Tools for Plumbing

Introduction

So far, we have studied the importance of plumbing system, its stages and the role and responsibilities of a plumber. We will now look at the various tools that help a plumber perform the plumbing activities effectively. Like any other sector, a thorough knowledge and working of tools and equipment used in plumbing are essential for a plumber to carry out the tasks.

A plumber requires several tools for the fitting work for plumbing, fixing a tap or to carryout repairs. These tools help the plumber in performing his/her work properly, and therefore it is important that the tools are used systematically and handled carefully to avoid any damage. They should be kept at a designated place after use. The tools can be categorised as per the nature of work like holding tools, fitting tools, cutting tools, pipe threading and bending tools, etc.

The major tools used in plumbing are categorised as:

1. *Holding tools*
   (a) Bench vice
   (b) Pipe vice

2. *Fitting tools*
   (a) Wrenches
   (b) Water-pump pliers
   (c) Spanners
3. *Cutting tools*
   (a) Pipe cutter
   (b) Hacksaw
4. *Pipe bending tools*
   (a) Pipe bending machine
   (b) Threading dies
5. *Other tools*
   (a) Chisel
   (b) Hammer
   (c) Chain wrench
   (d) Rover jumper
   (e) Trowel
   (f) Screw driver
   (g) File
   (h) Plier
   (i) Caulking tools
   (j) Drill machine
   (k) Drill bit
   (l) Hanger
   (m) Measuring tape
   (n) Plumb rule and bob
   (o) Spirit level
   (p) Spade
   (q) Shovel
   (r) Pickaxe
   (s) Mortar pan
   (t) Masons' square
   (u) Water level tube

Holding Tools

Tools which are used for holding the pipes, pipe fittings and fixtures for plumbing operations are called holding tools. Some of the commonly used holding tools are mentioned below.

Bench vice

A **vice** is a tool used for holding an object for various tasks like filing, chipping, sawing, threading, tapping,

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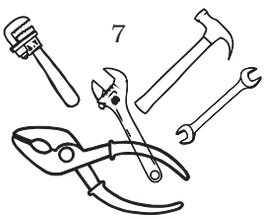


Fig. 2.1: Bench vice

bending, etc. The bench vice has two jaws, one of which is fixed and the other is movable. These jaws are fitted with plates for a better grip on the object during the task. The vice size depends on the width of the jaw. A bench vice is fixed to a table or a bench through a bolt. A vice is opened and closed with the help of a handle attached to a spindle. In this way, the object is held tightly. Bench vices hold the objects and allow use of other tools to complete the tasks (Fig. 2.1).

Fig. 2.2: Pipe vice

Pipe vice

It is a tool used for holding a pipe for carrying out assembly, disassembly, threading, cutting, etc. Pipe vices are of two types:

(i) Open side pipe vice

(ii) Fixed side pipe vice

Standard sizes of vices are 80 mm, 105 mm, 130 mm, 170 mm, etc., as per the opened size of the jaws.

Fitting Tools

While holding tools are used to keep the objects in place, fitting tools are used for carrying out various plumbing operations like cutting, tightening, fixing and other small tasks.

Wrenches

Fig. 2.3: Pipe wrenches

These are hand tools used for tightening and loosening the nuts and bolts. Wrenches hold slippery or small nuts and bolts for loosening or tightening them. Mostly, two types of wrenches are used—adjustable and non-adjustable. These are useful particularly in case of odd-sized nuts and bolts. These tools hold a pipe and pipe fittings for screwing or unscrewing. This is a very common tool, especially for small diameter pipes up to 50 mm.

Adjustable wrench

This type of wrench is used to loosen or tighten the nuts and bolts of any odd and regular sizes. It is used for tightening and loosening valves, cocks, geysers, flexible pipes, etc. It is a good maintenance tool for repair of plumbing items like valves, cocks, pumps, etc.

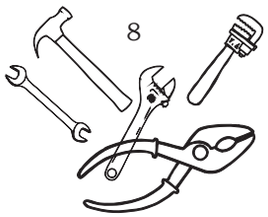


Fig. 2.4: Different type of wrenches (adjustable)

It has a fixed flat jaw with a handle and a square-toothed screw (Fig. 2.5). The movable flat jaw slides in the body of the fixed jaw with the support of a screw. The gap between the flat jaws is used to hold the object to be twisted for screwing or unscrewing.

Fig. 2.5: Adjustable wrench

Water-pump plier

It is a common plier used by plumbers for holding, tightening and loosening work during fixing process.

Steel is used for manufacturing water-pump pliers. These are available in only one standard size of 250 mm length. The maximum width possible between the two jaws is 40 mm (Fig. 2.6).

Fig. 2.6: Water-pump pliers

Spanners

This tool is used for tightening and loosening nuts and bolts of standard size. The standard spanners used are:

Ring spanners

These spanners have full circular closed ring at both ends. It is difficult to slip and cause damage. It is made through forging process, with a burnished finish or a chrome-plating (Fig. 2.7a).

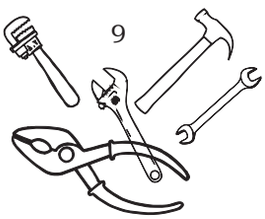
Fig. 2.7a: Ring spanner

Open-ended spanners

These types of spanners are open from both sides and are used for tightening and loosening nuts and bolts (Fig. 2.7b).

A spanner having open-ended jaws slides through the nut or bolt with square or hexagonal heads. The bolts or nuts are then turned with the required force to screw or to unscrew. The two jaws have two consecutive sizes like 6 mm and 7 mm or 1/4″ and 5/16″, etc.

Fig. 2.7b: Open-ended spanner



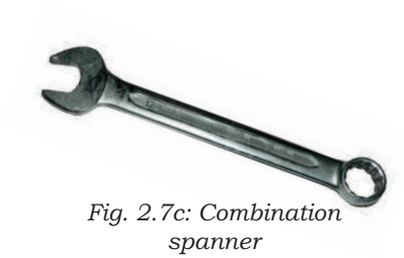


Fig. 2.7c: Combination spanner

Combination spanners

These spanners are open at one end and closed at the other (Fig. 2.7c).

Bi-hexagonal ring spanner

It has a bi-hexagonal shape at both the ends to hold a nut or bolt, the head of which is square or hexagonal. The sizes of the two ends are consecutive like 6 mm and 7 mm, 1/4″ and 5/16″, etc. (Fig. 2.8).

Fig. 2.8: Bi-hexagonal spanner

Cutting Tools

Tools that are used for cutting the pipes, fixtures and bolts, etc., are known as cutting tools. Some of the commonly used cutting tools are mentioned below.

Pipe cutter

This is a manual tool used to cut a pipe at the work site, especially when it is difficult to use a hacksaw frame. This tool has a sharp, round cutting wheel which is pressed with to and fro rotary motion for cutting a pipe (Fig. 2.9).

Fig. 2.9: Pipe Cutter

Hacksaw

This tool is generally used with both the hands. It cuts material like plastic pipe, steel rod, angle iron, sheets, iron pipes, etc. It can also be used for cutting the bolt heads and nuts when they are jammed. Important parts of a hacksaw are—handle, frame, blade and adjusting wing nut (Fig. 2.10).

Fig. 2.10: Hand-operated hacksaw

A hand-operated hacksaw is used for site work while a power hacksaw is used in a workshop for cutting heavy pipes quickly (Fig. 2.11).

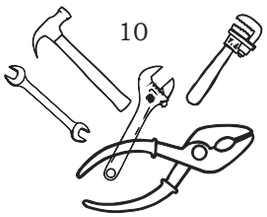
Fig. 2.11: Power hacksaw

Pipe bending tools

In most of the plumbing operations, pipes are required to be bent at different angles as per requirement, for which pipe bending tools are used. Some of these tools are mentioned below.

Pipe bending machine

This equipment is used to bend or turn pipes. The size and strength of the machine depends upon the



diameter of the pipe and the type of the pipe material to be bent. The mechanical or hand-operated pipe bending machines are available for 3/8– 1″ diameter pipes. For higher ranges, i.e., 1/2–2″, 1/2 – 3″, 1/2– 4″ and 2– 6″, hydraulic hand-operated machines are used (Fig.2.12).

Fig. 2.12: Pipe bending machine

Threading dies

Threading is crucial for joining pipes and fixtures effectively. A threading die is used for making threads in a pipe where it is to be joined with another pipe or fixture (Fig. 2.13).

Fig. 2.13: Threading die

Other Tools

Apart from the already mentioned holding, fitting, cutting and bending tools, various other tools are also used in plumbing operations. These are listed below.

Chisel

It is made of hard metal and is mostly used for cutting concrete surface and making grooves in the walls with the help of a hammer. (Fig. 2.14)

Fig. 2.14: Chisel

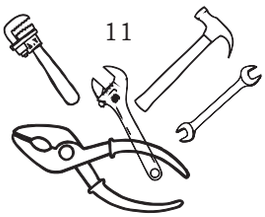
Hammer

These are general purpose workshop hand tools used for straightening of sections, riveting, striking of nails and inserting the component by striking, inserting keyways and fitting by striking. The hammer consists of a head made of hard and tampered steel, and a wooden handle. The head has a flat striking face and the other side is called pein. The peins are classified as per different shapes such as ball pein, cross pein and straight pein. The hammers made of hardened steel are known as engineer's hammers and are usually used while working with steel components. A one-kilogram hammer is the most commonly used hammer (Fig. 2.15).

Fig. 2.15: Hammers

Chain wrench

The common holding tools do not help much in case of large diameter pipes. For these, chain wrenches are used. A chain wrench consists of a toothed block, a



handle and a chain. The chain is round, grooved and held on the toothed end of the block. The chain grips the pipe fitting and screws or unscrews. The chain wrench is available in 3″, 4″, 6″, 8″ and 12″,with the length 475 mm, 585 mm, 834 mm, 1100 mm and 1360 mm respectively. These sizes are designated by the maximum diameter of the pipe it can hold (Fig. 2.16).

Fig. 2.16: Chain wrench

Screwdriver

This tool is often used by plumbers to fit the screws. Screwdrivers have a sharp tip which can easily fit into various screws. Different types of screwdriver are used for various types of screw. Various types of heads of the screwdriver are used by plumbers (Fig. 2.17).

Fig. 2.17: Screwdriver

Files

These hand tools are used for a variety of work, like removing of sharp edges, metal removal, shaping of jobs, smoothening of surfaces, finishing, producing different shapes, etc. The file has five parts: tang, heel, face, edge and point or tip. Various types of files of different shapes like hand round, pillar, square, three square, half round, flat, knife edge and needle file are used as per the work (Fig. 2.18).

Fig. 2.18: File

Pliers

They are important tools used for holding small objects and for tightening or loosening various parts. Several types of pliers are used by a plumber during work. Pliers can be used for cutting purpose also. Various shapes and sizes of pliers are available in the market. Pliers of different types are shown in Fig. 2.19.

Fig. 2.19: Plier

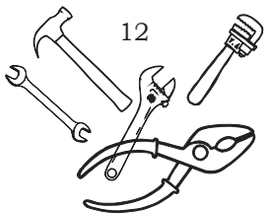
Caulking tools

For filling the gaps in the wall, caulking tools are used. This tool helps in filling and removing material in the building (Fig. 2.20).

Fig. 2.20: Caulking tools

Drill machine

One of the common but important tools used for making a hole in a metal or wood, or concrete surface. A drill



machine (Fig. 2.21) is fitted with a cutting tool like a drill bit. The attachment is tightened with a key.

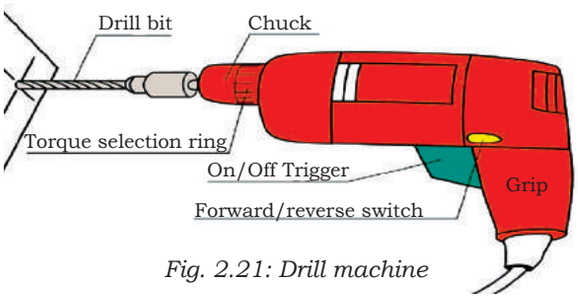


Fig. 2.21: Drill machine

Safety precautions

Before installing the bit in a drill machine, it should be sharpened.

The key in the chuck, a part of the drill machine used for tightening the drill bit, should be removed after tightening.

Drill bits

These are the tools used to make cylindrical holes by cutting the material. Bits are fitted in a tool which rotates it and make the hole. For non-cylindrical shaped holes, specialised bits are used (Fig. 2.22).

Fig. 2.22: Drill bits

Hangers

The purpose of a pipe hanger is to hold or support a pipe or a group of pipes from a slab, beam, ceiling or other structural elements (Fig. 2.23).

Fig. 2.23: Pipe hangers

Measuring tape

It is used for measuring the length of an item. The measuring tape is manufactured in various material like steel, cloth and PVC. The length range available is one metre, two metres, three metres, five metres, 10 metres, 15 metres, etc. (Fig. 2.24).

Fig. 2.24: Measuring tape

Plumb rule and bob

This is a useful tool to ensure verticality and uniformity during construction of walls, columns and wooden frames like doors and windows. It also helps in levelling the surface of the floor. It consists of a holding pipe, thread and a plumb bob made of wood and metal. The plumb bob is connected to the holding pipe with the thread (Fig. 2.25).

Fig. 2.25: Plumb bob

Spirit level

It is used to check the horizontality or levelling of the floor, roof, door, window frame, etc. (Fig. 2.26).

Fig. 2.26: Spirit level

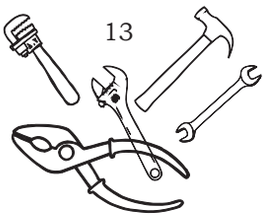


Fig. 2.27: Trowel

Trowel

It is used for mixing cement and sand for masonry work. It is used for plastering the surface (Fig. 2.27).

Fig. 2.28: Spade

Spade

A spade is used for digging purpose and for mixing cement, sand and concrete. It consists of a flat form made of steel with an eye hole to hold the wooden handle. The size of a spade is designated by its width and length of the plank (Fig. 2.28).

Fig. 2.29: Shovel

Shovel

It is used for mixing concrete and also for carrying concrete to mortar pans. Shovels are made of steel sheets. The size is designated by its length and width (Fig. 2.29).

Fig. 2.30: Pickaxe

Pickaxe

It is made of steel and is used to excavate hard soil. One end of the pickaxe is flat whereas, the other end is sharp in design (Fig. 2.30).

Fig. 2.31: Mortar pan

Mortar pan

This is used to carry the excavated material, cement mortar, concrete, etc. It should never be used for measurement of mixed cement mortar, etc. Mild steel sheet is used for making mortar pan (Fig. 2.31).

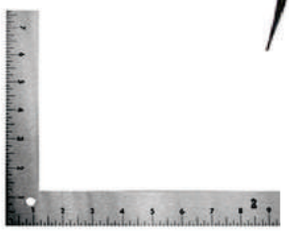


Fig. 2.32: Mason's square

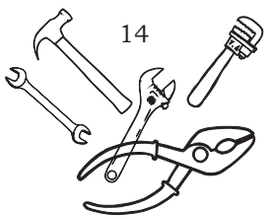
Mason's square

It is used to check rectangularity of external and internal corners. It is made of carbon steel sheet. The dimension is also marked on both the sides, either in inch or centimetre (Fig. 2.32).

Fig. 2.33: Water level tube

Water level tube

This tube is used to check and transfer water levels, etc. Water is poured inside the tube at the time of use. Polythene tubes of varying diameter from 10 to 15 mm, and lengths varying as per the requirement are used (Fig. 2.33).



Rover jumper

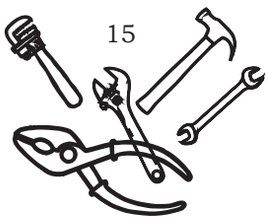
It is used for making a gap in the wall so that plumbing fixtures can be fixed (Fig. 2.34).

Fig. 2.34: Rover jumper

Safety during work

The following precautionary measures may be taken for the safe use of the plumbing tools.

1. Use the correct methods given in the 'Instruction Manual of tools' while using them.
2. Use the appropriate tools required for the specific work or job. For example, do not use pliers instead of a hammer; use only a hacksaw to cut.
3. Keep the tools in working condition and ensure the required maintenance.
4. Ensure that the necessary protective equipment are available.
5. Follow safety methods while using electrical wires.
6. Use kerosene oil for removing dust from rusty nuts.
7. Do not use tools without a handle as they may not give proper grip.
8. Remove burrs or stuck material from the head of the chisel and the edges of tools.
9. Wear safety glasses while using power tools like a drill machine.
10. Keep metal parts lightly lubricated.
11. Do not apply excessive pressure or force.
12. Inspect the tools regularly.
13. Use or wear safety gear (helmet, gloves, goggles, safety shoes, ear plugs, etc.).



Practical Exercises

Activity 1

Draw figures of plumbing tools.

Material Required

1. Pen
2. Pencil
3. Plumbing tools

Procedure

1. Collect the plumbing tools available in your classroom.
2. Make a list of the plumbing tools available.
3. Draw figures of the plumbing tools and label them.

Activity 2

Draw figures of masonry tools.

Material Required

1. Pen
2. Pencil
3. Masonry tools

Procedure

1. Collect the masonry tools available in your classroom.
2. Make a list of the masonry tools available.
3. Draw figures of the masonry tools and label them.

Check Your Progress

A. Answer the following questions

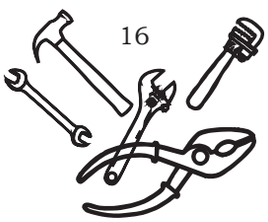
1. List down the different plumbing tools and their uses.
2. Differentiate between the fitting tools and cutting tools.
3. What are the different parts of a drill machine?
4. What are the methods adopted for safe handling of the pipe cutter, pipe bending and drilling machines?

B. Fill in the blanks

1. The bench vice is a type of _____tool.
2. The instrument which is used to check rectangularity of external and internal corners is called _____.
3. For excavating hard soils, _____ is used.
4. _____ is a tool used for making a hole in a metal, wood or concrete.
5. A chisel is used for _____ and joining works.

C. Match the following

Column A	Column B
(1) Spanner	(a) Holding tool
(2) Hacksaw	(b) Fitting tool
(3) Threading dies	(c) Cutting tool
(4) Bench vice	(d) Pipe bending tool



Unit 5

Pipe Fittings, Joints and Valves

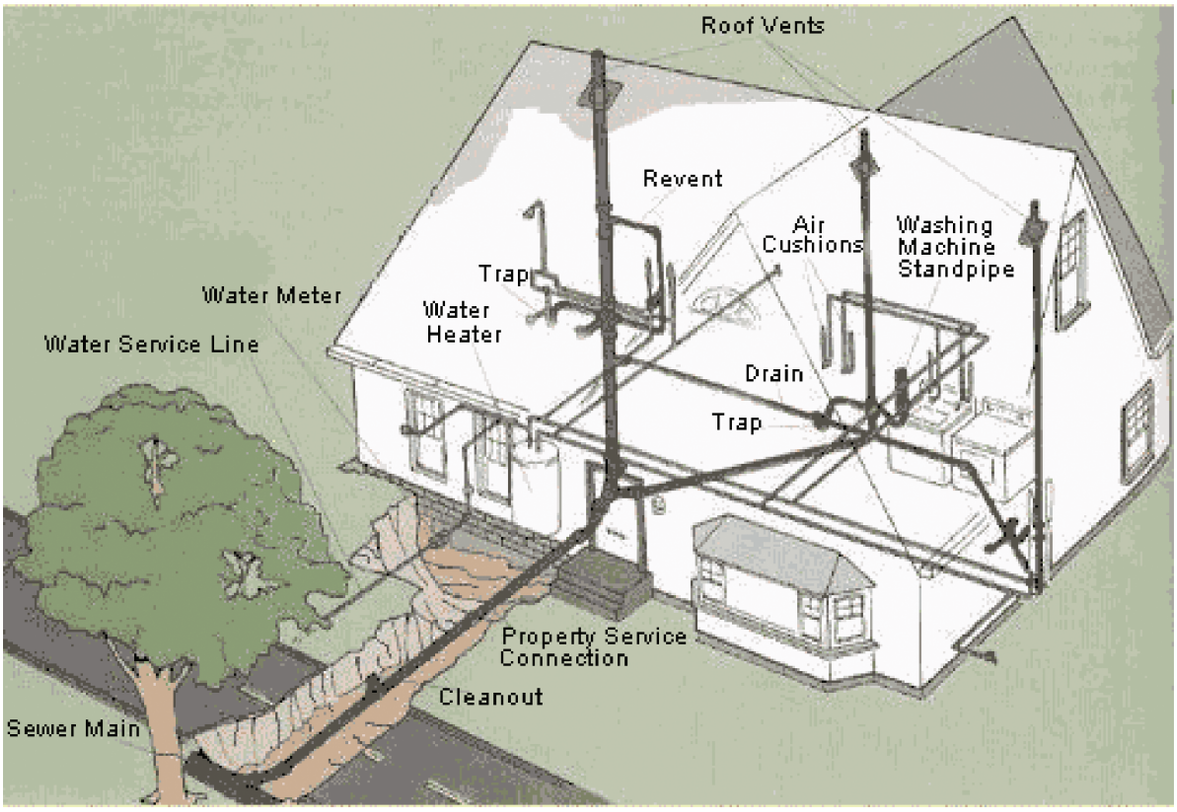


Fig. 5.1: Layout of pipeline (internal) in a building

Introduction

In Unit 4, we studied the importance of measurements in carrying out various plumbing tasks. At the same time,

a plumber must also have knowledge of the various pipe fittings like elbow, union, gasket, etc., joints and valves, and where these should be used while carrying out the tasks. Not only does this help in smooth functioning, but also ensures cost-effectiveness. For proper installation of the plumbing system in a building, various types of joints are used, which are shown in Fig. 5.1. As already mentioned, various types of fittings like elbow, gasket, union, etc., are used for making joints. It helps in changing the direction of water supply from main pipes to subsidiary pipes. Proper fitting also helps in checking leakage in the plumbing lines.

Pipe Fittings

Pipe fittings are an important component of the plumbing system. In plumbing, many types of fixtures are joined with the help of various types of material as per the requirement. Fittings are fixed in the plumbing system to join straight pipes or any section of tubes. We can say that the water-supply fittings like elbow, tee, socket, reducer, etc., are fitted to change the direction of flow, distribute the water supply from the main pipe to other pipes of equal size or lower size, etc.

Any part used in connection with water supply, distribution, measurement, controlling, use and disposal of water is known as a pipe fitting (Fig. 5.2).

Fig. 5.2: Pipe fittings

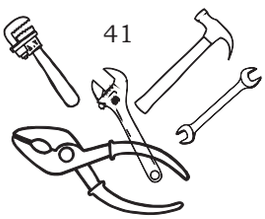
Type of Fittings

1. Collar
2. Elbow
3. Gasket
4. Union
5. Reducer
6. Tee
7. Nipple
8. Trap

Collar

While joining two pipes in the same length, collar is used. Collar is fitted in the end of pipe (Fig. 5.3).

Fig. 5.3: Collars



Elbow

It is installed at the time of joining two pipes. With the help of an elbow, the direction of liquid is changed. Normally a 45° or 90° elbow is used. When the two sides of pipes differ in size, an elbow of reducing size is used. This is called reducing type elbow or reducer type elbow. Elbows are categorised as follows—

Long Radius (LR) Elbows

Here, the radius is 1.5 times the diameter of pipe.

Short Radius (LR) Elbows

In this, the radius is 1.0 times the diameter of pipe.

90° Elbow

This is used when the change in direction required is 90° (Fig. 5.5).

45° Elbow

This is used when the change in direction required is 45° (Fig. 5.4).

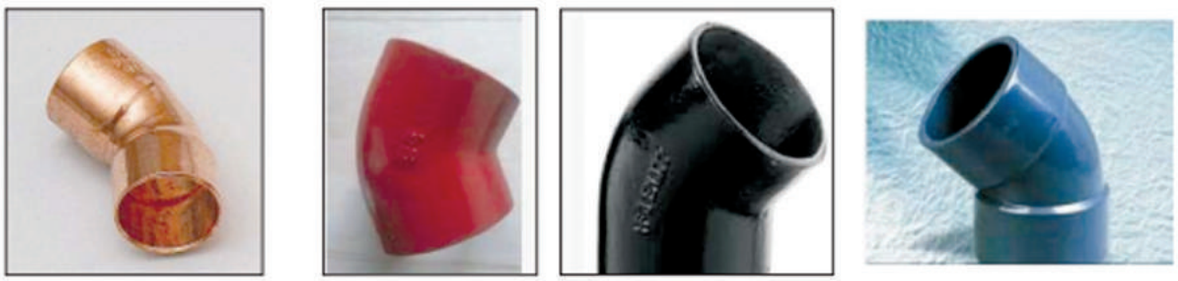


Fig. 5.4: Bend 45°

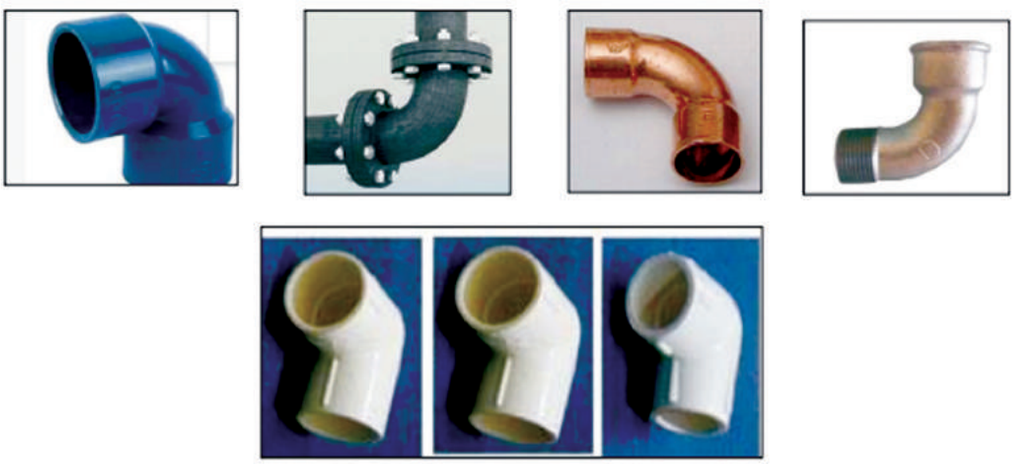


Fig. 5.5: Bend 90°

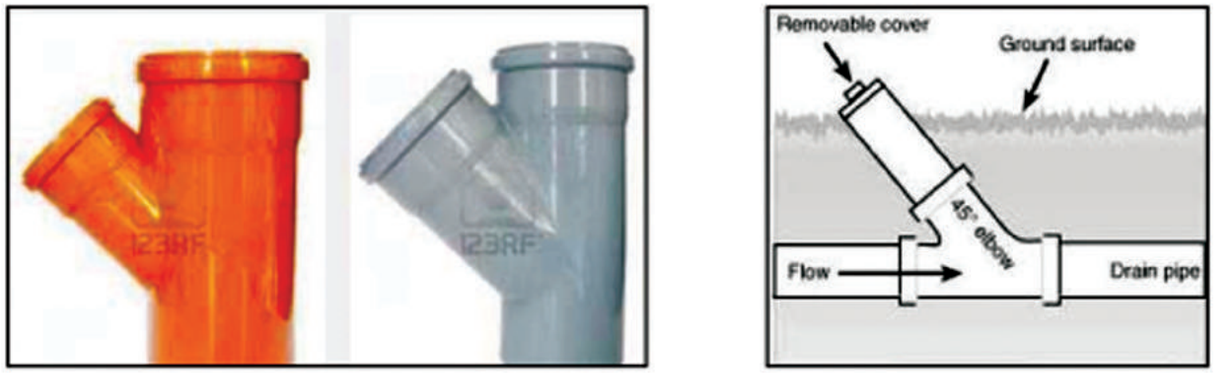


Fig. 5.6: Y-T Joint

Fig. 5.7: Double Y-T Joint-1

Fig. 5.8: Double Y-T Joint-2

Fig. 5.9: T Trap

Gasket

Fig. 5.10: Gasket

They are mechanical seals, generally ring-shaped type and fitted for sealing flange joints. A flange joint is a plate or ring to form a rim at the end of a pipe when fastened to the pipe. Gaskets are made as per by construction, materials and features. Important gaskets used are non-metallic, spiral-wound and ring-joint type (Fig. 5.10).

Union

Fig. 5.11: Union

When two ends of pipes are joined, the pipe fitting used is called union. A union is made of three parts namely a nut, a male end and a female end. The male and female ends are assembled with the support of the nuts, and necessary pressure is made to connect the joint. Since the pairing ends of the union are interchangeable, the union can be changed easily in a short time (Fig. 5.11).

Reducer

It is used to connect pipes of different diameters. A reducer may be of various types like reducer tee, reducer elbow and reducer socket (Fig. 5.12).

Fig. 5.12: Reducers

Tee

It is an important fitting with a side outlet at 90^0 to the run of the pipe. Tees connect pipes of various diameters and help in changing the direction of water or material in a pipe. Tees are made in various sizes like equal or

unequal. The equal tee is most commonly used (Figs. 5.13–5.15).

Fig. 5.13: Single tee socket

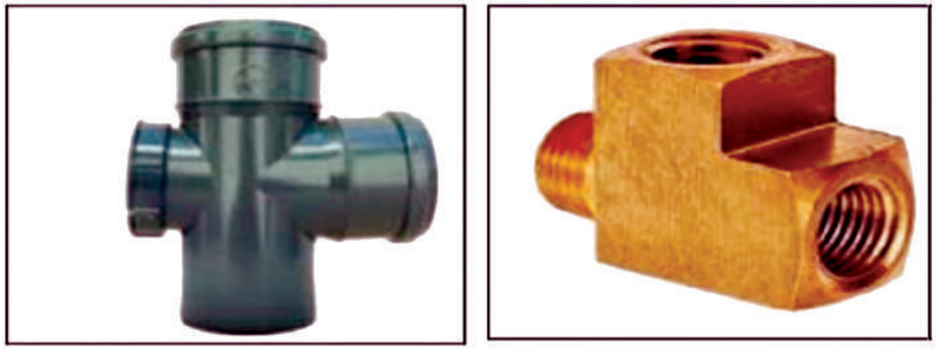


Fig. 5.14: Single tee socket

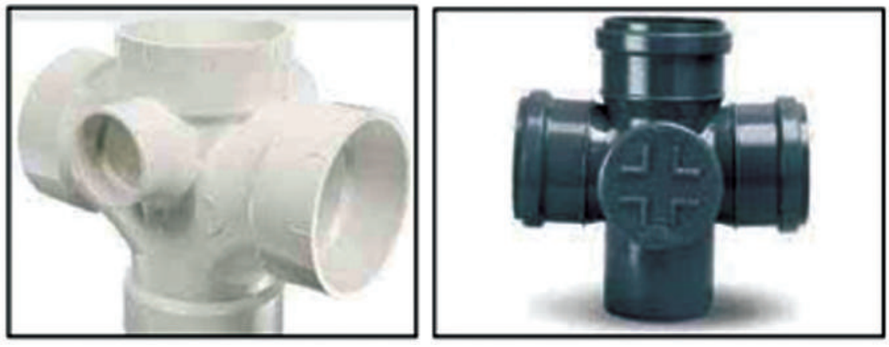


Fig. 5.15: Double tee socket

Nipple

It is a piece of pipe having thread at both sides, and could be used for short extension of plumbing lines. It

Fig. 5.16: Nipple

can also be used for connecting two fittings within small distance (Fig. 5.16).

Trap

It is a fitting in a P, U, S or J-shaped type (Fig. 5.17). Traps are fitted near a plumbing fixture. The trap bend is fitted to prevent sewer gases from entering the building. If the gases are inserted back into home, then it could lead to people inhaling foul smell, which could cause illnesses. It could even explode.

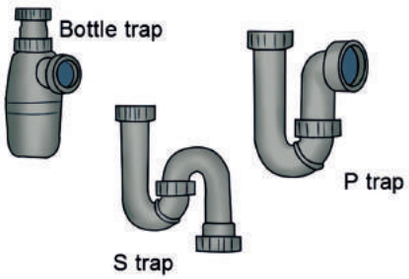


Fig. 5.17: Trap

Cross

When four pipes are joined,a cross is formed. It is also called a cross branch line or a four-way fitting (Fig. 5.18). This fitting has three outlets and one inlet. Cross fittings may deteriorate when temperatures change, because cross fitting is made at the centre of the four connection points.

Fig. 5.18: Cross

Offset

When an assembly of fittings on a pipeline makes one section of pipe out of line and parallel to a second section, then it is known as an offset (Fig. 5.19).

Fig. 5.19: Offset

Laying of GI Pipes in Buildings (Internal Work)

GI (galvanised iron) pipes in the internal work of a building are laid either on the surface or concealed in the wall. For fixing on the surface, the pipes should be kept 1.5 cm apart from the wall and should be laid perfectly vertical or horizontal. The pipes should be held in pipe clamps which are embedded in the wall, roof, etc., with cement mortar 1:3 (1 cement: 3 coarse sand) (Table 5.1).

Table 5.1: Pipe clamp spacing

Diameter of pipe(mm)	Horizontal length (metres)	Vertical length (metres)
15	2.00	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

The following points should be kept into consideration during laying of pipes.

1. GI pipes should not come in contact with lime or lime-mortar. They should be treated with anti-corrosive paints.
2. Whenever a pipe passes through a wall, provision of expansion should be made.
3. Under the floors, the pipes must be placed in the layer of sand to allow expansion.

Pipe Joints

Pipes are connected with the help of joints. A variety of joints are used in an assembly of pipes. Connecting two or more pipes together is called a fitting. Various types of joints could be used in a pipe as per the requirement. Joints are also used for multiple pipe connections, and are an important component of the plumbing system. Generally, the pipe joint fitted can easily sustain the pressure created in the pipe.

Types of pipe joints

Various types of pipe joints are as follows.

1. Threaded joint
2. Welded joint (butt welded, socket welded)
3. Brazed joint
4. Soldered joint
5. Grooved joint
6. Flanged joint
7. Compression joint

Threaded joint

When pipes are joined by screwing in threads which are provided in the pipe, it is called a threaded joint. In this

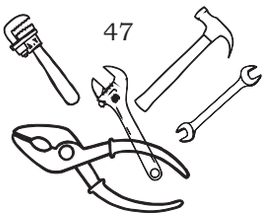


Fig. 5.20: Threaded joint

joint, one of the pipes has internal threads whereas the other pipe has threads externally. Thethreads are also made in various pipes like PVC, CI pipes, copper pipes and GI pipes, etc. (Fig. 5.20).

Threaded joints are used from 6 mm diameter to 300 mm diameter pipes.

Welded joints (Butt-welded joints)

It is one of the most common methods of joining pipes used in large infrastructure like commercial, institutional and industrial systems. Cost of material are low, but the labour costs are more due to the non-availability of trained welders and fitters. (Fig. 5.21).

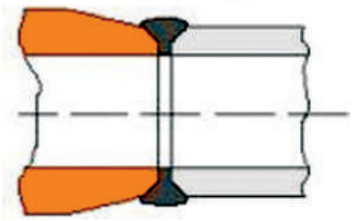


Fig. 5.21: Welded joint

Socket-welded joints

These are used when there is a high chance of leakage in the joints. Pipes are joined as putting one into other and welded around the joint, as shown in Fig. 5.22. Pipes having different diameters are suitable for this type of a joint. Socket-welded joint gives good results as compared to other joints.

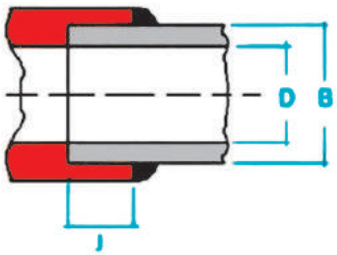


Fig. 5.22: Socket-welded joint

Brazed joints

When pipes are joined with the help of molten filler material at above 840°C, it is called brazing. Brazing is done for connecting copper pipes or copper alloy pipes. It is important to note that the melting point of the parent material (pipe material) should be higher than the filler material. Brazed joints have less mechanical strength, and are preferred in case of moderate temperatures (Fig. 5.23).

Fig. 5.23: Brazing

Soldered joints

Soldering and brazing are similar activities. In soldering, the filler material melts below 840°C. With the help of soldering, copper and copper alloy pipes are joined. During soldering, flux or metal joining material is used to prevent oxidation due to the flame. Soldered joints are suitable for low temperature areas and have low mechanical strength (Fig. 5.24 and Fig. 5.25).

Fig. 5.24: Brazed and soldered joint

Grooved joints

Fig. 5.25: Solder joint

When two pipes are joined together by making grooves (narrow cuts or depression) at the end of pipes with the help of sockets or couplings, such joints are called grooved joints. Due to the ease of assembly of the grooved joints, the labour cost is less. The piping system can be easily uninstalled and reinstalled frequently for maintenance (Fig. 5.26). These are mostly used for fire protection.

