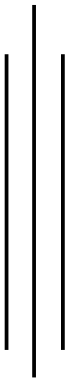
RURAL RECONSTRUCTION AND REHABILITATION SECTOR DEVELOPMENT PROGRAM (RRRSDP) PCU/CISC



GENERAL SPECIFICATIONS FOR CONSTRUCTION WORKS UNDER RURAL WATER SUPPLY & SANITATION

May, 2009

Rural Reconstruction and Rehabilitation Sector Development Program (RRRSDP)

PCU/CISC

GENERAL SPECIFICATIONS FOR RURAL WATER SUPPLY & SANITATION SUB-PROJECTS

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Rural Reconstruction and Rehabilitation Sector Development Program (RRRSDP)
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GENERAL SPECIFICATIONS FOR CONSTRUCTION WORK

GENERAL

The organization of construction works in a community-based Water Supply and Sanitation Sub-project would be fairly different than the contract-based implementation. The sub-project implementation would involve no or minimum of contract. Construction material, skilled labour payment and technical support would be provided by DPO/DIST/IC and unskilled voluntary labors provided by the community. Execution of construction works would be the collective responsibility of the DPO/DIST/IC and the VIUG (WUSC) members. VIUG (WUSC) members will organize, supervise and control the quality of construction work with technical support provided by the DPO/DIST/IC technicians. Water Supply and Sanitation Technicians (WSST) would closely work with the VIUG (WUSC) members in day to day basis and the Sub-Engineer Site-In-Charge would be the technical supervisor for all construction activities. An Engineer-In-Charge of DPO/DIST/IC would be responsible for all overall implementation of the project and advise technicians and the VIUG (WUSC) members on matters of specialized technical knowledge and know-how.

Inadequate knowledge of work specifications and lack of awareness on quality of construction among community, local labor and technicians is a major problem in maintaining the quality of construction. These Specifications are especially intended for the use and guidance of the DPO/DIST/IC technicians and the VIUG (WUSC) members. Thus, it is purposefully structured in instructional form rather than a standard and legal document for strict quality control of work if a professional contractor. It is also meant to be a useful reference for Engineer-In-Charge of community-based sub-projects. Though, these specifications might not be used directly for construction works under contract, for which other documents have to be referred. Nevertheless, this could be used as reference document for such purpose.

Specifications are simplified to the possible extent to make it relevant and applicable in a community-based construction works in rural environment.

Specifications for most common construction works in community-based rural sub-projects have only been included. While quality of locally available construction materials, skill of voluntary and hired labor and availability of tools and equipments in rural surrounding has been given due consideration in these specifications, maintaining the quality of construction in any situation is emphasized

Any standard test requirements, inspection procedures, and difficult to implement in remote and rural situation, has been included as optional. Whenever appropriate, simple on-site tests should always be carried out and arrangements should be made for laboratory tests.

The community should be educated, advised and motivated for following the specifications and maintaining the quality of local construction material to be contributed by them and

construction works to be implemented. Technicians and Site-In-Charge should inspect and ensure the quality of the construction material together with the WUSC members at the source or query sites, before they are transported to the construction sites. This would avoid an embarrassing situation of rejecting the materials collected through hard work of the community at the construction site. Any construction material to be transported from district store should be inspected for quality before they are dispatched for construction site.

1. Site Works

That part of the site occupied by the works should be cleared of all trees, roots, vegetation, rocks, boulders etc., and as much topsoil as instructed by the Site-In-Charge. Cutting and filling of earth on the site should be done to lines, levels and slopes as shown in the Drawings or as instructed by the Site-In-Charge. Surplus earth from the excavation within the area, if found suitable, may be utilized for filling, but any earth required in excess should be obtained from dry earth free from debris, plants and vegetable matter. The site should be examined for field drains, and these, when found, should be either entirely removed or diverted and trenches filled with dry earth. All fillings should be done in 15 cm layers and consolidated as instructed by the Site-In-Charge.

After completion of the work, the work sites should be in a clean and sanitary condition.

2. Excavation

All excavation should be carried out to the lines and levels as shown in the Drawings or as instructed by the Site-In-Charge.

In the excavation of trenches or foundation any materials e.g. rocks, stone, tree, roots, old foundations should be removed and water drained out. Pumping out the water should be preferred if the pumping equipment can be made available at the site. If necessary temporary shoring should be fixed in order to safe guard any slips of earth and safety of the worker.

Provision should be made at site to the shore up, support and adequately protect any works in the vicinity likely to be affected by the excavation. Any damage to drains, floors, building, pipe lines or any other existing work, should be made good at the expense of the project fund after securing approval of competent authority.

No blasting should be carried out without the permission of the Site-in-Charge. In carrying out blasting, all precautions must be taken to avoid damage or injury to person or property and observe the regulation laid down by Government of Nepal.

Precaution should be taken to prevent water from surface, subsoil or rainwater from accumulating in the excavated area, and keep such excavation reasonably dry at all times. All the surplus material should be deposited or removed as instructed by the Site-In-Charge. Any excavated rock, if advised by the Site-In-Charge, may be broken up and used as rubble required for the project work.

3. Excavation for Pipelines

Before excavation trenches for pipe lines, the alignment should be marked with pegs at 50 m stretch in straight section and at every bend.

The excavation should be carried out to the lines and levels shown in the plans and sections, and should be deep enough to permit a minimum cover of 900 mm. The trench width should be as per drawing or as advised by the Site-In-Charge.

Up to one-meter depth, the authorized width of trench for excavation shall be arrived at by adding 25 cm to the external diameter of pipe. The width of the pipe trench shall not be less than outside diameter of pipe plus 30 cm in case of gravel soil.

The width & depth of the trenches for the different diameters of pipe shall be:

Diameter of pipe (mm)	*Width of trench (cm)*	*Min. depth of trench (cm)*
15 – 50	*45*	*90*
63 and above	*60*	*90*

During the works in progress, the whole of the working site should be kept dry and free from water and construct such temporary water courses and drains as may be necessary. As far as practical, locally available best quality timbers should be used. Needed tools, equipment and pumps etc. would be provided by the project. Whole work should be executed as quickly as possible, due care being taken to avoid excessive pumping, which may cause settlement of surrounding land and property.

Any trench or excavation which may have been taken to a greater depth than necessary should be filled into the required level with suitable material as advised by the Site-In-Charge and rammed with watering.

Roots of trees within the distance of about 0.5 m from the trench site of the pipeline shall be removed. The excavated materials shall not be placed within 1 m or half of the depth of the trench, which ever is greater, from the edge of the trench.

4. Filling in Trenches for Pipes

When the pipe joints have been assured for water-tightness, the trench should be filled in by replacing the excavated earth in layers, the first layer to be 30 cms thick and free from all stone and similar materials. Subsequent layers should be 15 cms thick, and, as far as possible, should be watered and rammed as the work proceeds. Special care should be taken to see that the earth is packed uniformly around and under the pipes to ensure a sound bearing throughout the entire length of pipe line, and watered and rammed carefully so as to avoid injury to the pipe. *Pipes in trenches on a slope shall have extra attention*.

Any subsidence after the first refilling should be leveled by adding the necessary extra material, which should then be thoroughly rammed for proper consolidation.

