

Chapter 13

Water Supply

13.0. TERMINOLOGY

Airgap : The unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or fitting supplying water to a tank or other device and the flood level rim of the receptacle in a water supply system.

Air Valve : A valve that releases air from a pipe line automatically without loss of water, or introduces air into a pipe line automatically if the internal pressure becomes less than that of the atmosphere.

Available Head : The head of water available at the point of consideration due to main's pressure or overhead tank or any other source of pressure.

Back flow : The flow of water into the distributing pipes of water system from any source or sources other than its intended source.

Back siphonage : The flowing back of used, contaminated or polluted water from a plumbing fitting or vessel into a water supply system due to a lowering of pressure in such system.

Ball cock : A faucet opened or closed by the fall or rise of a ball pens in the direction of normal flow and closes with reversal of flow. (Refer Fig. 13.2)

Collar : A pipe fitting in the form of a sleeve for jointing the spigot ends of two pipes in the same alignment.

Coupling : A pipe fitting with inside threads only, used for connecting two pieces of pipe.

Cross : A pipe fitting used for connecting four pipes at right angles (Refer Fig. 13.1).

Elbow : A pipe fitting for providing a sharp change of direction in a pipe line (Refer Figure 13.1).

Ferrule : A pipe fitting for connecting a service pipe to a water main (Refer Fig. 13.1).

Fitting : Anything fitted or fixed in connection with the supply, measurement, control, distribution, utilization or disposal of water.

Fire Hydrant : A device connected to a water main and provided with necessary valve and outlets, to which a fire hose may be attached for discharging water at a high rate for the purpose of extinguishing fires, washing down streets, or flushing out the

water main (Refer Fig. 13.1)

Flange : A projecting flat rim on the end of a valve, pipe etc. (Ref. Fig.13.1)

Flanged Pipe : A pipe provided with flanges so that the ends can be joined together by means of bolts (Refer Fig. 13.1)

Float Valve : A valve in which the closure to an opening such as a plug or gate, is actuated by a float to control the flow into a tank.

Sluice Valve (Gate Valve) : A valve in which the flow of water is cut off by means of a circular disc., fitting against machine-smoothed faces, at right angles to the direction of flow. The disc is raised or lowered by means of a threaded stem connected to the handle of the valve, the opening in the valve is usually as large as the full bore of the pipe (Refer Fig.13.2).

Nipple : A tubular pipe fitting usually threaded on both ends and less than 300 mm long used for connecting pipes or fittings (Refer Fig.13.1).

Offset : A combination of elbows or bends which brings one section of the pipe out of line but into a line parallel with the other section in a piping system.

Reflux valve : A non return valve used in a pipe line at a rising gradient to prevent water that is ascending the gradient from flowing back in the event of a burst lower down (Refer Fig.13.2).

Socket : The female-part of the spigot and socket joint (Refer Fig.13.1).

Spigot : The male part of a spigot and socket (Refer Fig.13.1)

Stop Cock : A control valve fixed at the end of communication pipe which controls the supply in the water main (Refer Fig.13.2).

Storage tank : A tank or a cistern for storage of water which is connected to the water main by means of a supply pipe.

Service or supply pipe : Pipe through which supply is drawn from water mains.

Union : A pipe fitting used for joining the ends of two pipes neither of which can be turned (Refer Fig.13.1).

Valve : A device used for controlling the flow of water in a pipe line.

13.1 GENERAL REQUIREMENTS

i) For details reference may be made to IS 2065 Code of Practice for Water supply in buildings.

ii) Bureau of Indian Standards Hand Book on Water Supply and Drainage with special emphasis on plumbing SP35 (S&T) may also be referred to for details.)

13.1.1 Contractor's Responsibility

Any damage caused to the building, or to electric, sanitary, water supply or other installations .therein either due to negligence on the part of the Contractor, or due to actual requirements of the work, shall be made good and the building or the installations shall be restored to its original condition by the contractor. Nothing extra shall be paid for it, except where otherwise specified.

13.1.2. Execution of work: All water supply installation work shall be carried out through licensed plumbers only.

13.1.3. Inter connection of lines:

(a) It is most important to ensure that wholesome water supply provided for drinking and culinary purposes, is in no way liable to contamination from less satisfactory water. There shall, therefore be no cross connection whatsoever between a pipe fitting for conveying or containing wholesome water and a pipe or fitting for conveying or containing impure water or water liable. to contamination or of uncertain quality of water which has been used for any purpose. The provision of reflux or non-return valves or closed and sealed valves shall not be construed a permissible substitute for complete absence of cross-connection.

(b) Where a supply of wholesome water is required as an alternative or standby to supply of less satisfactory water or is required to be mixed with the latter, it shall be delivered only into a cistern, and by a pipe or fitting discharging into the air gap at a height above the top edge of the cistern equal to twice its nominal bore,, and in no case less than 15 cm.

13.1.4. Precautions in laying :

(a) No piping shall be laid or fixed so as to pass into, through or adjoining any sewer, scour outlet or drain or any manhole connected therewith nor through any ashpit or manure-pit or any material of such nature that would be likely to cause undue deterioration of the pipe.

(b) Where the laying of any pipe through fouled soil or pervious material is unavoidable, the piping shall be properly protected from contact with such soil or material by being carried through an exterior

cast iron tube or by some other suitable means. Any piping or fitting laid or fixed, which does not comply with the above requirements shall be removed and relaid in conformity with the above requirements.

13.1.5 Pipe work design.

(a) The design of the pipe work shall be such that there is no possibility of backflow towards the source of supply from any cistern or appliance whether by siphon age or otherwise, and reflux or non-return valves shall not be relied upon to prevent such backflow.

(b) All pipe work shall be so designed, laid or fixed, and maintained as to be and to remain completely watertight, thereby avoiding waste of water, damage to property and the risk of contamination of the water conveyed.

(c) In designing and planning the layout of the pipe work, due attention shall be given to the maximum rate of discharge, required economy in labour and materials, protection against damage and corrosion, protection from frost, if required, and to avoidance of airlocks, noise transmission and unsightly arrangement.

(d) To reduce frictional losses, piping shall be as smooth as possible inside. Methods of jointing shall be such as to avoid internal roughness and projection of the joints, whether of the jointing materials or otherwise.

(e) Change in diameter and in direction shall preferably be gradual rather than abrupt to avoid undue loss of head. No bend or curve in piping shall be made so as to materially diminish or alter the cross-section.

13.1.6 Underground piping: Underground piping shall be laid at such a depth that it is unlikely to be damaged by frost or traffic loads and vibrations. It shall not be laid in ground liable to subsidence, but where such ground cannot be avoided; special precautions shall be taken to avoid damage to the piping. Where piping has to be laid across recently disturbed ground, the ground shall be thoroughly consolidated so as to provide a continuous and even support.

13.1.7 Service pipes :

(a) Where the service pipe is of diameter less than 50 mm, the stop valves shall be of the screwdown type and shall have loose washer plates to act as non-return valves. Other stop valves in the-service line may be of the gate type.

(b) In flats and tenements supplied by a common service pipe a stop tap shall be fixed to control the branch serving each

separately occupied part. In large buildings a sufficient number of stop valves shall be fixed on branch pipes, and to control groups of ball valves and draw off taps, so as to minimize interruption of the supply during repairs. All such stop valves shall be fixed in accessible positions and properly protected from being tampered with. They may be of the gate type to minimise loss of head by friction.

(c) Water for drinking or for culinary purposes should as far as possible be on branch pipes connected directly to the service pipe.

(d) Pumps shall not be allowed on the service pipe as they cause a drop of pressure on the suction side thereby affecting the supply to the adjoining properties. In cases where pumping is required, a properly protected storage tank of adequate capacity shall be provided to feed the pump.

(e) Service pipes shall be so designed and constructed as to avoid air-locks, so that all piping and fittings above ground can be completely emptied of water to facilitate repairs. There shall be draining taps or draw-off taps (not underground) at the lowest points, from which the piping shall rise continuously to draw-off taps, ball valves, cisterns, or vents (where provided at the high points).

(f) Service pipes shall be designed so as to reduce the production and transmission of noise as much as possible. Appliances which create noise shall be installed as far distant as possible from the living rooms of the house. High velocity of water in piping and fittings shall be avoided.

Piping shall be confined, as far as possible, to rooms where appliances are fixed. It should have easy bends, and where quietness is particularly desired, holder bats or clamps shall be insulated from the piping by suitable pads.

(g) The rising pipe to the storage cistern if any or any feed cistern shall be taken as directly as possible to the cistern and shall be fixed away from windows or ventilators.

(h) No service pipe shall be connected to any water closet or urinal. All such supplies shall be from flushing cisterns which shall be supplied from storage tank.

(i) No service or supply pipe shall be connected directly to any hot-water system or to any apparatus used for heating other than through a feed cistern thereof.

13.1.8 Facility for inspection :

(a) All pipe work shall be planned so that the piping is accessible for inspection, replacement and repair. To avoid its being unsightly, it is usually possible to arrange it in or adjacent to cupboards, recesses, etc. provided there is sufficient space to work on the piping with the usual tools.

Piping shall not be buried in walls or solid floors. Where unavoidable, piping may be buried for short distances provided that adequate protection is given against damage and that no joints are buried. If piping is laid in ducts or chases, these shall be roomy enough to facilitate repairs and shall be so constructed as to prevent the entry of vermin. To facilitate removal of pipe casing, floor boards covering piping shall be fixed with screws or bolts.

(b) When it is necessary for a pipe to pass through a wall or floor, a sleeve shall be fixed therein for reception of the pipe and to allow freedom for expansion and contraction and other movement. Piping laid in wood floors shall, where possible, be parallel with the joists.

13.1.9 Storage tanks : Where storage tanks are provided to meet overall requirements of water, connection of service pipe with any distributing pipe shall not be permitted except one direct connection for culinary or drinking requirements.

13.1.10 Miscellaneous:

a) Conformity with bye-laws and rules : All water supply installations shall comply with the bye-laws and rules and regulations laid down by the Local Bodies or State Governments from time to time.

b) Conveyance and Distribution of Water : All pipe work shall be so designed, laid or fixed, and maintained as to be and to remain completely water tight, thereby avoiding waste of water, damage to the property and the risk of contamination of the water conveyed.

c) Pipes for Unfiltered water : For unfiltered water supply, the minimum size of GI pipes used shall be 25mm diameter.

13.2 MATERIALS, FITTINGS, SPECIALS, APPLIANCES ETC :

The standard size of brass or gun metal fittings shall be designated by the nominal bore of the pipe outlet to which the fittings are attached. A sample of each kind of fittings shall be got approved from the Engineer and all supplies made according to the approved samples.

All cast fittings shall be sound and free from laps, blow holes and pittings. Both internal and external surfaces shall be clean, smooth and free from sand etc. Burning, plugging, stopping or patching of the casting shall not be permissible. The bodies, bonnets, spindles and other parts shall be truly machined so that when assembled the parts shall be axial, parallel and cylindrical with surfaces smoothly finished. The area of water way of the fittings shall not be less than area of the nominal bore, chromium plating wherever specified shall be of 0.3 micron conforming to IS:4827. The chromium shall never be deposited on brass unless a heavy coating of nickel is interposed. In the case of iron, a thick coat of

copper shall first be applied, then one of nickel and finally the chromium. In finish and appearance the plated articles when inspected shall be free from plating defects such as blisters, pits roughness and unplated areas and shall not be stained or dis-coloured. Before fitting is plated, the washer plate shall be removed from the fittings and the gland packing shall be protected from the plating solution.

13.2.1 Ball Valve (Brass) (Ref. Fig. 13.1)

The ball valve shall be of Brass or Gunmetal as specified conforming to IS:1703. The ball valve shall be following two classes detailed in **Table 13.1**.

TABLE 13.1

	Nominal size of ball valve					
	15 mm	20 mm	25 mm	32 mm	40 mm	50 mm
Diameter of spherical float (mm) High pressure (HP)	127	152	203	229	254	305
Low pressure (LP)	114	127	178	203	203	254
Minimum weight of ball valve including Back nut, body and piston (gm)	283	446	823	1149	1589	1852

a) High pressure : Indicated by the abbreviation 'HP' for use on mains having pressure of 1.75 kg/sq.cm. or above. These shall remain closed at a test pressure of 10.5 kg/sq.cm.

b) Low pressure: Indicated by the abbreviation 'LP' for use on mains having a pressure upto 1.75 kg/sq.cm. These shall remain closed at a test pressure of 3.5 kg/sq. cm.

The ball valves shall be of following nominal sizes 15 mm, 20 mm, 25 mm, 32 mm, 40 mm, and 50 mm. The nominal size shall correspond with the nominal bore of the inlet shanks. Polyethelene floats shall conform to IS : 9762 which covers floats suitable for float valves of nominal sizes 15 mm to 50 mm.

13.2.2. Bib cock and Stop cock (Refer Figure 13.2) :

Brass : A bib cock (bib tap) is a draw off tap with a horizontal inlet and free outlet and a stop cock (stop tap) is a valve with a suitable

means of connections for insertion in a pipe line for controlling or stopping the flow. They shall be of specified size and shall be of screw down type and shall conform to IS : 781. The closing device shall work by means of disc carrying a renewable non-metallic washer which shuts against water pressure on a seating at right angles to the axis of the threaded spindle which operates it. The handle shall be either crutch or butterfly type securely fixed to the spindle. Valve shall be of the loose leather seated pattern. The cocks (taps) shall open in anti-clock wise direction.

The bib cock and stop cock shall be polished bright. The minimum finished weights of bib tap • (cock) and stop tap (cock) shall be as specified in **Table 13.2**.

In case these are required to be nickel plated, the plating shall be of the first quality with a good thick deposit of silvery whiteness capable of taking high polish which will not easily tarnish or scale.

TABLE 13.2

Size (mm)	Minimum finished weight	
	Bib tap (Kg.)	Stop tap (Kg.)
15	0.40	0.40
20	0.75	0.75

Plastic : Plastic Bib Taps and stop Valves (Rising Specials) for cold water services should conform to IS:9763. Nominal sizes covered by IS:9763 are 15mm and 20 mm.

13.2.3. Ferrules (Ref. Fig. 13.1) :

(a) The ferrules for connection with C.I. main shall generally conform to IS : 2692. It shall be of non ferrous materials with a C.I. bell mouth cover and shall be of nominal bore as specified. The ferrule shall be fitted with a screw and plug or valve capable of completely shutting off the water supply to the communication pipe, if and when required.

(b) As extracted from IS:2692, the scope, definition and nominal sizes of Ferrules are as under:

(i) Scope : Ferrules are commonly used in taking out branch lines from water mains and also in stopping supply to branch lines where desired. Different types of ferrules are available to suit specific purposes.

(ii) Definition : A draw-off appliance with a vertical inlet for screwing on to water main and a horizontal outlet, and closed by means of a washer plate carrying a renewable washer which shuts against the water pressure on a seating at right-angles to the axis of the threaded plug which operates it.

(iii) Nominal sizes:

Ferrules shall be of the following nominal sizes: 15, 20, 25, 32, 40 and 50 mm. The nominal sizes of the ferrule shall be designated by the nominal bore of the inlet connection.

13.2.4. Fire Hydrants (Ref. Fig. 13.1) : The hydrants shall be of spindle type with 65 mm outlet combined with sluice valve, unless

otherwise specified. The hydrant shall conform to IS : 909 and shall consist of the following components :

a) One sluice valve class 1 type, conforming to IS : 780 "Sluice valve for water works purposes 50 mm to 300 mm size".

b) A duck foot bend,

c) A 65 mm male coupling instantaneous pattern; and

d) Cast iron cap permanently secured to the duck foot bend by means of a chain. Where the fire service requirement of coupling differs from the above, the requisite coupling shall be provided at no extra cost.

The body and cover shall be of good quality cast iron, spindle of bronze and the nut and the valve seat of leaded tin bronze. The bodies, spindle and other parts shall be truly machined with surface smoothly finished.

13.2.5. Full Way Valve Brass (SLUICE VALVE) (Ref. Fig. 13.2) : Full way valve is a valve with suitable means of connection for insertion in a pipe line for controlling or stopping the flow. The valve shall be of brass fitted with a cast iron wheel and shall be of gate valve type conforming to IS : 780 opening full way and of the size as specified.

The valves shall be of best quality as approved by the Engineer and shall approximately have the weights specified in **Table 13.3** with a tolerance of 5%.

13.2.6. Full Way Valve with Wheel - Gun Metal (Ref. Fig. 13.2) : These shall be of the gun metal fitted with wheel and shall be of gate valve type opening full way and of the size as specified. These shall generally conform to IS : 778 and their weights shall be as specified in **Table 13.3**.

TABLE 13.3

Mm	Flanged ends (Kg.)	Screwed ends (Kg.)
15	1.021	0.567
20	1.503	0.680
25	2.495	1.077
32	3.232	1.559
40	4.082	2.268

50	6.691	3.232
65	10.149	6.804
80	13.381	8.845

13.2.7. Sluice Valves-Brass/Gun Metal (Ref. Fig.13.2) : The sluice valves are used in a pipe line for controlling or stopping flow of water. These shall be of specified size and class and shall be of inside non-raising screw type upto 300 mm size and raising or non-raising screw type above 300 mm with either double flange or double socket ends and cap or hand wheel. These shall in all respects comply with the Indian Standard Specification IS: 780 for valves upto and including 300 mm size and IS:2906 for valves above 300 mm size. Class I sluice valves are used for maximum working pressure of 10 Kg/ sq.cm (100 metre head) and class II sluice valve for 15 Kg/sq.cm (150 metre head).

The body, domes covers, wedge gate and stuffing box shall be of good quality cast iron, the spindle of bronze and the nut and valve seats of leaded tin bronze. The bodies, spindles and other parts shall be truly machined with surface smoothly finished. The area of the water way of the fittings shall be not less than the area equal to the nominal bore of the pipe. The valve shall be marked with an arrow to show the direction of turn for closing of the valve.

13.2.8. Surface Box (Ref.Fig. 13.3 & 13.4) :

For details IS 3950 Specification for surface

boxes for sluice valves may be referred to. This shall be of cast iron, well made and free from casting and other defects. All sharp edges shall be removed and finished smooth. The shape and dimensions for surface boxes for stop cocks, sluice valves, fire hydrants, water meters etc. shall be as specified in **Fig. 13.3 & 13.4**.

The C.I. surface boxes shall be coated with a black bitumenous composition except in case of fire hydrants where the cover of the surface box shall be painted with two coats of rust resisting bright luminous yellow paint for clear visibility during night;

13.2.9. Non-return valve or check Valve-Brass (Ref.Fig.13.2):

For details refer to IS 5312 - Specifications for Swing check Type Reflex (Non return) Valves for Water works. A non-return valve permits water to flow in one direction only and is provided on the ascending part of the main to check return flow. The non -return valve shall be of brass and shall be of horizontal or vertical flow type as specified.

The valve shall be of quality approved by the Engineer and shall have the weights specified in **Table 13.4** with a tolerance of 5 percent.

TABLE 13.4

Diamters mm	Horizontal type Kg.	Vertical type Kg.
15	0.30	0.25
20	0.55	0.25
25	0.90	0.75
32	1.25	0.90
40	1.70	1.20
50	2.90	1.45
65	5.25	2.15
80	7.70	4.10

13.2.10. Non-Return valve or Check valve - Gun Metal (Ref. Fig. 13.2) : Specification described in para 13.2.9 shall apply except that non-return valve shall be of gun metal

and shall generally conform to IS : 778.

13.2.11. Pipes and Specials – General :

Pipes and specials may be of any of the following types as specified :

- a) Asbestos cement pressure pipes - IS:1592
- b) Cast iron centrifugally cast (spun) - IS:1536
- c) Galvanised steel - IS:1239 & IS:4736
- d) Plastic unplasticised rigid PVC IS 4984 & IS 4985
- e) Polythene / aluminium / polythene composite pressure pipes for hot and cold water supplies as per IS 15450:2004 (PL-AL-PE Pipes)
- f) Centrifugally cast (Spun) ductile iron pipes pressure pipes for water, gas and sewage as per IS : 8329:1994.

In choosing the material for piping and fittings, account shall be taken of the

character of the water to be conveyed through it, the nature of the ground in which the pipes are to be laid and the relative economics.

13.2.12. Pipes-Cast Iron Centrifugally Cast (Spun):

13.2.12.1. The spun iron pipes shall conform to IS:1536. The spun iron pipes, shall be of cast iron casted centrifugally and vary in diameters from 80 mm to 750 mm. These shall be of class LA, class A and class B, as specified. These pipes shall be used for water pressures upto half the Hydrostatic test pressure as detailed in **Table 13.7**. Tolerances on specials shall be as given in **Annexure-13.1**.

TABLE 13.7

Types of pipes	Test pressure of Kg/Sq.cm		
	Class LA	Class A	Class B
Spigot and socket pipe in all diameters	12	18	24
Flanged pipes upto 600 mm dia		18	24

13.2.12.2. Specials : The specials shall conform to IS: 1538. The Hydrostatic test pressure of each class shall be as detailed in **Table 13.8**. Tolerances on specials dimension shall be as given in **Annexure-13.2**.

TABLE-13.8

Nominal – Diameter	Test pressure in Kg/Sq.cm (metre head)	
	Fitting without branches or with branches not greater than half the principal diameter	Fitting with branches greater than half the principal diameter
Upto and including 300 mm	25 (250)	25 (250)
Over 300 mm and upto and including 600 mm	20 (200)	20 (200)
Over 600 mm and upto and including 1500 mm	15 (150)	10 (100)

13.2.13. Pipes-Galvanised Iron :

13.2.13.1. The pipes (tubes) shall be galvanised mild steel hot finished seamless (IFS) or welded (ERW) HRIW or HFW screwed and socketed conforming to the requirements of IS: 1239 Part-I for medium grade. They shall be of the diameter (nominal bore) specified in the description of the item, the sockets shall be designated by the respective nominal bores of the pipes for which they are intended.

13.2.13.2. Galvanising shall conform to IS:4736 The zinc coating shall be uniformly adherant, reasonably smooth and free from such imperfections as flux, ash and dross-inclusions, bare patches, black spots, pimples, lumping runs, rust stains, bulky white deposits and blisters. The pipes and sockets shall be cleanly finished, well galvanised in and out and free from cracks, surface flaws laminations and other defects. All screw threads shall be clean and well

cut. The ends shall be cut cleanly, and square with the axis of the tube.

13.2.13.3. The dimensions and weights of pipes and sockets and tolerances shall be as prescribed in **Annexure 13.3**.

13.2.13.4. All screwed tubes and sockets shall have fine threads conforming to the requirements of IS:554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

13.2.13.5. All tubes shall withstand a test pressure of 50 Kg/sq.cm without showing defects of any kind.

13.2.13.6. Fittings : The fittings shall be of mild steel tubular or wrought steel fittings conforming to IS:1239 (Part-II) or as specified. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended.

13.2.14. Pipes-Plastic

13.2.14.1. The plastic pipes commercially available in the country are that of (i) low-density polyethylene (LDPE) (ii) High-density polyethylene HDPE, and (iii) Rigid (unplasticised) polyvinylchloride (UPVC). These pipes are corrosion resistant and light in weight, and have been found suitable for cold water services. Plastic materials perform on their own merits, and each of these plastic pipes has its own limitations and advantages for a particular application under conditions of use. Relevant Indian standard specifications have been laid down for these pipes.

13.2.14.2. Low Density Polyethylene to IS:3076 is flexible, it is now well established that this material is used for pipes with diameter upto 63 mm, generally recommended for use in long runs e.g. for point to point conveyance of water, because of its flexibility, and fact that LDPE pipes require closer spacing of clips for horizontal and vertical runs, their use has not been found practical for installation of internal water supply system.

13.2.14.3. High Density Polyethylene is rather tougher as compared to low-density polyethylene. Pipes upto 1600 mm diameter have been produced out of this material. In India however, HDPE pipes are available from 16 mm to 400 mm dia. Use of these pipes in small diameters for internal water supplies has not found ready acceptance because of practical problems like on-site jointing, and taking out of various connections in plumbing. Their use in larger diameters for conveyance of water/ effluents and in long runs from point to point has been

found very suitable and has been readily accepted by the Public Health Engineering and similar departments, in the country.

13.2.14.4. Polyethylene pipes are normally available in black colour. These are resistant to most chemicals, except nitric acid, and very strong acids, fats, and oils and certain solvents particularly chlorinated ones. There is a phenomenon called environmental stress cracking which means that if polyethylene is stressed at normal temperatures and comes into contact with certain materials then it will crack and eventually fail. The materials include detergents, organic acids, esters, aldehydes, ketone, amides, nitrocompounds, and alcohols (but not beer). The HDPE is worse than LDPE in this respect.

13.2.14.5. Rigid (Unplasticized) PVC Pipes are widely accepted for applications such as cold water services internal/external water supplies systems, water mains, rain water system, soil waste piping system, and underground (sewage pipes) drainage piping system. Rigid PVC is three times as rigid as polyethylene. It is also much stronger and will withstand much higher pressure for a given wall thickness. Joints can easily be made in rigid PVC pipes by solvent welding, and a whole range of injection moulded matching fittings and specials are available for these pipes. Rigid PVC pipes are normally available in the shades of White/cream. Light to dark grey, Black

In general, rigid PVC is resistant to most inorganic acids, alkalies and salts, as well as many organic chemicals. It is quite resistant to most effluents, salt water and plating solutions, corrosive fumes, soils and the like which lead to its applications over a wide field. The material is also perfectly safe with potable water, whether hard or soft, and in the former case it tends to retard the formation of scale. Those materials which do attack it include concentrated oxidizing acids, esters, ketones, aromatic and chlorinated hydrocarbons, organonitro compounds, organo-amino compounds, lacquer solvents and acetic anhydride.

The pipes shall be reasonably round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth & clean, free from grooving and other defects. The end shall be cleanly cut and square with the axis of the pipe. The pipe shall be designated by external diameter and shall

conform to IS : 4985 (Revised) in all respects. The dimensions and tolerances of rigid PVC pipes shall be as in **Annexure-13.4**.

13.2.14.6. Fittings : Fittings used shall be of the same make as that of PVC pipes, injection moulded or made in cast iron and shall conform to Indian standard wherever available.

13.2.14.7 Polythene / aluminium / polythene composite pressure pipes for hot and cold water supplies as per IS 15450:2004 (PE-AL-PE Pipes)

(Some important para of the above IS code are reproduced below for information and guidance.

3. PIPE DESIGNATION

PE-AL-PE composite pipes are designated by nominal inside and outside diameters. The concept of dimension ratio is not relevant to PE-AL-PE pipe and are not used to relate pressure rating with total wall thickness.

4. MATERIALS

4.1 The amterial from which PE-AL-PE pipe is manufactured shall comprise of polyethylene plastic and aluminium strip.

4.2 Polyethylene

Polyethylene compounds used for the manufacture of these pipes shall conform to IS 7328 as follows:

- a) PEEWA 45T006 for black pipes and
- b) PEELA 45T006 for coloured pipes

4.3 UV Stabilizer

The percentage of UV stabilizer used shall not be more than 0.5 percent by mass of finished resin. Raw material supplier to provide a certificate in this regard.

4.4 Aluminium

The material shall have the following properties and shall be tested as per IS 737:

- a) Minimum elongation : 20 percent
- b) Ultimate tensile strength : 100 Mpa

The aluminium strip shall have nominal thickness as specified in Table 1. Tolerances on all thickness for all sizes shall be +0.02 – 0.00 mm.

4.5 Rework Material

No rework material shall be used in the manufacture of pipe IS 15450 : 2004

Table 1 : Aluminium Thickness and Tolerances for PE-AL-PE Pipe (Clause 4.4)

SL	Nominal Pipe size mm	Nominal Aluminium Thickness mm
I	0.912	0.20
li	1.014	0.20
lii	1.216	0.20
Iv	1.620	0.25
V	2.025	0.25
Vi	2.532	0.30
Vii	3.240	0.30
Viii	4.050	0.30

5. PRESSURE RATING

The PE-AL-PE composite pipe meeting the requirement so f this specification shall be pressure rated for maximum water pressures of 1.38 MPa at 230C and 1.10 MPa at 600C (see Annex A).

6. NOMINAL DIAMETERS

The nominal outside diameter of pipes are 12, 14, 16, 20, 25, 32, 40 and 50 mm. Respective nominal inside diameters are

9,10,12,16,20,25,32 and 40 mm.

7. COLOUR

Pipe manufactured from compound grade PEEWA45T006 having carbon black shall be black and made from compound grade PEELA45T006 shall be pigmented according to the requirement of the customer.

8. DIMENSIONS OF PIPE

8.1 Pipe diameter, out of roundness total wall thickness and thickness of outer PElayer

shall be as given in Table 2. The thickness of the outer layer of polyethylene, when tested as per Annex B, in the PE-AL-PE pipe shall have a minimum value as specified in Table 2, except for polyethylene material overlaying the weld, which shall have a minimum thickness of half that specified in Table 2. Tolerances of nominal OD shall be $+0.30\text{mm}/-0.30\text{mm}$ up to and including 25 mm and $+0.50\text{mm}/-0.00\text{mm}$ for nominal OD 32 mm and above.

8.2 Method of Measurements

8.2.1 The outside diameter of pipe shall be taken as the average of two measurements taken at right angles. The wall thickness shall be measured by a dial vernier or ball ended micrometer. The resulting dimension shall be expressed to the nearest 0.1 mm.

8.2.2 Ovality shall be measured as the difference between maximum outside diameter and minimum outside diameter measured at the same cross section of pipe. For pipes to be coiled, the ovality shall be measured prior to coiling. For coiled pipes, however, re-rounding of pipes shall be carried out prior to the measurement of ovality.

8.3 Length of Straight Pipe

The pipe shall be supplied in straight lengths as agreed upon with the purchaser between 3 to 20 m.

8.4 Coiling

While coiling, the inside diameter of coils in mm, shall be not less than 20 times the

outside diameter of pipe.

9.0 VISUAL APPEARANCE

The internal and external surfaces of the pipe shall be smooth, clean and free from grooving and other defects. The ends shall be cleanly cut and shall be square with the axis of the pipes. Slight shallow longitudinal grooves or irregularities in the wall thickness shall be permissible provided that the wall thickness remains within the permissible limits.

RECOMMENDATORY INFORMATION for PL-AL-PL Pipes

A-1 STORAGE

A-1.1 Outside Storage

Pipe should be stored on a flat surface and supported in a manner that will prevent distortion.

A-2 CONNECTORS AND FITTINGS

A-2.1 PE-AL-PE pipes manufactured to this specification shall be capable of being joined with suitable connectors or fittings provided that the connector or fitting alone or in assembly with PE-AL-PE pipe complies with the requirements as given in A-2.2 and A-2.3.

A-2.2 Internal Pressure Test

The fitting or connector, when assembled with PE-AL-PE pipe, shall not fail or weep at the specified duration as given in Table 9. The joint shall not have any leakage during the test.

Table 9 Test Pressure and Duration

(Clause A-2.2)

SL.No.	Pipe Size	Test Pressure	Duration
i)	1.014	36.0	1
ii)	1.216	31.3	1
iii)	1.620	26.7	1
iv)	2.025	26.7	1
v)	2.532	23.0	1
vi)	3240	22.3	1
vii)	4.050	20.4	1

A-2-3 Pull Out Test

A-2-3.1 Apparatus

The apparatus shall consist of one of the following:

- A tensile testing machine together with grips capable of subjecting the test assembly to a constant longitudinal forces; and
- A frame with means for suspending a test piece together with stirrup at the lower

end to hold sufficient weight(s) with which to apply the specified forces.

A-2.3.2 Test Assembly

The test assembly shall comprise a straight coupling or any other fitting which can join two pipe pieces assembled in accordance with the manufacturer's instructions with two pieces of pipe of the appropriate nominal size. Separate combinations shall be assembled for each type of pipe for which

fitting is designed. Each pipe shall be at least 100 mm in length.

A-2.3.3 Procedure:

Secure the test assembly in the apparatus and apply gradually over a period of 20s the appropriate force at ambient temperature as given in Table 10 as applicable. Hold the specimen in constant tension for the specified duration.

Table 10 : Test Pressure and Duration for Pull out Test

(Clause 1-2.3.3)

SL.No.	Pipe Size	Test Pressure	Duration
i)	1.014	620	1
ii)	1.216	740	1
iii)	1.620	1.068	1
iv)	2.025	1.640	1
v)	2.532	2.427	1
vi)	3240	3.694	1
vii)	4.050	5.463	1

13.2.14.8 PPR Pipes & Fittings :

1) SCOPE

The scope comprises of supply, installation, testing and commissioning of piping network for water supply (hot and cold water) for internal and external services.

The Contractor shall make all necessary application and arrangements for his work to be inspected by the Local Authorities, Consultants and Site personnel.

2) PIPING MATERIALS

The piping system shall consist of Polypropylene Random Copolymer Type 3 pipes and fittings conforming to DIN 8078. The sizes and makes are specified in the Schedule of Quantities.

For any internal works, the Polypropylene pipes and fittings shall be embedded in the wall chase or run on the floor/ ceiling unless otherwise specified. No unsighted exposed runs shall be permitted. Outside the building the piping shall be installed atleast 1.0 meter below the finished grade level.

3) Fusion Welded Polypropylene Pipes and fittings

The pipes shall be 3-Layered Polypropylene Random Copolymer whereby the different layers of the pipes shall consist of :

- The inner-most layer of the pipe to be Anti-bacterial to prevent bacteria growth inside the pipe surface.
- The middle layer to be of plain PP-R which is neither in contact with Water and nor under direct effect of the atmospheric conditions.
- The outer-most layer to be of U.V. stabilized PP-R to prevent the pipe surface from sunlight under exposed atmospheric conditions.

The pipes should be conforming to the requirements of DIN 8078 April 1996 (PPR pipes General Quality requirements and Testing) and DIN 8077 December 1997 (PPR Pipe dimensions). The pipes should have smooth inner surface with Non – contracting diameters. The pipes shall be cleanly finished, free from cracks and other defects. The pipes shall be clean and well cut along ends after taking into consideration the desired length, using the Pipe scissors.

The fittings shall be as follows :-

- Plain fittings from sizes 16mm to 160mm
- Chrome Plated Brass Threaded fittings from sizes 16mm to 75mm.
- Valves from sizes 20mm to 63mm.

- a) The plain fittings shall be Polypropylene Random Copolymer and comply with all the requirements of the pipes. The size of fitting is specified in the schedule of quantities, corresponding to the size of the pipe. The plain fittings shall comprise of Socket, Elbow, Tee, Cross, Unions, Reducer socket, Reduction Tee, End Cap, Crossover, Omega, Threaded plug, and Wall Clamps in available sizes.
- b) The Chrome Plated Brass threaded fittings shall be Chrome Plated Brass threaded piece molded inside Polypropylene Random copolymer fitting. The Plastic end shall comply with all the requirements of the pipes while the C.P. Brass end shall comply with BSP standards of Threading. The size of the C.P. Brass threaded fitting is specified in the schedule of quantities, corresponding to the pipe size. The Chrome plated Brass threaded fittings shall comprise of Socket, Elbow and Tee (Male & Female) in available sizes. These are the fittings for C.P. connections and for continuations from existing Galvanized Iron Pipes and fittings.
- c) The valves shall be Polypropylene Random Copolymer Valves. The valves comprise of Gate Valve, Ball Valve, Concealed Stop Cock and Chrome Coated Valve in available sizes. The size and type of the Valve is specified in the Schedule of quantities.

The Valves sizes availability in Polypropylene Random Copolymer is as follows :

- i) Gate Valve - 20 MM & 63 MM
- ii) Ball Valve - 20 MM, 25 MM, 32 MM, 40 MM, 50 MM & 63 MM 75 MM 90 MM
- iii) Concealed Stop Cock - 20 MM & 25 MM.
- iv) Chrome Coated Valve - 20 MM & 25 MM.

However, the other Brass/ Bronze Valves

can be connected to Polypropylene Random pipes using C.P. Brass threaded fittings of desired sizes.

4) Laying and Jointing of Polypropylene Random Pipes and Fittings :

The Polypropylene Random Pipes and Fittings shall run in wall chase or ceiling or as specified. The installation of Polypropylene Random Copolymer pipes is similar to that of the metal pipes with the only difference in the Jointing procedure. The jointing of the Fusion welded PP-R pipes and fittings is done by means of a Welding Machine.

The quality of each installation system ultimately depends on the tightness, stability and lifetime of its connections. The homogeneous connection of PP-R pipes by fusion welding gives an absolutely safe pipe connection and guarantees utmost operational safety. It takes only a few seconds to make a connection by fusion welding process. After a couple of minutes, the welded joint cools down sufficiently and can be fully loaded. The pipe to the desired length is cut using the Pipe Scissors. The proper heating piece is taken and mounted on the welding machine. The welding device is switched on – Control lamp and switch lamp will lit. When ready, control lamp gets off, which means that welding temperature of 260 Degrees +/- 10 Degrees Celcius has been reached. The Pipe end and the fitting to be welded is heated on the welding machine. Before heating the fitting and the pipe, the dirty welding tools, pipe and fitting is cleaned with a cloth. When heated up (with heating time as per the Table shown below), the pipe and the fitting is removed from the welding machine and the two pieces connected together by applying a little pressure without twisting. The joint is allowed to cool down for a few seconds. The welding process is that safe because the properly heated parts of Polypropylene creates a homogeneous connection.

Guidelines for Welding PP-R Pipes and fittings (DVS guideline 2207, Part 11)

Outer diameter of pipe (MM)	Heating Time (Seconds)	Cooling Period (Minutes)
16	5	2
20	5	2
25	7	2
32	8	4
40	12	4
50	18	4

63	24	6
75	30	8
90	30	8
110	45	10
160	60	12

The same procedure shall be adapted for exposed as well as concealed fittings. The Crossovers may be used wherever the overlapping of the PP-R pipes is required. The fixing shall be done by means of Wall Support Clamps keeping the pipes about 1.5 cm clear of the wall where to be laid on the surface. Where it is specified to conceal the pipes, chasing may be adopted. For pipes fixed in the shafts, ducts etc. there should be sufficient space to work on the pipes with the usual tools. Where directed by the owner's site representative/ Architect, pipe sleeves shall be fixed at a place the pipe is passing, through a wall or floor for reception of the pipe and allow freedom for expansion and contraction and other movements. Fixed supports prevent any movement of the pipe by fixing it at some points. Fittings are used in creating the fixed points. Fixed supports must not be installed at bending parts and

the direction changes must be done in the pipe itself. In between the fixed supports some arrangements must be done to compensate any potential elongation or shrinkage in the pipe length.

Expansion or shrinkage compensation arrangements can be installed in buildings very easily. For making one expansion loop, four elbows will be enough. For straight pipes having length more than 5 meters, to compensate the expansion an expansion piece must be used.

When necessary Polypropylene Random pipes can be bend by heating, but the pipes should not be put on flame. Heating should be done by hot air blowing device. To bend the pipes, they should be heated upto 140 Degree Celcius. Advised minimum radius for bending are shown in the under table :-

PIPE DIAMETER (d)	BEND RADIUS, MINIMUM (R= 8x d)
20	160
25	200
32	256
40	320
50	400
63	500
75	600
90	720
110	880
160	1280

All pipe work shall be carried out in a proper workman like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire piping work shall be organised in consultation with other agencies work, so that all works can be carried out in one stretch.

PP-R pipes can be used in mixed installations and repair works. The pipes running parallel, should be separated by putting insulation parts to prevent sound reflection. To prevent noise, under or above ground installations the pipes should not contact to each other.

Cut-outs in the floor slab for installing the various pipes are indicated in the drawings.

The Contractor should carefully examine the cut-outs provided and clearly point out wherever the cut-outs shown in the drawings, do not meet with the requirements.