Fig. 5.26: Grooved joint

Flanged joints

This joint is commonly used for joining pipes in pumping stations, filter plants, hydraulic laboratories and boiler houses, etc. (Fig. 5.27). These joints are preferred due to easy process of assembly and disassembly, however these connections are costly. These joints can be disassembled and re-assembled when required. A pipe has flanged ends on both sides of the pipe length. Both the ends of pipes are joined at a proper level near one another. A hard rubber washer is placed between flanges and bolted. Flanges are generally fixed to the pipe by welding or threading. In certain cases, a flange-type joint is also called a lap joint. It may also be made by forging the process and machining the pipe end. There is no leakage in flanged joints even after rapid temperature fluctuations.

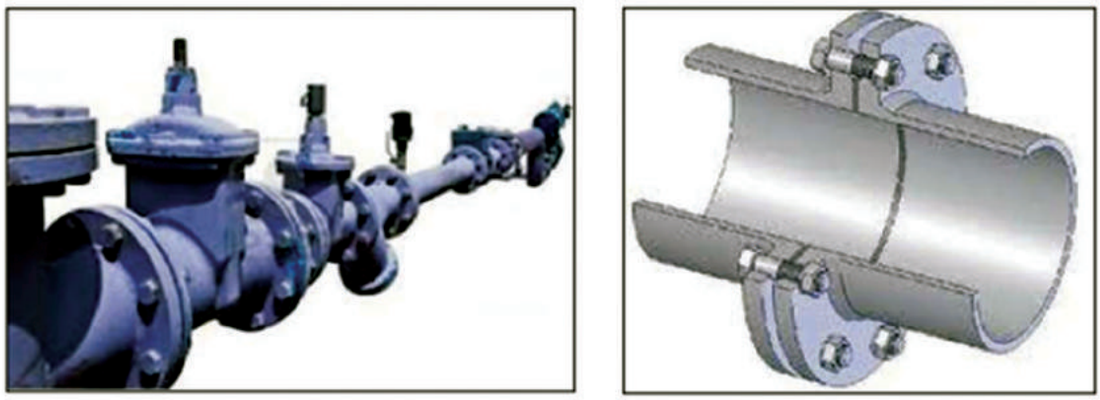
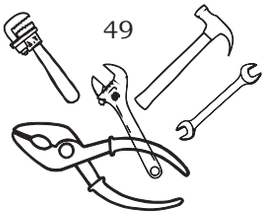


Fig. 5.27: Flanged joints



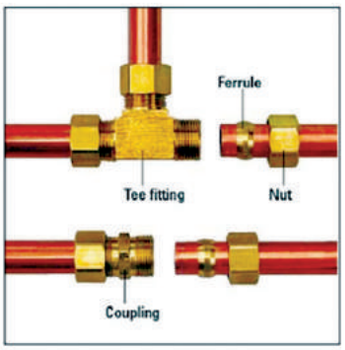


Fig. 5.28: Compression joints

Compression joints

These are applied to join the pipe without any preparations. The cost of installation of these joints is very economical. The pipes having plain ends are joined by fixing fittings at their ends, and such a joint is called a compression joint. The pipe ends are joined with threaded fittings or couplings. Joints are placed properly to check the flow pressure, otherwise, leakage may occur. These fittings are manufactured from different types of material. Selection of fittings is done as per requirement (Fig. 5.28).

Valves

For proper functioning of the pipeline, valves made of iron or brass are used in the water-supply mains. Valves stop or control the flow of fluid like liquid, gas, condensate, etc. These are classified according to their usage like isolation, throttling and non-return corrector. Various types of valves are manufactured depending upon their use and type of construction.

Fig. 5.29: Sluice valve

Sluice valve

It is fitted at an important place like at the entrance of a pipe. It may be the start of a new pipe from a tank, or a number of branches from the tank. This valve isolates the water-supply, as and when required. The sluice valve is specified by the pipe bore (diameter) of the water-way. The standard sizes are 50 mm, 65 mm, 80 mm, 100 mm, 150 mm, 200 mm, 250 mm and 300 mm. The sluice valves are classified as Class 1 and Class 2 (Fig. 5.29 and Table 5.2).

Table 5.2: Test pressure in sluice valve

Class	Test Pressure kg/cm²		Max. working Pressure kg/cm²
	Body	Seat	
Class 1	20	10	10
Class 2	30	15	15

Scour valve

This valve is provided at the lower level in a pipeline, so that such sections can be supplied and drained for maintenance purpose. The water is distributed into natural drains. It is basically a sluice valve and the very nature of its use has created the difference in the name (Fig. 5.30).

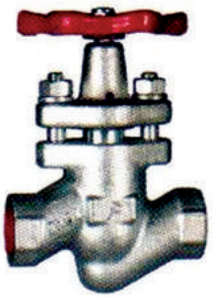


Fig. 5.30: Scour valve

Air valve

It is fitted to release the air automatically when the pipe is filled with water. This valve also permits entry of air when the pipe is drained. This valve is fixed at the end of a communication pipe and controls or stops the supply of water. This valve is specified by the standard bore (diameter) of the socket or pipe outlet, to which it is fitted. The standard sizes are 8 mm, 10 mm, 15 mm, 20 mm, 25 mm, 32 mm, 40 mm and 50 mm (Fig. 5.31).

Fig. 5.31: Air valve

The body components and washer plate are made of cast brass or leaded tin bronze. The washers are made from fibre, leather, rubber or nylon. This valve is available in two types: internally threaded and externally threaded.

Gate valve

It is used for starting or stopping flow. For a straight-line flow of fluid, minimum flow restriction can also be done with gate valve. In service, these valves are generally either fully open or fully closed. These valves are used for various types of liquids and make a tight seal when closed.

Fig. 5.32: Split taper non-rising gate valve

Types of gate valve

Gate valves have gates of wedge type, solid or split type, or gate of double disc or parallel type. The movement of the gate shall be by the internal or external screw on the spindle. The spindle, which controls the flow of a liquid, can be of the rising or non-rising type. See Fig. 5.32 and Fig. 5.33.

Fig. 5.33: Rising spindle split wedge gate valve

Parallel slide valve

It has two discs without spreading mechanism which slides between the two parallel body seats. The activation

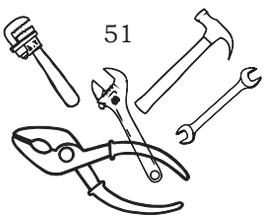


Fig. 5.34: Parallel slide valve

Fig. 5.35: Globe valve

Fig. 5.36: Angle valve-1

Fig. 5.37: Angle valve-2

Fig. 5.38: Check valve or non-return valve

Fig. 5.39: Ferrule

of the valve discs is by the internal and the external screw on the spindle and the spindle may be of the rising or non-rising type (Fig. 5.34).

Globe valve

It is a type of valve used for controlling flow in a pipeline. A component of valve includes a movable disc element and a stationary ring seat fitted in a generally spherical body. The globe valve is used for controlling flow control (Fig. 5.35).

Angle valve

It is used to control the movement of a fluid like liquids, gases, fluidised solids, or slurries by opening, closing or partially obstructing various pathways. This type of a valve generally has a round body, in which the body ends are fitted at right angles with each other and the disc moves up and down. The valve is moved to action by the internal or external screw on the spindle. The spindle may be of the rising or non-rising type. See Fig. 5.36 and Fig. 5.37.

Check valve or non-return valve

It is a valve which permits (fluid) water to move in one direction but checks all the returning flow. It is operated by the pressure above, having no external means of control (Fig. 5.38).

Ferrule

It is used for connecting a service pipe to the water main. It is usually made of non-ferrous metal and screwed to the main pipe (Figs. 5.39–5.42).

Foot valve

It is a valve used in the pump. It is also called check valve, as it makes sure that the pump is ready to use. If

Fig. 5.40: Swing check

Fig. 5.41: Horizontal check

Fig. 5.42: Vertical check

the pump is off, then the foot valve keeps enough fluid in the pump to ensure that it can start again. In a well, the foot valve will be between the water surface and the pump. In a water intake system, the foot valve will be at the end of the water intake line. The foot valve has a strainer on the outside which prevents obstructions also (Fig. 5.43).

Fig.5.43: Foot valve

Float valve

It is used for stopping water when the water tank or flush toilet is filled, so that it stops overflowing. When the water level rises, the float also rises; once it rises to a pre-set level, the water level forces the lever to close the valve and stops the water flow. A float valve is a fitting used for filling water tanks as well as flush toilets (Fig. 5.44).

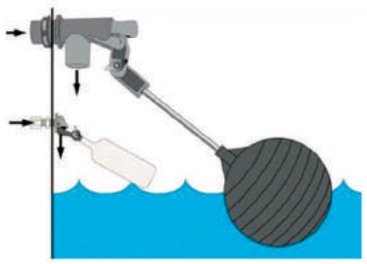


Fig. 5.44: Float valve

Practical Exercises

Activity 1

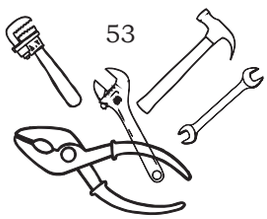
Prepare a list of fittings available in the market.

Material Required

1. Different types of fitting
2. Notebook
3. Pen

Procedure

1. Survey the local market.
2. Visit the plumbing hardware shop.
3. Identify the fittings available in the shop.
4. Prepare a list of the identified fitting items seen in the market.
5. Note down the cost of the fitting items and their manufacturing company's name.



Activity 2

Draw figures of the various types of bends.

Material Required

1. 45° and 90° bend
2. Notebook
3. Pen

Procedure

1. Inspect the plumbing items fitted in the school.
2. Identify the bends fitted.
3. Draw the figures of bends in your notebook.

Activity 3

Practice joining a pipe.

Material Required

1. Joints
2. Pipe
3. Tools

Procedure

1. Collect the pipe joints, pipes and tools.
2. Identify the components.
3. Collect the joints.
4. Join the pipe with the help of proper pipe joining tools.

Activity 4

Draw the figure of joints.

Material Required

1. Threaded joints, grooved joints and compression joints
2. Pen
3. Pencil

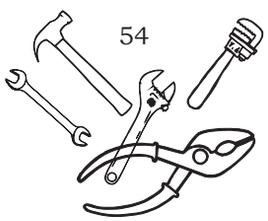
Procedure

1. Collect the figures or joints of threaded joints, grooved and compression joints.
2. Draw the figure of the joints.

Check Your Progress

A. Answer the following questions

1. Why are fittings used in plumbing? Write a short note on any four types of fittings.



2. Why are joints necessary? Discuss in detail, with suitable figures.
3. State the difference between threaded joint and a welded joint.
4. Explain the importance of valves. Write about two types of valves and their uses.
5. What is the role of a float valve? List down its uses and advantages.

B. Mark the correct option

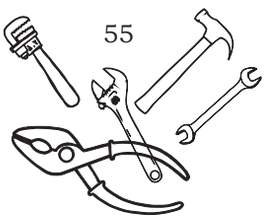
1. Which of the following fittings is used to connect two pipes with each other?
   (a) Tee (b) Connector
   (c) Elbow (d) All of the above

2. Which of the following fittings is used to connect four pipes?
   (a) Offset (b) Union
   (c) Cross (d) Reducer

3. The valve which avoids both overflow and back flow of water is_____.
   (a) float valve (b) angle valve
   (c) foot valve (d) check valve

C. Match the following

Column A	Column B
1. Nipple	(a) 
2. Ferrule	(b) 
3. Soldered joint	(c) 
4. Foot valve	(d) 



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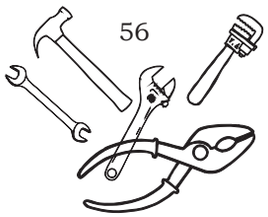
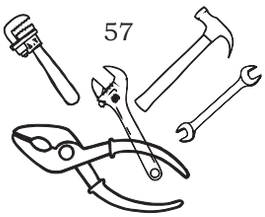


Answers

Unit	Fill in the blanks	Match the following	Mark the correct option	Full forms
1.	1. Water 2. Plumbing fixtures 3. Pipes 4. Installation, repair, maintenance, servicing		1. (c) 2. (d) 3. (d) 4. (a)	
2.	1. Holding 2. Mason's square 3. Pickaxe 4. Drill machine` 5. Cutting	1. (b) 2. (c) 3. (d) 4. (a)		
3.			1. (c) 2. (a) 3. (b)	1. Galvanized Iron 2. Asbestos Cement 3. Unplasticised Polyvinyl 4. Cast Iron
4.	1. 12 2. 1.09 3. 2.2046 4. 4.546 5. 27.68 6. 1		1. (b) 2. (b) 3. (d)	
5.		1. (d) 2. (c) 3. (b) 4. (a)	1. (d) 2. (c) 3. (a)	



Glossary

Assembly: *Process by which part samples (belonging to the same assembly standard [RFC]) are connected to one another. Assembling two basic parts always results in a new, larger composite part that can be used in future assemblies.*

Bending: *A technique used in various metal forming processes with the aim of increasing the fabrication capabilities of plumbing fixtures. The pipe can be bent at varying angles and in different directions. The simplest curve turns the tube at an angle of 90 degrees forming an elbow. Besides, pipe bending can be done in several other geometries that include 2D and 3D dimensions.*

Chipping: *Removal of wood, spatter, rust or old paints from iron work or plumbing work using hammer and cold chisel.*

Die: *It is used to cut or form the male portion of the mating pair (for example, a bolt).*

Disassembly: *When referring to hardware, disassembly is the process of breaking down a device into separate parts. A device may be disassembled to help determine a problem, to replace a part, or to take the parts and use them in another device or to sell them individually.*

Drilling: *Process of creating a smooth hole in a material with a drill and motor.*

Filing: *Process of removing excess material and deburring the surface. Sandpaper may be used as a filing tool for material, such as wood.*

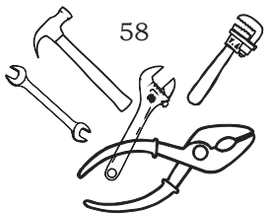
Sawing: *Process wherein a narrow slit is cut into the workpiece by a tool consisting of a series of narrowly spaced teeth, called a saw blade. Sawing is used to separate work parts into two or more pieces, or to cut off an unwanted section of a part.*

Tap: *It is used to cut or form the female portion of the mating pair (e.g., a nut).*

Taps and **dies:** *Tools used to create screw threads, which is called threading. Many are cutting tools; others are forming tools.*

Tapping: *Process of cutting or forming threads using a tap. It is the action that creates a thread into the side of the hole.*

Threading: *Process of cutting or forming threads using a die.*



Module 1

BASICS OF WATER SUPPLY SYSTEM

Training Module for Local Water and Sanitation Management

CEPT UNIVERSITY
ज्ञानं विज्ञानसहितम्

pas performance assessment system

Maharashtra Jeevan Pradhikaran

CONTENT

ABBREVIATIONS

CPHEEO	Central Public Health and Environmental Engineering Organisation
cu. m.	Cubic Meter
DN	Diameter Nominal
ESR	Elevated Surface Reservoir
FTS	Field Test Kit
GI	Galvanised Iron
GSR	Ground Service Reservoir
HDPE	High Density Poly Ethylene
HH	Household
ISI	Indian Standards Institute
MLD	Million Litres per Day
PHED	Public Health Engineering Department
PVC	Poly Vinyl Chloride
Mg/l	Milligram per litre
m	meter
MS	Mild Steel
MT	Metric Ton
NTU	Nephelometric Turbidity Unit
RCC	Reinforced Cement Concrete
r.mt.	Running Meter
TMT	Thermo Mechanically Treated

Conversion of basic units (with prefix)

1 meter (m)	100 centimeter (cm)
1 meter (m)	1000 millimeter (mm)
1 foot (ft/')	12 inches (")
1 inch (")	25.4 millimeter (mm)
1 meter (m)	3.28 feet (ft/')
1 cubic meter (cu.m)	35.31467 cubic foot (cu.ft.)
1 cubic meter (cu.m)	1000 litres
1 square meter (sq.m/ m^2)	10.76391 square foot (sq.ft.)
1 metric ton	1000 kilogram (Kg.)
1 kilogram (kg)	1000 grams (g)
1 gram (g)	1000 milligram (mg)

INTRODUCTION

Water Supply in India is now previewed as community based demand driven system, under which it is essential to enhance capacity of local community residing in villages and small towns to develop and manage their own water supply systems.

Role of community groups is to ensure effective and participatory implementation of water supply system in their village/town, water quality control, financial management and effective operation and maintenance of water supply system established.

Hence, it is evitable that such community groups are aware about the basics of water supply system, operation and maintenance of water assets and water supply system as well as basics of sanitation and waste management.

This training course series has been formulated in order to enhance capacity of community groups for enhanced operation and maintenance of water supply and sanitation systems in their village/town.

Module on Basics of Water Supply System provides insights on basics component of water supply system, installation and distribution of water supply systems, estimation and measurement of components of water supply system and drinking water quality control.

MODULE A: COMPONENTS OF WATER SUPPLY SYSTEM

Training tools: Slideshow and Quiz, powerpoint/on board presentation, question answer

Approximate time:

Presentation: 30 minutes

Slideshow and Quiz 15 minutes

Question and answer: 15 minutes

TOTAL 1 hour

Training Objectives

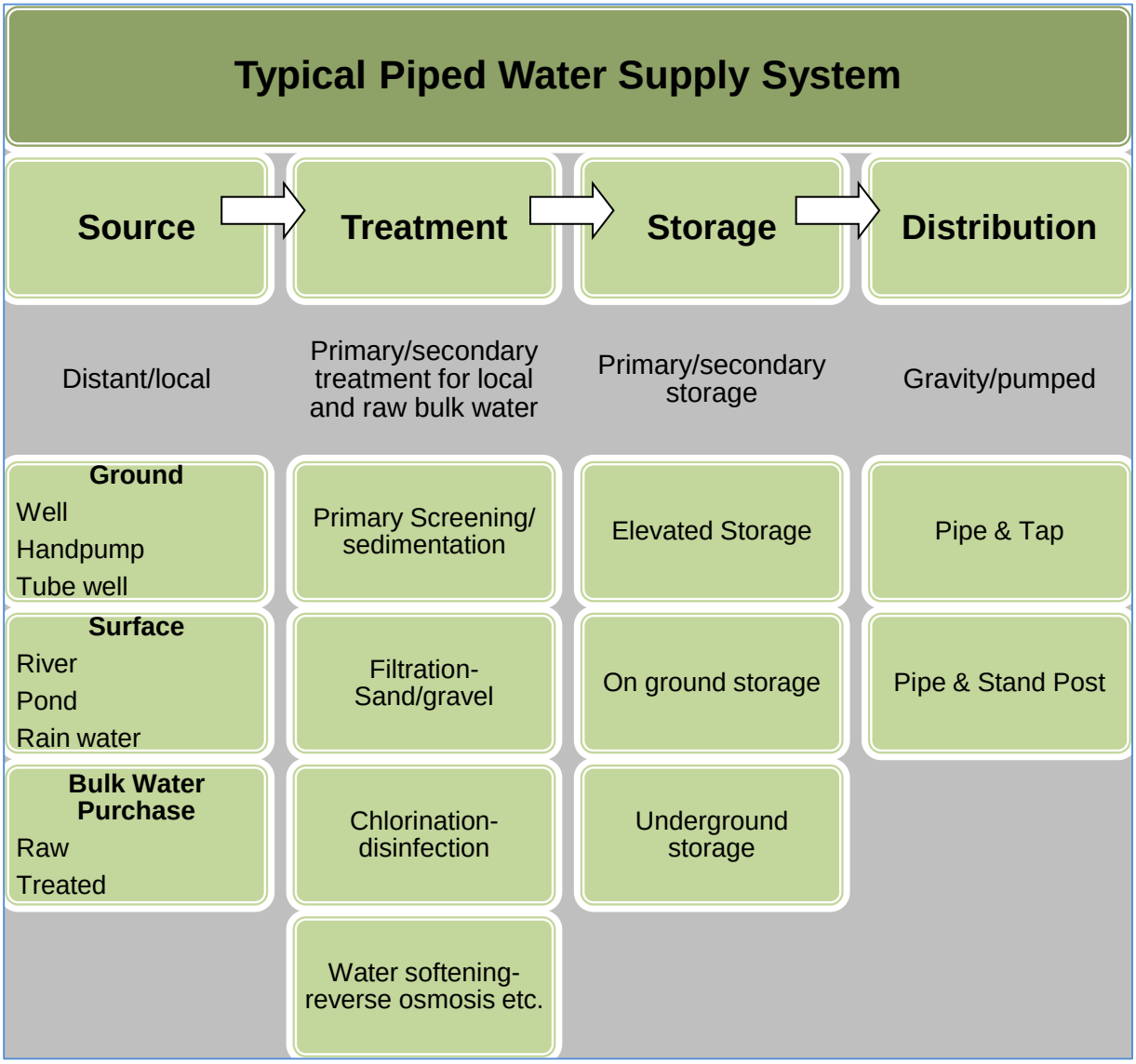
a) To know basic components of village/town water supply

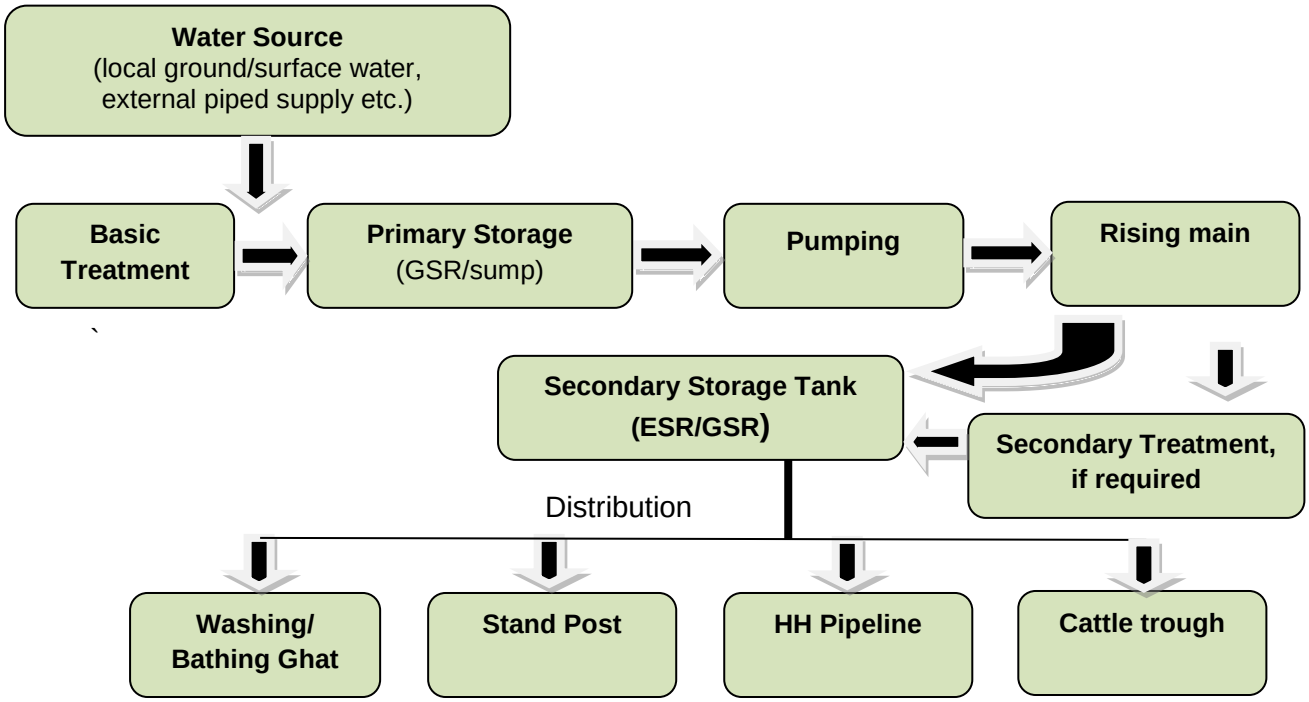
b) To know various sources of water

c) To understand water supply mechanism, storage facilities, distribution system.

A1 Typical Water Supply System

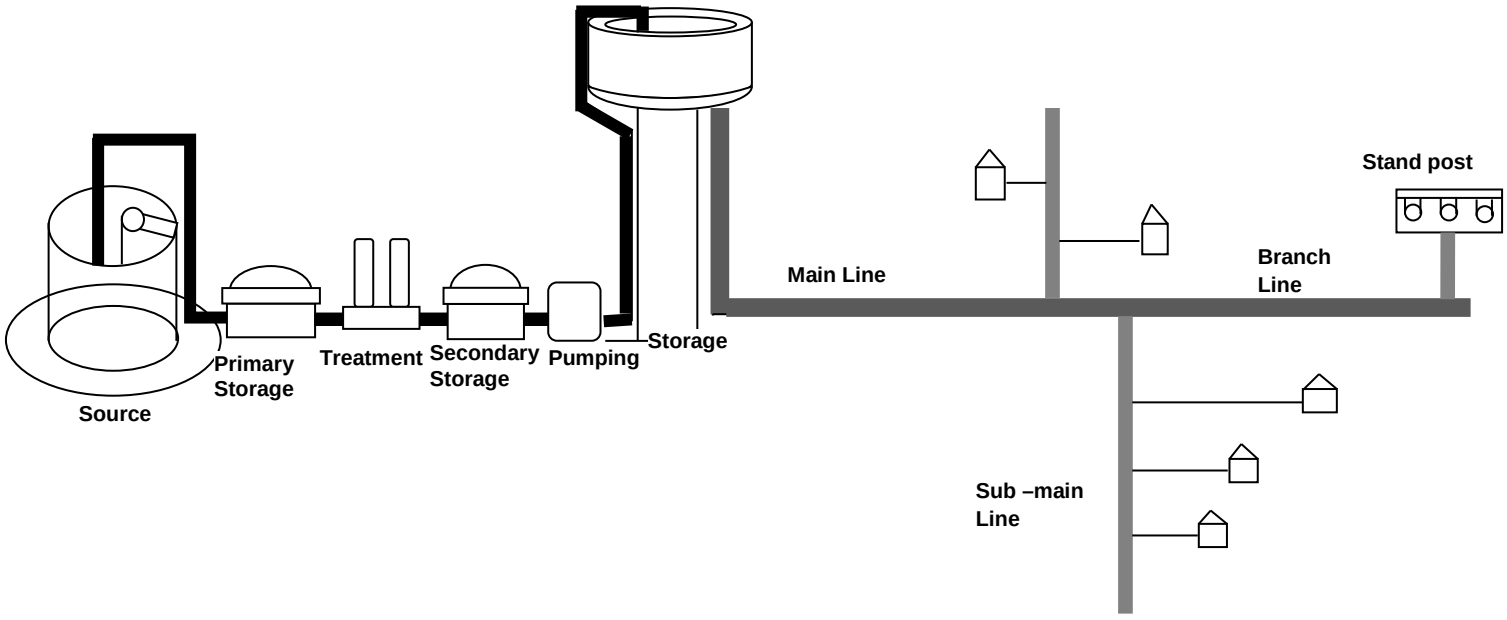
Typical Village/town water supply system constitutes of a gravity/pumping based transmission and distribution system from local/distant water source with needed water treatment system.





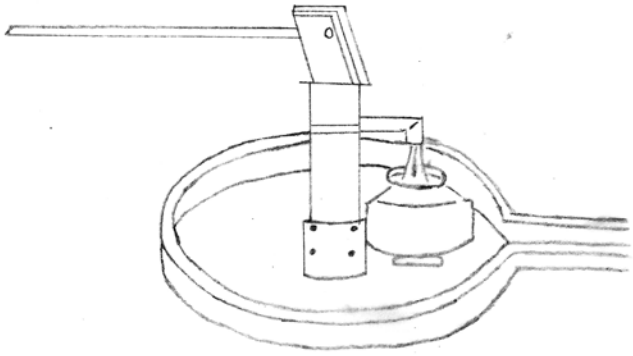
Standard Water supply System in village/town

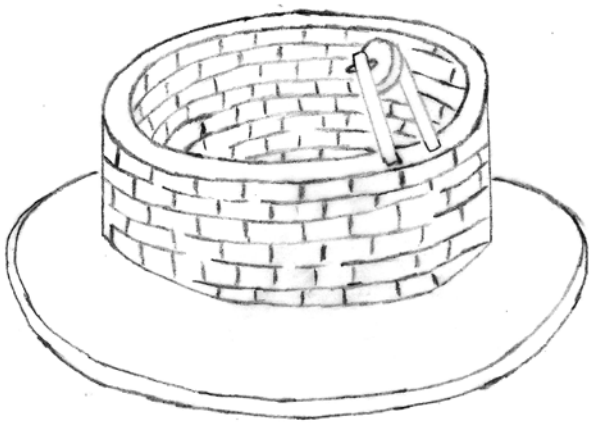
Sources	Open Well, Tube Well, Hand pump, Pond, Dam Site, External Pipe Supply, Rain Water Harvesting System/Tank
Village/town level Treatment	Reverse Osmosis System (RO), Chlorination, Sedimentation, Sand Filter, etc.
Storage	Elevated Surface Reservoirs (ESR), Ground Service Reservoirs (GSR), Sump
Distribution	Main Line, Sub-Main Line, Branch Pipe Line, Household Level Tape, Stand Post, Washing Unit.



A2 Sources of Water

Ground water: Open well, tube well/bore well, hand pump are sources which make water available from ground.





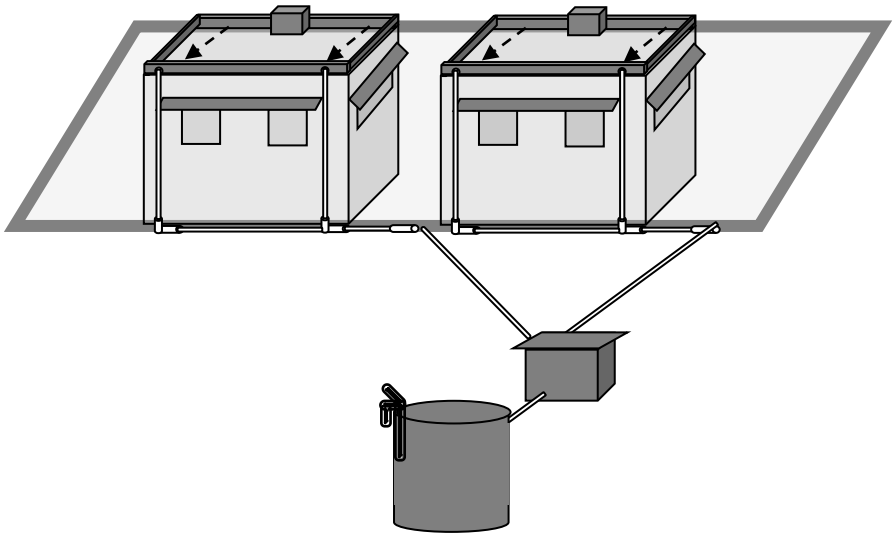
Open Well: Where ground water is available at low depth (less than 15 meters - and water is available all year round, open well is used.

Hand Pump: Where safe ground water is available upto 60 m depth, hand pump is ideal choice for a cluster or habitation.

Bore Well/Tube Well: Where ground water is at greater depth and open wells or hand pumps are not viable, bore well or tube well is installed.

Surface Water: River, pond, dam site are sources where surface water is available.

Moreover, rain water can be harvested and stored directly in storage tanks. This water is potable after first rain and can be used for drinking purpose also.



Rain Water Storage System

Classification of Water based on its Availability

A. **Local Source**: Sources which are available at village/town level like river, pond, open wells and bore wells.

B. **Distant Source**: When perennial reliable and safe source is not available, pipeline from distant sources can be laid. This bulk water is available from river, pond, dam, bore wells or storage tank itself, where water is available.

A3. Water Treatment

Water from source is treated at village level and even at household level, if needed. If bulk water available from the distant source is treated and potable, then further treatment may not be required at village level. There are various processes of treatment based on the source and quality of water in specific region.

- Village/town level water treatment systems are located mainly near head works. The treatment units are located in such a manner, where possible that flow of water from one unit to other can be done by gravity, so that additional pumping of water is not required. Sufficient area should be reserved near the treatment units for further expansion in future. Basic treatment system at village/town level involves removal of suspended solids through sedimentation, removal of micro-organisms and colloidal matter through sand/gravel filters, water softening through reverse osmosis (RO) system, disinfection through chlorination and any other chemical/specialised treatment for removal of fluoride, salinity etc.
- Treatment at household level is needed as there may be chances of water contamination while transmission of water. This mainly includes basic filtration for removal of any silt, etc.; boiling for removal of micro organisms or chlorination for disinfection.

It is very important to carry out water test in order to decide upon the type of treatment. It is also essential to carry regular water testing from various points starting from source to distribution points to maintain potable water quality. Details of water testing and treatment are discussed in detail in Module E.

A4 Water Supply Mechanism

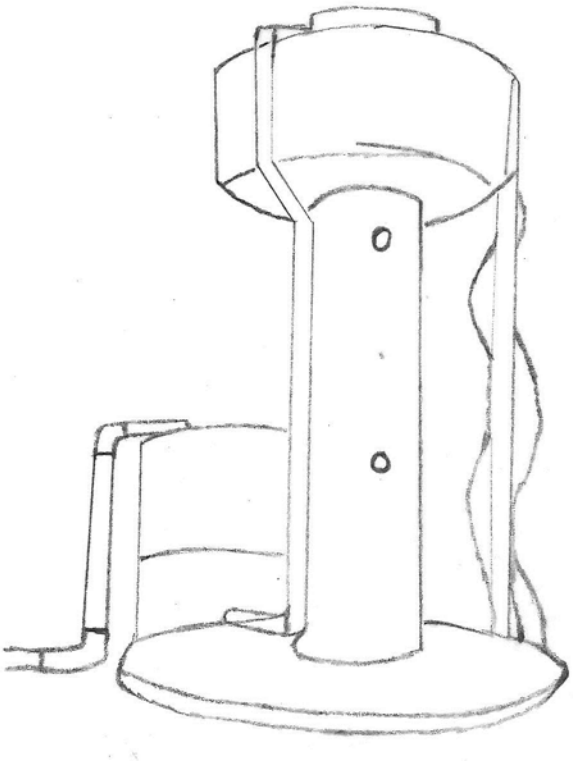
Pump House and Pumping Machinery: Pump is used to fetch water from source like bore well, open well, sump or ground water storage and supply it to pipelines or elevated storage. There are three main components: a) pump, b) electrical or oil engine, c) panel board. Pump house is constructed for security and safety of machineries.

Rising Main: The delivery line carrying water from pump to storage tank (elevated or ground) is called rising main.

A5 Storage Facilities

Elevated Surface Reservoir (ESR) or elevated storage tank: ESR is constructed, where water is to be supplied at elevated height (less than the level of ESR) or where the distance is large and topography is undulating. Generally, ESR is at height more than 15 m. Water can be distributed directly from this storage tank by gravity or pump.

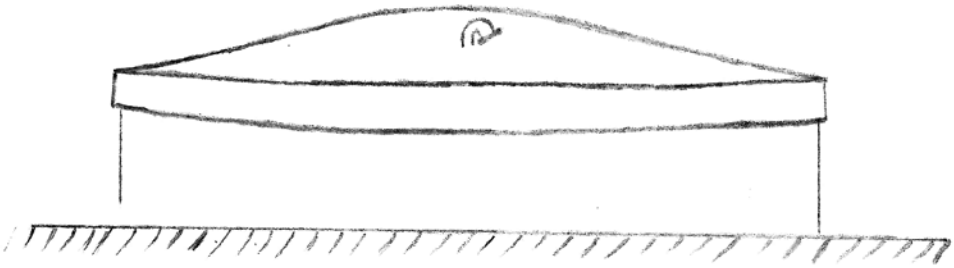
Ground Service Reservoir (GSR): GSR is ground level or plinth level storage tank. The plinth level is generally not more than 3 m.



GSR & ESR

Storage capacity of the service reservoirs is estimated based on pumping hours, demand and hours of supply, electricity available for pumping. Systems with higher pumping hours require less storage capacity. Normally, such reservoirs are calculated to store half to one day daily water requirement.

Sump: Sump is used as additional storage at village/town level or cluster level. It is not used for direct distribution of water. Rather, it is used as intermediate or contingency storage, to store water before it is pumped to ESR/GSR. The underground storage tank in circular shape with dome line covering is called sump. Generally, the capacity of sump is more (one and half to two times) than ESR or GSR or two to five days water requirement, so that if the supply is disturbed for that time, the water is available for the people.



Sump

A6 Water Distribution

For efficient distribution, it is required that water should reach end use with required flow rate with needed pressure in the piping system. There are three main types of distribution system that can be adopted in villages/towns:

a. Gravity Fed Distribution
   When the ground level of water source/storage is sufficiently raised than the core village/town area, such system can be utilised for distribution. The water in the distribution pipeline flow due to gravity and no pumping is required. Such system is highly reliable and economical.