5. Filling under Floors

The material used for filling under floors should be clean and of good hard composition, perfectly free from all organic and foreign matter, to the satisfaction of the Site-In-Charge.

In the event of any surplus excavated material not being required for filling to trenches, leveling site, etc., may be used for filling under floors.

All filling should be in layers not exceeding 15 cms in thickness, each layer being well watered and rammed. All filling should be completed before any floor or roof-work is commenced.

6. Barbed Wire Fencing

The fencing should be of 6 or 7 strands of galvanized barbed wire secured to posts spaced at 1.5 m. centers, complete with necessary corner and straining posts and struts as shown in Type Drawings. The galvanized barbed wire should be 12 SWG with four points every 75 mm. The general arrangement and design of the posts and struts and foundations and methods of securing the barbed wire to the posts, stiffeners etc., should be as shown in Type Drawings.

7. Cement

All cement used on the works should be the best quality Ordinary Portland cement of approved manufacture and should comply with the requirements of the current NS. 49-2041 or equivalent Indian or British Standard.

Direct purchase should be made from a trusted dealer or distributor for ensuring quality and strength of the cement. The supplier should be enquired of the manufactured date and receipt at his store to verify the age of the cement. Supplier's storage facility should also be inspected to verify possibility of quality deterioration during storage. Purchase should be made from latest received consignment and appropriately stored facilities.

Whenever appropriate and feasible in case of a contractor supplied cement, necessary test should be carried out at the construction site. The Site-In-Charge should take samples from any consignment of cement of testing in a approved laboratory. There should always be a sufficient supply of cement at the site to allow time for new consignment to be tested. The cement must be delivered in the manufacturer's sealed and branded bags. The costs of the tests should be borne by the contractor.

Whenever applicable, a pre-arrangement should be agreed with the contractor for production of Test certificates supplied by the manufacturers for each and every consignment and test procedures. The Engineer-In-Charge may at his discretion allow the use of the cement on the production of these certificates but should subsequent tests on samples from the consignment indicate it to be below the requirements of the NS, the Engineer-In-Charge may advise to demolished the works executed with such cement and refuse to allow the use of the cement.

Whatsoever may be the condition of the purchase, suitable weather-proof stores with raised wooden floors should be arranged, as may be necessary, to protect all cement at the site and all precautions must be taken to ensure that cement is stored in such a manner as to prevent deterioration or contamination.

No cooled, softened or retempered cement should be used and no crushing or reusing of partially set cement will be permitted - to maintain good quality of work required by the specification.

8. Aggregates

The material should be chemically inert in combination with cement used, strong hard, durable of limited porosity, clean and free from adhering coatings, Clay lumps and organic or the impurities which might cause the corrosion of reinforced cement or impair the strength or durability of the concrete. If required, all or any portion of the aggregate must be washed thoroughly as advised by the Site-In-Charge.

The maximum quantity of deleterious material shall not be more than 5% of the weight of coarse aggregate. (IS 383-1970)

Whenever feasible, periodic sampling and analysis of the aggregates should be done to maintain the quality and uniformity of the materials collected for use

Coarse aggregate should as far as possible be angular or rounded in shape. Aggregate with high percentage of flaky or elongated particles should be rejected. The amount of fine particles occurring in a free state or as a loose adherent should not exceed 1% when determined by the laboratory sedimentation test. After twenty-four hours in water, a previously dried sample should not gain more than 10% in weight.

Fine aggregate, whenever feasible should be natural sand. Fine aggregate derived by crushing coarse aggregate may be used in combination with natural sand in suitable proportions. The caustic soda tests for organic impurities should show a colour not deeper than of the Standard solution. The setting test for natural sand should be made and after being allowed to settle for three hours the layers of silt deposit on the coarse material should not exceed 8% and the layer of mica deposit should not exceed 2%.

The sand containing more than the allowable percentage of silt shall be washed so as to bring the silt content within the limit.

The aggregates should be stored in such a way as to prevent the admixture of foreign materials. The heaps of fine and coarse aggregates should be kept separate. Different sizes of fine or coarse aggregates should be stored in separate stock piles sufficiently removed from each other to prevent the material at the edge of the piles from getting intermixed.

Sand requiring for mortar for plasterwork shall conform to IS 1542-1977 and for masonry work shall conform to IS 2116-1980.

9. Water

As far as possible, only fresh and clean water free from all deleterious matter and chemically inert should be used for mixing mortar or concrete, and water from excavation should not be used. The Site-In-Charge should inspect the alternative water sources and advise the most suitable one to be used.

10. Bricks

The bricks should be the best quality available in the locality. It should be well burnt, true to shape and free from cracks, lumps and foreign matter and the structure when broken, should be uniform and compact. Site-In-Charge should inspect the brick kiln and approve the delivery. He should also bring samples for later comparison at the delivery to the site. Delivered bricks should be equal to the sample approved by the Site-In-Charge.

11. Reinforcement

The reinforcement should be:

(a) mild steel and medium tensils bars and hard-drawn steel wire conforming to IS : 1339 - 1960, *IS 432-1982 (Part I & II)*
(b) high strength deformed steel and wires for concrete reinforcement (IS 1786-1985)
(b) deformed bars conforming to IS : 1139 - 1959
(c) cold twisted steel bars conforming to IS : 1786 - 1960,
(d) hard-drawn steel wire fabric conforming to IS: 1566 - 1985, and
(e) structural steel sections conforming to IS : 226 - 1975,

All reinforcement when placed should be clean and free from loose mill-scales, dust, loose rust and coats of paint, oil, grease or other coatings which may destroy or reduce bond.

The sizes, positions and number of rods should be as shown in drawings. Rods should be bent cold and the dimensions of the bends etc. should be as shown in the schedule of reinforcement on the drawings.

If welded joints in reinforcement are used, test for important connections should be made to ensure that the joints are of the full strength of bars connected. Welding or reinforcement should be done in accordance with the recommendations of relevant Indian Standards for Welding of mild steel bars used in reinforced concrete construction.

Steel reinforcement should ordinarily be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. It is a good practice to coat reinforcement with cement wash before stacking to prevent rust.

12. Concrete

(i) **Grade of Concrete**: Commonly four grades of concrete in rural construction are in use: M 10, M 15, M 20, and M 25.

In the designation of a concrete mix, letter M refers to the Mix and the number to the 28-day work cube compressive strength of that mix expressed in N/mm^2.

(ii) **Strength Requirements of Concrete:**

Where Ordinary Portland Cement conforming to NS. 49-2041 is used, the compressive strength requirements for various grades of concrete should be as shown in Table I below.

The strength requirements specified should apply to both controlled concrete and ordinary concrete. Preliminary tests need not, however, be made in the case of ordinary concrete.

Where the strength of a concrete mix, as indicated by tests, lies in between the strength for any two grades, such concrete should be classified for all purposes as a concrete belonging to the lower of the grades between which its strength lies.

TABLE I: STRENGTH REQUIREMENTS OF CONCRETE
(All Values in N/mm^2)

Grade of Concrete	Compressive Strength of 15 cm cubes		
	Preliminary Test Min	at 28 days Works Test Min	at 7 days Works Test Min
M 10	135	10	7
M15	200	15	10
M20	260	20	13
M25	320	25	17

(iii) Controlled Concrete

As far as possible controlled concrete should be used on all concrete works. Controlled concrete for use in plain and reinforced concrete structures should be in grades M 10, M 15, M 20 and M 25.

