Draft Study Material

ADVANCE PLUMBING TECHNICIAN

(Qualification Pack: Ref. Id. QF-1023)

Sector: Plumbing

(Grade XI)

PSS CENTRAL INSTITUTE OF VOCATIONAL EDUCATION
(a constituent unit of NCERT, under Ministry of Education, Government of India)
Shyamla Hills, Bhopal- 462 002, M.P., India
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Preface

Vocational Education is a dynamic and evolving field, and ensuring that every student has access to quality learning materials is of paramount importance. The journey of the PSS Central Institute of Vocational Education (PSSCIVE) toward producing comprehensive and inclusive study material is rigorous and time-consuming, requiring thorough research, expert consultation, and publication by the National Council of Educational Research and Training (NCERT). However, the absence of finalized study material should not impede the educational progress of our students. In response to this necessity, we present the draft study material, a provisional yet comprehensive guide, designed to bridge the gap between teaching and learning, until the official version of the study material is made available by the NCERT. The draft study material provides a structured and accessible set of materials for teachers and students to utilize in the interim period. The content is aligned with the prescribed curriculum to ensure that students remain on track with their learning objectives.

The contents of the modules are curated to provide continuity in education and maintain the momentum of teaching-learning in vocational education. It encompasses essential concepts and skills aligned with the curriculum and educational standards. We extend our gratitude to the academicians, vocational educators, subject matter experts, industry experts, academic consultants, and all other people who contributed their expertise and insights to the creation of the draft study material.

Teachers are encouraged to use the draft modules of the study material as a guide and supplement their teaching with additional resources and activities that cater to their students' unique learning styles and needs. Collaboration and feedback are vital; therefore, we welcome suggestions for improvement, especially by the teachers, in improving upon the content of the study material.

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Module 1 Introduction to Advance Plumbing

Module Overview

In recent years, advancement in technology and engineering has significantly impacted the field of traditional plumbing. Plumbing systems do not just affect water use, but also influence energy use and occupant comfort within a building.

Advanced plumbing systems are basically optimized systems that add more innovative systems and technologies to provide unique features and functionality not found in a traditional system. You can be sure that Advance Plumbing (Fig. 1.1) has both the product depth and the qualified consultants to help you create a unique and creative look for your projects, considering the constantly expanding imagination and expectations of today's sophisticated consumer.

This module offers a thorough exploration of advanced plumbing, designed to equip learners with the critical skills and knowledge required for a successful career as an advanced plumbing technician. It begins by highlighting the specialized features of advanced plumbing technicians, emphasizing their expertise in managing complex and modern plumbing systems. This expertise is crucial as the demand for proficient plumbing professionals grows across residential, commercial, and industrial sectors.

Learning Outcomes

After completing this module, you will be able to:

- Understand the roles and responsibilities of an advanced plumbing technician.
- Interpret and use symbols and terminologies commonly found in plumbing installations.
- Identify and describe different types of water-lifting devices and their applications.

- Apply Indian standards (ISI/BIS) relevant to plumbing systems in practice.
- Create and read basic building drawings and maintain accurate records of plumbing installations.
- Design efficient water supply, drainage, and sewerage systems for various building types.

Module Structure

1.1 Recent Developments in Plumbing

An advanced plumbing system (Refer Fig. 1.1) is designed to ensure the efficient delivery of clean water and the effective removal of wastewater in various settings. It incorporates modern technologies and materials to enhance performance, reliability, and sustainability. Advanced systems often include water-saving devices, automated controls, and sophisticated diagnostics to prevent issues before they arise. These systems require skilled technicians who can design, install, and maintain complex plumbing infrastructures.

Fig.1.1: Advance Plumbing System

Some of the broad information about recent developments in plumbing:

- **Pipe materials**: There have been improvements in plumbing pipe materials as well. In addition to more recent options like cross-linked polyethylene (PEX) and chlorinated polyvinyl chloride (CPVC), traditional materials like copper and galvanised steel are now available. These materials have advantages like increased durability, resistance to corrosion, and simplicity of installation.

