SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
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SCHOOL OF BUILDING AND ENVIRONMENT
DEPARTMENT OF ARCHITECTURE

UNIT – I – INTERIOR SERVICES – SDE 2302

I. Introduction

UNIT I - WATER SUPPLY IN BUILDINGS
Standard of portable water and methods of removal of impurities, Consumption order of water for domestic purposes, distribution system, service connection from mains, house-service design, tube well, pumping of water, types of pumps, cisterns for storage

II. PORTABLE WATER

Potable water is defined as water that is suitable for human consumption (i.e., water that can be used for drinking or cooking). The term implies that the water is drinkable as well as safe. Drinkable water means it is free of unpleasant odors, tastes and colors, and is within reasonable limits of temperature. Safe water means it contains no toxins, carcinogens, pathogenic micro-organisms, or other health hazards.
Access to safe drinking-water is essential to health, a basic human right and a component of effective policy for health protection. In some regions, it has been shown that investments in water supply and sanitation can yield a net economic benefit, since the reductions in adverse health effects and health care costs outweigh the costs of undertaking the interventions. This is true for major water supply infrastructure investments through to water treatment in the home.

III. CHARACTERISTICS OF WATER

PHYSICAL CHARACTERISTICS

1. **Turbidity**
2. **Colour and temperature**
3. **Taste and odour**

TURBIDITY

- **Turbidity is caused due to presence of suspended and colloidal matter in the water.**
- **The character and amount of turbidity depends upon the type of soil over which the water has moved ground waters are less turbid than the surface water.**

COLOUR AND TEMPERATURE

- **Colour in water is usually due to organic matter in colloidal condition but sometimes it is also due to mineral and dissolved organic impurities**
- **Temperature of water is measured by means of ordinary thermometers. The temperature of surface water is generally at atmospheric temperature, while that of ground water may be more or less than atmospheric temperature.**
- **The most desirable temperature for public supply between 4.4°C to 10°C. The temperature above 35°C is unfit for public supply, because it is not palatable.**

TASTE AND ODOUR

• TASTE AND ODOUR in water may be due to presence of dead or live micro-organisms, dissolved gases such as hydrogen sulphide, methane, carbon dioxide or oxygen combined with organic matter, mineral substances such as sodium chloride, iron compounds and carbonates and sulphates of other substances.

CHEMICAL CHARACTERISTICS

• In the chemical analysis of water, these tests are done that will reveal the sanitary quality of the water. Chemical tests involve the determination of total solids, PH value, Hardness of water, Chloride content etc.

PH VALUE OF WATER

PH value denotes the concentration of hydrogen ions in the water and it is a measure of acidity or alkanity of a substance.

The PH value ranges from 0 to 14.

For pure water, PH value is 7 and
0 to 7 Acidic and
7 to 14 alkaline ranges.

• For public water supply PH value may be 6.5 to 8.5.

CHLORIDE CONTENT

• The natural waters near the mines and sea dissolve sodium chloride and also presence of chlorides may be due to mixing of saline water and sewage in the water.
• Excess of chlorides is dangerous and unfit for use.
• The chlorides can be reduced by diluting the water.
• Chlorides above 250p.p.m. are not permissible in water.

BIO-CHEMICAL OXYGEN DEMAND

• If the water is contaminated with sewage, the demand of oxygen by organic matter in sewage is known as biochemical oxygen demand.
• The aerobic action continues till the oxygen is present in sewage. As the oxygen exhausts the anaerobic action begins due to which foul smell starts coming.

BACTERIAL AND MICROSCOPICAL CHARACTERISTICS

• The bacteria may be harmless to mankind or harmful to mankind. The former category is known as non-pathogenic bacteria and the later category is known as pathogenic bacteria.

GOOD QUALITY OF WATER

1. It should be free from bacteria
2. It should be colourless and sparkling
3. It should be tasty, odour free and cool
4. It should be free from objectionable matter
5. It should not corrode pipes.
6. It should have dissolved oxygen and free from carbonic acid so that it may remain fresh.

Microbial aspects - Securing the microbial safety of drinking-water supplies is based on the use of multiple barriers, from catchment to consumer, to prevent the contamination of drinking-water or to reduce contamination to levels not injurious to health. Safety is increased if multiple barriers are in place, including protection of water resources, proper selection and operation of a series of treatment steps and management of distribution systems (piped or otherwise) to maintain and protect treated water quality.

Contamination increases the hardness of water. Hard water has a high level of TDS which needs reduction before consuming it. There are several hazards of drinking water that has high TDS. The table below shows the acceptable levels of TDS in water.

TDS Levels in mg/litre	Palatability Quotient
Less than 300	This is considered excellent to drink
300-500	These levels are good
600-900	These are fair levels
900-1200	This is considered poor palatability
Above 1200	This is an unacceptable range

IV. METHODS OF REMOVAL OF IMPURITIES

In a country where waterborne diseases result in over 10,000 deaths annually, we don't need to emphasize why there is an urgent need for a water purification in every household.

1. Boiling

The simplest method to purify water is to boil it for a good amount of time. High temperatures cause the bacteria and virus to dissipate, removing all impurities from the water. In doing so, chemical additions cease to exist in the water as well. However, the dead micro-organisms and impurities settle at the bottom of the water, and boiling does not help eliminate all the impurities. You must strain the water through a micro porous sieve to completely get rid of the impurities.

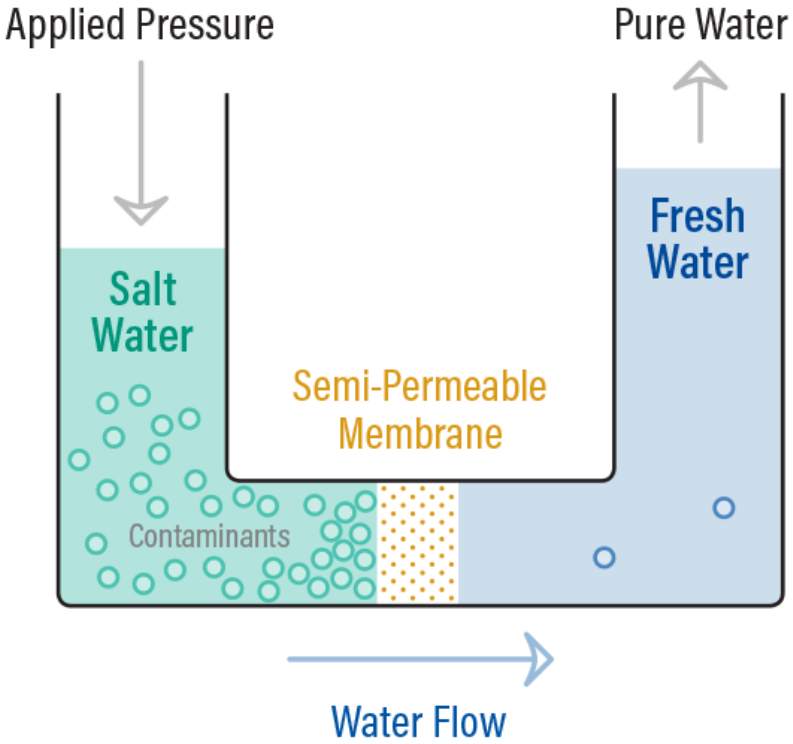
2. Water Purifier

An electric water purifier is the most trusted form of water purification that can be found in most houses today. A water purifier uses a multi-stage process that involves UV and UF filtration, carbon block, and modern water filtration technology that eliminates a majority of the chemicals and impurities making it the purest drinking water.

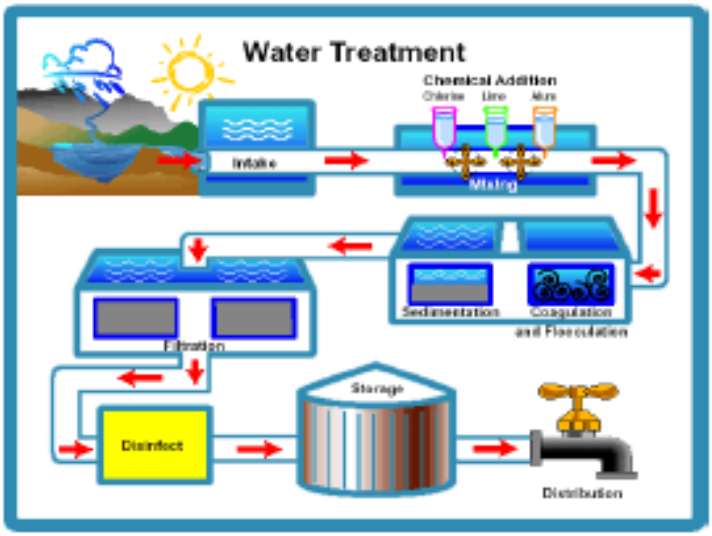
3. Reverse Osmosis

Reverse Osmosis forces water through a semipermeable membrane and removes contaminants. RO reduces TDS by forcing water through a fine membrane with microscopic pores which eliminates even the smallest of particles. All that can pass through are atoms smaller than 0.0001 microns. Thus, purifying water to the purest form. The TDS Controller and Mineraliser technology help retain the necessary nutrients while doing away with harmful impurities.

The finer particles that dissolve in the water are called TDS (Total Dissolved Solids). TDS in water is a combination of both, organic substances from natural sources and inorganic substances that are generated by industries, road salts, pesticides and more.



Water found at source i.e. glaciers has a lower TDS compared to water provided by the Municipal Corporation. A low level of TDS in water sounds fine, however, drinking water must contain a suitable quantity of dissolved salts. Thus, it becomes very important to ensure an optimum TDS level in water.



V. CONSUMPTION ORDER OF WATER FOR DOMESTIC PURPOSES

Activity-wise Consumption of Water at the household level,

Bathing consumes the highest amount of water at about 28 per cent of total consumption.
Consumption in toilets 20 per cent,
Washing clothes 18.6 per cent
Washing utensils 16.3 per cent
less than 10 per cent of the total water in a household is used for drinking and cooking.

The quantity of water required in the houses for drinking, bathing, cooking,washing etc is called domestic water demand and mainly depends upon the habits,social status, climatic conditions and customs of the people.