The concrete mix should be designed to have an average strength corresponding to the values specified for preliminary tests in TABLE I. The proportions chosen should be such that the concrete is of adequate workability for the conditions prevailing on the work in question and can be properly compacted with the means available.

Except where supply of properly graded aggregate of uniform quality can be maintained over the period of work, the grading of aggregate should be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions when required, the different sizes being stocked in separate stock piles. The grading of coarse and fine aggregate should be checked as frequently as possible, the frequency for a given job should be determined by the Site-In-Charge to ensure that the uniform grading are maintained with that of the samples used in the preliminary tests.

In proportioning concrete, the quality of both cement and aggregate should be determined by weight, Water should be measured by volume in calibrated tanks or weighed. All measuring equipment should be maintained in a clean serviceable condition and their accuracy periodically checked.

It is most important to maintain the water-cement ratio constant at its correct value. To this end, determination of moisture contents in both fine and coarse aggregates should be made as frequently as possible, the frequency being based on wheather conditions. The amount of added water should be adjusted to compensate for any observed variations in the moisture contents. For determination of moisture content in the aggregates. IS:2386 (Part III)-1963

Methods of Test for Aggregate for Concrete may be referred to. To allow for the variation in weight of aggregates due to variation in their moisture content, suitable adjustments in the weights of aggregates should also be made.

Workability of concrete should be checked at frequent intervals. The slump test may be adopted for this purpose.

(iv) Ordinary Concrete

Where it is considered not practicable to use controlled concrete, ordinary concrete may be used for concrete grades M 10, M 15, M 20, and M 25. The proportions of materials for nominal concrete mixes for ordinary concrete should be in accordance with Table II.

In proportioning concrete, the quantity of cement should be determined by weight. The quantities of fine and coarse aggregates may be determined by volume, but these should also preferably by determined by weight. In the latter case the weight should be determined from the volume specified in Table II and the weight per liter of dry aggregate. If fine aggregate is moist and volume batching is adopted, allowance should be made for bulking in accordance with IS: 2386 (Part III)-1963. The water-cement ratios should not be more than these specified in TABLE II.

In proportioning concrete, the quantity of cement should be determined by weight, The quantities of fine and coarse aggregates may be determined by volume, but these should also preferably by determined by weight. In the latter case the weight should be determined from the volume specified in TABLE II and the weight per liter of dry aggregate. If fine aggregate is moist and volume batching is adopted, allowance should be made for bulling in accordance with IS: 2386 (Part III)-1963.

TABLE II: CONCRETE MIX PROPORTIONS

ORDINARY CONCRETE

Grade of Concrete	Total quantity of dry aggregates by volume per 50 kg of cement (sum of individual volumes of coarse and fine aggregates, max) Litres	Proportion of fine aggregate to coarse aggregate	Quantity of water per 50 kg of cement, max Litres
M10	300	Generally 1:2 for fine aggregate to coarse	34
M15	220	aggregate by volume	32
M20	160	but subject to an	30
M25	100	upper limit of 1:1.5 & lower limit of 1:3	26

Note : It may be noted for general guidance that the grades of concrete listed correspond approximately to the nominal mixes generally used.

Grade of Concrete	Nominal Mix
M 10	1:3:6
M 25	1:2:4
M 20	1:1.5:3
M 25	1:1:2

The water cement ratios should not be more than these specified in TABLE II.

Workability of the concrete should be controlled by direct measurement of water content, making allowance for any surface water in the fine and coarse aggregates. The slump test in accordance with IS:1199-1959 may be used as a guide.

(v) Mixing of Concrete

Mechanical Mixing

Whenever feasible, mechanical mixing should be preferred. Concrete should be mixed in a batch mixer of approved type having a drum rotating about a horizontal or inclined axis. The speed of the drum is to be not more than twenty and not less than fourteen revolutions per minute. Each mixer is to be fitted with a water measuring device capable of accurate measurement to one gallon for one cubic yard mixer and pro rata for smaller sizes and so arranged that the accuracy is not affected by variations in the water supply line.

The fine and coarse aggregate and the cement are to be mixed for at least four turns of the drum, after which the required amount of water is to be added gradually while the drum is in motion and the concrete then mixed for at least one and a half minutes and until of uniform

colour and consistency. The volume of concrete mixed in any one batch is not to exceed the rated capacity of the mixer.

The whole of the mixed batch is to be removed before materials for a fresh batch enter the drum.

When mixing stops for any period exceeding 200 minutes, the mixer and all handling plant are to be washed out with clean water.

Hand Mixing

In hand mixing the aggregate and cement in the requisite proportions plus 10 percent of cement should be brought together and turned over twice in a dry state on the stage and after sufficient water to moisten the mass has been added the whole of the materials are again to be thoroughly turned over twice before leaving the stage in addition to any other turning which may be required to place the mass into the work.

(vi) Transporting of Concrete

Concrete should be transported from the place of mixing to the place of final deposit as rapidly as possible by methods, which will prevent the segregation or loss of the ingredients. It should be deposited as nearly as practicable in its final position to avoid rehandling or flowing within 30 minutes of the concrete materials being put into the mixer.

(vii) Placing of Concrete

Before the concreting is begun the form-work should be cleaned of all dust, wood shavings, pieces or wire or other extraneous matter.

A record should be kept on works of the time and date of placing the concrete in each portion of the structure. All surfaces (other than shuttering specially treated) upon or against which concrete is placed so that moisture will not be drawn from the concrete.

All excess water and laitance which appears on the surface of concrete which has been finally worked into place should be carefully removed before it has time to set.

(viii) Consolidation by Hand

The Concrete should be deposited in layers not greater than 30 cm thickness and after deposition, it should be well rammed into place with suitable rammers and should be worked until it has been made to penetrate and fill completely all spaces around and between reinforcing bars and until all air has been expelled from the mass. The concrete should be carefully worked against the form-work until all concrete faces should be free from air and water voids and is should not thereafter be disturbed.

(ix) Consolidation by Vibration

Whenever feasible, mechanical vibrators should be used for consolidation of concrete. Concrete should be placed in layers of thickness not more than height of the vibrator and

each layer should be vibrated by methods, which will not permit the ingredients to segregate. Vibration should not be used to distribute to concrete.

The vibration should be sufficiently intense to cause the concrete to consolidate or settle readily into place and should be determined at site, depending on the effective range of the vibrator under the particular circumstances.

An adequate number of vibrators should be used so that at the required rate of deposition, vibration and complete compaction are secured throughout the entire volume of each layer of concrete. A sufficient number of spare vibrators should always be available.

Internal vibrators be immersed in the concrete for periods not longer than 3 minutes or until liquid starts to collect on the surface of the concrete adjacent to the vibrator and withdrawal should be at a rate not exceeding 8 cms, per second. Care should be taken to ensure that the vibrator should not disturb concrete, which has been mixed longer than 30 minutes.

When vibrators are used they should be so located that forms in contact with concrete, which has been mixed over 30 minutes are in no way disturbed.