- **Pipe Inspection and Repair**: Modern inspection methods and tools are available to plumbers, enabling them to make more precise pipe issues diagnoses (Fig.1.2). Without extensive digging or property disruption, technologies like thermal imaging, video cameras, and acoustic leak detectors can help locate leaks, blockages, or damaged pipes.

Fig.1.2: Pipe Inspection

- **Water-saving fixtures**: Plumbing technology has advanced to include water-saving fixtures as water conservation has become an increasingly important issue. These fixtures are made to use less water without sacrificing performance. Low-flow toilets, water-saving showerheads, and aerator-equipped faucets are a few examples.

- **Smart plumbing systems**: The development of smart plumbing systems is a result of the Internet of Things' (IoT) growth. These systems use automation, connectivity, and sensors to monitor and manage various plumbing functions. They can improve productivity and reduce costs by finding leaks, controlling water temperature, and providing information on water usage.

- **Water Heaters (Energy efficient):** In recent years, people have started to favour energy-efficient water heaters (Fig.1.3). In comparison to conventional storage tank heaters, modern technologies like tankless water heaters and heat pump water heaters offer higher energy efficiency. These developments may contribute to lower energy use and utility costs.

Fig.1.3: Water Heater

- **Water Filtration and Treatment**: Systems for water filtration and treatment have improved as a result of plumbing advancements. In order to provide cleaner and safer water for domestic use, these systems can remove contaminants like chlorine, sediment, and bacteria.

As you know that in our daily life, water plays a very important role because it is used in multi-purpose ways like in a kitchen, washroom, bathroom, garden, etc. Therefore, it is very important that our residential and commercial buildings must be having a good plumbing system. Every plumbing system needs to be improved, and advanced plumbing systems should be built, whenever it is feasible.

The performance of plumbing systems can be optimised while using the least amount of water. A deliberate design strategy must be created in order to optimise your plumbing system, and the plumbing layout must be coordinated with other mechanical systems and the home's framing. Ironically, these procedures—and not the choice and application of materials and products—are where plumbing system issues are most frequently encountered.

However, the choice of product and system is equally important to plumbing system performance. In essence, advanced plumbing systems are systems that have been optimised and added more cutting-edge systems and technologies to offer special features and functionality not found in a conventional system. It may also contribute to the residential/commercial/industrial future adaptability.

A plumbing system can be designed and built in a variety of ways, but the fundamental ideas are always the same:

- Centralise the plumbing stack to efficiently reduce pipe runs and provide simple access for renovation or repair projects, all at a relatively low cost. Not incidentally, if you're constructing a LEED-certified home, this practise is creditable. The PATH Design Guide: Residential PEX Water Supply Plumbing Systems contains examples of centralised plumbing system layouts (Fig.1.4).

Fig.1.4: Centralised Plumbing System

- To provide control centres, use a home-run or manifold plumbing supply system. These systems can improve durability and remodelling flexibility while using less material and water. Home-run plumbing systems offer efficiency and adaptability unheard of in conventional piped systems when used in conjunction with modular quick-connect fittings and fixtures. Installing a home-run water supply system should cost about as much as installing a rigid pipe system, but if the trade contractors aren't familiar with the system, it might take more time to train and supervise them during installation.

- Your annual water heating expenses may be 20 to 60 percent "standby losses" (heat lost while your hot water is in the tank). These losses can be eliminated by utilising a tankless hot water heater. The price of a tankless water heater is comparable to that of a very high-efficiency tank model, but installation costs for a tankless water heater can be up to four times higher. This cost increase is the result of new pipe size requirements as well as additional electrical requirements.

- If a tankless heater doesn't seem feasible for your project, take other hot water heating strategies such as solar-assisted, If a tankless heater doesn't seem feasible for your project, take other hot water heating strategies such as solar-assisted hot water heating into consideration.

- New "dual flush" low-flow toilets do away with the need to flush twice, which was a major reason why consumers disliked the first low-flow toilets. hot water heating into consideration.