The details of the domestic consumption are

a) Drink ------	**5 litres**
b) Cooking------	**5 litres**
c) Bathing------	**55 litres**
d) Clothes washing------	**20 litres**
e) Utensils washing------	**10 litres**
f) House washing ------	**10 litres**
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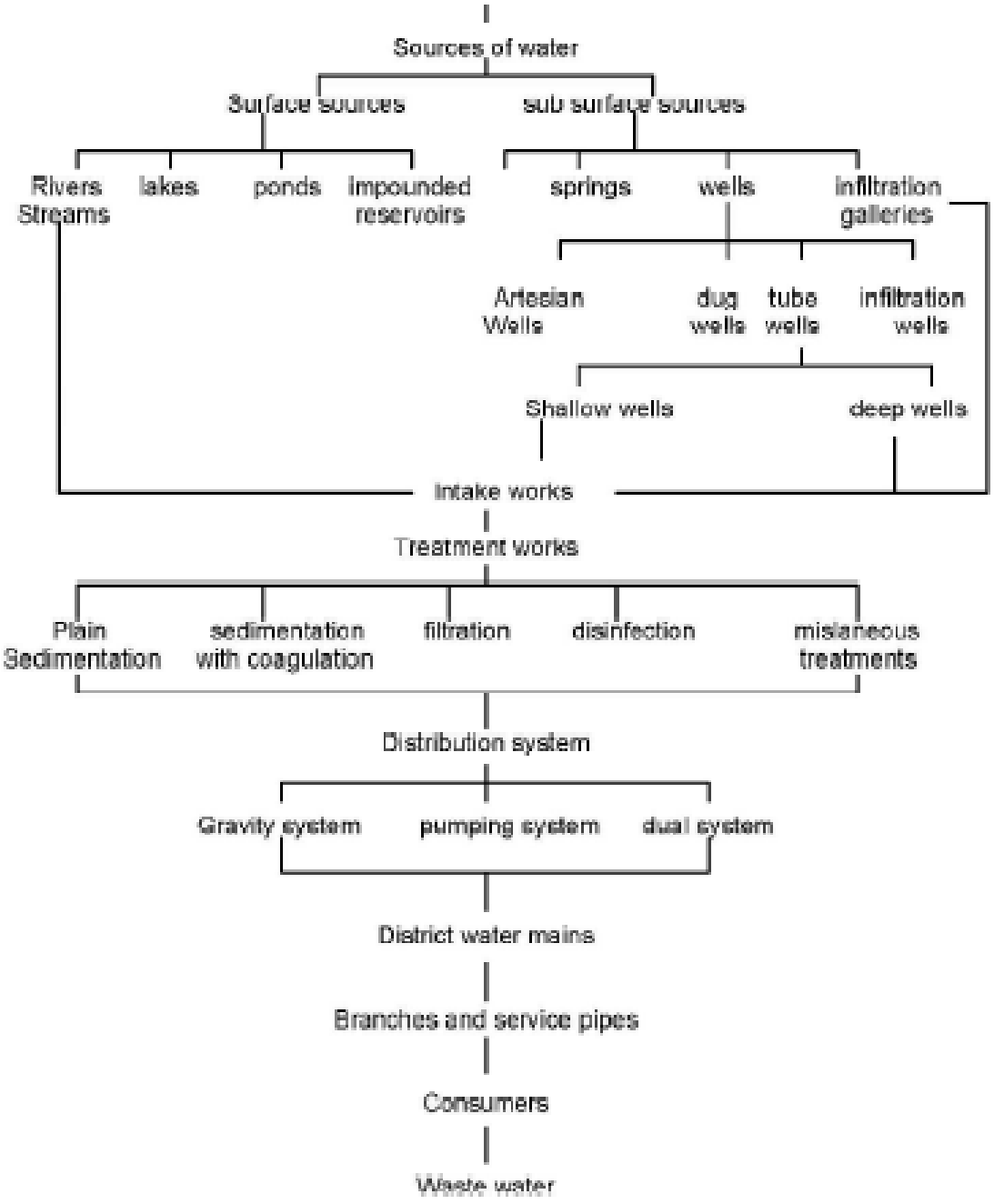
	135 litres/day/capita

VI. DISTRIBUTION SYSTEM

A water distribution system is a part of water supply network with components that carry potable water from a centralized treatment plant or wells to water consumers in order to adequately deliver water to satisfy residential, commercial, industrial and fire fighting requirements.

World Health Organization (WHO) uses the term water distribution system for a network of pipes that generally has a loop structure to supply water from the service reservoirs and balancing reservoirs to water consumers. A water distribution system consists of pipelines, storage facilities, pumps, and other accessories.



The purpose of distribution system is to deliver water to consumer with appropriate quality, quantity and pressure.
Distribution system is used to describe collectively the facilities used to supply water from its source to the point of usage.

VII. Requirements of Good Distribution System

Water quality should not get deteriorated in the distribution pipes.
It should be capable of supplying water at all the intended places with sufficient Pressure head.

It should be capable of supplying the requisite amount of water during fire fighting.

The layout should be such that no consumer would be without water supply, during the repair of any section of the system.
All the distribution pipes should be preferably laid one metre away or above the sewer lines.

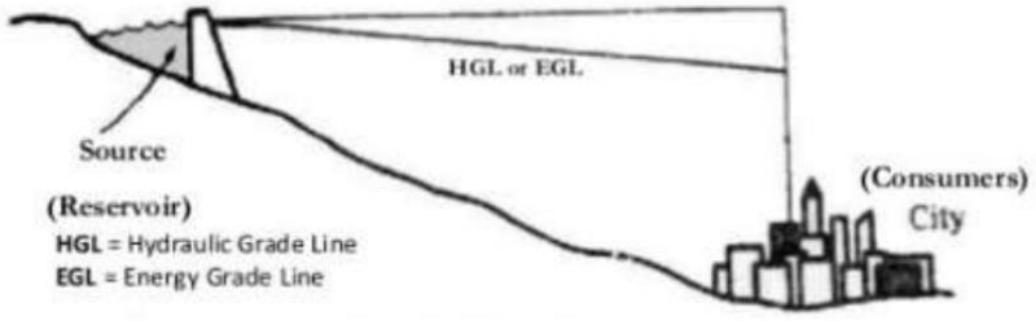
VIII. Methods of Water Distribution

- **For efficient distribution system adequate water pressure required at various points.**
- **Depending upon the level of source, topography of the area and other local conditions the water may be forced into distribution system by following ways**

–
Gravity system
Pumping system
Combined gravity and pumping system

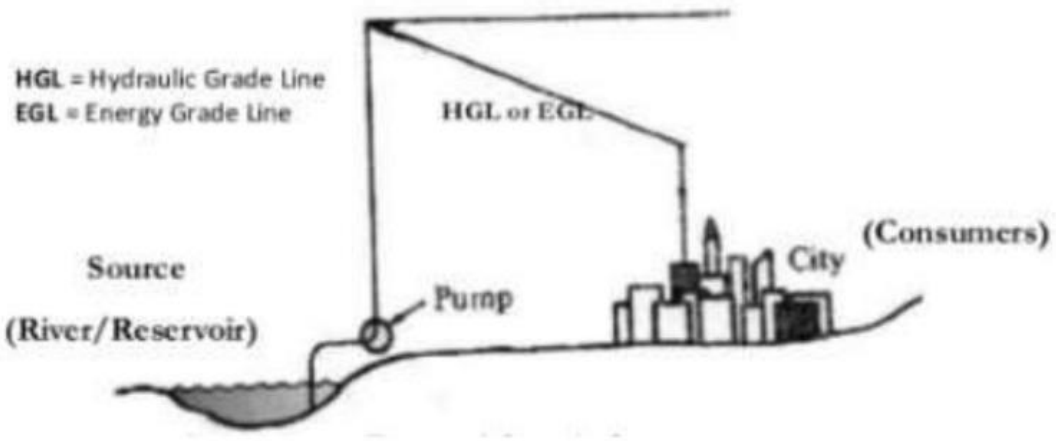
Gravity system:

- **Suitable when source of supply is at sufficient height.**
- **Most reliable and economical distribution system.**
- **The water head available at the consumer is just minimum required.**
- **The remaining head is consumed in the frictional and other losses.**



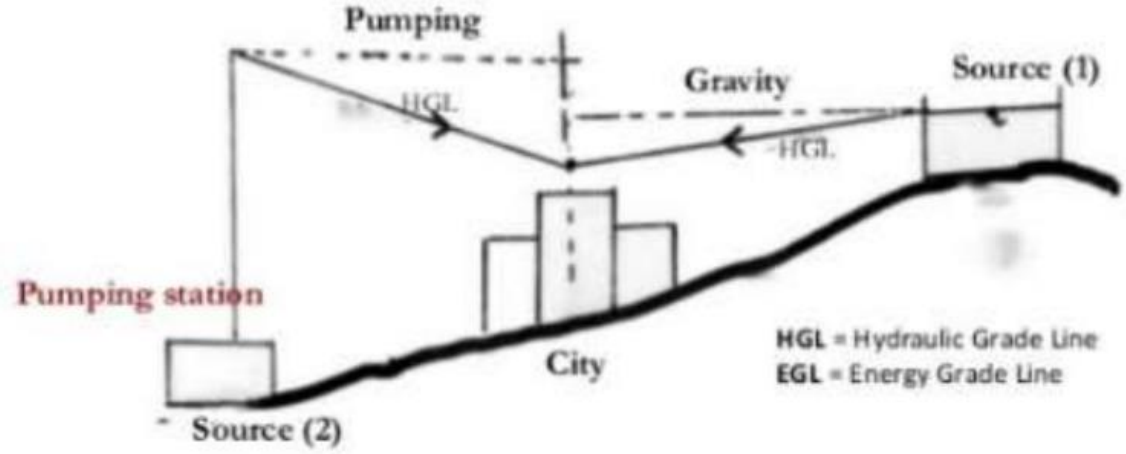
Pumping system

- **Treated water is directly pumped in to the distribution main with out storing.**
- **Also called pumping without storage system.**
- **High lifts pumps are required.**
- **If power supply fails, complete stoppage of water supply.**
- **This method is not generally used.**



Combined gravity and pumping system

- **Most common system.**
- **Treated water is pumped and stored in an elevated distribution reservoir.**
- **Then supplies to consumer by action of gravity.**
- **The excess water during low demand periods get stored in reservoir and get supplied during high demand period.**
- **Economical, efficient and reliable system.**



IX. SYSTEMS OF SUPPLY OF WATER:

CONTINUOUS SYSTEM OF WATER SUPPLY

24x7 supply is achieved when water is delivered continuously to every consumer of the service 24 hours a day, every day of the year, through a transmission and distribution system that is continuously full and under positive pressure. Continuous supply systems are designed using the following main parameters

1. Flow of raw water
2. Water treatment plant
3. Water transmission system

ADVANTAGES:

- **In this system water is not stagnant in pipe at any instant & hence fresh water is always available.**
- **Lesser pipe sizes are required.**
- **Fire hazards can be met within time.**

DISADVANTAGES:

- **If there are some minor leakages etc in the system, great volume of water is wasted because of long duration of flow.**
- **More water is required at the source which is difficult in tropical countries like India, which get rains only during a particular season.**
- **More wastage of water due to lack of civic sense.**

INTERMITTENT SYSTEM OF WATER SUPPLY

Intermittent system: If plenty of water is not available, the supply of water is divided into zones & each zone is supplied with water for fixed hours in a day. As the water is supplied after intervals, it is called intermittent system.