All pipes shall be accurately cut to the required lengths and then cleaned with a clean cloth before fusion welding. Open ends of the pipes where the C.P. Brass threaded fittings are welded for C.P. connections at the later stage should be closed by means of Plugs to avoid the entrance of foreign matter.

Automatic air valves shall be provided at all high points in the piping system for venting. Automatic air valves shall also be provided on hot water risers. Discharge from the air valves shall be piped to the nearest drain or sump. All pipes shall be pitched towards the

drain points.

Pressure gauges and Thermometers shall be provided as per the approved drawings and included in the Bill of quantities. Care should be taken to prevent these during Pressure testing.

5) INSTALLATION OF WATER METER AND VALVES

PP-R lines shall be cut to the required lengths at the position where the meter and Valves are required to be fixed. Suitable C.P. Brass threaded fittings shall be attached to the pipes. The meter and Valves shall be fixed in a position by means of connecting pipes, jam nut and socket etc. The Stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed. And the meter shall be installed exactly horizontally or vertically in the flow line in the direction shown by the arrow cast on the body of the meter. Care shall be taken to not to disturb the factory seal of the meter. Wherever the meter shall be fixed to a newly fitted pipeline, the pipeline shall have to be completely washed before fitting the meter.

6) TESTING

The Contractor shall inform in advance of any test so that Architect can witness tests if he so wishes. All water supply system shall be tested to Hydrostatic pressure test of atleast one and a half (1.5) times maximum working pressure but not less than 10 Kgs/Sqcm for a period of not less than 8 hours.

The pressure test is performed in 3 steps being preliminary test, main test and final test. For the preliminary test a pressure which is 1.5 times higher than the possible working pressure is applied and this is repeated two times in 30 minutes with intervals of 10 minutes. After a test period of 30 minutes, the test pressure must not be dropped more than 0.6 bar and no leak must occur. Main test follows the preliminary test. Test time is two hours, in doing so the test pressure taken from the preliminary test must not have fallen more than 0.2 bar. After completion of these tests, the final test comes which has to be done under a test pressure of 10 bar and 5 bar in the interval of 15 minutes. Between the respective test courses, pressure has to be removed.

All leaks and defects in joints revealed during the testing shall be rectified and got approved at site by retest. Piping required subsequent to the above pressure test shall be retested in the same manner. A record of

Pressure test has to be prepared and signed by the Client/ Architect and Contractor with statement of place and date.

7) DISINFECTION OF PIPING SYSTEM AND STORAGE TANKS :

Before commissioning the water supply system, the contractor shall arrange to disinfect the entire system. The water storage tanks and pipes shall first be filled with water and thoroughly flushed out. The storage tanks shall then be filled with water again and disinfecting chemicals (chlorine) are added gradually at the time of tanks being filled to ensure thorough mixing. Sufficient chemical shall be used to give water a dose of 50 ppm of water.

For any other chemical used, the proportions shall be specified by the manufacturer. When the storage tank is full, the supply shall be stopped and all the taps on the distributing pipes are opened successively. Each tap shall be closed when the water discharged begins to smell of chlorine. The storage tank and pipe shall then remain charged atleast for three hours. Finally the tank and pipes shall be thoroughly flushed out before any water is used for domestic purpose.

STERILIZATION OF MAIN

After the pipework has been tested and approved, but before it is coupled, it shall be sterilized with a solution of chloride of lime.

8) MEASUREMENTS

The length above ground shall be measured in running meter correct to a cm for the finished work, which shall include PP-R pipe and fittings including Plain fittings and Chrome Plated Brass Threaded fittings. Deductions for the length of valves shall be made. Rate quoted shall be inclusive of all fittings, clamps, Plugs, Chase cutting and making good the same and all items mentioned in the specifications and Bill of Quantities.

All PP-R pipes below ground shall be measured per linear meters (to the nearest cm) and shall be inclusive of all fittings including Plain fittings and Chrome Plated Brass Threaded fittings. Deductions for the length of valves shall be made. Rates quoted shall be inclusive of all fittings, clamps, excavation, back filling and disposal of surplus earth, cutting holes and making good all items mentioned in the Bill of Quantities.

9) SHIFTING OF EXCAVATED SURPLUS MATERIAL

Contractor shall make his own arrangement to shift the surplus excavated material within the site limits as directed by Owner's site representative at his own cost within time limit.

13.2.15. Shower Rose Brass : The shower rose shall be of chromium plated brass of specified diameter. It shall have uniform perforations. The inlet size shall be 15 mm or 20 mm as required.

13.2.16. Water Meter (Domestic Type)

For details IS:779 water meters (Domestic type may be referred to)

13.2.16.1. Water meters shall be selected according to flow to be measured and not necessarily to suit a certain size of main. The following points shall govern the selection of meters :

- a) The maximum flow shall not exceed the nominal capacity of the meter.
- b) The continuous flow shall be not greater than the continuous running capacity rating.
- c) The minimum flow to be measured shall be within minimum starting flows.

13.2.16.2. Inferential water meter has the same accuracy as the semi-positive type at higher flows; it passes unfiltered water better than a semi-positive meter and is lower in cost.

13.2.16.3. Special care is necessary in selecting the most suitable meter where large rates of flow may exist for short periods. The normal working flow shall be well within the continuous running capacity specified in IS:779, as high rates of flow over short period may cause excessive wear if the meter chosen is too small for the duty.

13.2.16.4. Owing to the fine clearances in the working parts of meters, they are not suitable for measuring water containing sand or similar foreign matter, and in such cases a filter or dirt box of adequate effective area shall be fitted on the upstream side of the meter. See **Fig. 13.2**. It shall be noted that the normal strainer fitted inside a meter is not a filter and does not prevent the entry of small particles, such as sand.

13.2.16.5. Water meters and their parts, especially parts coming in continuous contact with water shall be made of materials resistant to corrosion and shall be non-toxic. Use of dissimilar metals in contact under water shall be avoided as far as possible in order to minimise electrolytic corrosion.

13.2.16.6. Body : The body of water meter shall be made either from Type A or Type B

materials as specified below :

Type A : The body of water meters shall be made from bronze, brass or any other corrosion resistant material e.g. Grey iron castings, blackheart malleable iron, pearlitic graphite iron casting.

Type B : The body of the water meters shall be made from suitable plastics which shall have following qualities:

- i) It shall not affect the potability of water.
- ii) Elongation, 15 percent, Min. on a specimen of length 150 mm.
- iii) Water absorption on immersion for 24 hours should not exceed 0.6 percent by weight.
- iv) It shall be capable of withstanding temperature upto 55° C without undergoing deformation or softening and becoming unsatisfactory in performance.

13.2.16.7. Registration Box : Registration box of water meters of Type A shall be made from bronze, brass, aluminium alloy or suitable plastics. Registration box of water meters of Type B shall be made from suitable plastics or aluminium alloys. The registration box of dry dial water meters shall be provided with one or two escape holes for minimising the accumulation of condensed water.

13.2.16.8. Cap : Cap of water meters of Type A shall be made from brass, bronze, aluminium alloy or suitable plastics. The cap of water meters of Type B shall be made of plastics or aluminium alloy. Where the cap and registration box are integral, the materials for cap may be the same as used for registration box. The cap shall be so designed and fixed to the registration box as to avoid entry of water and dirt. The transparent window which covers the dial shall be inserted from the inside into the cap. The protective lid shall be secured by a robust hinge or other suitable method of robust construction.

13.2.16.9. Locking arrangement : Provision shall also be made to lock the lid. The provision shall be such that the lock is conveniently operated from the top. Where the provision is designed for use in conjunction with padlocks, the hole provided for padlocks shall be of a diameter not less than 4 mm.

13.2.16.10. Wiper : Where so required for dry-type water meters the transparent window covering the dial shall be provided with a wiper on the inner side for wiping off condensed water.

13.2.16.11. Connecting Arrangements :

The meter casing shall be fitted in the pipe line by means of two conical or cylindrical nipples or tail pieces with connecting nuts which shall be provided with each meter. The nipples of water meters of Type A shall be made of the same materials as specified for body. Nipples of water meters of Type B shall be made of the same materials as specified for the body where they are integral with the body of the water meters; where they are separate, they shall be made of

malleable iron, galvanized steel or suitable plastics. The nuts shall be of the same material as used for nipples. The internal diameter of the nipple where it connects the pipe line shall be equal to that corresponding to the nominal size of the meter. The threads on the connection shall conform to IS:554. The minimum length of the threads shall be as given in **Table 13.9**. Screws & studs shall be of brass or other corrosion resistant material.

TABLE 13.9
MINIMUM LENGTH OF THREAD ON CONNECTIONS (mm)

Nominal size of meter	Minimum length of thread
15	13
20	16
25	19
40	21
50	25

13.2.16.12. Strainers : Water meters shall be provided with strainers. Strainers shall be of a material which is not susceptible to electrolytic corrosion. They shall be of plastics or other corrosion-resistant materials for both Type A and Type B meters. They shall be rigid, easy to remove and clean, and shall be fitted on the inlet side of the water meter. It shall be possible to remove and clean the strainer in such a way as not to permit disturbing the registration box or

tampering with it. The strainer shall have a total area of holes not less than twice the area of the nominal inlet bore of the pipe to which the meter is connected. However, in the case of meters provided with internal strainer involving opening of the registration box for cleaning, an additional external strainer shall be fitted on the inlet side satisfying the above requirements. Overall dimension of water meters shall be as specified in **Table. 13.10**.

TABLE 13.10
OVERALL DIMENSIONS OF WATER METERS

Nominal size of Meter	Overall length including nipples	Overall width. (Max.)	Overall height (Max.)	Nominal flow rate KL/ Hour
1	2	3	4	5
15	250	130	180	1.5
20	290	130	180	2.5
25	380	140	200	3.5
40	430	230	250	10
50	470	250	300	15

All dimensions are in mm. Tolerance on the overall length shall be ± 5 mm.

13.2.16.13. Capacity on Short Period

Rating or Nominal Capacity : The nominal capacity of the water meters shall be as specified in **Table 13.11**. The meters shall be capable of giving minimum discharges as

stated in the Table without the head loss exceeding 10 m within the meters.

TABLE 13.11
NOMINAL CAPACITY OF WATER METERS

Nominal size of meter (mm)	Discharge per hour	
	Semi positive Type (liters)	Inferential Type (liters)
15	2000	2500
20	3400	3500
25	5500	5500
40	10000	16000
50	15000	23000

13.2.17. Yarn (Spun) : Spun yarn shall be of clean hemp and of good quality. It shall be soaked in hot coal tar or bitumen and cooled before use.

13.3 LAYING AND JOINTING OF PIPES AND FITTINGS – GENERAL

13.3.1. Unloading

13.3.1.1. The pipes shall be unloaded where they are required.

13.3.1.2. Except where mechanical handling facilities are available, pipes weighing upto 60 kg shall be handled by two persons by hand passing. Heavier pipes shall be unloaded from the lorry or wagon by holding them in loops, formed with ropes and sliding over planks set not steeper than 45 degree. The planks shall be sufficiently rigid and two ropes shall always be used to roll the pipes down the planks. The ropes should be tied on the side opposite the unloading. Only one pipe shall be unloaded at a time.

13.3.1.3. Under no circumstances shall the pipes be thrown down from the carriers or be dragged or rolled along hard surfaces.

13.3.1.4. The pipes shall be checked for any visible damage (such as broken edges, cracking or spalling of pipe) while unloading and shall be sorted out for reclamation. Any pipe which shows sufficient damage to preclude it from being used shall be discarded.

13.3.2. Storing

13.3.2.1. The pipes and specials shall be handled with sufficient care to avoid damage to them. These shall be lined up on one side of the alignment of the trench, socket facing upgrade when line runs uphill and upstream

when line runs on level ground.

13.3.2.2. Each stack shall contain pipes of same class and size, consignment or batch number and particulars of suppliers, wherever possible, shall be marked on the stack.

13.3.2.3. Storage shall be done on firm, level and clean ground. Wedges shall be provided at the bottom layer to keep the stack stable.

13.3.3. Cutting

13.3.3.1. Cutting of pipes, may be necessary when pipes are to be laid in lengths shorter than the lengths supplied, such as while replacing accessories like tees, bends, etc. at fixed position in the pipe lines.

13.3.3.2. A line shall be marked around the pipe with a chalk piece at the point where it is to be cut. The line shall be so marked that the cut is truly at right angle to the longitudinal axis of the pipe. The pipe shall be rigidly held on two parallel rafters nailed to cross beams, taking care that the portion to be cut does not overhang and the cut mark is between the two rafters. The pipe shall be neatly cut at the chalk mark with carpenter's saw or hacksaw having a long blade, by slowly rotating the pipe around its longitudinal axis so as to have the uncut portion on top for cutting. Cutting of the pipe at the overhang should, as far as possible, be avoided, as an overhanging end is liable to tear off due to its weight before the cutting is complete.

13.3.4. Trenches

13.3.4.1. The trenches shall be so dug that the pipes may be laid to the required alignment and at required depth. Excavation shall proceed to within about 7.5 cms of the finished formation level. The final 7.5cm is

to be trimmed and removed as a separate operation immediately prior to the laying of the pipe or their foundations.

13.3.4.2. Cover shall be measured from top of pipe to the surface of the ground.

13.3.4.3. The bed of the trench, if in soft or made up earth, shall be well watered and rammed before laying the pipes and the depressions, if any, shall be properly filled with earth and consolidated in 20 cm layers.

13.3.4.4. If the trench bottom is extremely hard or rocky or of loose stony soil, the trench shall be excavated at least 150 mm below the trench grade. Rocks, stone or other hard substances from the bottom of the trench shall be removed and the trench brought back to the required grade by filling with selected fine earth or sand (or fine moorum if fine soil or sand is not available locally) and compacted so as to provide a smooth bedding for the pipe. Where excavation requires blasting operation, it shall be ensured that no pipes have been stacked in the vicinity and completed pipe line in the vicinity has already been covered before starting of blasting operations; this is necessary to prevent damage to the exposed pipes in the vicinity by falling stones as a result of blasting.

13.3.4.5. After the excavation of the trench is completed, hollows shall be cut at the required position to receive the socket of the pipes and these hollows shall be of sufficient depth to ensure that the barrels of the pipes shall rest throughout their entire length on the solid ground and that sufficient spaces left for jointing the underside of the pipe joint. These socket holes shall be refilled with sand after jointing the pipe.

13.3.4.6. Roots of trees within a distance of about 0.5 metre from the side of the pipe line shall be removed or killed.

13.3.4.7. The excavated materials shall not be placed within 1 metre or half of the depth of the trench, whichever is greater, from the edge of the trench. The materials excavated shall be separated and stacked so that in refilling they may be relaid and compacted in the same order to the satisfaction of the Engineer.

13.3.4.8. The trench shall be kept free from water. Shoring and timbering shall be provided wherever required. Excavation below water table shall be done after dewatering the trenches.

13.3.4.9. Where the pipe line or drain crosses an existing road, the road crossing shall be excavated half at a time, the 2nd

half being commenced after the pipes have been laid in the first half and the trench refilled. Necessary safety measures for traffic as directed shall be adopted. All pipes, water mains cables, etc. met within the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the electrical and communication cable met with during course of excavation, removal of which, if necessary, shall be arranged by the Engineer.

13.3.5. Laying

13.3.5.1. The pipes shall be lowered into the trench by means of suitable pulley blocks, shear legs, chains, ropes etc. In no case the pipes shall be rolled and dropped into the trench. One end of each rope may be tied to a wooden or steel peg driven into the ground and the other end held by men which when slowly released will lower the pipe into the trench. After lowering, the pipes shall be arranged so that the spigot of one pipe is carefully centered into the socket of the next pipe, and pushed to the full distance that it can go. The pipe line shall be laid to the levels required. Specials shall also be laid in their proper position as stated above.

13.3.5.2. Where so directed, the pipes and specials may be laid on masonry or concrete pillars. The pipe laid on the level ground, shall be laid with socket facing the direction of flow of water.

13.3.5.3. The pipes shall rest continuously on the bottom of the trench. The pipes shall not rest on lumps of earth or on the joints. Four metre long wooden templates may be used to check the level of the bed. Clearance of approximately 100 mm in depth and width equal to length of the collar plus 30mm on both sides shall be provided at the joint which shall be refilled from sides after the joint is made.

13.3.5.4. In unstable soils, such as soft soils and dry lumpy soils it shall be checked whether the soils can support the pipelines and if required suitable special foundation shall be provided.

13.3.5.5. Some clayey soils (for example black cotton soil) are drastically affected by extremes of saturation and dryness. In changing from saturated to a dry condition, these soils are subjected to extraordinary shrinkage which is usually seen in the form of wide and deep cracks in the earth surface and may result in damages to under ground structures, including pipe materials. The clay forms a tight gripping bond with the pipe, subjecting it to excessive stresses as the

clay shrinks. It is recommended that in such cases an envelope of a minimum 100 mm of tamped sand shall be made around the pipe line to avoid any bonding.

13.3.5.6. In places where rock is encountered, cushion of fine earth or sand shall be provided for a depth of 150 mm by excavating extra depth of the trench, if necessary, and the pipes laid over the cushion. Where the gradient of the bed slopes is more than 30 degree it may be necessary to anchor a few pipes against sliding downwards (Ref. **Fig. 13.5**).

13.3.6. Thrust Blocks (Ref. Fig. 13.5)

13.3.6.1. Thrust blocks are required to transfer the resulting Hydrostatic thrust from the fitting of pipe on to a larger load bearing soil section.

13.3.6.2. Thrust blocks shall be installed wherever there is a change in the direction/size of the pipe line or the pressure line diagram, or when the pipe line ends at a dead end. If necessary, thrust blocks may be constructed at valves also.

13.3.6.3. Thrust blocks shall be constructed taking into account the pipe size, water pressure, type of fitting, gravity component when laid on slopes and the type of soil. The locations of thrust blocks for various types fittings is given in **Fig. 13.5**.

13.3.6.4. When a fitting is used to make a vertical bend, it shall be anchored to a concrete thrust block designed to have enough weight to resist the upward and outward thrust. Similarly at joints, deflected in vertical plane, it shall be ensured that the weight of the pipe, the water in the pipe and the weight of the soil over the pipe provide resistance to upward movement. If it is not enough, ballast or concrete shall be placed around the pipe in sufficient weight to counteract the thrust.

13.3.6.5. When the line is under pressure there is an outward thrust at each coupling. Good soil, properly tamped is usually sufficient to hold pipe from side movement. However, if soft soil conditions are encountered, it may be necessary to provide side thrust blocks or other means of anchoring. In such cases only pipe on each side of the deflected coupling shall be anchored without restricting the coupling.

13.3.6.6. Pipes on slopes need be anchored only when there is a possibility of the back fill around the pipe sloping down the hill and carrying the pipe with it. Generally for slopes upto 30 degree good well drained soil carefully tamped in layers of 100 mm under

and over the pipe, right upto the top of trench will not require anchoring.

13.3.6.7. For steeper slopes, one out of every three pipes shall be held by straps fastened to vertical supports anchored in concrete.

13.3.7. Back Filling and Tamping

13.3.7.1. Back filling shall follow pipe installation as closely as possible to protect pipe from falling boulders, eliminating possibility of lifting of the pipe due to flooding of open trench and shifting pipe out of line by caved in soil.

13.3.7.2. The soil under the pipe and coupling shall be solidly tamped to provide firm and continuous support for the pipe line. Tamping shall be done either by tamping bars or by using water to consolidate the back fill materials.

13.3.7.3. The initial back fill material used shall be free of large stones and dry lumps. In stony areas the material for initial back fill can be shaved from the sides of the trenches. In bogs and marshes, the excavated material is usually little more than vegetable matter and this should not be used for bedding purposes. In such cases, gravel or crushed stone shall be hauled in.

13.3.7.4. The initial back fill shall be placed evenly in a layer about 100 mm thick. This shall be properly consolidated and this shall be continued till there is a cushion of at least 300 mm of cover over the pipe.

13.3.7.5. If it is desired to observe the joint or coupling during the testing of mains they shall be left exposed. Sufficient back fill shall be placed on the pipe to resist the movement due to pressure while testing.

13.3.7.6. Balance of the back fill need not be so carefully selected as the initial material. However, care shall be taken to avoid back filling with large stones which might damage the pipe when spaded into the trench.

13.3.7.7. Pipes in trenches on a slope shall require extra attention to make certain that the newly placed back fill will not become a blind drain in effect because until back fill becomes completely consolidated there is a tendency for ground or surface water to move along this looser soil resulting in a loss of support to the pipe. In such cases, the back fill shall be tamped with extra care and the tamping continued in 100 mm layers right upto the ground level.

13.3.8. Hydrostatic Tests (Ref. Fig. 13.6): (Note: **Annexure-13.5** may be seen for details)

13.3.8.1. After a new pipe or any valved section thereof has been laid, jointed and back filled, it shall be subjected to the following two tests :

a) Pressure test at a pressure of at least double the maximum working pressure- pipe and joints shall be absolutely water tight under the test

b) Leakage test (to be conducted after the satisfactory completion of the pressure test) at a pressure to be specified by the authority for a duration of two hours.

13.3.8.2. Hydrostatic Tests : The portions of the line shall be tested by subjecting to pressure test as the laying progresses before the entire line is completed. In this way any error of workmanship will be found immediately and can be corrected at a minimum cost. Usually the length of the section to be tested shall not exceed 500 m.

13.3.8.3. Where any section of a main is provided with concrete thrust blocks or anchorages, the pressure test shall not be made until at least five days have elapsed after the concrete is cast. If rapid hardening cement has been used in these blocks or anchorages, test shall not be made until at least two days have elapsed.

13.3.8.4. Prior to testing, enough back fill as described in para 13.3.7 shall be placed over the pipe line to resist upward thrust. All thrust blocks forming part of the finished line shall have been sufficiently cured and no temporary bracing shall be used.

13.3.8.5. The open end of the section shall be sealed temporarily with an end cap having an outlet which can serve as an air relief vent or for filling the line, as may be required. The blind face of the end cap shall be properly braced during testing by screw jacks and wooden planks or steel plate as shown in **Fig. 13.6**.

13.3.8.6. The section of the line to be tested shall be filled with water manually or by a low pressure pump. Air shall be vented from all high spots in the pipe line before making the pressure strength test because entrapped air gets compressed and causes difficulty in raising the required pressure for the pressure strength test.

13.3.8.7. The test pressure shall be gradually raised at the rate of approximately one Kg./sq. cm./min. The duration of the test period if not specified shall be sufficient to make a careful check on the pipe line section.

13.4 Special Cast Iron Fittings and Accessories

13.4.1. Normally when pipe line is laid, a certain number of cast iron fittings such as tees, bends, reducers, etc. and special fittings such as air or sluice valves are required.

13.4.2. Laying of Fittings: All cast iron fittings shall be plain ended to suit the class and diameter of pipe manufactured. Cast iron fittings are jointed by cast iron detachable joints only. Cast iron specials having flanges are jointed in the pipe line with cast iron flange adapters having one end flanged and the other plain ended.

13.4.3. Anchorages : It shall particularly be noted that the cast iron joints do not hold pipe ends within firmly. During working or test pressure, there will be the tendency for the pipe ends or specials ends to slip out of the joint, more so in case of blank end cap used for closure of pipe line and in case of degree bends and tees. In order to keep them firmly in the pipe line, anchoring of these specials is necessary against the direction of thrust.

The anchorage shall consist of either concrete cast-in-situ or masonry built in cement mortar. The anchors shall be extended to the firm soil of the trench side. The shape of the anchors will depend on the kind of specials used. They shall be spread to the full width of trench and carried vertically by the side and over the special to about 15 cm. The bearing area on sides of the trench shall be proportional to the thrust and to the bearing capacity of the sides of the trench. (**Refer Fig. 13.5**).

13.4.4 Hydrostatic Tests

13.4.5.1. The pipes shall be tested as specified in IS:5913 in the factory and hence the purpose of field testing is to check the quality of workmanship and also to check whether the pipes have been damaged in transit. As such, the test pressure shall be kept as 1.5 times the actual operating pressure unless a higher test pressure is specified. However, it may be noted that the test pressure during the field test shall not exceed the values given in Table 13.12.

13.4.5.2. Asbestos cement pipes always absorb a certain amount of water. Therefore, after the line is filled, it shall be allowed to stand for 24 hours before pressure testing and the line shall be again filled.

TABLE 13.12

TEST PRESSURE FOR PIPES

Class of pipe	Maximum field test pressure kgf./sq.cm
5	3.75
10	7.50
15	11.25
20	15.00
25	18.75

13.4.6. Measurements

13.4.6.1. The net length of pipes as laid or fixed shall be measured in the running metres correct to a cm. Specials shall be excluded and enumerated and paid for separately. The portion of the pipe within the collar at the joints, shall not be included in the length of pipe work.

13.4.6.2. Excavation, refilling, shoring and timbering in trenches, masonry or concrete pillars and thrust blocks, wherever required, shall be measured and paid for separately, under relevant items of work.

13.4.6.3. The joints shall be enumerated and paid for separately.

13.4.7. Rates : The rate shall include the cost of materials and labour involved in all the operations described above except for the items measured/ enumerated separately under para 13.4.6.1, 13.4.6.2 and 13.4.6.3 which shall be paid for separately.

13.5. LAYING AND JOINTING OF CAST IRON PIPES AND FITTINGS (EXTERNAL WORK)

For details IS:12288 Code of practice for use and laying of Ductile Iron pipes may be referred to Specifications described in para 13.3 shall apply, as far as applicable.

13.5.1. Trenches:

13.5.1.1. The gradient is to be set out by means of boning rods and the required depth to be excavated at any point of the trench shall be as directed by the Engineer. The

depth of the trench shall not be less than 1 metre measured from the top of the pipe to the surface of the ground under roads and not less than 0.75 metre elsewhere.

13.5.1.2. The width of the trench shall be the nominal diameter of the pipe plus 40 cm but it shall not be less than 55 cm in case of all kinds of soils excluding rock and not less than 1 metre in case of rock.

13.5.2. Laying : Any deviation either in plan or elevation less than 11.25 degrees shall be effected by laying the straight pipes around a flat curve of such radius that minimum thickness of lead at the face of the socket shall not be reduced below 6 mm or the opening between spigot and socket increased beyond 12 mm at any joint. A deviation of about 2.25 degree can be effected at each joint in this way. At the end of each day's work the last pipe laid shall have its open ends securely closed with a wooden plug to prevent entry of water, soil, rats and any other foreign matter into the pipe.

13.5.3. Lead Caulked joints with Pig Lead

13.5.3.1. This type of lead caulking is generally done in providing joints in gas, water and sewer lines wherever it is practicable to use cast lead caulking, but not in case of wet conditions.

13.5.3.2. The approximate depth and weights of pig lead for various diameters of C.I. pipes and specials shall be as given in **Table 13.13.**

TABLE 13.13
LEAD FOR DIFFERENT SIZES OF PIPES

Nominal size of pipe (mm)	Lead per joint (Kg.)	Depth of lead joint (mm)
80	1.8	45
100	2.2	45
125	2.6	45
150	3.4	50
200	5.0	50

250	6.1	50
300	7.2	55
350	8.4	55
400	9.5	55
450	14.0	55
500	15.0	60
600	19.0	60
700	22.0	60
750	25.0	60

Note :

1. The quantity of lead given in the Table are on average basis and a variation of 10 percent is permissible.
2. Before pipes are jointed on large scale, three or four sample joints shall be made and the average consumption of lead per joint shall be got approved by the Engineer.
3. Only required quantity of spun yarn shall be put so as to give the specified depth of lead in the joint.

13.5.4. Lead Caulked joints with Lead Wool Yarn

13.5.4.1. This type of lead caulking is generally done when it is inconvenient or dangerous to use molten lead for joints, for example in cases such as inverted joints or in wet trenches or in exceptional cases. In such cases the joints shall be made with

lead wool or yarn. Caulking with lead wool, or yarn shall however be not carried out without the prior permission of Engineer.

13.5.4.2. The approximate weights and depths of lead wool or lead yarn required for each joint of various dia. of C.I. pipes and specials shall be as given in **Table 13.14**. Just sufficient quantity of spun yarn shall be put so as to give specified depth of lead wool.

13.5.4.3. Jointing : The spun yarn shall first be inserted and caulked into the socket as described under jointing with pig lead. Lead wool or yarn shall then be introduced in the joint in strings not less than 6 mm thick and the caulking shall be repeated with each turn of lead wool or yarn. The whole of the lead wool or yarn shall be compressed into a dense mass. The joint shall then be finally finished flush with face of the socket.

TABLE 13.14

Diameter of pipe (mm)	Weight of lead wool or lead yarn (kg)	Depth of lead wool or lead yarn (mm)
80	0.80	19
100	0.90	19
125	1.25	20
150	1.60	23
200	2.05	23
250	2.95	25
300	3.50	25
350	4.65	29
400	5.70	31
450	6.70	32
500	8.30	33
600	10.00	35
700	11.80	36
750	13.60	38

800	15.40	40
900	16.80	40

Note : An allowance of five per cent variation in the specified weights and depths is permissible.

13.5.4.4 Pig Lead : Pig lead shall be of uniform quality, clean and free from foreign materials. It shall be of uniform softness and capable of being easily caulked or driven. It shall conform to IS : 782 for caulking lead in all respects.

13.5.4.5 Lead Wool : Lead wool shall conform to IS : 782 in all respects. Lead wool shall consist of fine strands or plated ribbons of lead. The cross-section of the individual strands shall be flat. The dimensions in the sectional- plane shall not be less than 0.13 mm and not more than 0.90 mm and the rope shall be supplied in minimum lengths of two metres and the maximum length in any one package shall be such that the package does not weigh more than 50 Kg.

13.5.5. Flanged joints:

13.5.5.1. Cast iron pipes may be jointed by means of flanges cast on. The jointing material used between flanges of pipes shall be compressed fiber board or rubber of thickness between 1.5 mm to 3 mm. The fiber board shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per sqm shall be not less than 112 gm/mm thickness.

13.5.5.2. Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively. The practice of fully tightening the bolts one after another shall not be allowed.

13.5.5.3. Several proprietary flexible joints are available for jointing cast iron pipes and these may be used with the specific approval of the authority. However, they shall be used strictly in accordance with the manufacturer's instructions.

13.5.5.4. For joints in small diameter cast iron piping, copper-alloy screwed unions or

ferrules shall be used, and for large dia. the joints shall be made by flanged connecting pieces.

13.5.6. Hydrostatic Test : The procedure for testing for leakage under pressure shall be as described in **Annexure 13.5** which are to be read in addition to para 13.3.8. The joints of pipes and specials have to be repaired till the leakage in the portion under test is within the specified limit indicated in **Annexure 13.5**.

13.5.7. Measurements

13.5.7.1. The net length of pipes as laid or fixed, shall be measured in the running metres correct to a cm. Specials shall be excluded and enumerated and paid for separately. The portion of the pipe within the collar at the joints shall not be included in the length of pipe work.

13.5.7.2. Excavation, refilling, shoring and timbering in trenches masonry or concrete pillars and thrust blocks, wherever required, shall be measured and paid for separately, under relevant items of work.

13.5.7.3. Lead caulked joints shall be measured and paid for separately.

13.5.8. Rate : The rate shall include the cost of materials and labour involved in all the operations described above except for the items measured/ enumerated separately under paras 13.5.7.1, 13.5.7.2, 13.5.7.3 which shall be paid for separately.

13.6. LAYING AND JOINTING OF G.I. PIPES (EXTERNAL WORK)

13.6.0 The specifications described in para 13.3 shall apply, as far as applicable.

13.6.1. Trenches : The galvanised iron pipes and fittings shall be laid in trenches. The widths and depths of the trenches for different diameters of the pipes shall be as in **Table 13.15**.

TABLE 13.15

Dia of pipe (mm)	Minimum Width of trench (cm)	Minimum Depth of trench (cm)
15 to 50	30	60
65 to 100	45	75

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earth work in trenches. When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

13.6.2. Cutting and Threading : Where the pipes have to be out or rethreaded, the ends shall be carefully filed out so that no obstruction to bore is offered. The end of the pipes shall then be carefully threaded conforming to the requirements of IS: 554 with pipe dies and taps in such a manner as will not result in slackness of joints when the two pieces are screwed together. The taps and dies shall be used only for straightening screw threads which have become bent or damaged and shall not be used for turning of the threads so as to make them slack, as the later procedure may not result in a water tight joint. The screw threads of pipes and fittings shall be protected from damage until they are fitted.

13.6.3. Jointing : The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped round the screwed end of the pipe. The end shall then be screwed in the socket, Tee etc. with the pipe wrench. Care shall 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 ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

13.6.4. Thrust Blocks (Refer Fig. 13.5) : In case of bigger diameter pipes where the pressure is very high, thrust blocks of cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate of 20 mm nominal size) of adequate size and shape shall be provided on all bends to transmit the Hydrostatic thrust to the ground, spreading it over a sufficient area, depending upon the type of soil met with.

13.6.5. Painting : The pipes shall be painted with two coats of anticorrosive bitumastic paint of approved quality.

13.6.6. Testing of joints : The pipes and fittings after they are laid and jointed shall be tested to Hydrostatic pressure of 6 Kg/sq. cm

(60 meter). The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw off taps and stop cocks shall then be closed and specified Hydrostatic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least half an hour. The pipes and fittings shall be tested in sections as the work of laying proceeds, leaving the joints exposed for inspection during the testing. Pipes or fittings which are found leaking shall be replaced and joints found leaking shall be redone, without extra payment.

13.6.7. Trench Filling : The pipes shall be laid on a layer of 7.5 cm sand and filled upto 15 cm above the pipes. The remaining portion of the trench shall then be filled with excavated earth as described in para 13.3.7. The surplus earth shall be disposed off as directed.

13.6.8. Measurements : The lengths shall be measured in running metre correct to a cm for the finished work, which shall include G.I. Pipe and G.I. Fittings such as bends, tees, elbows, reducers, crosses, plugs, sockets, nipples and nuts, but exclude brass or gun metal taps (cocks), valves, unions, lead connection pipes and shower rose. All pipes and fittings shall be classified according to their diameters, method of jointing and fixing substance quality and finish. In case of fittings of an equal bore the pipe shall be described as including all cuttings and wastage. In case of fittings of unequal bore the largest bore shall be measured..

G.I. unions shall be paid separately in external work as paid in internal work in accordance with para 13.8.2. Digging and refilling of trenches shall either be measured separately as specified in the appropriate clauses of excavation and earth work or clubbed with main item.

13.6.9. Rate : The rate shall included the cost of labour and materials involved in all the operations described above. The rate shall not include excavation in trenches, painting of pipes and sand filling all round the pipes, unless otherwise specified.

13.7. LAYING AND JOINTING UNPLASTICISED P.V.C. PIPES (EXTERNAL WORK)

Note: For details IS:7634 Code of Practice

for Plastic pipes work for Potable Water supplies Part III Laying and Jointing of U PVC Pipes may be referred to)

13.7.1. Handling and Storage : Unplasticized P.V.C. pipes are light in weight material. Reasonable care shall be taken in handling and storage of these to prevent damages. On no account the pipes shall be dragged along the ground. Pipes shall be given adequate support at all times. They shall not be stacked in large piles, especially under warm temperature conditions as the bottom pipes may distort, thus giving rise to difficulty in pipe alignment and jointing.

For temporary storage in the field, where racks are not provided care shall be taken that the ground is level and free from loose stones. Pipes stored thus shall not exceed three layers and shall be so stacked as to prevent movement. The pipes shall preferably be stored under shade.

For satisfactory service performance of plastic pipes under conditions of use, the following points must be kept in view while undertaking installation of plastic piping system :

- a) The plastic materials are 'thermoplastic' in nature, and must not be used in contact with hot surfaces or hot water;
- b) They must be supported at regular intervals for above ground installation
- c) Allowance must be made, during installation for their expansion, particularly by using loose clips/clamp
- d) A range of specials, and matching fittings must be identified and their manufacturers/suppliers listed.

Rigid P.V.C. pipes upto 600 mm dia have been produced. However, in India these are available from 16 mm to 315 mm. In these specifications only the use of rigid (unplasticised) P.V.C. pipes for cold -water supplies is covered.

13.7.2. Trenches : The trench bottom shall be carefully examined for the presence of hard objects such as flints, rock projections or tree roots etc. Pipes shall be bedded in sand or soft soil free from rock and gravel. Back fill 15 cm above the pipe shall also be of fine sand or soft soil. Pipes shall not be painted. The width of trench shall be not less than outside dia meter of pipe plus 30 cm in case of gravel soils. Pipes shall be laid at least 90 cms below the ground level, measured from surface of the ground to the top of the pipe.

13.7.3. Jointing :

13.7.3.1. Solvent welded joints. (Fig. 13.8) : Non heat application Method :

In this method, instead of forming a socket on one pipe an injection moulded socket fitting or coupler is used, with a provision to take in the pipes at both ends. The solvent cements are applied on the surfaces to be jointed and the joint is made at ambient temperature. Injection moulded fittings only shall be used in preference to fabricated fittings. Only solvent recommended by the manufacturers of the pipes shall be used and full load on the joints applied only after 24 hours. The pipe shall be cut perpendicular to the axis of the pipe length with a metal cutting saw or an ordinary hand saw with small teeth. Pipe ends have to be beveled slightly with a beveling tool (Reamer) at an angle of about 30 degrees. The total length of insertion socket (injection moulded socket or coupler) shall be marked on the pipe and checked how far the pipe end could be inserted into the fitting socket. Attempt shall be made to push the pipe to the marked distance and if not possible it shall at least be pushed for 2/3 of this distance

Dust, oil, water, grease etc. shall be wiped cut with a dry cloth from the surface. Further the grease should be thoroughly removed with a suitable solvent, such as methylene chloride or as an alternative the outside surface of the pipe and the inside of the fitting may be roughened with emery paper.

Generous coatings of solvent cement shall be evenly applied on the insides of the fitting around the circumference for the full length of insertion and on the outside of the pipe end upto the marked line with non synthetic brush of suitable dimension. The pipe shall be pushed into the fitting socket and held for 1 or 2 minutes as otherwise the pipe may come out of the fitting due to the slippery quality of solvent cement and the tapering inside bore of the fitting. The surplus cement on the pipe surfaces shall be wiped out. If the solvent cement has dried up too much or the tapering of the socket is too steep, jointing will not be proper and pipe will come out of the fitting.

In summer months joints shall be made preferably early in the morning or in the evening when it is cooler., This will prevent joint from pulling apart when the pipe cools off at night. Heat application method for jointing shall not be allowed.

13.7.3.2. Flanged Joints : For jointing P.V.C. pipes particularly of larger sizes to valves and vessels and larger size metal pipes where the tensile strength is required,

the joint is made by the compression of a gasket or ring seal set in the face of C.I. flange. Flanges solvent welded to the P.V.C. pipes shall be supplied by the manufacturers.

13.7.3.3. Rubber Ring joints : Rubber ring joints can provide a water tight seal but do not resist pull. As such these may be used only as repairs collar and for jointing pipes larger than 110 mm. Such joints may be provided on pipes which are buried in the ground and supported throughout on a bedding so that they are not subject to movement and longitudinal pull. The material of rubber ring shall conform to IS: 5382. Where aggressive soils are met with, synthetic rubbers perform better for jointing. The ring shall be housed in a groove formed in plastic or metallic housing. The rubber is compressed and makes a seal between the pipe and the housing. The ring shape and the method of compressing the ring vary considerably in different types of joints. Most joints often require the application of lubricating paste which shall be procured from the manufacturer of P.V.C. pipes. Rubber rings shall be supplied by the manufacturers.

The rubber ring joints can be either of (i) With spigot and socket or (ii) With separate collar pieces having two rubber rings, one at either end.