- he wastewater from sinks, washing machines, dishwashers, and shower drains are term as greywater. It produces 60% of the water used in a home. Greywater recycling is safe for use in toilets, exterior washing, and irrigation. Systems for recovering greywater are relatively easy to install during new construction, but they are challenging to retrofit into a house. The initial cost to divert grey water away from black water (toilet water) for treatment is minimal. However, the cost of ongoing greywater system testing and treatment as well as the learning curve that code officials must go through may be substantial.

1.2 Salient features of Advance Plumbing Technician

Following are the duties of an advance plumbing technician:

- Assist in planning advance plumbing system.
- Assist in preparing plumbing drawings (Water system cold, hot, sanitation & drainage).

- Ability to address the risk and work on systems safety (assist to develop system setup to run properly, efficiently & safely).
- Perform the installation and repair of waste, drainage, and venting systems.
- Install and repair plumbing fixtures (sinks, faucets, sanitary wares, toilets, etc.).
- Installation of sensor basin faucet, a study of internal parts such as solenoid valve, battery box with battery.
- Installation of Advanced Pipes & Fittings in residential/commercial/industrial units, practices at par with American & European Standards.
- Ability to create Standard Operating Practices (SOP) to be followed during installation of pipes, Fittings and Faucets.
- Able to assemble and dissemble all advance plumbing system.
- Follow the workshop rules for health and safety guidelines.

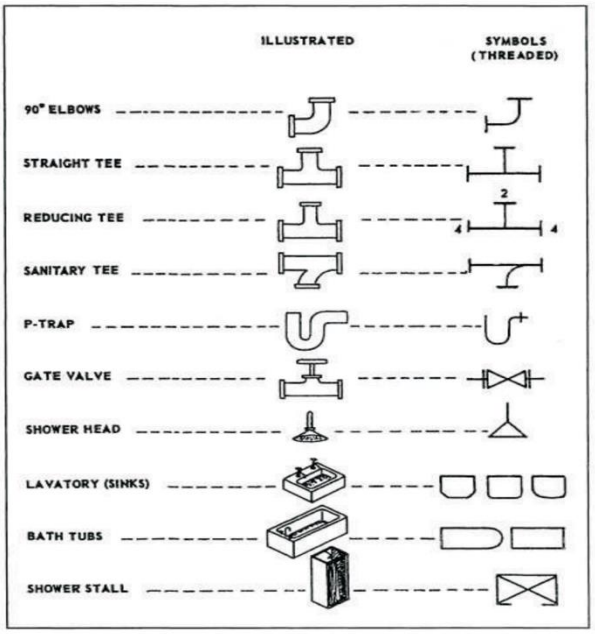
1.3 Job Opportunities for the Advance Plumbing Technician

After completion of this course- Advance Plumbing Technician may apply for various positions in different Companies/Industries/Institute like:

- Plumber
- Supervisor
- Plumbing Technician
- Senior Supervisor
- Plumbing Maintenance Technician
- Assistant Manager
- Plumbing Engineer
- Assistant Trainer
- Project Manager
- Pipeline Installer
- Pipe Fitter
- Supervisor Training
- Drain Technician
- Operator
- Startup/ Own Business
- Senior Operator