ADVANTAGES

- **For older distribution systems having weaker joints and more leakage, restrained supply hours can limit leakage**
- **Reduced pressure also helps lowering leakage**
- **Overall scarcity may sometimes be managed by interrupting the water supply and equally balancing the resources (controversial)**
- **Time is available for repair and maintenance out of supply hours**

DISADVANTAGES

- **Systems do not operate as designed: components are underused, others are overexploited and damaged**
- **Inconvenience to consumers, mostly the poor (often, one person per household is devoted to storing the water at supply times)**
- **Pipelines are subjected to vacuum condition after supply hours, which can cause groundwater infiltration into the pipelines with contamination of the supply or pipes deformation**
- **Frequent contamination requires household-level water treatment, as well as higher doses of residual chlorine by the supplier**
- **Consumers need to store water between supplies and tend to throw away remnant store. This causes water wastage and storage costs**
- **Frequent wear and tear on valves, water meters malfunction**
- **More manpower and infrastructures needed**
- **High capital cost of making the system stronger compared to a continuous water supply system, Often, no immediate supply and pressure in case of fire.**

X. Layouts of Distribution Network:

The distribution pipes are generally laid below the road pavements, and as such their layouts generally follow the layouts of roads.

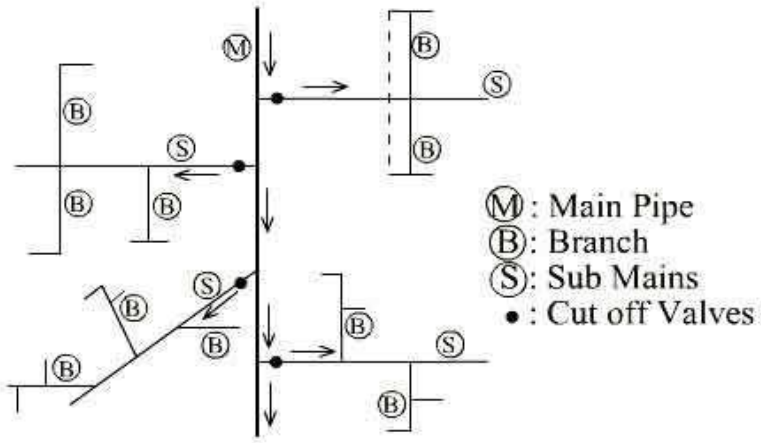
There are, in general, four different types of pipe networks; any one of which either singly or in combinations, can be used for a particular place.

They are:

Dead End System
Radial System
Grid Iron System
Ring System

Dead End System
It is suitable for old towns and cities having no definite pattern of roads.

Dead End or Tree System

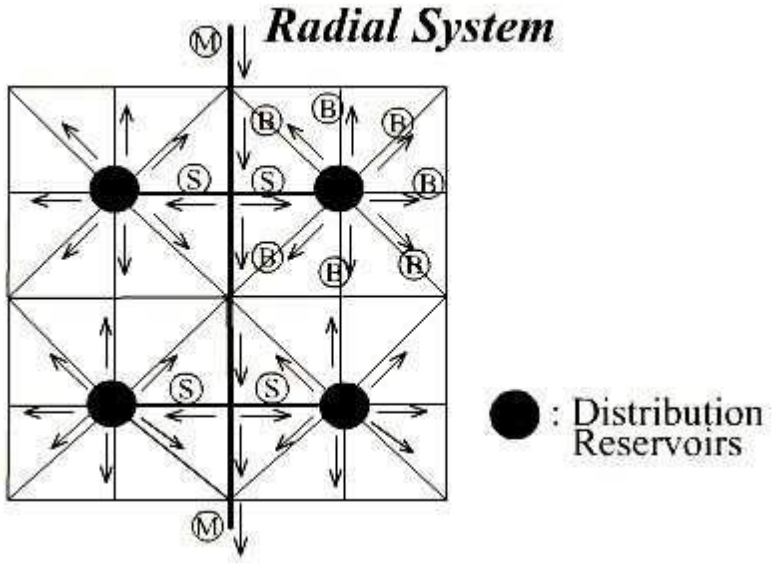


Advantages:
-Relatively cheap.
-Determination of discharges and pressure easier due to less number of valves.

Disadvantages:
-Due to many dead ends, stagnation of water occurs in pipes.

Radial System

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

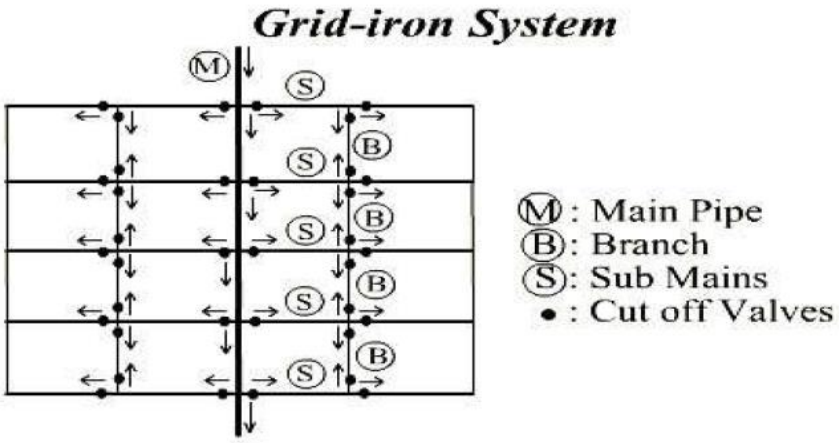


Advantages:
-It gives quick service.
-Calculation of pipe sizes is easy.

Grid Iron System
It is suitable for cities with rectangular layout, where the water mains and branches are laid in rectangles.

Advantages:
-Water is kept in good circulation due to the absence of dead ends.
-In the cases of a breakdown in some section, water is available from some other direction.

Disadvantages:
-Exact calculation of sizes of pipes is not possible due to provision of valves on all branches.



Ring System

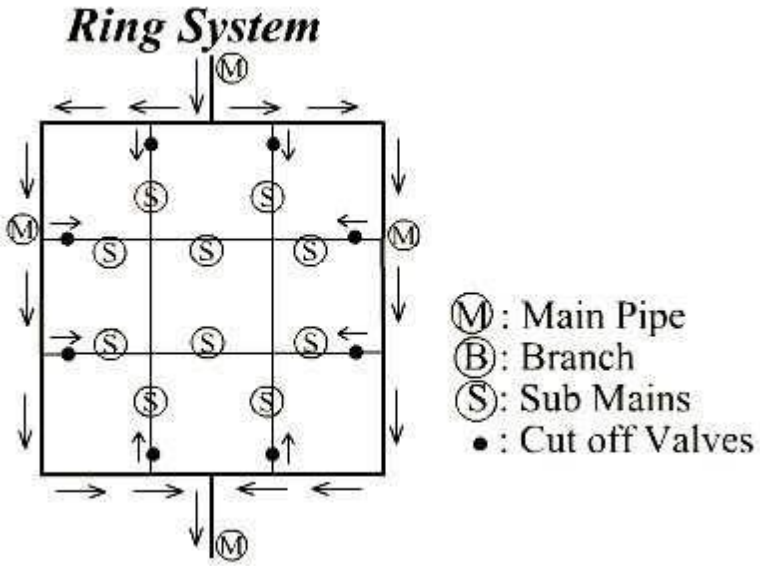
-The supply main is laid all along the peripheral roads and sub mains branch out from the mains.

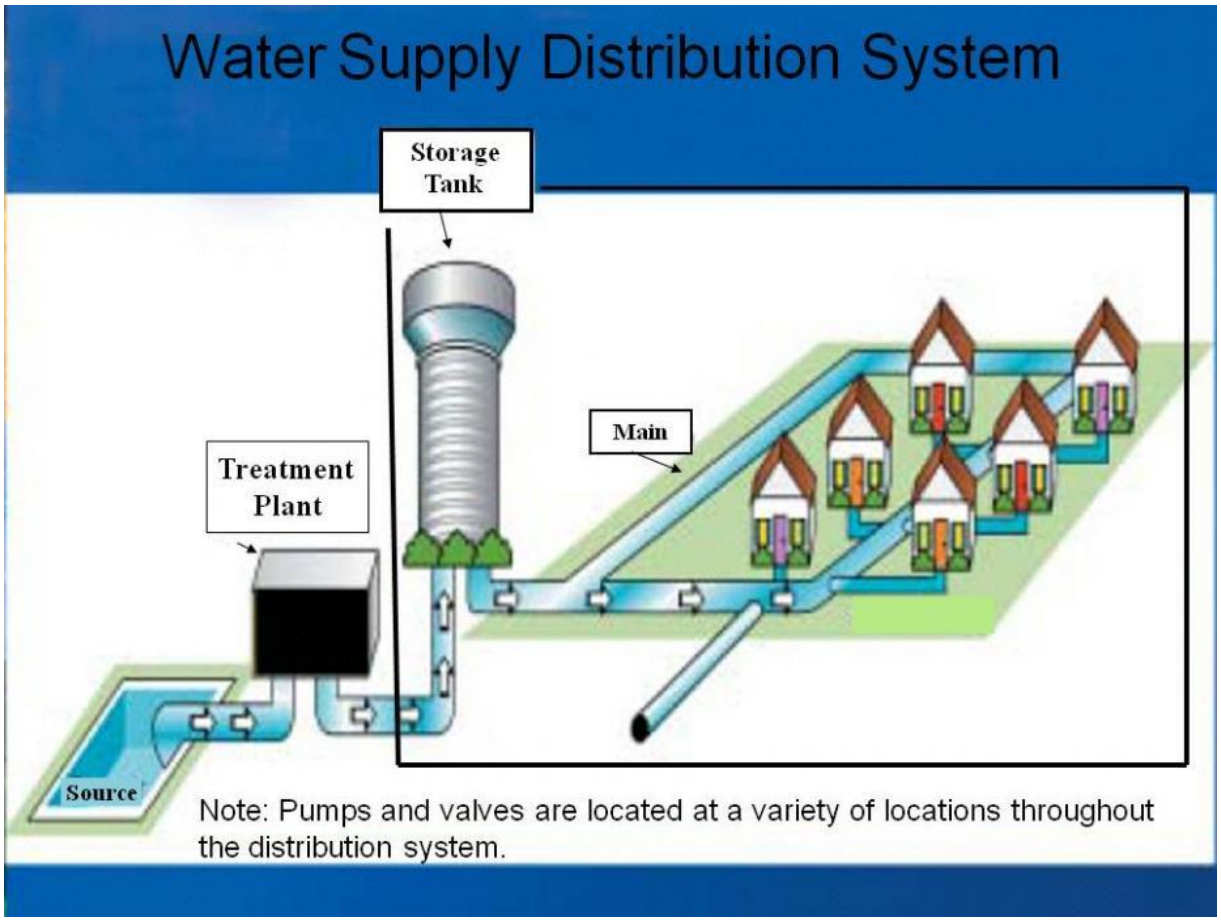
-This system also follows the grid iron system with the flow pattern similar in character to that of dead end system.