13.7.4. Crossing Road or Drain (Ref. Fig. 13.9) : Where the pipe line crosses a road or a drain, it shall be through C.I. or R.C.C. pipe.

13.7.5. Supports for Valve and Hydrant : Valve and hydrant tees shall be supported as shown in **Figure 13.10** so that the torque applied in operating a valve is not transmitted to the pipe line.

13.7.6. Inspection and Testing : Solvent welded pipe shall not be pressure tested until at least 24 hours after the last solvent cemented joint has been done.

All control valves shall be positioned open for the duration of the test and open end closed with water tight fittings. The testing pressure on completion of the work shall not be less than one and a half times the working pressure of the pipes.

Pressure shall be applied either by hand pump or power driven pump. Pressure gauges shall be correctly positioned and closely observed to ensure that at no time the test pressure is exceeded. The system shall be slowly and carefully filled with water to avoid surge pressure or water hammer.

Air vents shall be open at all high points so that air may be expelled from the system during filling.

When the system has been fully charged with water and air displaced from the line, air vent shall be closed and the line initially inspected for seepage at joints and firmness of supports under load. Pressure may then be applied until the required test pressure is reached.

Without any additional requirement of make-up water the test pressure should not fall more than 0.2 kg./sq.cm at the end of one hour test duration.

13.7.7. Measurements : The length shall be measured in running metre correct to a cm for the finished work which shall include P.V.C. fittings such as bends, tees, elbows, reducer, crosses, plugs, sockets, nipples and nuts, but exclude, taps, valves, etc. All pipes and fittings shall be classified according to their outside diameters and pressure ratings. Fittings of unequal outside diameter shall be measured alongwith the larger diameter pipe.

13.7.8. Rate : The rate shall include the cost of labour and material in all the operation described above except excavation in trenches, sand filling all round the pipes, metal pipe used for encasing P.V.C. pipe and anchor blocks, unless otherwise specified.

13.8. LAYING AND JOINTING G.I. PIPES (INTERNAL WORK)

13.8.1. General: For internal work the galvanised iron pipes and fittings shall run on the surface of the walls or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm clear of the wall. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts or recess etc., provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not ordinarily be buried in walls or solid floors. Where unavoidable, pipes may be buried for short distances provided, adequate protection is given against damage and where so required joints are not buried. Where directed by the Engineer, a M.S. tube sleeve shall be fixed at a place the pipe is passing through a wall or floor for reception of the pipe and to allow freedom for expansion and contraction and other movements. In case the pipe is embedded in walls or floors it should be painted with anticorrosive bitumastic paint of approved quality. The pipe shall not come in

contact with lime mortar or lime concrete as the pipe is affected by time. Under the floors the pipes shall be laid in layer of sand filling as done under concrete. floors.

All pipes and fittings shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed to walls with standard pattern holder bat clamps of required shape and size so as to fit tightly on the pipes when tightened with screwed bolts. These clamps shall be embedded in brick work in cement mortar 1:3 (1 cement: 3 coarse sand), and shall be spaced at regular intervals in straight lengths as shown in **Table 13.16**.

The clamps shall be fixed at shorter lengths near the fittings as directed by the Engineer .

For G.I. pipes 15 mm diameter, the holes in the walls and floors shall be made by drilling with chisel or jumper and not by dismantling the brick work or concrete. However, for bigger dimension pipes the holes shall be carefully made of the smallest size as directed by the Engineer. After fixing the pipes the holes shall be made good with cement mortar 1:3 (1 cement: 3 coarse sand) and properly finished to match the adjacent surface.

TABLE 13.16

Dia. of Pipe mm	Max Horizontal length M	Max Vertical length M
15	2.0	2.5
20	2.5	3.0
25	2.5	3.0
32	2.5	3.0
40	3.0	3.5
50	3.0	3.5
65	3.5	5.0
80	3.5	5.0

Unions will be provided to facilitate connections, additions and alterations as well as for maintenance and for change of pipes. The locations where unions are to be provided will be decided with prior written approval of the Engineer.

13.8.2. Measurements : The lengths shall be measured in running metre correct to a cm for the finished work, which shall include G.I. pipe and G.I. fittings such as bends, tees elbows, reducers, crosses, plugs, sockets, nipples and nuts, but exclude brass or gun metal taps (cocks), valves, unions, lead connection pipes and shower rose. All pipes and fittings shall be classified according to their diameters, method of jointing and fixing substance, quality and finish. In case of fittings of an equal bore the pipe shall be described as including all cuttings and waste. In case of fittings of unequal bore, the largest bore shall be measured. Pipes laid in trenches (or without supports) and pipes fixed to walls, ceilings, etc. with supports shall be measured separately.

13.8.3. Rate : The rate shall include the cost of labour and material involved in all the

operations described above. The rate shall include the cost of cutting holes in walls and floors and making good the same. This shall not however, include concealed pipe work in which case cutting of chase and making good shall be paid separately. It shall not include painting of pipes and providing sleeves, unless specified otherwise. It will also not include union which shall be paid for separately.

13.9. LAYING AND JOINTING P.V.C. PIPES (INTERNAL WORK)

13.9.1. Clamping : The pipes shall be laid and clamped to wooden plugs fixed above the surface of the wall, as shown in **Fig. 13.11**. Alternatively plastic clamps of suitable designs, wherever available, shall be preferred. Provision shall be made for the effect of thermal movement by not gripping the pipe at supports between the anchors for suspended pipes. The supports shall allow the repeated longitudinal temperature movement to take place without abrasion. Line or point contact with the pipe shall be avoided. Heavy components such as metal

valves shall be individually supported.

13.9.2. Supports : P.V.C. pipes require supports at close interval. Recommended support spacings for plasticised P.V.C. pipes

are given in **Table 13.17**. This spacing may be increased by 50% for vertical runs support.

TABLE 13.17

Pipe Din. (MM)	Max Support spacing (MM)
20	700
25	750
32	825
40	975
50	975

It is essential that P.V.C pipes shall be aligned properly before fixing them on the wooden plugs with clamps. Even if the wooden plugs are fixed using a plumb line, P.V.C. pipe shall also be checked for its alignment before clamping. The pipe line will be wavy if the clamps are not fixed keeping the pipe plumb.

13.9.3. Connection to a Water Tap : Connection to the water tap shall be made by means of a G.I. adopter as shown in the **Fig. 13.11**. G.I. adopter shall preferably be supplied by the same manufacturer as that of P.V.C. pipe. In any threaded coupling between P.V.C. and G.I. is preferable that P.V.C. is fitted inside the G.I. fitting. If however greater projection is desired, same shall be achieved by joining a short piece of a G.I. pipe (Nipple) as shown in **Fig. 13.11**.

13.9.4. Connection to a shower Rose : Shower rose connection shall be of G.I. pipes as shown in **Fig. 13.11**.

13.9.5. Connection from Masonry/Concrete Water Tank : Solvent cement shall be coated on the section of the pipe to be embedded in concrete. Fine dry sand and cement mixture shall be sprinkled uniformly around the pipe. This shall give a rough surface which can be safely embedded in concrete, water proofing cement shall be used to close the gap properly.

13.9.6. Measurements : The length shall be measured in running metre correct to a cm for the finished work which shall include P.V.C. fittings such as bends, tees, elbows, reducer, crosses plugs, sockets, nipples and nuts, but exclude, taps, valves, etc. All pipes and fittings shall be classified according to their outside diameters and

pressure ratings. Fittings of unequal outside diameter shall be measured along with the larger diameter pipe.

13.9.7. Rate : The rate shall include the cost of labour and material in all the operations described above, except metal pipe used for encasing P.V.C. pipe and anchor blocks, unless otherwise specified.

13.10. MAKING CONNECTION OF G.I. DISTRIBUTION BRANCH WITH G.I. MAIN

13.10.1. Preliminary Work : A pit of suitable dimensions shall be dug at the point where the connection is to be made with the main and earth removed upto 15 cm below the main. The flow of water in the water main shall also be disconnected by closing the sluice or wheel valves on the mains.

13.10.2. Making Connection : For cutting and jointing paras 13.6.2 and 13.6.3 shall apply. The G.I. main shall first be cut. Water if any collected in the pit shall be bailed out and, ends of the G.I. pipes threaded. The connection of distribution pipe shall then be made after fixing G.I. tee of the required size to the G.I. main and fittings such as jam nut, G.I. socket connecting piece etc.

13.10.3. Testing of Joints : After laying and jointing, the pipes and fittings shall be inspected under working condition of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra payment.

The pipes & fittings after they are laid shall be tested to Hydrostatic pressure of 6 kg./sq.cm. (60 m). The pipes shall be slowly and carefully charged with water allowing all

air to escape and avoiding all shock of water hammer. The draw of taps and stop cocks shall than be closed and specified Hydrostatic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least half an hour. The pipes and fittings shall be tested in sections as the work of laying proceeds, leaving the joints exposed for inspection during the testing.

13.10.4. Finishing: The portion of the pipe in the pit shall be painted with bitumastic paint and encased with sand 15 cm allround. The pit shall be filled with earth in level with the original ground surface watered, rammed and the area dressed.

13.10.5. Measurements : The work of making connections-shall be enumerated.

13.10.6. Rate : The rate shall include the cost of labour and materials involved in all the operations described above.

13.11. P.V.C. PIPES SERVICE CONNECTION (Ref. FIG. 13.9)

13.11.1. General: Either metal or P.V.C. saddles, as specified, shall be used for the off take of service connections from larger bore pipes (50 mm diameter and above). The saddle consists of two half round sections of metal or P.V.C. which are bolted together or held round the pipe by wedge grips. A seal is formed between the saddle and the pipe and the under surface of the upper section. The service connection is taken from a boss on the upper section.

Conventional equipment for tapping under pressure may be used with these service connections using a special cutter to pierce the pipe wall. Ferrules shall not be screwed directly into pipes without the introduction of saddle piece. A typical illustration of a ferrule connection is shown in **Fig. 13.9**.

13.11.2. Measurements : Connections shall be enumerated.

13.11.3. Rate : The rate shall include the cost of labour and materials involved in all the operations described above.

13.12. P.V.C. PIPE-REPAIRS :

13.12.1. General: While temporary or emergency repairs may be made to the damaged pipes, permanent repairs should be made by replacement of the damaged section. In case of damage by external

blows, the extent of the damage may be greater on the inner-surface.

Some times, pipes are damaged accidentally due to trenching operation in street repairs, Shell split or chipout occurs in the wall of the pipe. A short piece of pipe of sufficient length to cover the damaged portion of the pipe is cut. The sleeve is cut longitudinally and heated sufficiently to soften it so that it may be slipped over the damaged pipe.

13.12.2. Measurements : Repairs shall be enumerated.

13.12.3. Rate : Rate shall include the cost of all materials and labour involved in all the operations described above.

13.13. FIXING BRASS AND GUN METAL WATER FITTINGS:

13.13.1.General: The fitting shall be fully examined and cleared of all foreign matter before being fixed. The fitting shall be fitted in the pipe line in a workman like manner. The joints between fittings and pipes shall be leak-proof when tested to a pressure of 17.5 kg/sq.cm. The defective fittings and joints shall be replaced or redone.

13.13.2. Measurements : Fittings shall be enumerated.

13.13.3. Rate : The rate shall include cost of all the materials and labour involved in all the operation described above.

13.14. FIXING FERRULES:

13.14.1.General: For fixing ferrule the empty main shall be drilled and tapped at 45 degree to the vertical and the ferrule screwed in. The ferrule must be so fitted that no portion of the shank shall be left projecting within the main into which it is fitted.

13.14.2. Measurements : Ferrule shall be enumerated.

13.14.3. Rate : The rate shall include the cost of all materials and labour involved in fixing the ferrule.

13.15. INSTALLATION OF FIRE HYDRANT:

13.15.1. General : The hydrant shall be fully examined and cleared of all foreign matter before being fixed. The fixing shall be done on the water main which shall be of minimum 80 mm dia. The flanged end of the hydrant shall be fixed to the flanged outlet of a tee in the water main by means of bolts, nuts and 3 mm rubber insertion or

chemically treated compressed fibre board 1.5 mm minimum thickness and of weight not less than 0.183 gm. per sq.cm. This can also be fixed by means of flanged tail piece which may be connected to the water main by C.I. specials.

13.15.2. Measurements : Fire hydrant shall be enumerated.

13.15.3 Rate : The rate shall include the cost of materials and labour involved in all the operations described above against relevant item of work.

13.16. INSTALLATION OF SLUICE VALVE :

13.16.1. General: The valve shall be fully examined and cleared of all foreign matter before being fixed. The fixing of the valve shall be done by means of bolts, nuts and 3 mm rubber insertions or chemically treated compressed fibre board 1.5 mm minimum thickness and of weight not less than 0.183 gm./sq.cm. with the flanges of spigot and the socketed tail pieces drilled to the same specification in case of S&S pipes and with flanges in case of flanged pipes, the tailpieces shall conform to IS: 1938. These shall be jointed to the pipe line by means of lead caulked joints.

13.16.2. Measurements: Sluice valve shall be enumerated.

13.16.3 Rate: The rate shall include the cost materials and labour involved in all. the operations described above.

13.17. INSTALLATION OF WATER METER AND STOP COCK (REFER FIG. 13.2)

13.17.0. For details IS:2401 Code of Practice for selection, installation and maintenance of domestic water meters may be referred to.

13.17.1. General: The G.I. line shall be cut to the required length at the position where the meter and stop cock are required to be fixed. The ends at the pipe shall then be threaded. The meter and stop cock shall be fixed in position by means of connecting pipes, G.I. jam nut and socket etc. The paper disc inserted in the nipples of the meter shall be removed and the meter installed exactly horizontal or vertical in the flow line in the direction shown by the arrow cast on the body of the meter.

Care shall be taken that the factory seal of the meter is not disturbed. Wherever the meter shall be fixed to a newly fitted pipe

line, the pipe line shall have to be completely washed before fitting the meter. For this purpose a piece of pipe equal to the length of the meter shall be fitted in the proposed position of the meter in the new pipe line. The water shall be allowed to flow completely to wash the pipe line and then the meter installed as described above by replacing the connecting piece.

13.17.2. Testing of Joints: Testing of joints shall be done as described in para 13.3.8.

13.17.3. Measurements: The work of fixing meters and stop cocks shall be counted in numbers separately according to the diameters.

13.17.4. Rate: The rate shall include the cost of labour and materials involved in all the operations described above excluding the cost of stop cock and water meter.

13.18. FIXING SURFACE BOX (REFER FIG.13.3 & 13.4):

13.17.1. General: The C.I. surface box shall be fixed on the top of masonry chamber in plain or reinforced cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) as the case may be.

13.18.2. Measurements: Masonry chambers shall be enumerated under the relevant items.

13.18.3. Rate : The rate shall include the cost of materials and labour involved in all the operations described above, except the excavation in saturated soil, soft or decomposed and hard rock if met with. The difference of cost, between ordinary soil and saturated soil or soft or decomposed or hard rock as the case may be, shall be paid for separately

13.19. CONSTRUCTING R.C.C. POST FOR HYDRANT (REFER FIG. 13.10):

13.19.1. General: The R.C.C. post for a hydrant shall be of the size 25 x 25 cm at the bottom and 15 x 15 cm at the top. A pipe of specified size shall be provided during casting in the centre of the post. The post shall be of 170 cm height, out .of .which 60 cm shall be kept below ground level.

13.19.2. Earth Work : The excavated earth shall be disposed off as directed by the Engineer .

13.19.3. Reinforced Cement Concrete Work : The post shall be made of cement concrete 1:2:4 (1 cement: 2 coarse sand: 4

graded stone aggregate 12.5 mm nominal size) and reinforced with 4 Nos. 10 mm dia. bars at corners. 6 Nos. square stirrups of 6 mm diameter bars shall be provided for keeping the vertical reinforcement in position.

13.19.4. Finishing : The R.C.C. post shall be plastered with 6 mm thick cement plaster 1:4 (1 cement: 4 fine sand) on all the exposed surfaces and, upto a depth of 15 cm below ground level. The plastered surface shall be finished with a floating coat of neat cement.

13.19.5. Measurements: The R.C.C. posts shall be enumerated.

13.19.6. Rate: The rate shall include the cost of labour and materials required for all the operations described above including providing and embedding of the pipe in the post.

13.20. CONSTRUCTING MASONRY PILLAR FOR HYDRANT (Refer FIG. 13.10):

13.20.1. General: The section of the pillar shall be one and half brick square or one brick square, as specified. The height of the pillar above ground shall be 110 cm.

13.20.2. Earth Work : The excavated earth shall be disposed off as directed by the Engineer

13.20.3. Concrete Work : Foundation concrete shall consist of 15mm thick cement concrete 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) or as specified.

13.20.4. Brick Work : The masonry shall be with bricks of class designation 75 in cement mortar, 1:4 (1 cement: 4 fine sand). The brick masonry shall be kept upto-a height of 100 cm above ground level. The hydrant pipe shall pass through the post or shall be fixed to pillar with G.I. holder bat clamps as directed by the Engineer.

13.20.5. Finishing : The pillar masonry shall be plastered with 12 mm cement plaster 1:4 (1 cement: 4 coarse sand) finished with a floating coat of neat cement. The top of the masonry pillar shall have 10 cm thick cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 12.5 mm nominal size) coping with edges rounded off. The concrete of the coping shall be rendered smooth with neat cement.

13.20.6. Measurements: Hydrant pillars shall be enumerated.

13.20.7. Rate:: The rate shall include the cost of labour and materials required for all

the operations described above except providing and fixing of pipe which shall be paid separately.

13.21. CONSTRUCTING MASONRY PLATFORM FOR STAND POST (Refer FIG.13.10):

13.21.1. General: The internal dimension of the platform shall be 120 x 120 cm or 90 x 90 cm as specified.

13.21.2. Earth Work : Earth work shall be done true to dimensions as shown in the drawing. The excavated earth shall be disposed off as directed by the Engineer .

13.21.3. Concrete Work : Foundation for the platform shall consist of 10 cm thick cement concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size) or as specified.

13.21.4. Kerbing: The kerbing for the platform shall be of half brick thick with bricks of class designation 75 in cement mortar 1:4 (1 cement : 4 fine sand). The kerb shall be plastered on top and sides with 12 mm thick cement plaster 1:4 (1 cement : 4 coarse sand) finished with a floating coat of neat cement. The junctions and corners of the kerbing and the floor shall be rounded off.

13.21.5. Flooring: Flooring shall consist of 40mm thick cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) which shall be finished with a floating coat of neat cement. The floor shall be given proper slopes as directed by the Engineer.

13.21.6. Measurements: Platforms for stand posts shall be enumerated.

13.21.7. Rate: The rate shall include the cost of labour and materials for all the operations described above.

13.22. POLYETHYLENE WATER STORAGE TANKS:

13.22.0. For details IS:12701 "Rotational Moulded Polyethylene Water Storage Tanks" may be referred to.

13.22.1. Material : Polyethylene used for manufacture of tanks and manhole lids may be high density (HDPE), low density (LDPE) or linear low density (LLDPE) and shall conform to IS: 10146. Polyethylene shall be compounded with carbon black so as to make it resistant to ultra violet rays from the sun. The percentage of carbon black content in polyethylene shall be 2.5 ± 0.5 percent and it shall be uniformly distributed. The materials used for the manufacture of

tank, manhole lid and fittings shall be such that they neither contaminate the water nor impart any taste, colour, odour or toxicity to water.

13.22.2. Manufacture and Finish : The tanks shall be manufactured by rotational moulding process. Each tank and the manhole lid shall be single piece having arrangement for fixing and locking the manhole lid with the tanks. Excess material at the mould parting line and near the top rim shall be neatly cut and finished. The internal and external surface of the tanks shall be smooth, clean and free from hidden internal defects like air bubbles, pit and metallic or other foreign material inclusion. Capacity of the tank, minimum weight of the empty tank (without manhole lid) and the manufacture brand name shall be embossed on the top surface of the tank near manhole.

13.22.3. Shape, Size and Capacity: The tank shall be cylindrical vertical with closed top having a manhole. Diameter and height of the tank of various capacities shall be as per manufacturer's specifications and a tolerance of ± 3 percent shall be permitted on these dimensions. Capacity of the tank shall be upto the bottom of the inlet location. Capacity of the tank shall be specified and extra capacity if any, shall be ignored.

13.22.4. Weight and Wall Thickness : Minimum weight of the empty tank (exclusive of manhole lid fittings) and the minimum wall thickness of top, bottom and sides shall be as specified in, **Table 13.19**. Wall thickness shall be checked beyond

150 mm of the edge where the direction of the plane of tank surface changes.

13.22.5. Installation and Fittings : The flat base of the tank shall be fully supported over its whole bottom area on a durable rigid flat and level platform sufficiently strong to stand without deflection, the weight of the tank when fully filled with water. Depending upon the capacity and location tanks may be suitably anchored as per the directions of the Engineer. For inlet, outlet and other connections fully threaded GI, HDPE or PVC connections with hexagonal check nuts and washers on either side of the tank wall shall be provided. Holes for threaded connections shall be drilled and not punched. Pipes entering or leaving the tank shall be provided with unions and suitably supported on a firm base to avoid damage to the tank walls.

13.22.6. Manhole lid : The lid shall rest evenly and fit over the rim of the manhole so as to prevent the ingress of any foreign matter into the tank. The lid shall be provided with suitable arrangement for locking it with the tank.

13.22.7. Local Bye laws: The tank and its components shall conform to the local bye-laws for prevention of mosquito menace.

13.22.8. Measurements : Dimensions shall be measured to the nearest cm. and weight of the empty tank shall be recorded to the nearest 100g. Capacity of the tank as defined in para 13.23.3 shall be calculated to the nearest litre.

TABLE 13.19

SL	Capacity litres	Minimum Wall thickness mm	Minimum Weight of empty tank (Kg.)
1	2	3	4
1	200	4.4	7.8
2	300	4.4	9.0
3	400	5.5	15.0
4	500	6.0	18.0
5	700	6.6	23.5
6	1000	7.0	33.0
7	1250	7.0	40.0
8	1500	7.0	47.0
9	1700	7.0	54.0
10	2000	8.2	64.0
11	2500	8.2	81.0
12	3000	8.8	96.0

13	4000	10.4	138.0
14	5000	10.7	191.0
15	6000	10.7	209.0
16	7500	10.7	250.0
17	10000	11.5	363.0
18	15000	11.5	550.0
19	20000	13.2	814.0

13.22.9. Rate : The rate shall include the cost of the tank, manhole lid, carriage and delivery at the place specified. Hoisting, installation, fittings, platform and anchoring shall be payable separately.

13.23. R.C.C. STORAGE TANKS:

13.23.1. General: These tanks shall be cast in situ, circular/ rectangular in shape and 270 and 540 litres capacity. These shall be as per approved drawing.

13.23.2. Concrete Mix: The mix of R.C.C. shall be 1:1.5:3 for walls and bottom slab and 1:2:4 for top slab. The specification for R.C.C. shall be as per Chapter 4. The top slab shall have the cover of 2 mm thick M.S. sheet 35 mm x 35 mm size having frame of angle iron 20 x 20 x 5 mm size. The detailed specifications shall be as per steel work in Chapter 8.

13.24. FIXING R.C.C. OR P.V.C. STORAGE TANK

13.24.1. Location : Tank shall be located nearest to the fittings for which water is to be supplied. It should not be visible as far as possible from the main road and compound of the buildings. The overflow pipe shall discharge at a convenient and visible point so that it does not damage the building and does not prove a nuisance, should the tank go out of order.

13.24.2. Hoisting : The hoisting of tanks into position, as directed by the Engineer, shall be carried so that no part of the tank or of structure is damaged in the operation. The tank shall be installed in position truly level. The supports for the tanks shall be provided as ordered and shall be measured and paid for separately.

13.24.3. Measurements : Water storage tanks shall be counted in numbers for the complete job.

13.24.4. Rate : The rate shall include the cost of materials and labour involved in all the operations described above except the cost of external painting, providing and fixing

stop cock and supports for storage tank for which separate payment shall be made under respective items of work.

13.25. TUBE WELLS WITH HAND PUMPS

13.25.1. Casing Pipe : The casing pipe shall be of M.S. or W.I. of 100 mm dia. and strong enough to stand hammering and vibrations to which it is subject.

13.25.2. Filter and Brass Strainer : The filter shall consist of a G.I. pipe of the required diameter with 15 mm diameter holes covered with brass strainer both inside and outside. It shall have a driving point rivetted or welded to it.

13.25.3. Hand Pump : This shall be of approved quality. It shall be complete with necessary bolts and nuts for joining to the masonry or concrete base.

13.26 DUCTILE IRON FITTINGS FOR PRESSURE PIPES FOR WATER, GAS AND SEWAGE As Per IS 9523 : 2000 - Some important paras of above IS code are reproduced below for information & guidance (Para numbers are as per IS code) -

3. TERMINOLOGY

For the purposes of this standard, the following definitions shall apply.

3.1 Ductile Iron – Type of iron used for pipes, fittings and accessories in which graphite is present primarily in spheroidal form as per IS8329:1994

3.2 Pipe – Casting of uniform bore, straight in axis, having either socket, spigot or flanged ends, except for flanged sockets, flanged spigots and collars which are classified as fittings.

3.3 Fitting – Casting other than a pipe, which allows pipeline deviation, change of direction or bore. In addition flanged sockets, flanged-spigots and collars are also classified as fittings.

3.4 Accessory – Any item other than a pipe or fitting which is used in a pipeline,

such as :

- glands and bolts for mechanical flexible joints;
- glands, bolts and locking rings or segments for restrained joints.

NOTE : Valves and hydrants of all types are not covered by the term accessory.

3.5 Flange – Flat circular end of fittings, extending perpendicular to its axis, with bolt holes equally spaced on a circle.

NOTE : A flange may be fixed (for example, integrally cast threaded on or welded on) or adjustable; An adjustable flange comprises of a ring in one or several parts bolted together. which bears on an end joint hub and can be freely rotated around the fittings axis before joining.),

3.6 Collar, Coupling – Connecting piece used to join together the spigots of mat pipes or fittings.

3.7.1 Spigot – Male end of fittings.

3.8 Socket – Female end of fittings to make the joint with spigot of an adjacent component.

3.9 Gasket – Sealing component of a joint.

3.10 Joint – Connection between the ends of fittings in which a gasket is used to effect a seal.

3.11 Flexible Joint: Joint which provides significant angular deflection and movement parallel and / or perpendicular to the fittings axis.

3.12 Push-on Flexible Joint – A flexible joint in which an elastomeric gasket is located in the socket and the joint assembly is effected by entering the spigot through the gasket into the socket.

3.13 Mechanical Flexible Joint – Flexible joint in which sealing is obtained by applying pressure to the gasket by mechanical means, for example, a gland.

3.14 Restrained Joint – Joint wherein a device is provided to prevent separation of the assembled joint.

3.15 Flanged Joint – Joint between two flanged ends.

3.16 Nominal Size (DN) – Numerical designation of size which is common to all components in a piping system. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions.

3.17 Nominal Pressure (PN) – A numerical designation expressed by a number which is used for reference purposes. All compo of the same nominal size DN designated by the

same PN number have compatible mating dimensions.

3.18 Batch – Quantity of castings from which a certain number of samples may be taken for testing purposes during manufacture.

3.19 3.19 Length – Effective length of a fitting, as shown on the drawings of 11.2

3.20 3.20 Ovality – Out of roundness of a fittings section it is equal to $100 (a_1 - A_2) / (A_1 + A_2)$ where a_1 is the maximum axis and A_2 the minimum axis of the fittings cross section.

3.21 Deviation in Length – Amount by which the design length may differ from the standardized length of a fittings.

Note :-Fittings are designed to a length taking into account standard length plus or minus the deviation; they are manufactured to this length plus or minus the tolerances given in Table-14.

4. MANUFACTURE AND REPAIR

4.1 The metal used for the manufacture of casting shall conform to the appropriate grade as specified in IS 1865, in commensurate with the requirements as laid down in this standard. It shall be prepared at the discretion of the manufacturer in a cupola, or an active mixer or other suitable furnace.

4.2 The castings shall be stripped with all precautions necessary to avoid warping or shrinkage defects, detrimental to their good quality. The castings shall be sound and free from surface or other defects.

4.3 Casting showing small imperfections which result from the method of manufacture and which do not affect its final use shall not be rejected on that account alone.

4.4 Minor defects may be rectified with the approval of the purchaser. Repairing of defects by welding, plugging off leaks by caulking or by application of epoxy putty may not be done without previously securing the approval of the purchaser. Repairs are to be carried out according to a written procedure included in the manufacturer's quality assurance system. Any dressing to remove imperfections, shall not reduce the thickness of the casting below the specified thickness.

4.5 The castings shall be such that they could be cut, drilled or machined. In case of dispute the castings may be accepted provided that the hardness measured on the external un-machined surface does not exceed 250 HBS.

4.6 Where castings are required to

withstand pressure higher than those specified in this standard, the casting may be strengthened by means of increased wall thickness, if necessary, at the expense of the internal diameter or by suitable ribbing or as may be mutually agreed between the manufacturer and the purchaser, to suit the pressure specified by the purchaser.

5. THICKNESS

The thickness 'e' of fittings is calculated as a function of the nominal diameter 'DN' by using the formula, given below with the following values for K:

$$e = K (0.5 + 0.001 \text{ DN})$$

Where K = 14, e = 7 + 0.014 DN

Where K = 12, e = 6 + 0.012 DN

For 'DN 80' the thickness of the fitting has been limited to minimum of 7 mm, so that, taking the tolerances into account, the thickness of the fittings is always at least equal to that of the pipes of the same nominal diameter. Threaded-on welded-on) or adjustable; an flange comprises of a ring, in one or several parts bolted together, which bears on an end joint hub and can be freely rotated around the fittings axis before jointing.

5 JOINTS

5.1 In the case of push-on-joints for sizes 'DN 600' and above the sockets may be with or without centering rings.

5.2 Design of the socket and rubber gaskets are no within the scope of this standard.

5.3 If agreed between the manufacturer and the purchaser, the fittings can be made with plain end also, for jointing with the help of a collar/coupling provided that the overall length of the fitting remains the same. The length of the spigot necessary for jointing shall not be less than the length of the socket of the jointing pipe.

5.4 In case of push-on-joints the spigot end of fitting, if any, shall be suitably

chamfered to facilitate smooth entry of spigot in the socket of the pipes or fittings fitted with rubber gasket.

5.5 In case of flange and mechanical joint casting the flange shall be at right angle to the axis of the joint. The bolt holes shall be either cored or drilled.

5.6 The centre of bolt holes circle shall be concentric with the bore circle and shall be located off the centre line, unless otherwise specified by the purchaser. Where there are two or more flanges, the bolt holes shall be correctly aligned between them.

5.7 The flanges shall be plain faced or with raised boss as given in Tables 4, 5, 6 and 7 over the contact surface with a tool mark finishing having a pitch of 1 ± 0.3 mm, serrations may be spiral or concentric.

5.8 For high pressure mains, requiring working pressure greater than 2.4 MPa, suitable flexible joint may be preferred where the joint is restrained against axial movement.

5.9 Push-on-joint fittings are normally not used for sizes above DN 1600.

7. RUBBER GASKETS

The material of rubber gaskets for use with mechanical joints and push-on-joints shall conform to IS 5382. Unless otherwise agreed between the manufacturer and the purchaser, dimensions of the rubber gasket shall be as per manufacturer's own design.

10. HYDROSTATIC TEST

For hydrostatic test, the fittings shall be kept under pressure for 10 seconds. They shall withstand the pressure test without showing any sing of leakage, sweating or other defect of any king. The test shall be conducted before the application of surface coating.

10.1 The fittings shall withstand the hydrostatic pressure given in Table 2

Table 2 Hydrostatic Test Pressure for Castings

Nominal Diameter	Hydrostatic Test Pressure At works, MPa
Upto and including 300	2.5
Over 300 and up to and including 600	1.6
Over 600 and up to and including 2000	1.0

NOTE : The work hydrostatic test pressure is less for fittings than for pipes specified in the relevant Indian Standard for pipes because the shape of the fittings makes it

difficult to provide sufficient restraint to high internal pressure during the test.

10.2 When fittings are required for higher test pressures, the test pressures are subject

to agreement between the purchaser and the manufacturer (see 4.6).

11. SIZES

The standard nominal sizes `DN; of the fittings covered in this standard are as follows:

80, 100, 125, 150, 200, 250, 300, 350, 400, 450, 500, 600, 700, 750, 800, 900, 1000, 1100, 1200, 1400, 1600, 1800 and 2000 mm.

NOTE: Nominal size is a number used to classify fittings/joints/casting and corresponds approximately to their internal diameter.

11.1 Dimensional and other requirements for sockets/spigot to push-on-joints, mechanical joints and flanges shall conform to the requirements specified in Tables 3, 4, 5, 6 and 7 under Section 2 as relevant.

11.2 Dimensional and other requirements for fittings for specified DN shall conform to the values as given in the Table 15 to 31 under Section 3.

13. COATING

13.1 Fittings and accessories shall be normally delivered internally and externally coated.

13.1.1 External Coatings

By agreement between the manufacturer and the purchase, any one of the following coatings may be applied depending upon the external condition of use:

Metallic Zinc with finishing layer as included in Annex ;

Zinc rich paint with finishing layer

Bituminous paint : as included in Annex C

13.1.2 Internal Linings

By agreement between the manufacturer and the purchaser, the following lining may be applied depending on the internal conditions of use:

Portland cement (with or without additives) mortar, as included in Annex B;

Blast furnace slag cement mortar as included in Annex B;

High alumina (calcium aluminate) cement mortar as included in Annex B;

Cement mortar with seal coat : as included in Annex B; and Bituminous paint as included in Annex C.

13.2 Unless otherwise between the purchaser and the manufacturer, the external coating and the internal lining when applied shall conform to the requirements specified in this standard (including Annex).

Additional requirements other than those specified may be agreed between the purchaser and the manufacturer.

14. QUALITY ASSURANCE

14.1 General

The manufacturer shall be able to demonstrate the conformity of the product to the requirements contained in this standard by controlling the manufacturing process and carrying out the various tests as specified in this standard.

14.2 Quality Assurance System

The manufacturer shall control the quality of the product during manufacturing process by a system of process control in order to comply with the technical requirements contained in this standard wherever possible statistical sampling techniques should be used to control the process so that the product is produced within the specified limits.

15. MARKING

15.1 Each fittings shall have as cast, stamped or indelibly painted on it, the following appropriate marks.

- Indication of the source of manufacture,
- The nominal diameter
- The last two digits of the year of manufacture,
- PN rating of flanges when applicable, and
- Any other mark required by the purchaser.

15.1.1 Marking may be done on the barrel of castings or on the outside of the sockets.

ANNEX B (Clause 13.1.2)

CEMENT MORTAR LINING

B-1 MATERIALS

B-1.1 Cement

The cement used for the lining shall conform to the existing standards on cement.

The type of cement to be used is to be mutually decided between the purchaser and the manufacture. Normal recommendation are :

- Portland cement (as per IS 269 or IS 455) mortar lining perform rather well and have an expected life of approximately 50 years in soft water with moderate amount of

aggressive CO₂ and when pH is within 6 to 9. Longer service life can be obtained by increasing the mortar lining thickness.

(ii) Where cement mortar lining may be exposed to sulphate attack, ordinary Portland cement should be replaced by sulphate resisting Portland cement (as per IS 12330 or IS 6909). The sulphate concentration limit for sulphate resisting Portland cement is approximately 3000 mg/l, the same as ballast furnace slag cement which naturally possess a good resistance to

sulphate attack. For sea water transmission ballast furnace slag cement which has C3 A content below 3 percent can be used.

(iii) High Alumina cement (as per IS 6452) mortar lining is suitable for continuous use of pH between 4 and 12 and no severe damage occur after occasional exposure to pH 3 to 4 to 12 to 13..

(iv) The recommended types of cements used for lining are as given in Table 32.

Table 32 Recommended Types of Cements Used for Lining

Water Characteristics	Portland Cement	Sulphate Resisting Cements (Including Blast Furnace Slag	High Alumina Cement
Minimum value of pH	6	5.5	4
Maximum content (mg/l of			
Aggressive CO ₂	7	15	no limit
Sulphates (SO ₄)	400	3000	no limit
Magnesium (MG++)	100	500	no limit
Ammonium (NH ₄ +))	30	30	no limit

B-1.2 Sand

The sand used shall have a controlled granulometric distribution from fine to coarser elements; it shall be clean and shall be composed of inert, hard, strong and stable granular particles.

The fine fraction comprising particles passing through a sieve of aperture size 0, 125mm shall not be more than 10 percent by mass.

The fraction comprising grains up to a maximum diameter equal to one third of the normal thickness of the mortar lining shall not be less than 50 percent by mass.

The coarsest fraction (comprising particles which do not pass through a sieve of the aperture size closest to half the normal thickness of the mortar lining) shall not exceed 5 percent by mass

B-1.4 Mortar

The mortar of the lining shall be composed of cement, sand and water.

Additives, which shall be specified, may be used provided that they do not prejudice the quality of the coating and that of the transported water.

The mortar shall be thoroughly mixed and shall have a consistency which results in a dense and homogeneous lining.

The mortar shall contain by mass at least one part of cement to 3.5 parts of sand.

B-2 CONDITION OF THE INTERIOR SURFACE OF THE FITTINGS BEFORE APPLICATION OF THE LINING

All foreign bodies, loose scale or any other material which could be detrimental to good contact between the metal and the lining shall be removed from the surface to which the lining is to be applied.

The inner surface of fittings shall also be free of any metal projections likely to protrude beyond 50 percent the thickness of the lining.

B-3 APPLICATION OF THE LINING

The mortar will be works applied by a suitable process. Smoothing with a trowel is permitted. The layer of mortar should be free of any cavity or visible air bubbles and care shall be taken to ensure maximum density at all points.

After the lining is applied it shall be cured at temperatures greater than 40°C. Any loss of water from the mortar by evaporation shall be sufficiently slow so that hardening is not impeded.

B-4- REPAIR OF LINING

Repairs to damaged or defective areas are allowable. The damaged mortar shall first be removed from these areas. Then the defective part shall be repaired by using, for example, a trowel with fresh mortar so that a

continuous lining having a constraint thickness is again obtained.

For the repair operation, the mortar shall have a suitable consistency, if necessary, additives may be included to obtain good adhesion against the side of the existing undamaged mortar.

B-5 THICKNESS OF THE LINING

The nominal thickness of the lining and its negative tolerance and maximum crack width/radial displacement are given in Table 33.

At the fittings ends, the lining may be reduced to values below the minimum thickness. The length of the chamber shall be as small as possible but, in any case, shall be less than 50 mm.

B-6 DETERMINATION OF LINING THICKNESS

The thickness of the lining is checked on the

freshly centrifuged mortar by the insertion of a steel pin, or on the hardened mortar by means of a non destructive method of measurement.

The thickness of the lining shall be measured at both ends of the fittings in at least one section perpendicular to the fittings axis.

B-7 SURFACE CONDITION OF THE HARDENED LINING

The surface of the cement mortar lining shall be uniformly smooth. Only isolated grains of sand are allowed to appear on the surface of the lining.

The lining shall be such that it cannot be dislodged with pressure of hand and shall be free from corrugations or ridges that could reduce the thickness of the lining to less than the minimum value at one point, as specified in the Table 33.

Table 33 Thickness of Lining

(Clauses B-5 and B-7)

All dimensions in mm

DN	Thickness		Maximum Crack Width & Radial displacement
	Nominal value	Tolerance	
080 to 300	3.0	-1.5	0.8
350 to 600	5.0	- 2.0	1.0
700 to 1200	6.0	-2.5	1.2
1400 to 2000	9.0	-3.0	1.5

NOTE : Fittings ends may have a chamfer of maximum length 50mm.