Vibrating should be restricted to concrete of 'low slump' and all other concrete should be hand punned.

(x) Construction Joints

Concerting should be carried out continuously to pre-determined construction joints, in positions shown in the Drawings or as advised by the Engineer-In-Charge.

All construction joints should be of tongue and groove formation and where possible, the width of groove should be one-third of the thickness of the wall or slab in which the joint is being formed and of adept one-half the width of the groove. Any alternative proposal should be approved by the Engineer-In-Charge.

Horizontal construction joints in the wall should be kept to the minimum and when unavoidable should be spaced and so made that the planes of junction between each successive lift of concrete should be truly horizontal and continuous around the structure.

Vertical construction joints in the wall should be made in accordance with the Drawings and should be so placed as to reduce the accumulative setting contraction to a minimum. Vertical construction joints in the reservoir walls should be continuous for the full height of the wall and they should include a water barrier.

Where horizontal construction joints are unavoidable and concreting is to be resumed on horizontal surfaces of set concrete, the surface should be thoroughly roughened by approved means and all dross should be removed to expose clean concrete. The surface should be washed and spread over with a 1/2 layer of cement mortar 1:2, immediately before, fresh concrete is deposited.

Vertical faces should be similarly treated except that they should be covered with freshly mixed cement grout immediately before the fresh concrete is placed in lieu of the cement mortar in the horizontal joint.

(xi) Expansion Joints

Expansion and contraction joints should be formed in the wall and roof of the reservoirs in strict accordance with the designs and position shown in the Drawings.

(xii) Curing

Concrete should, after being placed, be suitably protected during the first stages of hardening from the harmful effects of sunshine, drying winds, heavy rain, surface water and shocks. The concrete made with normal setting cement should be prevented from drying out for not less the 7 days by continuous spraying of water or covering with damp sand or any other approved means that may be convenient and effective. When rapid hardening cement are used special attention should be given to the maintenance of moist conditions of curing, in particular, concrete made with high alumina cement should be kept thoroughly wet for the first 24 hours.

(xiii) Tests

Wherever feasible, arrangements for testing the strength of the concrete should be made. The Site-In-Charge should make, under conditions exactly similar to those of the actual work, four six inch cubes in steel moulds. The cubes should be sent to a testing laboratory, where two cubes of each set will be tested when seven days old and the remaining two at twenty-eight days old. An identification mark must be placed on each cube, and keep a record of casting and proportions, & should notify such information to the testing laboratory when forwarding the cubes. The minimum results of each cube should not be less than the values given in TABLE I.

(xiv) Finishes to Exposed Faces of Concrete

All the faces of the concrete should be rubbed down immediately after the formwork has been struck and any fins and other projections should be removed and all places which appear rough or of imperfect texture should be at once treated to produce a satisfactory surface.

Horizontal concrete surface which will not be finished against form-work should be brought to an even surface by means of screwed and tempers and be given a smooth finish by the use of floats during the operation of placing.

Where a non-slip finish to threads of stairs or elsewhere is called for, it should be obtained by using coarsely ground cement and broken stone aggregate. Gravel aggregate should not be used. Any special method proposed for producing an effective surface should be as advised by the Engineer-In-Charge.

Where a tooled finish is required the operation should be carried out with an efficient equipment in order to give the desired effect. Attention is drawn to the close relations

between the distribution of the aggregates in the concrete and the surface appearance when the skin has been removed.

(xv) Fair Faced Concrete

Where so described or measured, faces on concrete should be finished by means of form-work lined good quality hardboard, so as to produce a perfectly true surface and should have all imperfections on the concrete face cut out, made good in cement mortar to match the texture and colour of the concrete and rubbed down with Carborundum stones dipped in cement grout to finish clean and smooth to a high standard, without trace of shuttering marks, joints or other disfigurement.

(xvi) Holes, Pipes etc.

The Site-In-Charge should take care in incorporation of electrical conduit pipes, fixing blicks, chases, holes etc., in concrete members as required and make sure that the strength of effective cover of any part of the structure is not adversely affected or the finished work damaged by any movement of the blocks. All fixing blocks, chase, holes, etc., to be left in concrete, should be accurately set out and cast with the concrete. Openings, chases, holes or other voids should only be cut or formed in concrete under the supervision of the Site-In-Charge.

(xvii) Timber Form-work

Form-work for fair faced work should be made of planed and dressed timber or undressed timber lined with a good quality fiber board. A board mark finish may be used for all other surfaces. The form-work should be constructed accurately to represent the shape of the work to be built. For circular work the curvature of the forms should correspond to the designed circumferences. The form-work should fit so as to prevent the leakage of liquid and should be so finished on the faces in contact with the concrete as to leave the concrete with a perfectly smooth face. The interior face of all form-work should be coated with preparation to prevent the adhesion of the concrete thereto and the preparation used should not stain the concrete. Joints in the timber plates of fiber board in contact with the concrete should be uniformly spaced and should be truly horizontal and/or vertical.

The strutting and bracing of the form-work should be such that there should be no deformation of the forms under the weight of the plastic concrete and no appliances for supporting form-work or staging should be fixed into the permanent structure except when advised by the Engineer-In-Charge.

Form-work should be so constructed that its removal can be affected without damage to the concrete either by shock or vibration or by any other cause. Where holes are boxed out in the concrete for the subsequent building in of pipes brackets, rag bolts and other ironwork and fittings, the boxes should be accurately set out and positioned and securely fixed. Should any of the boxes become dislodged and/or displaced during the placing of the concrete or should the boxes be found subsequently to be in any way of the required true position or to have been omitted altogether the additional cutting out of the concrete and making good should be carried out under the supervision and direction of Engineer-In-

Charge. To use other methods for building-in the above ironwork or fittings, such methods should only be used with Engineer-In-Charge's approval.

The removal of form-work should always be supervised by the Site-In-Charge and it should be ensured that no excessive loads are permitted to come upon the new work.

No form-work or staging should be struck or slackened without the presence of the Site-In-Charge. The minimum periods of time, which should elapse between pouring the concrete and striking or slackening the form-work on the various classes of work should be as follows;

Class of Work	**Type of Cement**
Vertical faces of walls and columns	2 days
Sides of beams and lintels	2 days
Soffits of slabs (subject to 10 days props retention)	4 days
Soffits of beams and lintels (subject to 14 days props retention)	7 days

13. Cement Mortar and Grout

Cement mortar, where specified should be composed of Portland cement, and clean sharp sand in the proportion stated. The ingredients should be properly gauged, and the sand and cement should then the thoroughly mixed by turning them over at least twice dry, upon a watertight stage as specified for concrete. Sufficient water should then be added to give a stiff consistency, and the mixture should be turned over twice wet. The mortar should be used immediately after it has been mixed, and any that has stiffened by commencing to set should not be used, over though fresh cement were to be mixed with it. In the case of grout, sufficient water should be added to the mix to enable it to be poured into joints or voids.

14. Cement Rendering

The cement rendering should consist of two coats. The rendering coat should be composed of cement and sand in specified proportions, 15 mm thick (unless otherwise specified), and the surfaces setting coat of neat cement 3 mm thick applied within half an hour of the completion of the rendering. The total thickness should be as specified in the drawing.