-So, determination of the size of pipes is easy.

Advantages:

-Water can be supplied to any point from at least two directions.



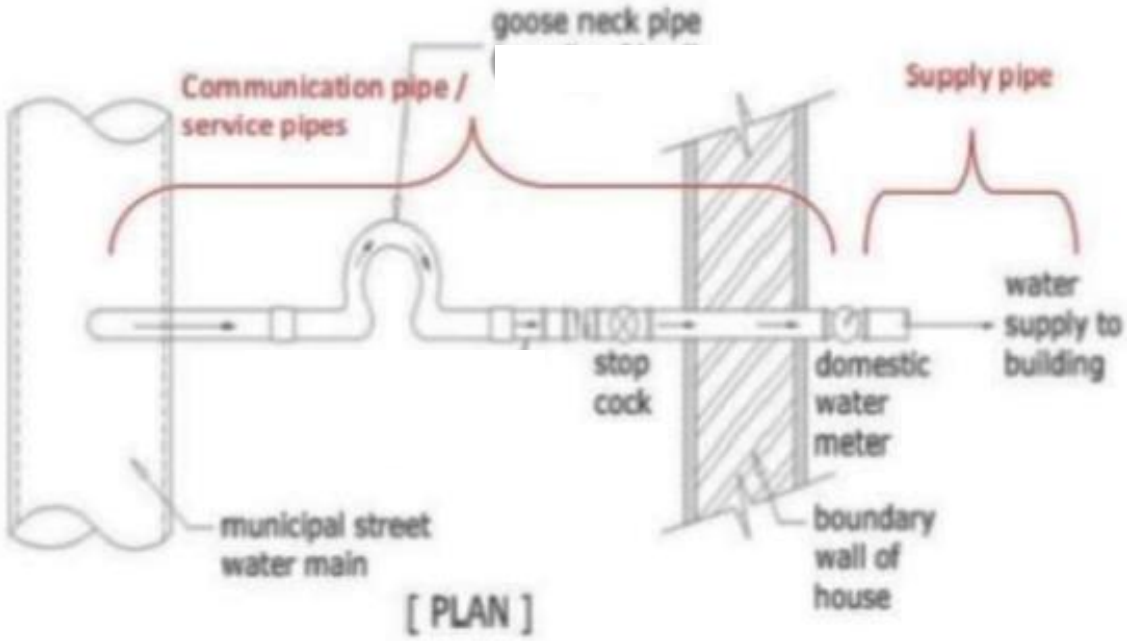


XI. Service connection from the mains:

Distribution System for a Building:

Water is conveyed from the street mains to the individual building, and then to the taps and other fixtures. The supply from the main line to the individual is made through the house service connection. It consist of two types:

1. **Communication Pipe**: The Pipe which runs from the municipal distribution mains to the boundary of the premises.
2. **Supply Pipe**: The pipe which runs inside the premises is called as supply pipe/consumers pipe.



XII. SYSTEM OF SUPPLY

System of Supply:

- Water supply from the mains to the building is through one of the following system depending on the pressure of the water and timings of the supply.

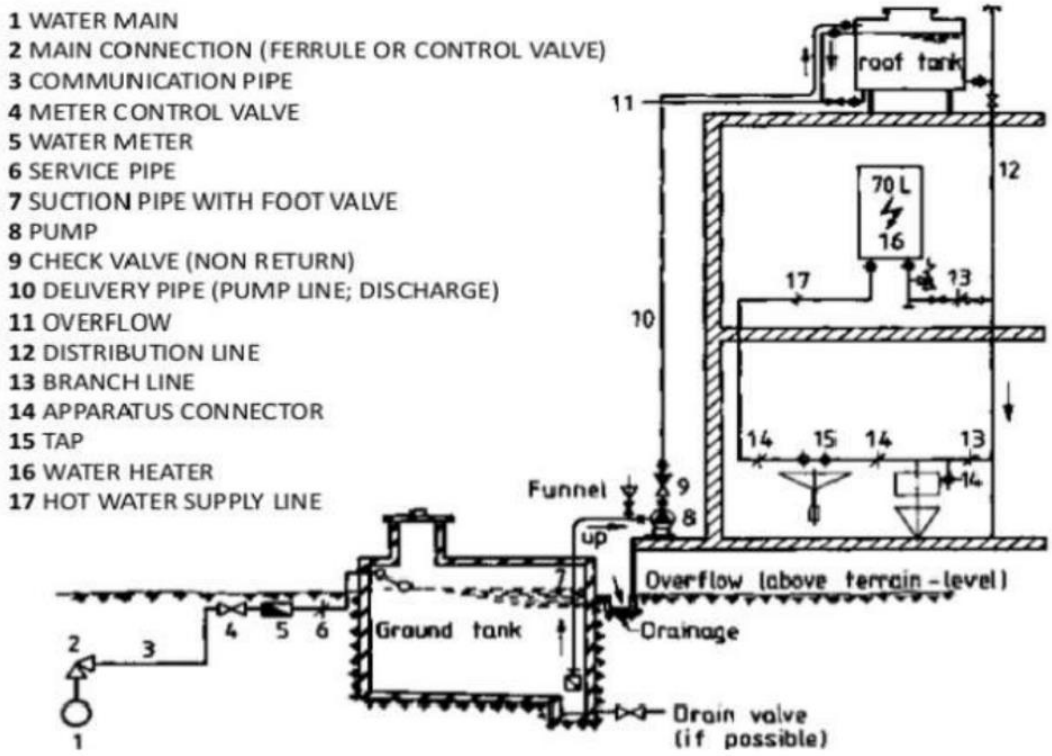
Direct supply system (upward distribution):

- Supply of water is directly given to various floors with required pressure for sufficient hours.
- This is only useful for the building which is not more than two floors.
- Separate connections to be provided for domestic and non domestic requirement.

Indirect supply system (down take supply):

- Used generally when the pressure in the mains is not sufficient.
- The water is pumped directly to the overhead storage tank and from there the water is supplied to different floors by gravity
- The water is stored in the underground tank and from there water is pumped to the overhead tank and then it is supplied to different floors by gravity.

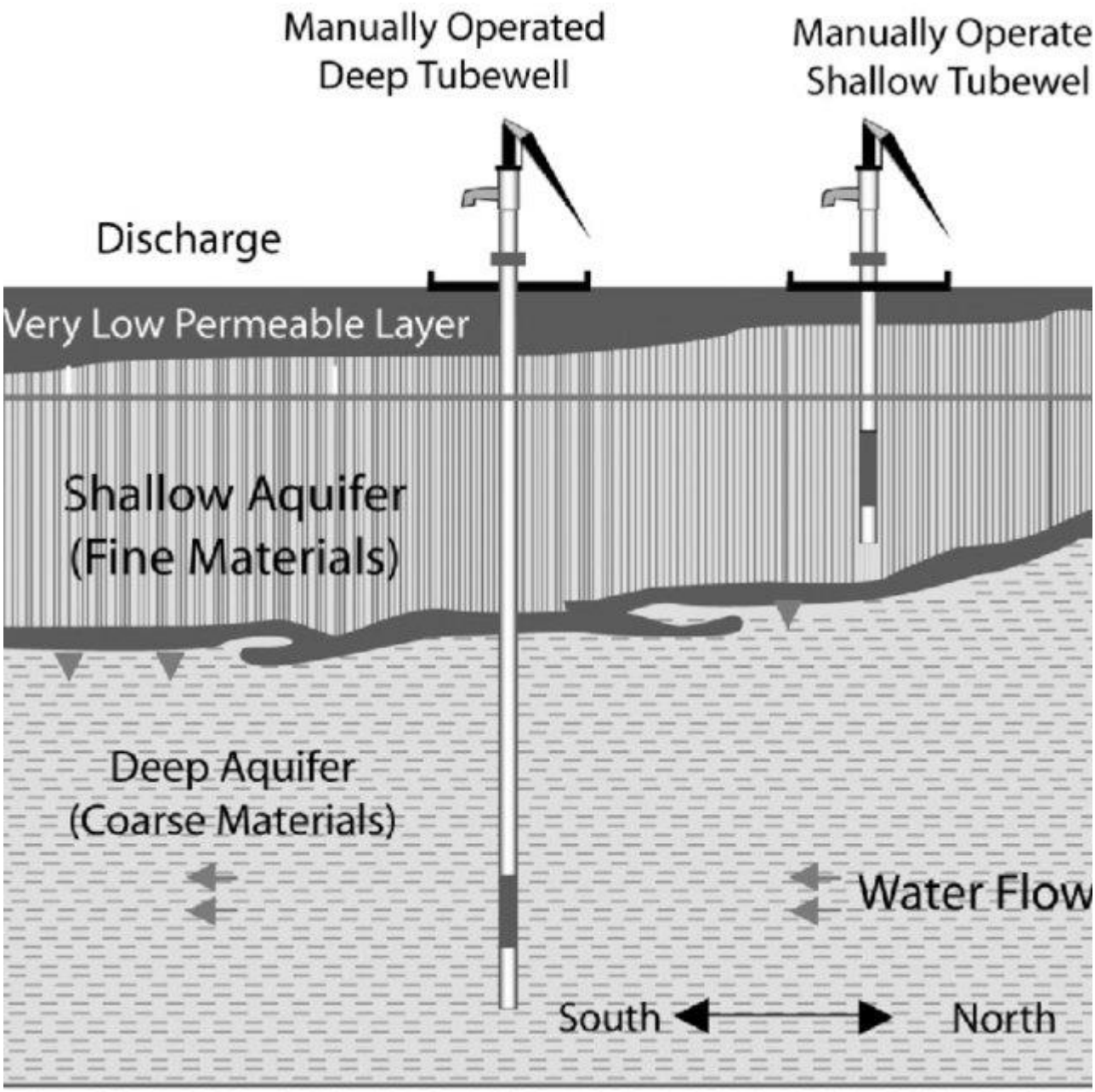
Schematic Water Supply of a Building



XIII. TUBE WELL

A tube well is a type of water well in which a long, 100–200 millimetres (3.9–7.9 in)-wide, stainless steel tube or pipe is bored into an underground aquifer. The lower end is fitted with a strainer, and a pump lifts water for irrigation. The required depth of the well depends on the depth of the water table.

