compacted.

No pipe laying is to take place until the bottom of the trench is carefully examined by the Engineer’s representative.

* 1. **Minimum trench depth**

The minimum depth for pipe trenches shall be that which provides a cover of 300 mm above the Backfilling in pipe trenches

Backfilling around the pipe and to a height of 300 mm above it is to be carried out by using material that is free from stones and carefully compacted in layers not exceeding 150 mm thick.

Backfill to trenches shall be properly compacted and subsequent subsidence shall be the Contractor’s responsibility and shall make it good at his own expense.

All topsoil shall be kept aside during excavation and replaced after backfilling. All surplus material from the excavations shall be disposed.

* 1. **Removal of timbering**

All timbering materials shall be removed from trenches before or during backfilling unless, in the opinion of the Engineer, its removal will cause any subsidence in which case he may instruct the contractor to backfill leaving the timbering in place.

* 1. **Reinstatement**

Immediately backfilling of trenches has been completed, temporary reinstatement of the ground surface shall take place.

When in the opinion of the Engineer’s representative a suitable period has elapsed after the temporary reinstatement and expects no further settlement, he shall allow the contractor to carry out the permanent reinstatement. This shall in any way relieve the contractor of his responsibility for the reinstatement and, should any further unforeseen settlement take place, the contractor will be required to make good the reinstatement at his own expense.

Permanent reinstatement means the ground surface shall be restored to its original form and condition.

* 1. **Handling and storing pipes**

Particular care shall be taken during loading, unloading, handling and transportation to avoid distortion, flattening, denting, scoring or any damage to external or internal coating, sheathing or lining of the pipes, fittings, etc.

Pipes shall be stacked clear of the ground on the timbers of adequate dimensions to prevent damage to the pipes and successive tiers shall be separated by timber of similar dimensions. Wooden wedges shall be fixed to these timbers to prevent the wedges from rolling.

Fittings etc. shall be stacked clear of the ground on timbers not more than 1 tier high.

All valves rubber joint rings, gaskets, nuts, bolts, washers and similar fittings shall be stored in approved locked premises and shall not be distributed to the trench until immediately prior to fixing. All rubber joint rings and gaskets must be stored in a cool place.

All UPVC pipes and fitting should be stored under cover and protected from weather to the satisfaction of the Engineer.

* 1. **Examination of pipes**

Before laying each pipe must carefully be examined for damage. Any defects in the external coating or internal lining shall be made good. The pipes shall be carefully examined for cracks or chipped ends. Damaged ends shall be cut off beyond the damaged area and machined true.

All pipes shall be cleaned internally before laying.

* 1. **Laying of pipes**

Pipes shall be laid true to line by means of a string line stretched along the sides of the pipes and true to level by means of a straight edge of at least 4 meters long kept inside the pipes and pulled forward to pegs boned in at suitable intervals between sight rails set to the proper levels

Where pipes are to be laid on ‘normal’ or imported material the floor of the trench shall be compacted and shaped so that the barrel rests over a width of the least one third of its diameter and throughout the length of the barrel upon the floor. Holes shall be excavated under the joints and sockets so that the sockets do no bear on the ground. The underside of the barrel and socket shall then be packed hard with earth or gravel fill material as directed by the Engineer and of maximum particle size not exceeding 25mm diameter and rammed solid

Mains shall be boned to even gradients using site rails no dips or bumps permitted.

All pipes shall be solidly bedded on the trench bottom. Joint holes shall be as small as possible and filled in compactly before the refilling of the trench commences.

The contractor shall make full allowance for all cuttings and jointing of pipes.

* 1. **Concrete surround to pipelines**

Where pipelines pass under streams and rivers or under roads the sectionsof pipeline under the stream river or road and for a minimum distance of1.0m clear on either side of the bank or edge thereof or such greaterdistance as the Engineer’s Representative may require shall be surroundedwith Class 15 concrete in accordance with the typical detail shown on theDrawings to provide a minimum 150mm thickness protectivesurround to the pipe.

Similar class 15 concrete surround shall be provided elsewhere as may berequired by the Engineer for the added protection of the pipeline at anypoint along the pipeline route.

* 1. **Thrust and anchor blocks**

Concrete thrust and anchor blocks shall be formed at bends tees and valves in accordance with the typical sections shown on the Drawings or otherwise as directed by the Engineer. The additional excavation shall be made after the bends etc. have been jointed and the concrete shall then be placed with all possible speed. The back of supports and blocks shall abut on to solid ground all loose material being removed before concreting. The concrete used for thrust and anchor blocks shall be Class 15 and after placing shall be kept in view for not less than six hours. No pressure shall be applied in any section of main until the concrete has had at least three days **curing.**

* 1. **Flotation of pipeline**

The Contractor shall be solely responsible for ensuring that flotation of thepipeline does not occur during construction. The extent of the backfillplaced over each pipe after laying and before testing shall be such as willprevent flotation of the pipeline

Should any section of the pipeline float out of line or level, the section ofpipeline so affected shall be removed and re-laid in accordance with theSpecification to the satisfaction of the Engineer’s representative.

* 1. **Fixing surface boxes and penstocks**

Valves penstocks and other fittings shall be securely fixed and whererequired extension spindles and headstocks shall be properly aligned andfixed in a vertical position. They shall be tested for ease of operation andwater tightness and valve glands shall be repacked where necessary. Anydamaged protective coating shall be made good, and they shall be left cleanin all respects.