All rendering must be protected from the weather and suitable and adequate coverings must be fixed in advance. The rendering should be kept damp while setting.

The rate for rendering should include for all scaffolding ladders, platforms, etc., and for striking out joints of brick work and hacking or roughing concrete surfaces to form a key, brushing down and thoroughly saturating all surfaces with water immediately before rendering and for forming, all rises, covers, chamfers and stopped edges against woodwork etc.

Any rendering, which is defective should be cut out and rendered again.

15. Cement Rendering to Invert

The inverts in drains and manhole, etc., should be of cement and sand mixture 1:2 and should be finished to an even and polished surface with a float, trowels or other suitable tool, special care being taken to obtain perfectly smooth faces. Unless otherwise specified, it should be 19 mm in thickness.

16. Concrete Floors

All concrete floors, excluding the surface layer, are to be cast to the full specified thickness and as shown in drawings in one continuous operation for any given section in hand. The surface should not be smooth but when set wet for a period of at least fourteen days and afterwards retained in position as a protection during construction work and until such time as is expedient to lay the surface layer. The sand protection should be swept away and the base layer thoroughly washed, cleaned and saturated with water before the application of the surface layer which should be finished smooth to the approved sample area.

No sprinkling of neat cement or addition of water or excessive trowelling to obtain a smooth surface should be allowed.

Expansion joints should be formed as directed by Engineer-In-Charge or necessary by inserting strips of straight, smooth, sheet iron, or by planed wood strips tapered 7 mm such strips should extend from the surface of the floor to the reinforcement and should be left in place until the concrete is firm but not fully set, when they should be gently removed and the concrete edges carefully tripped up. Later and just before the completion of the building these open joints should be carefully cleaned out and filled with a mixture of cement and sand 1:2 well rammed in, the addition of a good quality pigment. The edges of the joints are to be carefully protected throughout the work.

After the concrete has been laid and is firm it should be well and continuously watered for fourteen full days and after it is hard enough to bear it should be covered with a layer of jute hessian or sand not less than 12 mm thick and kept so, far the duration of all the major carcass building operations.

17. Brick Floors

Brick floors should be laid perfectly level, or to falls, as advised by the Site-In-Charge with good sound bricks as specified in clause for Bricks, bedded and jointed in lime and sand 1:2 and rendered with cement and sand 1:2 not less than 12 mm thick with the top surface finished smooth. All brick joints should be raked out before cement rendering is done.

18. Chambers

All valves should be provided with suitable chamber or chambers as shown in details in drawings and as advised by the Engineer-In-Charge for each and every purpose.

19. Lintels

Concrete lintels should be cast in situ of concrete composed of one part cement two parts sand and four parts stone broken to pass a 19 mm ring, (1:2:4). The bearing should be at

least 22 cm at each end unless otherwise shown or indicated and the reinforcing bars of diameter shown in plan, should be the full lengths of the inlet.

20. Brickwork

(i) Bonding Walls

Load-bearing brickwork generally should be of Quetta Bond (nominal thickness 35 cms) and reinforced as shown in the detailed drawings. One brick walls (nominal thickness 23 cms) should be in English Bond and half brick walls (nominal thickness 11 cms) in Stretcher Bond. No broken bricks or bats should be used unless required to or bond.

All perpernds, quoins, reveals and other angles of walls should be built strictly true and square.

(ii) Setting out Wall

Proper setting-out rod and set out all work on same for corners, openings, heights, etc., should be provided and should build the walls and piers etc., to the width, depth and height indicated on the drawings and as advised by the Engineer-In-Charge.

(iii) Wall Building

Bricks should be wetted before being laid and the top of walling where left off should be wetted before re-commencing building. Walls to be kept wet for three days after building. Bricks should be well buttered with mortar before being laid and the brickwork carried up evenly course by course and so that no part is allowed to be carried up more than 50 cm higher at any time than any other part.

(iv) Wall Finish

Where Walling is to be finished with a fair face, the bricks are to be selected so that the exposed face is free from defects and the joints finished flush as the works proceed. The faced work should be kept perfectly clean and no rubbing down of brickwork will be allowed.

Where brickwork is to be plastered the joints should be raked out as the work proceeds.

(v) Mortar

All mortar should consist of cement, lime, sand in the proportion as shown in the drawings.

The ingredients of mortars should be measured in proper gauge boxes on a boarded platform all being mixed dry and again whilst adding water. In the case of cement/lime mortar, the sand and lime should be thoroughly mixed to a uniform consistency with only sufficient water to obtain a plastic condition suitable for trowelling. Mortar, which has commenced to set should not be used or knocked up again for use.

(vi) Filling of Brickwork

Where brickwork cavities are specified to contain reinforcing bars they should be filled with the grade of appropriate concrete specified. The filling should be placed and consolidated in section not exceeding 3 feet in height. Cavities that are to be filled should be kept free of all mortar dropping.

(vii) Brick Lintels

Lintels over doors and under openings except where in concrete, should be formed in brickwork by reinforcing the three courses immediately above and opening with steel wire reinforcement projecting 45 cm at either end of the opening.

(viii) Putlog Holes

All putlog holes should be not less than one course deep and carefully filled with bricks cut to fit size of opening beds and joints filled with mortar well tamped in after the scaffolding is removed.

(ix) Keeping Clean

The fair faced brickwork should be kept free from mortar at all times and clean the work on completion.

(x) Damp Proof Course

Lay over the full width of the walls and at the height shown in the drawings a mortar screwed of sufficient thickness to form a level surface and cover the screwed with two coats of hot bitumen.

(xi) Sliding Joints

Where sliding joints are indicated on the drawings two layers of bitumen coated galvanized steel sheet should be provided.

21. Placing of Reinforcement

The number, size, form and position of all the steel bars, ties, stirrups and other members of the reinforcements should be in exact accordance with the drawings. They should be thoroughly cleaned and free from all scale, rust, etc., and be given a thick coat of cement slurry and should be placed in position shown and be securely wired and held there so as to prevent displacement before or during the process of concreting. A lap of not less than forty-five diameters should be provided at the junctions of all bars for which the lap is not specially detailed on the Drawings.

Reinforcements for beams and slabs should be temporarily supported in position by means of slings wherever possible, and where supporting blocks are permitted they should be removed in advance of the placing of the concrete.

Unless otherwise stated clear cover for reinforcements should be bar diameter or 15 mm, which is greater.

22. Rubble Masonry, Stone Paving & Pitching

Random Rubble stone should be hard, tough, sound, clean and regular on faces. Stone, for masonry works, should be derived from a source that normally and satisfactorily used for the masonry purpose. Stones directly from the river bed with round shapes are not allowed to be used. If quarry stones are not available then big boulder stones from the river should be allowed after breaking down to the required sizes and as advised by Site-In-Charge.

The joints should be broken vertically and staggered bond stones should be provided to the full wall thickness. More than one meter high wall should not be allowed and constructed at a time. Each stone should be 150 mm to 250 high, 200 mm to 300 mm long and 100 mm to 150 mm wide and the whole masonry work should be well bonded by cement mortar as mentioned in the drawings.