A tube well is dug manually; no mechanized equipment necessary. First, a steel pipe with a sharp blade is inserted into the ground and used to dig into the soil. ... At the base of the well are filters which strain out sand, allowing clean water to be sucked to the surface via a hand pump.



XIV. TYPES OF DOMESTIC PUMPS

There is the following category of domestic pumps:

Centrifugal Pumps : This type uses centrifugal force to pump out water and mostly operated by an electric motor. Centrifugal pump in the jet engine is operated on the same mechanism. But a water pump just pumps water sucked from the water to improve efficiency. They are designed to pump clear water that is free from any solid impurity.

Hence, they used mainly for supplying water to homes, draining water tanks, filling swimming pool and for irrigating the garden. They are highly efficient compared to regenerative pumps.

Submersible Pumps : The second type of domestic pumps is submersible who is submerged underwater. The motor of the pump is concealed and mostly used in borewells and wells. As they are already in the water, so no priming is needed for them. Moreover, it has further two types; tube well submersible pumps and well submersible pumps.

Borewell Compressor Pumps : This type is designed to draw water from borewells as deep as 650 feet. It uses air pressure to pull the water from the top where the borewells contain less water. Further types are belt-driven and Monobloc.

Pressure Booster Pumps : This type is designed to increase the pressure of the water. That is why; they are mainly used in homes for increasing water pressure. We need to install them in places where the pressure of the water is too low. A pressure tank is connected in the unit supplies water to provide constant pressure across all pipes which makes it very suitable for residential complexes.

Shallow Well Pumps : This type is mostly used in rural areas for shallow wells. It has 8 meters suction head that provides great suction capacity.

Every pump is distinct in its features. That is why the engineers have made each type for specific purposes.

XV. STORAGE TANKS

Distribution storage tanks, familiar sights in many communities, serve two basic purposes: equalizing storage and emergency storage. Equalizing storage is the volume of water needed to satisfy peak hourly demands in the community. During the late night and very early morning hours, when water demand is lower, high-lift pumps fill the tank. During the day, when water demand is higher, water flows out of the tank to help satisfy the peak hourly water needs. This allows for a uniform flow rate at the treatment plant and pumping station. Water in a distribution storage tank may also be needed for fighting fires, cleaning up accidental spills of hazardous materials, or other community emergencies. The capacity of a distribution storage tank is designed to be about equal to the average daily water demand of the community.

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UNIT – II – INTERIOR SERVICES – SDE 2302

I. INTRODUCTION

UNIT II BUILDING DRAINAGE
Layout, Principles of drainage, Trap type, materials and functions, Inspection chambers, Design of Septic tanks and soak pits, Ventilation of house drains ; Anti-syphonage or vent pipes, One and two pipe systems Sinks, bath tub, water closets, flushing cisterns, urinals, wash basins, bidet, shower panel etc.

II. DRAINAGE SYSTEM

It is the arrangement provided in a house or building for collecting or conveying waste water through drain pipes, by gravity, to join either a public sewer or a domestic septic tank is termed as house drainage or building drainage.

Wastewater: Water when used for different purpose like domestic commercial, industrial etc., receives impurities and become wastewater. Thus wastewater is used water and it has physical, chemical, and biological Impurities in it.

Sewage: The waste water coming from W.C. and containing human excreta is known as sewage.

Sullage: The Wastewater coming from bathrooms and kitchens which does not contain fecal matter is known as sullage.

Plumbing/Drainage System: It is entire system of pipe line for providing water supply to the building or it is a system of pipes for disposal of wastewater from the building.

Sewer: A pipe carrying sewage/ wastewater is called sewer.

Soil Pipe: It is pipe carrying sewage from W.C.

Vent Pipe : A vertical pipe that provides circulation of air to and from the Drainage system.

Stack: A general term used for any vertical line of soil, waste or vent piping.

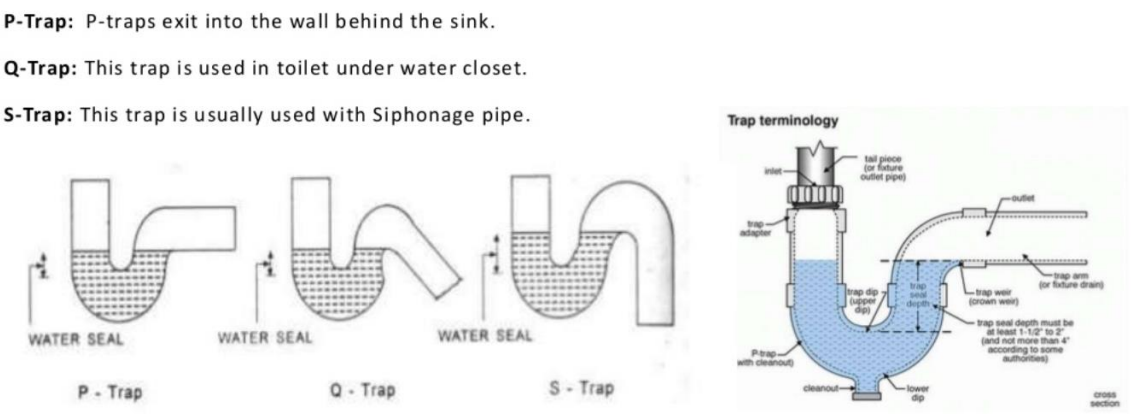
Traps: Based on the Use, the traps are classified as:
Floor Traps (Nahni Trap): This trap is generally used to admit sullage from the floors of rooms, bathrooms, kitchen etc. in to the sullage pipe. This is provided with cast iron or

stainless steel or galvanized gratings (Jallis) at its top so that the entry of larger matter is prevented thereby chances of blockage are reduced.

Gully Traps: A Gully trap or gully is provided at a junction of a roof drain and other drain coming from kitchen or bathroom.

Intercepting Traps: Intercepting traps is provided at junction of a house sewer and municipal sewer for preventing entry of foul gases of municipal sewer in to the house drainage system.

Traps: Traps are U shaped fixtures that have Water seal in it. This water in the trap creates a seal that prevents sewer gas from passing from the drain pipes back into the occupied space of the building. Essentially all plumbing fixtures including sinks, bathtubs, and toilets must be equipped with either an internal or external trap. Depending upon the shapes the traps are classified as:
P-Trap: P-traps exit into the wall behind the sink.
Q-Trap: This trap is used in toilet under water closet.
S-Trap: This trap is usually used with Siphonage pipe.



III. PRINCIPLES OF DRAINAGE

***House Drainage should be preferable laid by side of the building to facilitate easy repair and better maintenance.**
***The sewage or sullage should flow under the force of gravity.**
***The house sewer should always be straight.**
The entire system should be well ventilated from start to the end.
***The house sewer should be connected to the manhole such that the invert level is sufficiently higher to avoid back flow of sewage in house sewer.**

***Where ever there is change in direction of sewer line in the premises, provide inspection chamber at the junction.**
***House sewer joints should be leek proof because leakage if any shall create an odour problem and leaked wastewater shall infiltrate in the ground and shall reduce bearing capacity of soil below foundation, which is not desirable.**
***Rain water from roofs or open courtyards should not be allowed to flow through the house sewers.**
***Siphonage action can never be permitted and therefore adequate ventilation systems should be installed.**

IV. SEPTIC TANK

A septic tank is designed to carry out the liquid waste of the household or community including human feces. It has to be constructed based on the instruction given in the Indian Standard Code IS 2470.

The function of Septic Tank

The septic tank was designed to retain the wastes at a minimum period of 24 to 48 hours which is received from the households. The wastes retaining period in the septic tank is called the **detention period**.

During that period certain biological decomposition will happen by the action of anaerobic bacteria. The night soil will leave a small quantity of sludge, settled down the tank. The balance surface water runs to the soak pit through the outlet pipe.

What is meant by Sludge?

The settled semi-solid waste in the tank is called Sludge. The sludge was cleaned out from the tank at every 1 or 2 year cycle period.

The septic tank have to be designed and constructed accordingly.

A soak pit is constructed in the natural ground by the dry bricks with open joints in a circular shape as shown in the below picture. The wastewater can easily soak on the ground.

The soaking pit should be raised above ground level and the surface water should not enter into the soak pit.

Design consideration of Soak Pit

- The soak pit shall not be less than 900mm in diameter& 1500mm in depth below the invert level of the inlet pipe.
- The absorption area of the soak pit could be 1 Sqm to 1.5 Sqm per head of the user.
- The soaking pit should be covered by the precast slab.

A typical septic system consists of a septic tank and a drainfield, or soil absorption field.

The septic tank digests organic matter and separates floatable matter (e.g., oils and grease) and solids from the wastewater. Soil-based systems discharge the liquid (known as effluent) from the septic tank into a series of perforated pipes buried in a leach field, chambers, or other special units designed to slowly release the effluent into the soil.

This is how a typical conventional septic system works:

1. **All water runs out of your house from one main drainage pipe into a septic tank.**
2. **The septic tank is a buried, water-tight container usually made of concrete, fiberglass, or polyethylene. Its job is to hold the wastewater long enough to allow solids to settle down to the bottom forming sludge, while the oil and grease floats to the top as scum.Compartments and a T-shaped outlet prevent the sludge and scum from leaving the tank and traveling into the drainfield area.**
3. **The liquid wastewater (effluent) then exits the tank into the drainfield.**
4. **The drainfield is a shallow, covered, excavation made in unsaturated soil. Pretreated wastewater is discharged through piping onto porous surfaces that allow wastewater to filter though the soil. The soil accepts, treats, and disperses wastewater as it percolates through the soil, ultimately discharging to groundwater.**
   If the drainfield is overloaded with too much liquid, it can flood, causing sewage to flow to the ground surface or create backups in toilets and sinks.
5. **Finally, the wastewater percolates into the soil, naturally removing harmful coliform bacteria, viruses and nutrients.**

V. Ventilation of house drains

Plumbing vents are pipes that extend from the waste pipes to the outside of the building, often going through the roof. The vent pipes allow the sewer gases to escape to the outside, rather than being released inside the house. The vent pipes also allow oxygen into the waste pipes. This enables bacteria to break down the sewage aerobically, meaning by the use of oxygen.