On contraction of the lining, the formation of cracks cannot be avoided. These cracks, together with other isolated cracks which may result from manufacturer or may develop during transportation, are acceptable up to a width given in the above.

B-8 SEAL COAT

B-8.1 General

When specified the cement lining shall be given a seal coat of bituminous material or any other epoxy based material compatible with Cement Mortar Lining. Other seal coat materials may be used, but they shall be agreed on at the time of purchase and shall be specified on the purchase order.

The purpose of seal coat is to minimize lime leaching of the cement mortar as well as to restrict the unwanted rise in pH value of the transmitted water.

When the pipes are to be used for conveying potable water the inside coating shall not contain any constituent soluble in such water

or any ingredient which could impart any taste or whatsoever to the potable water after sterilization and suitable washing of the mains.

ANNEX C

(CLAUSES 13.1.1 AND 13.1.2)

BITUMINOUS COATING

C-1 General :

Unless otherwise agreed between the purchaser and the manufacturer, fittings shall be coated externally and internally with the same material. (Bituminous coatings are either hot applied or cold applied).

C-2 GENERAL CHARACTERISTICS

C-2.1 Coating shall not be applied to any fittings unless its surfaces are clean, dry and free from rust.

C-2.2 Unless otherwise agreed between the purchaser and the manufacturer all fittings shall be coated externally and internally with the same material. The method of coating shall be as per usual practice of the manufacturers. The coating

materials shall set rapidly with good adherence and shall not scale off. The mean thickness of the coating shall be not less than 70 μm and the local minimum thickness shall be not less than 50 μm .

C2.3 Where the coating material has a tar or similar base, it shall be smooth and tenacious and hard enough not to flow when exposed to a temperature of 650 C but not so brittle at a temperature of 00C as to chip off when scribed with a penknife.

C-2.4 When the pipes are to be used for

conveying potable water the inside coating shall not contain any constituent soluble in such water or any ingredient which could impart any taste or whatsoever to the potable water after sterilization and suitable washing of the mains.

C-2.5 Pipes with or without sockets and flanges which are imperfectly coated or where the coating does not set or conform to the required quality, the coating shall be removed and the pipes/flanges recoated.

ANNEXURE 13.1**TOLERANCES FOR CAST IRON (CENTRIFUGALLY CAST) PIPES**

Tolerance in Diameter Dimensions	Nominal diameter (DN)	Tolerance in mm
a) External diameter of barrel (DE)	All diameters.	$\pm (4.5 + 0.0015 \text{ DN})$
b) Internal diameter of socket (DI)	All diameters.	$\pm (3.0 \pm 0.001 \text{ DN})$
c) Depth of socket (P)	(1) Upto and including 600 mm	± 5
	(2) Over 600 mm and upto and including 1000 mm	± 10

Note: (1) The jointing tolerances applicable to rubber joints (mechanical or push in joints) shall be as specified by their manufacturer and shall be within the tolerances specified above.

Tolerance on Thickness

Dimensions	Tolerance in mm
a) Wall thickness	$- (1 + 0.05 e)$
b) Flange thickness	$\pm (2 + 0.05 b)$

Where e = the thickness of the wall in millimeters and

b = the thickness of the flange in millimeters.

Tolerance on Length

Type of Casting	Tolerance in mm
a) Socket and spigot, and plain ended pipes	± 25
b) Flanged pipes	± 10

ANNEXURE 13.2**TOLERANCES FOR SPECIALS OF CAST IRON PIPES**

Tolerances in Diameter			
Dimension	Nature of joint	Nominal diameter (DN)	Tolerance in mm
External diameter of spigot (DE)	Lead joint	All diameters	$\pm 1/2 F$ or $\pm (4.5 + 0.0015 DN)$
Internal diameter of socket (DI)	Lead joint	diameters	$\pm 1/3 F$ or $\pm (3 + 0.001 DN)$
Depth of socket (P)	Lead joint	Upto and including 600 mm	± 5
		Over 600 mm upto and including 1000 mm.	± 10
		Over 1000 mm upto and including 1500 mm	± 15

Tolerances on Thickness	
Dimension	Tolerance in mm
Wall thickness	$-(2 + 0.05 e)$
Flange thickness	$\pm (3 + 0.05 b)$
Where e = the standard thickness of the wall in millimeters, and b = the standard thickness of the flange in millimeters.	

Tolerance on Lengths		
Type of fitting	Nominal diameter	Tolerance in mm
Socket fittings and flange spigot pieces	Upto and including 450 mm	± 20
	Over 450 mm	$\pm 20 - 30$
Flanged fittings	All diameters	± 10

ANNEXURE 13.3**PARTICULARS OF MEDIUM GRADE G.I. PIPES**

Nominal Bore (mm)	Dimension of pipes			Weight of pipe	
	Outside diameter		Thickness	Plain end	Screwed end socket
	Max. (mm)	Min. (mm)	(mm)	Kg/m	Kg/m
6	10.6	9.8	2.0	0.404	0.407
8	14.0	13.2	2.3	0.641	0.645
10	17.5	16.7	2.3	0.839	0.845
15	21.8	21.0	2.6	1.21	1.22
20	27.3	26.5	2.6	1.56	1.57
25	34.2	33.3	3.2	2.41	2.43
32	42.9	42.0	3.2	3.10	3.13
40	48.8	47.9	3.2	3.56	3.60
50	60.8	59.7	3.6	5.03	5.10
65	76.6	75.3	3.6	6.42	6.54
80	89.5	88.0	4.0	8.36	8.53
100	115.0	113.1	4.5	12.2	12.50
125	140.8	138.5	4.8	15.90	16.40
150	166.5	163.9	4.8	18.90	19.50

Tolerance in Thickness and Weight.

A)	Thickness		
	1.	Butt welded medium tubes	+ not limited - 10 percent.
	2.	Seamless tubes	+ not limited -12.5 per cent
B)	Weight		
	1.	Single tube (light series)	+ 10 percent - 8 percent
	2.	Single tube (medium and heavy series)	± 10 percent
	3.	For quantities per load of 10 tonnes, min (light series)	± 5 percent
	4.	For quantities per load of 10 tonnes, min (medium and heavy series)	± 7.5 percent

ANNEXURE 13.4**UNPLASTICISED RIGID P.V.C PIPES**

A. For internal work

Outside dia. in mm	Tolerance on outside dia.	Wall thickness in mm for 10 Kgf/sq. cm. working pressure	
		Min.	Max.
20	+ 0.3	2.8	3.3
25	+ 0.3	2.9	3.4
32	+0.3	3.4	3.9
40	+ 0.3	3.6	4.2
50	+0.3	3.7	4.3

B. For External work

Outside diameter	Tolerance on outside dia	Wall thickness for working pressure							
		2.5 Kgf/sqcm		4 Kgf/sqcm		6 Kgf/sqcm		10 Kgf/sqcm	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
16	+0.3							1.1	1.5
20	+0.3							1.1	1.5
25	+0.3							1.4	1.8
32	+0.3							1.8	2.2
40	+0.3					1.4	1.8	2.2	2.7
50	+0.3			1.2	1.6	1.7	2.1	2.8	3.3
63	+0.3			1.5	1.9	2.2	2.7	3.5	4.1
75	+0.3			1.8	2.2	2.6	3.1	4.2	4.9
90	+0.3	1.3	1.7	2.1	2.6	3.1	3.7	5.0	5.7
110	+0.4	1.6	2.0	2.5	3.0	3.7	4.3	6.1	7.0
125	+0.4	1.8	2.2	2.9	3.4	4.3	5.0	6.9	7.7
140	+0.5	2.0	2.4	3.2	3.8	4.8	5.5	7.7	8.7
160	+0.5	2.3	2.8	3.7	4.3	5.4	6.2	8.8	9.9
180	+0.6	2.6	3.1	4.2	4.9	6.1	7.0	9.9	11.1
200	+0.6	2.9	3.4	4.6	5.3	6.8	7.7	11.0	12.3
225	+0.7	3.3	3.9	5.2	6.0	7.6	8.6	12.4	13.9
250	+0.8	3.6	4.2	5.7	6.5	8.5	9.6	13.8	15.4
280	+0.9	4.1	4.8	6.4	7.3	9.5	10.7	15.4	17.2
315	+1.0	4.6	5.3	7.2	8.2	10.7	12.0	17.3	19.3

ANNEXURE 13.5**PROCEDURE FOR PRESSURE TEST**

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

2. If the trench has been partially back-filled the specified pressure based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer. The duration of the test shall not be less than 5 minutes.

3. Examination under Pressure : All exposed pipes, fittings, valves, hydrants and joints should be carefully examined during the open-trench test. When the joints are made with lead, all such joints showing visible leaks shall be recaulked until tight. When the joints are made with cement and show seepage or slight leakage, such joints shall be cut out and replaced as directed by the Engineer. Any cracked or defective pipes, fittings, valves or hydrants discovered in consequence of this pressure test shall be removed and replaced by sound material and the test shall be repeated until satisfactory to the Engineer.

4. If the trench has been back-filled to the

top, the section shall be first subjected to water pressure normal to the area and the exposed parts shall be carefully examined. If any defects are found, they shall be repaired and the pressure test repeated until no defects are found. The duration of the final pressure tests shall be at least one hour.

Procedure for Leakage Test

5. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

No pipe installation shall be accepted until the leakage is less than the number of cm³/h determined by the formula :

$$ql = \frac{ND \sqrt{P}}{3.3}$$

Where ql = the allowable leakage in cm³/h.

N = number of joints in the length of the pipe line.

D = diameter in mm, and

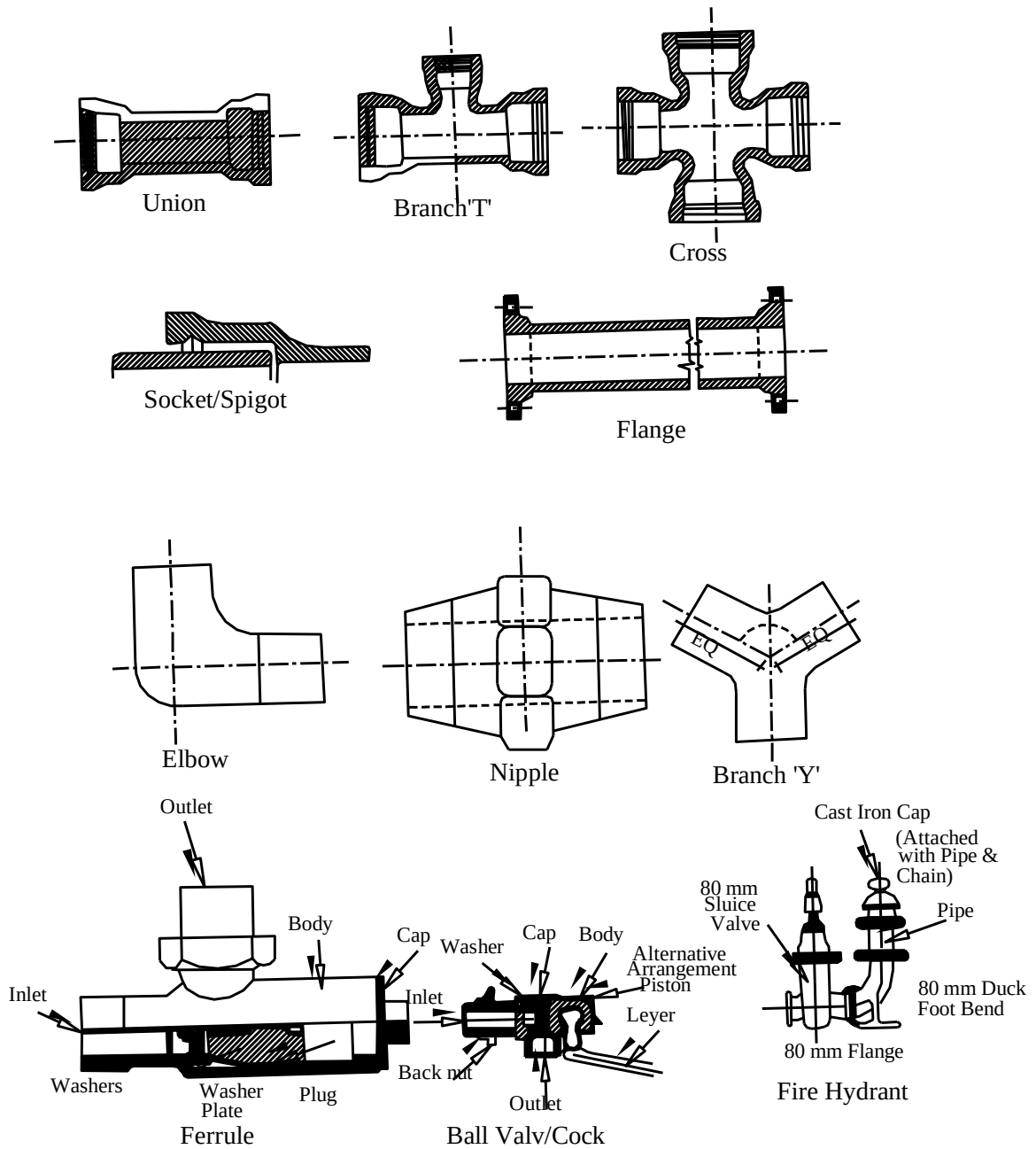
P = the average test pressure during the leakage testing kg/cm².

6. Variation from Permissible Leakage :

Should any test of pipe laid in position disclose leakage greater than that specified in para 5 the defective joints shall be repaired until the leakage is within the specified allowance.

FITTING & SPECIALS

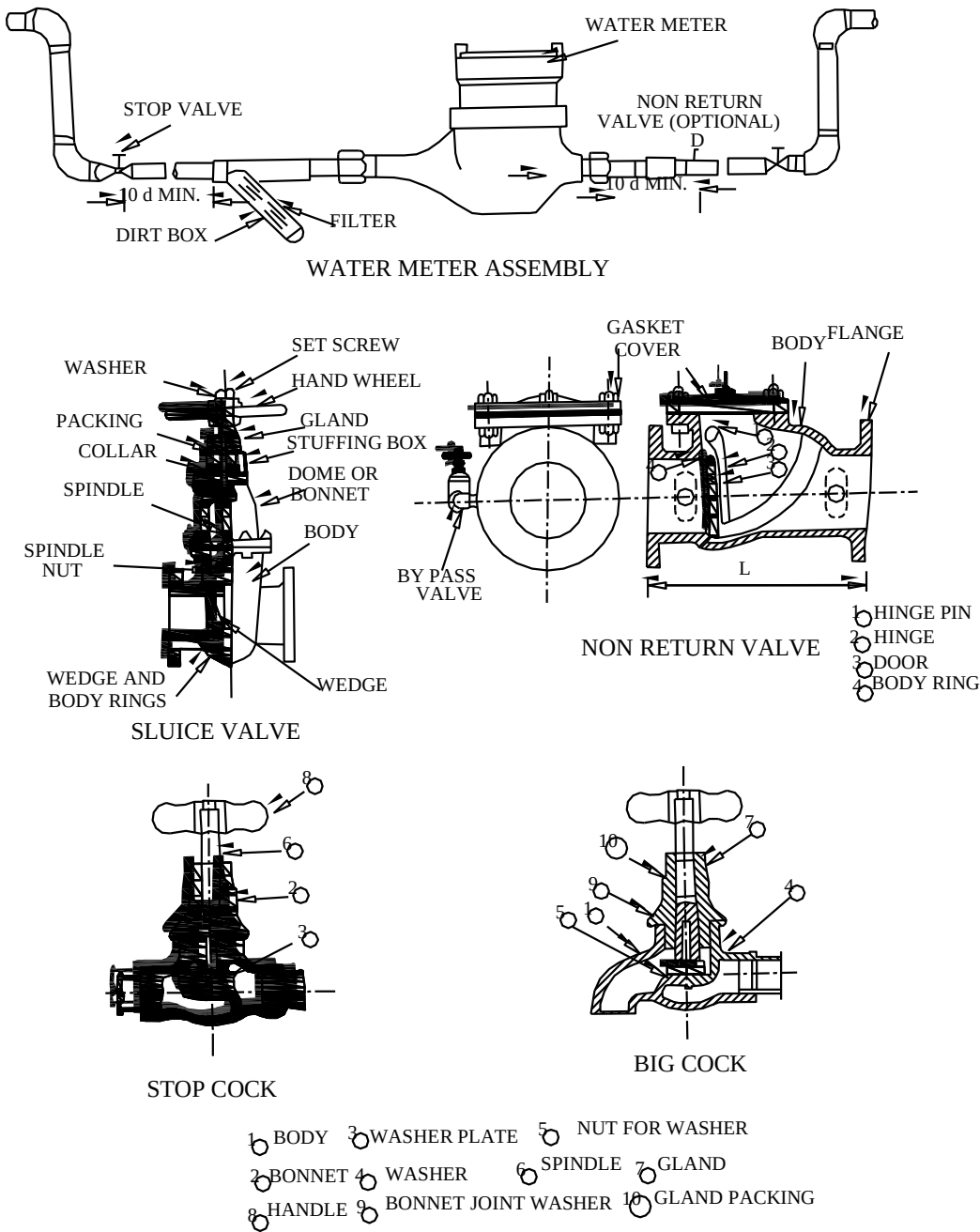
FIGURE 13.1



All dimensions are in mm
Drawings not to Scale

WATER SUPPLY COCKS, VALVES & METERS

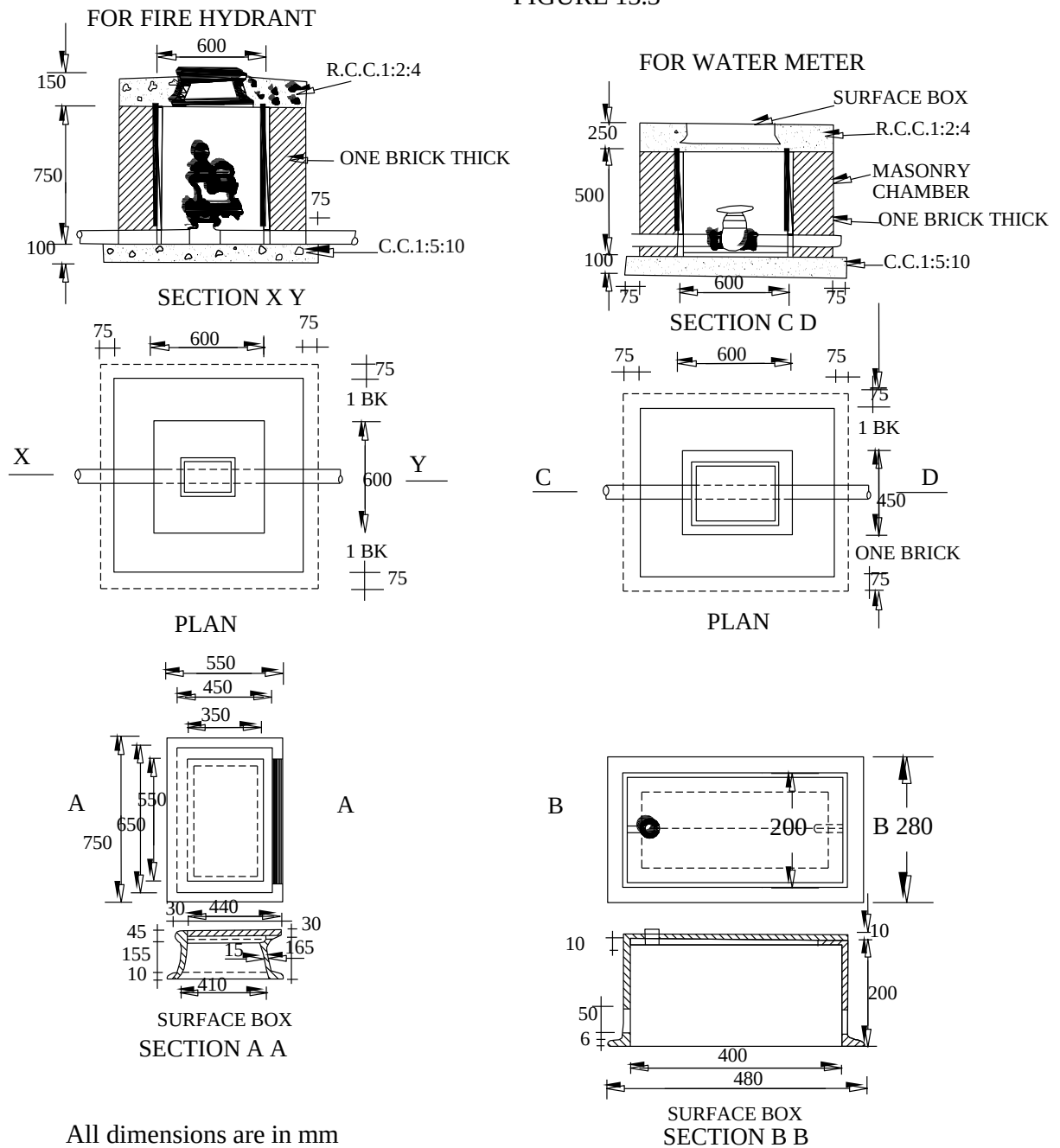
FIGURE 13.2



All dimensions are in mm
Drawings not to Scale

MASONRY CHAMBERS & SURFACE BOXES FOR FIRE HYDRANTS AND WATER METERS

FIGURE 13.3

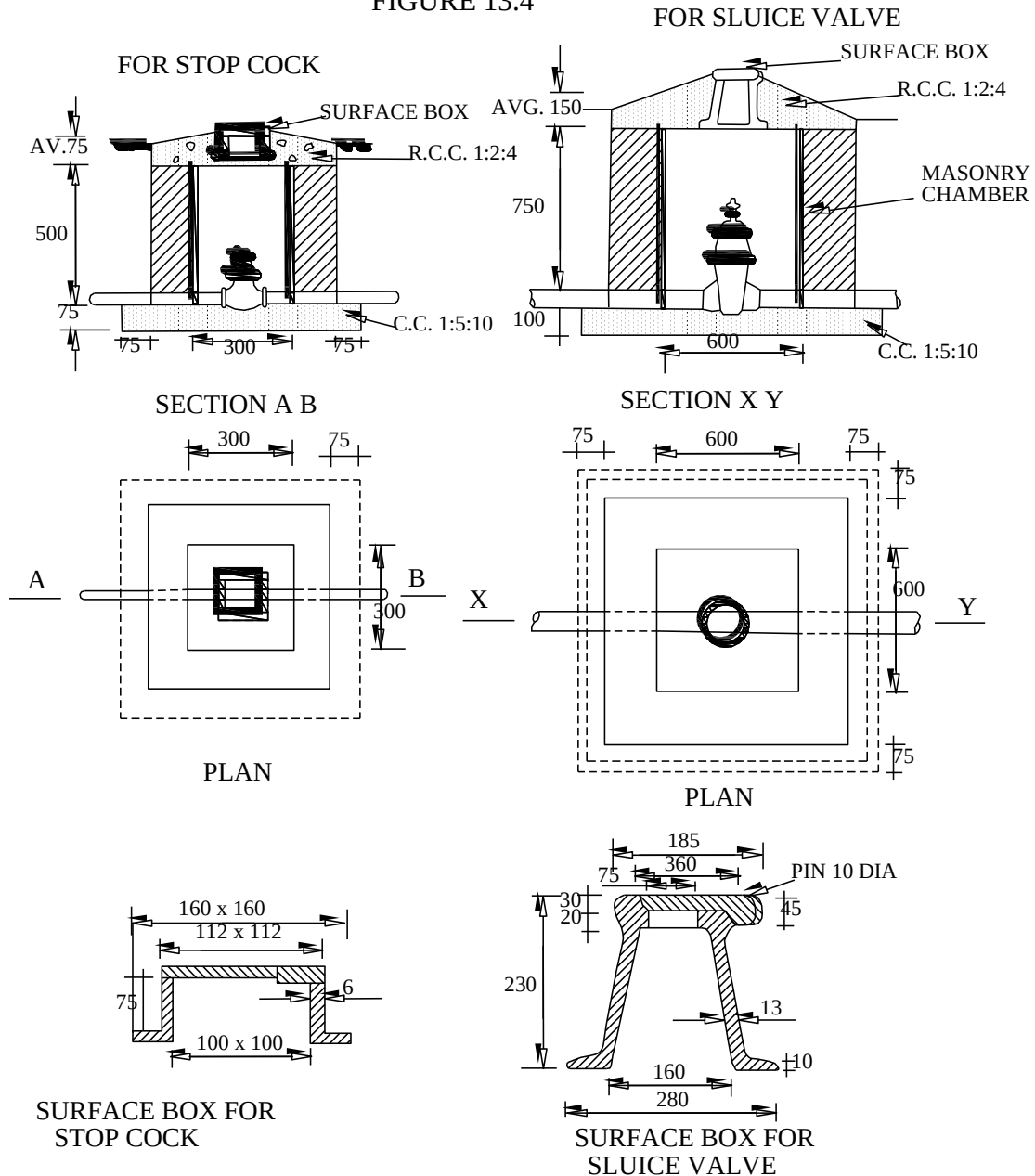


All dimensions are in mm
Drawings not to Scale

MASONRY CHAMBERS & SURFACE BOXES

(CONTD)

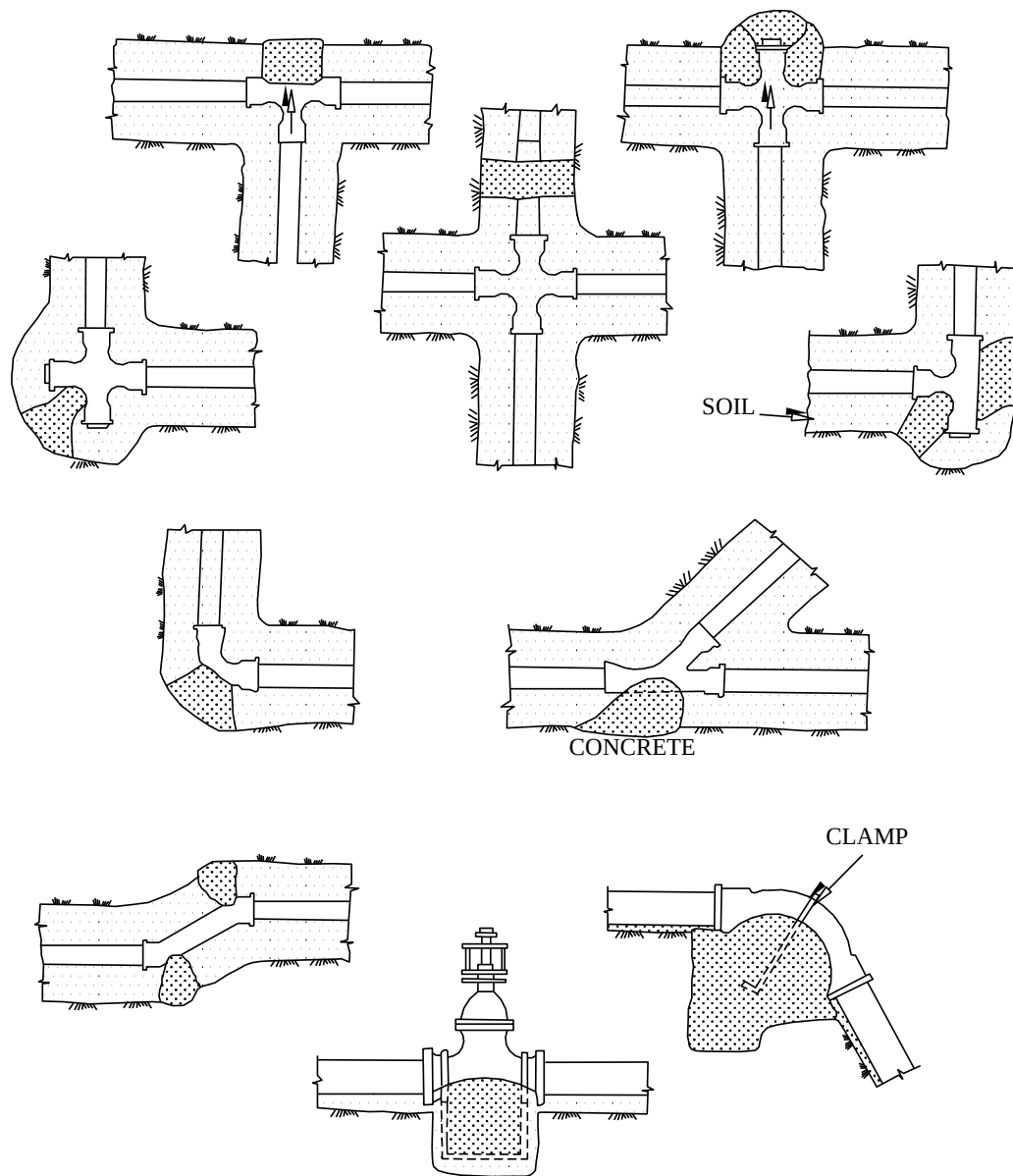
FIGURE 13.4



All dimensions are in mm
Drawings not to Scale

THRUST BLOCKS

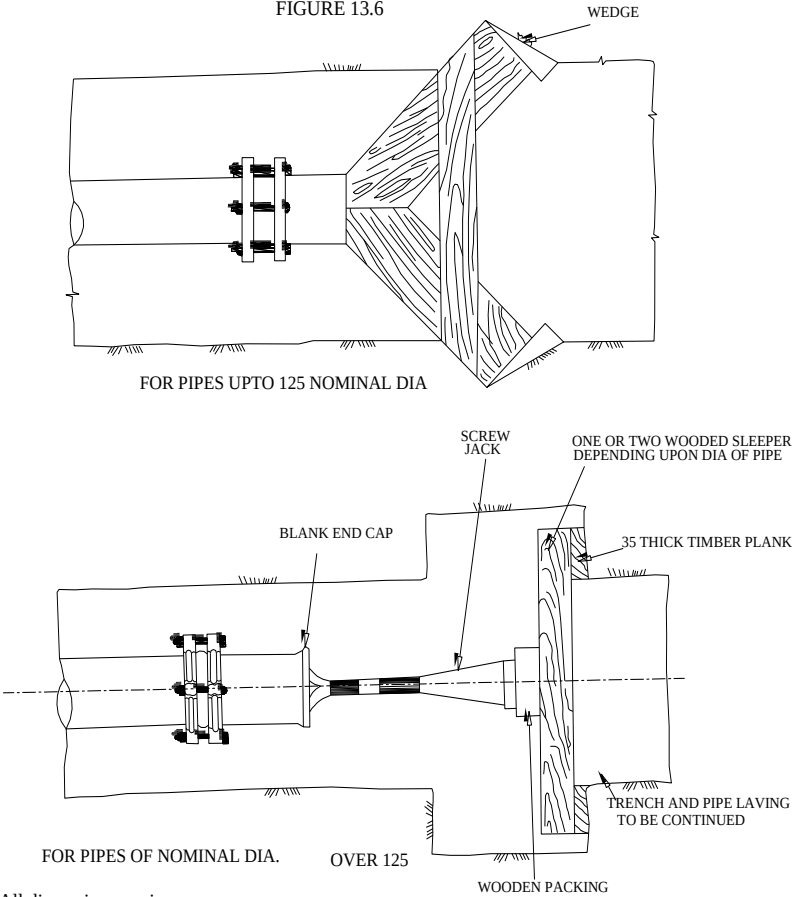
FIGURE 13.5



Drawings not to Scale

HYDROSTATIC TESTS
(END CLOSURE FOR PIPES)

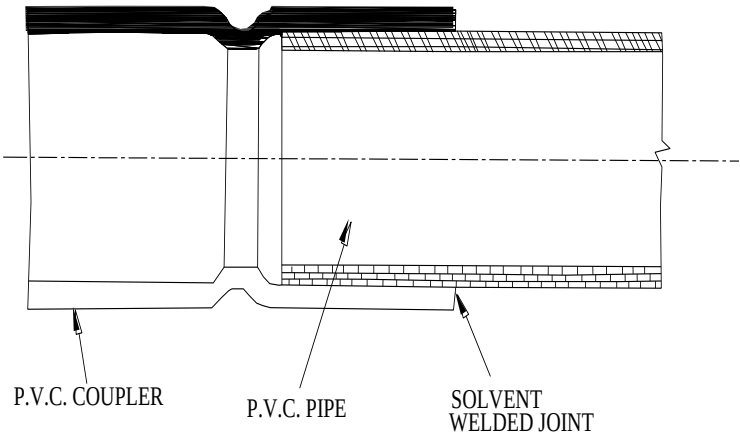
FIGURE 13.6



All dimensions are in mm
Drawings not to Scale

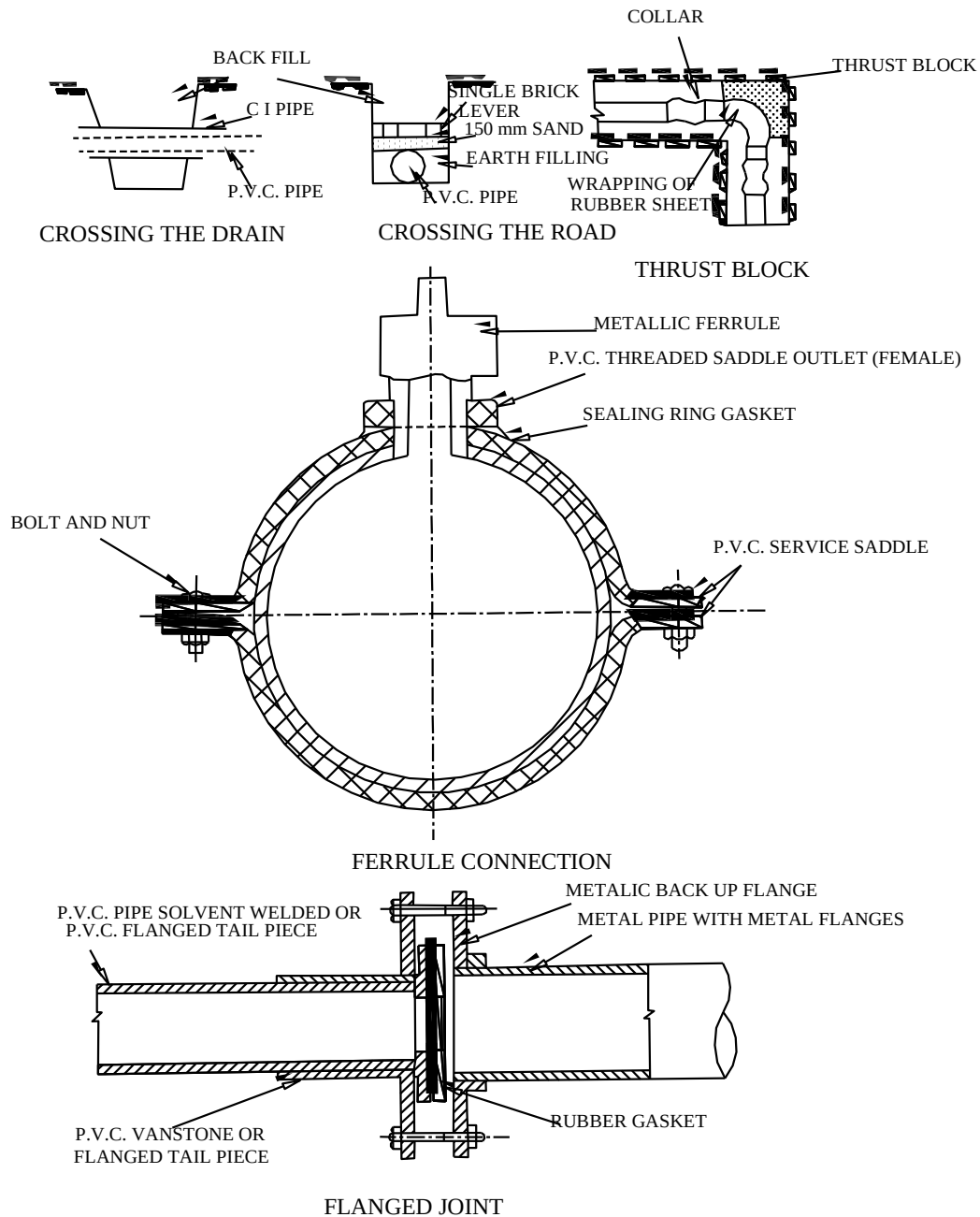
P.V.C.. SOLVENT WELDED JOINT

FIGURE 13.8



P.V.C.. PIPING

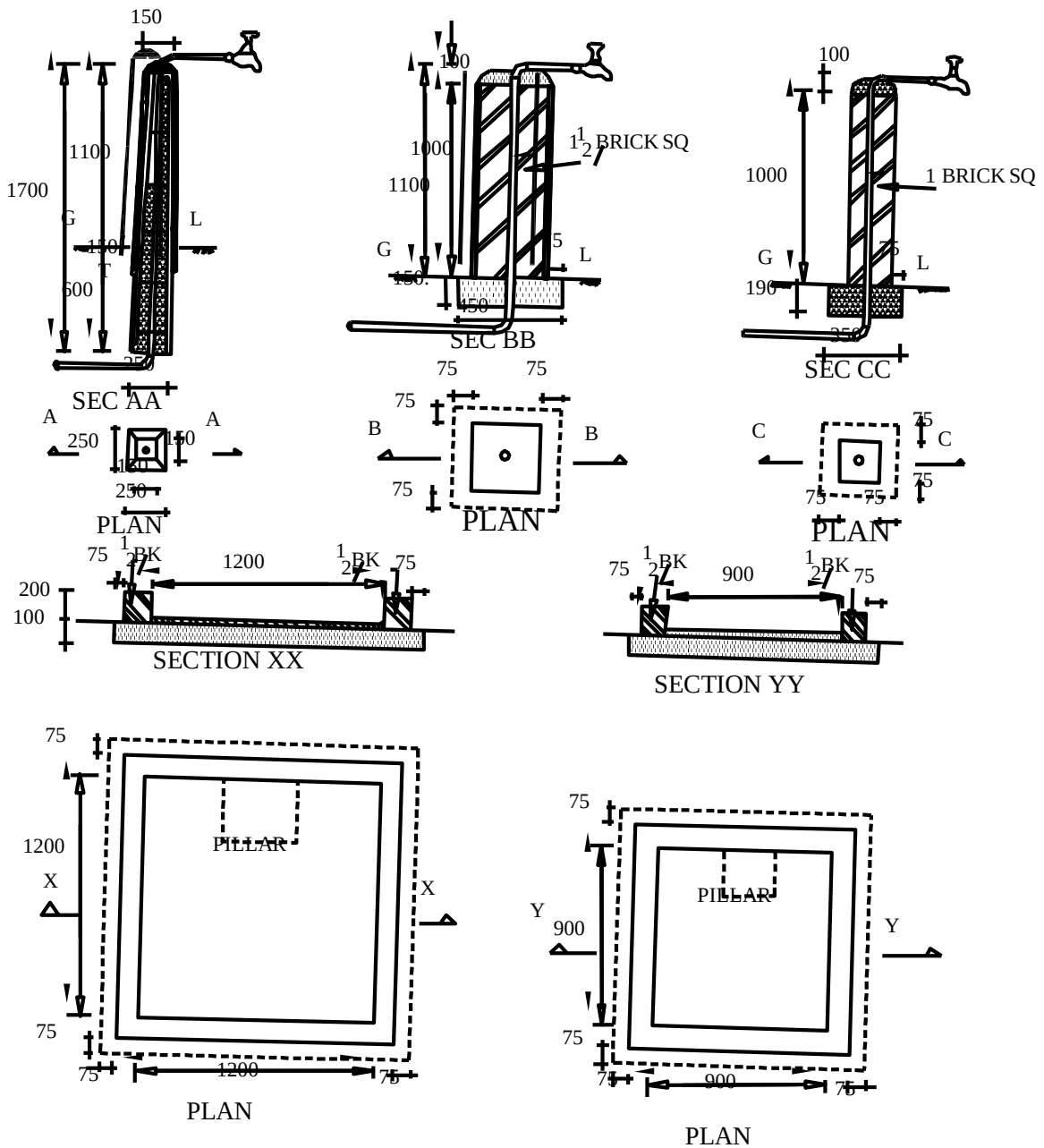
FIGURE 13.9



Drawings not to Scale

HYDRANT POSTS AND PLATFORMS

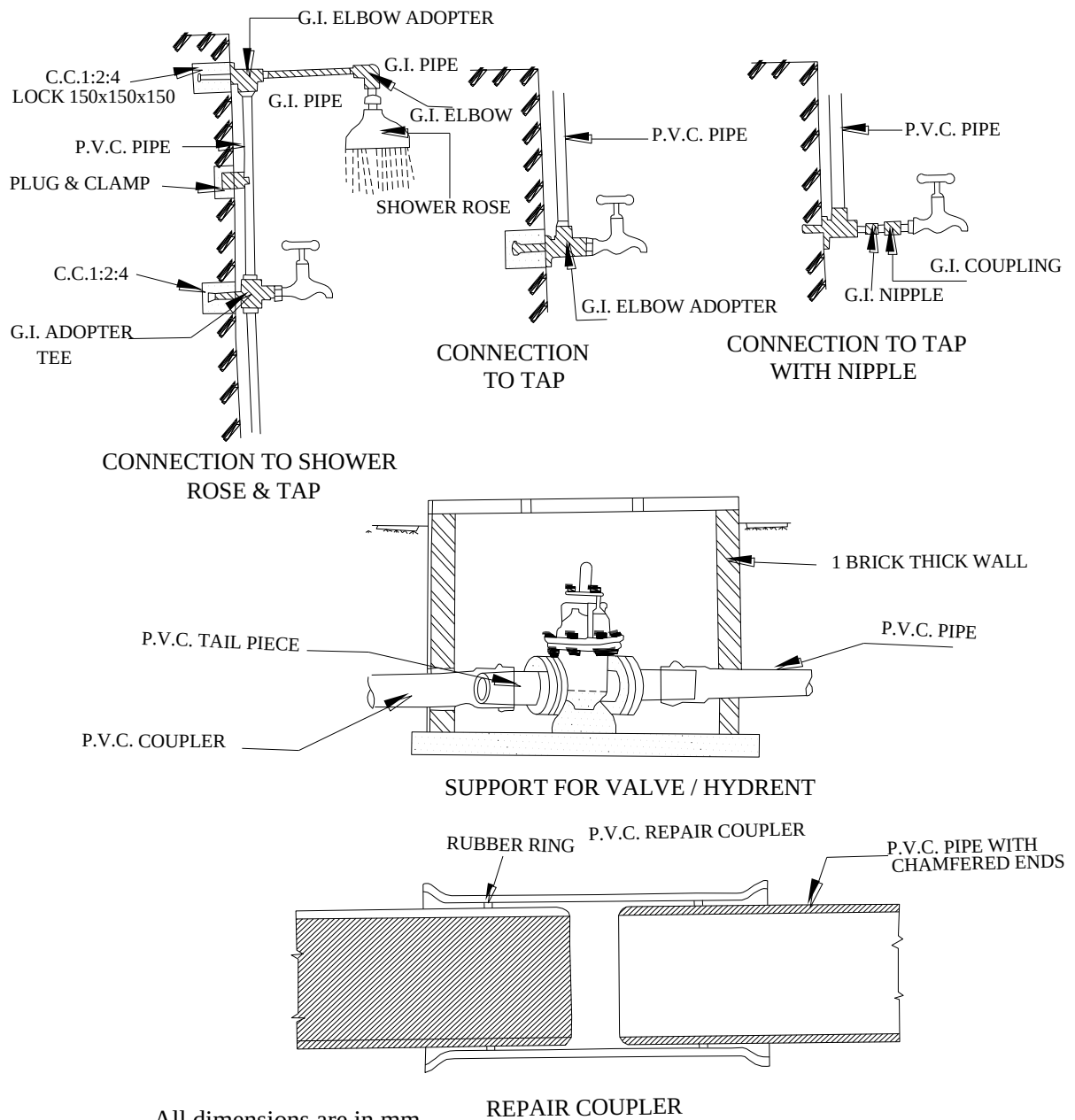
FIGURE 13.10



All dimensions are in mm
Drawings not to Scale

P.V.C. PIPING SPECIALS

FIGURE 13.11



All dimensions are in mm
Drawings not to Scale

Chapter 17

Miscellaneous Building Works

17.1 DAMP PROOFING AND WATER PROOFING

17.1.1 General

17.1.1.1 Damp Proofing of basements and floors and waterproofing of roofs is necessary for protection against entry of moisture either from ground capillary action or from rain water.