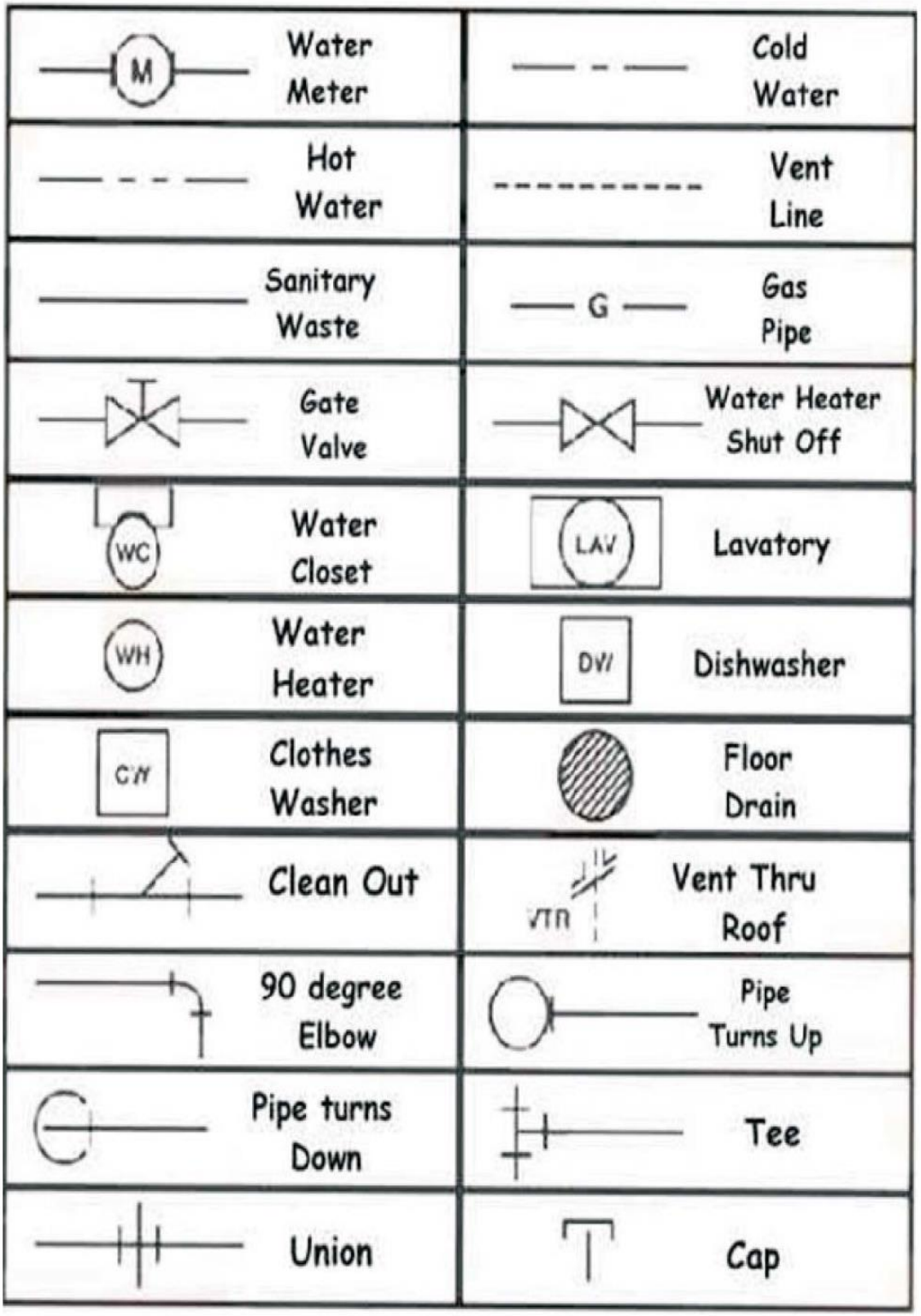
1.4 Symbols and terminologies used in plumbing installation

Plumbing symbol is a very important part of plumbing that before installation, every plumber or technician should know about basic terminology and symbol used in plumbing work.



A well-trained plumber does the installation of fittings and fixtures as per the drawing given in the assembly sheet of plumbing fixtures as per the manufacturer catalogue. These drawings consist of symbols, assembly of fixtures, and installation methods. If we can identify the symbols given in the drawing of fixtures then it is very easy for a plumber to do the installation work. Plumbing symbols are given in this unit. Students should identify and learn the symbols so that they will be helpful in the future.