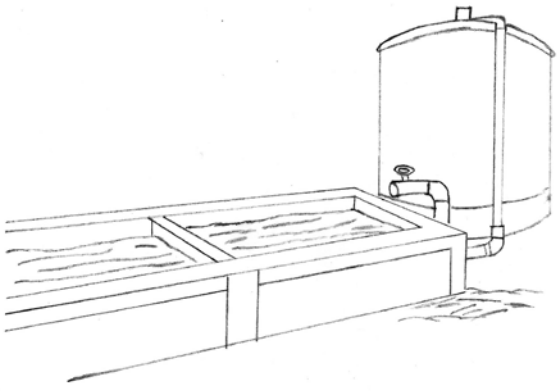
b. Pumping System
   In such system, water is supplied by continuous pumping. Treated water is directly pumped into the distribution main with contant pressure without intermediate storing..Supply can be affected during power failure and breakdown of pumps. Hence, diesel pumps also in addition to electrical pumps as stand by to be maintained. Such system works only in condition where there is continous power supply, reliable water source and where intermediate storage system cannot be installed.

c. Dual/Combination
   In such system, both gravity as well pumping systems are used. Such systems are used where there are variations in topography in town/village.

   Minimum Residual Pressure in a distribution system should be 7 m for single storied, 12 m for two storied and 17 m for three storied building (Source: CPHEEO)

Distribution Lines: The lines carrying water from storage to its end use (stand post/ household tap etc.) are called distribution lines. Distribution pipelines consist of main pipeline connected from secondary storage; sub-main pipes connected from main pipeline and service/branch pipes connected from sub-main for distribution to households. Generally, Mild Steel (MS), Galvanised Iron (GI), High Density Polyethylene (HDPE)/ Poly Vinyl Chloride (PVC) pipes, Ductile Iron (DI) pipe with 15-200 mm diameter are used in distribution. These lines are generally underground (1-3 feet below ground). Valves are used to control the distribution.

Stand Post: Stand post with one or more taps are installed at cluster level or near the storage tank, in the villages/towns where household tap connection is not available or possible. Stand posts are constructed of masonry or concrete structures. Stand posts should have normal output of 12 litres/minute. One stand post is estimated for every 250 persons. In case of independent habitation, even if population is less than 250 and there is no potable water source, once stand post is provided. Moreover, stand posts should not be more than 500 m from any such targeted household.



Cattle Trough

Cattle Trough: These are masonry/RCC structures to provide water to cattle.

Bathing or Washing Cubicles: These masonry structures are generally constructed to facilitate washing clothes and bathing.

A7 Type of Water Supply

a. Continuous
   In this system, there is continuous water supply (for 24 hours). This is possible where adequate quantity of water is available. The major advantage of such system is that due to continuous water supply, water remains fresh and rusting of pipes will be low. However, losses of water will be more in case of any leakage.
b. Intermittent
   In such system, supply of water is either done in whole village/town for fixed hours or supply of water is divided into zones and each zone is supplied with water for fixed hours in a day or as per specified day. Such system is followed when there is low water availability, however, in certain cases, wastage of water is more due to tendency of community for storing higher amount of water than required. In such system, pipelines are likely to rust faster due to wetting and drying. However, maintenance can be easily done during no-supply hours.

Activity Sheet

Section A Components of Village/Town Water Supply System

1. List various components of water supply system

2. Mention various sources of water in village/town used for drinking/domestic purpose

3. Mention various storage facilities and its basic use for water supply system

4. Mention types of distribution system in water supply system

MODULE B: BASICS ON PLANNING AND ESTIMATING COMPONENTS OF WATER SUPPLY

Training tools: Powerpoint/on board presentation, worksheets

Approximate time:

Power point presentation:

30 minutes

Activity Sheet: 1 hour

TOTAL 1 hour 30 minutes

Training Objectives

a) To know principles of planning of water supply

b) To estimate water demand and availability of water

c) To estimate components of water supply

B1 Basic Planning Principles of Water Supply System

- Rural water supply system should be designed to provide :
  a. Atleast 70 liter per capita per day (lpcd) for piped water supply with household tap connections,
  b. Atleast 55 lpcd for mix system with household (HH) tap supply + public taps/standpost + handpump
  c. Atleast 40 lpcd where no other source except hand pump, open wells, protected ponds etc are available. Such areas can be augmented with alternative sources.

  (Source: Strategic Plan 2011-22, "Ensuring Drinking Water Security in Rural India", Department of Drinking Water and Sanitation, Ministry of Rural Development, Government of India)

- Stand posts/hand pumps should be provided where household water supply is not possible. They should have normal output of 12 litres/minute. Generally, one stand post/hand pump is estimated for every 250 persons. In case of independent habitation, even if population is less than 250 and there is no potable water source, once stand post/hand pump is provided. Moreover, stand posts/hand pump should not be more than 500 m from targetted household. (Source: Accelerated Rural Water Supply Programme (ARWSP), Ministry of Rural Development, Government of India)

- For towns, water supply is designed to provide atleast 40 litres/person/day where water is made available through standposts,70 litres/person/day where piped supply is provided but sewerage system is not available. For urban areas with piped supply and sewerage system, water supply is designed for 135 litres/person/day (Source: Manual on Water Supply & Treatment, CPHEEO, 1999)

- The water supply system should be designed for at least 20-30 years.

- Population forecast needs to be done while designing of system. There are various methodologies for population forecast. However, population for 15 years can be considered 1.1 times current population and for 20 years can be considered 1.2 times current population for design.

- Public storage tanks are designed to store at least 50 percent of total daily requirement (or for atleast 12 hours supply) or requirement of peak period (Water Demand in peak period = average water demand * peak factor). Peak factor is about 3 for population upto 50,000 persons, 2.25 for population ranging from 50,000- 2,00,000 and 2 for population over 2,00,000. Such tanks can be installed at cluster/falia level or one single tank can be installed for a village/town.

- Thumb rule for distribution pipelines for rural areas.

Population	Length of total distribution pipeline
Upto 300	750 m
301- 750	1,500 m
751-1500	2,250 m
1501-3000	3000 m
>3000	3,750 m

- Design service life of various components (Source: CPHEEO):

Storage by dams	50 years
Infiltration works	30 years
Civil Works (pump house, water treatment civil work building etc)	30 years
Service reservoirs (overhead or underground)	15 years
Electric Pump and Motor	15 years
Pipeline	30 years

Water Treatment Units	15 years

B2 Calculate Domestic Need of Water per Day in Your Village/Town

Government has laid standard of 40 -135 lpcd for villages and towns. The total per day consumption can be worked out by multiplying this demand to number of people residing in the village/town.

Table 1 (Yearly Water Demand of Village/town)			
Total population of village/town	**Water requirement per person per day**	**Total water requirement per day at village/town level**	**Total water requirement in a year**
(a)	(b)	C= (a*b)	C* 365
	40/70/135 lpcd		

B3 Assess Domestic/Drinking Water Availability:

Water availability for water supply system can be calculated based on water availability and usage from surface, ground source as well as rain water harvesting system.

Sources which can be utilised for domestic/drinking purpose should only be computed. Those source used for irrigation should not be computed. Moreover, sources with high contamination of water should not be considered unless the water is treated considerably. Consider only public water sources here.

Compute yearly water availability in Table 2 for each source type. Detailed method of computing water availability for source type is explained in Tables 2.1 to 2.5. (Details for Grey coloured boxes in each table can be put in Table 2).

Table 2 (Yearly Water Availability in Village)					
	No. of source	**Total water availability in year**	**Season availability**		
			(put tick if available)		
			summer	winter	monsoon
Surface water					
Pond/lake					
Ground water					
Hand pump					
Open well					
Bore/tube well					
Other					
External piped supply					
Any other					
TOTAL					

Estimating water availability from ponds/lakes

Table 2.1 Estimating water availability from ponds/lakes					
	Name of source	Size/capacity		No. of filling per year*	Total capacity of storage (litres)
		(cu. m)	Litre (cu. m. *1000)		
			(a)	(b)	a*b
1					
2					
3					
				TOTAL	

*partial (0.25-0.75), full (1), over flow (more than>1)

Estimating water availability from community hand pumps

Table 2.2 Estimating water availability from community hand pumps					
No. of source	Average working hours per day*	Average discharge rate per hour**	Per day water availability	No. of functional days in year	Total water availability in year (litres)
(a)	(b)	(c)	d=(a*b*c)	e	d*e
				TOTAL	

*Can be presumed to about 6 hours
**Can be assumed as 12 litres/minutes or 720 litres/hour if data not available

Estimating water availability from community bore/tube well

Water availability from bore well can be determined from discharge rate of pump placed for drafting water.

Table 2.3 Estimating water availability from bore/tubewell					
Bore well	Discharge rate of water (litres/hour)*	Average hours of pumping in a day**	Total water availability (litres/day)	Average no. of days of water availability in a year	Water availability in a year (litres/year)
	a	b	c=a*b	d	c*d
1					
2					
3					
				Total	

*Discharge rate can be estimated from average volume of tank filling in an hour.
**Normally, pumping is done from 8-12 hours/day.

Estimating water availability from community open well

Water availability from open well can be calculated based on size of well (cu. m.) multiplied by number of times the well is filled in year. However, number of times well is filled needs to be calculated based on geo-hydrology of region with support of expert. Hence, easier way is to calculate based on average extraction of water per day by local community multiplied with number of day of water availability in well.

If the well is being pumped through motor, then calculation should be based on water discharge rate of pump and number of hours of operation of pump per day (as listed in section of bore/tubewells).

Table 2.4 Estimating water availability from open well

Open well	Average no. of people extracting water from well daily	Average water that a person extracts in a day (litres)	Total water extracted in day (litres)	Average no. of day of water availability in a year	Water availability in a year (litres/year)
	a	b	c=a*b	d	c*d
1					
2					
3					
				Total	

Estimating water availability from external piped supply

Various methods can be adopted for estimating water availability from external piped supply.

Table 2.5 Estimating water availability from external piped supply

		Water availability Litres/day	Average days of water supply in year	Total yearly water availability
		a	b	a*b
Method 1	Through average volumetric measurement through water meters installed	____ litres /day		
Method 2	Number of filling of head work/sump/main storage tank at village/town level in day	No. of fillings of tank per day * capacity of tank= ____ litres/day		

B4 Assess Domestic Water Gap

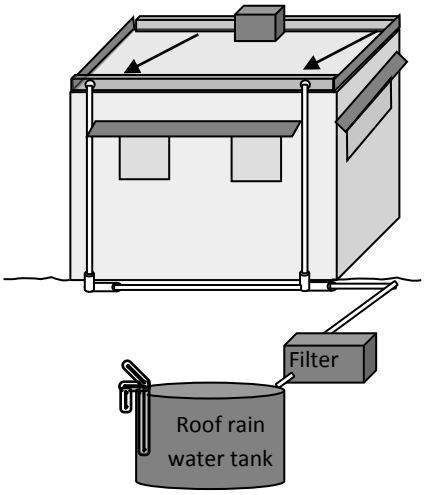
Table 3 (Water Gap)		
Yearly water demand as per table 1	**Yearly water availability as per table 2**	**Yearly water gap**
(a)	(b)	C= (a-b)

B5 Estimating Component of Water Supply System

Components required					**Existing**	**Gap**
No. of HH tap connections						
No. of Stand posts						
No. of Hand pump						
Village/town level storage tank (ESR/GSR/sump)	Type	No.	Capacity (litres)	Total capacity (litres)		
Filter/treatment unit	Type	No.	Capacity (litres)	Total capacity (litres)		
Pipeline (r. mt)						
Main						
Sub-main						
branch						
(HH/cluster level rain water harvesting system)	No.	Storage capacity (litres)		Total storage capacity (litres)		

B6 Basics on Calculating Roof Top Water Harvesting

- Roof top rain water harvesting is a simple method to collect and store rain water from roof top.



- Such system can be installed at household as well as community level like schools, panchayat building etc.

- Typical rain water harvesting unit consists of
  a. Gutter pipes for conveying water from sloped roofs.
  b. Conveyance pipes connected from gutter pipes (sloped roofs) or directly from roof outlet.
  c. Valve prior to filter unit for flushing impure water, mainly first rain.
  d. Filter unit consisting of sand-gravel bed for basic filtration.
  e. Storage tank (normally 5,000-10,000 litres tank can be installed at HH level for family of five. At community level storage size can be decided on water that can be harvested and funds available). Storage tank normally should be underground.
  f. Hand pump/motorised pump to withdraw water from the tank

- Normally, first rain water is not filled in tank as the roof top gets cleaned. Even for subsequent rains, allow rain water for first 5-10 minutes to flush away for getting rid of impurities from roof.

- Calculation for water that can be harvested from roof top in litres:

  Area of roof in m^2 (a) X run-off coefficient (c) X annual rainfall in region in meter X 1000 (for converting m^3 into litres).
  - Area of roof is measured as length in meter X breath in meter.
  - Run off co-efficient caters to spillage, leakage, absorption by roof material. For smooth/pucca roof like sheet/tiled/RCC roof, run off co-efficient can be generally taken as 0.8. For kutcha roof, the co-efficient can be taken as 0.6
  - Annual rainfall is normally available in millimeter. So convert it into meter by dividing it with 1,000.

- Sample calculation for small house with RCC slab roof =
  36 m^2 (area of roof) x 0.8 (run-off co-efficient) x 0.8 meter (annual rainfall) x 1000 = 23,040 litres, day 20,000 litres.

  This means that a standard house can harvest 15,000-20,000 litres of rain water in a year from roof top.

MODULE C: BASICS ON WATER PUMPING AND DISTRIBUTION

Training tools: Powerpoint/on board presentation, question-answer, movies and pipe joining.
Approximate time:

Powerpoint presentation: 1 hour
Question-answer: 30 minutes Movies: 30 minutes

TOTAL: 2 hours

Training Objectives

a) To know basics on pumping and types of pumps for water supply

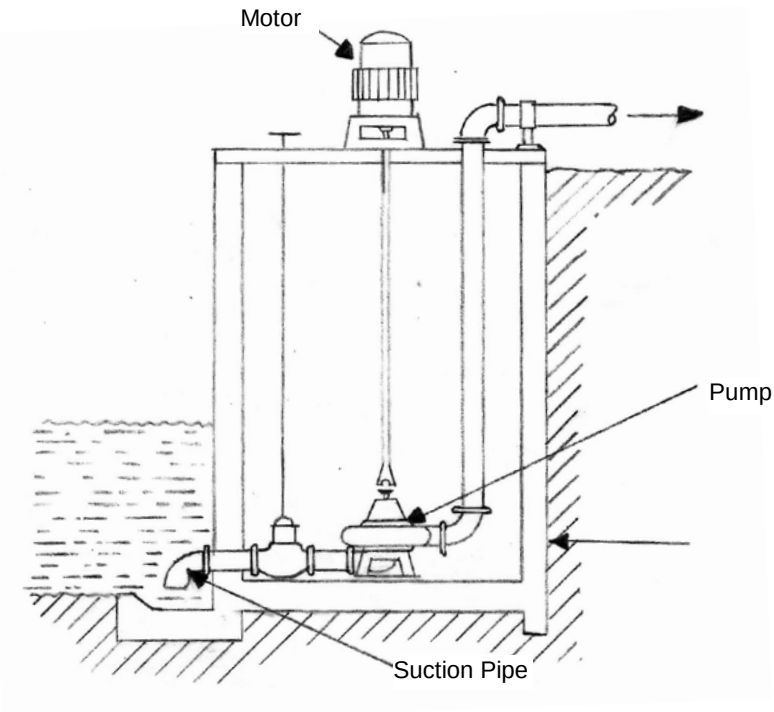
b) To know basics on pipelines distribution networks

c) To know basics on types of pipe materials, pipe fitting, joining and laying of pipelines (with major focus on sub-mains/branch pipes)

C 1 Basics on Water Pumping

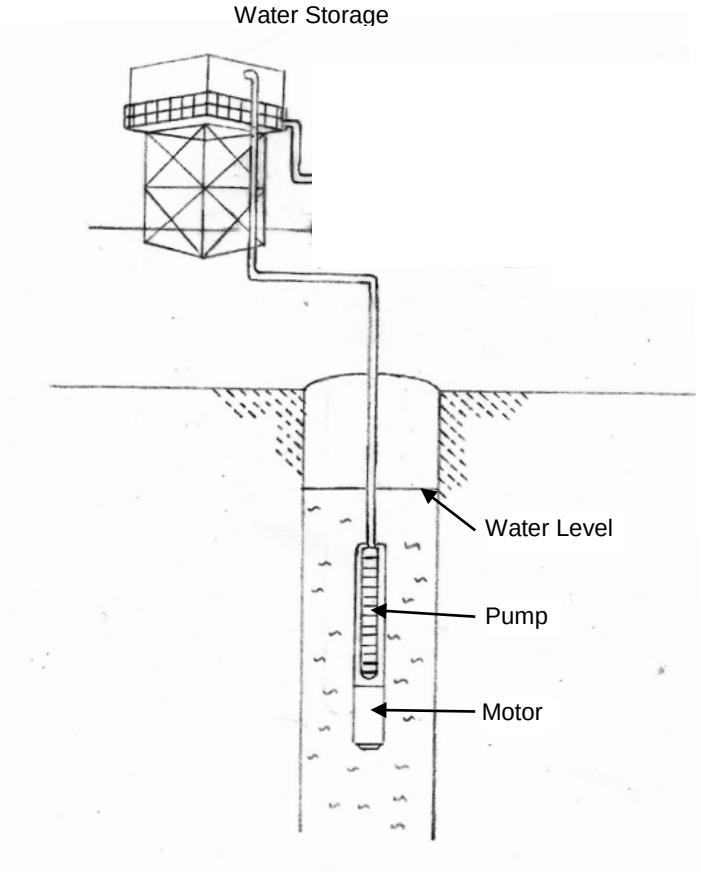
- Pumping Machinery is used for transfer of water from one place to another and pumping of water from water source. Pumping is required for
  a) Lifting water from the source (surface or ground) to purification works or the service reservoir.
  b) Transfer of water from source to distribution system.
  c) Pumping water from sump to elevated/ground surface tanks.
- Pump house (civil works) is constructed for installation of pumping machinery.
- Pump House is designed for life of atleast 30 years, while pumping machinery is designed for atleast 15 years lifespan.
- Pumping Machinery consists of 3 major components:
  a. Pump for lifting of water
     The function of pump is to transfer water to higher elevation or at higher pressure. Pumps are driven by electricity or diesel or even solar power. They are helpful in pumping water from the sources, that is from intake to the treatment plant and from treatment plant to the distribution system or service reservoir.
  b. Electric/diesel/solar powered motor
     For pumping, 3 phase electric connection is required.
  c. Panel board
     Panel board consists of circuit breaker or switch and fuse, starter level controls etc for transmission of electric supply.

- For water supply system, three main types of pumps are used:
  a. **Centrifugal Pump** which is used for pumping water from well/sump. It is a type of velocity pump where water is moved through continuous application of power. This type of pumps are used widely in water supply schemes containing sand, silt etc. Centrifugal force is made use of in lifting water. Electrical energy is converted to potential or pressure energy of water. The pump consist of following part:
     - Casing
     - Delivery Pipe
     - Delivery Valve
     - Impeller
     - Prime Mover
     - Suction Pipe
     - Strainer and Foot Valve



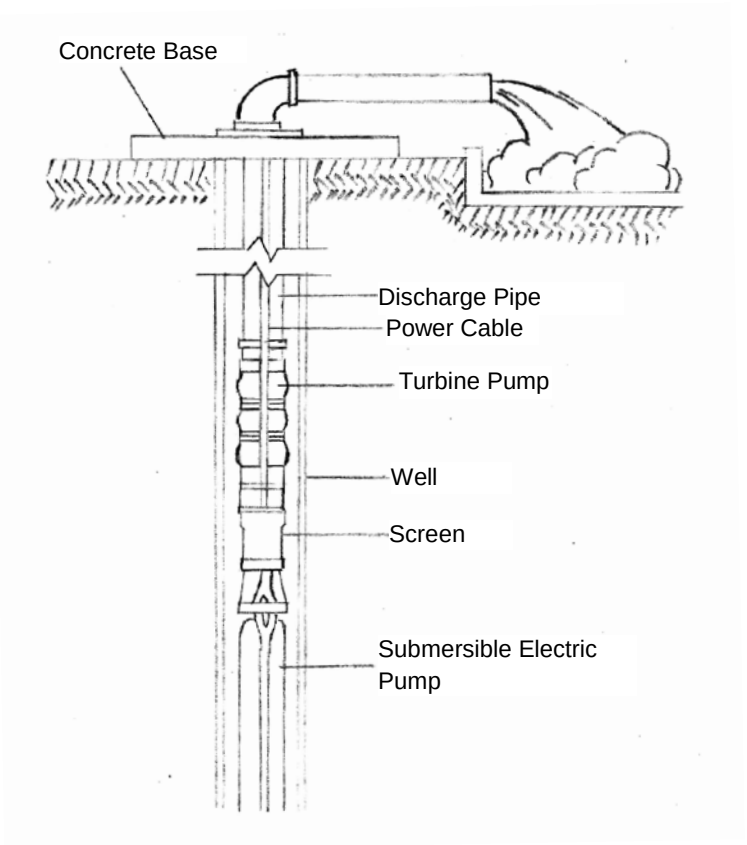
The pump consists of an Impeller which is enclosed in a water tight casing. Water at lower level is sucked into the impellor through a suction pipe. Suction pipe is air tight. A strainer foot valve is connected at the bottom of the suction pipe to prevent entry of foreign matter and to hold water during pumping. Suction pipe is kept larger in diameter than delivery pipe to reduce cavitations and losses due to friction.

b. Turbine Pump



The principle of a pump used as turbine: When water flows back through a pump, the impeller will run in reverse and the pump will function as a turbine. The energy recovered from pressure differences, heads or flow can be fed back into the system or into the mains. Turbine pumps are mainly used in elevation of water from ground level storage to elevated areas/storage or pumping from deep wells/tube wells. If the water requirement is large and there is a large source of falling water (head and flow rate) nearby, turbine-pump sets can provide the best solution.

c. **Submersible pump** is designed such that it can be introduced into well casing and lowered to the bottom of the well. It is highly used for pumping from bore well and underground sumps. Such pumps are used for water yield of 100 litres per minute. It is driven by an electric motor, which is directly attached to the pumping element and therefore totally submerged. This pump type is mainly used where electric power is available or ideally in combination with a Solar Pumping System. The main parts of a submersible pump are:



a) Electric motor

enclosed in a stainless steel sleeve.
b) Pump body with multiple impellers, foot valve and strainer.
c) Rising main of GI or stainless steel pipes connected with sockets or PVC-hose. If a hose is used, the motor with connected pump body has to be hung from the top of the well by a stainless steel cable.
d) Electrical cable for connecting the motor to the starting panel (power source).
e) Starting panel.
Various sizes of submersible pumps are available, which can be installed in casings of diameter 4", 6", 8", 10" and 12".

Submersible pump have high efficiency and durability, low operation cost and high resistance to sand content.

- Criteria for Pump Selection for water supply
    a) Type of pumping required, i.e. whether continuous, intermittent or cyclic.
    b) Present and projected demand and pattern of change in demand.
    c) The details of head and flow rate required.
    d) Type and duration of the availability of the power supply.
    e) Selecting the operating speed of the pump and suitable drive/driving gear.
    f) The efficiency of the pumps and consequent influence on power consumption and the running costs.
    g) Ease in installation.

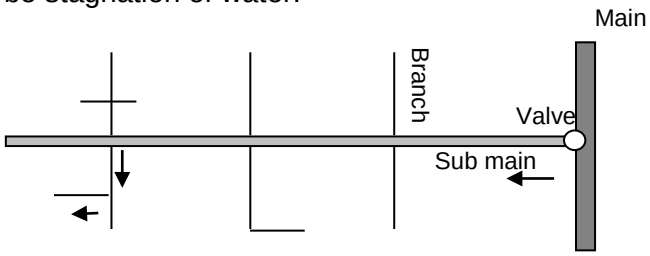
Guideline on pump selection	
Site Condition	Preferable Pump Type
Inside river	Submersible pump
Low lift raw water pumping, dry well built in the river/dam bank with suction head not to exceed 6 m	Centrifugal pump
Low lift raw water pumping, dry well built in the river/dam bank with suction head more than 6 m	Turbine pump
Ground level reservoir/sump	Centrifugal/Turbine
Line booster (small discharge < 1000 lpm)	Centrifugal pump
Open well with suction head less than 6 m in the lean period	Centrifugal pump/Submersible pump
Open well with the water level goes down and the discharge is less than 50 lpm	Submersible pump
Open well when water level is more than 15 m and discharge is more than 50 lpm	Turbine
Pumping from tube well	Submersible/Turbine

C 2 Pipeline Distribution Networks

Pipeline distribution networks are aimed at design of suitable routes for piping. It is very important for proper water pressure, capital cost and operation and maintenance cost. Different types of networks are adopted looking to the pressure requirement, operation and maintenance (O&M) strategy adopted, cost parameter and over all length of distribution system.

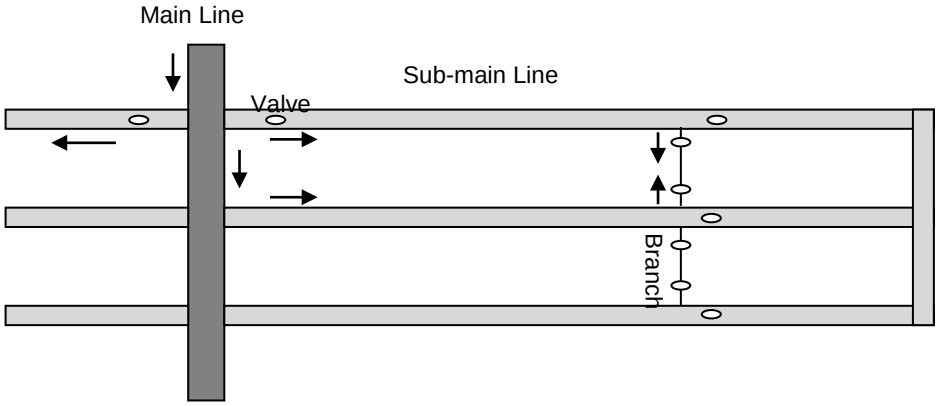
a. Dead end distribution system

In such system, sub main pipes are connected at right angles from main pipeline and branch pipes are connected to sub mains at right angles. This system is easy to lay. However, in case of failure in pipeline, it will be difficult to supply water to the area ahead of affected area. Also pressure at the tail end will be low compared to other area and there will be stagnation of water.



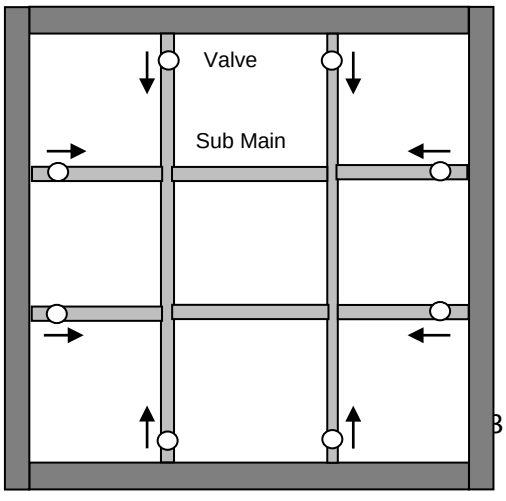
b. Grid Iron System

In such system; main, sub main and brach pipes are interconnected to each other. A grid sytem is laid. Here, total length of pipeline required is high, but this helps in equitable water pressure. Also, blockage of piepes in one area does not affect the supply in the rest of area as there are multiple supply points to any area. This will also help in avoiding water stagnation. The system required higher number of valves.

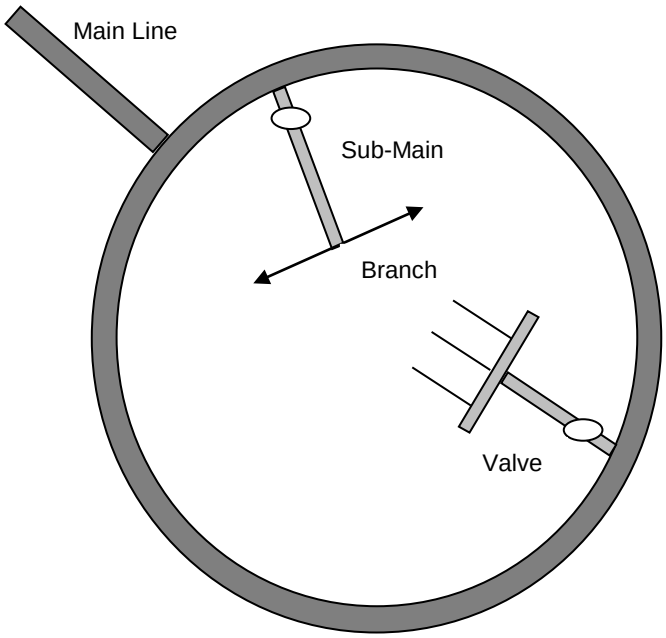


Ring System

The whole system is enclosed by main pipeline in radial or rectangular shape. Smaller areas are enclosed by sub main pipeline. In case of failure of system, very small area will be affected. The area ahead of affected area can get water from other point. The system requires higher number

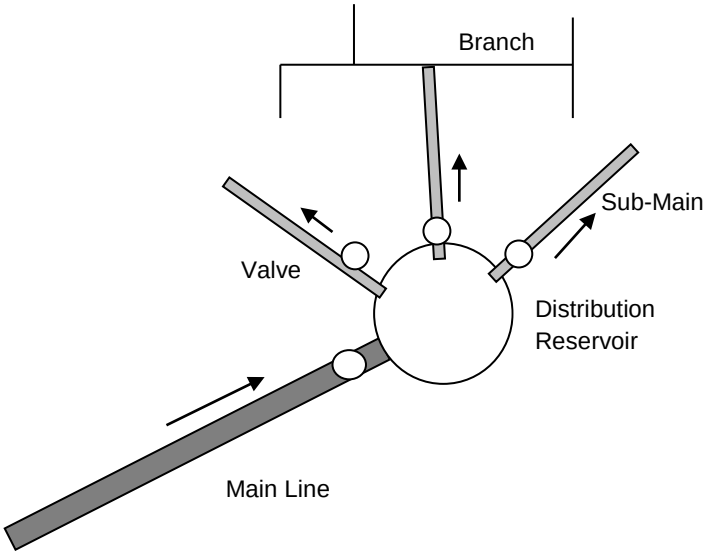


of valves. Here water can be supplied to any point from two directions.



c. Radial System

The area is divided into different zones. The water is pumped into the distribution reservoir kept in the middle of each zone and the supply pipes are laid radially ending towards the periphery.



C3 Type of Pipe Material for Pipelines for Water Distribution

Various types of pipes are used for water supply system including metallic and non-metallic pipes. Most common types of pipes used for water supply system are:

a. Galvanised Iron Pipes – metal pipe
b. Mild Steel Pipes metal pipe
c. Poly Vinyl Chloride pipes - non- metal pipe
d. High Density Poly Ethylene Pipes - non metal pipe
e. Ductile Iron Pipes

For water mains, mainly GI and MS pipes or even large HDPE pipes are used, while for branch/service pipes, most commonly used are galvanised iron and HDPE/PVC pipes. DI pipes are used for both purposes.

1. Mild Steel Pipes
   - Number of joints are less as they are available in longer length.
   - Pipes are durable and can resist high internal water pressure and highly suitable for long distance high pressure piping.
   - Flexible to lay in certain curves.
   - Light weight and easy to transport. Damage in transportation is minimal.
   - Pipes are prone to rust and require higher maintenance.
   - Require more time for repairs and not very suitable for distribution piping.

   - Available in diameter of 150-250 mm for water supply and cut lengths of 4 - 7 m (2.6-4.5 mm wall thickness).
   - Steel Pipes are joined with flanged joints or welding.

2. Galvanised Iron (GI) Pipes
   - Cheap in cost and light in weight.
   - Light in weight and easy to join.
   - Affected by acidic or alkaline water.
   - GI pipes are highly suitable for distribution system. They are available in light (yellow colour code), medium (blue colour code) and heavy grades (red colour code) depending on the thickness of pipe used. Normally, medium grade pipes (wall thickness 2.6-4.8 mm) are used for water supply system. Normally, 15-150 mm size pipes (nominal internal diameter) are used for distribution system. They are available in length of 3 m.

   - GI pipes can be used in non-corrosive water with pH value greater than 6.5.
   - GI pipes can be used for rising main as well as distribution.
   - GI pipes are normally joined with lead putty on threaded end.

3. Poly Vinyl Chloride (PVC unplasticised) Pipes

- Cheap in cost and light in weight.
- Economical in laying and jointing.
- They are rigid pipes.
- Highly durable and suitable for distribution network.
- Free from corrosion and tough against chemical attack.
- Good electric insulation.
- Highly suitable for distribution piping and branch pipes.
- Less resistance to heat and direct exposure to sun. Hence, not very suitable for piping above the ground.
- PVC pipes weigh only 1/5th of steel pipes of same diameter.
- Certain types of low quality plastic impart taste to water.
- Available in size 20-315 mm (nominal internal diameter) for water supply with pressure class of 2.5, 4, 6, 8 & 10 kg/cm^2 for water supply. Ideally pipes with 6 kg/cm^2 should be used.
- Classification of pipes is done according to its pressure class.

Class	Working Pressure
Class 1	2.5 kg/cm^2
Class 2	4 kg/cm^2
Class 3	6 kg/cm^2
Class 4	8 kg/cm^2
Class 5	10 kg/cm^2
Class 6	12.5 kg/cm^2

- Available in lengths of 2, 3, 4, 6 m. For plain ended pipes, the overall length shall be measured from end to end. For socketed pipe for solvent cement jointing the effective length of pipe shall be determined by subtracting from the overall length, the socket length.
- Jointing of PVC can be made by solvent cement or rubber ring joint.

4. HDPE

- Light in weight.
- Flexible than PVC pipes.
- HDPE pipes are black in colour.
- Suitable for underground piping and can withstand movement of heavy traffic.
- Allows free flowing of water.
- Highly durable and suitable for distribution network.
- Free from corrosion
- Good electric insulation.
- Useful for water conveyance as they do not constitute toxic hazard and does not support microbial growth.

Normally, 20-315 mm diameter pipes are used for water supply and distribution system with pressure ranging from 6-

10 kg/cm^2. Available in coils in small diameters. Above 110 mm diameter, available in lengths starting from 6 m.

5. Ductile Iron Pipes

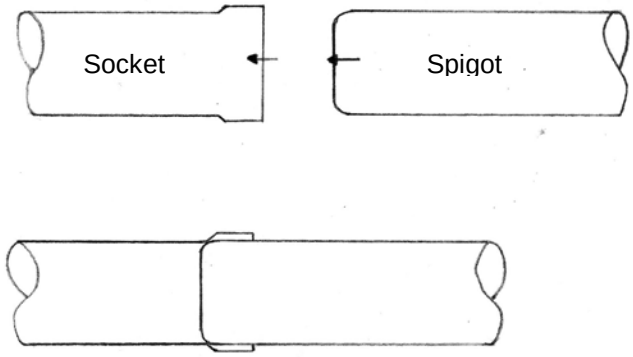
- Ductile Iron pipes are better version of cast iron pipes with better tensile strength.
- DI pipes are prepared using centrifugal cast process.
- DI pipes have high impact resistance, high wear and tear resistance, high tensile strength, ductility and good internal and external corrosion resistance.
- DI pipes are provided with cement mortar lining on inside surface which provides smooth surface and is suitable for providing chemical and physical barriers to water. Such pipes reduce water contamination.
- The outer coating of such pipes is done with bituminous or Zinc paint.
- DI pressure pipes are available in range from 80-1000 mm diameter in lengths from 5.5-6 m.
- Available in thickness class K7 and K9 with barrel wall thickness ranging from 5-13.5 mm. Also available in pressure class (Like C25, C30, C40 etc.).
- They are about 30 percent lighter than conventional cast iron pipes.
- DI pipes lower pumping cost due to lower frictional resistance.

What is spigot and socket end in pipes?

Spigot and sockets are type of pipe ends.

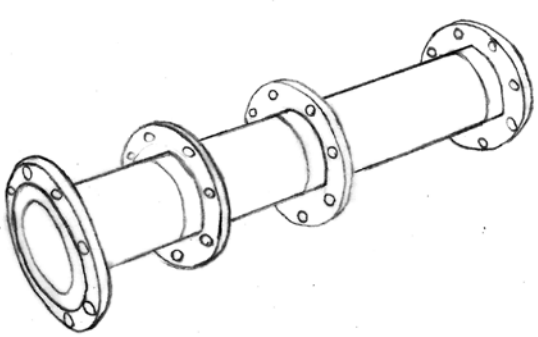
Spigot is the pipe end which is inserted into socket

Spigot and socket are joined with rubber seals, lubricants etc.