The vents also keep the air pressure the same on both sides of the trap. And this keeps the water in the trap. If the air pressure were unequal, the water would be sucked out toward the section of the pipe with the lower pressure.

As mentioned, the air pressure in sewer pipes is the same up and down the length of the pipe. But when water moves through the pipe, it compresses the air ahead of it, creating a positive pressure. This pressure buildup must be released somehow, or the positive pressure will push back on the water. If the air were allowed to push back, this would cause the wastewater to back up through the plumbing fixture and come out the drain, which would have obvious health consequences.

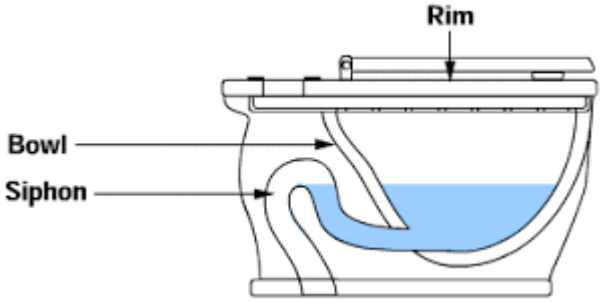
Similarly, if the air is not replaced behind the water as it moves, it would create negative pressure, sucking the water out of the trap.

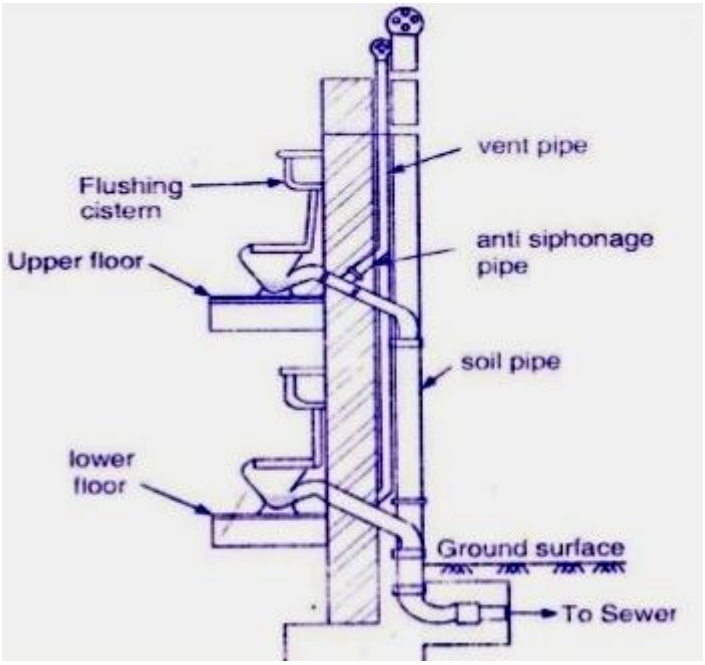
Vent pipes are placed strategically, near all plumbing fixtures, for example, to prevent both negative and positive pressure from occurring in the pipe.

VI. ANTI-SYPHONAGE

An extra pipe connected to the outlets of toilet seats of all the floors, the other end of which is exposed to atmosphere is called anti-syphonage pipe. These are provided to maintain water seal so that foul gases of the sewer line do not find entry in to the toilet/ bathrooms.

If we look into a toilet seat we find some water at the bottom, which remains there even after flushing. The seats are designed with a trap so that the water remains in the seat. The water is maintained to prevent entry of foul gases from the toilet pipe/ soil pipe/ sewer lines into the toilet room. This is called water seal.

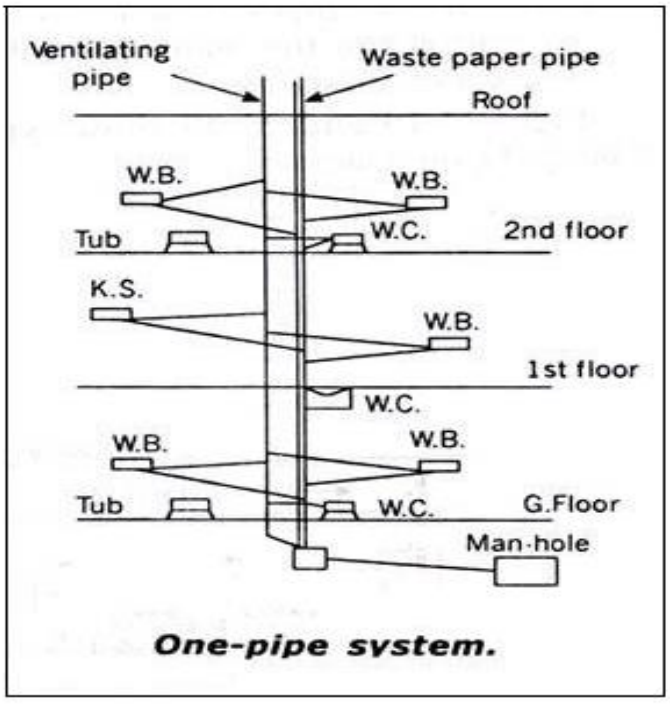




VII. ONE PIPE SYSTEM

In this system only one main pipe is used which collects both the foul soil waste as well as waste from the building. The main pipe is directly connected to the manhole/drain.

The provision of waste pipes and gully traps are completely eliminated. All the traps of the water closets, basins, sinks, etc are fully ventilated and connected to the ventilation pipes.



One-pipe system.

The following precautions should be taken in this plumbing system.

a) All the joints off waste pipes should be air-tight.

b) Each waste pipe should be connected to common stack directly.

c) Vent pipe diameter should not be less than 50 mm.

VIII. TWO PIPE SYSTEM

This is the most common system used in India. This method provided an ideal solution, where it is not possible to fix the fixtures closely.

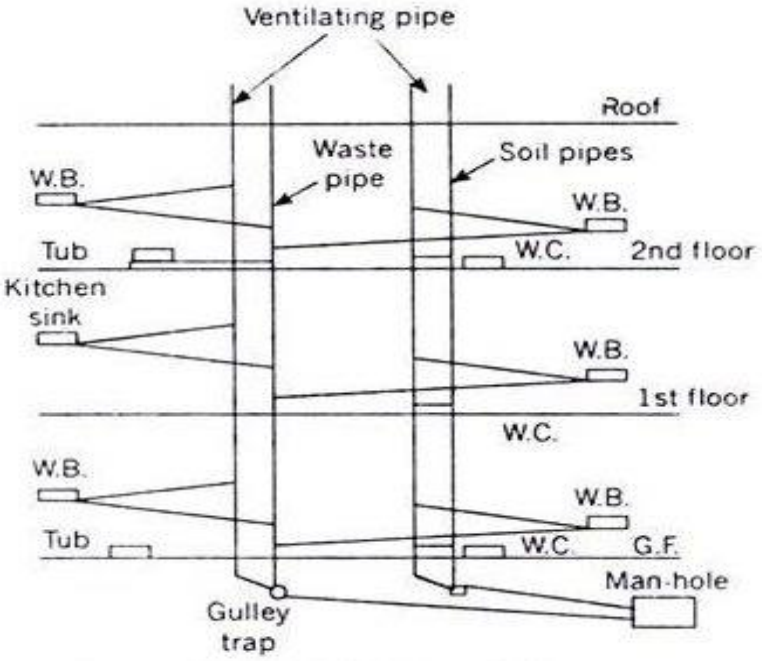
One pipe collects the foul soil and water closet wastes, and the second pipe collects the water from the kitchen, bathrooms, house washings, etc.

The soil pipes are directly connected to the manhole/drain, where is the waste pipes arc connected through a fully ventilated gully trap.

1. The gully trap receives the bath, basin, and sink wastes. It provides aerial disconnection of these wastes from the drain air.

2. The man soil vent pipe rises to above the level of the eves and is so placed so that gases leaving it cannot be a nuisance or a danger to health.

3. A vent cowl of cast iron or other material unaffected by corrosion at the top of the vent pipe to prevent nesting birds



Two-pipe system.

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SCHOOL OF BUILDING AND ENVIRONMENT
DEPARTMENT OF ARCHITECTURE

UNIT – III – INTERIOR SERVICES – SDE 2302

I. INTRODUCTION

UNIT III PLUMBING
Common hand tools used for plumbing and their description and uses, Joints for various types of pipes, Sanitary fitting standards for public conveniences; Different types of pipes and accessories for water supply, controlling fixtures like valves, taps, etc. Fittings and Choice of materials for piping: cast iron, steel, wrought iron, galvanized lead, copper, cement; concrete and asbestos pipes, PVC pipes; Sizes of pipes and taps for house drainage.

II. COMMON HAND TOOLS USED FOR PLUMBING

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, 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

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

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.

It has a fixed flat jaw with a handle and a square-toothed screw 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.

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

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

Open-ended spanners

These types of spanners are open from both sides and are used for tightening and loosening nuts and bolts

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.

Combination spanners

These spanners are open at one end and closed at the other

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.

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

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

A hand-operated hacksaw is used for site work while a power hacksaw is used in a workshop for cutting heavy pipes quickly

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

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

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.

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

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.

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.

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.

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.

Caulking tools

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

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 is fitted with a cutting tool like a drill bit. The attachment is tightened with a key.

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.

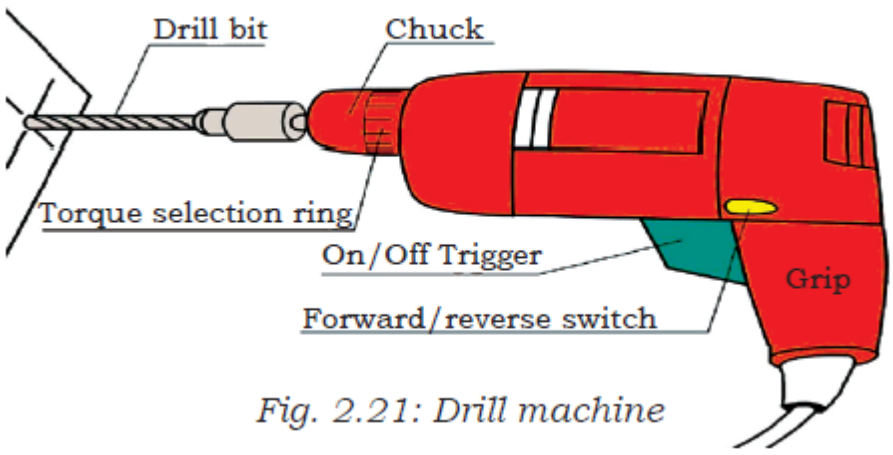


Fig. 2.21: Drill machine

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.