* 1. **Surface water**

No surface water or other extraneous matter shall be allowed to enter the pipes during or after laying. Should this happen, the contractor shall arrange for the necessary cleaning of the pipe at his own expense.

Plans to divert lagga flow through the existing pipes should be discussed and confirmed with the engineer.

* 1. **Painting of exposed pipes, valves, fittings, and metalwork**

All pipes, valves, tubes, manhole covers and the like, that are left exposed to the air at river crossings, in manholes, chambers etc., except where galvanized, shall be thoroughly cleaned and painted with two coats of approved bituminous paint after erection.

* 1. **Testing of pipes**

All pipes and apparatus that are to contain water under pressure shall be tested to the working pressure plus 50%. If the pipes are in the trench, they shall be backfilled for the two thirds of the distance between joints, leaving joints exposed. The fill shall be a minimum of 450mm deep.

Testing shall take place in the presence of the Engineer’s representative as the work proceeds, test lengths being approved by the Engineer. The maximum length of the pipe laid without pressure testing must not exceed 3 km.

Pipes shall be securely anchored, and pipe ends shall be closed by means of caps or blank flanges. Sluice valves shall not be used at the end of a test length.

The contractor shall give the Engineer’s representative a minimum of 24 hours’ notice of his intention to carry out a test.

All water, materials, and apparatus for carrying out the tests are to be provided by the contractor at no extra cost.

The procedure for testing is as follows.

1. The test length shall be filled with water and brought to the required test pressure by means of a pressure pump. When the required is obtained, indicated by an approved pressure gauge, the pump shall be disconnected, and the pressure of the water watched for a period of 60 minute, any drop in pressure being carefully monitored.
2. If there is a drop in pressure at the end of the 60 minutes period, the pump should be reconnected, and the test pressure re-established. The pump should then be disconnected and the pressure lowered immediately by bleeding off the water from the mains through a tap into a container. When the pressure reaches the same pressure that was indicated at the end of, the 60 minutes test period, the tap is closed, and the amount of water collected in the container is measured. This amount of water is the leakage and for the test to be successful must not be greater than the “allowable leakage” as calculated below.

Allowable leakage (litres) = d\*l\*p/1,227,000

Where.

* d –Diameter of pipe (mm)
* l-length of pipe under test(m)
* p- Average pressure in pipe(m)

1. If the test fails, it is the contractor’s responsibility to locate the leak and remedy it so that the pipeline passes the test.
   1. **Sterilization**

Treated water mains should be washed out and sterilized before being put into service. Sterilization should consist of introducing water containing a quantity of chlorine such that there is a concentration of chorine throughout the mains at not less than 30 parts per million. This solution is to remain in the pipeline for a period of 24 hours after which the main shall be thoroughly flashed out with water to be used for the supply.

The inside of water retaining structures shall, after being thoroughly cleaned, be filled to overflow level with water containing 20 parts per million of chlorine and left for at least 24 hours before flushing out.

After flushing, bacteriological samples of water shall be taken in accordance with the Engineers instructions. If any of the samples proves to be inferior to that of the supply water, the sterilization and flushing shall be repeated.

All costs of sterilization shall be the contractor’s responsibility. The cost of sampling and testing shall be the responsibility of the employer if successful but if not shall be borne by the contractor.

* 1. **Manholes and Chambers**

Manholes and chambers shall be constructed in accordance with thestandard manhole detail drawings. Where the Contractor wishes toconstruct manholes or chambers other than in accordance with the saiddrawings he shall submit details to the Engineer for his approval at least14 days prior to the intended date of commencement of construction.

The incoming and outgoing lengths of pipes shall terminate at the internalface of the concrete with spigot ends which in the case of concrete pipesshall not be cut ends. The concrete surrounding the spigot ends shall beplaced in the single operation to at least 150mm. over the top of the pipesfor the full thickness of the wall and the whole of the base wall brought upto the same level. The concrete shall be of a minimum thickness of40mm. between the pipe and structural floor and particular care shall betaken to ensure that the concrete completely fill the spaces beneath pipesand that a sound joint is made all round each pipe.

Access opening to manholes shall be sited on the downstream side ofmanholes unless another position is necessary for accommodating therodding-eye of a backdrop.Manholes and chambers are no necessary to be placed centrally overpipelines but shall be so located that the best use can be made of the areaof the bottom of the manhole of chamber when arranging channels,particular regard being paid to backdrop.

* 1. **Channels and Benches**

Channels in manholes and chambers are to be formed in Class ‘20’ concrete benching finished with 50mm, minimum Class ‘20’ fine concrete or as directed by the Engineer. The invert of the channel is to be formed to a fall not less than the lesser gradient of the two adjacent pipelines. All branch drains are to be connected to the main channel with half-channel branches of a proper angle and radius to lead into the run of the main channel the bends being as “slow” as possible.

Sides of channels and benches are to be finished with 50mm thick Class ‘20’ fine concrete and all shall be homogeneous. Special care shall be taken to produce perfectly smooth finish all over and to ensure the uniformity of the slope of the benching of the top of the nosing and of the invert and that proper clearance is given round valves, penstocks and other fittings.

Sides of channels shall be carried up vertically above the half round channel and shall join the benchings with nosings of 25mm. radius. Benchings shall rise at a slope of one in six from the edge of the main channel starting from an assumed line between the crowns of the incoming and outgoing pipes. Inverts sides of channels and benching’s of each manhole are to be completed before the chamber slab is placed in position