17.1.2 Preparatory Works

In order to obtain satisfactory performance, special care has to be taken in preparing the building surface (sub-floor) for receiving the treatment.

17.1.2.2 Damp Proofing and waterproofing shall be taken up only when the sub-soil water level is at its lowest, that is, in the dry season.

Sufficient working space shall always be provided for external Damp-proofing on new buildings which shall in no case be less than 600 mm suitably protected all-round the basement.

Dewatering shall be continued during the laying of the layers of damp-proofing materials until they have hardened and the surface has developed enough strength to resist full hydrostatic pressure.

17.1.3 Damp Proof Treatment above ground level for buildings

17.1.3.1 Damp Proofing of walls:- The mortar bed on which the Damp proofing treatment is to be laid shall be levelled and made free from projection liable to cause damage to the Damp Proofing treatment. The treatment shall cover the full thickness of wall and shall not be set back from wall face for pointing. The DPC must be continuous with the floor and shall not be carried across doorways, verandah arches and similar openings. To arrest the passage of moisture between the flooring and the masonry, the faces of walls, pillars etc coming into contact with the flooring on the inside will be painted with hot Tar or Bitumen.

a) Damp Proof Course may be one of the following types as specified by the Engineer-in-charge

i) Cement Concrete :

Generally it will be of CC 1:2:4 mix with coarse aggregate of size 6mm to 20mm and

of thickness 4 cm unless otherwise directed by the Engineer. Where an approved Water Proofing compound to IS 2645-1975 is specified, it shall be done in accordance with the directions of the Manufacturer. The top of the DP Course shall be criss crossed and made rough for receiving the course of masonry over it. The DP course may be built over after curing for 3 days. Where no water proofing compound is used, the concrete may be cured for not less than 7 days and allowed to dry. When properly dried, it shall be cleaned with brushes and thereafter rubbed with cloth soaked in kerosene oil for priming. Hot Tar or Bitumen shall then be applied uniformly all over in two separate coats each coat being closely followed by sprinkling of dry sand over it while still hot. Coal Tar shall not be mixed with oxidised bitumen. The building up of masonry may be done thereafter.

ii) Cuddappah or similar slabs

The Cuddappah or similar slab shall be of uniform thickness of not less than 5 cms. The slabs shall be of the same width as the wall and laid on a bed of Cement Mortar 1:3 of thickness 12mm. The vertical joint between consecutive slabs shall be kept clear of mortar and shall be filled thoroughly with a hot mixture of tar or bitumen and dry sand.

Where so specified, the DPC may be made up of 2 layers each of 4 cm thickness of flat bedded dense grained flagging stone of non absorbent texture. The stones shall be bedded solidly in Cement Mortar 1:1 and neatly pointed on the exposed surface.

17.1.3.2 Damp Proofing of Floor

a) Where the horizontal damp proofing treatment has to be carried over to a vertical face a Cement Mortar 1:4 Fillet 75mm in radius shall be provided at the junction with both horizontal and vertical surfaces finished smooth.

b) Damp proofing of Floors may be by one of the following methods as specified:-

i) Treatment with Bitumen Felt

The Bitumen felt shall conform to the requirements of IS 1322-1993 and IS 7193-1974 as specified. Bitumen Primer shall conform to IS 3384-1986. Blown Bitumen shall conform to IS 702-1988 of Grades

85/25 or 90/15. Where specified surface on which felt is to be laid shall be made up of Cement Mortar 1:4 which shall be paid for separately. The surface on which the DPC is to be laid shall be first sprayed with Bitumen Primer conforming IS 3384-1986 @ 0.4 litre / m² Over it, the following will be applied.

- Hot applied Blown Bitumen at the rate of 1.50 kg/ m²
- Hessian Base self-finished Felt Type 3, Grade 2 or Glass fibre base Type 2, Grade II (as specified) and
- Hot applied Blown Bitumen at the rate of 1.50 kg/ m²

The method of laying the Bitumen Felt has been described in subsequent Para 17.1.4.2 (i) (c)

17.1.4 Water Proofing of Roof

17.1.4.1 Waterproofing with Bitumen Felt Para 10.15 may be referred to.

17.1.4.2 Water Proofing with Cement Slurry mixed with Fibre Glass Cloth consisting of applying:

After surface preparation, first layer of slurry of cement @ 0.488 kg/sqm mixed with Armourcrete or Tapecrete manufactured by M/s The Structural Water Proofing Co. Pvt. Ltd. or Tapecrete of M/s CICO Engineering Services @ 0.253 kg/sqm.

Laying second layer of Fibre glass cloth manufactured by M/s. The Structural Water Proofing Company Pvt. Ltd. when the first layer is still green. Overlaps of joints of fibre cloth should not be less than 10 cm.

Third layer of 1.5mm thickness consisting of slurry of cement @ 1.289 kg/sqm. mixed with Armourcrete or Tapecrete @ 0.670 kg / sqm and coarse sand @ 1.289 kg./sqm. This will be allowed to air cure for 4 hours followed by water curing for 48 hours.

The entire treatment will be taken upto 30 cm on parapet wall and tucked into groove in parapet all around.

Fourth and final layer of brick tiling with cement mortar (which will be paid for separately)

For the purpose of measurement the entire treated surface will be measured.

17.1.4.3 Integral cement based water proofing treatment- This shall be carried out as under for roofs, balconies, terraces etc.

a) Applying and grouting a slurry coat of neat cement using 2.75 kg/sqm of cement admixed with proprietary water proofing compound conforming to IS 2645 over the

RCC slab including cleaning the surface before treatment.

b) Laying 20mm thick layer of cement mortar of mix 1:5 (1 cement : 5 coarse sand) admixed with proprietary water proofing compound conforming to IS: 2645 to required slope and treating similarly the adjoining walls upto 300mm height including rounding of junctions of walls and slabs.

c) Laying cement concrete using broken bricks / brick bats 25mm to 100mm size with 50% of cement mortar 1:5 (1 cement: 5 coarse sand) admixed with proprietary water proofing compound conforming to IS 2645

d) After two days of proper curing, applying a second coat of cement slurry admixed with proprietary water proofing compound conforming to IS 2645. Finishing the surface with 20mm thick joint less cement mortar of mix 1:4 (1 cement: 4 coarse sand) admixed with proprietary water proofing compound conforming to IS 2645 and finally finishing the surface with trowel with neat cement slurry and making of 300 x 300mm square.

e) The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curing and for final test.

All above operations to be done in order and as directed and specified by the Engineer.

17.1.4.4 Procedure for waterproofing of underground/overhead tanks

(1) Placing and fixing **12mm N.B.M.S.** threaded Nozzles of **75mm length** with dummy rod for maintaining the hole up to required depth in an approximate grid pattern at a spacing not exceeding **1.5 M c/c** on the entire surface prior to or during concreting. Similar threaded Nozzles along with dummy rod shall also be fixed at a regular interval not exceeding **1.5 M** apart along the construction joints. Similar Nozzles shall also be post fixed at critical points, if required by drilling or making holes with suitable tools.

(2) Casting of RCC slab (Minimum **M-20** grade and W/C ratio not exceeding **0.50**) admixed with '**CICO PLAST-N**' Normal Plasticiser-cum-Cement Waterproofer/ '**CICO PLAST SUPER**' – Superplasticiser /High Range Water Reducing Admixture as per recommended dosage.

(3) Injection of '**CICO NON- SHRINK POLYMERIC WATERPROOF GROUTING COMPOUND**' admixed with Cement Slurry through the Nozzles under pressure by pump. The grout should flow through all pores and voids thereby sealing them.

(4) Sealing off the Nozzles after the injection operation is over with '**CICO QUICK SETTING ADMIXTURE**' admixed with cement wherever required.

(5) After sealing the nozzles, the concrete surface to be cleaned from all debris, loose material, dust etc.

(6) Application of two coats of '**TAPECRETE-P151**'- Acrylic polymer Modified Cementitious Slurry coating over the properly rendered RCC surface.

(7) Providing **12mm** plaster in the ratio **1: 4 (Cement : Sand)** admixed with CICO SUPER over the '**TAPECRETE-P151**' applied surface to protect the 'Tapecrete' applied surface .

17.1.4.5 **WALLS**

(1) Casting of RCC Walls (minimum M-20 grade and W/C ratio not exceeding 0.50) admixed with 'CICO PLAST-N' Normal Plasticiser-cum-cement Waterproofer /'CICO PLAST SUPER' – Superplasticiser /High Range Water Reducing Admixture, as per recommended dosage.

(2) Placing and fixing **12mm N.B.M.S.** threaded Nozzles of **75 mm length** in an approximate grid pattern in a spacing not exceeding **1.5 M c/c** on the entire Retaining Wall after concreting by drilling or making holes with suitable tools up to required depth of the Wall. Similar threaded Nozzles shall also be provided at a regular interval not exceeding 1.5 M apart along the construction joints. Similar Nozzles shall also be post fixed at critical joints, if required by drilling or making holes with suitable tools.

(3) Injection of '**CICO NON-SHRINK POLYMERIC WATERPROOF GROUTING COMPOUND**' admixed with Cement Slurry through the Nozzles already fixed under pressure by pump. The grout should flow through all pores & voids thereby sealing them.

(4) Sealing off the Nozzles after the grouting operation is over with '**CICO QUICK SETTING ADMIXTURE**' admixed with cement wherever required.

(5) Application of two coats of '**TAPECRETE-P151**'- Acrylic Modified Cementitious Slurry Coating over the properly rendered internal face of the Wall.

(6) Providing **12mm thick** plaster in the ratio **1:4 (Cement: Sand)** admixed with CICO SUPER on the external face of the retaining wall if backfilling is not done with Sand or Earth.

17.1.4.6 **Water Proofing with Polymeric Membrane**

a) **Material**

(1) APP (Atactic Poly Propylene) modified Polymeric membrane manufactured by Bengal Bitumen Integrated Water Proofing Ltd. or General Membranes:-This shall be one of the following as specified:-

A) 1.5mm thick of 2.25 kg/sqm. weight consisting of five layers prefabricated with centre core as 20 micron HMHDPE (High Molecular High Density Polyethylene) film sandwiched on both sides with polymeric mix and the polymeric mix is protected on both sides with 20 micron HMHDPE film. or

B) 2.0 mm thick of 3.00 kg/sqm weight consisting of five layers pre-fabricated with centre core as 100 micron HMHDPE film sandwiched on both sides with polymeric mix and the polymeric mix protected on both sides with 20 micron HMHDPE film or

C) APP (Atactic Polypropylene Polymer) modified prefabricated five layer 2mm thick waterproofing membrane black finished reinforced with glass fibre matt manufactured by Bitumat Co.Ltd. Soprema or Tamko, or

D) As above but 3mm thick, or

E) As above 3mm thick but with non woven polyester matt instead of glass fibre matt.

(2) Bonding Material:- Blown type Bitumen of Grade 85/25 conforming to IS 702.

(3) Bitumen Primer manufactured by Bitumat Co. Ltd., Supreme or Tamko of density at 25° C 0.87 to 0.89 kg/litre and viscosity 70-160 cps.

b) **Seven Course** Water proofing treatment with APP modified Polymeric Membrane of Bengal Bitumen or similar.

1st Layer – Bitumen primer (a) (3) above @ 0.40 kg/sqm.

2nd, 4th & 6th Layer Bonding material (a) (2) above @ 1.20 kg/sqm

3rd & 5th Layer – APP Membrane 1.5mm or 2mm thick as specified as at (a) (1) above.

7th Layer – Finishing layer of Brick Tiles of class designation 100 grouted with Cement Mortar 1:3 (1 cement: 3 fine sand) mixed with 2% integral water proofing compound by weight of Cement over 12mm layer of cement mortar 1:3 (1 cement: 3 fine sand) finished neat.(7th layer shall be paid for separately)

c) **Five Course** water proofing treatment with APP modified Polymeric membrane of Bengal Bitumen or similar

1st Layer - Bitumen Primer 1(a) (3) above @ 0.40 kg/sqm.

2nd & 4th Layer - Bonding material (a) (2) above @ 1.20 kg/sqm.

3rd Layer - APP Membrane 2.00mm thick a(1) above.

5th Layer of - Finishing layer of Brick Tiles as described as 7th Layer in (b) above. (to be paid for separately)

(d) Seven Course Water Proofing treatment with APP Modified Polymeric Membrane of Bengal Bitumen or similar

1st Layer - Bitumen Primer 1(a) (3) above @ 0.40 kg/sqm.

2nd, 4th and 6th Layer of - Bonding material (a) (2) above @ 1.20 kg/sqm.

3rd and 5th Layer - APP Membrane 2.00mm thick a(1) above.

7th Layer of - Finishing layer of Brick Tiles as described as 7th Layer (b) above.

(e) Waterproofing Treatment with 2mm thick APP modified membrane with glass fibre matt of Bitumat Co. Ltd. or similar (For corrugated roof sheets)

1st Layer - Bitumen Primer 1(a) (3) above @ 0.40 Ltr./sqm.

2nd Layer - 2mm thick APP modified membrane with glass fibre(a) (1) above laid using Butane torch and sealing all joints etc.

The vital physical and chemical parameters of the membrane shall be as under :

Joint strength in longitudinal and transverse direction at 23° C as 350/300 N/5 cm. Tear strength in longitudinal and transverse direction as 60 /80N. Softening point of membrane not less than 150° C. Cold flexibility shall be upto (-)2° C when tested in accordance with ASTM, D-5147. The laying of membrane shall be got done through the authorized applicator of the manufacturer of membrane.

(f) Water proofing Treatment with 3mm thick APP modified membrane with glass fibre matt or Bitumat Co. Ltd. or similar

Same as in (e) above.

(g)(g) Water proofing Treatment with 3mm thick APP modified membrane with non-woven polyester matt of Bitumat Co. Ltd. or similar.

Same as in (e) above.

17.2 ANTI TERMITE TREATMENT

17.2.0 General : Sub-terranean termites are responsible for most of the termite damage in buildings. Typically, they form nests or

colonies underground, in the soil near ground level in a stump or other suitable piece of timber in a conical or dome shaped mound. The termites find access to the super-structure of the building either through the timber buried in the ground or by means of mud shelter tubes constructed over unprotected foundations.

Termite control in existing as well as new building structures is very important, as the damage likely to be caused by the termites to wooden members of building and other household article like furniture, clothing, stationary etc. is considerable. Anti-termite treatment can be either during the time of construction, i.e. pre-constructional treatment or after the building has been constructed, i.e. treatment for existing buildings.

Prevention of the termite from reaching the super structure of the building and its contents can be achieved by creating a chemical barrier between the ground, from where the termites come and other contents of the building which may form food for the termites. This is achieved by treating the soil beneath the building and around the foundation with a suitable insecticide.

17.2.1 Materials

17.2.1.0 Chemicals : The following chemical in water emulsion to achieve the percentage concentration specified against the chemical shall be used for anti-termite treatment.

(1) Chemical Imidacloprid 30.5% SC shall be used @ 0.075% concentration, mixed at the ratio of 2.1 ml of Imidacloprid 30.5% SC to 1 litre of water. or

(2) Chemical Chloropyrifos emulsifiable concentrate (IS:8944) mixed with water @ 1% concentration by volume.

Chemicals are available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the specified percentage of concentration, chemical should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemicals with water in the required proportion to achieve the desired percentage of concentration. For example, to dilute chemical of 30% concentration, 59 parts of water shall be added to one part of chemical for achieving 0.5% concentration.

The Engineer shall procure the chemical of required concentration in sealed original containers directly from the reputed and authorised dealers. The chemical shall be kept in the custody of the Engineer or his authorised representatives and issued for

use to meet the day's requirements. Empty containers after washing and concentrated chemical left unused at the end of the day's work shall be returned to the Engineer or his authorised representative.

17.2.1.1. Measurements: Concentrated chemical in sealed containers shall be measured in litres. Chemicals of different concentration shall be measured separately.

17.2.1.2. Rate : The rate for the concentrated chemical shall include the cost of material, containers and all the operations involved in transportation and delivery at the place specified.

17.2.2 Safety Precautions

All chemicals used for anti termite treatment are Poisonous. These chemicals can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed.

The containers having emulsifiable concentrates shall be clearly labelled and kept securely closed in stores so that children or pets cannot get at them. Storage and mixing of concentrates shall not be done near any fire source or flame. Persons using these chemicals shall be warned that absorption through skin is the most likely source of accidental poisoning. Particular care shall be taken to prevent skin contact with concentrates. Prolonged exposure to dilute emulsion shall also be avoided. After handling the concentrates or dilute emulsion, workers shall wash themselves with soap and water and wear clean clothing, especially before eating. In the event of severe contamination, clothing shall be removed at once and the skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of soap and water and immediate medical attention should be sought.

Care should be taken in the application of chemicals to see that they are not allowed to contaminate wells or springs which serve as source of drinking water.

In case of poisoning, suitable measures shall be taken for protection in accordance with IS 4015 (Pt I) and (Pt II) as stipulated in IS 6313.

17.2.3 Pre-construction Chemical Treatments

17.2.3.0. Chemical treatment of soils for the protection of buildings from attack of subterranean termites shall be done as per IS: 6313 (Part II). Treatment shall be got done only from the approved specialised agencies using the chemical procured

directly by the Engineer from reputed and authorized dealers. Graduated containers shall be used for dilution and spraying of the chemical shall be done using hand operated pressure pumps. Proper check should be kept to ensure that the specified quantity of chemical is used for the required area during the operation.

17.2.3.1 Time of application : Soil treatment should start when foundation trenches and pits are ready to take bed concrete / levelling course in foundations. Laying of bed concrete / levelling course should start when the chemical emulsion has been absorbed by the soil and the surface is quite dry. Treatment should not be carried out when it is raining or soil is wet with rain or sub soil water. Treatment to the surface of earth filling within the plinth shall also be done in the same manner before laying the sub-grade for flooring.

17.2.3.2 Disturbance: The treated soil barrier shall not be disturbed. If for some reasons the treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system.

17.2.3.3 Treatment for Masonry Foundations & Basements : (a) The bottom surface and the sides (upto a height of 300mm) of the excavations made for masonry foundations and basements shall be treated with the chemical at the rate of 5 litres per square metre of surface area (**Annexure A**)

b) After the masonry foundations and the retaining wall of the basements come up, the backfill in the immediate contact with the foundation structure shall be treated at the rate of 7.5 litres per sqm of the vertical surface of the sub-structure for each side. If water is used for ramming the earth fill, the chemical treatment shall be carried out after the ramming operation is done by rodding the earth at 150mm centres close to the wall surface and spraying the chemical with the above dosage. The earth is usually returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the concrete or masonry surfaces of the columns and walls so that the earth in contact with these surfaces is well treated with the chemical (**Annexure-A**)

17.2.3.4 Treatment for RCC Foundation and Basements : In the case of RCC foundations, the concrete mix is dense (being 1:2:4 or richer). It is, therefore, unnecessary to start the treatment from the bottom of excavations. The treatment shall start at the

depth of 500mm below ground level except when such ground level is raised or lowered by filing or cutting after the foundations have been cast. In such cases, the depth of 500mm shall be determined from the new soil level resulting from the filling or cutting mentioned above, and soil in immediate contact with the vertical surfaces of RCC foundations shall be treated at the rate of 7.5 litres per square metre of surface area. The other details of treatment shall be as laid down in Para 17.2.3.3 (b)

17.2.3.5 Treatment of Top Surface of Plinth Filling: The top surface of the filled earth within the plinth walls shall be treated with chemical emulsion at the rate of 5 litres per sqm of the surface before the sand / sub-grade is laid. Holes upto 50 to 75mm deep at 150mm centres both ways shall be made with crow bars on the surface to facilitate saturation of the soil with chemical emulsion.

17.2.3.6 Treatment at Junction of the Walls and the Floor: To achieve continuity of the vertical chemical barrier on inner wall surfaces from the ground level, a small channel 30 x 30 mm shall be made at all the junctions of walls and columns with the floor (before laying the sub-grade) and rod holes made in the channel upto ground level 150mm apart and the chemical emulsion poured along the channel @ 7.5 litres per sqm of the vertical wall or column surface so as to soak the soil right up to bottom. The soil shall be tamped back into place after this operation.

17.2.3.7 Treatment of Soil along External Perimeter of Building: After the building is complete, 300 mm deep holes shall be provided in the soil with iron rods along the external perimeter of the building at intervals of about 150mm and these holes shall be filled with chemical emulsion at the rate of 7.5 litres per sqm of vertical surface of the external walls. If the depth of filling is more than 300mm, the external perimeter treatment shall extend to the full depth of filling upto the ground level so as to ensure continuity of the chemical barrier. In case the earth outside the building is graded on completion of building, this treatment shall be carried out on completion of such grading.

17.2.3.8 Treatment of Soil under Apron (Plinth Protection) along External Perimeter of Building: Top surface of the consolidated earth over which the apron is to be laid shall be treated with chemical emulsion at the rate of 5 litres per square metre of the surface before the apron is laid. If consolidated earth does not allow emulsion to seep through,

holes 50 to 75mm deep at 150mm centres both ways may be made with 12mm diameter mild steel rod on the surface to facilitate saturation of the soil with the chemical emulsion.

17.2.3.9 Treatment for expansion joints: Anti termite treatment shall be supplemented by treating with chemical emulsion through the expansion joint after the sub-grade has been laid @ 2 litres per linear metre of expansion joint.

17.2.3.10 Treatment of Walls Retaining Soil above Floor Level: Retaining walls like the basement walls or outer walls above the floor level retaining soil need to be protected by providing chemical barrier by treatment of retained soil in the immediate vicinity of the walls, so as to prevent entry of termites through the voids in masonry, cracks and crevices, etc. above the floor level. The soil retained by the walls shall be treated at the rate of 7.5 litres per square metre of the vertical surface so as to effect a continuous outer chemical barrier, in continuation of the one formed under 17.2.3.3.

17.2.3.11 Treatment of Soil Surrounding Pipes, Wastes and Conduits: When pipes, wastes and conduits enter the soil inside the area of the foundations, the soil surrounding the points of entry shall be loosened around each such pipe or conduit for a distance of 150mm and to a depth of 75mm before treatment is commenced. When they enter the soil external to the foundations, they shall be similarly treated for a distance of over 300mm unless they stand clear of the walls of the buildings by about 75mm.

17.2.3.12 Measurements: All dimensions shall be measured correct to a cm. The measurements for all the operations described above shall be the plinth area of the building in square metres at floor 1 level (Ground Floor). Nothing extra shall be measured for payment.

17.2.3.13 Rate: The rate for the anti-termite treatment shall include the cost of labour and all other inputs (except concentrated chemical) involved in all the operations described above.

17.2.4 Treatment for Existing Buildings

17.2.4.0 Once the termites have aningress into the building, they keep on multiplying and destroy the wooden and cellulosic materials, and as such it becomes essential to take measures for protection against termites. Anti-termite measures described below are necessary for the eradication and control of termites in existing buildings. To

facilitate proper penetrations of chemical into the surface to be treated, hand operated pressure pump shall be used. To have proper check for uniform penetration of chemical, graduated containers shall be used. Proper check should be kept so that the specified quantity of chemical is used for the required area during the operation. Chemical treatment for the eradication and control of sub-terranean termites in existing buildings shall be done as per IS 6313 (Part III). Treatment shall be got done only from the approved specialised agencies using the chemical procured directly by the Engineer from reputed and authorised dealers.

17.2.4.1 Treatment Along Outside of Foundations: The soil in contact with the external wall of the building shall be treated with chemical emulsion at the rate of 7.5 litres per square metre of the vertical surface of the sub-structure to a depth of 300mm. To facilitate this treatment a shallow channel shall be excavated along and close to the wall face. The chemical emulsion shall be directed towards the wall at 1.75 litres per running metre of the channel. Rodding with 12mm diameter mild steel rods at 150mm apart shall be done in the channel, if necessary, for uniform dispersal of the chemical to 300mm depth from the ground level. The balance chemical of 0.5 litre per running metre shall then be used to treat the backfill earth as it is returned to the channel directing the spray towards the wall surface.

If there is a concrete or masonry apron around the building, approximately 12mm diameter holes shall be drilled as close as possible to the plinth wall about 300mm apart, deep enough to reach the soil below and the chemical emulsion pumped into these holes to soak the soil below at the rate of 2.25 litres per linear metre.

In case of RCC framed structures, the soil (backfill) in contact with the column sides and plinth beams along the external perimeter of the building shall be treated with chemical emulsion at the rate of 7.5 litres/sqm of the vertical surface of the structure. To facilitate this treatment, trenches shall be excavated equal to the width of the shovel exposing the sides of the column and plinth beams upto a depth of 300 mm or upto the bottom of the plinth beam, if this level is less than 300mm. The chemical emulsion shall be sprayed on the backfill earth as it is returned into the trench directing the spray against the concrete surface of the beam or column as the case may be.

17.2.4.2 Treatment of Soil Under Floors:- Chemical treatment shall be done by drilling 12mm holes at the junction of floor and walls along the cracks on the floor and along the construction joints at the interval of 300mm to reach the soil below. Chemical emulsion shall be squirted into these holes using a hand operated pressure pump to soak the soil below until refusal or upto a maximum of one litre per hole. The holes shall then be sealed properly with cement mortar 1:2 (1 cement: 2 coarse sand) finished to match the existing floors. The cement mortar applied shall be cured for atleast 10 days as per instructions of the Engineer.

17.2.4.3 Treatment of Voids in Masonry: The movement of termites through the masonry wall may be arrested by drilling holes in masonry wall at plinth level and squirting emulsions into the holes to soak the masonry. The holes shall be drilled at an angle of 45° from both sides of the plinth wall at 300mm intervals and emulsion squirted through these holes to soak the masonry using a hand operated pump. This treatment shall also be extended to internal walls having foundations in the soil. Holes shall also be drilled at wall corners and where door and window frames are embedded in the masonry or floor at ground. Emulsion shall be squirted through the holes till saturation or to a maximum of one litre per hole. Care shall be taken to seal the holes after the treatment.

17.2.4.4 Treatment at Points of Contact of Wood Work : All existing wood work in the building which is in contact with the floor or walls and which is infested by termites, shall be treated by spraying at the points of contacts with the adjoining masonry with the chemical emulsion by drilling 6mm holes at a downward angle of about 45° at the junction of wood work and masonry and squirting chemical emulsion into these holes till refusal or to a maximum of half a litre per hole. The treated holes shall then be sealed.

17.2.4.5 Measurements : All dimensions shall be measured correct to a cm. The measurements shall be made of the surface actually provided with anti-termite treatment. Measurements shall be done separately for treatment of foundations, soils under floors, voids in masonry and wood work as detailed below:

Treatment along outside of foundations : The measurements shall be made in running metres taking lengths along the plinth of the building.

Treatment of soil under floors : The measurements shall be made in square metres. inside clear dimensions of rooms, verandah, etc shall be taken.

Treatment of voids in masonry : The measurements shall be made in running metres along the plinth of the building.

Treatment to wood work: The measurements shall be made in running metres for chowkhats, joists, purlins, beams etc.

17.2.4.6 Rates : The rates shall include the cost of labour and all other inputs (except concentrated chemical) involved in all the operations described above including drilling, refilling and making good the holes.

17.2.5 Pest Management :

17.2.5.1 Rodent Control :

Rodenticide to be used should be safe and highly effective single dose anticoagulant rodenticide like (OR having active ingredient 'BROMADIOLONE'). Rodenticides should not have the disadvantages that the other rodenticides have such pre-baiting, secondary poisoning and bait shyness.

Mode of Treatment :

The treatment would commence with closing of all the burrows within the compound area of the railway property to identify live burrows. The opened burrows shall be baited with Bromadiolone bait to bring the infestation under control. Subsequently, fortnightly visits to continue the baiting and to keep vigil on rodent population. The baits shall be placed in "Rodent Bait Station Box" along the external wall, to keep the bait safe.

TRUBBLE GUM traps shall be placed indoors to trap the rodents entering the structures. These traps shall be placed in "Rodent Bait Station Box" to simulate a burrow & to keep the traps safe.

17.2.5.2 General Pests (Cockroaches, ants etc.) :

This treatment comprises of placing Cockroach Gel dots at strategic places in the cabinets, drawers, cupboards, cracks & crevices. This is followed by thorough insecticidal spray especially at the cracks, vices and wall & floor junction of rooms, toilets, passages, staircase and common drainage manholes harboring cockroaches.

Chemicals to be used for Household Pest management :

Active Ingredient	Formulation%	%Emulsion concentrate	Dilution/ ltr of water	Dosage per sqm
Lambdacyhalothrin	10 WP	0.05	05 gms	020 ml
Deltamethrin	2.5 SC	0.02	10 ml	100 ml
Cyfluthrin	050 EW	0.04	08 ml	050 ml
Imidacloprid	2.15 %	RTU Gel Bait		300 dots/ cartridge
Fipronil	0.03%	RTU Gel Bait		300 dots/ cartridge
Fipronil	0.05%	RTU Gel Bait		1100 dots/cartridge
CMT	Ready to use Cockroach Monitoring Traps			
Deltamethrin	2.5 WP	0.1	40 gms	030 ml
Cyphenothrin	05 EC	0.1	20 ml	050 ml
PestSeal™	PCI RTU Formulation		RTU	

(B) Frequency : Quarterly i.e. 4 services in a year at an interval of 3 months. If the infestation seen in interim period same shall be treated without extra charge.

17.3 CEMENT CONCRETE PLINTH PROTECTION

17.3.0 General: Plinth protection shall be provided, as specified, to required width. It normally comprises 5 cm. thick cement concrete 1 : 3 : 6 (1 cement : 3 coarse sand :

6 graded stone aggregate 20 mm nominal size) over 7.5 cm bed of dry brick aggregate 40 mm nominal size, grouted with fine sand. The outer edge shall be lined with bricks of the class specified in the item laid on edge and joints laid in cement-mortar 1 : 4 (1 cement : 4 fine sand). Plinth protection shall be laid with a minimum outward slope of 1 in 50.

17.3.1. Preparing Ground : The ground, where plinth protection is to be laid shall first be prepared to the required slope. The high

portions of ground shall be excavated, hollows and depressions filled upto the required level with the excavated earth and watered and rammed to give uniform outward slope. Preparation of any area involving cutting and filling upto a depth of 15 cm shall not be paid for separately. Cutting and filling beyond 15 cm shall be paid for separately. The bed shall be watered adequately and rammed with iron rammers. Surplus earth, if any, obtained shall be disposed off within a lead of 50 metres or as directed by the Engineer.

17.3.2. Brick Edging : The edging shall be of bricks of class specified in the item. The specifications of bricks shall be as described in 5.1. Trenches of required depth and width shall first be made along the edge of the plinth protection to receive the bricks for edging. The bed of trenches shall be compacted to a firm and even surface. The brick shall be laid true to line in cement mortar 1:4 (1 cement : 4 fine sand) with length parallel and abutting the plinth protection. The top face of the brick edging shall be in one level, to conform to the finished level of the plinth protection adjacent to the edging. After the concreting is done, no portion of the brick edging shall project above the adjacent concrete surface. Cement mortar shall conform to the specifications described in 2.2.2.

17.3.3 Sub-grade : The sub-grade shall consist of a bed of dry brick aggregate of 40 mm nominal size. Brick aggregate shall be spread evenly over the prepared surface to 7.5 cm depth (unconsolidated) and given a minimum outward slope of 1 in 50. The aggregate shall be carefully laid and packed, bigger size being placed at the bottom. The brick aggregate shall be consolidated dry with heavy iron rammers. After the brick aggregate has been consolidated the surface shall be checked with a straight edge and any depressions etc. filled up and consolidated. The aggregate shall then be grouted evenly with fine sand @ 0.06 cubic metre/10 sq. metre area, adequately watered to ensure filling of the voids by sand and again rammed with heavy iron rammers. The finished surface shall give uniform appearance.

17.3.4. Cement Concrete Topping : After the subgrade has been compacted and prepared as under 17.3.3, 5 cm thick cement concrete 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 20 mm, nominal size or as specified in the item) shall be laid in one operation as described in 9.2.4,

except that the top shall not be finished with neat cement slurry but shall be finished with only wooden floats. The concrete surface shall not be finished with mortar. The length of each panel shall not be more than 5 m. The finished surface shall have a minimum outward slope of 1 in 50.

17.3.5 Curing : Specification shall be as described in 3.2.12.

17.3.6 Measurements : The length and breadth of cement concrete topping shall be measured correct to a cm and the area calculated in square metre correct to two places of decimal. No deduction shall be made not anything extra paid for any opening' for pipes etc. upto 0.1 sqm. Brick edging shall be measured in running metre correct to a cm and paid for separately.

17.3.7. Rate : The rate shall include cost of material and labour described in all the above operations except for brick edging which will be paid for separately.

17.4 BRICK PLINTH PROTECTION

17.4.0 General: Plinth protection shall be provided as specified, to the required width. It shall consist of a layer of bricks of class specified, in cement mortar 1:6 (1 cement : 6 fine sand) over a bed of dry graded brick aggregate of 40 mm nominal size grouted with fine sand. The top brick layer shall be finished with pointing in Cement mortar 1:2 (1 cement : 2 fine sand). Plinth protection shall be laid with a minimum outward slope of 1 in 50.

17.4.1. Specifications:- The specifications for 'Preparing ground' and 'Sub-grade' shall be as described in paras 17.3.1 and 17.3.3 respectively.

17.4.2. Brick Topping : After the sub-grade had been compacted thoroughly, brick flooring with bricks of **class** designation 75 in cement mortar 1:6 (1 cement : 6 fine sand) or as specified shall be laid to the required slope. The bricks shall be **laid as** described in para 9.1.5.

17.4.3. Pointing : The pointing which shall be in 1:2 cement mortar (1. cement : 2 fine sand) shall conform to the specifications given in para 11.24 'Pointing' under sub-head 'Finishing'.

17.4.4 Curing : Specification for curing shall be as in paras 5.2.6.

17.4.5 Measurements: Length and breadth shall be measured correct to a cm and area calculated in square metre correct to two places of decimal. No deduction shall be

made nor anything extra paid for any openings for pipes etc. upto 0.1 square metre.

17.4.6 Rate : The rate shall include the cost of all materials and labour involved in all the operations described above.

17.5 URINAL PARTITIONS

17.5.1 Marble Slab Partition

17.5.1.0. The partition shall be of marble slab, embedded in the wall. The size of the marble slab shall be 105 cm high and 60 cm deep (overall). The finished thickness shall be 2.5 cm. The marble shall be of white Makrana unless otherwise specified. The marble shall be cut into slabs of required thickness and shall be one piece.