What is flanged end in pipes?

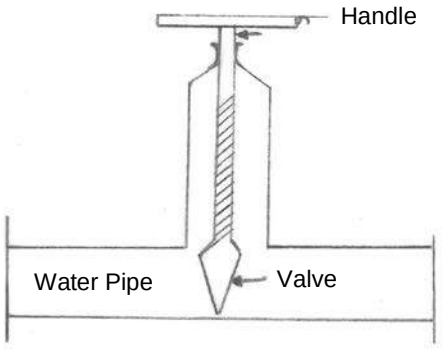
Pipes have flanged at their ends which are joined with nuts and bolts.



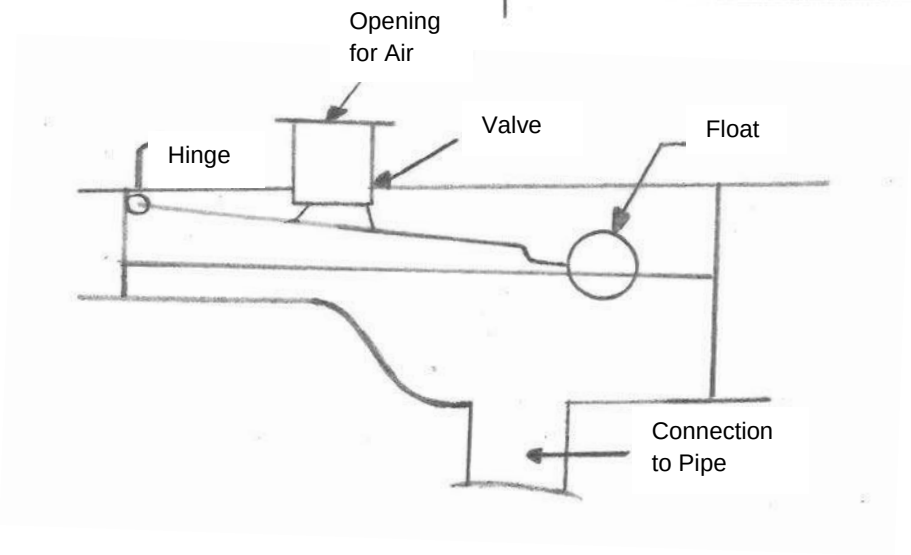
C4 Type of Valves for Water Flow Control and Estimation

Valves are used for control of water flow in pipeline and cleaning of pipes.

1. Sluice Valve
   It is used for control on water flow in pipeline. It is fixed in main line and at start of branch line. It is also used as scour valve for cleaning of pipeline. They are provided in straight pipeline at 150-200 m intervals. When two pipes lines interest, valves are fixed in both sides of intersection.



2. Air Valve
   Air valve are fixed in order to allow air circulation in pipeline. It is placed in pumping main line and distribution line mainly which are at higher levels. Air valves may be placed at every 1000 m for pipe lines upto 600 mm dia.



3. Water Meters

- These are devices installed on pipes to measure quantity of water flowing in particular area. These are installed to keep control on water usage in case of metered water supply.

- Meters installed to measure household consumption are called domestic water meters. Water meters can also be installed for measuring quantity at stand posts.
- Water meters having sizes from 15 mm to 50 mm are considered for domestic water meters.

- Water meters are made normally of cast iron/brass/plastic body and plastic gears.
- Meters are classified according to the operating principle, type of end connections, the standard by which the same are covered, constructional features, method of coupling between the counter and primary sensor, the metrological characteristics etc.
- Automatic water meter reading system are used now in order to collect data from all the meters at central point through GSM/internet. This help in saving

time for collecting data from each individual place. This system helps in collection, displaying and processing of data at one single place. It also helps in monitoring of data daily.

- Sizing of water meter
  Water meter has to be selected according to the flow to be measured and not necessarily to suit a certain size of water main. The maximum flow shall not exceed the maximum flow rating. The nominal flow should not be greater than the nominal flow rating.
- Installation guidelines and sizing reccomendations for water meters are normally given by the supplier.

4. Flow Meters

- Flow meters are devices installed mainly to measure velocity/speed of water and also derive quantity of water.
- Flow meters are placed near water intake/head works, transfer mains, storage tanks/reservoirs, distribution network like branch/main/sublines etc.
- Various type of flow meters are available based on characteristic and performance line accuracy of measurement, range, resolution etc.

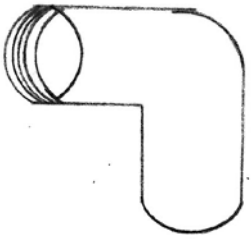
Difference of water meter against flow meter

- Water meter is a quantity meter and not a flow rate meter.
- Water meter is a mechanical device whereas flow meter is mechanical or an
- electronic device.
- Water meter is always specified in two accuracies i.e. lower range and upper range accuracies whereas a flow meter it is specified in a single range accuracy.
- The upper range and lower range accuracies are 2 percent and 5 percent of the actual quantity respectively for the water meter whereas it is variable for flow meter as per the customer’s requirement.

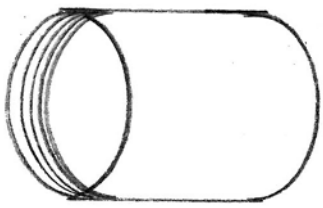
C5 Type of Pipe Fittings

Pipe fitting are important component of pipelines as they connect pipes and control pipe leakages. Various pipe fitting are used for distribution piping system. Choose the diameter of the fitting based on the size of pipe. These fitting are available with threading, mainly for metallic pipes. For PVC pipes, non-threaded fittings are normally used for smaller diameter pipes. For HDPE pipe fitting special flanged fittings are available for joining pipes.

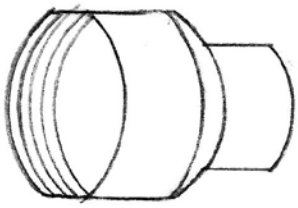
a. Socket or coupling - It is used to connect two straight lengths of pipes. The outer diameter of pipe will be equal to inner diameter of socket after threading.
b. Elbow – It connects two pipes of same diameter at an angle, normally 90 degrees.
c. Tee - it will fit two straight pipes and will have an outlet at right angle.
d. Union - It is used for joining the ends of two pipes which cannot be rotated. They are used in long stretches of straight pipes in the beginning of a pipe system and near all appliances along stop valves.
e. Reducer - It is used to connect two pipes with different size (diameter) to reduce the size of pipe. Reducer can be a socket, elbow or a tee as per required distribution network requirement.
f. Nipple - it is tubular pipe fitting, mainly in 300 mm length. It is used for extending pipeline.
g. Plug - It is used to plug the flow of water at dead ends.



Elbow

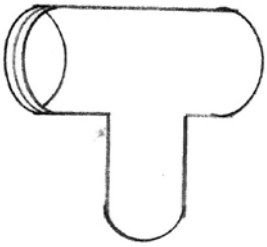


Coupling

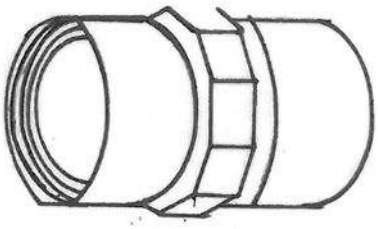


Reducer

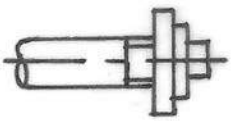
Bend



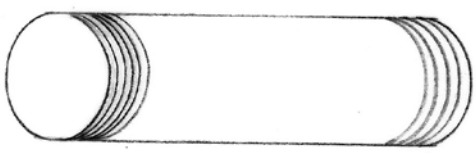
Tee



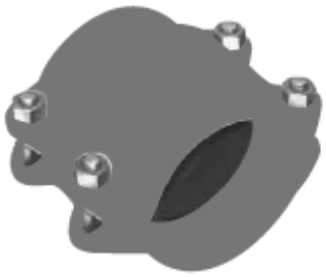
Union



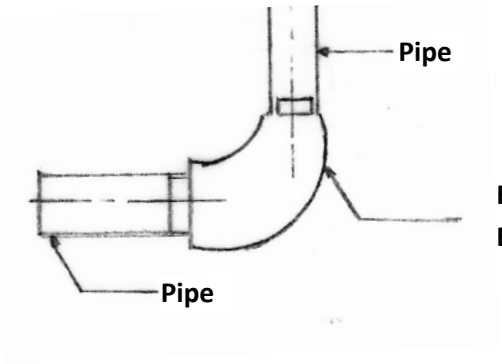
Plug

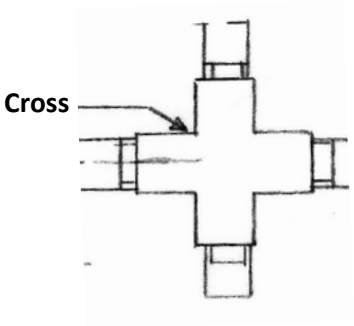


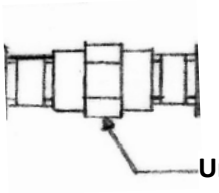
Nipple

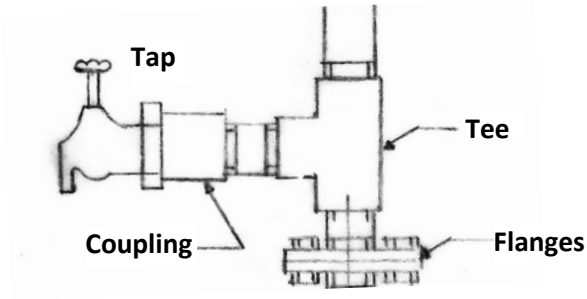


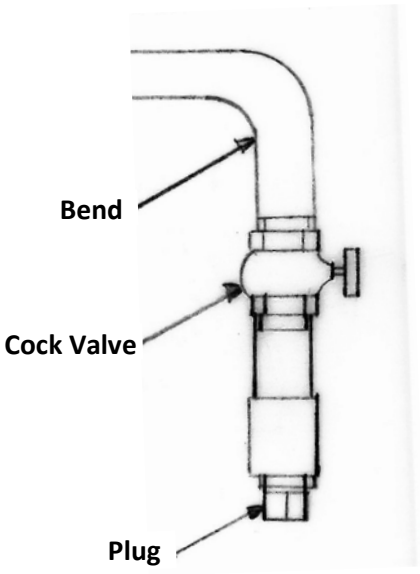
Special Mechanical Fitting for HDPE pipes











Typical piping Layout with pipe fittings

C6 Types of Pipe Cutting and Assembling Tools

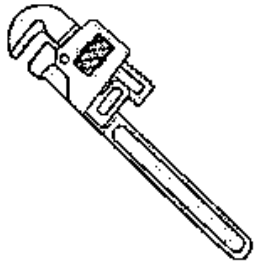
For pipe sizes greated than 25 mm, powered tools are used. And for pipe sizes below 25 mm following tools are used:

1. **Pipe Vice -** It is used for holding pipes in position rigidly for cutting and threading. Pipe vices are available in market in various sizes for holding pipes starting from 37 mm diameter.

2. **Pipe Wrench -** It is used for screwing and unscrewing small pipes. It is also used for tightening of nut and bolts, fixing of small taps, valves etc in pipelines. Pipe wrench size should be selected such that its opening exactly pits the pipe. Pipe wrench should not be used for bending, raising or lifting pipe.

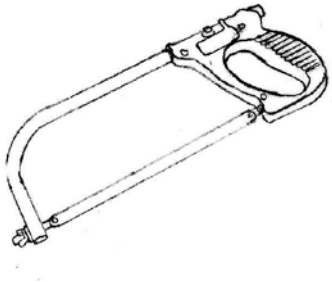
3. **Chain Wrench** - It is used for turning and fixing large diameter threaded pipes. Chain wrenches are commonly available for holding pipes of 50 mm - 300 mm diameter.

Chain Wrench

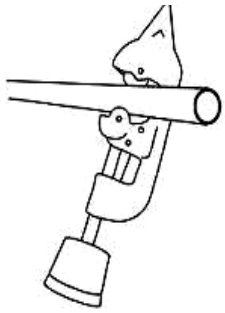


Pipe Wrench

4. **Pipe Cutter -** It is used for cutting of pipes. It is placed around pipes and tightens so that it holds the pipe tight. However, over tightening may damage pipe. The cutter is rotated around the pipe one to two times and then the pipe is tightened again. The process is repeated unless the pipe is cut. Pipe cutters are available for cutting of pipes from 25-150 mm.



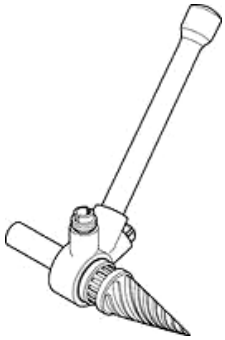
Hack Saw



Pipe Cutter

5. **Hack Saw with Blades -** It is used for cutting pipes of smaller diameters (15-25 mm). It consists of frame, handle, prongs, tightening screw and nut. The frame may be fixed type or adjustable type. Blade is fixed in position by means of tightening screw. The direction of the cutting teeth of the blade is to be in the forward direction.

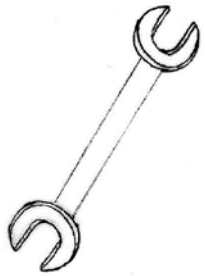
6. **Pipe Reamer -** It is used for chamfering on pipes. When the pipes are cut of threded, burr or metal parts remain which are removed with pipe reamer. Various sizes are available in market. It should be slected based on the the pipe diameter.



Pipe Reamer

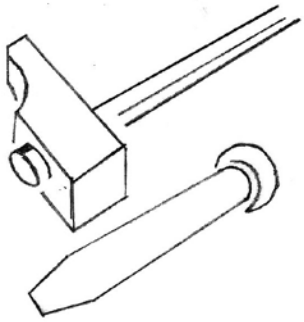
7. **Pipe Bending Machine -** It is used for bending pipes. Fix wooden stopper to one end of the pipe. Fill the pipe with sand completely. Fix wooden stopper from other side of pipe. Fix the pipe in the machine. Location of the the bend hsould be in centre of pulley. Tight the screw. Bend the pipe with help of lever till required bend. Remove stopper and sand from pipe.

8. **Spanner** – Spanner is used for fixing and opening nuts and bolts. Different types of spanners and size are availabel as per requirment of pipe size.



Spanner

9. **Chisel and Hammer -** Chisel is meant for cutting metal pipes when very smooth surface is not required. Chisel is blown with hammer for cutting**.**



Chisel & Hammer

10. **Pipe Threading Die Set -** It is used for threading external taper threadeds of pipe. Pipe is fixed in the pipe vice and threading is done ith help of the die set as per pipe size requirement.

Using instructions

a) Take required size of pipe threading die.
b) Fix the pipe in the pipe vice tightly.
c) Cut the pipe to required szie at right angle.
d) Hold the die in right angle ot the pipe and put some oil on pie.
e) Cut the thread on the pie with die rotating in clockwise direction. Rotate the die in anti clockwise direction so that the cut material will come out.
f) Clean the chips or burr.

Pipe threading die set

C7 Types of Line and Levelling Instruments for Laying of Pipelines

1. Plumb bob - It is used for determining straight vertical lines/plumb lines. It is most basic tool for measuring vertical lines while laying pipelines. It consists of string attached to pointed weight which swings and halts to give perfect vertical line.

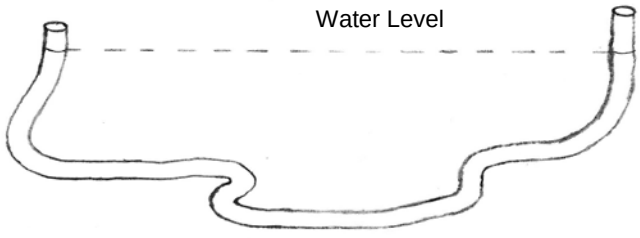
2. Spirit level - It is used for leveling as it helps is maintaining horizontal lines. It helps in slope adjustment while laying pipes.

3. Water Tube Level - It is used for leveling while laying pipes. It consists of a plastic tube, where water is filled for levelling of tubes.

Plumb Bob

How to use water tube level

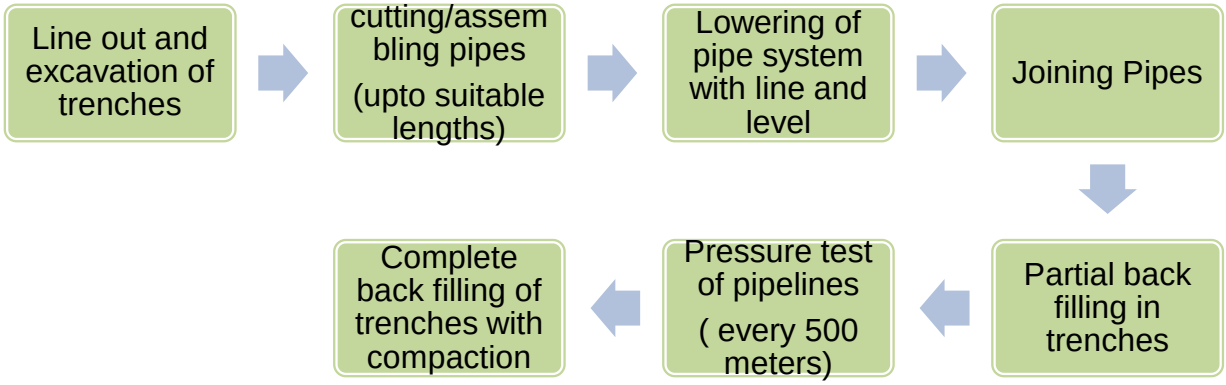
a) Fill a jug with water for pouring water into tube.
b) Attach one end of the tube to the jug, and place mouth on the other end. Begin sucking on the tube to get the water flowing. Suck from the tube hard enough to get the water moving. Once you get the water moving a little, it should flow freely.
c) Pull out the tube from the water jug once it is nearly full.
d) Hold both ends of the tube vertically so that no water can escape. Tap finger along the tubing to loosen any trapped air bubbles. Hold the ends of the tube even with one another, and verify that the water lines up equally. If it does not, you need to continue tapping the tube, as it is likely that air bubbles are still trapped.



Water Tube Level

e) Foe leveling two persons are required. The person must hold the tube against the surface which requires leveling at a predetermined height. Hold the tubing at the desired height.
f) Use chalk to mark the spot on the wall where the water line inside the tube falls.

C8 Basics About Laying of Distribution Pipelines

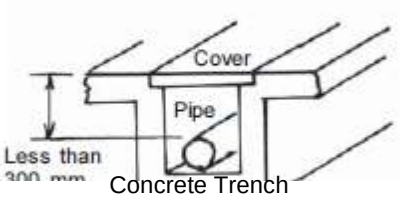


i. Preparation Prior to Laying of Pipes

- Carry out line out as per need and plan with line out tools.
- Maintain exact stipulated levels and gradient for laying the pipelines with leveling tools. Difference in level may disrupt the flow of water or pressure at the end point.
- Excavate trenches for laying under ground pipelines. Trenches should be excavated with 600 mm width and 1000-1200 mm depth. Mimimum clearance of about 150-200 mm is requried on either sides of pipes in tenaches.

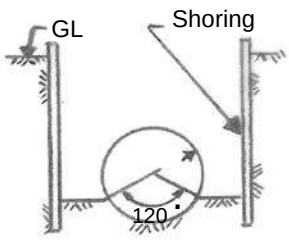
Type of pipe	Minimum cover below road (mm)	Minimum clearance from either side of pipe in trenches (mm)
Steel (MS/GI/DI)	1200	200
Plastic (PVC/HDPE)	1000	200

- Maintain levels after excavation. Place extra formworks and shuttering where needed in case the soil is soft to prevent collapse of soil. If excavation is done more than planned size, fill it with the soil and compact it. If the soil is hard or rocky the depth may be reduced. In hard rock, use blasting for excavation.
- If excavation is not possible, PVC pipes should be encased in masonry/concrete or steel pipes to prevent breakage and pressure of moving vehicles.

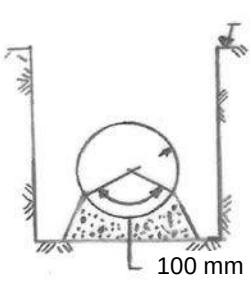


Concrete Trench

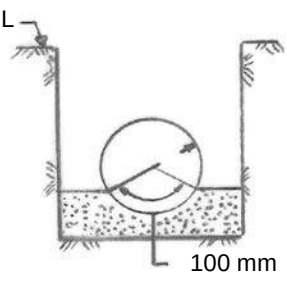
- In rocky surface, if necessary, the laying surface should be cushioned with a layer of sand or cement concrete bedding. This will prevent pipe from breakage due to point pressures.



Trench in Earth or Murrum



Trench in Hard Rock with Cement Concrete Bedding



Trench in Hard Rock with Sand Bedding

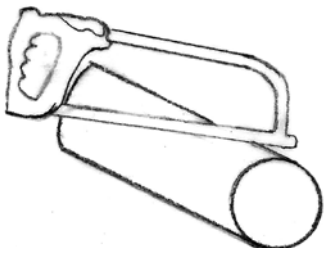
- All vegetation, shrubs, roots of the plant should be clean in and around of the laying line.

ii. Joining, assembling and laying of various types of pipes

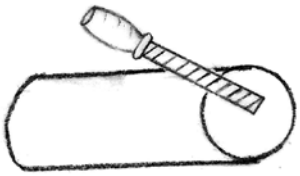
Joining and Laying of PVC Pipeline

Preparatory

- All care should be taken to clean the inner surface of the pipe before laying. The residual adhesive/ cement mortar or any other obstructing objects should be cleaned.
- Mark each pipe with pencil or marker for required length.
- Cut the pipes as per required length with a fine tooth hand saw/hack saw or power saw. Chamfer the pipe ends at 15-20 degree and 3-5 mm for proper joining of pipes and adhesive. Clean the edge and surfaces with clean cloth. Light sand paper or emery can be used lightly for cleaning if needed.

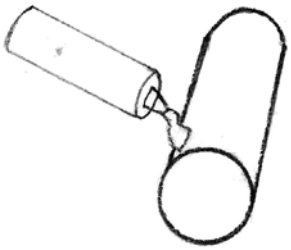


- Before joining pipes, mark the insertion depth of each pipe/fitting to be joined with marker/pen.



Jointing of pipes

- Pipes should be laid and joined with fittings on side of trenches in suitable lengths and lowered after suitable lengths are prepared.
- PVC pipes are joined in following ways for distribution piping:

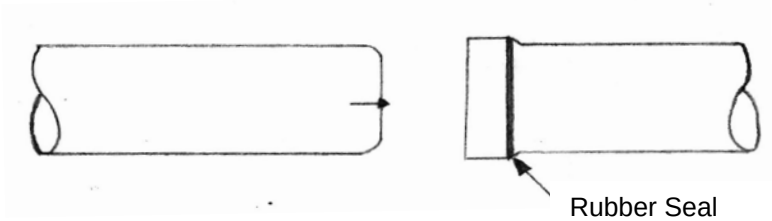


— Solvent welded joints - This system involves joining of pipes with solution made of polymer. This system is used for service pipes of water mains, branch pipes etc. For pipes upto 50 mm, regular viscosity solvent cement can be used, and for 50-150 mm diameter pipes, medium viscosity solvent cement should be used. Solvent is applied on end of pipe/fitting with brush. Within 20 seconds of last application of solvent cement, insert the pipe into fitting/socket and press it and hold it for a minute. Turn the pipes upto ¼-1/2 turn. Clean the extra solvent. Following table enlist number of joint which can be made from 1 litre of solvent

Diameter of pipe in inches	2”	1.5”	¼”	1”	¾”	½”
Approximate no. of joints which can done by 1 litre of solvent	70	100	130	150	180	200

Teflon tape can also be used for threaded connection for water seal.

— Rubber Ring joints - Rubber rings are joints are used for water tightness, but they cannot resist pull. Such joint are used where the soils in trenches are rough or aggressive. They are normally used for large sized pipes (> 63 mm dia). Insert the rings provided by manufacturer into the socket/groove and ensure that it is properly seated. Apply lubricant outside the spigot upto half the insertion depth. Insert the spigot end into the socket. Place a firm wooden block against the other end of pipe end. Using crow bar as level, push the spigot upto insertion depth mark. For larger pipes use jointing jack.



Lowering of pipes

Lower the cut pipes and fitting into trench manually. Care should be taken that they are not thrown in trenches. Mechanical device for lowering pipes can be done only in case large size pipes (>160 mm) are used. After laying, the open end of the pipes should be temporally plugged to prevent access of water, soil or any other foreign matter

Joining and Laying of MS Pipeline

Preparatory

- All care should be taken to clean the inner surface of the pipe before laying.
- Cut the pipes as per required length and thread with threading die and filed for proper cleaning where needed Clean the edge and surfaces with clean cloth. Light sand paper or emery can be used lightly for cleaning if needed.

Jointing of pipes

MS pipes are joined in two ways:

a) Threaded joint - Smaller pipes, below 200 mm are joined in such manner. Pipes have threaded ends with one socket. They are lowered down in trenches and laid to alignment and gradient. The pipes are joined with white lead and spun yarn. White lead is applied on the threaded end with spun yarn and inserted into socket of another pipe. The pipe is then turned and tightened.

b) Welding - Large diameters pipes, normally above 200 m are joined by welding. Pipes are first lowered down manually or with chain pulley. Pipes are laid in level alignment before joining. Pipe ends are butted against each other. Plain ended pipes are joined by butt ends and sleeved pipes by fillet welds. For laying long straight pipeline, butt joint is preferred. Cement mortar is applied after welding.

Lowering of pipes

Lower the prepared pipes and fitting into trench manually or with chain pulley. Care should be taken that they are not thrown in trenches. The pipe laid on level ground shall be laid with socket facing the direction of flow of water. After laying, the open end of the pipes should be temporally plugged to prevent access of water, soil or any other foreign matter.

Joining and Laying of GI Pipeline

Preparatory

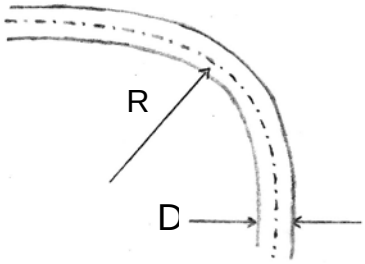
- All care should be taken to clean the inner surface of the pipe before laying.
- Cut the pipes as per required length and thread with threading die and filed for proper cleaning where needed Clean the edge and surfaces with clean cloth. Light sand paper or emery can be used lightly for cleaning if needed.

Jointing and laying of pipes

- Join inside of socket and the screwed end of the piped with white lead and put few turns of teflon tape or spun yarn around the screwed end of the pipe. Screw the end with socket, tee, etc. with a pipe wrench.
- After laying, the opens ends of the pipes should be temporarily plugged to prevent access of water, soil or any other foreign matter.
- Any threads exposed after jointing should be painted or coated with approved anti-corrosive paint to prevent corrosion.

Joining and Laying HDPE Pipeline (Mainly for Service/Branch Connections)

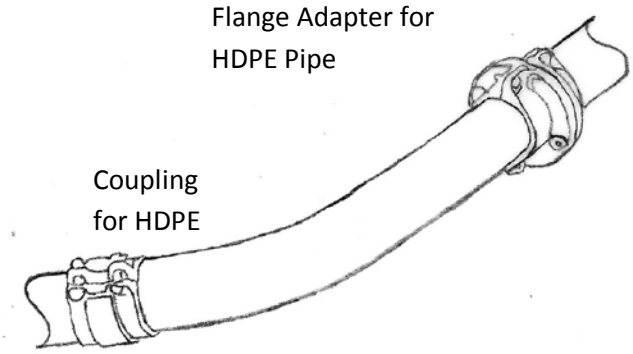
- Small diameter pipes are flexible and available in coils and do not need special like bend, elbows etc. The can be cold bended easily. The radius (R) of the bend should be greater than 20 times the outside diameter of the pipe (D).



- Forming of small radius bend may easily be done by the application of heat. The pipe should be heated to a temperature of 130°C in an inert liquid, such as glycerol (or any oil in emergency). It should however be done by trained personnel.

- After the pipes are bent, they are joined with mechanical joints, and fixed with bolts. Use of synthetic rubber gasket can also be done with it to improve water tightness of pipes. For joining HDPE pipes to any other pipe, HDPE-to-metal transition couplings, outlets and fittings are used.

- The pipe line may be laid along side of the trench and jointed there. There after the jointed pipeline shall be lowered into the trench carefully without causing undue bending, manually or with chain pulley, sling etc .The pipeline shall be laid inside the trench with a slack/looseness of about 1.0 m per 100 m of pipe line as they contract later on. For mechanical joints, thrust anchor are required in trenches for support it.



- As the pipe is laid, the front pipe in the trench should always be closed with a plug either of iron or wood and securely fastened. The plug should not be removed except, when pipe laying is resumed or for purposes of testing.

Joining and Laying of Ductile Iron (DI) Piping System

Preparatory

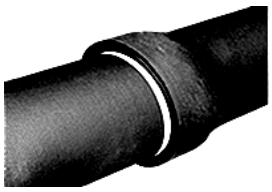
- Cut the pipes of needed length with hack saw, wheel cutter of pipe cutting machine.
- Where flexible joints are to be made, the cut ends must be trimmed with a file or grinder to remove the burr formed during cutting and a chamfer must be provided. When pipes are to be laid in aggressive soils, the pipes should be wrapped externally with protective coatings, such as bitumen or coaltar sheathing protective tapes.
- Lower all the pipes, pipe fitting etc. in the trench with ropes or suitable tools/equipments.
- Before joining, all the pipes must be cleaned of lumps, blistersm excess coating and must be clean from oil/grease etc.

Types of Joints for DI Piping System

a. Socket and Spigot flexible joints
   1. Push on Joints
   2. Mechanical Joints

The spigot and sopcket flexible joints incorpoate joinig of pipes with gasket (rubber/elastomeric material) which pemits angular deflection and compensates ground movment and thermal expansion/contraction. Such joints are used when piepeline is laid under ground. In push on joints, gasket is inserted between socket and spigot and lubircant is applied on the gasket and spigot fro effective joining. In mechanical joints, the joining is done by placing of gasket and tightening of follower gland and socket assembly with nut-bolt.

Flexible Joints for laying under ground



Push On Joints

b. Flanged joints

Flanged joints are used when DI pipes are to placed over gorund or have exposed installations to over head tanks etc. These joints act as self-restained joints and reduce use of thrust blocks. Flanged joints are made on pipes having a machined flange at each end of the pipe. The pipes are joined by placing of gasket and is compressed between two flanges by nut and bolts on flanges.

Mechanical Joint assembly

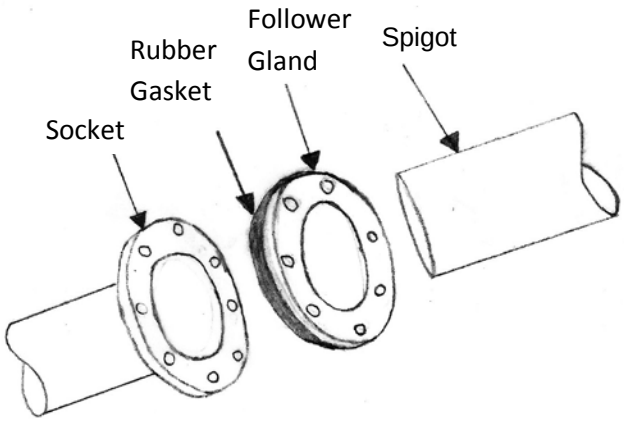
Flanged DI Joint Fitting

Joining of DI Pipes with Push on Joints

1. Clean the socket grooves and outside spigot end.
2. Place the gasket inside the socket.
3. Apply lubricant on the gasket and spigot as per manufacturer instruction. Do not use petroluem prodcuts for lubrication.
4. Properly align both the pipes. Gently push the spigot into the socket with suitable mechanical means like crow bar, etc.

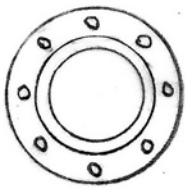
Joining of DI Pipes with Mechanical Joints

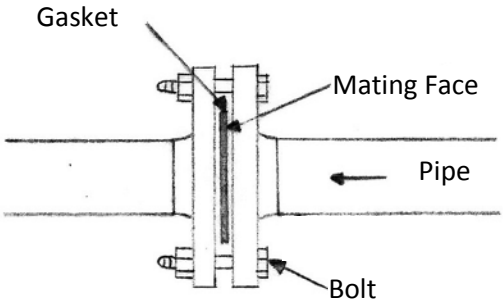
1. Clean the socket and spigot of the pipe.
2. Insert the follower gland and gasket on the spigot.
3. Put the spigot into the socket and align the pipes. Slide the glands and gasket in position. Insert nut bolts and tighten it.
4. Ensure that follower gland presses the rubber gasket properly.



Joining of DI Pipes with Flanged Joints

1. Align the pipes.
2. Clean flange faces.
3. Position gasket.
4. Lubricate bolt threads, mating surface and flange with automotive grade oil/grease.
5. Indsert nut bolts one by one and tighten oppossite bolts one by one.





iii. Filling Excavated Pit after Laying of Pipes and Testing of Piping System

- All backfill material should be free from cinders, ashes, slag, rubbish, vegetable or organic matter, boulders etc. Sand used for back fill should be natural sand, fine or course. Gravel used for back fill should be natural gravel with no boulders larger than 50 mm. Back fill can be done with excavated materials like clay, sand, gravel, etc.
- After laying of piping system, fill the trench upto 300 mm and compact by tamping.
- Carry out leakage testing of piping system after partial back filling.

The leakage can be detected in 2 ways:

1. Direct observation - spots of wet places in the pipeline indicates leakages.
2. Hydraulic test with pressure.
   All the piping system laid should be tested for leakage. At village/town level, leakage test can be carried out after every 500-1000 m for such test and mainly for the mains. Pressure gauge should be fixed at lowest end of pipe. The water should be filled in from lowest point in network to be tested and air vents should be provided at higher points. During such filling of pipe line with water, air should be released from air vent pipes and care should be taken to close air vents only when complete air has been released from the pipe line and smooth flow of water starts. Calibrated tank can be installed for water supply and collection. For leakage test, 1.5 times the working test pressure of the pipes selected is done. There are specific formulas for testing the leakage amount at end of each test. It will vary with the pipe length, number of joints in pipeline and diameter of pipe. Consult the site engineer for its details.

Note: solvent joined pipes should not be tested before 24 hours of fixing.

- Fill the remaining pit in layer of 50mm with required compaction and watering.

iv. Disinfection of Pipeline

- The mains of water supply line should be disinfected before it is used.
- Flush the pipe with water of sufficient velocity to remove dirt and other foreign material.
- Later disinfection with chlorine water can also be done. Chlorine concentration of 20 mg/litre can be used for chlorination of mains. Chlorine water should remain for 24 hours in the main for proper disinfection. Hence, all the valve, etc. should be closed along mains before the procedure.
- The chlorine water can then be disposed off and pipeline be cleaned with fresh water.

C9 Installation of Water Meters

- Installation manual is normally given by the meter supplier.

- Domestic Water Meters can fixed at household level in case there is 24 hours supply and water tariff is collected based on actual water consumption.

- A masonry pit is constructed around the meter to protect it. A lid should be placed on pit for taking readings. The protective lid should normally be kept closed and should be opened only for reading the dial.

- Technical parameter for fixing of water meters
  a) Water meters must be fitted in the right direction of flow and positioned to allow easy visibility for manually reading the meter and for viewing the serial number.

  b) The length of pipe that accommodates the water meter must be completely filled with water immediately upstream and downstream of the meter under all operating conditions.

  c) Install meter such that top of the meter is below the level of the communication pipes so that meters always contain water.

  d) Water meters are to be located to avoid damage (eg. vehicles, livestock, vandalism, flooding) a protective box/masonry pit may be necessary in some situations.

  e) Water meters are to be installed as close as practicable to the extraction point and must be located upstream of any valves (except air valves), tees, takeoffs, diversions or branches.

  f) Water meters are to be installed above ground if possible and located outside of wells to allow for safe and easy meter reading. If a water meter is required to be located below ground, or down a well then it should not be deeper than 500 mm below ground level.

  g) Water meters fitted onto PVC, or HDPE pipeline must be adequately supported by a concrete block, or fabricated steel bracing to ensure stability.