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.

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.

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.

Spirit level

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

Trowel

It is used for mixing cement and sand for masonry work. It is used for plastering the surface.

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: Spade

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: Shovel

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.

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.

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.

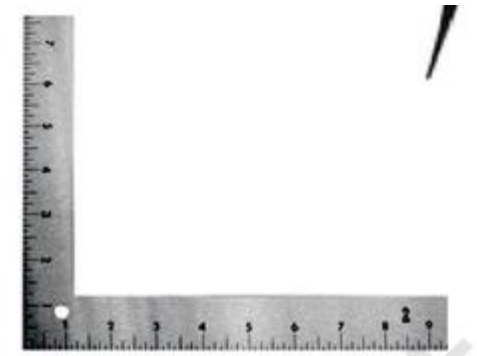


Fig. 2.32: Mason's square

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: Water level tube

Rover jumper
It is used for making a gap in the wall so that plumbing fixtures can be fixed.

Fig. 2.34: Rover jumper

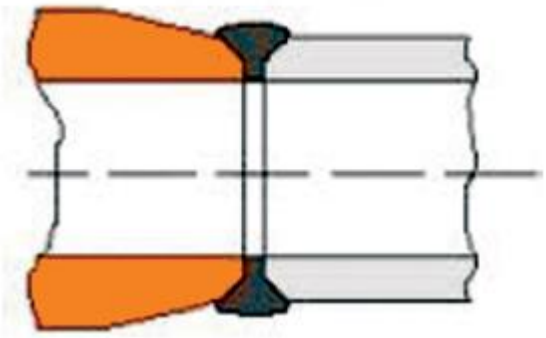
III. PIPE JOINTS

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.

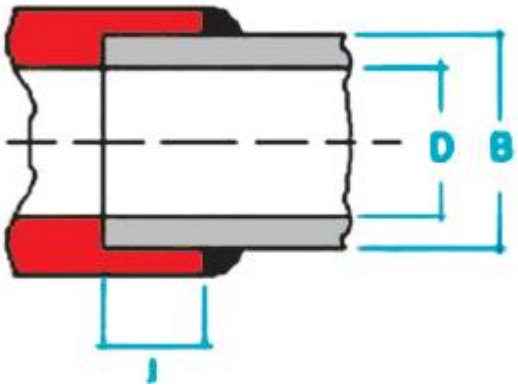
Types of pipe joints Various types of pipe joints are as follows.
1. Threaded joint
2. Welded joint (butt welded, socket welded)
3. Brazed joint
4. Soldered joint
5. Grooved joint
6. Flanged joint
7. Compression joint

Threaded joint When pipes are joined by screwing in threads which are provided in the pipe, it is called a threaded joint. In this 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. 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 nonavailability of trained welders and fitters.



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. Pipes having different diameters are suitable for this type of a joint. Socket-welded joint gives good results as compared to other joints.

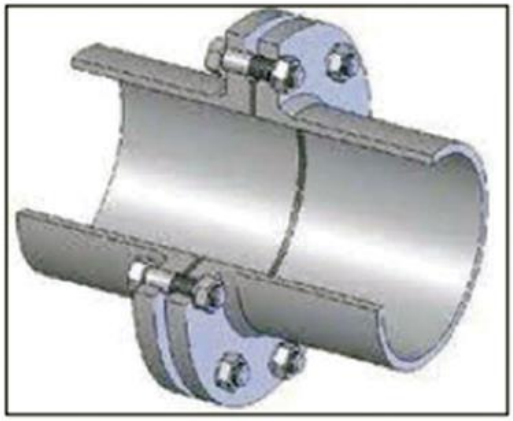


Brazed joints When pipes are joined with the help of molten filler material at above 840°C, it is called brazing. Brazing is done for connecting copper pipes or copper alloy pipes. It is important to note that the melting point of the parent material (pipe material) should be higher than the filler material.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

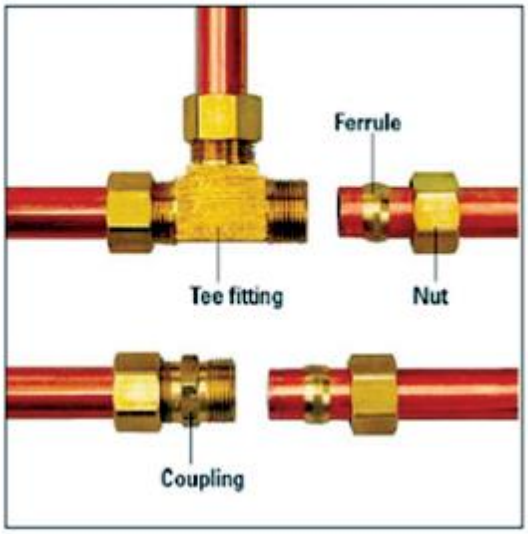
Soldered joints, Soldering and brazing are similar activities. In soldering, the filler material melts below 840oC. With the help of soldering, copper and copper alloy pipes are joined. During soldering, flux or metal joining material is used to prevent oxidation due to the flame. Soldered joints are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

Grooved joints, 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. These are mostly used for fire protection.

Flanged joints, This joint is commonly used for joining pipes in pumping stations, filter plants, hydraulic laboratories and boiler houses, etc. 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.



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



IV. 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.

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.

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

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

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.

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.
Parallel slide valve

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

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

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.

Fig. 5.36: Angle valve-1

Fig. 5.37: Angle valve-2

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: Check valve or non-return valve

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

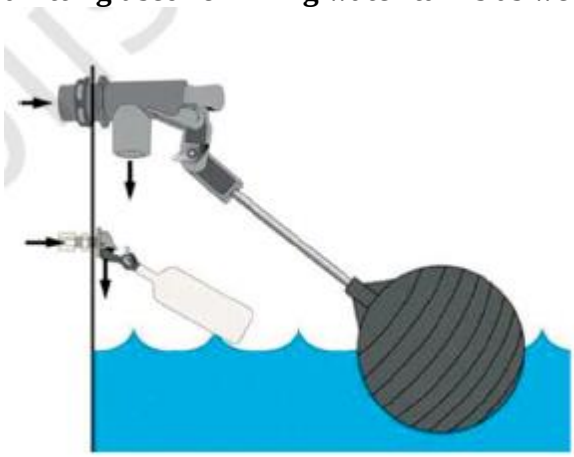
Foot valve

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 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: Foot valve

Float valve

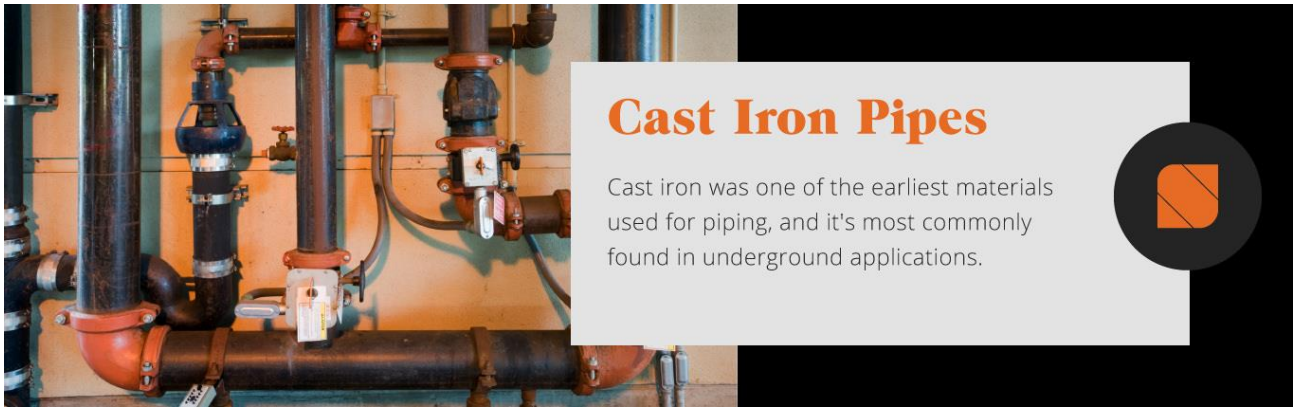
It is used for stopping water when the water tank or flush toilet is filled, so that it stops overflowing. When the water level rises, the float also rises; once it rises to a pre-set level, the water level forces the lever to close the valve and stops the water flow. A float valve is a fitting used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



V. TYPES OF PIPING MATERIAL AVAILABLE

Now that you know what factors will affect the piping material you should choose, let's talk about six of the most popular piping materials, as well as the conditions that each of them would work best for.

1. **Cast Iron**



Cast iron was one of the earliest materials used for piping, and it's most commonly found in underground applications. Piping that carries materials like water, gas and sewage underground must be incredibly durable, pressure-resistant and long-lasting since these pipes must last for several decades without having to be replaced. Soil pipes are also

commonly made using cast iron due to its excellent corrosion-resisting properties. Cast iron pipes are more popular in apartment buildings rather than private dwellings due to its fire resistance and noise-dampening qualities.

If you need underground piping at your facility that will last as long as possible, cast iron may be the best material for your fluid handling system.

2. Steel and Steel Alloys

Carbon steel pipes and steel alloys are created using different manufacturing methods to provide multiple piping material options all made from steel. Steel is a desirable piping material because of its thickness and ability to contain highly pressurized fluids. Two common types of steel piping materials for manufacturing facilities are:

Carbon steel pipes: Carbon steel pipes are available in several different grades depending on the amount of carbon the pipe contains. This type of steel piping is more subject to corrosion than other varieties, making it ideal for indoor systems transporting non-corrosive materials.

Galvanized steel: The second option for steel piping is galvanized steel, which is better equipped to handle corrosive fluids, as well as high-temperature materials. However, it is not as ideal for high-pressure substances, as it is rated only for pressures of up to 250 psi.

3. Nonferrous

The category of nonferrous pipe materials refers to any piping material that is a metal other than steel. Popular options for nonferrous metals include:

Brass: Brass piping is popular for the transportation of corrosive materials, and the most common type is red brass.

Aluminum: Several varieties of aluminum piping exist based on the type and amount of alloy added to the aluminum. The level of aluminum pipe you choose will be dependent on whether you're transporting highly corrosive or high-pressure materials.

Copper: Copper piping is standard for both commercial and residential water applications, such as plumbing and other waterlines. You can choose between several types of copper piping based on thickness.

Copper-nickel: Copper-nickel piping is most commonly used in marine and offshore applications for its excellent ability to transport seawater effectively and with minimal corrosion. As a durable pipe material option, copper-nickel can also handle materials of high temperatures.