The faces of all stones showing externally should be rough hammer dressed to a convex surface. The mortar joints should be 15 to 20 mm thick or as advised by the Engineer-In-Charge. The mortar mix proportions for different works under this item should be as per the drawings. Finished stone cement masonry works should be wetted by water and prevented from drying out for at least seven days after construction.

Stone paving should be pitched by hand and set in places in such a manner as to secure the greatest possible compactness and solidity; the smaller interstices are to be filled in with stone chips firmly wedged in with hammers.

Rubble for pitching or paving is to be carefully bedded and grouted in cement mortar (1:3) to form and even surface, as shown in the Drawings or as advised by the Site-In-Charge.

23. Preparation of Pipes

All pipes should be inspected both internally and externally before being put up in positions for jointing or lowering into the trenches. They should be internally brushed through out (except in the case of pipes in coils) to remove any soil, but in such a manner that internal coating of pipes should not be scratched or injured in any way. The inside of the sockets and the outside of spigots should be carefully cleaned and small pipes tested to remove any accumulation, or obstruction.

After clearing and cleaning the pipes and assembling or placing them alongside the trench, ready for lowering, the length should be lowered into trenches under the supervision of the Site-In-Charge.

24. Laying and Jointing of Galvanized Mild Steel Tubes

When the pipes are to be cut or threaded the ends should be carefully filed so that no obstruction to bore is offered. The ends of the pipes should then be threaded conforming to the requirements of IS 554-1795 with pipe dies and taps carefully in such a manner as will

not result in slackness of joints when the two pieces are screwed together. The screw threads of pipes and fittings should be protected from damage until they are fitted.

In jointing the pipes, the inside of the socket and the screwed end of the pipes should be oiled and smeared with white or red lead and wrapping around with a few turns of the fine spun yarn round the screwed end of the pipe. The end should then be tightly screwed in the socket, tee, etc. with the pipe wrench. Care should be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. *Burr from the joint shall be removed after screwing.* After laying, the open end of the pipes should be temporally plugged to prevent access of water, soil or any other foreign matter. *The pipe laid on level ground shall be laid with socket facing the direction of flow of water.*

25. Laying and Jointing of HDPE Pipes

Jointing

Fusion welding is commonly used in HDPE and is a permanent type of joint and should be carried out in accordance with Indian Standard: 7635 (Part II)-1975 or manufacturers instructions. The pipe should be cut square and the face of the pipe should be slightly scraped prior to welding to remove oxidized layer.

At the time of Welding, leveling of the pipes is essential particularly in case of larger diameter pipes, Welding temperature should be 200° C and surfaces of heating mirror should be 210 ± 50 C. The welding of the pipe should be held in either side of the heating mirror with only contact pressure of about 0.2KG/cm^2. When the rim of the molten material is found, the pipes are removed from the heating mirror and immediately the joint is made by application of moderate pressure of approximately 1 to 2 Kg/cm^2 for 2 to 3 seconds. The initial heating time for achieving molten rim varies from 1 to 5 minutes depending upon the pipe wall thickness and size. In the making of the joint care should be exercised on the following:

- the rim formed should not be excessive.
- while jointing the pressure should be maintained until the joint is lukewarm and after pressure is relived, the joint allowed to cool completely.
- the mirror should be kept exactly around 210° C. It is also essential to see that the temperature is maintained constant by the proper setting or regulator. *In case of electric mirror* For detecting the correct temperature, crayon chalk is used. For example at 220°C the colour of crayon dot on the mirror changes within 2 second. But the dot made should be thin and if no, time taken will be more, indicating a wrong temperature.

Flanged joints are used for jointing HDPE pipes particularly of larger size to valves and large size metal pipes where strength in tension is required. It consists of flanges either loose or welded to the pipe ends. In most cases, sealing is improved by incorporating a natural or synthetic rubber gasket between flanges.

Bending

Small diameter pipes have a degree of flexibility and this enables gradual curves to be negotiated without the need for special bends or flexible coupling. The radius of the bend should be greater than 20 times the outside diameter of the pipe. Cold bends should only be used on pipes operating at ambient temperatures.

Forming of small radius bend may easily be done by the application of heat. The pipe should be heated to a temperature of 130°C in an inert liquid, such as glycerol (or any oil in emergency). Electrical heating coils or plates may be used only by experienced technicians.

In preheating operations, the low thermal conductivity of polyethylene should be kept in mind. Over heating can usually be recognized by surface discoloration and distortion. On the other hand bending operations should not be performed at too low a temperature, because of excessive stress that could result. At bending temperature, the bore of the pipe tends to collapse and therefore requires support during the bending operation. Internal support should be affected before heating by packing the bore of pipe with warm fine dry sand or by inserting rubber pressure hose, rubber rod, or a flexible spring. After the pipe is uniformly heated, it should be pulled around a simple jog and held in the correct position until cool. The radius of the bend of larger diameter will require an increase in radius.

Installation

While installing the pipes in trenches, the bed of the trench should be level and free from sharp edged stones. While laying in rocky areas suitable bed of sand or gravel should be provided. The initial back fill to about 10 to 15 cm above the pipe should be fine sand or screened excavated materials. In very hard rocky area, where excavation of trenches is not feasible or is not economical, GI pipes should be used with proper anchoring as shown in the drawing or as advised by the Engineer-In-Charge.

Where the gradient of the bed slopes is more than 30 degree it may be necessary to anchor a few pipes against sliding downwards.

All types of manual controls, and valves in particular should be anchored firmly so as to minimize the turning movement imparted to the pipe by operation of the hand wheel.

26. Tools and Materials

Necessary tools and accessories for laying and jointing cast iron, wrought iron, and HDP pipes should be arranged by the Site-In-Charge.

27. Plugs

As the pipe is laid, the front pipe in the trench should always be closed with a plug either of iron or wood and securely fastened. The observation of the above is extremely important and no excuse whatsoever will be accepted for non compliance. Waste or sacking of any form of plug other than properly prepared iron or wooden plug to fit various diameters should not be used. The plug should not be removed except, when pipe laying is resumed or for purposes of testing.

28. Flanged Joints

Flanged joints should be made with the joint rings and nuts washers and bolts provided. Two washers should be used per bolt one under the bolt head and the other under the nut. The tightening of bolts should be done evenly all round by tightening at one time diametrically opposite pairs. In no case should excessive tightening be exerted on any nut or bolt. After the satisfactory conclusion of the water-tightness test, all buried flange joints should be wrapped using mastic and tape supplied by the project.

29. Butt-Welding of HDP Pipes

The tools required for butt-welding are :

- Heating Plate
- Blowtorch or other source of heat
- Thermo chrome crayon
- Hacksaw (with blades)
- Scraper or knife

Other helpful tools are :
- Mould
- Mitre box
- Hand mitre saw

Following step-by-step welding procedure is given below to serve as guidance to the technicians;

(a) Hold pipes in the mitre box and cut it to the desired angle. Care should be taken to prevent movement of the pipe while cutting so as to prevent any change in the profile on the surface.

(b) Remove fibrous material with a scraper of knife to obtain a smooth surface. Care should be taken that the trimming of the pipe ends is complete over the entire pipe circumference. After trimming nothing should be allowed to touch the newly exposed faces.