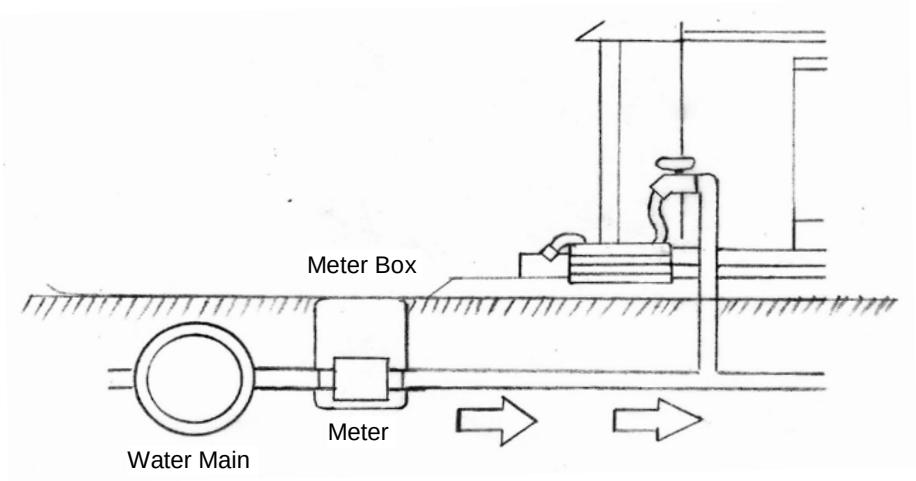
  h) Before connecting the meter to the water pipe, it should be thoroughly cleaned by installing in the place of the water meter a pipe of suitable length and diameter and letting the passage of a fair amount of water flow through the pipe work to avoid formation of air pockets. It is advisable that the level of the pipeline where the meter is proposed to be installed should be checked by a spirit level.

  i) Before fitting the meter to the pipeline check the unions nuts in the tail pieces and then insert the washers. Thereafter screw the tail pieces on the pipes and install the meter in between the nuts by screwing. In order to avoid its rotation during the operation, the meter should be kept fixed with suitable non-metallic

clamps. Care should be taken that the washer does not obstruct the inlet and outlet flow of water.

j) Where intermittent supply is likely to be encountered the meter may be provided with a suitable air valve before the meter in order to reduce inaccuracy and to protect the meter from being damaged.

k) Test and calibrate the water meter before use and at regular intervals as per instructions given by manufacturer.



Typical Installation System for Domestic Water Meter

Activity Sheet

Section C

1. List components for water pumping

2. List types of pipes and mention any one advantage and disadvantage of each

3. List types of pipe fittings

4. Which tools are used for pipe cutting

5. List line and leveling tools for pipe laying

6. List sequence for pipe laying

7. How will your test any water leakage after pipeline laying

8. Which chemical is used for pipe disinfection

9. What is a water meter and what does it measure

MODULE D: BASICS ON WORK MEASUREMENT AND SPECIFICATIONS IN WATER SUPPLY SYSTEM

Training tools: Powerpoint/on board presentation, question-answer
Approximate time:

Powerpoint presentation: 45 minutes hour

Question-answer: 25 minutes

TOTAL 1 hour 10 minutes

Training Objectives

a) To know basics on material quality check and control on site

b) To learn on basic specifications of various material and items for water supply system and in what units it can be measured.

D 1 Checklist for Quality Check of Basic Construction Materials for Water Supply System (at Site/Village/Town level)

This checklist is mainly for understanding specifications of materials to be ordered, its storage mechanism on site as well as quality check on site as per the order placed.

1. Cement
   - Cement should be 53 grade ordinary Portland cement (OPC) with ISI mark.
   - Cement should be used within three months from the date of manufacture. Date of manufacture is written on cement bags.
   - Do not purchase cement bags which are damp.
   - Store cement bags so that they do not catch dampness.

2. Sand
   - River sand should be clean and sieved. It should not contain silt and dust.
   - Use sand after washing it.

3. Gravel/Kaptchi/Aggregates
   - Such aggregates come is 4-40 mm size.
   - They should not be larger than 40 mm each.
   - They must be hard, non-porous and free from excessive quantities of dust.
   - They should not be rounded or with flakes.
   - They should be angular, tough, and sharp and well graded stone metal, Basalt from approved source.

4. Stone
   - Use stone from standard mines.
   - Use stone which are hard and similar colour.
   - Do not use stones which are round or very irregular in shape.
   - Length of stone should not exceed three time its height. Height of stone can be upto 300 mm.
   - Width/breadth of stone base shall not be greater than $3/4^{th}$ of wall thickness. However, width of stone shall not be less than 150 mm.

5. Bricks
   - Use bricks of even sizes from standard suppliers.
   - Standard traditional size of bricks is 9” x 4.5” x 3”.
   - Use first class bricks.
   - Bricks should not be over burnt or under baked.
   - Bricks should be free from cracks, chips, flaws and stone.
   - Compressive strength of bricks should be atleast 35 kg/cm^2.
   - Use bricks with frog in it.
   - Check few bricks on unloading for its size. The size (length/breadth/height) individually should not be more/less than 5 percent of size ordered.

6. Cement Concrete Blocks
   - Compressive strength of blocks should be atleast 35 kg/cm^2.

7. Water
   - Use clean water as far as possible.
   - Do not use saline water.
   - Water should be free from oils, acids, salts and other organic material/substances which may be harmful to concrete/pipes.

8. Steel Reinforcement Bars
   - Use steel bars with ISI mark only.
   - Store steel bars on site in such a manner that it does not catch corrosion and is not in contact with moisture/water.

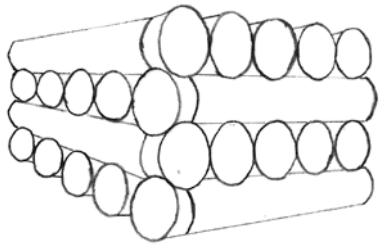
9. Pipes for water distribution

General

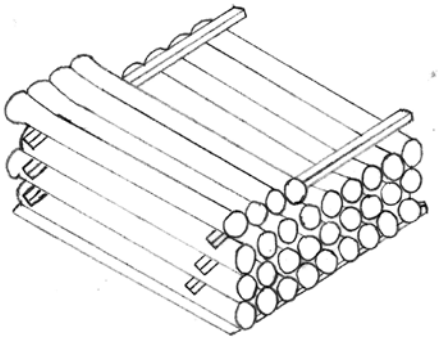
- Check manufacturer's trademark and name, ISI mark, outside diameter in mm, class of pipe and pressure rating, month and year of manufacture as well as length of pipe, once the pipes are unloaded on site. Check whether the pipes unloaded are as per specifications while ordering.

Metal pipes

- Pipes and fittings should not be thrown from trucks, nor dragged or rolled along hard surface. Pipes may be handled in slings of canvas or non-abrasive materials.
- Pipes can be stored in layer with each layer at right angle to another. Height of stack should not exceed 2 meter. Alternatively, parallel stacking can be done using timber.



- The pipes should be inspected while unloading for defect like grooves, dents, notches. If large portion of such defect are found, material should be replaced.
- The pipes should be stored under cover on the site if it is to be used after long period.
- Pipes of different sizes should be stacked separately.



Plastic pipes

- Pipes should be stored undercover if it has to be used after longer period as it will get damaged due to direct sunlight.
- HDPE coils may be stored either on edge or stacked flat one on top to another. Straight lengths PVC/HDPE can be stored in horizontal racks with support. Pipes should not be stored in stacks more than 1.5 m in height. Pipes of different sizes should be stacked separately.

Pipe Fittings

- Check manufacturers' identification mark, ISI mark and size as well as working pressure when delivered.

D2. Basics on Material and Item Specification and Mode of Measurement.

Below listed are details for measuring of various material and activities. This checklist will help in placing orders and tendering for purchase of materials as well as for work estimation and cost estimation.

Specimen Specification and Unit of Measurement for Basic Construction Materials and Labour Work Mainly for Pipeline

Sr. No	Material/Item	Specification for inviting quotation	Quantity Measured in (unit)
1	Cement	Providing 53 grade OPC cement bags to the site specified with loading-unloading, taxes and transport to site (with ISI Mark).	Bags (50 kgs)
2	Sand	Provision of river sand to the site specified (with loading, unloading, taxes and transport to site).	cu. m
3	Stone	Provision of stone from quarry, with royalty, loading-unloading, taxes and transport to site	cu. m
4	Kaptchi	Provision of Kaptchi/grit from quarry, with royalty, loading- unloading, taxes and transport to site 6 mm-12 mm size 12 mm-20 mm size 20 mm-40 mm size	cu. m
5	Bricks	Providing first class burnt clay bricks of size 9"x4"x3" including loading-unloading, taxes and transport to site	1000
6	Cement Concrete Blocks	Providing cement concrete blocks 9"x4"x3" including loading-unloading, taxes and transport to site	1000
7	Excavation of pipeline trenches	Excavation for pipe line trenches including all safety provisions using site rails and stacking excavated stuff up to a lead of 90 m, cleaning the site etc. Complete for lifts and strata as specified for depth of 1.5 m. In all sorts of soil and soft murrum In hard murrum, boulders incl. macadam road. In soft rock and/or masonry in CM or L M or Lime Concrete. In hard rock and / or in C. C. 1:2:4 or RCC with blasting and chiselling or by chiselling only.	cu. m.
8	Extra for formwork	Shoring or timbering for trench with 50 mm thick planks and suitable size struts etc.	sq. m.

	during excavation	complete.	
9	Back fill of trenches	Refilling the pipeline trenches incl. ramming, watering, consolidating disposal of surplus stuff as directed within a radius of 3 km	cu. m.
10	PVC Pipe	Providing and supplying in standard lengths ISI mark rigid unplasticised PVC pipes (test pressure 6 kg/cm^2 pressure) suitable for potable water with solvent cement joints including cost of couplers, as per IS specification no. 4985/1988 including all local and central taxes, transportation, freight charges, inspection charges, loading, unloading, conveyance to the site stacking including cost of jointing material i.e. solvent cement, etc. complete (as per specified diameter).	r. mt.
		Making available PVC fittings with all taxes, and carting, unloading etc. on site/store.	No.
		Lowering, laying and jointing PVC pipes and specials of specified class and diameter including cost of conveyance from stores to site of works including cost of labour, material, except cement solvent, giving satisfactory hydraulic testing as per ISI code.	r. mt.
11	Mild Steel Pipe	Supply and Delivery of M.S.Pipe, medium duty conforming to IS-3589 to the site including all taxes, insurance, transportation, freight charges, inspection charges, loading, unloading,, stacking etc. complete. (as per specified diameter).	r. mt.
		Lowering and laying in position to correct line and level M.S. Pipe with outer coating and inside lining/Epoxy painting on pedestal or chairs upon prepared formation or prepared bedding in trenches the rates include conveyance from store to site of work loading, unloading, joint plastering, hydro testing etc. complete. (as per specified diameter).	r. mt.
		Extra Welding in all positions with required number runs, for M.S. Pipes internally and/or externally including gauging wherever necessary, fixing appurtenances and other accessories in connection with pipe laying work as per specification. As per specified diameter.	r. mt.
12	GI pipes	Providing and supplying medium duty GI pipes in standard lengths as per specified diameter, ISI mark , with required coupling, suitable for potable water including all local and central taxes, transportation, freight charges, inspection charges, loading, unloading, conveyance to the site stacking including cost of jointing material i.e. solvent cement, etc. complete.	r. mt.
		Lowering & laying in position to correct line & level M.S. Pipe of specified diameter with	r. mt.

		required specials/fitting including conveyance from store to site of work loading, unloading, joint plastering, hydro testing etc. complete.	
13	HDPE pipes	Providing and supplying in standard length ISI mark high density Polyethylene HDPE Pipes of specified diameter suitable for potable water as per IS specification no. 4984/1995 including all local and central taxes, transportation, freight charges, inspection charges, loading, unloading, conveyance to the dept. stores etc. comp. (PE-100 or as specified).	r. mt.
		Lowering, laying and jointing HDPE pipes and specials of following class and diameter (By butt fusion welding method) including cost of conveyance from stores to site of works including cost of labour, material, giving satisfactory hydraulic testing.	r. mt.
14	Ductile Iron Pipes	Providing and supplying D. I. pipes for specified class and nominal bore diameter with internal cement mortar lining including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete. (IS 8329-2000).	r. mt.
		Supply and& Delivery of Ductile Iron Flange socket spigot bends, tees, reducers or any other specials as per BS-EN-545/1995 Class-A series K12 suitable for use with D.I. Pipes manufactured as per IS:8329/1994 delivery of specials is to be made to store or site of works including all taxes, loading, unloading, carting, stacking, insurance, inspection charges, octroi etc. complete.	Kg
		Providing, laying and jointing sockets and spigot centrifugally cast (spun) ductile iron pressure pies with inside cement moratr lining (class K 7/K 9) confirming to IS 8329/2000 with suitble rubber gasket joints as per IS 5382/85 for specified diameter.	r. mt.
15	Valves (PVC/CI/other)	Providing and supplying ISI mark D/F Sluice Valves , Butterfly Valves & Reflux/air Valves of specified class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete.	No.
		Lowering, laying and jointing in position following specified valves, Butterfly valves, Sluice valves and air valves including cost of all labour, jointing material, including nut bolts and giving satisfactory hydraulic testing, etc. complete.	No.

IS Code for basic materials		
Sr. No	Type of Material	IS code
1	Ordinary Portland Cement (OPC)-43 grade	IS 8112
	Ordinary Portland Cement (OPC)-53 grade	Is 12269
2	Natural building stone	IS 1123
2	Coarse and fine aggregates	IS 383
3	Mild Steel	IS 432
4	Burnt Clay bricks	IS 1077
5	Fly Ash bricks	IS 13757
6	UPVC pipe	IS 4985
7	GI pipe	IS 1239
8	MS pipe	IS 1239 & IS 3589
9	HDPE pipe	IS 4984
10	DI pipe	IS 8329

Mode of measurement for specific work items		
Sr. No	Item **	Quantity Measured in (unit)
1	Water Storage tank	litres
1	Cement concrete	cu.m.
2	RCC	cu.m
2	Labour work for steel reinforcement	MT
3	Flooring	sq.m.
4	Colour works	sq.m.
5	Pumping Machinery	no.
6	Stand post installation	no.
7	Cattle trough installation	no.
8	Washing Ghat installation	no.
9	Water meter	no.
10	RO plant/filter units	no. / MLD
11	Electric panel board	no.
12	Water testing apparatus	no.

** These items include both, labour and material cost or can be taken up individually.

Worksheet
Section D

1. In which units are following material and work measured

Cement	
Steel	
Bricks	
Pipes	
Cement concrete	
Excavation of trenches	
Back filling of trenches	

2. What will you check quality when following materials are unloaded on site
   a. Cement

   b. Steel

   c. PVC pipes

   d. GI pipes

3. How will you store and stack following materials on site

   a. Cement

   b. PVC Pipe

MODULE E: WATER TREATMENT AND QUALITY CONTROL

Training Objectives

a) To know basic drinking water quality parameters
b) To know type of tests and method of testing of selected parameters
c) To know household and community treatment processes for drinking water

Training tools: Presentation/class room sessions, practical sessions (if testing kit available)
Approximate time: 2.5 hours

E.1 Water Quality and Testing

Water from ground or surface sources are not always potable for drinking and need some level of water treatment prior to supply for water supply system. Following are some of the quality issues that are normally seen in various types of water sources:

Water Source	Type of quality issues
Surface water	
Lakes and ponds	Development of algae on top, development of Micro organisms, high turbidity in bottom layers. May be affected by organic and chemical pollutants by disposal of wastewater.
River, irrigation canals	Organic debris, mineral salts May be affected by organic and chemical pollutants by disposal of wastewater.
Ground Water	
Well, tube wells, hand pump etc	Salinity, fluoride, alkalinity, hardness Chemical contaminations due to disposal of domestic waste/industrial chemical near by

There are certain parameters for potable drinking water, recommended by Government of India (IS 10500 -1991) which are enlisted below:

Parameter	Desirable Value	Maximum Permissible Value	Effects if not controlled
Colour	5 hazen unit	25 hazen unit	Unacceptable by people
Odour	odourless	Odourless	Unacceptable by people
Turbidity	5 NTU	10 NTU	Unacceptable by people
Soluble Salts/TDS	500 mg/l	2000 mg/l	Stomach ache
pH	6.5- 8.5	6.5- 8.5	Intestinal problems
Hardness	300 mg/l	600 mg/l	Not appropriate for cooking, washing clothes. flaking in pipes
Calcium	75 mg/l	200 mg/l	Not appropriate for cooking,
Chlorides	250 mg/l	1000 mg/l	Corrosion, taste differs
Sulphate	200 mg/l	400 mg/l	Indigestion, stomach problems
Magnesium	30 mg/l	100 mg/l	Stomach ache
Nitrates	45 mg/l	100 mg/l	Can lead to Blue baby (1-6 months child)
Fluorides	1.00 mg/l	1.50 mg/l	Fluorosis of teeth, bones and muscles
Alkalinity	200 mg/l	600 mg/l	Taste differs
E-coli	Count 0 in 100 ml		Infectious disease and intestinal problems
Coliform	<10 in 100 ml	Not detected in more than 50% sample in year	

For testing of water, services can be availed from Maharasthra Jeevan Pradhikaran, Public Health Engineering Department (PHED) and health department offices located at block/taluka level, or other water testing laboratories in the region.

Types of tests to be conducted

a. Physical test including temperature, turbidity, colour, taste, and odour.
b. Chemical tests including pH, alkalinity, acidity, hardness, calcium, magnesium, iron, manganese, copper, zinc, aluminum, sulphates, fluorides, chlorides, nitrates, total dissolved and suspended solids, tests for toxic chemicals (lead, mercury etc.), test for radio-activity.
c. Bacteriological examination for presence of bacteria like coliform, E-coli

Sampling Frequency

Water from all the sources like wells/tubewell/hand pump or collection point like stand post or HH level/intermediate storage tank should be tested at regular intervals. Normally, one sample for every 5000 population should be tested in each month. Additional tests should be conducted during monsoon and epidemics as per need. Where there are issues of biological contaminations, samples should be taken every week from the specified water source.

Following chart enlists the minimum sampling frequency from distribution system as per CPHEEO guidelines:

Minimum Sampling Frequency and number from Distribution System		
Population	Maximum intervals between successive sampling	Minimum number of samples to be taken from entire distribution system
Upto 20,000	One month	1 sample per 5,000 population per month
20,000-50,000	Two weeks	
50,000-100,000	Four days	
>100,000	One day	1 sample per 10,000 of population per month

Sampling Methods

a. Sampling for physical and chemical test
   - Samples should be collected in inert materials like glass or polythene.
   - Sample bottle must be cleaned prior to taking samples as directed by laboratories.
   - About 2.5 litres is required for testing from each sample.
   - Prior to filling, the sample bottle must be rinsed 2-3 times with water to be collected.
   - Sample should reach the testing place within 72 hours of collection.
   - Certain parameters like pH, temperature chlorine etc may change during transport and it is advisable if they are tested on spot by specific kits.
   - Samples collected from wells should be taken only after the well has been pumped for sufficient times so that the sample will represent ground water.

b. Sampling for bacteriological test
   - Sterilised bottle, as directed by laboratory should be used for sample collection.
   - While collecting sample, hand should not touch the bottle neck or stopper. Bottle should be held from the base, filled without rinsing and stopper be closed immediately. Bottle should have some air space left and should not be filled completely. Finally, brown paper should be wrapped for avoiding further contamination of water.
   - Size of sample should be at least 250 ml (1/4th of litre).
   - The sample should preferably be analysed within one hour after collection. The test of the sample should be done maximum within 24 hours.

   Note for collecting sample from various sources
   - While taking sample from river, lake, etc. sample should be taken from middle of bank. Stagnant water should be avoided for sample.
   - While taking sample from tap (HH or stand post), water should be allowed to flow for two to three minutes prior to taking sample. Tap from which sample is collected should be clean and free from grease etc.
   - While taking sample from hand pump, water should be allowed to flow for four to five minutes prior to collection of sample.
   - While collecting sample from well/bore well, sample be collected from discharge end through fitted mechanical pump.

Water Testing Kits

Several testing kits are available in market to test water quality at village/town level. Use of these kits need specialised training appropriate for tools and equipments of the kit.

Water Testing Kits in India

1. FTC (Field test kits)
   - As per National Rural Drinking Water Quality Monitoring and Surveillance Programme, field testing kits are provided at Gram Panchayat level for testing of various parameters at village/town level. These Kits are meant for water quality monitoring and testing by PHED engineer, NGOs, Voluntary agencies, Women group etc. Such kits are used for primary detection of chemical and biological contamination of water sources in village/town. All the water sources should be tested twice a year for bacteriological contamination and once a year for chemical contamination.

   - Such kits include testing of water for turbidity, pH, hardness, chloride, iron, nitrate, fluoride, residual chlorine, arsenic and bacteriological quality.

2. Jal Tara Water Testing Kits (Designed by Development Alternatives)
   - Jal Tara Kits are developed by Development Alternatives, New Delhi
   - The kit is available for testing various parameters. These kits are validated by UNICEF.
   - A standard Jal Tara kit can test 14 parameters
     Physical: pH, Temperature, turbidity, hardness
     Chemical: chlorine, fluoride, iron, nitrate, residual chlorine, dissolved oxygen phosphorous, ammonia
     Biological: Coliform bacteria
     100 tests can be performed by this kit. However, 10 test for coliform can be done

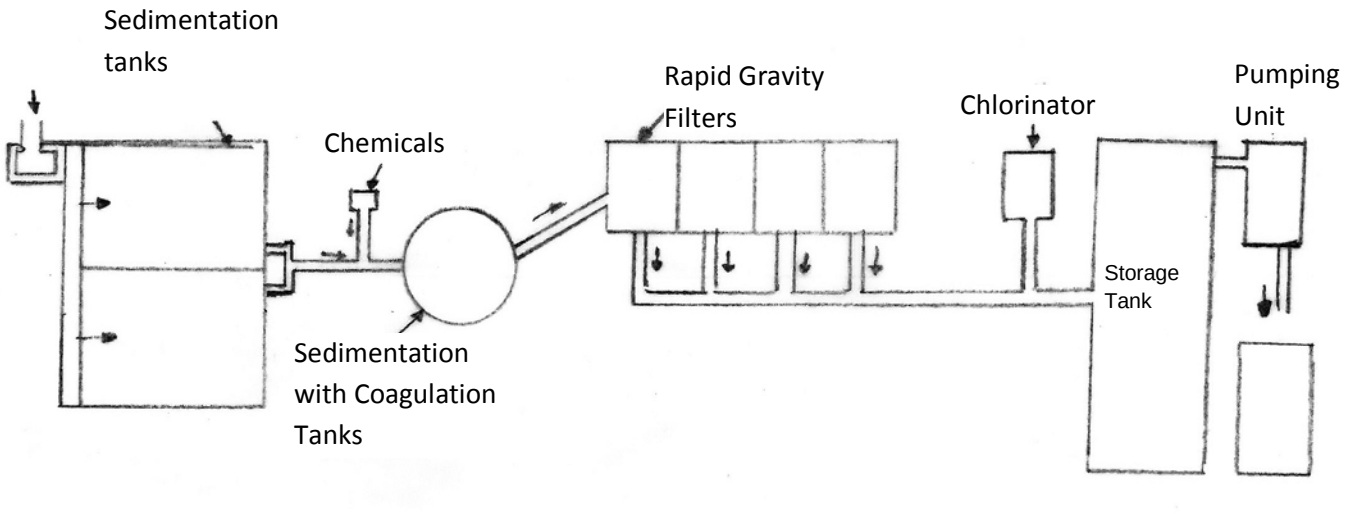
E.2 Water Treatment Systems

Normally, water supplied for drinking is treated at head works under the water supply system. However, water needs treatment even at household level as there may me chances of water contamination while transmission of water. Type of treatment depends on quality of raw water and source. Chart below enlists some of the common methods of water treatment used in water supply system:

Type of Filtration	Purpose	Type of unit
Sedimentation	Removal of suspended solids like sand, clay, silt etc.	Sedimentation tanks
Sedimentation with coagulation	Removal of suspended solids, colour, odour, taste, turbidity etc.	Sedimentation with chemical input
Filtration	Removal of micro organism and colloidal matter	Slow/rapid sand filter
Water softening plant	Removal of water hardness/salts	RO (reverse osmosis plant)
Disinfection	Removal of pathogenic bacteria	Chlorination
specialised water treatment plants	Removal of fluoride	De-fluoridation units, Nalgonda System
	Excessive salinity	De-salination plants

Village/Town Level Water Treatment Systems

- Village/town level water treatment systems are located mainly near head works, and should be located near to village/town if possible so as to avoid contamination in further water conveyance.
- The treatment units should be located in such a manner where possible that flow of water from one unit to other can be done by gravity, so that additional pumping of water is not required.
- Sufficient area should be reserved near the treatment units for further expansion in future.



Types of Water Treatment System at Village/Town Level

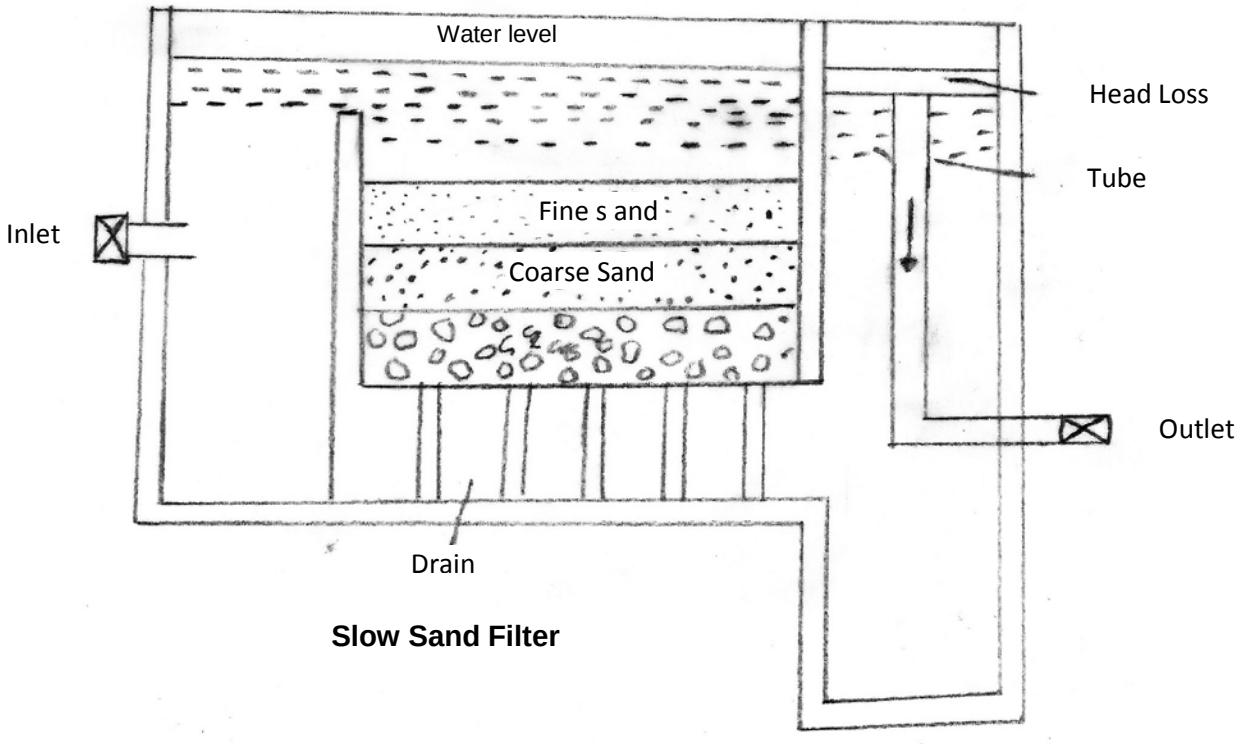
1. Primary Screening
   - Screens are fixed in the intake works or at the entrance of treatment plant so as to remove the floating matters as leaves, dead animals etc.

2. Sedimentation
   - In this process, suspended solids are made to settle by gravity under still water conditions. The sedimentation tanks may be rectangular or circular in shape.

   Advantages
   - Plain sedimentation lightens the load on the subsequent process.
     - The operation of subsequent purification process can be controlled in better way.
     - Less quantity of chemicals is required in the subsequent treatment processes.

3. Sedimentation with coagulation
   - This process is used when raw water contains fine clay and colloidal impurities and needs extra chemical treatment for them to settle unlike plain sedimentation. In this process certain chemical/coagulant are added in the process along with sedimentation for impurities to settle down. This process is useful in removal of colour, odour and taste from water. Turbidity and bacteria can also be removed to certain extent.
   - Coagulants are added based on pH of water. Alum or aluminium sulphate is common and cheaper coagulants added in the process. They are added in powder or solution form to raw water through some mechanical means.

4. Filtration
   - This involves treatment of water by passing it through bed of sand, gravel and other granular materials. This system is useful in removal of bacteria, colour, odour, taste.
   - This system is highly useful in removal of suspended impurities.



Slow Sand Filter

- The common type of filtration system is slow sand filter mainly used in rural/small urban areas. Such filter is made up of tank containing sand in top layer (size 0.2-0.3mm) upto thickness of 750-900 mm. Course sand layer is placed below fine sand layer upto 300 mm. The last layer is of graded gravel (2-45 mm) upto thickness of 200-300 mm. Water from sedimentation tank is passed through sand filter tank. Average flow of water from such filter is about 2400-3600 litres/m^2/day. Hence, size of tank is decided upon daily requirement of water to be treated. The sand needs to be replaced every 6-8 weeks as it gets clogged with impurities. Gravel can be washed and cleaned and replaced again.

5. Water chlorination
   - Chlorination is the cheapest form of water disinfection.
   - Chlorination is done at head works/main storage tank in village/town prior to water distribution.
   - Water test of the source needs to be done in laboratory in order to derive require amount of dosage of chlorination. Additional test should be done during monsoon and in case of epidemics.
   - Bleaching powder or chlorine solutions are used for this purpose. If chlorine is used in powder form, it should be first diluted in form of solution and mixed in tank for proportionate mixing in the tank. Any form of chlorine should be of ISI mark. Normal dosages used for chlorination are listed below, however, prior test of water source needs to be done for deriving exact dosage:

	Quantity of chlorine	
Quantity of water to be used (litres)	**Powder form chlorine/bleach (grams)**	**Chlorine solution (milliliter)**
	25-35% powder	5% solution
1000	5	25
5000	15	125
1 lakh	500	1500
5 lakhs	2500	12500

   - Chlorine gas is also used for water chlorination and it is available in cylinders. Such form is used for larger quantity of treatment in urban areas.
   - Chlorine reaction time with water should be atleast half an hour. After this chlorine residue in water should be about 0.2 ppm. In monsoon/epidemics, this residue can be upto 1 ppm.
   - Chlorine should not be stored in open area with direct sunlight as it will disintegrate. Chlorine containers should be closed immediately after its use.
   - Chlorine should not be used in excessive amounts in drinking water as it may lead to health problems.
   - Potential problems
     - Chlorination is less effective in alkaline water (pH above 8.0);
     - When the water contains excessive organic matter or suspended material, it will need to be pretreated;
     - Chlorination affects the taste of water.
   - Despite these limitations, disinfecting drinking-water by chlorination is one of the most effective and least-expensive technologies available and should be encouraged.

Equipments for Chlorination at Cluster/Village/Town Level

Equipments for chlorination are selected based on type of source/storage to be chlorinated, availability of form of chlorine (powder, liquid or gas) and treatment capacity of the equipment. Following are some of the common types of equipments used for

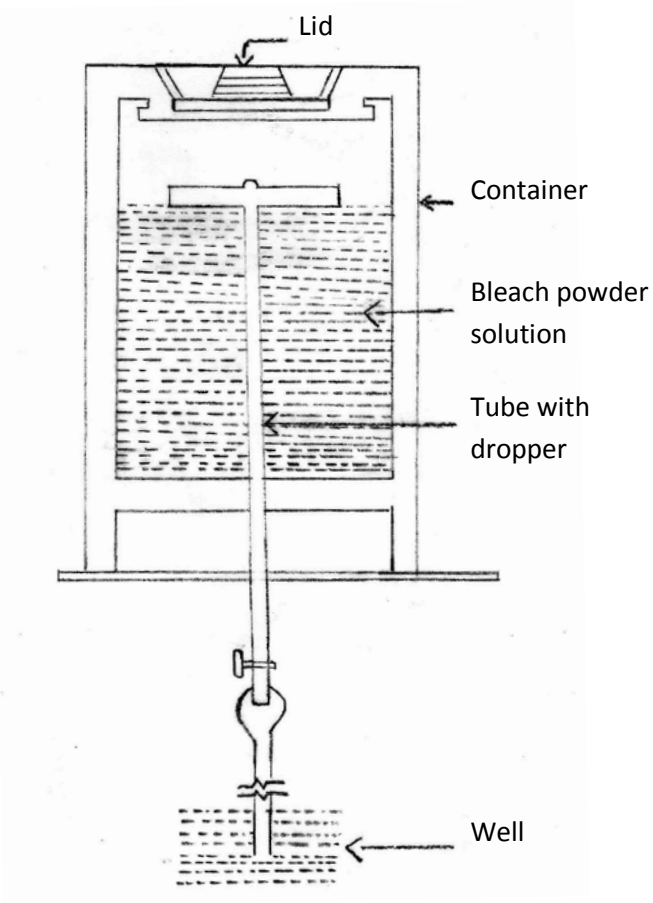
chlorination.

a) Differential Pressure Type Chlorinator (with use of bleaching powder):
This equipment is widely used for piped water supply. The equipment consists of mild steel container with rubber bag inside it, which contains bleaching power and soda ash in proportion of 5:1. This instrument is connected to water supply pipeline. Valve in the equipment helps in controlling application of bleaching powder as per required dosage. Such equipment is useful for small piped water supply with capacity of treating 3-20 lakh litres/day.

b) Drip type equipment:
Such equipment is used for chlorination of dug wells of flowing surface water. Such system consists of tank (may be made of RCC/masonry with glased tiling or may be plastic tank), for containing chlorine solution, lid to filling tank and plastic drip pipe with stop cock. The drip pipe is placed in the well and chlorine solution is fed as per required dosage in the well.

Such system can also be used for chlorination of ground service reservoirs.

If the tube is placed directly into flow of water, then the rate of drops will slow down as level in the tank lowers. In that case, a constant head device is placed in the chlorinator system.



Drip Chlorinator

c) Gas Chlorinator:
Such system comprise of gas cylinder and gas absorption system which mixes the gas into raw water by dissolving chlorine gas in water. Various types of gas chlorinator system like gravity fed, pressure fed and vaccum fed are available in market.

6. Nalgonda System for Fluoride Removal

- Nalgonda Technique useful in treating of raw water with high amount of fluorides (1.5-20 mg/l). In this technique, besides fluoride, turbidity, colour, odour, pesticides and organic substances are removed. Bacterial contamination is also reduced.
- Nalgonda Technique involves additional of aluminium salts, lime and bleaching powder followed by rapid mixing, flocculation sedimentation, filtration and disinfection.

7. Reverse Osmosis System (RO)

- Treatment plants ranging from 10-6,000 litres/hour capacity are available.
- The system involves process that uses semi-permeable spiral wound membranes to spate and remove dissolved solids, colloidal matter and bacteria from water.
- Such plants are capable of removing upto 98 percent of TDS, upto 99 percent of organic matter, and upto 99 percent of bacteria. They are effective even with TDS concentration of 10000-20000 ppm. Hence, RO plants are highly useful in treating water with various impurities.
- Such system requires high investment cost as well as operation and maintenance.
- Community based RO plants are operated by private operators/water and sanitation committee.

Household Water Treatment Systems

- Basic filtration and boiling.
- Domestic chlorination.

1. Boiling at household level
   - Water heating is effective in killing micro-organisms.
   - Water should be heated in container for at least 10 minutes.
   - Prior to boiling water should be filtered with sieve or clean cloth. Sieving will remove any particulate matter in water.
   - Potential problems
     - The water becomes re-contaminated after boiling;
     - Fuel for boiling the water is scarce and, consequently, expensive;
     - Boiled water tastes flat – this may be corrected by adding herbs to the water during boiling and not drinking it for six hours after it has been boiled.

2. Water chlorination at household level
   - Chlorination of water is a form of disinfection of water, mainly for removal of micro organisms causing water borne diseases like diarrhoea etc.
   - This method is used mainly for drinking water to be consumed at household level.
   - Chlorination at household level can be done through addition of chlorine pills. Such pills are available with PHED/Health Department/Asha worker. The chlorine pill should be allowed to dissolve in water and the mixture should be used only after half an hour.
   - Based on the water quality, dosage of chlorine will vary. Instruction about the dosage can be sought from Asha worker/Health Department in your region.
   - Chlorination should be done specially in monsoon.