4. Concrete

The most typical application for concrete pipes is in large-scale engineering projects such as water resource management and stormwater control. Depending on the diameter of the pipe, concrete pipes are typically reinforced with another layer or durable wire to allow it to maintain its strength underground. Concrete pipes used for civil purposes must pass several destructive tests to ensure they can withstand any potentially disastrous occurrences.

These pipes must also be regularly maintained, as dirt and debris can easily stick to the insides of concrete pipes and cause a backup. Depending on the type of material the pipes are carrying, a sewage or stormwater backup could be very hazardous to the surrounding areas. Most manufacturing facilities would not benefit from using concrete piping for their fluid handling systems.

5. Plastic

Plastic pipes are an option you may seriously consider for your facility's fluid handling system. Options for plastic pipes include:

PVC: Polyvinyl chloride (PVC) pipes are the most widely used type of plastic piping, ideal for both structural and electrical applications.

Polypropylene: Polypropylene pipes are most effective and appropriate for transporting chemical waste and other highly corrosive materials.

Polyethylene: Polyethylene is a flexible but strong material that is best for piping in irrigation, sprinkler and other water-related applications.

PEX: PEX pipes are essentially polyethylene pipes that have been processed to be both stronger and more resistant to hot and cold temperature changes. This material is becoming a significant alternative to traditional copper pipes.
ABS: You'll find ABS pipes in sewer, waste, drain and vent applications.

6. Lined Pipe

We saved the best type of pipe for most industrial and manufacturing systems for last — lined pipe and fittings are recommended for fluid handling systems in most facilities. Plastic-lined steel pipe is essentially the "best of both worlds," combining the corrosion-resisting qualities of plastic with the durability of metal materials. You can choose which type of plastic material you want your steel pipes to be lined with. Popular choices for plastic-lined pipe and fittings include:

Polyvinylidene Fluoride (PVDF): When you're transporting high-strength acids and other corrosive liquids, opting for PVDF-lined pipe and fittings is a durable choice. These pipes are designed to withstand the corrosive properties of fluids involved with chemical processing and electronics manufacturing.

Fluoropolymer (PTFE): PTFE-lined pipe and fittings are known for their ability to transport fluids at high temperatures and pressures. Its strength and corrosion-resistance make it a popular piping material for many industrial applications.

Polypropylene (PP): PP-lined pipe is the best choice for handling basic fluids with low chemical makeup and low to no corrosive qualities. It's the most economical option for small-scale operations and transporting liquids at an average temperature.

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SCHOOL OF BUILDING AND ENVIRONMENT
DEPARTMENT OF ARCHITECTURE

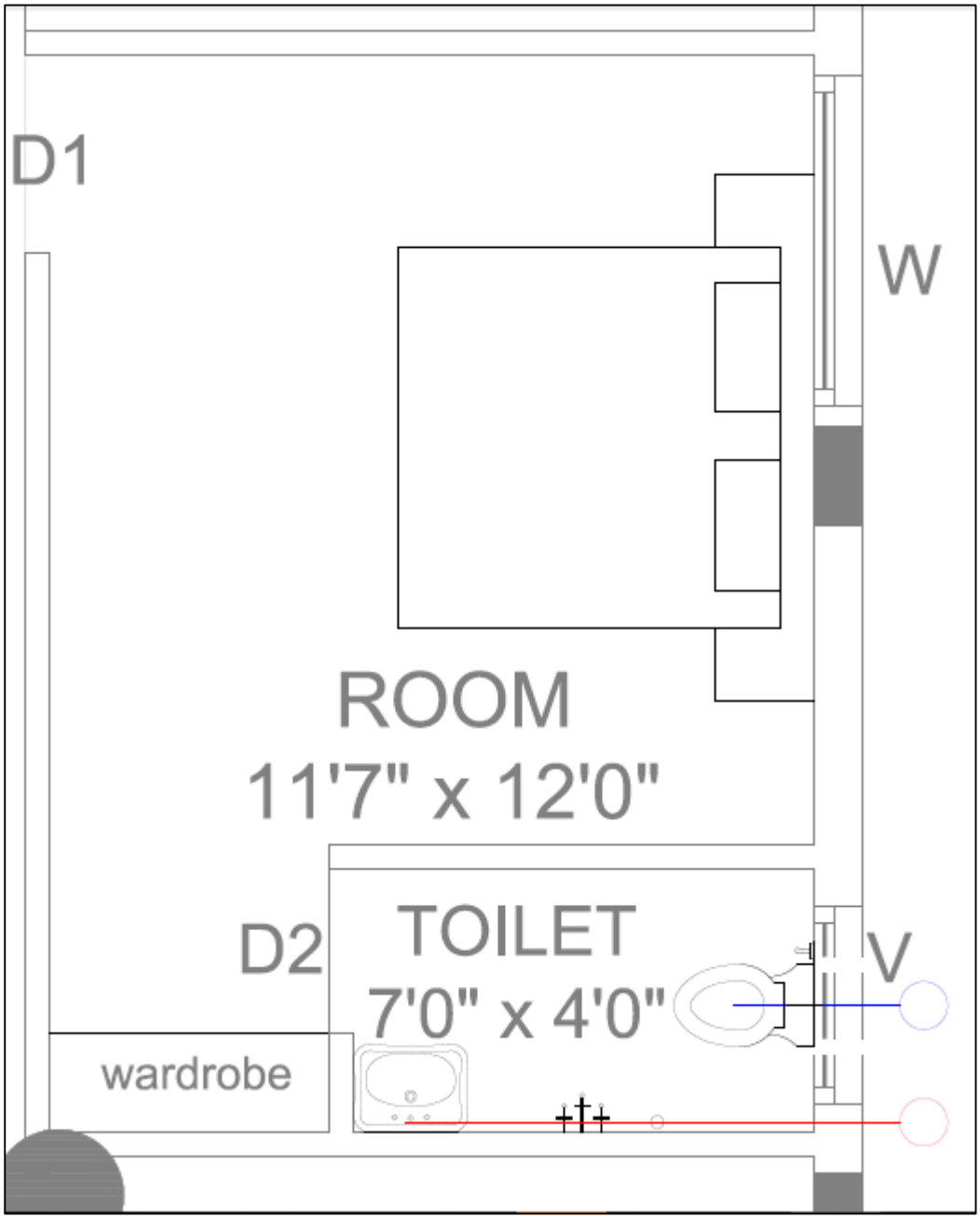
UNIT – IV– INTERIOR SERVICES – SDE 2302

I. INTRODUCTION

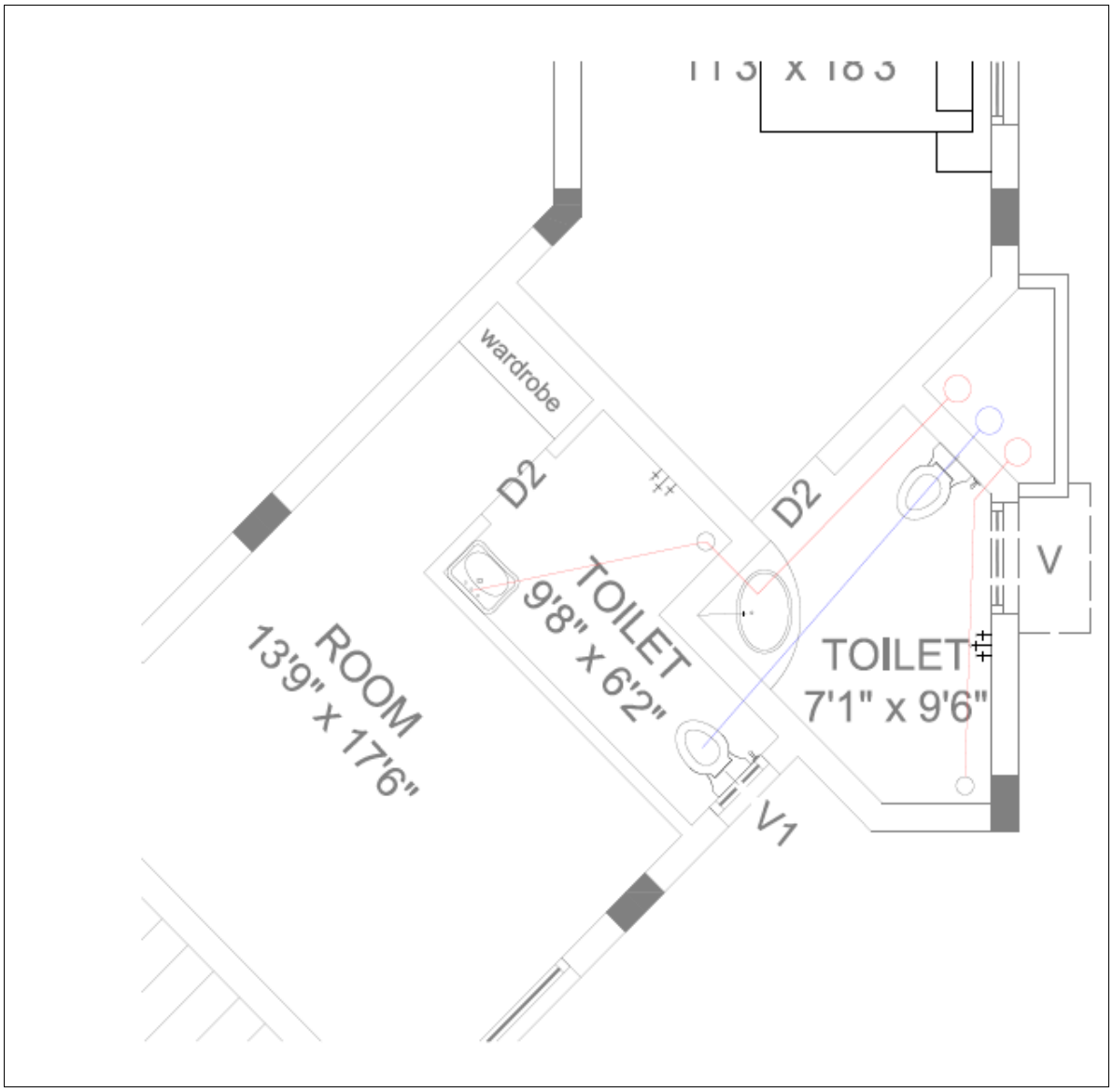
UNIT IV SERVICES STUDIO

Preparation of plumbing layout of a single storey building & working drawings of various fittings and fixtures of water supply and sanitary installations.

II. TYPE 1 - SINGLE TOILET



III. TYPE 2 - COMBINED TOILETS



IV. TYPE 3 - COMBINED TOILETS