17.5.1.1. Finishing: The partition of the slab to be embedded in the masonry shall be rough dressed. The exposed faces and sides of stones forming joint upto 6mm from the face shall be fine tooled such that a straight edge laid along the face of the stone is in contact with every point in it. These surfaces shall then be rubbed smooth. All visible angles and edges shall be true, square and free from chipping. The surface of the stone coming in contact with backings need not be dressed. The dressed slab shall be of the thickness as specified with a tolerance of ± 1.5 mm. The slab shall be got approved from the Engineer before fixing. **(Annexure-D)**

17.5.1.2. Fixing shall be as in para 17.5.1.1 except that the recess shall be 7.5 cm wide.

17.5.1.3. Measurement shall be as in para 17.5.1.4.

17.5.1.4. Rate : The rate shall include the cost of labour and materials involved in all the operations described above including the leaving/cutting of recess in the wall.

17.6. CUP BOARD

17.6.0. General: The work shall be carried out as per drawing or as directed by the Engineer. The timber shall conform to the specifications given in 7.1.

17.6.1. Frame Work : Frame work shall be made to the sizes and shape as shown in the drawings, or as specified. The specifications given in 7.3 shall be applicable to frame work.

17.6.2 Shutters : The quality and the thickness of the shutters shall be as specified or as shown in the relevant drawings. The shutters shall be flush/panelled/ glazed or panelled and glazed as specified or as shown in the drawings.

Specifications for flush shutters shall be as described in para 7.7. Specifications for panelled glazed or paneled and glazed shutters shall be as described in para 7.6.

17.6.3 Shelves : The number, size and thickness of the shelves shall be as shown in the relevant drawings or as specified. The planks for shelves shall be of specified timber and planed on all faces and edges. The shelves shall rest on wooden supports, 25 x 25 mm, for their full depth. The wooden supports shall be fixed in the masonry by means of wooden plugs and screws or as shown in the drawings, at suitable intervals. The shelves shall be fixed to the supports with wood screws of suitable size at 10 cm centre to centre. The shelves, when fixed, shall be truly horizontal.

17.6.4 Internal partitions: Where specified or shown in the drawings, the vertical partition of timber of size and thickness shown shall be provided and shall be of one piece upto 30 cms. It shall be secured to shelves by means of screws to avoid slipping or lateral movement. The partition, when fixed, shall be truly vertical.

17.6.5. Hanger-rod : The hanger rod, where specified or shown in the drawing, or as directed by the Engineer, shall be provided at the top of cup board. The clear gap above the rod shall be not less than 8 cm. The rod shall be of single piece. The diameter of wooden rod shall be 25 mm while that of metal shall be 20 mm, unless otherwise specified. The end supports shall consist of brass or C.P. brass bracket of approved quality fixed to the side masonry of the cup board with suitable plugs and screws.

17.6.6 Fittings : These shall be provided and fixed as per specifications and schedule of fittings given in **Chapter 7** unless otherwise specified. **17.6.7. Finishing :** All the wood work shall be painted or finished as specified. After fixing the plugs for supports, the plaster should be neatly repaired with cement mortar 1:4 (1 cement : 4 coarse sand). Where wood lining is not specified, the inside plaster portion shall be finished with two coats of oil bound distemper or flat wall paint of approved colour, as specified. When required, the inside of the cub board shall be lined with wooden planks/ply wood of specified quality where shown on the drawings or specified in the description of the item. The lining shall be directly fixed without any battens on the masonry surface by means of plugs and screws spaced at not more than 20 cm apart in both directions. The finishing of the exposed surface of the

lining shall be as specified above in this clause.

17.6.8. Measurements :

The cup boards shall be paid as per individual items.

17.6.9. Rate : Payment will be made at the rate specified in the contract. Separate rates shall be payable for each type of cup board, depending upon the size, the shelves, finishing and other features.

The rate shall include the cost of all materials and labour involved in all the above operations. However, the rate does not include any brick work, plastering, R.C.C. work, flooring and holdfasts for frames, which shall be paid for separately under relevant items, if executed.

17.7 PROVIDING AND FIXING ALUMINIUM STRIP EDGING TO STAIRS

17.7.1. Aluminium Sections : Size and shape of aluminium sections shall be as specified in the relevant items of work/drawings.

17.7.2. Fixing : A suitable recess shall be provided in the step, both in tread and riser portions, to receive the step edging so that, after fixing, the top surface of the edging and the top surface of the tread shall be perfectly in one level. Similarly the outer face of the vertical leg of the edging shall be flush with the finished surface of the riser.

In cases where the finish over the risers and treads consists of plain cement concrete flooring and cement mortar respectively, the edging shall be fixed after the flooring/plastering are completed. Where the finish consists of marble chip flooring and marble chips plastering, the edging shall be fixed after the polishing of the flooring/plastering.

The recess shall be thoroughly cleaned of all loose material, mortar droppings etc. before fixing the edging. The surface of the recess shall be given a coat of cement mortar 1:3 (1 cement : 3 coarse sand). Holes shall be drilled in the leg of the edging coming on the tread, to receive the screw of specified size. The edging shall be kept in position, tapped gently to make it sit firmly on the mortar bedding and then fixed in position with necessary 25 mm size wood screws. Each edging shall be in one piece only. After the work is completed and the mortar has set, no hollow sound shall be given when the edging is tapped. Any edging giving hollow sound shall be taken out and refixed properly. Wooden plugs of suitable size at approximately 20 cm apart shall be fixed at

desired level during laying of cement concrete in steps for fixing the edging. The fixing may be done using rawl plugs/detefix also, instead of wooden plugs.

17.7.3. Measurements : The length of aluminium step edging shall be measured in running metres correct to 3 mm.

17.7.4. Rate : The rate shall include the cost of labour and the material required for all the operations described above including making holes, providing wooden plugs/rawl plugs etc.

17.8 SHOTCRETE (GUNITING)

17.8.1 General

17.8.1.1 Shotcrete is mortar or concrete conveyed through a hose and pneumatically projected at high velocity on to a surface. Shotcrete can be either plain or reinforced, as specified

17.8.1.2 Shotcrete is done by two processes, namely, drymix process and wet mix process. Pneumatically conveyed shotcrete in which most of the mixing water is added at the nozzle is dry mix process. Shotcrete wherein all the ingredients, including mixing water, are mixed in the equipment before introduction into the delivery hose in wet mix process.

17.8.2 Materials

17.8.2.1 Cement, aggregates, water, admixtures and reinforcement are generally as specified in Chapters 26,3 and 4.

17.8.2.2 Aggregates

a) Fine aggregate (sand) – Sand for concrete shall comply with the requirements of IS 383: 1970 and graded evenly from fine to coarse as per Zone II and Zone III grading. Further sand for finish or flash coats may be finer from the above grading.

b) Coarse aggregate – Coarse aggregates, when used, shall comply with IS 383: 1970. It shall conform to one of the gradings given in Tables 3.1 and 3.2.

17.8.3 Shotcreting process

17.8.3.1 General - The two basic processes are - Dry mix process and Wet mix process

17.8.3.2 Dry Mix Process - In this process, a mixture of cement and moist sand is conveyed through the delivery hose to a nozzle where most of the mixing water is added, under pressure (see **Figure 17.7 Annexure-B**). The mortar is jetted from the nozzle at high velocity on to the surface to be shotcreted.

17.8.3.3 Wet Mix Process – In this process, all the ingredients including water are mixed before they enter the delivery hose. The mortar or concrete is jetted from the nozzle at high velocity on to the area to be shotcreted.

17.8.3.4 Shotcrete may be produced by either of the processes for normal constructional requirements unless specified

17.8.4 Properties of Shotcrete

17.8.4.1 Shotcrete, if properly applied is a structurally adequate and durable material capable of excellent bond with concrete, masonry, steel, and other materials. However, these favourable properties of sound shotcrete are contingent on proper supervision, and on the skill and continuous attention by the operating staff.

17.8.4.2 The water cement ratio for shotcrete in place normally falls within a range of 0.35 to 0.50 by mass

It will tend to give more shrinkage cracking and may require a closer joint spacing. The durability of shotcrete is good.

17.8.5 Pre-Construction testing

17.8.5.1 Testing shall be done prior to the commencement of the work in order to check the operation of equipment, skill of the operating staff and the quality of shotcrete. The procedure is detailed in 17.8.5.2 to 17.8.5.7.

17.8.5.2 Test panels shall be fabricated, simulating actual job conditions, by the operating staff using the equipment, materials and mix proportions proposed for the job.

17.8.5.3 For the dry mix process, the amount of water added at the nozzle is adjusted so that the in – place shotcrete appears to be adequately compacted and neither sags nor shows excessive rebound. Where justified by the size and importance of the job or lack of previous experience with the materials, it may be advisable to test two or three mixes, generally within the range of 1 part of cement to 3 to 4 ½ parts of sand, before deciding on the final mix proportions.

17.8.5.4 The procedure for wet-mix process is similar to the dry mix process except that the entire concrete mix is premixed to give a workability judged to be appropriate for the work, before it is introduced to the chamber of delivery equipment. Tests on more than one mix design are usually recommended where it is desired to include coarse aggregate in the mix. Normally 20 to 40 percent of coarse aggregate is first tried with

subsequent mixes adjusted to reflect the results of the first trial.

17.8.5.5 The panels are fabricated by gunning on to a back form of plywood. A separate panel shall be fabricated for each mix design being considered, and also for each gunning position to be encountered in the structure, that is, slab, vertical and over head sections. Atleast part of the panel shall contain the same reinforcement as the structure, to show whether sound shotcrete is obtained behind the reinforcing rods. The panel shall be large enough to obtain all test specimens needed, and also to indicate what quality and uniformity may be expected in the structure. Generally, the size of the panel shall be not less than 75 cm x 75 cm. The thickness shall be the same as in the structure, except that it shall normally be not less than 7.5cm.

17.8.5.6 Cubes of cores shall be taken from the panels for testing. The cores shall have a minimum diameter of 7.5cm and length to diameter ratio of at least one if possible. The specimens shall be tested in compression at the age of 7 and 28 days both.

17.8.5.7 The cut surfaces of the specimens shall be carefully examined and additional surfaces shall be exposed by sawing and breaking of the panel when it is considered necessary to check the soundness and uniformity of the material. All cut and broken surfaces shall be dense and free from laminations and sand pockets.

17.8.6 Mixing

17.8.7.1 Dry Mix Process

a) Batching by mass is preferred. The moisture content of the sand shall generally be within 5 to 6 percent to permit flow at a uniform rate.

b) The mixing equipment shall be capable of thoroughly mixing the sand and cement in sufficient quantity to maintain continuity of placing. The mixing time shall be not less than a minute in a drum type mixer. The mixer shall be thoroughly cleaned to prevent accumulations of batched materials.

c) Supply of clean dry air under pressure should be ensured through an air compressor. The air pressure should be uniformly steady (non-pulsating). The operating pressure shall drive the material from the delivery equipment into the hose.

d) For length of hose up to 30m, the operating pressure shall be 0.3 N/mm^2 (3 kg/cm^2) or more; for each additional 15m length of hose, pressure may be increased by 0.035 N/mm^2 (0.35 kg/cm^2) and the same

increase allowed for each 7.5m that the nozzle is raised above the gun.

e) Water under pressure shall be supplied; the water pressure shall be sufficiently greater than the operating air pressure at the discharge nozzle. Water pressure shall also be steady and non pulsating.

17.8.7.2 Wet Mix Process

a) Batching by mass is preferred. Aggregates may be batched by volume. Periodic checks are to be made to ensure that the masses are maintained within the required tolerance. Water may be batched either by volume or mass.

b) The mixing time will depend on the mix being used and the efficiency of the mixer.

c) The other details are as per dry-mix.

17.8.7 Application of Shotcrete

17.8.7.1 Surface Preparation

a) Shotcrete shall not be placed on any surface which is frozen, spongy or where there is free water.

b) Surfaces shall be kept damp for several hours before shotcreting.

c) In case of repairs, all existing deteriorated concrete shall be removed. The final cut surface shall be examined to make sure that it is sound and perfectly shaped; all edges shall be tapered. The surface shall be cleaned of all loose and foreign materials.

d) Exposed reinforcement shall be free of rust, scales, etc.

17.8.7.2 Form work

Forms may be plywood sheeting or other material, true to line and dimension. They shall be so constructed as to permit the escape of air and rebound during gunning operations. Forms shall be oiled and dampened just before gunning. Short removable bulkheads may be used at intersections.

Appropriate scaffolding shall be erected to permit suitable positions for holding the nozzle.

17.8.7.3 Reinforcement

a) Reinforcement shall be so placed as to cause least interference to gunning operations.

b) Minimum clearance may be 12mm to 50mm between form work and reinforcement for mortar work and concrete mix respectively.

c) Clear spacing between bars shall be not less than 65 mm.

d) As far as possible, bars shall be so arranged as to permit shooting from the opposite side.

e) Lapped reinforcing bars shall not be tied together, they shall be separated by at least 50mm.

f) For repair work, existing work may be fixed with reinforcement by nails.

g) All detailing shall be as per IS 456: 2000.

17.8.7.4 Alignment Control

Adequate ground wires shall be installed to ensure thickness and surface planes of shotcrete build up.

17.8.7.5 Placing of Shotcrete

a) Shotcrete may be built up in layers, Shotcrete shall be forced behind bars. When bars are closely spaced more than one bar may be shot from each position of the nozzle to avoid building up on the front face of the bar.

b) The first layer shall completely embed the bar for walls, columns and beams, beginning at the bottom.

17.8.7.6 Rebound

a) Rebound is aggregate and cement paste which ricochets (reflects) off the surface during the application of shotcrete. Rebound may be as below :

Surface	Percentage of Rebound
Floors or slabs	5-15
Sloping and vertical walls	15-30
Overhead work	25-50

b) Rebound shall not be worked back into the concrete; it shall not be included in later batches.

17.8.7.7. Preparation for Succeeding Layers

The earlier layer shall be allowed to take initial set before the second layer is commenced. Then laitance, loose material and rebound shall be removed. The surface shall be thoroughly sounded with a hammer for drummy areas resulting from rebounding

pockets or lack of bond. Drummy areas shall be cut off and replaced with succeeding layers. Surfaces to be shot shall be damp.

17.8.7.8 Construction Joints

Construction Joints shall generally follow the principles for normal concrete constructions.

17.8.7.9 Finishing

The natural gun finish is preferred both from structural and durability considerations. Finishing may be difficult for dry-mix work.

17.8.7.10 Suspension of work

a) The work shall be suspended when exposure to high wind, breezing or rain is likely.

b) When work is stopped, the shotcrete shall be sloped off to a thin edge and then the work resumed after cleaning the surface.

17.8.7.11 Curing

The surfaces shall be kept continuously wet for atleast 7 days.

17.8.7.12 For more details reference may be made to IS 9012: 1978 on recommended practice for shotcreting.

17.9 UNDER-REAMED PILE FOUNDATION

17.9.1 Description

Under-reamed piles are of bored cast in situ and bored compaction concrete types having one or more bulbs formed by suitably enlarging the bore hole of the pile stem.

17.9.2 Materials:

a) Cement: The cement used shall conform to the requirements of IS 269: 1989 or IS 455: 1989 or IS 8041 : 1990 or IS 6909: 1990 or IS 1489 (Parts 1 and 2) 1991: of IS 12269: 1987 as specified

b) Steel – Reinforcement steel shall conform to IS 432 (Part I): 1989 or IS 1786:1985 or IS 2062: 1992 as specified

For under-reamed bored compaction piles, the reinforcement cage shall be prepared by welding the hoop bars to withstand the stresses during compaction process.

c) Concrete

1) Slump of concrete shall range between 100mm and 150mm for concreting in water free unlined bore holes. For concreting by tremie, a slump of 150mm to 200mm shall be used.

2) In case of tremie concreting of piles of smaller diameter and depth upto 10m, the minimum cement content should be 350 kg/cum of concrete, unless otherwise specified For piles of larger diameter and /

or deeper piles, the minimum cement content should be 400 kg/ cum of concrete, unless otherwise specified

In case the piles are subsequently exposed to water or in case piling is done under water or drilling mud is used in methods other than tremie, 10 percent extra cement shall be used over and above that required for the grade of concrete at specified slump.

For making concrete, aggregate as described in IS 456: 2000 shall be used. For tremie concreteing, aggregates having nominal size more than 20mm should not be used.

For bored compaction piles Rapid Hardening Cement to IS 8041-1990 shall not be used.

17.9.3 Equipment

Normally the equipment required for manual operations are:

- a) auger
- b) under-reamer
- c) boring guide and
- d) accessories.

For piles of deeper and larger size greater than 30 cm a portable tripod hoist with manually operated winch is required.

For piles in high ground water table and unstable soil conditions, boring and underreaming shall be carried out using suitable equipment. Tremie pipe shall be used for concreting.

For compact piles, the additional equipment required are drop weight for driving the core assembly and pipe or solid core.

17.9.4 Construction

a) Bore holes may be made by earth augers. In case of manual boring, an auger boring guide shall be used to keep the bores vertical or at the desired inclination and in position. After the bore is made to the required depth, enlarging of the bore shall be carried out by means of an under-reaming tool.

b) Drilling mud shall be used for boring and under-reaming in a site with high water table. Bentonite may also be used.

c) To avoid irregular shape and widening of borehole in a very loose strata at top, a casing pipe of suitable length shall be temporarily used, as specified

d) For batter under-reamed piles, the reinforcement cage should be placed guiding it by a chute or any other means.

e) In order to achieve proper under-reamed bulb, the depth of bore hole should be checked before starting under-reaming. It should also be checked during under-reaming, any extra soil at the bottom of bore hole shall be removed by auger before reinserting the under-reaming tool.

f) The completion of the desired under reamed bulb is ascertained by vertical movement of the handle and when no further soil is cut.

g) In multi under-reamed piles, the boring is first completed to the depth required for the first (top) bulb only, and after completing under-reaming bulb, the boring is extended further down to the second bulb and so on.

h) The piles shall be installed as correctly as possible, both at the correct location and truly vertical (or at the specified batter). Piles shall not deviate by more than 75mm or one quarter the stem diameter whichever is less. For piles of diameter more than 600mm, the deviation may be 75mm or 10 percent of the stem diameter.

i) Concreteing shall be done as soon as possible after completing the bore. The bore hole full of drilling mud should be concreted between 12 to 24 h depending on the stability of the hole.

j) The method of concreting should be such that the entire volume of the pile bore is filled up without formation of voids and / or mixing of soil and drilling fluid in the concrete. For placing concrete in pile bores, funnel should be used.

In the empty bore holes for under-reamed piles a small quantity of concrete is poured to give about a 100mm layer of concrete at the bottom. Reinforcement is lowered next and positioned correctly. The concrete is poured to fill the bore hole. Care shall be taken that soil is not scrapped from sides if rodding is done for compaction. Vibrators shall not be used.

If the subsoil water level is confined to the bucket length portion at the toe, the seepage is low the water should be bailed out before commencing concreting.

In case the pile bore is stabilized with drilling mud or by maintaining water head within the bore hole, the bottom of bore hole shall be carefully cleaned by flushing it with fresh drilling mud and the pile bore be checked before concreting.

k) Concreting shall be done by the tremie method. The tremie should have a valve at the bottom and lowered with the valve closed at the start and filled up with concrete. The

valve is then opened to permit concrete which permits the upward displacement of drilling mud. The pouring should be continuous and the tremie is gradually lifted up such that the pipe opening remains always in the concrete. In the final stage the quantity of concrete shall be enough so that on the final withdrawal some concrete spills on the ground.

l) In inclined piles, concreting should be done through a chute or by tremie method.

m) A bored compaction pile is one in which the compaction of surrounding ground as well as fresh concrete in the bore is simultaneously accomplished. In under-reamed bore compaction piles, the pile shall be filled up with concrete, without placing reinforcement. Immediately, the core assembly shall be driven and extra concrete shall be poured in simultaneously to keep the level of concrete up to ground level. If a hollow driving pipe is used in core assembly, the pipe shall be withdrawn after filling it with fresh concrete.

In these compaction piles it shall be ensured that concreting should be done uninterruptedly. Accidental withdrawal should be completely avoided.

n) The top of the concrete pile shall be brought above the cut off level to permit removal of all laitance and weak concrete before capping and to ensure good concrete at the cut off level for proper embedment into the pile cap.

o) Where cut off level is less than 1.5m below working level, concrete shall be cast to minimum of 300mm above cut off level, for every excess of 0.3m over 1.5m, additional of 50mm shall be cast over and above 300mm.

When tremie method is employed, it shall be cast to the piling platform level to permit overflow of concrete for visual inspection or to a minimum of 1m above cut off level.

When the cut off level is below the ground water level, there is a need to maintain a pressure on the unset concrete equal to or greater than the water pressure and a length of extra concrete above the cut off level may be permitted to provide this.

p) When defective piles are formed, they shall be removed or left in place whichever is convenient, without affecting the performance of adjacent piles or the cap as a whole.

Any deviation beyond permissible limits from the designed location, alignment or load capacity of any pile shall be noted and

adequate measures taken well before the concreting of the pile cap and plinth beam. The pile should project 50mm into the cap concrete.

17.10 STORAGE OF MATERIALS

17.10.1 General

17.10.1.1 Material shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for use in the work. Materials shall also be stored to protect against atmospheric agencies, fire and other hazards.

17.10.1.2 Materials like timber, coal, paints etc. shall be stored in such a way that there may not be any fire hazards. Inflammable materials like kerosene, petrol, etc shall be stored in accordance with the relevant rules and regulations in force prescribed by the Authority, so as to ensure safety during storage (see also IS 7969: 1975).

Explosives like detonators shall be stored in accordance with the rules and regulations in force.

Materials which are likely to be affected by subsidence of soil, like precast elements, large size timber sections, etc shall be provided with unyielding supports.

In areas, likely to be affected by floods, the materials shall be suitably stored to prevent their being washed away or damaged by floods.

During construction, stairways, passageways and gangways shall not be obstructed due to storage of materials, tools or rubbish.

17.10.2 Cement

Cement shall be stored at the work site in a building or shed which is dry, leak proof and as moisture proof as possible. The building shall have minimum number of windows and close fitting doors which shall be kept closed as far as possible.

Cement stored in bags shall be stacked and shall be kept free from the possibility of any dampness or moisture coming in contact with the bags. Cement bags shall be stored / stacked off the floor on wooden planks in such a way as to be clear above the floor by 150mm to 200mm and a space of 450mm minimum around between the bags and external walls. In the stacks, cement bags shall be kept close together to reduce circulation of air as much as possible. Owing to pressure on the bottom layer of bags

'warehouse pack' is developed in these bags. This can be removed easily by rolling the bags when the cement is taken for use.

The height of the stack shall be not more than 15 bags to prevent the possibility of lumping up under pressure. The width of the stack shall not be more than four bags length of 3m. In stacks more than 8 bags high, the cement bags shall be arranged alternately lengthwise and cross wise so as to tie the stacks together and minimize the danger of toppling over. Cement bags shall be stacked in a manner to facilitate their removal and use in the order in which they are received.

During the monsoon or when it is expected to be stored for a long period, the stack shall be completely enclosed by a waterproofing membrane, such as, polyethylene sheet. Care shall be taken to see that the membrane is not damaged any time during use.

Different types of cements shall be stored separately.

17.10.3 Lime

Quick lime deteriorates rapidly on exposure by taking up moisture and carbon dioxide from atmosphere. Therefore, it should be stacked as soon as possible before deterioration sets in. If unavoidable, quicklime may be stored in compact heaps having only minimum of exposed area. The heaps shall be stored on a suitable platform and covered to avoid direct contact with moisture/ rain or being blown away by wind. In case it is stored in a covered shed, a minimum space of 300mm should be provided around the heaps to avoid bulging of walls.

Hydrated lime is generally supplied in containers such as jute bags, lined polyethylene or HDPE woven bags lined with polyethylene or craft paper bags. It should be stored in a building to protect lime from dampness and to minimize warehouse deterioration.

Dry slaked lime should be stored on a platform suitably covered from rain and wind if it is to be used within a few days. If required to be stored for longer periods not exceeding 2 months it may be kept in a dry and closed godown.

17.10.4 Bricks

Bricks shall not be dumped at site. They should be stacked in regular tiers as and when they are unloaded to minimize breakage and defacement of bricks.

Bricks shall be placed close to the site of work so that least effort is required to unload

and transport the bricks again by loading on pallets or barrows. Unloading of building bricks or handling in any other way likely to damage the corners or edges or other parts of bricks shall not be permitted.

Bricks shall be stacked on firm ground. For proper inspection of quality and ease in counting, the stacks shall be 50 bricks long and 10 bricks high, the bricks being placed on edge. The width of each stack shall be 6 to 8 bricks. Clear distance between adjacent stacks shall not be less than 0.8m.

Bricks of different types and class shall be stacked separately.

17.10.5 Aggregate

Aggregate shall be stored at site on a hard and dry level patch of ground. If such a surface is not available, a platform of planks or of corrugated iron sheets, or a floor of dry bricks, or a thin layer of lean concrete shall be made so as to prevent the admixture of clay, dust, vegetable and other foreign matter.

Stacks of fine and coarse aggregate shall be kept in separate stack piles, sufficiently removed from each other to prevent the materials at the edge of the piles getting intermixed. On a large job it is desirable to construct dividing walls to give each type of aggregate its own compartment. Fine aggregate shall be stacked in place where loss due to the effect of wind is minimum.

Unless specified otherwise or necessitated by site conditions, stacking of aggregate should be carried out in regular sizes.

17.10.6 Fly Ash

Fly ash shall be stored in such a manner as to permit easy access and proper inspection and identification of each consignment. Fly ash in bulk quantities shall be stored in a stack similar to fine aggregate as referred to above, avoiding any inclusion of foreign matter. Fly ash in bags shall be stored in stack not more than 15 bags high.

17.10.7 Timber

Timber shall be stored in stacks upon well treated and even surfaced beams, sleepers or brick pillars as to be above the ground level by atleast 150mm. The various members shall preferably be stored separately in different lengths, and material of equal lengths shall be piled together in layers with wooden battens, called crossers, separating one layer from another. The crossers shall be of sound wood, straight and uniform in thickness. In any layer, air space of about 25mm shall be provided between adjacent members. The larger

pieces shall be placed in the bottom layers and the shorter pieces in the upper layers, but one end of the stack including crossers shall be in true vertical alignment. The most suitable width and height of a stack are recommended to be about 1.5m and 2m. Distance between adjacent stacks is shown in **(Annexure-C)**. The stacks shall be protected from hot dry winds or direct sun and rain. Heavy weights, such as metal rails or large sections of wood, are recommended to be placed on top of the stack to prevent distortion or warping of timber in the stack. In case timber is stored for about a year or more, to prevent end cracking in the material, the ends of all members shall be coated with coal tar, aluminium leaf paints (hardened gloss oil), micro crystalline wax or any other suitable material.

17.10.8 Steel

Separate areas shall be earmarked for storing each classification (type and grade) of steel. It is desirable that the ends of bars and sections of each class be painted in distinct separate colours.

Steel reinforcement shall ordinarily be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. It is desirable to coat reinforcement with cement wash before stacking to prevent scaling and rusting. The cement collected from sweepings may be used for this purpose.

Bars of different classification, sizes and lengths shall be stored separately to facilitate issue in such sizes and lengths so as to minimize wastage in cutting from standard lengths.

In case of long storage, reinforcement bars shall be stacked above ground level by atleast 150mm. A coat of cement wash shall be given, for such long storage, to prevent scaling and rusting.

Other structural steel sections of different classification (types and grades), sizes and lengths shall be stored separately. It shall be stored above ground level by atleast 150mm upon platforms, skids or other suitable supports to avoid distortion of sections.

For long storage, suitable protective coating of primer shall be given to prevent scaling and rusting.

For storage in coastal area, similar protective treatment shall be given for reinforcement bars and structural steel sections.

17.10.9 Doors, Windows and Ventilators

While unloading, shifting, handling and stacking timber door and window frames and shutters care shall be taken to ensure that the material is not dragged one over the other as it may cause damage to the surface of the material, for example, in case of decorative shutters. The material should be lifted and carried preferably flat to avoid damage to corners or sides.

Metal doors, windows, and ventilators shall be stacked upright (on their sills) on level ground preferably on wooden battens and shall not come in contact with dirt and ashes. If received in crates they shall be stacked according to manufacturer's instruction and removed from the crates as and when required for the work.

Metal frames for doors, windows and ventilators shall be stacked upside down with the kick plates at the top. They shall not be allowed to stand for long in this manner before being fixed so as to avoid the door frames getting out of shape and hinges being strained and shutters drooping.

During period of storage aluminium doors, windows and ventilators shall be protected from loose cement and mortar by suitable cover such as tarpaulin. The tarpaulin shall be hung loosely on temporary framing to prevent circulation of air and prevent condensation.

All wooden frames and shutters shall be stored in dry and clean covered space away from any infestation and dampness. The storage shall be preferably in well ventilated dry rooms. The frames shall be stacked one over the other in vertical stacks with cross battens at regular distances to keep the stack vertical and straight. The cross battens should be of uniform thickness and placed vertically one above the other. The door shutters shall be stacked in the form of clean vertical stacks one over the other and at least 80mm above ground on pallets or suitable beams or rafters. The top of the stack shall be covered by a protecting cover and weighed down by means of scantlings or other suitable weights. The shutter stack shall rest on hard and level ground.

Separate stacks shall be built for each size, each grade and each type of material. When materials of different sizes, grades and types are to be stacked together for want of space, the bigger size shall be stacked in the lower portion of the stacks. Suitable pallets or separating battens shall be kept in between two types of material.

If any wooden frame or shutter becomes wet during transit, it shall be kept separate from

undamaged material. The wet material may be dried by stacking in shade with battens in between adjacent boards with free access of dry air generally following the guidance laid down in IS 1141:1993.

17.10.10 Roofing Sheets

Roofing sheets shall be stored in such a way as not to damage them in any way.

Asbestos cement sheets shall be stacked to a height of not more than one metre on a firm and level ground with timber or other packing beneath them. If stacked in exposed position, they shall be protected from damage by wind.

Asbestos cement sheets of the same variety and size shall be stacked together. Damaged sheets shall not be stacked with sound materials. All damaged sheets shall be salvaged as early as possible.

17.10.11 Boards

Gypsum boards shall be stored flat in a clean covered and dry place.

Boards shall not be stored in the open and exposed to sun and rain, particularly if they are wood based boards, such as plywood, fibre board, particle board, block board etc.

The boards shall be stacked on a flat dunnage, on top of which a wooden frame shall be constructed with 50mm x 25mm battens in such a way that it will give support to all the four edges and corners of the boards with intermediate battens placed at suitable intervals to avoid warping.

The boards shall be stacked in a solid block in a clear vertical alignment. The top sheet of each stack shall be suitably weighed down to prevent warping.

The boards shall be unloaded and stacked with utmost care avoiding damage to corners and surface. In case of decorative plywood and decorative boards the surfaces of which are likely to get damaged by dragging one over the other it is advisable that these boards are lifted in pairs facing each other as far as possible.

17.10.12 Glass Sheets

It is important that all sheets whether stored in crates or not shall be kept dry. Suitable covered storage space shall be provided for the safe storage of glass sheets. In removing glass sheets from crates great care shall be taken to avoid damage to glass. The glass sheets shall be lifted and stored on its long edges and shall be put into stacks not more than 25 panes, supported at two points by fillets of wood at 300mm from each end. The first pane laid in each stack shall

be so placed that its bottom edge is about 25mm from the base of the wall or other support against which the stack rests. The whole stack shall be as close and as upright as possible.

17.10.13 Asbestos Cement, Pipes and Fittings

The pipes shall be unloaded where they are required, when the trenches are ready to receive them.

The pipes shall be stored on firm, level and clear ground and wedges shall be provided at the bottom layer to keep the stack stable.

The stack should be in pyramid shape or the pipes be arranged lengthwise and cross wise in alternate layers. The pyramid stack is advisable for smaller diameter pipes for conserving space in the store room. The height of the stack shall not exceed 1.5m.

Each stack shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible.

Cast iron detachable joints and fittings shall be stacked under cover and separated from asbestos cement pipes and fittings.

Rubber rings shall be kept clean, away from grease, oil, heat and light.

17.10.14 Polyethylene Pipes

Black polyethylene pipes are suitably protected from ageing due to sunlight by the addition of appropriate quantity and type of carbon black during manufacture. Therefore they may be stored even in the open; however, it is preferable that they are stored under cover.

Natural polyethylene pipes, however, shall be stored under cover and protected from direct sun.

Pipe coils may be stored either on edge or stacked flat one on top of another, but in either case they should not be allowed to come in contact with heat, such as, through hot water or steam pipes. They should also be kept away from hot surfaces.

Straight lengths of pipes should be stored on horizontal racks giving continuous support to prevent the pipe getting a permanent set if allowed to sag. Storage of pipes in heated areas exceeding 27° C shall be avoided.

17.10.15 Unplasticised PVC Pipes

These pipes shall be given support at all times. Pipes should be stored on a reasonably flat surface free from stones and sharp projections so that the pipe is supported all along its length. Pipes should not be stored on racks.

Pipes should not be stacked in large piles especially under warm temperature conditions as the bottom pipes may be distorted, thus creating problems in jointing. Socket and spigot pipes should be stacked in layers with sockets placed at alternate ends of the stacks to avoid lopsided stacks. Stacks shall not be more than 1.5m high. Avoid storing one pipe in another.

Pipes of different sizes and classes should be stacked separately.

On no account should pipes stored in a stressed or bent condition. The ends of pipes should be protected from abrasion particularly those specially prepared for jointing.

In tropical conditions, pipes should be stored in shade. In wintry conditions or cold weather the impact strength of PVC is reduced making it brittle; therefore more care shall be exercised in handling of the pipes.

If due to improper storage or handling, a pipe becomes kinked, the damaged portion should be cut out completely. Kinking is likely to occur in thin walled pipes.

17.10.16 Bitumen, Road Tar and Asphalt

All types of bitumen, road tar, asphalt, etc in drums or containers shall be stacked vertically on their bottoms upto 3 tiers. Leaky drums should be segregated. Empty drums shall be stored in pyramidal stacks neatly in rows.

17.10.17 Water

Wherever water is to be stored for construction purposes, it shall be done in proper storage tanks to prevent any organic impurities polluting the water.

17.10.18 Flat tiles

Flat tiles shall be stacked on well treated and hard surface. Tiles shall be stacked at site in proper layers and tiers and they shall not be dumped in heaps.

In a stack, the tiles shall be so placed that the mould surface of one faces another. The height of the stack shall not be more than 1 m.

Tiles when supplied in packed boxes / crates shall be stored as such. They shall be opened only at the time of use.

17.10.19 Oil Paints

All containers of paints, thinners and allied materials shall preferably be stored on floors with sand cushions in a separate room which is well ventilated and free from excessive heat, sparks of flame and direct rays of the sun. The containers of paint shall be kept

covered or properly fitted with lid and shall not be kept open except when in use.

17.10.20 Sanitary Appliances

All sanitary appliances shall be carefully stored under cover to protect from damage. When accepting and storing appliances, consideration shall be given to sequence of removal from the store to the assembly positions. Proper stacking to assist the later stage will be advantageous. As nearly all assemblage have need for separating brackets, these shall be readily accessible as they will be required at an early stage.

17.10.21 Piles

Pile shall be stored on firm ground free from liability to unequal subsidence of settlement under the weight of the stack of piles. The piles shall be placed on timber supports which are truly level and spaced so as to avoid undue bending in the piles. The supports shall be left around the piles to enable them to be lifted without difficulty. The order of stacking shall be such that the older piles can be withdrawn for driving without disturbing the new piles. Separate stacks shall be provided for different lengths of piles. Whenever curing is needed during storage, arrangements shall be made to enable the piles to be watered if the weather conditions so require.

Care shall be taken at all stages of transporting, lifting and handling of piles to see that they are not damaged or cracked during handling. During transportation the piles shall be supported at appropriate lifting holes provided for the purpose. If piles are put down temporarily after being lifted, they shall be placed on trestles or blocks located at the lifting points.

17.10.22 Other Materials

Small articles like screws, bolts, nuts, door and window fittings, polishing stones, protective clothing, spare parts of machinery, linings and packings, water supply and sanitary fittings etc shall be kept in a suitable and properly protected store rooms. Valuable small materials shall be kept under lock and key.

17.10.23 Special Considerations

Material constantly in use shall be relatively nearer the place of use. Heavy units like precast concrete members shall be stacked near the hoist and the ramp. Materials which normally deteriorate during storage shall be kept constantly moving by replacing old materials with new stocks. Freshly arrived materials shall never be placed over materials which had arrived earlier. Fire

extinguishers and fire buckets shall be provided wherever necessary for safety.

17.11 OPEN WELLS FOR WATER SUPPLY General Details

17.11.1 General: Open wells may be used for water supply for individual households colonies; and wayside stations. Percolation wells can be sunk in bed of streams within Railway boundary. Open wells for water supply may be unlined kutcha wells, pervious lined wells or impervious lined wells.

17.11.2 Well Curb and Cutting edge

(a) Well Curb: Well curbs shall be made of wood, steel or reinforced concrete. Wooden well curbs shall be made of hard and durable wood e.g. keekar, sheesham, padak, sal or tamarind which do not rot due to continuous immersion in water. Curbs for large size wells, or where the nature of soil demands are also provided with a suitable cutting edges.

17.11.3 Cutting edge : The cutting edge shall be fabricated from old rails or the steel sections specified on the drawings. The steel sections shall not be heated and forged into shape. 'V' cuts may be made in the horizontal portion uniformly throughout the length to facilitate bending. Such 'V' cuts shall not be less than 8 in number. The sections shall then be cold-bent and pressed to shape and 'V' cuts electrically welded together. For larger wells they will be cold bent and site riveted at joints with cover plates. **Steining :** The steining shall be of brick work, dry stone masonry, precast concrete blocks or cast in situ concrete as specified and or shown in the Drawing. The steining shall be constructed to the relevant standard specification for the type of masonry specified. The well curb shall be secured to the steining by iron tie rods as shown in the drawings. The steel work involved in tie rods, bond plate etc shall be paid for under item for steel work in single sections in the chapter of "Steel work". **Well sinking**

a) Excavation : Open excavation in the form of a pit shall be carried down to the sub-soil water level or to the bottom of clay or non-water bearing strata whichever is higher, before the well curb is laid. Where the ground water level is quite deep, the depth of open excavation shall take into account the nature of the soil and the safety of the workmen. The contractor shall obtain prior written approval of the Engineer before resorting to dry sinking.

b) Laying the well curb : The well curb shall be laid at the bottom of the open excavation where dry sinking has to be resorted to. Where the open excavation is carried down to the ground water level, the well curb shall be laid within 15 cm of the ground water level. Wet sinking shall be paid from a level 15 cm above the sub-soil water level irrespective of the exact level at which the well curb is laid. The sub-soil water level shall be recorded before wet sinking is commenced. The curb shall be levelled truly, and placed in exact position before the steining is commenced.

c) Building up Steining: In order to obtain perfectly vertical descent and to enable the direction of sinking of the well to be easily corrected, the first height of the steining shall be built up to a much shorter height. Generally, the first height shall not exceed 2 metres and the second height 2.5 metres. Subsequent steining masonry shall be built to convenient heights generally not exceeding the diameter of the well. While building up the steining masonry in stages, it should be checked for continuity with the surface of the preceding masonry by straight edges and not with a plumb bob, for verticality. The height of the steining shall be marked continuously from the bottom of cutting edge in metres(subdivided into 0.1 metre) painted on the inside to record the well height as the steining work progresses. Nothing extra shall be paid for this marking.

d) Sinking:- After the steining masonry has set and is sufficiently strong to withstand loading and accidental shock, a temporary loading platform shall be constructed on the top of the steining. Load may be applied in the form of gunny bags filled with earth or in any other manner, subject to the approval of the Engineer. The load shall be placed on the outer edges of the platform leaving sufficient clear space in the middle for lifting the excavated materials. Sinking may be facilitated by excavation of soil inside the well and below the curb. Where substantial flow of water is encountered, excavation by 'Jham' dredging, pumping or bailing may be resorted to, if permitted or ordered by the Engineer.

a) **Clay puddle backing:** In case of drinking water wells, the space between the excavation and the back of the steining shall be filled with good clay puddle for a depth atleast 2.5 to 3 metres below the ground level, the average thickness of this puddle being atleast one metre. This is necessary to prevent contamination by infiltration of

surface water. The clay shall be consolidated by ramming and watering in successive layers of about 30 cm depth. Average thickness of puddle shall be 1.0 m .