(c) Check the joint for neat contact and true alignment. At no point of the joint should there be a gap of more than 0.5 mm.

(d) Heat the clean plate a short time. Put marks with the thermo chromes crayon on it and continue with heating. During the heating the colour of the marks will change from white to brown. When the marks are dry and brown, the plate has the right temperature of 220°C and the heating plate must be removed immediately from the blowtorch.

(e) It is very important to weld with the correct heating plate temperature. Every new joints needs the same procedure. Hold the pipe ends on the two sides of the hot plate and press them gently until a low rim of melted material is formed.

(f) Remove the heating plate and without delay bring the pipe ends into contact under light but firm pressure. At no time should excessive pressure be applied. Keep

pressure on the joint until it has cooled. It is recommended that contact with cold water should not be used in speeding up joint cooling.

(g) Every joint has to be checked by bending and good visual control.

30. Jointing HDP Pipe to G.I. Pipe or G.I. Fittings

HDP cannot be joined to metal by butt-welding, but there are several other methods of making such a joint. The two commonly used methods are jointing with flanges and joining with brass unions. Technicians should follow the manufacturer's recommendations for the making of these joints.

(i) Using Flanges

In making a flanged joint a flange set is used. A flanged set has :-

- one threaded flange
- one flange not threaded
- a HDP flange adapter
- rubber gasket and
- nuts and bolts to hold these together.

First the set is assembled by removing the bolts. Second, the flanges are screwed on to the G.I. Pipe. Third, the unthreaded flange is slide on to the HDP Pipe. Fourth, the gasket is replaced and the flanges are bolted together again.

(ii) Using Brass Unions

A brass union of this type consists of 5 parts:
- The union body, which has female threads on one end and male threads on the other.
- A brass ring, with female threads
- A brass expansion plunge
- A neoprene ring
- A neoprene gasket a flat rubber coaster

First the female threaded end of the union is screwed into the G.I. Pipe. Second, the brass ring is unscrewed and slides over the HDP pipe. Third, the neoprene ring is also slide over the pipe. Fourth, the end of the HDP pipe is heated until it becomes soft. Fifth, the expansion plunge is inserted into the HDP pipe, small end first. The nozzle should be pushed in until its large end is even with the pipe end, but no further. This must be done while the pipe end is still warm. Sixth, the neoprene gasket is placed in the male threaded union socket. Seventh, the brass ring is screwed tightly into the union.

31. Air Valves

Air Valves of the various diameters of inlet should be provided according to particulars shown in the Drawings. The air valve should be of the single or double type fitted with isolating valve and of approved manufacture. All valves should be tested by the manufacturer and be accompanied by a certificate of the same specifying their efficiency.

The floating ball in the valve should be of suitable metal or vulcanite or rubber specially prepared for tropical conditions.

32. Washout Valves

Washout or scour valves should be provided at appropriate positions indicated on the plans and sections and at convenient points relative to draining of washout pipe. Suitable lead away arrangement should be made to discharge the washout water at a convenient point. Care should be taken to see that no local erosion takes place. Each valve should be housed in a suitable chamber as per details with cover and surface box.

33. Testing of Pipe Lines

Whenever possible, the pipeline should be tested after each section of the pipe line has been laid and jointed and anchorages built in for the bends, the pipe line should be tested in lengths of 500 meters or less under the supervision of the Site-In-Charge. Before testing, the trench should be partially backfilled except at the joints. The Site-In-Charge should arrange the accessories needed viz test pump. Pressure gauge, end pieces included connected valves and piping etc., for carrying out the hydrostatic tests. The pipes and joints found to be defective during the test should be replaced and or redone.

The two tests that should be carried out are :

(a) Pressure test at a pressure of at least the maximum working pressure; pipes and joints should be absolutely watertight under the test.

(b) Leakage test (to be conducted after the satisfactory completion of the pressure test) at a pressure specified for duration of two hours. Unless otherwise specified the leakage test pressure should be the lower of $1^1/_2$ times the maximum static pressure that will be experienced by the section under test or the maximum allowable test pressure after installation.

Where any section of the main is provided with concrete thrust blocks or anchorages; the pressure test should not be made until at least five days have elapsed after the concrete was cast.

The procedure to be followed are as follows :

(a) Pressure Test

Each valve section of the pipe should be slowly filled with water and all air should be expelled from the pipe through hydrants and blow-offs. If these are not available at high places, tapping may be made at points of highest elevation before the test is made and plugs inserted after the tests have been completed.

If the trench has been partially back-filled the specified pressure based on the elevation n of the lowest point of the line or section under test and corrected to the elevation of the test gauge, should be applied by means of a pump connected to the

pipe in a manner satisfactory to the Site-In-Charge. The duration of the test should not be less than 5 minutes.

All exposed pipes, fittings, valves and joints should be carefully examined. Any cracked or defective pipes, fittings and valves discovered in consequence of this pressure test should be removed and replaced by sound material and the test should be repeated. All joints showing visible leaks should also be re-caulked or redone until tight.

(b) Leakage Test

Leakage is defined as the quantity of water required into the newly laid pipe, or any valve section thereof, maintaining the specified leakage test pressure.

The pipe installation should be acceptable if the leakage is less than that determined by the formula

$$q_1 = \frac{N\ D\ P^{0.5}}{3.3}$$

Where, q_1 = the allowable leakage in cm^3/h,
N = number of joints in pipeline length,
D = diameter in mm, and
P = average leakage test pressure in Kg/cm^2.

Should any test of pipe laid disclose leakage greater than that specified, the defective joints should be repaired until the leakage is within the specified allowance.

34. Testing of Reservoir for Water-tightness

When the construction of the reservoir is completed, and before the filling of any earthen embankment, the Site-In-Charge should test it for water-tightness. Then each compartment of the reservoir should in turn be filled with water gradually up to the level of the top of the partition wall (if any). IS 3370 (Part 1) General requirement, Code of practice for the concrete structures for the storage of liquids, specifies water tightness test at full supply level.

After allowing four days for the water to be thoroughly absorbed by the walls, the water level should be left undisturbed for seven days. If any diminution in water levels noticed other than attributable or evaporation the cause should be determined and necessary repairs should be made. Test for leaks and repair should be repeatedly done until the reservoir is completely watertight and satisfactory.

35. Water Proofing of Reservoirs/Structures

Waterproofing is to keep the unwanted water out of the system. It is not only a problem in old structures but also occurs in absolutely new construction. One of the basics of waterproofing is to lower the wettable characteristics of the concrete.

Waterproofing materials are permeability reducers or they impart to the concrete water repellent or hydrophobic properties. While the permeability reducers are effective for waterproofing even under hydrostatic pressures the water- repellents are normally suitable for damp proofing of structures where the entry of water is via the capabilities. The proprietary waterproofing materials are normally combinations of permeability reducing chemicals as well as water repellents and capillary pore blocking materials with hydrophobic properties.

Basically there are five general type of waterproofing treatment system. These are:

1. **Integral treatment system**- By waterproofing plasticiser & superplasticiser on mixing stage for concreting and plastering**.**

2. **Pressure grouting treatment system**- Injection of ultra fine cement with expanding grout additives or injection of polymer based and other epoxy based products to prevent the severe leakage.