Work Sheet

Section C

1. List basic parameters that need to be tested for water used for drinking purpose

2. Mention major drinking water quality issues from various sources in your village/town.

3. What type of treatment can be done for drinking water sources in your village/town

4. Mention various types of household level water treatment and its use.

5. Mention best way of drinking water-disinfection at village/town level

6. What type of treatment system is used when there is high amount of TDS.

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Source of photographs on cover page

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The Performance Assessment System (PAS) Project

The Performance Assessment System (PAS) Project aims to develop appropriate methods and tools to measure, monitor and improve delivery of water and sanitation in cities and towns in India. The PAS Project includes three major components of performance measurement, performance monitoring and performance improvement. It covers all the 400+ urban local governments in Gujarat and Maharashtra.

CEPT University has received a grant from the Bill and Melinda Gates Foundation for the PAS Project. It is being implemented by CEPT University with support of Urban Management Centre (UMC) in Gujarat and All India Institute of Local Self-Government (AIILSG) in Maharashtra.

PAS Project

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pas performance assessment system

Chapter 6

Sanitary Drainage

6.1 PURPOSE

The purpose of this chapter is to set forth provisions for planning, design and installation of waste disposal systems in and out of buildings

6.2 SCOPE

6.2.1

This chapter specifies the general requirements for environmental sanitation for different categories of buildings according to their occupancy classification.

6.2.2

This chapter also covers the design, installation and maintenance of drainage systems together with all ancillary works such as manholes and inspection chambers used within the building and from the building to public sewers or to offsite waste disposal system (i.e. into septic tanks and seepage pits or subsurface drainage system).

6.2.3

The disposal of wastes from industries, nuclear plants, slaughter houses, etc. are not covered by this Code. These wastes shall be properly treated as specified by environmental quality standards of Bangladesh before their disposal into public sewers or into natural bodies of water.

6.3 TERMINOLOGY

This section provides an alphabetical list of all terms used and applicable to this chapter of the Code. In case of any conflict or contradiction between a definition given in this section and that in any other chapter or part of the Code, the meaning specified in this chapter shall govern for interpretation of the provisions of this chapter.

BEDDING FACTOR : The ratio of the product of design load and factor of safety to the minimum crushing strength.

BRANCH : Any part of the piping system other than a main, riser, or stack.

BRANCH INTERVAL : The length of soil or waste stack corresponding in general to a storey height, but in no case less than 2.5 m within which the horizontal branches from one floor or storey of building are connected to the stack.

BRANCH VENT : The vent connecting one or more individual vents with a vent stack or stack vent.

BUILDING DRAIN : The building (house) drain is that part of the lowest piping or open channel of a drainage system which receives the discharges from soil, waste, and other drainage systems inside the walls of the building and conveys the same to the building (house) sewer, beginning at 0.9 m outside the building wall.

BUILDING SEWER : The building (house) sewer is that part of the horizontal piping of a drainage system which extends from the end of the building drain and which receives the discharge of the building drain and conveys it to a public sewer, private sewer, individual sewage disposal system, or other point of disposal. Also known as SEWER.

CIRCUIT VENT: Venting of branch drainage pipe with which multiple fixtures are connected in battery.

DRAIN: A drain is any pipe or open channel which carries waste water or waterborne wastes in a building drainage system.

DRAINAGE SYSTEM: A drainage system (drainage piping) includes all the piping within public or private premises, which conveys sewage, rain water, or other liquid wastes to a legal point of disposal, but does not include the mains of a public sewer system or a private or public sewage treatment or disposal plant.

DRINKING FOUNTAIN: A fountain or a tap with potable water supply connection.

EXISTING WORK: The existing work is a plumbing system or any part thereof which was installed prior to the date of enforcement of this Code.

FIXTURE UNIT: A fixture unit is a quantity in terms of which the load producing effects on the plumbing system of different kinds of plumbing fixtures are expressed on some arbitrarily chosen scale.

FLUSH VALVES: A flush valve is a device installed on the fixtures for the purpose of flushing those fixtures.

FRENCH DRAIN: A shallow trench filled with coarse rubble, clinker or similar material with or without field drain pipes.

GRADE: The grade is the slope or fall of a pipe in reference to a horizontal plane. In drainage it is usually expressed as the fall in mm per m length of pipe.

HORIZONTAL BRANCH : A horizontal branch is a drain pipe extending laterally from a soil or waste stack or building drain, with or without vertical sections or branches, which receives the discharge from one or more fixture drains and conducts it to the soil or waste stack or to the building (house) drain.

HORIZONTAL PIPE: A horizontal pipe is any pipe or fitting which is installed in a horizontal position or which makes an angle of less than 45 degrees with the horizontal.

IMHOFF TANK: These are two-storeyed settling cum digestion tanks used for primary treatment of domestic sewage in a very anaerobic environment.

INDIVIDUAL VENT: An individual vent is a pipe installed to vent a fixture trap and which connects with the vent system above the fixture served or terminates in the open air.

INTERCEPTOR: An interceptor is a device designed and installed so as to separate and retain deleterious, hazardous, or undesirable matter from normal wastes and permit normal or liquid wastes to discharge into the disposal terminal by gravity.

INVERT: The lowest point of the internal surface of a pipe or channel at any cross-section.

KITCHEN SINK: Sink or washing facilities raised above or at the level of the floor fitted with a tap.

LEADER: A vertical drainage pipe that carries rainwater from roof or gutter drain to building storm drain or building drain or private disposal system. It is also called Rainwater Down Pipe (RDP)

LIQUID WASTE: The liquid waste is the discharge from any fixture, appliance, or appurtenance in connection with a plumbing system which does not receive faecal matter.

LOAD FACTOR: The load factor is the percentage of the total connected fixture unit flow rate which is likely to occur at any point in the drainage system. It varies with the type of occupancy, the total flow unit above the point being considered, and with the probability factor of simultaneous use.

LOCAL VENT STACK: A vertical piping to which connections are made from the discharge side of traps and through which vapour or foul gas is removed from the fixture or device used on bedpan washer.

LOOP VENT: Also called Circuit vent. See CIRCUIT VENT.

MAIN: The main of any system of continuous piping is the principal artery of the system, to which branches may be connected.

MAIN SEWER: See PUBLIC SEWER.

MAIN VENT: The main vent is the principal artery of the venting system, to which vent branches are connected.

MANHOLE : An opening through which a man may enter or leave a drain, a sewer or other closed structure for inspection, cleaning and other maintenance operations, fitted with a suitable cover.

MANHOLE CHAMBER: A chamber constructed on a drain or sewer so as to provide access thereto for inspection, testing or the clearance of obstruction.

NONSERVICE LATRINE: A latrine other than service latrine.

OFFSET : An offset in a line of piping is 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.

PIPE SYSTEM: The system to be adopted will depend on the type and planning of the building in which it is to be installed and will be one of the following:

a) Single Stack System (see Fig 8.6.1) : The one pipe system without trap ventilation pipe work.

b) One Pipe System (see Fig 8.6.2) : The plumbing system in which the waste from sinks, bath rooms and wash basins, and soil pipe branches are all collected into one main pipe connected directly to the drainage system. Gully traps and waste pipes are completely dispensed with but all the traps of water closets, basins, etc. are completely ventilated to preserve the water seal.

c) Two Pipe System (see Fig 8.6.3) : A discharge pipe system comprising two independent discharge pipes, one conveying soil directly to the drain, the other conveying waste water to the drain through a trapped gully. The system may also require ventilating pipes.

PLUMBING : The plumbing includes the practice, materials, and fixtures used in the installation, maintenance, extension, and alteration of all piping, fixtures, appliances, and appurtenances in connection with any of the following : sanitary drainage or storm drainage facilities, the venting system and the public or private water supply systems, within or adjacent to any building, structure, or conveyance; also the practice and materials used in the installation, maintenance, extension, or alteration of the storm water, liquid waste, or sewerage, and water supply systems of any premises to their connection within any point of public disposal or other acceptable terminal.

PLUMBING FIXTURES : The plumbing fixtures are installed receptacles, devices, or appliances which are supplied with water or which receive or discharge liquids or liquid borne wastes, with or without discharge into the drainage system with which they may be directly or indirectly connected.

PLUMBING SYSTEM : The plumbing system includes the water supply and distribution pipes, plumbing fixtures and traps, soil, waste and vent pipes, building drains and building sewers, including their respective connections, devices, and appurtenances within the property lines of the premises, and water treating or water using equipment.

PUBLIC SEWER : A public sewer is a common sewer directly controlled by public authority. Also known as MAIN SEWER.

RELIEF VENT : A relief vent is a vent the primary function of which is to provide circulation of air between drainage and vent systems (Fig 8.6.6).

RISER : A water supply pipe that extends vertically one full storey or more to convey water to branches or fixtures.

SANITARY SEWER : A sanitary sewer is a pipe which carries sewage and excludes storm, surface, and ground water. Also known as SEWER.

SEEPAGE PIT : See SOAK PIT.

SEPTIC TANK : A septic tank is a watertight settling tank which receives the discharge of a drainage system or part thereof and is designed and constructed so as to separate solids from the liquid, digest organic matter through a period of detention, and allow the liquids to discharge into the soil outside the tank through a system of open joint or perforated piping or disposal pit (Fig 8.6.15).

SERVICE LATRINE : A latrine from which the excreta are removed by manual agency and not by water carriage.

SEWAGE : The sewage is any liquid waste containing animal or vegetable matter in suspension or solution and may include liquids containing chemicals in solution.

SEWER : See BUILDING SEWER or PUBLIC SEWER or SANITARY SEWER or STORM SEWER.

SLUDGE : A settled portion of the sewage or waste water effluent from a sedimentation tank in semi-solid condition.

SOAK PIT : A pit, dug into permeable soil lined to form a covered perforated chamber or filled with sand at the bottom and gravel or broken bricks at the top into which effluent from septic tank or storm water is led and from which these may soak away into the ground. Also known as SEEPAGE PIT or SOAK WELL.

SOAK WELL : See SOAK PIT.

SOIL PIPE : A soil pipe is any pipe which conveys the discharge of water closets, urinals, or fixtures having similar functions, with or without the discharge from other fixtures, to the building drain or building sewer.

SOIL VENT : See STACK VENT.

STACK : A stack is the vertical main of a system of soil, waste, or vent piping.

STACK VENT : A stack vent (sometimes called a waste vent or soil vent) is the extension of soil or waste stack above the highest horizontal drain connected to the stack. Also known as SOIL VENT.

STACK VENTING : Stack venting is a method of venting a fixture or fixtures through the soil or waste stack.

STERILIZER VENT : A separate pipe or stack, indirectly connected to the building drainage system at the lower terminal, which receives the vapour from non pressure sterilizers or the exhaust from pressure sterilizers and conduct the vapour directly to the outer air.

SUBSOIL DRAIN : A subsoil drain is a drain which receives only subsurface or seepage water and conveys it to a place of disposal.

SULLAGE : The discharge from wash basins, sinks and similar appliances, which does not contain human or animal excreta.

SUMP : A sump is a tank or pit which receives sewage or liquid waste, located below the normal grade of the gravity system, and which must be emptied by mechanical means.

SUPPORTS : The supports, hangers, and anchors are devices for supporting and securing pipe and fixtures to walls, ceilings, floors, or structural members.

TRAP : A trap is a fitting or device so designed and constructed as to provide, when properly vented, a liquid seal which will prevent the back passage of air or gas without materially affecting the flow of sewage or waste water through it.

TRAP SEAL : The trap seal is the maximum vertical depth of liquid that a trap will retain, measured between the crown weir and the top of the dip of the trap.

VENT PIPE : See VENT SYSTEM.

VENT STACK : A vent stack is a vertical vent pipe installed primarily for the purpose of providing circulation of air to and from any part of the drainage system.

VENT SYSTEM : A vent system is a pipe or pipes installed to provide a flow of air to or from a drainage system or to provide a circulation of air within such system to protect trap seals from siphonage and back pressure. Also known as VENT PIPE.

VERTICAL PIPE : A vertical pipe is any pipe or fitting which is installed in a vertical position or which makes an angle of not more than 45 degrees with the vertical.

WASTE PIPE : A waste pipe is a pipe which conveys only liquid waste free of faecal matter.

YOKE VENT: A yoke vent is a vent provided between drainage and vent stacks to provide circulation of air between drainage and vent systems (Fig 8.6.6).

6.4 DRAINAGE AND SANITATION PLANS

6.4.1 Requirement of Permit

Drainage and sanitation system shall not be installed until a permit for such work has been issued by the Authority for existing (only for addition or for alteration) or new building or for any other premises.

6.4.2 Application for Permit

An application for a permit for drainage and sanitation work shall be made on a prescribed form (see Appendix 8.5.A) by the licensed plumber and the owner, or by his appointed person or agent to install all or a self-contained or workable part of such work. The application shall accompany building drainage plans and adequate description of the proposed drainage and sanitation installation in a drawing (drawn to a scale not less than 1:100) with the following details:

a) plan(s) of the building with typical arrangement of plumbing fixtures;

b) sanitary waste disposal system;

c) venting system in the building drainage system;

d) materials, sizes and gradients of all proposed piping;

e) the position of manhole, traps, waste pipe, rainwater pipe, vent pipe, water closet, urinal, lavatory, sink or other appliances in the premises and their connection with sewerage/drainage system or with private waste disposal system; the following colours may be used to indicate sewers, waste water pipes, rainwater pipes and existing works:

proposed sanitary sewers and sanitary waste disposal pipes : red

proposed sanitary sewers and sanitary waste disposal pipes : blue

existing network : black

f) the position of refuse chute, inlet hopper and collection chamber for buildings more than six storeys high.

6.4.3

In addition to drainage plan a separate site plan of the building shall be submitted with the following particulars:

a) adjoining plots and streets with their identification;

b) the position and invert level of the public sewers (if any) and the direction of flow in it;

c) the level of the proposed drains connecting to the sewers (if any);

d) the position and layout of private waste disposal system (in absence of public sewers); and

e) the alignment, size and gradients of all drains.

6.4.4

For high rise buildings, design calculations and specifications for various items of the work involved shall be submitted along with the drawings.

6.4.5 Permits and Approvals

The building official shall examine or cause to be examined all applications for permits and, amendments thereto within 45 days. If the application does not conform to the requirements of all pertinent laws, such application shall be rejected in writing, stating the reasons therefore. If the proposed work satisfies all the Code requirements, the Authority shall issue a nontransferable permit.

6.5 LICENSING OF PLUMBER

6.5.1 License Requirement

No individual, partnership, corporation or firm shall engage in the business of installation, repair, alteration or maintenance of plumbing, drainage and sanitation work without obtaining a license from the Authority.

6.5.2 Examination and Certification

The Building Authority shall establish a plumber's examination board. The board will determine the requirements for the qualification and procedures for examination of applicants for license. The Authority will issue license to such applicants who meet the qualifications therefore and successfully pass the examination conducted by the board.

6.5.3 Annulment of License

The license of a licensed plumber may be nullified by the Building Authority, if it is proved that a plumbing work has been completed and certified by the licensed plumber violating the provisions of this Code deliberately setting aside the approvals given in the permit or without receiving the permit from the Building Authority.

6.6 DRAINAGE AND SANITATION REQUIREMENT

6.6.1 General

6.6.1.1

Each family dwelling unit on premises abutting a public sewer or with a private waste disposal system shall have at least one water closet and one kitchen sink or washing facilities. It is recommended to have at least one bathroom with a bath tub or shower to meet the basic requirements of sanitation and personal hygiene and in that case bath and water closet shall be separately accommodated.

6.6.1.2

All other structures for human occupancy or use on premises abutting a sewer or with a private waste disposal system shall have adequate sanitary facilities but in no case less than one water closet and one other fixture for cleaning purposes.

6.6.1.3

There shall be one water tap and arrangement for drainage in the vicinity of each water closet in all buildings.

6.6.1.4

There shall be at least one water tap and arrangement for drainage in the vicinity of each urinal or group of urinals in all buildings.

6.6.1.5

There shall be separate facilities for each sex for public toilets and for public bathing places based on the percentage of each anticipated sex.

6.6.1.6

Where drinking water fountain is provided, it shall not be installed in toilet room.

6.6.1.7

Rooms containing water closets or urinals shall be separated by partition wall from places where food will be prepared and served.

6.6.1.8

All water closets and urinals shall be provided with flushing system.

6.6.2 Minimum Number of Fixtures

Table 8.6.1 and Sec 6.6.2.1 and 6.6.2.2 provide the minimum number of fixtures required for different categories of buildings according to their occupancy classifications. The fixture requirement for the occupancy not provided in these sections shall be subject to the approval of the Building Authority.

6.6.2.1

The Size of drainage pipe of fixtures shall be provided as shown in Table 8.6.0.

Table 8.6.0 :The minimum internal diameter for sanitary appliances shall be as follows:

Sanitary Appliance Minimum Internal Diameter of Waste Outlet mm	
Soil appliances	
a) Indian and European type water closets	100
b) Bed pan washers and slop sinks	100
c) Urinal with integral traps	75

d) Stall urinals (with not more than 50-120 mm of channel drainage)	40
e) Lipped urinal smallhge	40
Waste appliances	
f) Drinking fountain	25
g) Wash basin	32
h) Bidets	32
j) Domestic sinks and baths	40
k) Shower bath trays	40
m) Domestic bath tubs	50
n) Hotel and canteen sinks	50
p) Floor traps (outlet diameter)	65

6.6.2.2 Automatic Clothes Washers

Waste connection. The waste from an automatic clothes washer shall discharge through an *air break* into a standpipe in . The trap and *fixture drain* for an automatic clothes washer standpipe shall be a minimum of 2 inches (51 mm) in diameter.

6.6.2.3 Floor drains

Floor drains shall have removable strainers. The floor drain shall be constructed so that the drain is capable of being cleaned. *Access* shall be provided to the drain.

6.6.2.4 Physically Handicapped Plumbing Facilities

All buildings other than residential, educational, storage and hazardous according to building occupancy classification, having public toilet facilities with required number of fixtures shall have at least one water closet for each sex (or one unisex water closet facility) and one drinking fountain accessible to and usable by physically handicapped persons. The water closet compartment for physically handicapped persons shall be in accordance with Sec 6.9.4.

6.6.2.5 Drainage and Sanitation Requirements for Traffic Terminal Stations

a) The minimum sanitary conveniences provided at any traffic terminal station like railway station, bus station etc. shall consist of non service type latrines one for each sex, and one non service type urinal for males for a daily passenger volume up to 300 persons. For large stations and airports, sanitary arrangements shall be in accordance with Table 8.6.1.

b) There shall be adequate arrangements for satisfactory drainage of all sewage, sullage and waste water. The drainage shall be so designed as to cause no stagnation at the maximum discharge rate for which the different units are designed.

c) Adequate scavenging arrangements shall be provided to keep the stations or terminals clear of all refuse. Refuse containers shall be placed at convenient points.

6.6.3 Accessibility

The fixtures specified in Sec 7.6.2 for public building shall be located not more than one floor above nor more than one floor below the floor occupied by the people for whose use the fixtures are intended, unless elevator service is available, except that in buildings which are accessible to the physically handicapped, there shall be minimum facilities as specified by the Code. It is desirable that the path of travel to the facilities shall not exceed a travel distance of 150 m.

6.7 MATERIALS AND APPLIANCES

Different sanitary appliances, materials and fittings listed in Tables 8.6.1 to 8.6.4 and 8.5.9 (Chapter 5) shall conform to the standard or one of the standards cited against them. For other appliances, materials and fittings not provided in Tables 8.6.2 to 8.6.5 and 8.5.9 (Chapter 5) shall be subject to the approval of the Building Authority. Applicable standards for different materials and appliances have also been listed in Part 5.

Table 8.6.1: Plumbing Fixtures Requirement

Type of Building Occupancy	Water Closets*	Urinals**	Wash Basins ***	Bathtubs or Shower	Drinking Fountains	Other Fixtures
A Residential Buildings						
A1 Detached Single Family Dwelling A2 Flats or Apartments A4 Minimum Standard Housing	1 per dwelling or apartment	-	1 per dwelling or apartment	1 per dwelling or apartment	-	1 kitchen sink per dwelling
A3 Mess, Boarding Houses and Hostels						
For Residence and Residential Staff	Males: 1 for 8 persons Females: 1 for 6 persons	Males: 1 for 25 persons up to 150 persons. Add 1 fixture for each additional 50 persons	Males: 1 for 8 persons Females: 1 for 6 persons	Males: 1 for 8 persons Females: 1 for 6 persons	1 for 75 persons	1 kitchen sink in each kitchen
For Nonresidential Staff	Males: 1 for 1-15 persons 2 for 16-35 persons 3 for 36-65 persons 4 for 66-100 persons Females: 1 for 1-12 persons 2 for 13-25 persons 3 for 26-40 persons 4 for 41-57 persons 5 for 58-77 persons 6 for 78-100 persons	Males: Nil up to 6 persons 1 for 7-20 persons 2 for 21-45 persons 3 for 46-70 persons 4 for 71-100 persons	Males: 1 for 1-15 persons 2 for 16-35 persons 3 for 36-65 persons 4 for 66-100 persons Females: 1 for 1-12 persons 2 for 13-25 persons 3 for 26-40 persons 4 for 41-57 persons 5 for 58-77 persons 6 for 78-100 persons	-	1 for 100 persons	-
Rooms wherein Outsiders are Received	Males: 1 for 100 persons up to 400 persons and add 1 fixture for additional 250 persons Females: 2 for 100 persons up to 200 persons and add 1 fixture for additional 100 persons.	Males: 1 for 50 persons	Male: 1 per water closet and 1 per urinal or group of urinals Females: 1 per water closet	-	-	-

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Table 8.6.1 (Contd.)
Plumbing Fixtures Requirement

Type of Building Occupancy	Water Closets*	Urinals**	Wash Basins ***	Bathtubs or Shower	Drinking Fountains	Other Fixtures
Houses						
For Residential Public and Staff	1 for 8 persons omitting the occupant of the room with attached water closet; minimum of 2 if both sex are lodged.	-	1 for 10 persons omitting the wash basins installed in the room or suite.	1 for 10 persons omitting the occupants of the room with bath in suite.	1 for 100 persons	1 kitchen sink in each kitchen
For Public Rooms	Males: 1 for 100 persons up to 400 persons and add 1 for additional 250 persons or part thereof. Females: 2 for 100 persons up to 200 persons and add 1 for additional 100 persons or part thereof.	Males: 1 for 50 persons	Males: 1 per water closet and 1 per urinal or group or urinals Females: 1 per water closet	-	1 for 100 persons	-
For Nonresidential Staff	Males: 1 for 1-15 persons 2 for 16-35 persons 3 for 36-65 persons 4 for 66-100 persons Females: 1 for 1-12 persons 2 for 13-25 persons 3 for 26-40 persons 4 for 41-57 persons 5 for 58-77 persons 6 for 78-100 persons	Males: Nil up to 6 persons 1 for 7-20 persons 2 for 21-45 persons 3 for 46-70 persons 4 for 71-100 persons	Males: 1 for 1-15 persons 2 for 16-35 persons 3 for 36-65 persons 4 for 66-100 persons Females: 1 for 1-12 persons 2 for 13-25 persons 3 for 26-40 persons 4 for 41-57 persons 5 for 58-77 persons 6 for 78-100 persons	-	1 for 100 persons	-

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Table 8.6.1 (Contd.)
Plumbing Fixtures Requirement

Type of Building Occupancy	Water Closets*	Urinals**	Wash Basins ***	Bathtubs or Shower	Drinking Fountains	Other Fixtures
B Educational Building						
B1 Education Facilities	Males: 1 for 40 persons Females: 1 for 25 persons	Males: 1 for 20 persons	Males: 1 for 60 persons but minimum 2 Females: 1 for 40 persons but minimum 2	-	1 for 50 persons	Service sink: 1 per floor.
B2 Preschool Facilities	1 for 15 children	-	1 for 15 children	-	1 for 50 children	Service sink: 1 per floor
C Institutional Buildings						
C1 Institution for Care of Children	Boys: 1 for boys Girls: 1 for girls	Urinals may be provided in boys toilet rooms in lieu of water closets but for not more than ½ of the required number of water closets	Boys: 1 for 8 boys Girls: 1 for 6 girls	1 for 8 persons (boys or girls)	1 for 50 persons (boys or girls)	Service sink: 1 per floor
C 2 Custodial Institutions for Physically Capable C3 Custodial Institution for the Incapable	1 unisex facility or 1 for each sex for 1-100 persons 2 unisex facilities or 1 unisex facility and 1 for each sex for 100-200 persons. Over 200 persons one additional unisex facility or 1 for each sex for each additional 100 persons.	- -	1 for 200 persons	1 for 10 persons but not less that 1 for use by both sexes.	1 for 100 persons	Service sink: 1 per floor
C4 Penal and Mental Institutions	1 per cell	-	1 per cell	1 for 15 persons	1 for 100 persons	Service sink

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Table 8.6.1 (Contd.)
Plumbing Fixtures Requirement

Type of Building Occupancy	Water Closets*	Urinals**	Wash Basins ***	Bathtubs or Shower	Drinking Fountains	Other Fixtures
D Health Care Building						
D1 Normal Medical Facilities (Indoor Patient Ward)	1 for 8 patient (male or female)	-	2 up to 30 patients and add 1 fixture for additional 30 patients	1 for 8 patients	1 for 75 patients	Service sink: 1 for each ward. Bed pan washing sink: 1for each ward. Kitchen sink: 1 for each kitchen
D2 Emergency Medical Facilities and Outdoor Patient Ward	Males: 1 for 100 persons Females: 2 for 100 persons	Males: 1 for 50 persons	1 fro 100 persons	-	1 for persons	Service sink: 1 for each ward
E Assembly Building						
E1 large Assembly with Fixed Seats E2 Small Assembly with Fixed Seats E3 Large Assembly without Fixed Seats E4 Small Assembly without Fixed Seats						
Mosque	1 for 30 persons	-	-	1 for 100 persons	1 for 100 persons	Water taps with drainage arrangement: 1 for 10 persons
Junction Stations, Intermediate Stations, Terminal Stations and Bus Terminals	Males: Min 2, 4 for 1000 persons and add 1 for additional 1000 persons. Females: Min 2, 5 for 1000 persons and then add 1 for additional 1000 persons	Male: Min 2, 4 for 1000 persons and then add 1 for additional 1000 persons	Males: Min 2, 4 for 1000 persons and add 1 for additional 1000 persons. Females: Min 2, 6 for 1000 persons and then add 1 for additional 1000 persons	-	1 for 300 persons	Service sink: 1 per floor

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Table 8.6.1 (Contd.)
Plumbing Fixtures Requirement

Type of Building Occupancy	Water Closets*	Urinals**	Wash Basins ***	Bathtubs or Shower	Drinking Fountains	Other Fixtures
Domestic Airport Minimum for 200 persons for 400 persons for 600 persons for 800 persons for 1000 persons	 Males: 2 Females: 2 Males: 4 Females: 5 Males: 6 Females: 8 Males: 8 Females: 10 Males: 9 Females: 13 Males:10 Females:13	 Males: 1 Males: 2 Males: 4 Males: 5 Males: 6 Males: 7	 2 4 6 8 9 10	 - 	1 per 300 persons	Service sink: 1 per floor
International Airport for 200 persons for 600 persons for 1000 persons	 Males: 6 Females: 10 Males: 12 Females: 20 Males: 18 Females:29	 Males: 8 Males: 22 Males: 22	 10 20 25	 4 shower stalls in the females or males toilet in the transit and departure lounge and also in the main concourse	1 for 300 persons	Service sink: 1 per floor
Cinemas, Concert halls, Theatres (for public use)	Males: 1 for 100 persons Up to 400 persons. Add 1 for each additional 250 persons. Females: 3 for 100 persons up to 200 persons. Add 2 for each additional 100 persons.	Males: 1 for 25 persons	1 for 200 persons	-	1 for 500 persons	Service sink 1
Cinemas, Concert halls, Theatres (for permanent employee use)	Males: 1 for 1-15 persons 2 for 16-35 persons Females: 1 for 1-12 persons 2 for 13-25 persons	Males: Nil up to 6 persons 1 for 7-20 persons 2 for 21-45 persons	Males: 1 for 1-15 persons 2 for 16-35 persons Females: 1 for 1-12 persons 2 for 13-25 persons	-	1 for 500 persons	-
Art Galleries, Libraries, Museums (for public use)	Males: 1 for 200 persons up to 400 persons. Add 1 for each additional 250 persons Females: 1 for 100 persons up to 200 persons. Add 1 for each additional 150 persons	Males: 1 for 50 persons	1 for 200 persons up to 200 persons and then add 1 for additional 250 persons	-	1 for 500 persons	Service sink: 1

Table 8.6.1 (Contd.)
Plumbing Fixtures Requirement

Type of Building Occupancy	Water Closets*	Urinals**	Wash Basins ***	Bathtubs or Shower	Drinking Fountains	Other Fixtures
Art Galleries, Libraries, Museums (for permanent employee use)	Males: 1 for 1-15 persons 2 for 16-35 persons Females: 1 for 1-12 persons 2 for 14-25 persons	Males: Nil up to 5 persons 1 for 7-20 persons 2 for 21-45 persons	Males: 1 for 1-15 persons 2 for 16-35 persons Females: 1 for 1-12 persons 2 for 14-25 persons	-	1 for 100 persons	-
E5 Sports Facilities	Males: 1 for 75 persons Females: 1 for 50 persons	Males: 1 for 75 persons	1 for 60 persons	1 for 50 persons	1 for 300 persons	Service sink: 1
F Business and Mercantile Building						
F1 Offices F4 Garages and Petrol Stations F5 Essential Services	Males: 1 for 25 persons Female: 1 for 15 persons	Males: Nil up to 6 persons 1 for 7-20 persons 2 for 21-45 persons 3 for 46-70 persons 4 for 71-100 persons Add@ 3% for 101-200 persons and @ 2.5% for over 200 persons	1 for 25 persons	-	1 for 100 persons	Service sink: 1 per floor.
F2 Small Shops and Markets F3 Large Shops and Markets	1 for 500 persons	Urinals may be provided in toilet room in lieu of water closets for men but for not more than ½ of the required number of water closets.	1 for 750 persons	-	1 for 1000 persons	Service sink:1

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Table 8.6.1 (Contd.)
Plumbing Fixtures Requirement

Type of Building Occupancy	Water Closets*	Urinals**	Wash Basins ***	Bathtubs or Shower	Drinking Fountains	Other Fixtures
G Industrial Buildings Factories	Males: 1 for 1-15 persons 2 for 16-35 persons 3 for 36-65 persons 4 for 66-100 persons Females: 1 for 1-12 persons 2 for 13-25 persons 3 for 26-40 persons 4 for 41-57 persons 5 for 58-77 persons 6 for 78-100 persons	Males: Nil up to 6 persons 1 for 7-20 persons 2 for 21-45 persons 3 for 46-70 persons 4 for 71-100 persons Add@ 3% for 101-200 persons and @ 2.5% for over 200 persons	1 for 25 persons	As required by particular trades or occupations	1 for 100 persons	Service sink: 1 per floor
H Storage Buildings	1 for 100 persons	-	1 for 100 persons	Provisions for emergency shower	1 for 1000 persons	Service sink:1
J Hazardous Buildings	1 for 100 persons	-	1 for 100 persons	Provisions for emergency shower	1 for 1000 persons	Service sink:1

* Some of the water closets may be of European style. The water closet(s) shall not be oriented in the east-2est direction.

** The urinal(s) shall not be oriented in the east-west direction.

*** Toilet(s) of public use shall have at least one water tap with adequate drainage arrangement for ablution purpose when the numbers of devotees exceed twenty.

Table 8.6.2 Sanitary Appliances

Appliances	Standard
Ceramic wash basin and pedestals	BDS 1162-87
Ceramic wash down water closet pans	BS 1213
Foot rest vitreous china	BDS 1163-87 parts 1 & 4
Integrated squatting pans vitreous china	BDS 1163-87 parts 1 & 5
Metal hand rinse basin	BS 1329
Metal sink for domestic purpose	BS 1244
Urinals (bowl type) vitreous china	BDS 1163-87 parts 1 & 3
Wash-down water closet pans, vitreous china	BDS 1163-87 parts 1 & 2
Water closet seat plastic	BS 1254
Water closet flushing cisterns and pipes	BS 1125

Table 8.6.3 Building Drainage and Vent Pipe

Material	Standards
Acrylonitrile butadiene styrene (ABS plastic pipe)	ASTM D2661, ASTM F 628
Aluminum tubing	ASTM B429, ASTM B745M
Brass pipe	ASTM B43
Cast iron pipe	ASTM A74
Copper or Copper-alloy tubing	ASTM B75M, ASTM B88M, ASTM B251M, ASTM B306
Galvanized steel pipe	ASTM A53
Polyvinyl chloride plastic pipe	ASTM D2665, ASTM D2949, ASTM F891

Table 8.6.4 Building Sewer or Building Storm Sewer Pipe

Material	Standards
Acrylonitrile butadiene styrene (ABS plastic pipe)	ASTM D2261, ASTM D2751, ASTM F628, ASTM D2321
Bihuminized fibre pipe	ASTM D1861, ASTM D1862
Cast iron pipe	ASTM A74
Concrete pipe	ASTM C14M, ASTM C76M
Copper or Copper-alloy tubing	ASTM B75, ASTM B88M, ASTM B251M
Unplasticiged Polyvinyl chloride (uPVC) plastic pipe	ASTM D2665, ASTM D2949, ASTM D3034, ASTM D2321, ASTM F891
Vitrified clay pipe	ASTM C4, ASTM C700

Table 8.6.5 Subsoil Drainage Pipe

Material	Standard
Bituminous fibre pipe	ASTM D2311
Cast iron pipe	ASTM A74
Concrete pipe	ASTM C654 M
Polyethyline (PE) plastic pipe	ASTM F405
Unplasticiged Polyvinyl chloride (uPVC) plastic pipe	ASTM D2729, ASTM F891
Vitrified clay pipe	ASTM C4, ASTM C700

6.8 HANGERS AND SUPPORT AND PIPE JOINTING

6.8.1 Hangers and Support

The piping, fixtures and equipment used for plumbing, water supply and drainage system shall be provided with hangers and support in accordance with Sec 5.13 in Chapter 5.

6.8.2 Pipe Joints

The joints between different piping and fittings shall conform to the standards cited against them in Table 8.6.6. The requirements for the joints not specified in the table shall be subject to the approval of the Building Authority.

6.9 DESIGN CONSIDERATIONS

6.9.1 Objective

For the design of drainage and sanitation system of different buildings according to building classification, the objective shall be to safeguard against fouling, deposition of solids and clogging and with adequate cleanouts and inspection chambers so arranged that the drains may be readily cleaned without the risk of health hazard.

6.9.2 General

a) The plumbing system shall be designed and adjusted to use the minimum quantity of water consistent with proper performance and cleaning.

b) Plumbing fixtures, devices and appurtenances shall be supplied with required volume of water at pressures adequate to enable these to function properly and without undue noise under normal conditions of use.

6.9.3 Different Building Drainage Systems

For the design and installation for drainage piping, one of the following building drainage systems shall be adopted :

i. single stack system,

ii. one-pipe system, and

iii. two-pipe system.

Table 8.6.6 Joints Between Different Pipes and Fittings

Material	Standard
ABS plastic pipe and fittings	ASTM D2235, ASTM D2661, ASTM D3212, ASTM F628 ASME B1.20.1
Aluminium tubing	ASTM C564
Asbestos cement pipe and fittings	ASTM D1869
Brass pipe and fittings	ASME B1.20.1
Cast iron pipe and fittings	ASTM C564
Concrete pipe and fittings	ASTM C443
Copper or Copper-alloy pipe and fittings	ASTM B32, ASME B1.20.1
Copper-alloy tubing and fittings	ASTM B32
CPVC plastic pipe and fittings	ASTM F493, ASME B1.20.1
Galvanized steel pipe and fittings	ASME B1.20.1
PE plastic pipe and fittings	ASTM D2657

Material	Standard
PVC plastic pipe and fittings	ASTM D2657, ASTM D2855, ASTM D3139, ASTM D3212, ASTM F402, ASTM F656, ASME B1.20.1
Vitrified clay pipe and fitting	ASTM C425

a) Single stack system may be used with 100 mm diameter stack for buildings up to 5-storey height. The fixtures in each floor shall be connected to a single stack for increasing the rate of discharge in the downward direction. There shall be at least 200 mm vertical distance between the waste branch and the soil branch connection, while the soil pipe will be connected to stack above the waste pipe. The size of soil branch shall not be less than 100 mm. The horizontal branch distance for fixtures from stack and bend(s) at the foot of stack to avoid back pressure as well as the vertical distance between the lowest connection and the invert of drain shall be as shown in Fig 8.6.1. The recommended depth of water seal trap for different fixtures shall be in accordance with Table 8.6.7.