(b) In case of "Sinking water wells" inside face of steining should be flush cement pointed or plastered to depth required by Engineer or as shown in Drawing to prevent seepage.

(c) Also, in case of domestic water wells a paved impervious platform should be provided above ground level for a minimum width of 1.5m and sloping outwards. The platform should be built after the earth around the well has settled down. A coping should be provided around the well of such a design as not to permit buckets or pots being placed on top of it and it should prevent spilled water falling into the well.

Well steining will be paid for the volume of masonry / concrete in the steining. Additional cost incurred for doing a trial bore and testing of water for its suitability for drinking and providing pebble / shingle / boulder at the bottom of well, if ordered to be done will be paid for extra.

17.11.4 Drinking Water wells

a) In the case of "drinking water wells" though the procedure is similar to the one adopted on well sinking for Bridge foundation additional steps that will have to be taken in the case of sinking of well for shall be as follows:-

b) Records of sample of strata and sample of underground water are to be collected by the Contractor and made over to the Engineer for chemical and meteorological analysis. If necessary and if so ordered by the Engineer, the trial boring at the spot may be carried out before actual sinking of the well to get the samples of strata and the underground water. For the trial boring extra payment will however be made.

c) When the walls have been sunk to the full depth required, any sump below the bottom of the wall curb may be filled with clean shingle 50-75mm and shingle boulders 150mm size both mixed together. This should only be done where it is feared that due to pumping from the well critical velocity of flow may be exceed at any time disturbing the finer particles of the sub-soil and there is the need for keeping it within safe limit. This shall be paid for separately.

17.11.5 Yield Test

The yield test of the well should be assessed at the cost of the Contractor in presence of the Engineer or his authorized representative

and according to his instructions. All arrangements for carrying out yield test should be done by the Contractor at his own cost. On satisfactory completion of the yield test the Contractor will be finally paid.

17.11.7 Rate: Unless otherwise specified, the rates for well sinking will cover the cost of all tools, plants, steam hoist, dredger, pulsometer, gantry, kentledge, etc as well as loading and unloading of kentledge and bailing or pumping of water where required, including removing the excavated soil to a distance of 50 metres or as specified. Steining will be paid for in cum at the rate specified.

a) Cost of cutting edge, curb, tie rods, sand filling in the well, plugging and plastering, if any, shall be paid extra.

b) Wet sinking shall be paid from a level 15 cm above the sub-soil water level, irrespective of the exact level at which the well curb is laid.

c) The item of well sinking shall be paid on the basis of volume displaced. For calculating the volume, the gross cross sectional area enclosed within the external edge or edges of the steining will be multiplied by the depth through which the bottom of cutting edge of well curb has been sunk.

17.12 TUBE WELL SINKING

17.12.1 Shallow Tube Wells

(a) Shallow tube wells or deep tube wells are to be sunk according to the directive of the Engineer and at the spot fixed / shown by the Engineer. Shallow tube wells will, however, be sunk for tapping shallow water table upto a depth of 20-25 metres where only a small quantity of water is required. (b) For supplying small quantity of water (upto 50 lts./min.) tube wells can be sunk in shallow water table area. The tube is driven into the ground at the lower end of which a strainer is fixed. Driving of pipe is done by percussion or rotary tools or by jetting with the excavated materials being taken out by means of bailer or by some hydraulic process.

17.12.2 Deep Tube Wells-Drilling

a) In Percussion method, drilling is done by chiselling action of a tool which is alternately lifted and dropped into the bore hole which pounds the strata in small fragments and the pulverised materials are taken out to surface by means of a bailer. This can be operated by hand or by machine according to the strata. Hand operated

method is convenient upto 40m to 60m depth with bore holes of 40mm to 80mm dia.

b) Core drilling method is used for drilling in hard and rocky strata. A core drill bit is made of artificial diamond or chilled steel shots or steel teeth and these are fixed to a ring. The ring is attached to a drill rod and rotated and as the cutter advances a core rises inside the ring which is removed from time to time. This core gives a sample of material met with. Water is pumped into the bore hole to act as lubricant.

c) Rotary drills can be employed in drilling in almost all types of formations, hard or soft. Power driven machines are used with tripod or four legged derrick. Drilling is accompanied by rapid rotation of a pipe fitted with a toothed cutting shoe at the lower end. Rotary rings perform the operations like breaking, loosening, grinding and removing rocks simultaneously. Water is continuously pumped into the well under pressure through holes in the cutting shoe to rise to the surface between the side of the hole and the pipe, carrying the loosened material with the water. The mud or slush thus coming out gives an idea of the type of strata met without their depth. A 200mm dia hole may be drilled upto 6m in 2 hours in soft rock by this method.

d) Water jet boring is used for boring through hard and tenacious soluble clays and for deep boring. Drilling is accomplished with the help of water jet pipe with a nozzle at the end which is introduced into the casing pipe and water forced through it under pressure. The water formed into slurry comes up to the surface through the space between the casing pipe and the jet pipe. Casing pipe sinks by its own weight or by weight added on top.

17.12.3 Provision of Strainers

a) During sinking of pipes, samples of strata are to be collected for examination and to decide on the likely yield of water. The samples of such strata and water samples should be preserved for deep boring. These are to be presented to the Engineer for his consideration and whenever necessary sent for analysis of soil and quality of water. From this analysis the Engineer will decide on the type and length of strainer necessary depending on quantity of water available and locations for placing the strainer.

b) Strainers fitted over an iron shoe or a blind pipe (upto 1.5m) having a cap or plug fixed at the bottom and plain pipe above the

strainer will be assembled. The whole assembly is lowered and fixed at the required depth of the bore hole as decided earlier and the casing pipe taken out. Plain pipes screwed to the strainer and lowered along with strainer to the required depth of the bore hole shall be as decided by the Engineer. The top of pipe should be above HFL or level as directed by the Engineer so that in case of unusual flood in the location, outlet is not submerged.

c) After sinking the casing pipe to the requisite depth if it is found that the strata is not sufficiently water bearing or a suitable sandy or gravity strata in which the strainer can be placed is not available and if it is decided by the Engineer to abandon the bore hole, payment will be made to the contractor for only sinking and withdrawing the casing pipe. The work of sinking at any other new site decided by the Engineer or his authorized representative should then be done.

d) In cases where the strainer is in fine sand, it will be necessary to complete the tube well by putting in fine clean ballast or gravel in the annular space between the casing pipe and the tube well strainer as a "shrouding". The extraction of the casing pipe after the work of "shrouding" as narrated above should be done under the direction of the Engineer.

e) Mild steel and cast iron are attacked by sodium salt and copper pipe is attacked by sodium carbonate and sodium chloride while brass is not readily attacked by the salts usually present in soil. Hence the strainer material shall be chosen to suit local conditions and the type of strata in which is to be placed and chemical content of water.

f) Verticality of bore-hole

The casing pipe or the housing pipe shall be placed reasonably vertical in the boring. The deviation from verticality of the housing pipe shall not be more than 50mm (at any stage) upto 20 metres below the ground level.

17.12.4 Yield Tests After the strainers and the pipes have been lowered the tube well will have to be tested for the yield by experienced staff of tube boring section or of any specialised agency under the guidance of the Engineer. The yield test of the tube well shall be carried out by the Contractor at his own cost and in the presence of the Engineer or his authorized representative. Expenses incurred in arranging for presence of the expert (in absence of Railways staff) will be borne by the Contractor at his cost. The yield test will have to be carried out for a

period of 3 days and not less than 8 hours continuous pumping shall be carried out a day. On satisfactory completion of the yield test final payment for the tube well will be made.

Pumps

Pumps of approved quality and make should be fixed on the shallow tube wells operated by hand. In deep tube wells, however, pumps will be arranged by the department concerned.

17.12.5 Remedial Measure of (clogged) choked screen

a) Clogging of screen is generally due to following two causes

1) excessive pumping with velocity of inflow more than the optimum velocity of the strata which disturbs the materials surrounding the strainer drawing in sand particles.

2) Chemical action on the strainer metal due to the presence of corrosive salts in water which gradually corrode the strainer.

17.12.6 Back washing and cleaning Tube wells

Back washing under pressure will dislodge the sand particles clogging the strainer holes. Water is forced into the well with a pump or from a high level storage tank through a water jet tube over the strainer openings and compressed air blown into the strainer. If a turbine pump is operated without a foot valve and suddenly stopped the water in the pump column will cause the back flow. Incrustation of lime in the strainer can be removed by introducing weak hydrochloric acid into the well and allowing it to act for several hours. This will dissolve the salt (lime particles) and heavy pumping will bring up the incrustations. Where screen is obstructed by heavy growth of iron bacteria, a 50 ppm chlorine solution will be injected, which will clear the bacterial agents.

17.12.8 Measurement for Payment

Drilling, provision of case pipe, provision of strainer and main pipe of the tubewell will each be paid for in terms of running meter for the specified diameter, unless otherwise specified. Linear measurements will be made to nearest centimetre.

Supply and filling the annular space in the tube well with pebbles will be paid for actual quantity used or theoretical requirement plus 5%, whichever is less. It will be measured in cubic meters reckoned correct to nearest 0.001 cum.

Supply of pump (hand or power) will be measured in unit.

Yield test of tube well and testing the water for quality is considered part of the job and will not be paid for extra unless specified otherwise.

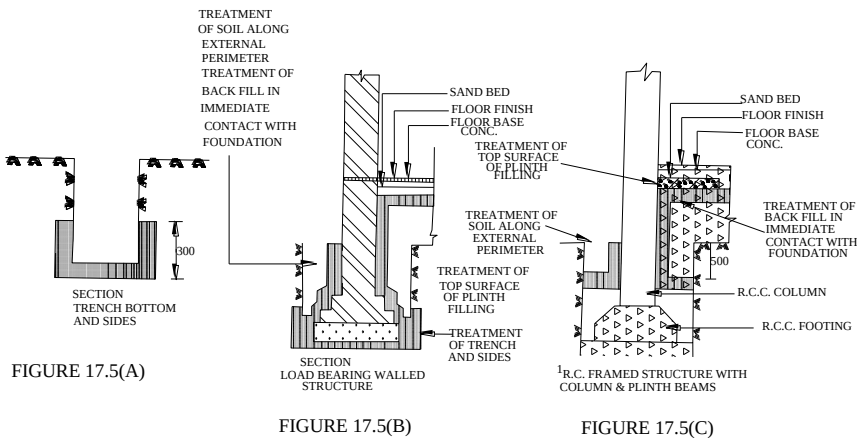
17.12.9 Rate

The contract unit rate will include cost of all labour, materials, tools and plant and equipment required for doing the boring and provision of tube well with strainer filling annular space, if any, yield test, testing of water, supply of pump, if any. Rate for drilling

bore includes supply of bentonite, drilling, installing casing and removal of casing etc., as required. Supply of pump includes provision of necessary foundation base/suspension arrangements and installation of foot valve, if any, required. It also includes extraction and supply of soil samples of strata passed through. All masonry work in and around the pump will be paid separately as per relevant item.

Annexure-A

ANTI TERMITE TREATMENT (PRE-CONSTRUCTION)

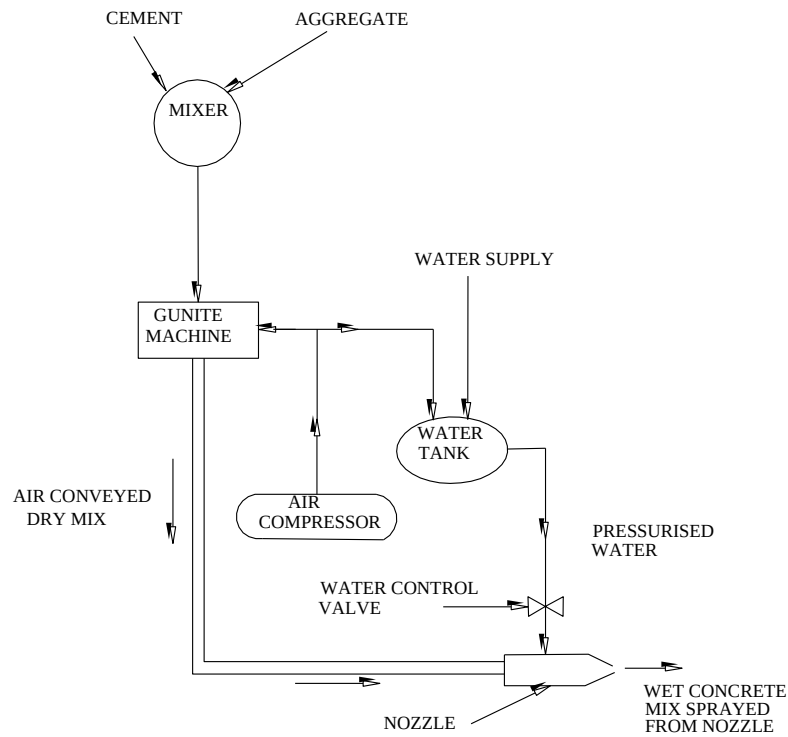


All dimensions are in mm

Drawings not to Scale

Annexure-B

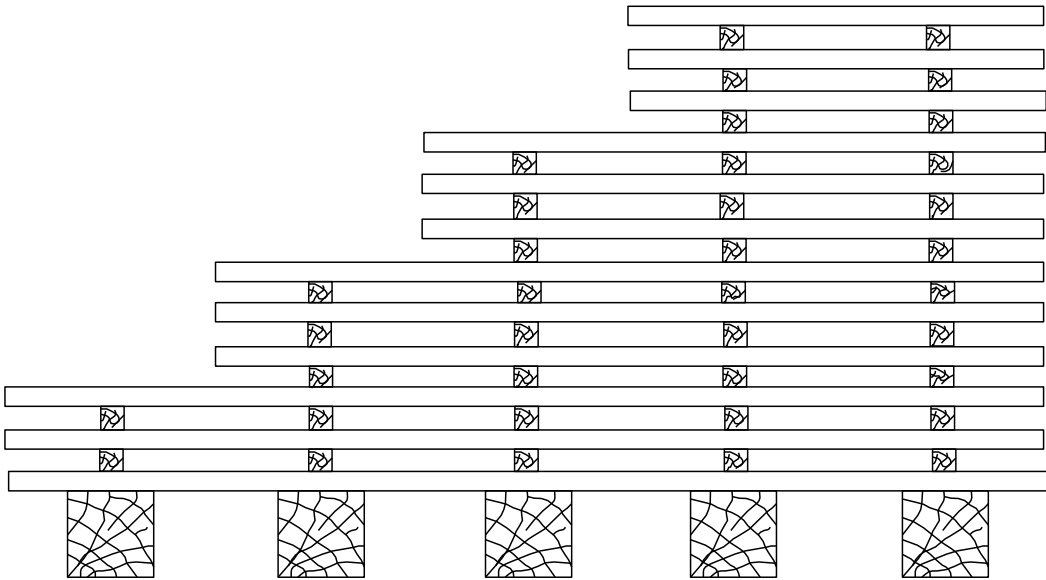
DIAGRAMATIC REPRESENTATION OF GUNITE PROCESS



Annexure-C

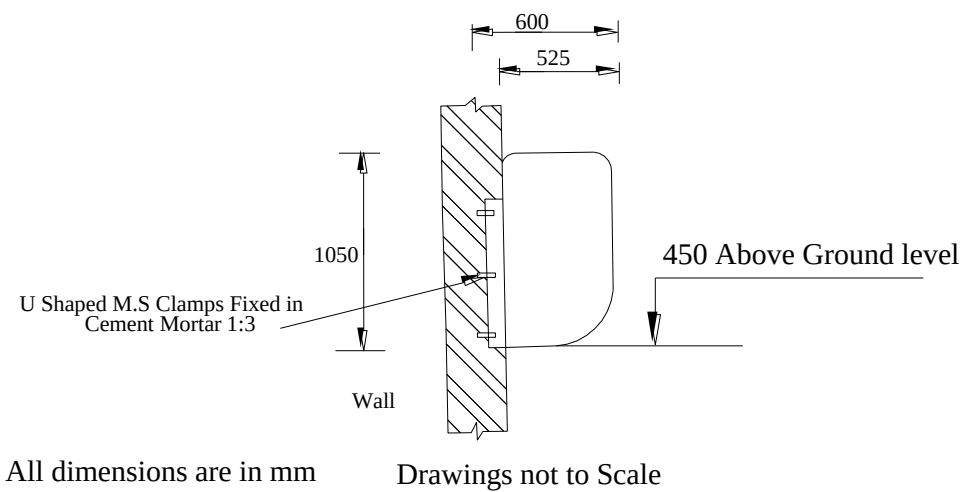
TYPICAL TIMBER STACK

FIGURE 17.8



Annexure-D

URINAL PARTITION FIXING



Chapter 18

Dismantling And Demolition

18.0 TERMINOLOGY

18.0.1 Dismantling

The term "Dismantling" implies carefully separating the parts without damage and removing. This may consist of dismantling one or more parts of the building as specified or as shown on the drawings.

18.0.1 Demolition

The term "Demolition" implies breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified or as shown on the drawings.

18.1 GENERAL

18.1.1 Need for Special Care:- Demolition of any structure is, inherently, more hazardous than the construction or erection of the same. From the point of view of safety, the conditions usually encountered while dismantling a structure, whatever its magnitude, do not lend themselves to the degree of control possible in the construction operations, where, more stable conditions are generally obtainable. It is all the more imperative, therefore, that adequate attention is paid to planning and execution of demolition work, in its various stages, so as to minimize the risk of accidents and injuries to the personnel engaged in demolition operations. Dismantling requires greater care than in case of Demolition so as to ensure that the portion of the building to be left intact is not affected in any way by the dismantling of the adjacent portion.

18.1.2 Basic Requirements:- The demolition work shall be proceeded in such a way that:

- a) it causes least damage and nuisance to the adjoining building and the members of the public; and
- b) it satisfies all safety requirements to avoid accidents.

18.1.3 Sorting out materials: Any serviceable material obtained during dismantling or demolition shall be separated out and stacked properly as directed by the Engineer within a lead of 50 metres. All unserviceable materials, rubbish etc shall be disposed off as directed by the Engineer. The serviceable material should be handed over to the Engineer or his authorized

representative properly before the payments for this operation are made.

18.2 PLANNING

Before beginning the actual work of demolition, a careful study shall be made of the structure which is to be pulled down and also of its surroundings. This shall include the following:

- a) The manner in which the various parts of buildings are supported and how far the stage by stage demolition would affect the safety of the adjoining structure;
- b) A definite plan and procedure of demolition work shall be prepared, taking into account the loads on various structural parts and their supports;
- c) Before commencement of each stage of demolition, the supervisor shall brief the workmen in detail regarding the safety aspects to be kept in view;
- d) It should be ensured that the demolition conditions do not, at any stage, enhance the nuisance value of demolition work on the use of adjacent buildings;
- e) No structure or part of the structure or any floor or temporary support or scaffold, side wall or any device for equipment shall be loaded in excess of the safe load bearing capacity, in its then existing condition; and
- f) Stairs and stair railings, passage ways and ladders shall be left in place as long as possible. These should be maintained in a safe condition.

18.3 PRECAUTIONS AND PROTECTIVE MEASURES BEFORE STARTING DEMOLITION WORK

The following precautions and protective measures shall be taken before commencement of demolition work:

- a) On every demolition job, danger signals shall be conspicuously posted all round the structure and all doors openings giving access to structures shall be kept barricaded or manned except during the actual passage of workmen or equipment. However provision shall be made for at least two independent exits for escape of workmen during any emergency.

b) Walkways and passageways shall be provided for the use of the workmen who shall be instructed to use them and all such walkways and passageways shall be kept adequately lighted, free from all debris and other materials.

c) Where in any work of demolition it is imperative, because of existing danger, to ensure that no unauthorized person shall enter the site of demolition outside working hours, a watchman shall be employed. In addition to watching the site he shall also be responsible for maintaining all signs, notices, lights, barricades, etc. During nights, red lights shall be placed on or about the barricades.

d) The power on all electrical service lines shall be shutoff and all such lines cut or disconnected at or outside the property line. The only exception would be any power lines required for the demolition work itself. Prior to cutting of such lines, the necessary approval of the concerned Authority shall be obtained.

e) All mains and meters of the building shall be removed or protected from damage.

f) All gas, water, steam and other service lines shall be shut off and capped or otherwise controlled at or outside the property line.

g) If a structure to be demolished has been partially wrecked by fire, explosion or other catastrophe, the walls and damaged roofs shall be shored and braced suitably.

h) Construction sheds and tool boxes should be so located as to protect workers from injuries of falling objects, wall, etc.

j) A warning device should be installed in the area to be used to warn the workers, in case of danger.

k) Screens shall be placed, where necessary, to prevent flying pieces from injuring the fellow workmen.

m) No demolition work shall be carried out during storm or heavy rain.

n) No demolition work shall be carried out at night specially when the building or structure to be demolished is in habited area except in special circumstances and when specifically approved by the Engineer.

p) All necessary safety appliances shall be issued to the workmen and their use explained. It shall be ensured that the workers are using all the safety appliances while at work. The safety appliances should be as follows:

1) Safety helmets as per IS 2925: 1984;

2) Goggles made of celluloid lens to be worn at the time of demolition of floors, walls, tearing of plaster, etc, specially when equipment like jack hammers are used for demolition work, to protect the eyes from flying pieces, dust, dirt, etc that may be blown up by wind.

3) Leather or rubber gloves worn during demolition of RCC work or removing steel work, where the hands of workers are likely to be injured.

4) Safety belts while working at higher level to prevent falling from the structure.

q) First-aid equipment shall be available at all demolition works of any magnitude. Also, by prior arrangement, a qualified doctor should be available at call.

r) When there is a possibility of fire breaking out, appropriate portable first-aid fire appliances (see IS 2190:1992) shall be kept at hand.

s) The removal of a member may weaken the side wall of an adjoining structure and to prevent possible damage, these walls shall be supported until such time as permanent protection is provided. In case any danger is anticipated to the adjoining structure, the same shall be got vacated to avoid any danger to human life.

t) Ladders, when used, shall conform to IS 3696 (Part 2): 1991. Ladders or their side rails shall extend not less than 1.0m above the floor or platform to which the ladder gives access. All ladders shall be secured against slipping out at the bottom and against movement in any direction at the top.

u) All exterior wall openings which extend down to the floor level shall be barricaded to a height not less than 1m above the floor level. All floor openings and shafts not meant as material chutes shall be floored over and endorsed with ground rails and toe boards.

v) All existing fixtures/ services required during demolition operations shall be well protected with substantial covering to the satisfaction of the Engineer.

w) When demolition is to be done by mechanical means such as weight ball and power showels, the following additional precautions are necessary:

1) The area shall be barricaded for a minimum distance of $1\frac{1}{2}$ times the height of the wall;

2) While the mechanical device is in operation no workmen shall be allowed to enter the building being demolished;

- 3) The device shall be so located as to avoid falling debris; and
- 4) The device when being used shall not cause any damage to adjacent structure, power_line, other services etc.

18.4 PROTECTION OF THE PUBLIC

Protection of the public before and during demolition is important and the following point should be kept in mind:

- a) Every sidewalk or road adjacent to the work shall be closed or protected. All main roads, which are open to the public shall be kept open to the public clear and unobstructed at all times.
- b) Children and public shall be kept out of the building and the adjoining yards.
- c) If the structure to be demolished is more than two-storeyed or 7.5m high, measured from the sidewalk or street which cannot be closed or safely diverted, and the horizontal distance from the inside edge of the side walk to the structure is 4.5m or less, a substantial side walk shed (**FIGURE 18.1**) (see also (k)) shall be constructed over the entire length of the sidewalk adjacent to the structure, of sufficient width with a view to accommodating the pedestrian traffic without causing congestion. The sidewalk shall be lighted sufficiently to ensure safety at all times.
- d) A toe board atleast 1m high above the roof the shed shall be provided on the outside edge and ends of the sidewalk shed. Such boards may be vertical or inclined outward at not more than 45°.
- e) Except where the roof of a sidewalk shed solidly abuts the structure, the face of the sidewalk shed towards the buildings shall be completely closed by providing sheeting / planking to prevent the falling material penetrating into the shed.
- f) The roof of the sidewalk shed shall be capable of sustaining a load of 730 kg/m². Only in exceptional cases, (say) due to lack of other space, the storing of the material on a sidewalk shed may be permitted in which case the shed shall be designed for a load of 1460 kg/m². Roof of sidewalk shed shall be designed taking into account the impact of the falling debris. By frequent removal of loads it shall be ensured that the maximum load, at any time, on the roof of the shed is not more than 600 kg/m². The height of the sidewalk shed shall be such as to give minimum clearance of 2.4m.

g) Sidewalk shed openings, for loading purposes, shall be kept closed at all times except during actual loading operations.

h) The deck flooring of the sidewalk shed shall consist of plank of not less than 50mm thickness closely laid and deck made watertight.

j) All members of the shed shall be adequately braced and connected to resist displacement of members or distortion of frame work.

k) When the horizontal distance from the inside edge of the sidewalk to the structure is more than 4.5m and less than 7.5m, a sidewalk shed or fence may be built or in their place a substantial railing shall be constructed on the inside of the sidewalk or roadway along the entire length of demolition side of the property with movable bars as may be necessary for the proper prosecution of the work.

l) Where workers' entrances to the building being demolished are not completely protected by sidewalk sheds, all such entrances shall be protected by canopies extending from the face of the building to a point not less than 2.5m from it. In such a case, overhead projection shall be atleast 0.6m wider than the building entrance or opening and every canopy shall be as strong as the sidewalk shed.

18.5 SEQUENCE OF DEMOLITION OPERATIONS

The sequence of demolition shall generally be as given below:

- a) The demolition shall always proceed systematically storey by storey in descending order and the demolition of upper floors shall be completely over before any of the supporting member or other important portion on the lower floor is disturbed. No unnecessary work shall go on below when the demolition is in progress above. When some work is to be done at the lower level, adequate protection shall be provided for all the workmen so engaged.
- b) The requirements of (a) shall not prohibit the demolition of structures by sections, if means are taken to prevent injuries to persons or damage to property.
- c) Roofs (or floors) should generally, be demolished first before demolishing the supporting walls / structural elements.
- d) All glazed sash, glazed doors and windows etc shall be removed before the demolition of roofs and walls starts. All

fragile and loose fixtures shall be removed. Lath and loose plaster should be stripped off throughout the entire structure. This is advantageous because it reduces glass breakage and also eliminates a large amount of dust producing material before more substantial parts of the building are removed.

18.6 DEMOLITION OF FLOORS

For demolition of floors the following procedure may be followed:

- a) A slit in width not exceeding 300mm shall be cut at the first stage for the entire length of the slab along which it spans (see **Figure 18.2**). The opening shall thereafter be increased to the desired width by suitable installments.
- b) Planks of sufficient strength not less than 50mm thick and 250mm wide shall be provided at a spacing not greater than 0.4m. These planks shall be so placed as to give workmen firm support to guard against any unexpected collapse.
- c) Stringers of sample strength shall be installed to support the planks where necessary and the ends of stringers shall be supported by floor beams, girders and not by floor slab alone.
- d) When floors are being removed, no workmen shall be allowed to work in the area, directly underneath and such area shall be barricaded to prevent access to it.
- e) The demolition of the floor in question shall be started only after the surrounding area for a distance of 6m has been entirely cleared of persons, and the debris and other unnecessary material removed.
- f) Planks used for temporary protection shall be sound and at least 50mm thick. They shall be laid close together with ends overlapping at least 100mm over solid bearing to prevent tipping under load.

18.7 DEMOLITION OF WALLS

18.7.1 Procedure

The following procedure should be followed when demolishing walls:

- a) While walls or sections of masonry are being demolished it shall be ensured that they are not allowed to fall as a single mass on the floors of the building so as not to exceed the safe carrying capacity of the floors; wherever practicable, they may fall away from the floors (see para 18.7.2) on to catch platforms. Overloading of floors shall be prevented by removing the accumulating debris through chutes or by other means

immediately (see para 18.9). The floor shall be inspected by the Engineer before undertaking demolition work and if the same is found incapable of carrying the load of debris, necessary precautions shall be taken to prevent any unexpected collapse of the floor.

b) Walls shall be removed part by part. Stages shall be provided for the men to work on, if the walls are very thin and dangerous to work by standing over them.

c) No section of the wall whose height is more than 15 times the thickness, shall be permitted to stand without lateral bracing unless such a wall is in good condition and was originally designed to stand without such lateral bracing or support.

d) Structural or load supporting members on any floor shall not be removed or cut until all the storeys above that floor have been demolished and removed.

e) Before demolishing any interior or exterior wall within 3m of the opening in the floor immediately below, such opening shall be substantially planked over, unless access is denied to workmen to that portion of the floor immediately below the opening, in the floor of the storey being demolished, where any debris passing through the opening may fall.

f) In framed structures, the frame may be left in position during demolition of masonry work. Where there is done all beams, girders, etc shall be cleared of all loose materials as the demolition of masonry work progresses downward provided it is still strong enough to stand as an independent structure.

g) Walkways shall be provided to enable workmen to reach or leave their work on any scaffold or wall. Such walkways shall neither be less than 3 planks wide, nor less than 0.8m in width.

h) After completion of each day's work, all walls shall be left stable to avoid any danger of getting overturned.

j) Foundation walls which serve as retaining walls to support the earth or adjoining structure, shall not be demolished until such time an adjoining structure has been underpinned or braced and the earth removed by sheet piling or sheathing.

18.7.2 Catch Platforms

Catch platforms shall be provided in case of demolition of exterior walls in multi-storey buildings. The following details may be considered.

a) Catch platform shall generally be provided for multi-storey buildings more than 20m high to prevent injuries to the workers and to the public when exterior walls are being demolished.

b) Such platforms shall be constructed and maintained not more than three storeys below the storey from which the exterior wall is being demolished. When demolition has progressed to within three storeys of ground level, catch platforms will not be considered necessary.

c) Catch platforms shall not be less than 1.5m in width measured in a horizontal direction from the face of the structure and shall consist of outriggers supported not more than 3m apart. Planks shall be laid tight together, without openings between them and the walls. Catch platforms shall be provided with a continuous solid parapet along its outer edge of atleast 1m height. The parapet may be constructed with the same material as the platform.

d) Catch platform shall be capable of sustaining a live load of not less than 610 kg/m^2 .

e) Catch platforms shall neither be used for storing of materials nor dumping of materials.

18.8 DEMOLITION OF DIFFERENT TYPES OF STRUCTURES AND ELEMENTS

18.8.1 General

Structures may be dealt with as masonry, concrete, steel and timber. The structures or their elements shall be dealt with as below, in addition to other requirements as applicable.

18.8.2 Masonry Structures

a) Jack Arches – Where tie rods are present between main supporting beams, these should not be cut until after the arch or series of arches in the floor have been removed. Particular care should be exercised and full examination of structure be made before the demolition is commenced (see **Fig. 18.3**). The floor should be demolished in strips parallel to the span of arch rings (at right angles to the main floor beam).

b) Brick Arches – 1) As much dead load as possible may be removed provided it does not interfere with stability of main arch rings; it should be noted that the load carrying capacity of many old arches relies on the filling between the spandrels. On no account should the restraining influence of the abutments be removed before the dead load

of the spandrel fill and the arch rings are removed. The normal sequence of demolition shown in **Figure 18.4A** includes the following:

- remove the spandrel filling down to the springing line
- remove the arch rings
- remove the abutments
- special temporary support shall be provided in the case of skew bridges.

2) A single span arch can be demolished by hand, by cutting narrow segments progressively from each springing parallel to the span of the arch, until the width of the arch has been reduced to a minimum which can then collapse (see **Figure 18.4B**) Where it is impossible to allow debris to fall to the ground below, centering designed to carry the load should be erected and the arch demolished progressively. The design of the centering should make appropriate allowance for impact.

3) Where deliberate collapse is feasible the crown maybe broken by the demolition ball method working progressively from the edges to the centre (see **Figure 18.4C**)

4) Collapse of structure can be effected in one action by the use of explosives. Charges should be inserted into boreholes drilled in both arch and abutments. This method is the most effective for demolition of tall viaducts. The work should be done by observing all the provisions of Indian Explosive act.

5) In multi-span arches, before individual spans are removed, lateral restraint should be provided at the springing level. Demolition may be proceeded as for a single span care being taken to demolish the spandrels down to the springing line as the work proceeds (see **Figure 18.4D**) Where explosives are used it is preferable to ensure the collapse of the whole structure in one operation to obviate the chance of leaving unstable portions standing.

18.8.3 Reinforced Concrete Cast in situ

a) Before commencing demolition, the condition and position of reinforcement and possibility of lack of its continuity should be ascertained. Demolition should be commenced by removing partitions, non load bearing cladding, etc and similar non structural elements.

b) Where hand demolition methods are used, the following procedures should be used:

1) Beams – For beams, supporting rope should be attached to the beam. Then the concrete should be removed from both ends by pneumatic drill and the reinforcement exposed. The reinforcement should then be cut in such a way as to allow the beam to be lowered under control to the floor (see **Figure 18.5A**)

2) Columns – For columns reinforcement should be exposed at the base after restraining wire guy ropes have been placed around the member at the top. The reinforcement should then be cut in such a way as to allow the column to be pulled down to the floor under control (see **Figure 18.5B**)

3) Walls – Reinforced concrete walls should be cut into strips and demolished as for columns (see **Figure 18.5C**)

4) Suspended Floors and Roofs – Solid slabs should be demolished as described in para 18.6 and **Figure 18.2**. Where ribbed construction is used, the principle of design and method of construction should be ascertained before demolition. Care should be taken not to cut the ribs inadvertently.

18.8.4 Precast Reinforced Concrete

a) Precast reinforced concrete units in a structure are normally held in position by the strength of the joints in-situ or on supporting walls, etc. As such before starting on demolition the joint structures or the supporting mechanisms shall be studied and understood.

b) In devising and following demolition sequences, due precaution shall be taken to avoid toppling over of the prefabricated units or any other part of the structure and wherever necessary temporary supports shall be provided.

18.8.5 Prestressed Concrete

Before commencing of the demolition work involving such structures advice of an expert engineer should be obtained. Work should be done only as per approved dismantling plan or drawing.

18.8.6 Steel

a) No beams shall be cut until precautions have been taken to prevent it from swinging freely and possibly striking any worker or equipment or any part of the structure being demolished.

b) All structural steel members shall be lowered from the building and shall not be allowed to drop.

c) Tag lines shall be used on all materials being lowered or hoisted up and a standard signal system shall be used and workmen

instructed on the signals. No person shall be permitted to ride the load line.

d) When a derrick or hoisting equipment is used care shall be taken to see that the floor on which it is supported shall be strong enough for the loading. If necessary heavy planking shall be used to distribute the load to floor beams and girders. Overloading / overturning of the equipment shall be avoided.

18.8.7 Other Elements

a) Roof Trusses – Roof trusses shall be removed to wall plate level by hand methods. Sufficient purlins and bracing should be retained to ensure stability of the remaining roof trusses while each individual truss is removed. Temporary bracing should be added, where necessary, to minimize instability. The end frame opposite to the end where dismantling is commenced, or a convenient intermediate frame should be independently and securely guyed in both directions before work starts. On no account should the bottom tie of a truss be cut until the principal rafters are prevented from making outward movement.

b) Cantilevers – A cantilever type of construction depends on the balancing superimposed structure for its stability. Canopies, cornices, staircases and balconies should be demolished or supported before the balancing load is removed.

c) Heavy Floor Beams – Heavy baulks of timber should be supported before cutting at the extremities and should then be lowered to a safe working place.

18.9 REMOVAL OF MATERIALS

18.9.1 General

Removal of dismantled materials should be done carefully; they may be thrown / lowered to the ground. The materials shall preferably be dumped inside the building. Normally such materials shall be lowered to the ground or to the top of the sidewalk shed where provided by means of ropes or suitable tackles.

18.9.2 Through Chutes

a) Wooden or metal chutes shall be provided for removal of materials. The chutes shall preferably be provided at the centre of the building for efficient disposal of debris.

b) Chutes if provided at an angle of more than 45° from the horizontal shall be entirely enclosed on all sides, except for opening at

or about the floor level for receiving materials.

c) Opening for chutes shall not exceed 1.20m in height measured along the wall of the chute and in all storeys below the top floor such opening shall be kept closed when not in use.

d) To prevent the descending material attaining a dangerous speed, the chute shall not extend in an unbroken line for more than two storeys. A gate or step shall be provided with suitable means of closing at the bottom of each chute to stop the flow of materials.

e) Chutes at an angle less than 45° to the horizontal may be left open on the upperside provided that at the point where such chute discharges into the chute steeper than 45° to the horizontal, the top of the steeper chute shall be boarded over to prevent the escape of materials.

f) Any opening into which workmen dump debris at the top of the chute shall be guarded by a substantial guard rail extending at least 1 m above the level of the floor or other surface on which men stand to dump the materials into the chute.

g) A toe board or bumper not less than 50mm thick and 150mm high shall be provided at each chute opening, if the required material is dumped from the wheel barrows. Any space between the chute and the edge of the opening in the floor through which it passes shall be solidly planked over.

18.9.3 Through openings

a) Debris may also be dropped through holes in the floor without the use of chutes. In such a case the total area of the hole cut in the intermediate floor, one which lies between floor that is being demolished and the storage floor shall not exceed 25 percent of such floor area. It shall be ensured that the storage floor is of adequate strength to withstand the impact of the falling material.

b) Openings in all floors below the floor from which materials are being removed, shall be protected by standard railings and toe boards (see IS 4912: 1978) or preferably planked over if the holes are not being used for dumping materials (see para 18.3(s))

c) All intermediate floor openings for passage of materials shall be completely closed with barricades or guard rails not less than 1m high and at a distance of not less than 1m from the edge of the general opening. No barricades or guard rails shall be removed until the storey immediately above has been demolished down to the floor line and all debris cleared from the floor.

d) When cutting a hole in an intermediate floor, between the storage floor and the floor which is being demolished, makes the intermediate floor or any portion of it unsafe, then such intermediate floor shall be properly shored. It shall also be ensured that the supporting walls are not kept without adequate lateral restraints.

18.10 MEASUREMENTS

(a) All work shall be measured net in the decimal system, as fixed in its place, subject to the following limits, unless otherwise stated hereinafter.

(a) Dimensions shall be measured correct to a cm.

(b) Areas shall be worked out in sqm correct to two places of decimal

(c) Cubical contents shall be worked out to the nearest 0.01 cum.

(b) Parts of work required to be dismantled and those required to be demolished shall be measured separately.

(c) Measurements of all work except hidden work shall be taken before demolition or dismantling and no allowance for increase in bulk shall be allowed.

(d) Specifications for deduction for voids, openings etc. shall be on the same basis as that adopted for new construction of the work.

(e) Work executed in the following conditions shall be measured separately.

(a) Work in or under water and / or liquid mud

(b) Work in or under foul position

18.11 RATES

The rate shall include the cost of all labour involved and tools used in demolishing and dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing off unserviceable material within a distance of 50 metres unless specified otherwise.