3. **Flexible membrane system**- by coating of polymer modified cement based material or by other polyacrylic copolymer based material coating.

4. **Crystallization system**- by coating of cement based powder, which develops a catalytic reaction in the pores and capillary tracts of the concrete substrate and this reaction generates non -soluble fibrous crystalline growth up to the few millimeter depth inside from the surface of the concrete structures.

5. **Water-repellent surface coating system**- by application of hydrophobic silicone based transparent surface impregnator and sealing coat.

The most effective waterproofing treatment is flexible membrane system and injection grouting system.

36. Disinfection of Reservoir and Pipe Lines

(i) Reservoir

Whenever possible, Site-In-Charge should disinfect the reservoirs and the pipelines. The internal surfaces of the reservoir and external surfaces of all pipes and fittings within the reservoir should be thoroughly cleaned and if necessary scrubbed to remove all obvious contaminating matter and the water from the operations removed and drained out through the washout main.

The reservoir should then be filled with water containing hypochlorite or liquid chlorine solution in such quantity and such strength as will result in a concentration of free chlorine of not less than 10 parts per million. This chlorinated water should be allowed to remain in the reservoir for a minimum period of 24 hours and then flushed out.

The reservoir should be refilled with source/treated water and samples should be taken for bacteriological analysis. If the results of the analysis are unsatisfactory, the sterilizing process and refilling and sampling should be repeated until the analysis is satisfactory.

(ii) Pipe Lines

After the pipelines have been filled and flushed out to remove all debris and contaminating matter it should be filled with chlorinated water of strength as prescribed above in (i) and left to stand for 24 hours. Then the pipes should be flushed out and refilled with source/treated water.

If subsequent analysis reveals contamination, the sterilizing process should be repeated until satisfactory result is obtained.

37. Gabions

(i) Materials

Gabions should consist of steel wire mesh crates. The steel wire should be mild steel wire complying with I.S. 280 - 1962. All wire used in the manufacture of the crates or supplies in diaphragms, binding and connecting wire should be galvanized with an extra heavy coating of zinc by an electrolytic galvanized process. The weight of deposition of zinc should be a minimum of 260 grams per square metre equivalent for the gauge of wire specified. The wire should be woven into a hexagonal mesh with a minimum of 3 twists. All edge of the crates should be finished with a selvedge wire at least 3 gauges heavier than the mesh wire. Gabions should be manufactured in the standard sizes shown in Table III with mesh and wire sizes as shown in Table IV. Diaphragms should be manufactured of the same material as the parent gabion and should have selvedge wire throughout their perimeter. The number and size of diaphragms to be provided with each crate should be as in Table III. All crates should be supplied with binding and connecting wire of the gauges shown in Table IV of sufficient quantity to bind all diaphragms and closing edges. Filling for gabions will be clean hard angular stone. The smallest dimension of any stone should be at least twice that of the longer dimension of the mesh of the crate.

(ii) Assembly

Gabions should be assembled by binding the edges together at the selvedges with binding wire of the thickness shown in Table IV. The binding should be in the form of continuous lacing so that the interval between laces is approximately 50 mm. The diaphragms should be laced into position at the time of assembly leaving the "lids" of the crates open.

(iii) Filling

Except in the case of sack gabions, the crates should be placed in their final position before filling commences. They should be stretched to their full dimension and securely pegged to the ground or wired to adjacent gabions before filling. The vertical corners should be kept square and to full dimension by inserting a steel bar of at least 20 mm diameter at each vertical corner, maintaining it in the correct final position throughout the filling process and

removing it when the crate is full. Before filling commences, the selvedges of the crate will be bound to the selvedges of adjacent crates with binding wire.

Where crates are being assembled in position in a wall the binding of the edges of each crate in the assembly process and the binding together of adjacent crates may be carried out in the same operation. The filling will be carried out by placing individual stones into the gabion by hand in courses in such a manner that the stones are bedded on each other and bonded as in dry random rubble masonry. No loose stones should be tipped into the crate and the practice of coursing and bonding the outer layer and filling the interior with unlid stones will not be permitted. When the crates are filled, the lids will closed and the selvedges bound with binding wire as in the assembly process.

On completion the crates should be completely and tightly filled, square true to dimensions and the line and level shown in the Drawings.

TABLE III: STANDARD SIZE OF WIRE MESH GABIONS

Dimensions **metres**	**Number of Diaphragms**	**Dimensions of Diaphragms** **metres**	**Volume of crate** **cubic metres**
2x1x1	1	1x1	2
3x1x1	2	1x1	3
4x1x1	3	1x1	4
2x1x0.5	1	1x0.5	1
3x1x0.5	2	1x0.5	1.5
4x1x0.5	1	1x0.5	2
2x1x0.3	1	1x0.3	0.6
3x1x0.3	2	1x0.3	0.9
4x1x0.3	3	1x0.3	1.2

TABLE IV: STANDARD SIZED OF MESH AND WIRE IN GABIONS

Mesh Size Min	Thickness of mesh wire		Thickness of Binding and connecting wire		Thickness of selvedge wire	
	S.W.G.	mm	S.W.G.	mm	S.W.G.	mm
50x70	12	2.64	13	2.34	9	3.66
60x80	12	2.64	13	2.34	9	3.66
60x80	11	2.95	13	2.34	8	4.06
80x100	11	2.95	13	2.34	8	4.06
80x100	10	3.25	12	2.64	7	4.47
80x100	9	3.66	11	2.95	6	4.88
100x120	10	3.25	12	2.64	7	4.47
100x120	9	3.66	11	2.95	6	4.88

(iv) Timber Fenders

Where shown in the drawing aprons, steps or walls may be protected by timber fenders. In such cases, the timber fenders should be Sal wood of the size and at the intervals shown in the Drawings. They should be attached to the gabions by binding wire of the size specified for the crate selvedge at intervals equal to the smaller dimensions of the mesh size of the crate.

Annex: 1

Nepal Standard for civil & Sanitary Engineering	
Ns 1 -2035	Ordinary Brick
Ns 9 -2036	Construction Lime
Ns 40 -2040	High Density Polythene Pipe
Ns 49 -2041	Ordinary Portland Cement
Ns 80 -2042	Hume Pipes
Ns 84 -2042	Mild steel rod
Ns 104-2042	C.I.Manhole cover frame
Ns 149-2044	Gunmetals Gate valves
Ns 163-2045	Zinc coatings in wires
Ns 168-2045	Zinc coated barbed wires
Ns 169-2045	Mild steel wire
Ns 199-2046	Zinc coated mild pipe for water supply
Ns 206-2046	PVC Pipes for water Supply
Ns 223-2047	Testing methods of water part 4 microbiological test
Ns 297-2050	Gravel aggregates
Ns 298-2050	Sampling methods of gravels
Ns 305-2050	Testing methods of gravels
Ns 338-2051	Shallow tube wells hand pumps
Ns 361-2053	Furrule for water services
Ns 362-2053	Bib taps and stop valves
Ns 382-2054	Copper alloys globe and check valves
Ns 402-2054	Injection moulded HDP fittings
Ns 415-2056	Testing methods of fresh concrete
Ns 428-2058	Water meter (Domestic)