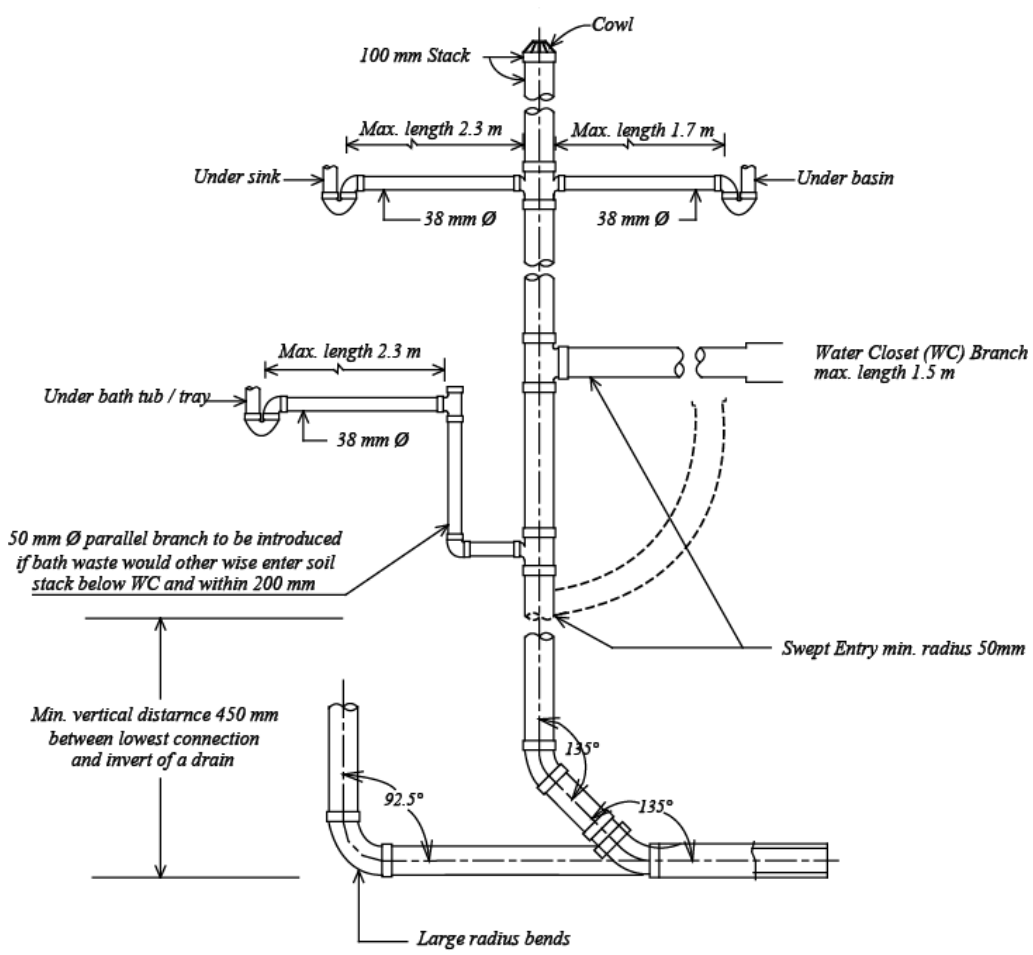


FIG. 8.6.1 SINGLE STACK SYSTEM

b) Where all types of waste from the building are desired to be discharged into a common sewer or into same waste disposal system, one pipe system may be used (Fig 8.6.2).

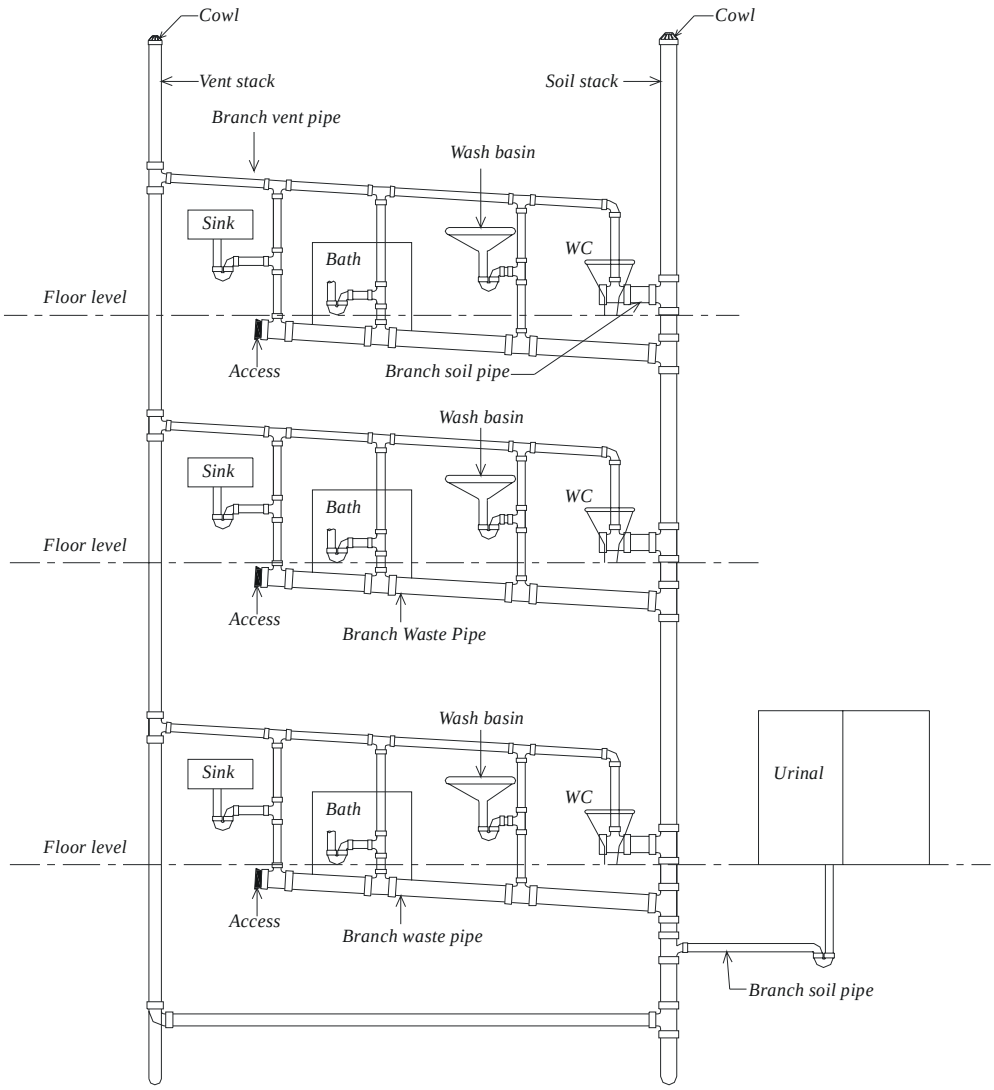


FIG. 8.6.2 DIAGRAM OF ONE - PIPE SYSTEM

c) Where the sullage from kitchen and bath will be dealt with separately and where soil waste shall be discharged into septic tank or Imhoff tank, the two pipe system shall be used (Fig 8.6.3).

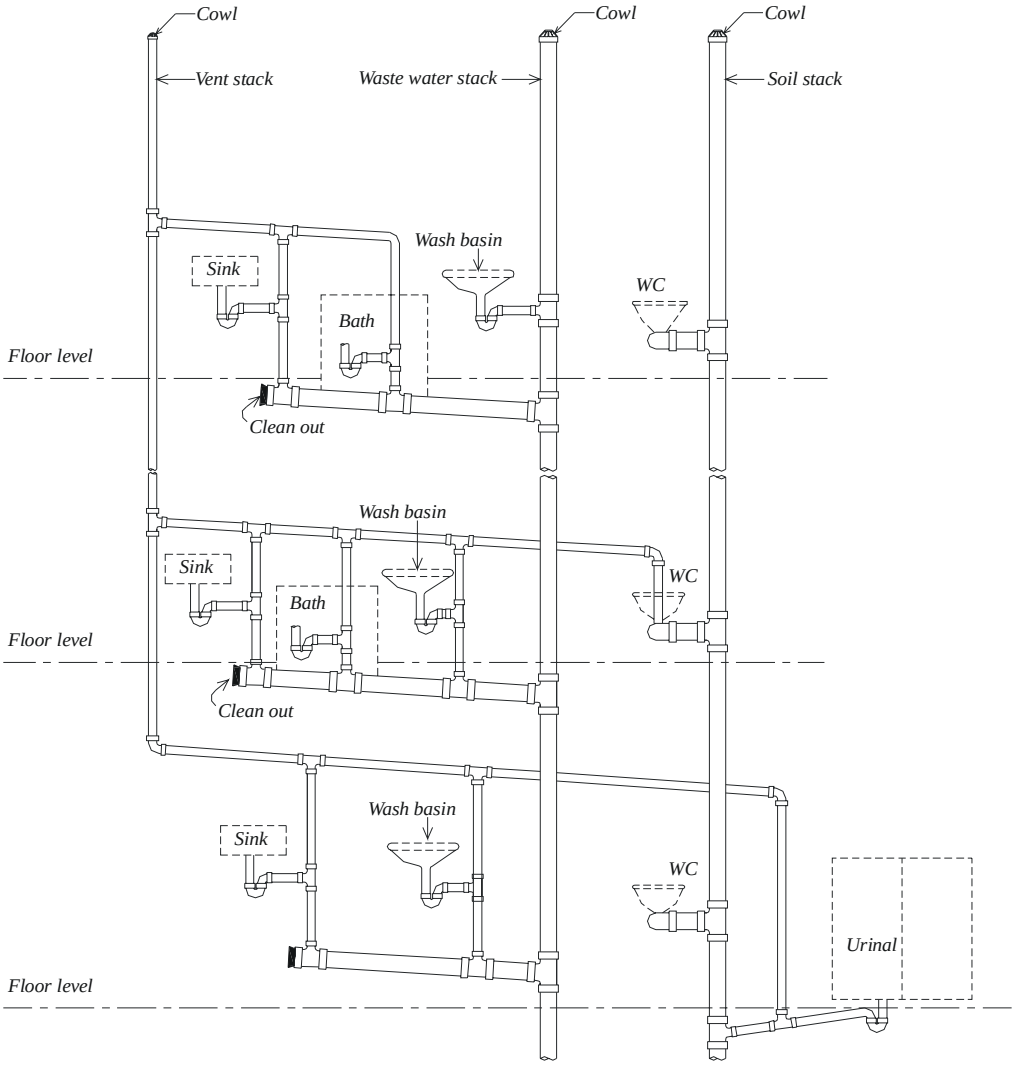
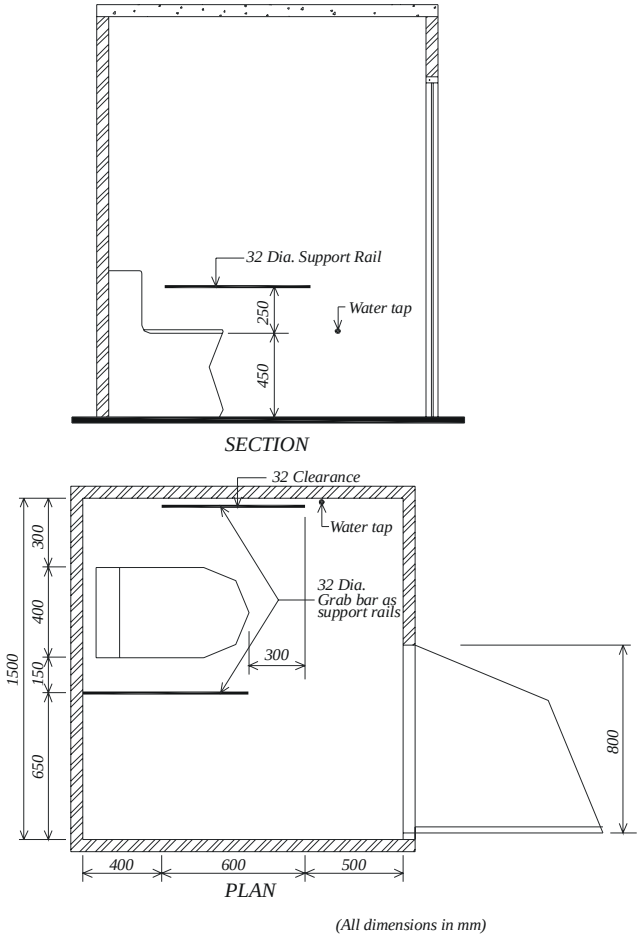


FIG. 8.6.3 DIAGRAM OF TWO PIPE SYSTEM

6.9.4 Water Closet Compartment for Physically Handicapped

6.9.4.1 Provision for Wheelchair Users

The water closet compartment for wheelchair users shall have at least the dimensions and fittings as shown in Fig 8.6.4.



(All dimensions in mm)

FIG. 8.6.4 WATER CLOSET COMPARTMENT FOR WHEELCHAIR USER

6.9.4.2 Provision for Ambulant Disabled People

The minimum dimension for water closet compartment and the fittings for ambulant disabled people shall be as shown in Fig 8.6.5.

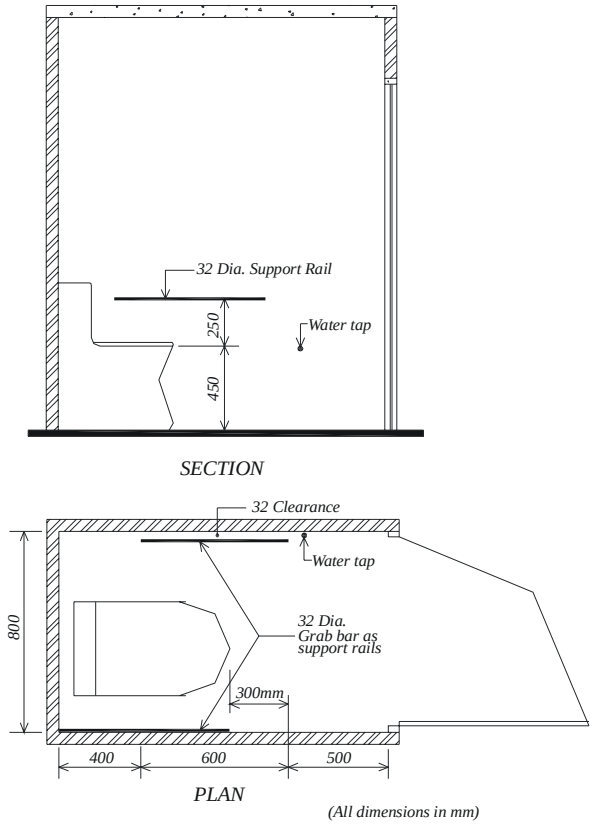


FIG. 8.6.5 WATER CLOSET STALL FOR AMBULANT DISABLED PEOPLE

Table 8.6.7 Recommended Depth of Water Seal Trap for Different Fixtures

Fixture	Water Seal (mm)
Water Closets	50
Floor Traps	50
For Waste Branch of 75 mm diameter or More	40
For Waste Branch of Less Than 75 mm diameter	75

6.9.5 Installation of Drainage System

6.9.5.1

All plumbing fixtures shall be made of smooth and nonabsorbent materials, free from concealed fouling surfaces and may be located in ventilated enclosures.

6.9.5.2

Whenever possible, all drainage system shall be drained to the public sewer or private waste disposal system by gravity.

6.9.5.3

Horizontal drainage piping of 75 mm diameter and less shall be installed with a fall of not less than 20 mm per m.

Horizontal drainage piping larger than 75 mm diameter shall be installed with a fall of not less than 10 mm per m.

It is a good policy to design the system for the highest possible velocity. However, consideration should be given to the fact that the high velocities in pipes with slopes greater than 20 mm per m may cause self-siphoning of trap seal.

6.9.5.4

Where conditions do not permit building drains and sewers to be laid with a fall as great as that specified, a lesser slope may be permitted provided the computed velocity in the drains will not be less than 0.6 m per second. The maximum recommended velocity will be 2.5 m per second.

6.9.5.5

The soil pipe conveying any solid or liquid filth to a drain shall be circular with a minimum diameter of 100 mm.

6.9.5.6

The waste branch from bath room, wash basin or sink shall be of 32 mm to 50 mm diameter and shall be trapped immediately beneath such wash basins or sink by an efficient siphon trap with adequate means of inspection and cleaning. The minimum recommended size of waste stack is 75 mm.

6.9.5.7

The soil and waste stack shall be continued upward undiminished in size 0.6 m above the roof surface when the roof will be used only for weather protection. Where the roof will be used for any purpose other than weather protection, the soil and vent stack shall run at least 2 m above the roof surface so that there shall be least possible nuisance.

6.9.5.8

The soil and waste stack shall be firmly attached to the wall with a minimum clearance of 25 mm from the wall.

6.9.5.9

All soil, waste, vent (ant siphoning) stacks shall be covered on top with cowl of same pipe material.

6.9.6 Installation of Venting System

6.9.6.1

The vent stack or main vent shall be installed in conjunction with a soil or waste stack in a building. One vent stack may serve not more than two soil or waste stacks.

6.9.6.2

Ventilating pipes should be so installed that water cannot be retained in them. They should be fixed vertically. Whenever possible, horizontal runs should be avoided. Ventilating pipe shall be carried to such a height and in such a position as to afford by means of the open end of such pipe or vent shaft, a safe outlet for foul air with the least possible nuisance.

6.9.6.3

The building with building drain shall have at least one 100 mm vent stack or stack vent carried full size to outdoor air above the roof in accordance with Sec 6.9.5.7 above.

6.9.6.4

The diameter of a vent stack shall not be less than 50 mm.

6.9.6.5

The diameter of a branch vent pipe on a waste pipe shall not be less than 25 mm or two-thirds of the diameter of the branch waste pipe ventilated.

6.9.6.6

The branch vent pipe on a soil pipe shall not be less than 32 mm in diameter.

6.9.6.7

All main vents or vent stacks shall connect full size at their base to the building drain or to the soil or waste stack at or below the level of the lowest drainage connection to them. All vent stacks shall extend undiminished in size above the roof or shall be reconnected to a vent header or to the stack vent portion of the soil or waste stack, at least 150 mm above the flood level of the highest fixture connection discharging into the soil or waste stack. Where the roof is to be used for any purpose other than weather protection, the vent extension shall be in accordance with the Sec 6.9.5.7.

6.9.6.8

In case of offsetting of stacks a relief vent shall be provided at the base of upper stack just above the start of offset and at top of the lower stack portion just below the end of offset.

6.9.6.9

In high rise buildings yoke vent shall be provided at 10 storey intervals counting down from top.

6.9.6.10

In case huge number of fixtures are installed in battery to a single branch drainage pipe, circuit or loop vents shall be provided after 8 fixtures interval for 100 mm drain pipe and 24 fixtures interval for 150 mm drain pipe as shown in fig. 8.6.7

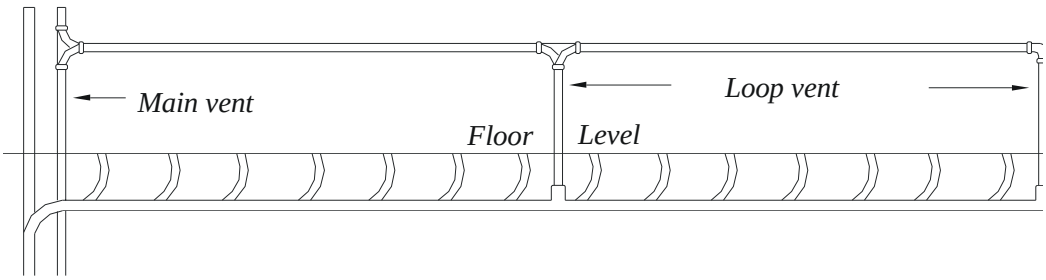


FIG. 8.6.7 CIRCUIT VENT FOR A BATTERY OF WATER CLOSETS

6.9.6.11

Offset in the stack vent portion of soil or waste stack, offset in vent stack and connection of vent stack at the bottom to soil or waste pipe or to the building drain shall be at an angle of at least 45 degrees to the horizontal.

6.9.6.12

All vent and branch vent pipe shall be so graded and connected that sufficient slope is provided for condensation to drain back to soil or waste pipe by gravity.

6.9.6.13

Where fixtures, other than water closets discharge into the stack downstream of a water closet, each fixture connecting downstream shall be individually vented.

6.9.6.14

Soil and waste stacks in a building having more than 10 branch intervals shall be provided with a relief vent (Fig 8.6.7) at each tenth interval counting from the top floor.

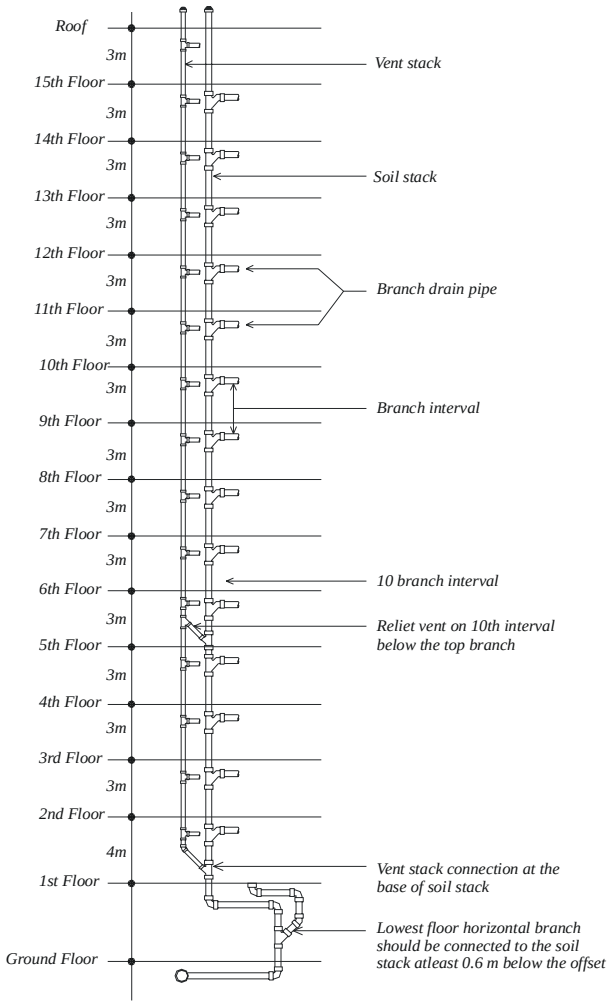


FIG. 8.6.7 RELIEF VENTS FOR STACK OF MORE THAN TEN BRANCH INTERVALS

6.9.6.15

In case the adjoining building is taller, the ventilating pipe shall be carried higher than the roof of the adjacent building, wherever it is possible.

6.9.6.16

The building drain intended for carrying waste water and sewage from a building shall be provided with at least one ventilating pipe situated as near as practicable to the building and as far away as possible from the point at which the drain empties into the sewer or other earner.

6.9.7 Clearance of Blockages

6.9.7.1

There shall be sufficient and suitable access points at every change of alignment, gradient or diameter or at bends and junctions for clearing blockages from drains which cannot be reached by any other means.

6.9.7.2

In case of straight run of pipes, access points shall be provided at intervals of 15 meter.

Tables 8.6.8 and 8.6.9 show the maximum spacing and the recommended minimum dimensions for access fittings and chambers for the specified depth.

Table 8.6.8 Maximum Spacing of Access Points

From	To			
	Access Fitting	Junction	Inspection Chamber	Manhole
	(m)	**(m)**	**(m)**	**(m)**
Start of external drain	12	-	22	45
Rodding eye	22	22	45	45
Access fitting †	-	12	22	22
Inspection chamber	22	22	45	45
Manhole	22	-	45	90

† higher spacing may be used for larger size access fitting.

Table 8.6.9 Minimum Dimensions for Access Points

Access Points	Depth (m)	Internal Sizes		Cover Sizes	
		Length x width (mm x mm)	Diameter (mm)	Length x width (mm x mm)	Circular (mm)
Rodding eye		min. 100 mm or size of drains			
Access fitting	0.6 or less	150 x 100	150	150 x 100	150
Inspection chamber	1.0 or less	450 x 450	450*	450 x 450	450*
Manhole	1.5 or less	1200 x 750	1050	600 x 600	600
	over 1.5	1200 x 750	1200	600 x 600	600
	over 2.7	12000 x 840	1200	600 x 600	600

* 190 mm dia may be used for depth ≤ 0.6 m

6.9.7.3 Access should be one of the following four types :

i. rodding eyes - capped extensions of the pipes,

ii. access fittings - small chambers (or an extension of the pipes) but not with an open channel,

iii. inspection chambers - chambers with working space at ground level, and

iv. manholes - large chambers with working space at drain level.

6.9.7.4

Inspection chambers and manholes shall have removable non-ventilating covers of durable material and be of suitable strength. Inspection chambers and manholes in buildings shall have mechanically fixed airtight covers unless the drain itself has watertight access covers. Manholes deeper than 1 m shall have non-corrosive steps or fixed ladders. Fig 8.6.8 and 8.6.9 show the details of typical manholes at smaller depth (<1 m) and at higher depth (>1 m) respectively. Fig 8.6.9 shows the details of a drop manhole. The drop manhole is a manhole that serves as a junction and receives sewer lines at two different elevations.

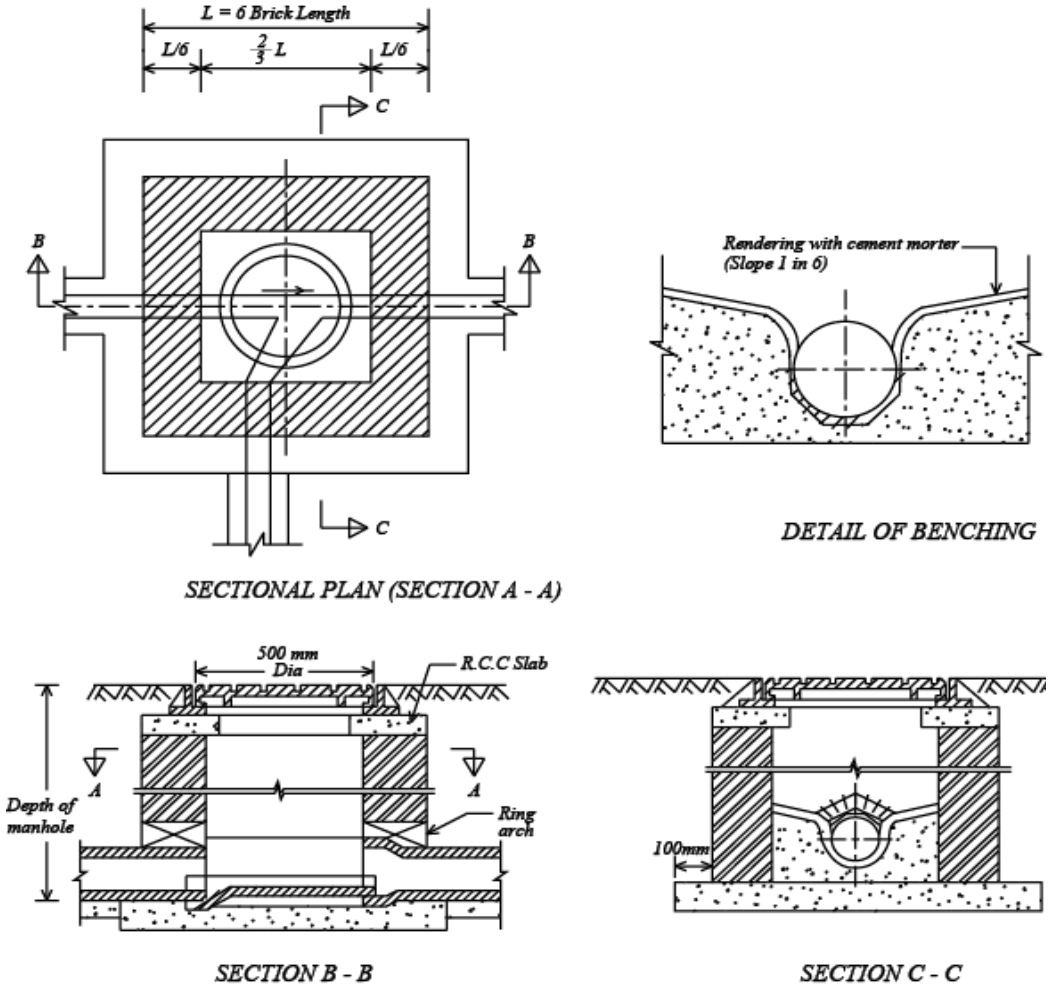
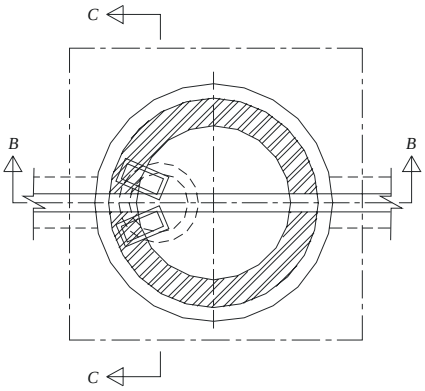
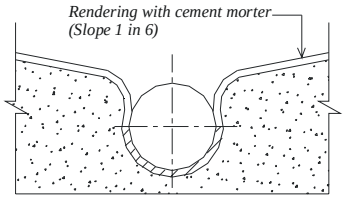


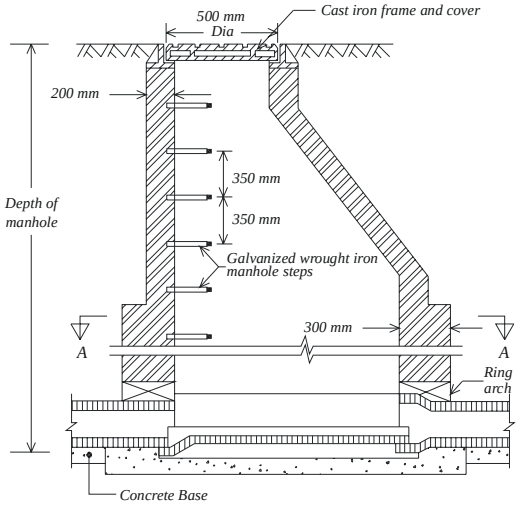
FIG. 8.7.8 DETAIL OF MANHOLE (Depth 1m And Below)



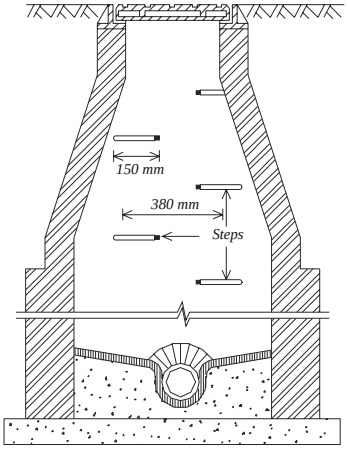
SECTIONAL PLAN (SECTION A - A)



DETAIL OF BENCHING

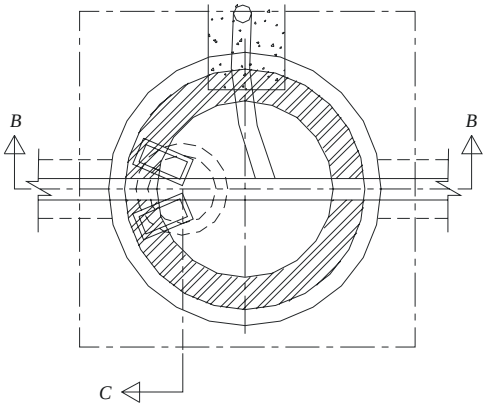


SECTION B - B

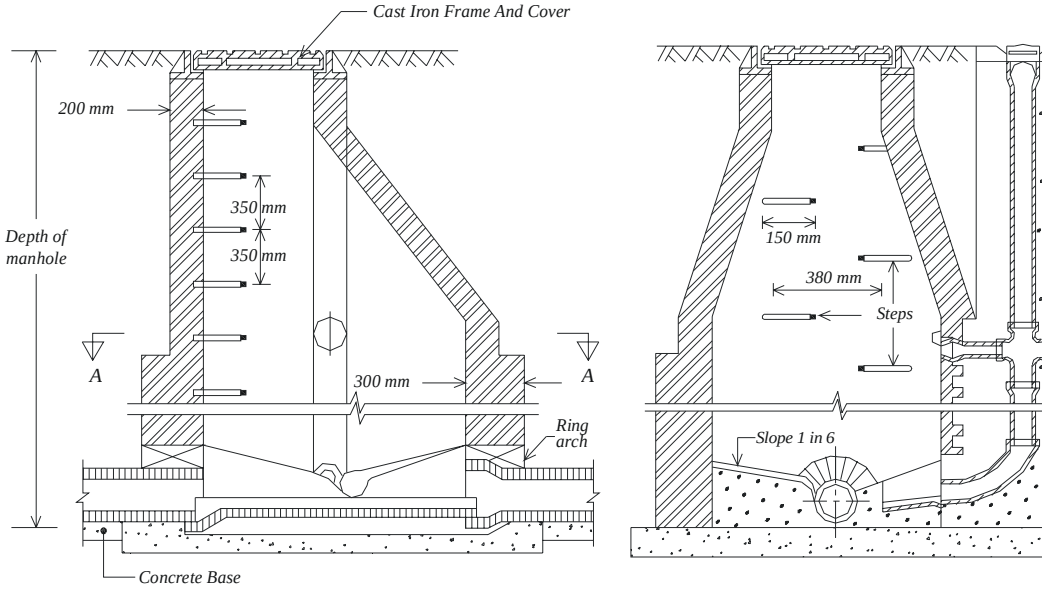


SECTION C - C

FIG. 8.6.9 DETAIL OF MANHOLE (Depth more than 1 m)



SECTIONAL PLAN (SECTION A - A)



SECTION B - B *SECTION C - C*

FIG. 8.6.10 DROP MANHOLE

6.9.7.5 Spacing of manholes

The spacing of manholes for a given pipe size should be as follows:

	Pipe Diameter (mm)	*Spacing of Manhole (m)*
a)	Up to 300	*45*
b)	301 to 500	*75*
c)	501 to 900	*90*
d)	Beyond 900 Spacing shall depend upon local condition and shall be gotten approved by the Authority	

6.9.8 Protection Against Rodent

Holes through walls shall be such that they will not provide passage of rodent or other insects from room to room or from floor to floor. Materials used for embedding pipes shall be rodent proof.

6.9.9 Bedding and Backfilling

The choice of bedding and backfilling depends on the depth of the bed, and size and strength of the materials. Fig 8.6.10 and Table 8.6.10 show two types of bedding and backfilling and minimum and maximum depth of cover for each type of bedding for rigid pipings. The bedding and backfilling for flexible pipings is shown in Fig 8.6.11. The minimum depth of bedding for flexible pipings shall be 0.3 m where there will be no extra surcharge load coming on pipe other than back filling.

The depth shall not be more than 10 m. The flexible pipe may be laid with less cover in fields and gardens. The bedding and backfilling shall be in accordance with Fig 8.6.12.