The rate shall also include for temporary shoring for the safety of portions of buildings not required to be pulled down, or of adjoining properly, and providing temporary enclosures or partitions, where considered necessary.

18.12 ROOFS

(a) Roof coverings generally including battens boarding, mats, bamboo jaffari or other subsidiary supports shall be measured in square metres except lead sheet roof covering which shall be measured in quintals and stone slab roof covering which shall be measured in cubic metres.

Ridges, hips and valleys shall be girthed and included with the roof area. Corrugated or semi corrugated surfaces shall be measured flat and not girthed.

(b) Mud phuska on roofs shall be measured in square metres.

(c) Lead sheets in roofs shall be measured in quintals and hips, valleys, flashings, lining to gutter etc. shall be included in this weight.

(d) R.B. or R.C.C. roofs shall be measured as specified in para 18.17

(e) Supporting members, such as rafters, purlins, beams, joists, trusses etc where of wood shall be measured in cubic metres and steel or iron sections in quintals.

18.13 CEILINGS

The stripping of ceilings shall be measured in square metres

(a) Dismantling of supporting joists, beams etc shall be measured in cubic metres or in quintals as specified in para 18.12 (e)

18.14 FLOORING AND PAVINGS

Dismantling of floors (except concrete and brick floors) shall be measured in square metres. Supports such as joists, beams etc. if any shall be measured as per para 18.12

(e) Concrete and bricks paving shall be measured as per para 18.15.

18.15 CONCRETE AND BRICK ROOFS AND SUSPENDED FLOORS

Demolition of floors and roofs of concrete or brick shall be measured in cubic metres. Beams, cantilevers or other subsidiary supports of similar materials shall be included in the item. In measuring thickness of roofs provided with water proofing treatments with bitumen felts, the thickness of water proofing treatment shall be ignored.

18.16 WALLS AND PIERS

(a) Taking down walls and independent piers, columns of brick, stone or concrete shall be measured in cubic metres. All copings, corbels cornices and other

projections of the same building materials shall be included with the wall measurements.

In measuring thickness of plastered walls, the thickness of plaster shall be ignored.

(b) Ashlar face stones, dressed stone work, precast concrete articles, etc if required to be taken down intact shall be so stated and measured separately in cubic metres.

(c) Cleaning bricks stacking or measurements including all extra handling and removal and disposing off the rubbish as stated shall be enumerated in thousand of cleaned bricks.

(d) Cleaning stone obtained from demolished /dismantling stone masonry of any description including ashlar facing dressed stone work, stone slabs or flagging and precast concrete blocks including all extra handling and disposing off the rubbish as stated shall be measured in cubic metres of cleaned stone.

(e) Honey comb works or cavity walls of bricks, stone or concrete shall be measured as solid.

18.17 REINFORCED CONCRETE AND BRICK WORK

(a) Reinforced concrete structures and reinforced brick roofs and walls shall be measured in cubic metres and if reinforcement is required to be salvaged, it shall be so stated.

(b) Where reinforcement is required to be separated, scraped and cleaned, the work shall be measured separately in quintal of salvaged steel.

18.18 PARTITIONS, TRELLIS WORK ETC.

Partitions or light walls, of lath and plaster, trellis work, expanded metal, thin concrete or terracota slabs and other similar materials including frame work if any shall be measured in square metres stating the over all thickness.

18.19 WOOD WORK

(a) All wood work including karries average 40 sqcm or over in section, shall be measured in cubic metres, while that under 40 sq_cm in section, in running metres. Ballies shall be measured in running metres.

(b) Boarding including wooden chajjas and sunshades along with supports shall be measured in square metres in its plane.

18.20 STEEL AND IRON WORK All steel and iron work shall be measured in quintals. The weight shall be computed from standard tables unless the actual weight can readily be determined.

18.21 Riveted work, where rivets are required to be cut, shall be measured separately.

(a) Marking of structural steel required to be re-erected shall be measured separately.

(b) In framed steel items, the weight of any covering material or filling such as iron sheets and expanded metal shall be included in the weight of the main article unless such covering is not ordered to be taken out separately.

18.22 DOORS AND WINDOWS

Dismantling of doors, windows, clerestory windows, ventilators etc (wood or metal) whether done separately or along with removal of wall by making recess in the wall shall be enumerated. Those exceeding 3 sqm each in area shall be measured separately. The item shall include removal of chowkhats architraves, hold fasts and other attachments.

If only shutters are to be taken out it shall be measured separately.

18.23 PIPES AND SEWER LINES

(a) Water pipe lines including rain water pipes with clamps and specials, sewer lines (salt glazed ware or concrete) etc shall be described by their diameter and length measured in running metres inclusive of joints.

(b) If the joints, specials and fittings etc are required to be separated, it shall be so stated and enumerated.

(c) Pucca drains shall be measured under relevant items.

(d) Valve cistern, public fountain platform, fire hydrants, etc shall be enumerated.

(e) Manholes and inspection chambers shall be enumerated stating the size and depth of manhole/ inspection chamber. They shall be classified into different groups depending upon the depth, in unit of half and one metre depth. The depth of the manhole shall be the distance between the top of manhole cover and invert level of the drain.

(f) Ventilating shafts, gully traps, flushing cisterns and other appurtenant items of work shall be enumerated.

18.24 POSTS AND STRUTS

Posts or struts (wood, steel or RCC) section including taking out embedded portion shall be measured in running metres.

18.25 FENCING WIRE MESH

Wire mesh fencing of any type with frame shall be measured in square metres.

18.26 GLAZING

(a) Taking out any portion of serviceable glass except polished plate, from old slashes, skylights, etc (any thickness, weight or size) raking out old putty, etc shall be measured in square metres.

(b) Irregular or circular panes shall be measured as rectangle or square enveloping the same. The width and height being measured correct to the nearest 0.5cm.

18.27 ROAD WORK

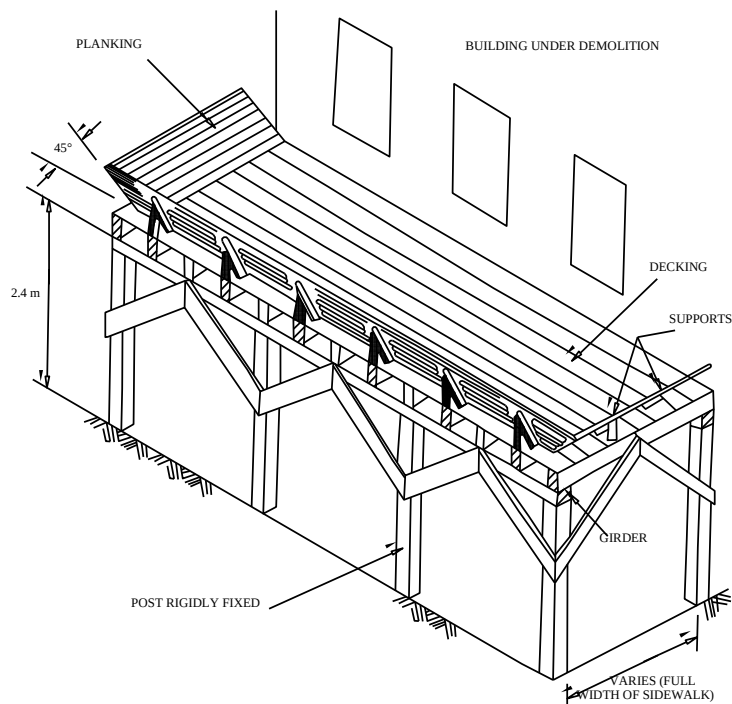
a) Different types of road surfaces shall be measured separately.

b) Road surfaces metalling or soling (base) shall be measured in-cubic metres.

c) Concrete paving shall be measured as in 18.15 or 18.17 as the case may be.

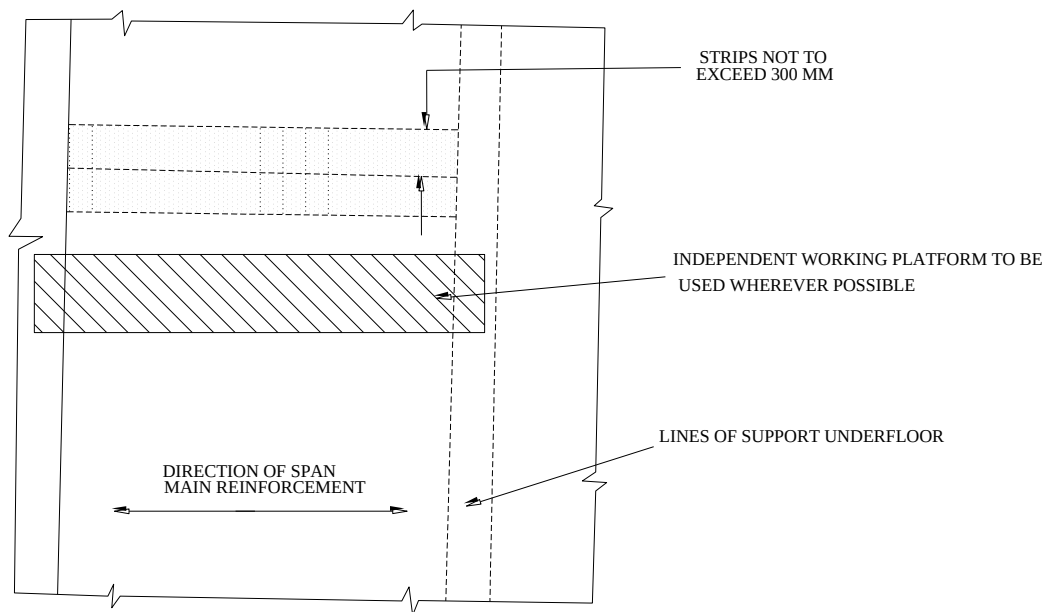
SKETCH OF SIDE WALK SHED

FIGURE 18.1



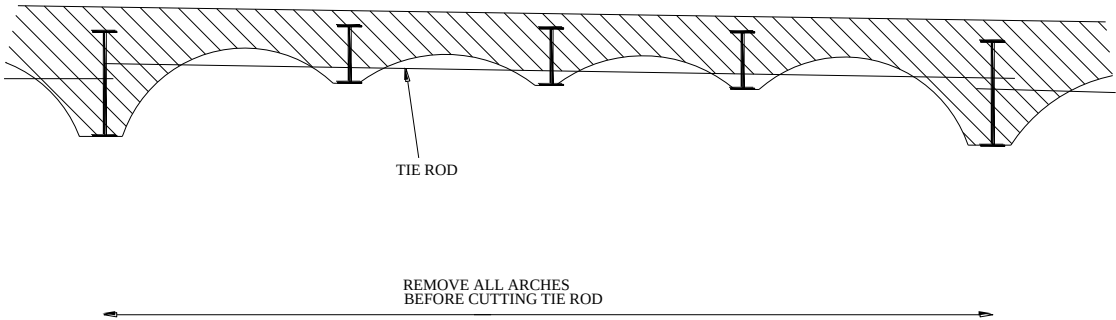
DEMOLITION OF REINFORCED CONCRETE FLOOR

FIGURE 18.2



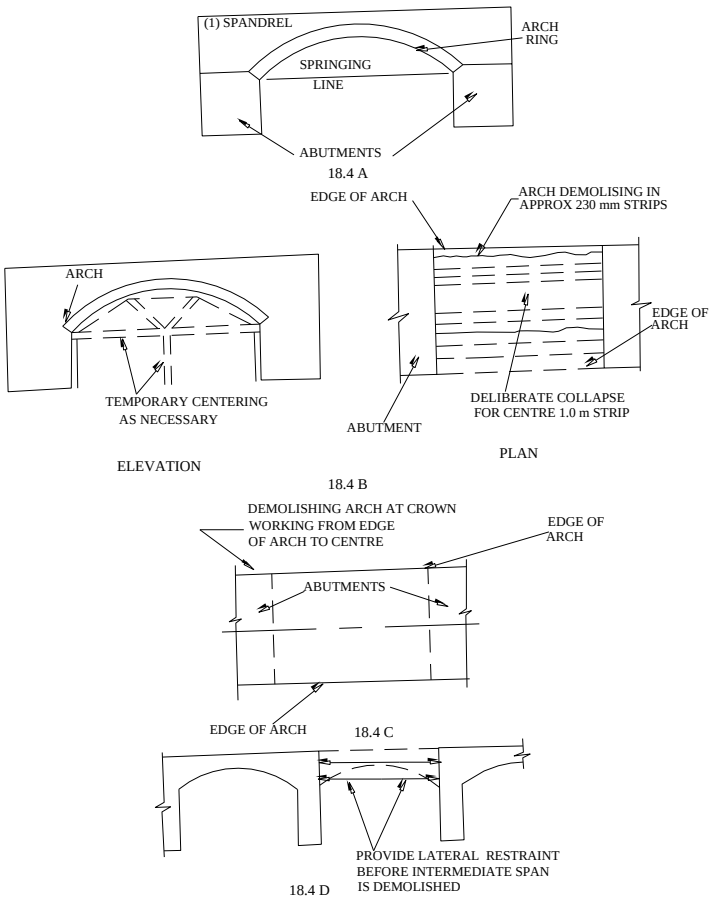
DEMOLITION OF JACK ARCHES

FIGURE 18.3



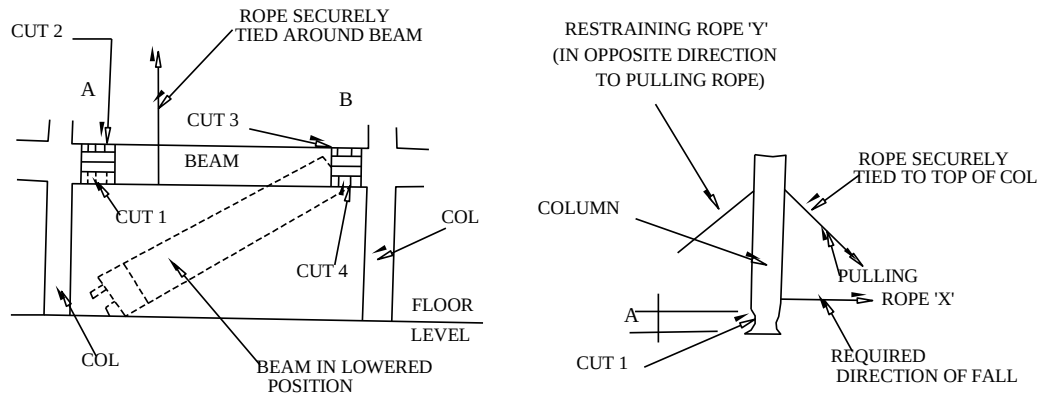
DEMOLITION OF MASONRY AND BRICKWORK ARCHES

FIGURE 18.4



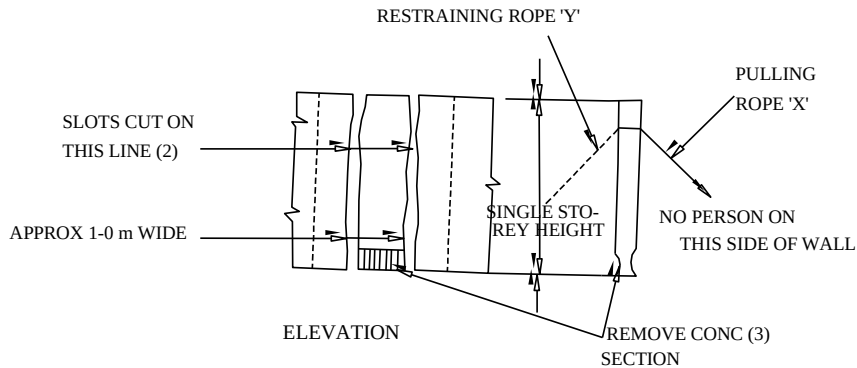
HAND DEMOLITION OF CONCRETE STRUCTURE CAST IN SITU

FIGURE 18.5



18.5 A RC Beams

18.5 B RC Columns



18.5 C RC Walls

Chapter 24

Fencing And Boundary Marks

24.1 FENCING

24.1.1 General

Fencing can be made of wire (plain strand; plain or barbed strands) fixed to Posts or of Posts with railing or with Pales. The posts may be of RCC, scrap rails or of angle iron. These shall be of standard size with the standard length of posts being 1.8m, rails 2.25 m, and pales 1.25 m. Tolerance in length of 12 mm in length and 3mm in other dimensions is permissible. Longer posts and more rows of wires may be used in special cases, if so specified.

Posts ,rails and pales: In case of RCC posts and pales, they shall be precast in concrete mix M15 (or 1:2:4) with stone aggregate 12.5 mm nominal size. Posts shall be with slots as specified in Drawing or by the Engineer and reinforced with 10 mm dia M>S bars in case of posts and pales and 6mm in case of rails. For the whole of their length below the top of the rail the paling shall have a projecting dovetail shape at the back which shall fit into dovetail grooves in each of the rails. The part projecting above the top rail shall be left square to prevent their dropping through the rails. The posts, rails and pales shall be free from cracks, twists and such other defects..

RCC Posts and Struts :

All posts and struts shall be of standard size, the length of posts being 1.8 m or otherwise specified and that of struts being minimum length of 2.0m.. They shall be of RCC precast with concrete mix M15 (1:2:4), finished smooth with cement mortar 1:2; reinforced with 6 mm or higher dia MS bars as per drawing or as directed. Posts and struts shall be free from cracks, twists and such other defects. GI staples on wooden plugs or 6 mm bar nibs will be provided in the posts while casting, as directed by Engineer or as shown in drawing.

24.1.2 Barbed Wire Fencing with RCC Posts

24.1.2.1 Materials: RCC posts and struts shall be as described in 24.1.1 above. Barbed wire used shall be as per IS: 278.

24.1.2.2 Spacing of Posts and Struts: The posts shall be spaced at three metres centres, unless otherwise specified or as

directed by the Engineer, to suit the dimensions of the area to be fenced. Every 15th post, corner posts and last but one end post shall be strutted on both sides and end post shall be strutted on one side (inside) only.

24.1.2.3 Fixing of posts and struts: Pits 450 x 450 mm and 750 mm deep or as directed by the Engineer shall be excavated true to line and level to receive the posts. In case of struts, pits 700 x 450 mm and 750 mm deep or as directed by Engineer shall be excavated to suit the inclination of the strut so that it is surrounded by concrete by not less than 150 mm at any point. The pits shall first be filled with a 150 mm layer of concrete to mix 1:3:6 (C.A to be graded stone aggregate 40 mm nominal size. Posts and struts shall then be placed in the pits in correct position and with 1.2 m or the specified height above ground, true to line and position. If the ground is sloping or undulating the posts shall be placed so that the tops and the positions at which wires are to be fixed are in a predetermined uniform slope or geometric line vertically on selected stretches, in consultation with the Engineer. Cement concrete of 1: 3: 6 proportion mix shall then be filled in the pit around the posts and struts upto a level below ground level of 150 mm for posts and 250 mm for struts, so that the posts are embedded in a concrete block of 450 x 450x 600 mm and the struts are embedded in block of size 700 x 450 x 500 mm. The concrete in foundations shall be watered and cured for at least 7 days. The remaining portion of the pit shall be filled with the excavated earth and well tamped and dressed on top. Surplus earth will be disposed off as directed by the Engineer.

24.1.2.4 Fixing of Barbed wire: The barbed wire shall be stretched and fixed in specified number of rows, and two diagonals in each panel. The bottom row shall be 140 mm above ground and the rest at 125 mm centre to centre, unless otherwise specified in drawing or by the engineer. The diagonals shall be stretched adjacent posts from top wire of one post to the bottom wire of the second post and vice versa. The diagonal wires shall be interwoven with horizontal wires by fixing the odd rows of wires, then the diagonal cross wire and lastly even row

of wires. The barbed wire shall be held to the RCC posts by means of GI staples fixed to wooden plugs or GI binding wire tied to the 6 mm bar nibs fixed to the posts while casting them. Turnbuckles and straining bolts shall be used on end posts or as specified. If the posts are provided with holes at positions of barbed wire, the barbed wire shall be fixed to posts with GI wire of approved gauge and passing through the hole.

24.1.2.5 Measurements: The finished fencing shall be measured in total length from centre to centre of posts, correct upto nearest cm.

2.6 Rates: The rate shall include the costs of all labour and materials, handling and transport, provision of tools and plant involved in all operations described above but excluding the cost of posts, struts, turnbuckle, straining bolts and excavation and concrete in foundations for which separate payments shall be made under respective items. Rate for supply and fixing of the posts and struts include the costs of all labour and materials including cast in fixtures curing, handling, transport and provision of tools and plant thereof.

24.1.3 Barbed Wire Fencing with Angle Iron Posts

24.1.3.1 Materials Alternatively angle iron posts and struts can be used for supports. They will be of mild steel in accordance with specifications in Chapter on Steel work. Barbed wire shall be as per IS: 278. The angle iron shall be 40 x 40 x 6 mm unless otherwise specified

24.1.3.2 Spacing of posts and struts. The posts shall be spaced at three metres centres, unless otherwise specified or as directed by the Engineer, to suit the dimensions of the area to be fenced. Every 15th post, corner posts and last but one end post shall be strutted on both sides and end post shall be strutted on one side (inside) only.

24.1.3.3 Fixing of posts and struts: This shall be as per Para 24.1.2.3. In addition, angle iron post at bottom shall be split and banded at right angle in opposite direction for 100 mm length.

24.1.3.4 Fixing barbed wire: The barbed wire shall be stretched and fixed in specified number of rows and two diagonals. The bottom row shall be 140 mm above ground level and the remaining at 125 mm centre to centre. The diagonal shall be stretched between adjacent posts from top wire of one post to the bottom wire of the second post and vice versa in each panel.

The diagonal wire will be interwoven with horizontal layers as specified in Para 24.1.2.4. The barbed wire shall be held drilling holes of 10 mm in the post and tied with GI wires. Turnbuckles and straining bolts shall be used to tighten the wires at the end posts, if so specified.

24.1.3.5 Fixing posts and struts on top of boundary walls: Barbed wire fencing may be specified for some heights over boundary walls of workshops, depots etc.. In such cases, the posts shall be made of angle iron which shall normally be bent at an angle (30° to 45°) to the plane of the wall. The bottom 300 mm length of the posts struts shall be vertical, of which the bottom most 100 mm length will be split and banded at right angle in opposite direction. This vertical leg of the post and struts will be fixed on top of boundary wall, leaving 75 mm length above the coping and remaining portion embedded in concrete of mix 1:2:4 in preformed holes on top of wall, in such a way that there is a minimum concrete cover of 45 mm allround.

24.1.3.6 Measurements: This shall be same as per Para 24.1.2.5.

24.1.3.7 Rates: This shall be same as per Para 24.1.2.6 except that angle iron posts shall be paid for in weight to nearest kilogram and worked out based on standard tables for gross length of angles used without any deduction for holes and cuts. The rate shall include cutting, splitting, bending etc as per these specifications at no extra cost.

24.1.4 Plain Wire Fencing

24.1.4.1 Plain Wire Fencing will be provided in lieu of barbed wire fencing in some circumstances, if so specified or instructed by Engineer.

24.1.4.2 Materials: Posts and Struts may be of RCC or of angle iron and specifications for same will be as indicated in Paras 24.1.2.1 or 24.1.3.1 respectively. Wire used will be from 1 mm dia strands to IS: 2140

24.1.4.3 Fixing posts and struts will be same as in Paras 24.1.2.3 or 24.1.3.3 respectively

24.1.4.4 Fixing wire: This will be as per Paras 24.1.2.4 or 24.1.3.4, except that the wires will be threaded through the holes preformed in the posts or drilled in angle iron posts. At every 15 posts, corner posts and, they will be secured to the posts by GI wires. At end posts, they will be secured with turnbuckles and straining bolts.

24.1.4.5 Measurements: This will be as per Paras 24.1.2.5 and 24.1.3.6 respectively for RCC post fencing and angle iron post fencing.

24.1.4.6 Rates: This will be as per Paras 24.1.2.6 and 24.1.3.7 respectively for RCC post fencing and angle iron fencing respectively.

24.1.5 Welded Steel Wire Fabric Fencing with RCC Posts

24.1.5.1 Materials: RCC posts and struts shall be as specified in Para 24.1.2.1. Welded steel wire fabric will conform to IS: 4948 and shall be of rectangular mesh 75 x 25 mm size weighing not less than 7.75 kg /sqm.

24.1.5.2 Fixing: of RCC posts and struts shall be as specified in clause 24.1.2.3.

24.1.5.3 Fixing wire mesh: shall be as described in 24.1.2.4 except that instead of barbed wire, steel fabric 900 mm wide will be fixed to the posts by means of GI staple on wooden plugs or tied to 6 mm bar nibs with binding wire. The steel fabric shall be fixed to leave 150 mm clearance at the bottom of and top of the parts.

24.1.5.4 Finishing: The steel wire fabric shall be painted with two or more coats of approved shade of enamel paint over a coat of steel primer as for new work.

24.1.5.5 Chain Link Fencing: Chain link made of GI wires made into meshes of 50 x 50mm size conforming to IS: 4948 shall be fixed to RCC posts and struts, as described in paras 24.1.5.2 and 24.1.5.3. They will not be painted.

24.1.5.6 Measurements and Rates: Measurements and rates shall be as described in Paras 24.1.2.5 and 24.1.2.6 except that the wire mesh fixed shall be measured and paid for in square metre, computed from linear measurements made to nearest cm.

24.2 BOUNDARY MARKS, KM POSTS , CURVE POSTS ETC

24.2.1 Boundary Marks

24.2.1.1 Materials: Boundary stones will be of precast concrete or hard or sound stones of durable quality or precast RCC blocks made in accordance with Standard Drawings. Where no standard drawing exists, following guide lines shall be followed. Dressed stone boundary posts shall be of hard stone like granite, basalt or other approved locally available stones. They shall be sound, free of cracks, fault lines, fissures, holes etc.

24.2.1.2 Dimensions: Precast concrete stones will be at least 900 mm long, of which 450 mm depth will be below ground and 450 mm projecting above ground level and it will be of square cross section of minimum 150 mm sides, unless otherwise specified. The portion above ground may in some cases be made of circular cross section of 150 mm diameter, if so specified. They will be reinforced with four numbers 6mm dia MS bars longitudinally and with 6 mm stirrups at 150 mm spacing and will be made of 1:2:4 mix concrete and finished smooth with cement mortar 1:3 mix. A tolerance of 12.5 mm shall be permitted in the case of specified dimensions. Stones shall be dressed square in cross section of sides 150 mm and be of minimum length 900 mm.

24.2.1.4 Fixing: Boundary stones shall be fixed firmly into the ground to a depth of 450 mm and embedded in foundation concrete of Mix 1:4:8 so as to provide a minimum cover of 150 mm around and extending for a depth of 100 mm below the bottom of the stone. The pit around should be properly filled, watered and tamped in layers and thus well compacted.

24.2.1.4 Spacing: Boundary stones shall be fixed at the railway boundary at spacing as directed by the Engineer. Spacing should be not less than 200 metres alongside the tracks and all sides of the colony or office boundaries, at every point of change of direction. They will be spaced at closer intervals in important stations and railway colonies and railway property located in vulnerable areas as decided by the Engineer.

24.2.1.5 Measurements for Payment
Measurements shall be made in numbers of boundary stones fixed at site.

24.2.1.6 Rate.

The unit rate for boundary stones/ posts shall cover full costs of providing all labour, materials, tools and plant for preparing the boundary stone (in manufacturing PCC or stone including quarrying, cutting and dressing of stone), transport, excavation of pit, concreting for embedment and making good the pits and all incidental charges to complete the work as per these specifications.

24.2.2 Kilometer Posts

24.2.2.1 Location: Kilometer stones and 100 m stones shall be of standard dimensions as given in drawings. They shall be fixed on the cess, clear of ballast sections placed normal to centre line of the track. They shall have the lettering engraved and

painted. Letters will be in black on white background.

24.2.2.2 Materials: Kilometer and other sign posts shall be precast with cement concrete 1:2;4 and finished smooth with cement mortar 1:3. They will be reinforced with a mesh formed of 6mm MS bars or as otherwise directed.

24.2.2.3 Fixing: Trenches 500 mm wide and 450 mm deep shall be excavated to required length to receive the stone, the lower portion of stone shall then be firmly fixed in position in ground and sides filled with earth, watered and rammed and thoroughly consolidated. If so specified, the stones will be fixed in cement concrete 1:4:8 with stone aggregate 40mm nominal size, so that there is 150 mm of concrete in bottom below the stone and 150 mm all round upto formation level. Trenches will, in that case be excavated to required dimensions.

24.2.2.4 Finishing: The exposed surfaces above ground shall be painted with two coats of approved paint in white or as specified over a coat of primer as for new work. The letters (numbers in Roman numerals) will be painted black.

24.2.2.5 Measurements: Kilometer and 100 m stones shall be enumerated as erected.

24.2.2.6 Rates: The rate shall include the cost of materials and labour, tools and plant, handling transport etc involved in all operations, but excluding the costs of excavation, concreting in fixing, painting the surface and numbers for which payment shall be made separately under relevant items of schedule.

24.2.3 Curve posts

Curve posts made in concrete shall be placed at beginning and ends of curves of track on the cess. They will be made in RCC to dimensions given in standard drawings for same. They will be similar to Kilometer posts except that the detailed particulars of curves will be etched and painted on them in English letters and Roman numerals. The lettering shall be in black over yellow background. Specifications will be similar as given in clause 24.2.2 above.

24.3 NAME BOARDS AND SIGN POSTS

24.3.1 Location: Name boards and sign boards shall be of standard dimensions as

given in respective drawings. They shall be fixed on platforms and circulating areas in stations or on sides of roads in colonies at locations and in directions as directed by the Engineer. They shall have the lettering engraved and painted. Letters of specified dimensions will be in black on yellow background.

24.3.2 Materials: Name and sign boards and posts on which they are to be fixed shall be precast with cement concrete 1:2;4 and finished smooth with cement mortar 1:3. Boards will be reinforced with a mesh formed of 6mm MS bars and posts reinforced with appropriate number of MS rods as shown in drawings or as otherwise directed.

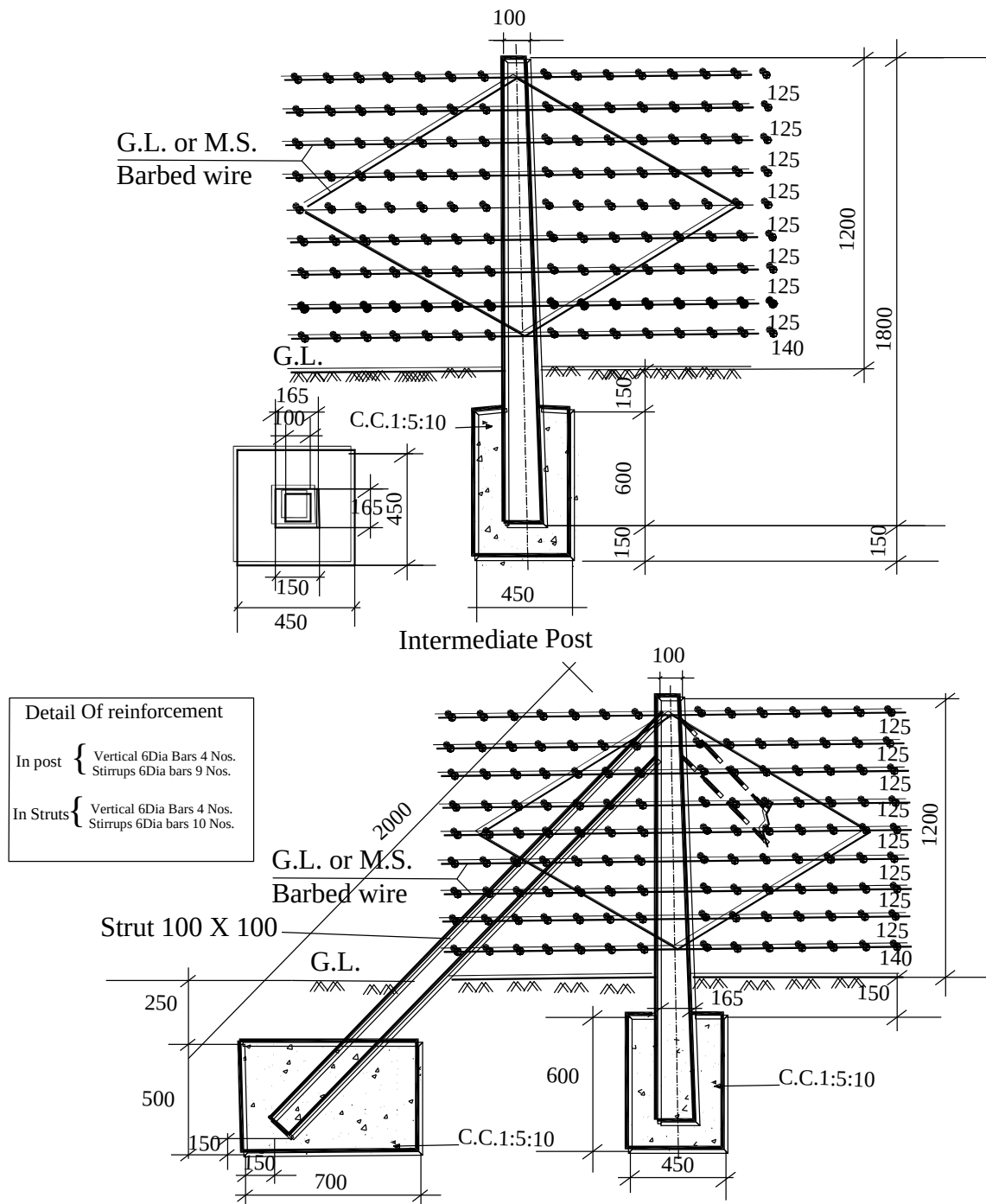
24.3.3 Fixing posts: Pits of size 450 mm x 450 mm and 600 mm deep (or as otherwise directed shall be excavated to receive the posts. The posts shall be fixed in the pits in cement concrete 1:3:6 with stone aggregate 40mm nominal size, so that there is 150 mm of concrete in bottom below the bottom of posts and all round filling the pit upto 100 mm below platform/ road/ ground level.

24.3.4 Fixing Boards: The boards shall be fixed on to the posts by insertion into the grooves or fixed with bolts and nuts in holes provided for same as directed by the Engineer. The gap in the grooves and slots in posts/ slots shall be filled with cement mortar 1:3 and finished flush with surfaces of posts and boards.

24.3.5 Finishing: The exposed surfaces above ground shall be painted with two coats of approved paint in canary yellow or as specified over a coat of primer as for new work. The letters (letters in languages specified and numbers in Roman numerals, unless otherwise directed) will be painted black.

24.3.6 Measurements: Posts and boards shall be enumerated as erected.

24.3.7 Rates.: The rate shall include the cost of materials and labour, tools and plant, handling transport etc involved in all operations, but excluding the costs of excavation, concreting in fixing, painting the surface and numbers for which payment shall be made separately under relevant items of schedule.

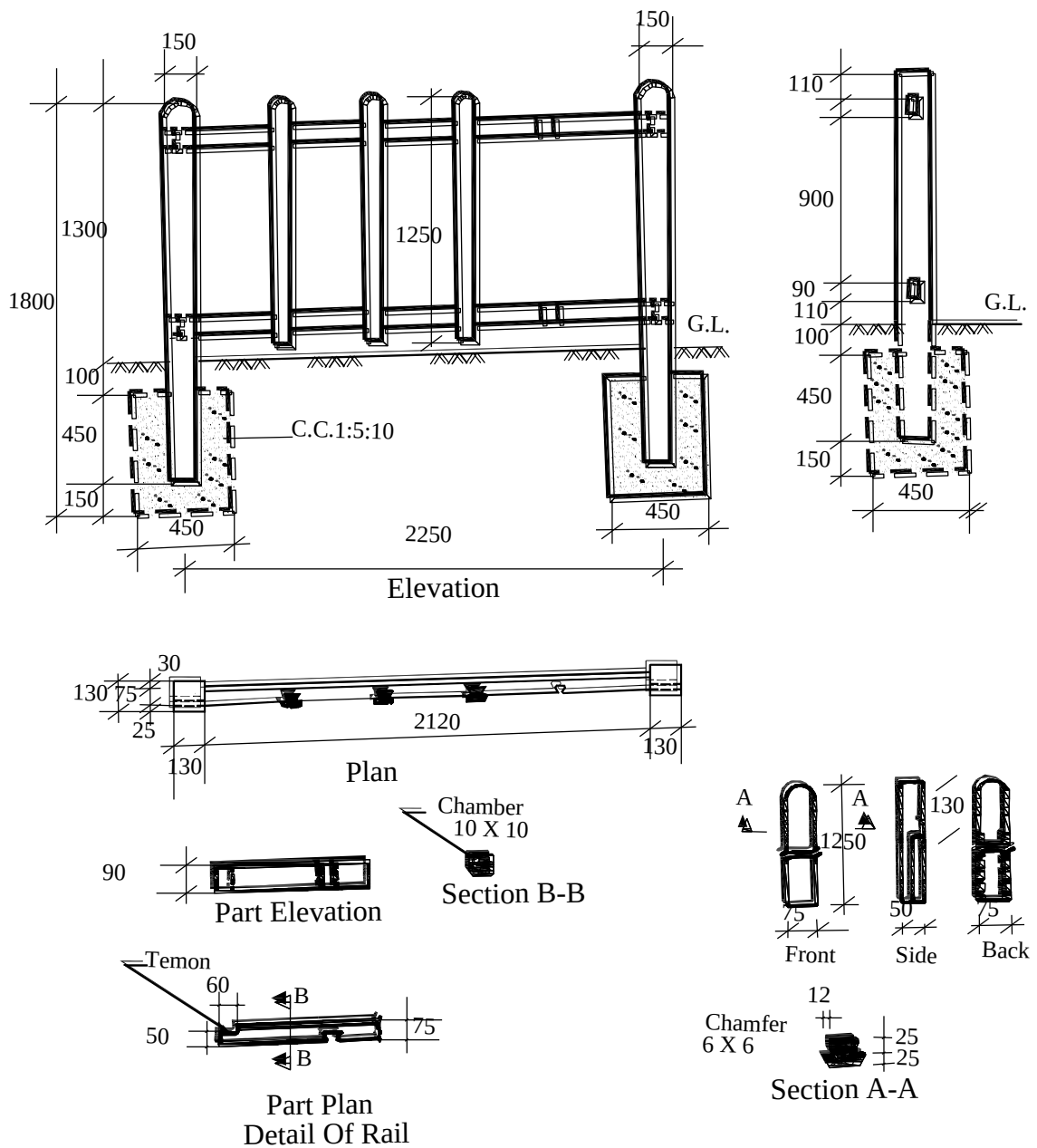


1. In case of end post one Strut shall be omitted.

Drawings are not to scale.

All the dimensions are in MM

Barbed Wire Fencing (With R.C.C. Post)



Fencing with R.C.C. Post ,Rails,Pales

Chapter 25

Supply Of Materials

25.1 **Specification** : Items of general use required for day to day maintenance by departmental staff have been included in this chapter. Specifications for each item shall be as given in the relevant chapter. Where no specification has been given for any particular item, relevant IS Specification shall apply. List of all relevant IS Codes has been given in Chapter 0.

25.2 **Location Of Supply** : The materials are to be supplied at SSE/SE store in the city. In case, the material is to be supplied at a store located at a far away place or way side station extra

payment for leading shall be made separately as per site conditions. Payment for lead shall be made only for the incremental lead on account of location of the railway store.

25.3 **Rates** : Rates include all the element of cost of material, loading at purchase point, unloading and staking in the railway store but do not include re-handling if required. Deductions in quantity / volume for voids shall be made as per specification of relevant item. Rates shall include all the taxes, royalties, octrai etc.