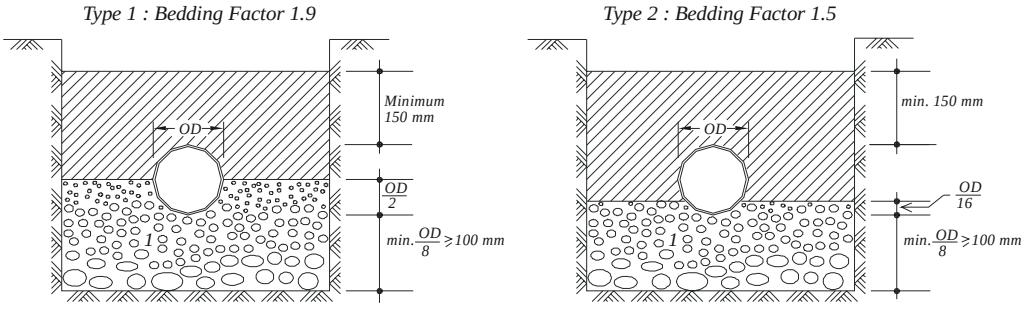


FIG. 8.6.11 BEDDING FOR RIGID PIPES

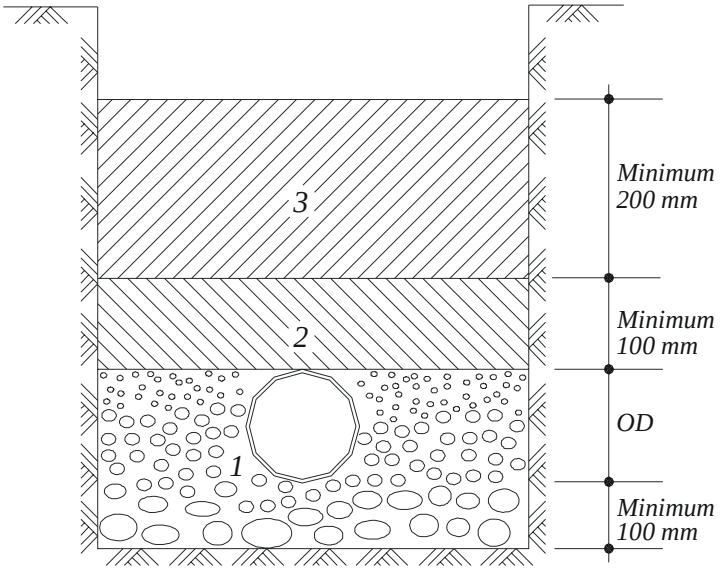


FIG. 8.6.12 BEDDING FOR FLEXIBLE PIPES

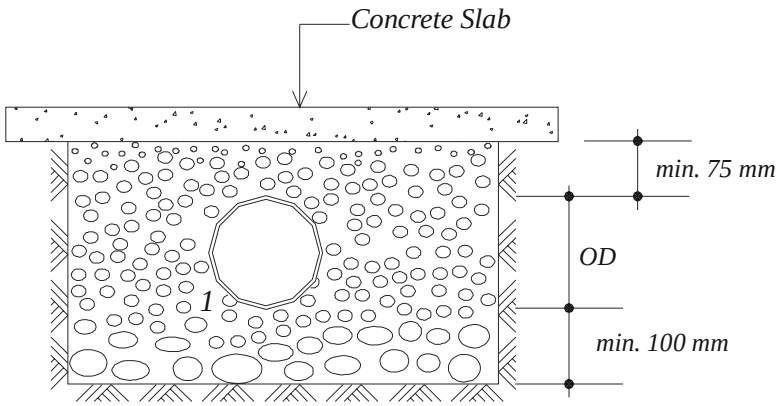


FIG. 8.6.13 FLEXIBLE PIPES BEDDING UNDER CONCRETE SLAB

Table 8.6.10 Limits of Cover (m) for Standard Strength Rigid Pipes in any Width of Trench

Pipe Bore	Bedding	Fields and Gardens		Light Traffic Roads		Heavy Traffic Road	
(mm)	Class	Min	Max	Min	Max	Min	Max
100	Type 1	0.3	7.4	0.4	7.4	0.4	7.2
	Type 2	0.3	5.8	0.5	5.8	0.5	5.5
150	Type 1	0.6	5.0	0.6	5.0	0.6	4.6
	Type 2	0.6	3.9	0.7	3.8	0.7	3.3

6.9.10 Grease Traps

Oil and grease is found in wastes generated from kitchens in hotels, industrial canteens, restaurant, butcheries, some laboratories and manufacturing units having a high content of oil and greases in their final waste.

Waste exceeding temperature of 60° C should not be allowed in the grease trap. When so encountered it may be allowed to cool in a holding chamber before entering the grease trap.

Oil and greases tend to solidify as they cool within the drainage system. The solidified matter clogs the drains and the other matter in the waste stick to it due to the adhesion properties of the grease. Oil and greases are lighter than water and tend to float on the top of the waste water.

Grease traps shall be installed in building having the above types of wastes. In principle the grease laden water is allowed to retain in a grease trap which enables any solids to be settled or separated for manual disposal. The retention time allows the incoming waste to cool and allow the grease to solidify. The clear waste is then allowed to discharge into the building's drainage system.

6.9.11 Oil Interceptors

Oils and lubricants are found in wastes from vehicle service stations, workshops manufacturing units whose waste may contain high content of oils. Oils, for example, petroleum, kerosene and diesel used as fuel, cooking, lubricant oils and similar liquids are lighter than water and thus float on water in a pipe line or in a chamber when stored. Such oils have a low ignition point and are prone to catch fire if exposed to any flame or a spark and may cause explosion inside or outside the drainage system. The flames from such a fire spread rapidly if not confined or fire vented at the possible source. Lighter oils and lubricants are removed from the system by passing them through an oil interceptor/petrol gully. They are chambers in various compartments which allow the solids to settle and allow the oils to float to the top. The oil is then decanted in separate containers for

disposal in an approved manner. The oil free waste collected from the bottom of the chamber is disposed in the building drainage system.

6.9.12 Septic Tank

6.9.12.1

Septic tank(s) (Fig 8.6.15 and 8.6.16) discharging into either a subsurface disposal field or one or more seepage pits shall be required for the approval of drainage and sanitation plans for the places where public sewers are not available.

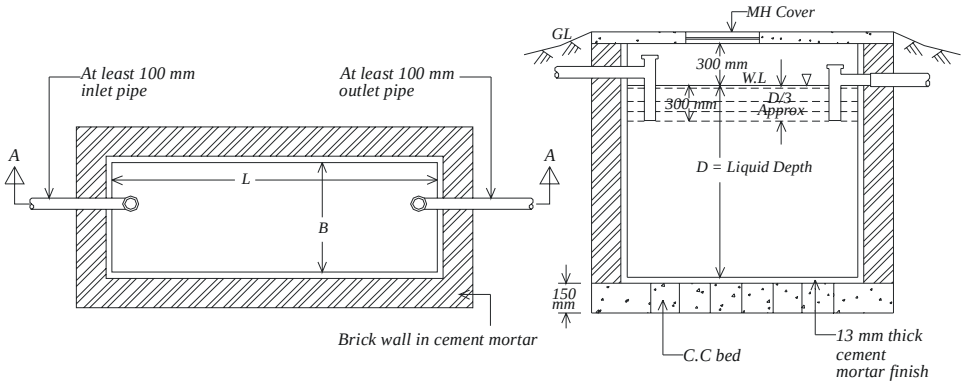


FIG. 8.6.16 TYPICAL ONE CHAMBER BRICK SEPTIC TANK

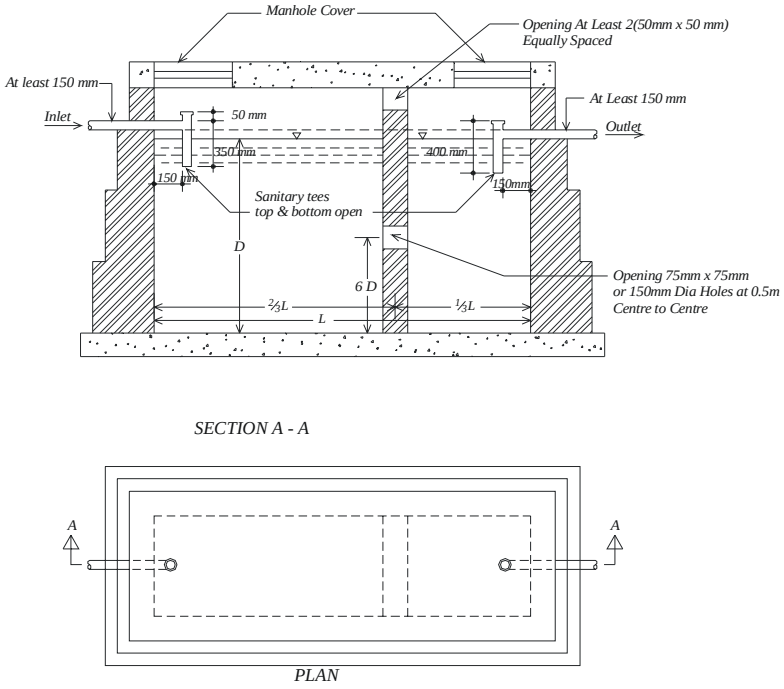


FIG. 8.6.17 TYPICAL TWO CHAMBER CONCRETE SEPTIC TANK

6.9.12.2

Such disposal method shall be designed by a licensed professional in accordance with the requirement of the provisions of this Code and regulations of the concerned authorities.

6.9.12.3

The design of such system shall be on the basis of location with respect to wells or other sources of water, soil permeability, ground water elevation, area available and maximum occupancy of the building.

6.9.12.4

Sullage water shall not be discharged into the septic tank.

6.9.12.5

Effluent from septic tank(s) shall not discharge into open water courses.

6.9.12.6

The minimum distance for various components of the disposal system shall be in accordance with Table 8.6.11.

6.9.12.7

The flow into a septic tank may be calculated on the basis of plumbing fixtures discharging soil wastes simultaneously into it. The capacity of septic tank for residential buildings shall be determined according to the formula in Appendix 8.6.C. For other occupancies a reduction factor shall be used as shown in Table T1 in Appendix 8.6.C.

6.9.12.8

The septic tank shall have a minimum liquid capacity of 2000 liters, minimum width 1 m and minimum liquid depth 1 m. The minimum length of a septic tank shall be at least thrice its width. It is recommended that the maximum length of a septic tank shall be not more than 4 times its width.

6.9.12.9

The maximum size of a septic tank shall be limited to the number of users not exceeding 300 persons for residential buildings.

6.9.12.10

The volume required for digested sludge and scum may be computed on the basis of 0.04 m^3/capita/year. There shall be a clearance between top of the liquid level and bottom of the tank cover slab which shall be at least 300 mm.

6.9.12.11

The liquid retention time of a septic tank shall be at least 1 day.

6.9.12.12

The de sludgging frequency of a septic tank shall be at least 6 months interval and maximum once a year.

6.9.12.13

It is recommended to use two chamber septic tank when the capacity of a septic tank exceeds 3000 liters. The inlet compartment of a two chamber septic tank shall have a capacity not less than two-third of its total capacity (Fig 8.6.16).

Table 8.6.11 Location of Components of Sewage Disposal System

System Component	Distance (m)				
	Building Foundation	Well	Stream	Seepage Pit	Dry Well
Septic tank	1.5	8	-	1.5	-
Disposal field	3	15	7.5	6	6
Seepage pit	4.5	15	15	6	6
Dry well	3	15	-	6	-

6.9.12.14

The septic tank shall be constructed of corrosion resistant material and be of permanent water tight construction. The manhole cover and the roof of the tank shall be designed for at least 7 kPa live load. The inlet compartment shall be provided with a manhole. Outlet compartment shall also be provided with a manhole. The design guideline of a septic tank is presented in Appendix 8.6.C.

6.9.13 Imhoff tank(s)

6.9.13.1

Imhoff tank(s) (Fig 8.6.17) discharging into either a subsurface disposal field or one or more seepage pits shall be required for the approval of drainage and sanitation plans for the places where public sewers are not available.

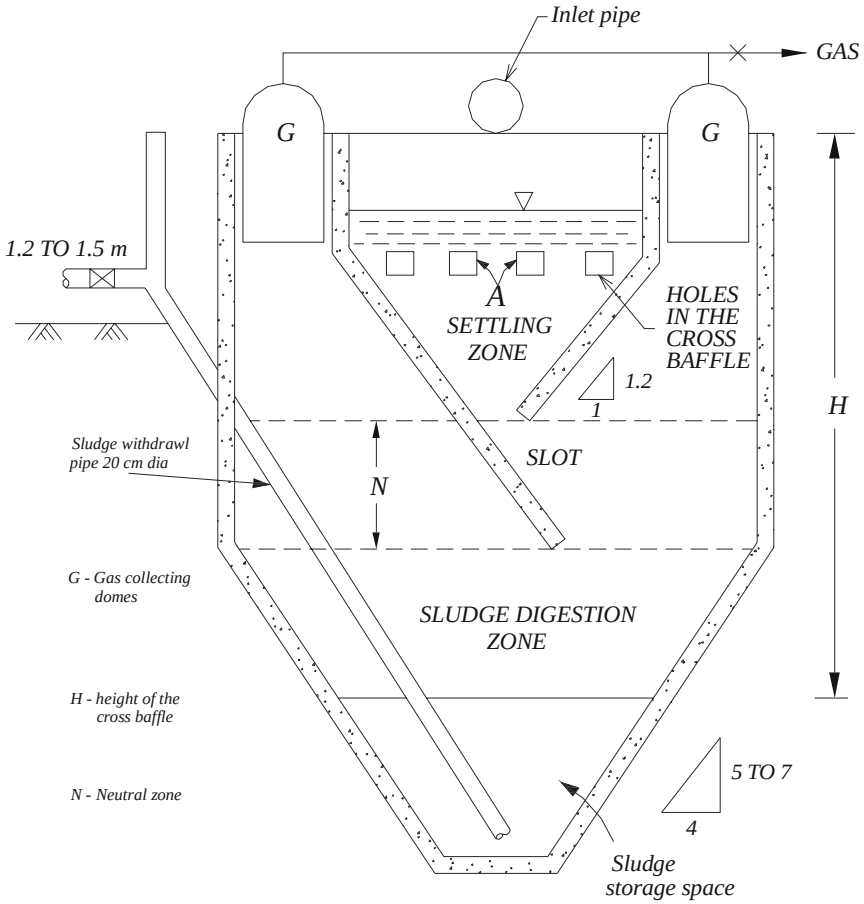


FIG. 8.6.18 CROSS SECTION OF AN IMHOFF TANK

6.9.13.2

Imhoff tanks shall be used where more than 300 peoples of residential buildings are to be served.

6.9.13.3

The settling chamber shall be designed for a detention period of 1.5 to 4.0 hours and an over flow rate of 0.95 to 1.4 m/hr. The displacement velocity should not be more than 18 m/hr. Sloping sides of settling chamber shall have inclination 1.0 horizontal to 1.2 vertical. The slot at the bottom is 0.15 to 0.25 meter measured along the slope of the hopper. The width of the side spaces should not be less than 0.45 meter. The digestion chamber should have a capacity to store about 6 to 12 months digested sludge. Capacity of the digestion chamber can be found from the following formula-

$$C = [V_f - 2/3 (V_f - V_d)] t.$$

Where C is the volume of the digestion tank in m^3/capita below the neutral zone which is 0.2 m below the slot. V_f is the volume of fresh sludge in m^3/capita day and V_d is the volume of the digested sludge in m^3/capita day and t is the time required for digestion. The digestion chamber should have sloping side with a ratio of 4 horizontal to 5 vertical.

6.9.13.4

The Capacity found in sec. 6.9.12.3 is true for residential buildings. For other occupational buildings use a reduction factor as shown Table 8.6.C.1 in Appendix 8.6.C.

6.9.14 Installation

Septic and Imhoff Tank shall be located with a horizontal distance not less than specified in Table 802.8 between various elements. Tanks installed in ground water shall be securely anchored. A 3-inch-thick (76 mm) compacted bedding shall be provided for all septic and other treatment tank installations. The bedding material shall be sand, gravel, granite, lime rock or other noncorrosive materials of such size that the material passes through a 0.5 inch (12.7 mm) screen.

Table : Minimum horizontal separation distances for treatment tanks element distance (feet)

Building	5
Cistern	25
Foundation wall	5
Lake, high water mark	25
Lot line	2
Pond	25
Reservoir	25
Spring	50
Stream or watercourse	25
Swimming pool	15
Water service	5
Well	25

Each cleanout shall be installed so that it opens to allow cleaning in the direction of flow of the soil or waste or at right angles thereto, and except in the case of wye branch and end-of-line cleanouts, shall be installed vertically above the flow line of the pipe.

The bath tub shall be fitted with overflow and waste pipe of nominal diameter of not less than 32 mm and 40 mm respectively.

6.9.15 Disposal Field and Seepage Pit

6.9.15.1

A distribution box shall be provided to receive the effluent from the septic tank or Imhoff tank to assure equal distribution to each individual line of disposal field. The distribution box shall be connected to the septic tank or Imhoff tank by a watertight sewer line and shall be located at the upper end of disposal field. Fig 8.6.19 shows the plans and sections of typical distribution boxes.

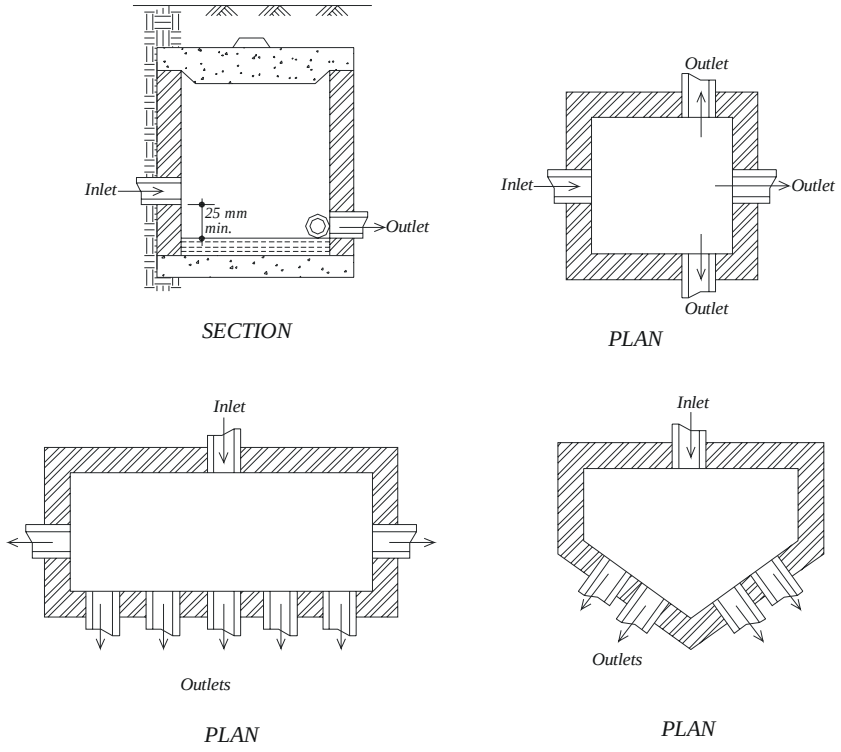


FIG. 8.6.19 DISTRIBUTION BOXES

6.9.15.2

Soil percolation tests (at least for three holes) shall be performed at the site of a proposed individual sewage disposal system installation to determine the suitability of soil and site.

6.9.15.3

The liquid capacity (volume below inlet line) of seepage units (disposal field or seepage pit) shall be at least twice that of a septic tank or Imhoff tank. Effective absorption area of seepage unit may be computed in accordance with Table 8.6.12.

6.9.15.4

No seepage unit shall be extended into water table directly. The bottom of seepage unit shall be at least 1 meter above the highest water table.

6.9.15.5

Each disposal field shall have at least two outlet distribution lines from the distribution box. No portion of disposal field shall be installed under any pavement or any area where there will be vehicular traffic or parking

6.9.15.6

Minimum standards for disposal field construction shall be as shown in Table 8.6.13.

Table 8.6.12 Absorptive Capacity of Disposal Field and Seepage Pit

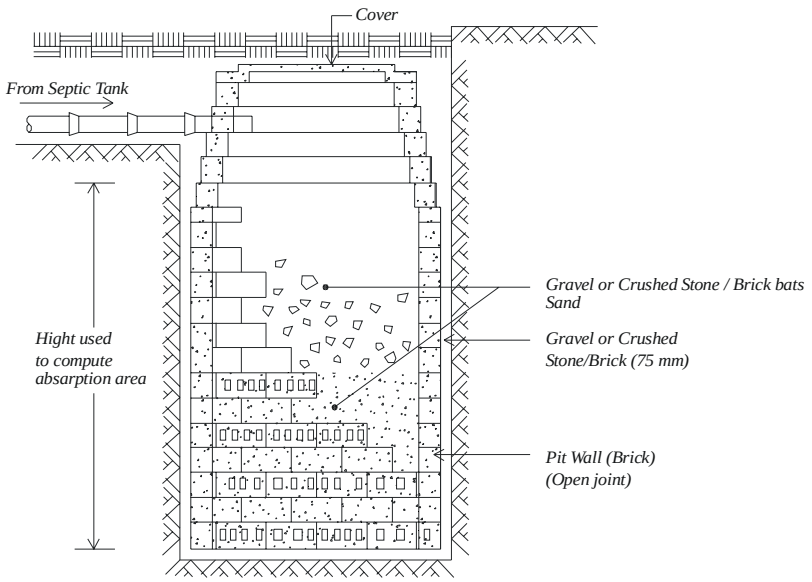
Percolation Test Rate in Minutes for Water to Fall 25 mm	Effluent Allowance Rate of Seepage Unit in litre per m^2 per day	
	Disposal Field Trenches (bottom of trench)	Seepage Pit (wall area)
2 or less	128	172
5	96	128
10	68	92
30	32	44
60 (not recommended)	16	24
over 60 (not suitable)	-	-

Table 8.6.13 Design Features of Disposal Field

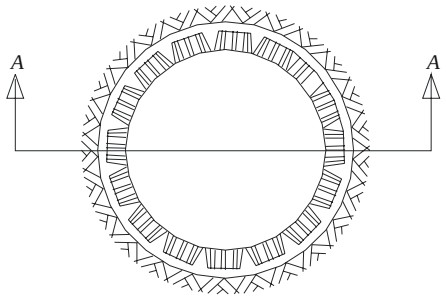
Number of lateral branches	2
Maximum length of branch	20 m
Minimum diameter of field distribution pipe	100 mm
Maximum slope of field distribution pipe	3.3 mm per m
Depth of trench	0.45 m to 9 m
Trench bottom, minimum above ground water	0.61 m
Trench bottom width	0.45m to 0.75m
Depth of coarse material	
under pipe	150 mm
over pipe	50 mm
Size of coarse material	12 mm to 63 mm

6.9.15.7

Seepage pit (soak pit) shall be lined with stone, brick or concrete blocks laid up dry with open joints that are backed up with at least 75 mm coarse aggregate. The joints above the inlet shall be sealed with cement mortar. A reinforced concrete cover shall be provided. For cover area more than 0.75 m^2 the pit shall have an access manhole. The bottom of the pit shall be filled with coarse gravel, or crushed stone/brick to a depth of 0.3 m. Figure 8.6.20 provides the details of a seepage pit.



SECTION A - A



PLAN

FIG. 8.6.20 TYPICAL SEEPAGE PIT

6.9.15.8

Large dry well shall be constructed in accordance with the requirements for seepage pit (Sec 6.9.12). However, for small dry wells handling limited quantities of wastewater the pit may consist of a 2.0 metre deep and 1.0 m diameter pipe filled with crushed bricks/ stone.

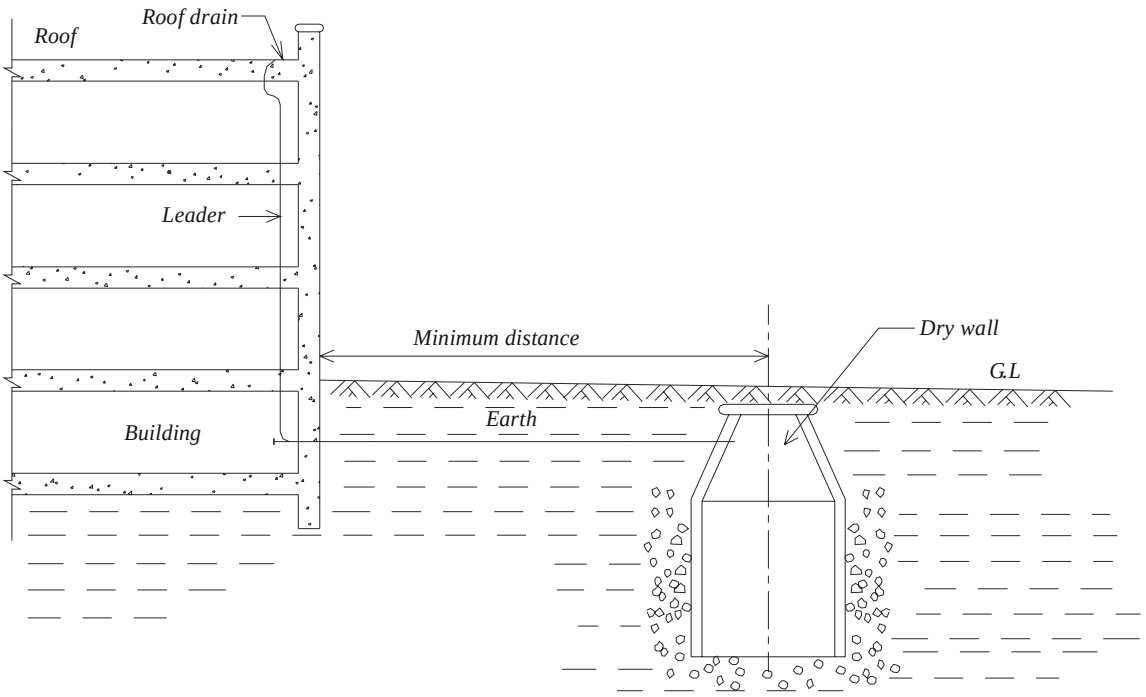


FIG. 8.6.21 TYPICAL LOCATION OF A DRY WALL

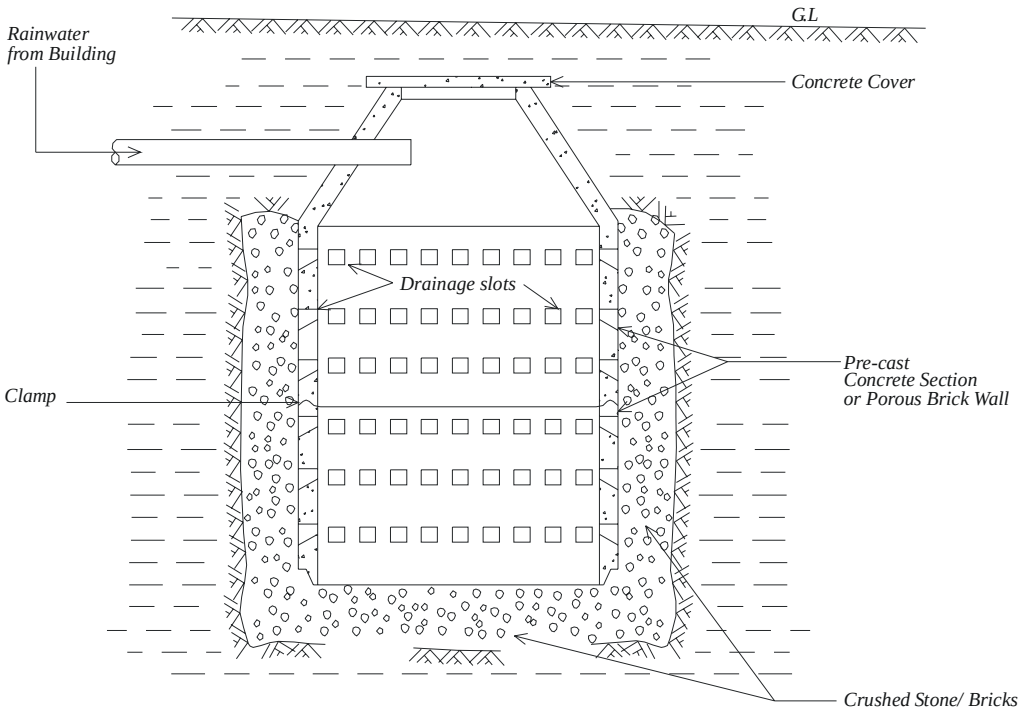


FIG. 8.6.22 INSTALLATION DETAILS OF A DRY WALL

6.9.15.9

French drains may be employed as surface water drains for drainage of unpaved surfaces.

6.10 DESIGN OF DRAINAGE AND SANITATION SYSTEM

6.10.1 Estimation of Maximum Load Weight of Waste Water

To estimate the total load weight carried by a soil or waste pipe, the relative load weight for different kinds of fixtures are provided in Table 8.6.14. Table 8.6.15 provides an approximate rating of those fixtures not listed in Table 8.6.14.

6.10.2 Gradient and Size of Pipe

6.10.2.1

The building drains and sewer shall be designed to discharge the peak simultaneous load weight flowing half-full with a minimum self-cleansing velocity of 0.75 m per second. However, flatter gradient may be used if required but the minimum velocity shall not be less than 0.6 m per second. Again, it is undesirable to employ gradients giving a velocity of flow greater than 2.5 m per second.

6.10.2.2

The maximum number of fixture units that may be connected to a given size of building sewer, building drain, horizontal branch or vertical soil or waste stack shall be provided as in Tables 8.6.16 and 8.6.17.

6.10.3 Size of Vent Piping

6.10.3.1

The size of vent piping shall be determined from its length and the total number of fixture units connected thereto in accordance with Table 8.6.21.

6.10.3.2

The branch vent shall be sized in accordance with Table 8.6.22.

6.11 CONSTRUCTION RELATING TO CONVEYANCE OF SANITARY WASTES

6.11.1 Conveyance of Sanitary Wastes

6.11.2

The layout of drainage systems shall be simple. Change of direction and gradient shall be minimized and shall be as easy as practicable.

6.11.3

The excavation, where necessary, shall be made in accordance with Table 8.6.23.

Table 8.6.14 Fixture Units for Different Sanitary Appliances or Groups

Type of Fixture	Fixture Unit Value as Load Factors
One bathroom group consisting of water closet, wash basin and bath tub or shower stall :	
a) Flush Tank water closet	3
b) Flush-valve water closet	6
Bathtub*	2
Bidet	2
Combination sink and tray (drain board)	2
Drinking fountain	0.5
Floor traps†	1
Kitchen sink, domestic	2
Wash basin, ordinary‡	1
Wash basin, surgeon's	2
Shower stall, domestic	2
Shower (group) per head	3
Urinal, wall hung	4
Urinal, stall	4
Water closet, tank operated	3
Water closet, valve operated	6

* A shower head over a bath tub does not increase the fixture unit value.
† Size of floor trap shall be determined by the area of surface water to be drained.
‡ Wash basin with 32 mm and 40 mm trap have the same load value.

Table 8.6.15 Fixture Unit Values for Fixtures Based on Fixture Drain or Trap Size

Fixture Drain on Trap Size	Fixture Unit Value
30 mm and smaller	1
40 mm	2
50 mm	3
65 mm	4
75 mm	5
100 mm	6

Table 8.6.16 Maximum Number of Fixture Units that can be Connected to Branches and Stacks

Diameter of Pipe (mm)	Maximum Number of Fixture Units that can be Connected			
	Any Horizontal Fixture Branch[a]	One Stack of 3 Storeys in Height or 3 Intervals	More than 3 Storeys in Height	
			Total for Stack	Total at One Storey or Branch Interval
30	1	2	2	1
40	3	4	8	2
50	6	10	24	6
65	12	20	42	9
75	20	30	60	16
100	160	240	500	90
125	360	540	1100	200
150	620	960	1900	350
200	1400	2200	3600	600
250	2500	3800	5600	1000
300	3900	6000	8400	1500
375	7000	b	b	b

[a] Does not include branches of the building sewer.

[b] Sizing load based on design criteria

Table 8.6.17 Maximum Number of Fixture Units that can be connected to Building Drains and Sewers

Diameter of Pipe (mm)	Maximum Number of Fixture Units that can be Connected to any Portion* of the Building Drain or the Building Sewer for Various Slopes			
	1/200	1/100	1/50	1/25
100	-	180	216	250
150	-	700	840	1000
200	1400	1600	1920	2300
250	2500	2900	3500	4200
300	2900	4600	5600	6700
375	7000	8300	10000	12000

* Includes branches of building sewer

Table 8. 6.18 Size of Vertical Leaders*

Size of Leader **	Maximum Projected Roof Area and Flow	
(mm)	(m^2)	(ℓ/min)
50	202	87
65	367	155
75	598	253
100	1287	544
125	2336	986
150	3790	1602
200	8180	3450

* Table 8.7.18 is based upon a maximum rainfall of 25 mm per hour for a 1-hour duration. The figure for drainage area shall be adjusted to local conditions (Appendix 8.6.C).

** The equivalent diameter of square leader will be the diameter of that circle which can be inscribed within the cross-sectional area. The equivalent diameter of the rectangular leader will be the short dimension of the rectangular leader. However, the ratio of width to depth of rectangular leader shall not exceed 3:1.

Table 8.6.20 Size of Semicircular Roof Gutters*

Dia of Gutter (mm)	Maximum Projected Roof Area for Gutter of Various Slopes							
	5 mm per m		10 mm per m		20 mm per m		40 mm per m	
	m	ℓ/min	m^2	ℓ/min	m^2	ℓ/min	m^2	ℓ/min
75	61	25	87	36	123	51	174	73
100	130	55	185	77	260	110	370	155
125	227	96	320	136	455	192	645	273
150	350	148	495	210	700	296	1010	425
175	503	210	710	300	1000	425	1420	600
200	725	307	1020	430	1300	610	2040	862
250	1300	555	1850	785	2610	1110	3650	1540

* Table 8.7.20 is based upon a maximum rainfall of 25 mm per hour for 1-hour duration. The figure for drainage area shall be subject to local conditions in accordance with Appendix 8.6.C.

6.11.3.1

The depth of cover shall be in accordance with Sec 6.9.8.

6.11.3.2

The pipe shall be laid to even gradients and change of gradient shall be combined with an access point (Sec 7.9.6). However, access points shall be provided only if blockages could not be cleared without them.

6.11.3.3

The joints and connection in drainage and venting system shall be gastight and watertight for the pressures required by the test, with the exception of those portions of perforated or open joint piping which will be installed for the purpose of collecting and conveying ground or seepage water to the underground storm drains.

6.11.3.4

Piping in drainage and venting system shall be installed without undue strains and stresses and provision shall be made for expansion, contraction and structural settlement. Vertical piping shall be secured at sufficiently close intervals to keep the pipe in alignment and carry the weight of the piping and its content. The horizontal piping shall be supported at sufficiently close intervals (Sec 6.8) to keep it in alignment and to prevent sagging.

6.12 REFUSE CHUTE SYSTEM

6.12.1

All buildings higher than 6-storeys shall be provided with refuse chute system for transporting and collecting refuse from different floors in a sanitary way. The refuse shall be received from the respective floor through an inlet hopper in to the chute which conveys refuse and discharges into the collection chamber. The refuse from the collection chamber shall be cleared at suitable intervals.

6.12.2

The refuse chute, inlet hopper and collection chamber shall be constructed with smooth and nonflammable materials.

6.12.3

The hopper shall be self-cleaning and shall be fitted with self-closing shutter to prevent the passage of foul gases inside the building.

6.12.4

The diameter of the chute shall not be less than 300 mm. It shall be adequately ventilated at the top. The chute shall be provided with suitable arrangements for flushing with water for the full length.

6.13 BASEMENT FLOOR DRAINAGE SYSTEM

6.13.1

All buildings having basement floor below the surrounding sewer system and area more than 1000 sqm shall have pumping system to drain out wastewater.

6.13.2

All buildings having basement floor below the surrounding sewer system and area more than 1000 sqm shall have one sump pit for every 1000 sqm .

6.13.3

For more than one sump pit, pits shall be connected to a master sump pit from where pumping shall be done to drain out the waste. Minimum diameter of sump pit connection drain pipe shall be 75 mm.

6.13.4

For wastewater and sewage drainage from basement floor separate drainage system shall be provided.

Table 8.6. 21 Size and Length of Vent Stacks and Stack Vents

Diameter of Soil or Waste Stack (mm)	Total Fixture Unit (FU) Connected to fixture	Maximum Development Length of Vent (m)* for Diameter (mm) of Vent Pipes										
		30	40	50	65	75	100	125	150	200	250	300
30	2	9										
40	8	15	45.5									
40	10	9	30.5									
50	12	9	22.5	61								
50	20	8	15	45.5								
65	42		9	30.5	91.5							
75	10		12.5	45.5	109.5	317						
75	21		9.5	33.5	82	247						
75	53		8	28.5	70	207						
75	102		7.5	26	64	189						
100	43			10.5	26	76	298.5					
100	140			8	19.5	61	228.5					
100	320			7	16.5	52	195					
100	540			6.5	15	45.5	176.5					
125	190				8.5	25	97.5	301.5				
125	490				6.5	19	76	231.5				
125	940				5.5	16	64	204				
125	1400				4.5	15	58	180				
150	500					10	39.5	122	305			
150	1100					6.5	30.5	94.5	237.5			
150	2000					6	25.5	79	201			
150	2900						23.5	73	183			
200	1800						9.5	29	73	286.5		
200	3400						7	22	58	219.5		
200	5600						6	19	48.5	186		
200	7600						5.5	17	42.5	170.5		
250	4000							9.5	23.5	94.5	292.5	
250	7200							7	18	73	225.5	
250	11000							6	15.5	61	192	
250	15000							5.5	14	55	173.5	
300	7300								9.5	36.5	116	286.5
300	13000								7	28.5	91.5	219.5
300	20000								6	24	76	186
300	26000								5.5	22	70	152.5
375	15000									12	39.5	94.5
375	25000									9.5	29	73
375	38000									8	24.5	61
375	50000									7	22.5	55

* The development length shall be measured from the vent connection to the open air

6.13.5

The collection chamber shall be of suitable size and located at ground level.

6.13.6

The design and arrangement of the system shall be in accordance with established engineering practices.

6.14 Health care drainage system

6.14.1 General

The health care drainage system shall comply with applicable drainage and venting requirements specified in this chapter and with this section.

6.14.2 Special Fixtures and Equipment

The hospital shall be provided with clinical sink, bedpan washer and such other fixtures and equipment for disposal of bedpan contents and for the cleansing and disinfection of such fixtures. A clinical sink shall not be considered as a substitute for service sink.