ITEM	SYMBOL	SAMPLE APPLICATION (S)	ILLUSTRATION
PIPE	SINGLE LINE IN SHAPE OF PIPE- USUALLY WITH NOMINAL SIZE NOTED		
JOINT- FLANGED	DOUBLE LINE		
SCREWED	SINGLE LINE		
BELL AND SPIGOT	CURVED LINE		
OUTLET TURNED UP	CIRCLE AND DOT		
OUTLET TURNED DOWN	SEMICIRCLE		
REDUCING OR ENLARGING FITTING	NORMAL SIZE NOTED AT JOINT		
REDUCER CONCENTRIC	TRIANGLE		
ECCENTRIC	TRIANGLE		
UNION SCREWED	LINE		
FLANGED	LINE		



Some of the terminologies generally used in plumbing are as follow:

- **Air gap**: The distance between the lowest point of a water inlet or pipe to a tank and the overflowing level of the tank.

- **AC pipes**: Asbestos-Cement pipe used in water distribution systems.
- **Appliance**: A container or apparatus in which water is heated, treated or measured, or in which it is utilised before passing to waste.
- **Auger**: A tool having a rotating helical screw blade used for drilling a hole.
- Available head: The head of water available at the point of consideration due to main's pressure or overhead tank or any other source of pressure.
- **Backflow**: It is an unwanted flow of water in the reverse direction. It leads to wastage of water and it is due to leakage or defect in the system.
- **Backflow prevention device**: This device is fitted in such a way that allows water to flow in one direction but never in the opposite direction. Its sole job is to prevent drinking water from being contaminated due to backflow.
- **Back siphonage**: The flowing back of used contaminated or polluted water from a plumbing fixture or vessel into a water supply pipe due to reduced pressure in such a pipe.
- **Bathroom vanity**: It can be defined as the combination of the bathroom sink or basin and the storage that surrounds it.
- **Bidet**: It is a special plumbing fixture that allows a person to use water to wash their genitals, anus, and inner buttocks after using the bathroom. These fixtures are very popular with both men and women in developed countries.
- **Branch**: Any part of the piping system other than a main pipe is known as a branch.
- **Branch soil pipe (BSP):** A pipe connecting one or more soil appliances to the main soil pipe.
- **Branch soil waste pipe (BSWP):** A pipe connecting one or more soil and/or waste appliances to the main soil waste pipe (one-pipe system)
- **Branch ventilating pipe (BVP):** A pipe, one end of which is connected to the system adjacent to the trap of an appliance and the other to a main ventilating pipe or a drain ventilating pipe. It is fitted to prevent loss of water seal from a trap, owing to partial vacuum back pressure, or surging caused by air movement within the pipe system. It also provides ventilation for the branch waste pipe.
- **Branch waste pipe (BWP):** A pipe connecting one or more waste appliances to the main waste pipe.
- **Building drain**: The building (house) drain is part of the lowest horizontal piping of a drainage system that receives the discharge from soil, waste, and other drainage pipes inside the walls of the building. It carries the discharge to the building sewer beginning one meter outside the building wall.
- **Building sewer**: The building sewer is part of the horizontal piping of a drainage system that extends from the end of the building drain and which receives the discharge of the building drain and carries it to a public sewer, private sewer, individual sewage-disposal system, or another point of disposal.

- **Burr**: It is a raised edge or a small piece of material remaining attached to a workpiece after a modification process. It is usually an unwanted piece of material and is removed with a de-burring tool in a process called deburring.
- **Cistern**: A tank for storing water, especially one supplying taps or as part of a flushing toilet.
- **Cleaning eye**: When the removable plug is fitted with a removable cover into the pipe fitting as eye-opening and clearing of obstructions is done through this opening, it is called access eye or cleaning eye.
- **Couplers**: When we connect two pieces of uniform or varying diameter pipe, a piece of pipe known as a coupler is used for joining these pipes. One end of a coupler may be of a higher or lower diameter size as per requirement.
- **Crown of trap**: The topmost point of the inside of a trap outlet.
- **Direct tap**: A tap or faucet, which is connected to a supply pipe and subject to pressure from the water main for Domestic purposes. All purposes are incidental to the occupation of a dwelling.
- **Down take tap or faucet**: A tap or faucet connected to a system of piping, not subject to water pressure from the water main.
- **Drain water outlet**: Any pipe which conveys discharges from sanitary appliances in a drainage system.
- **Drain ventilating pipe (DVP):** It is a pipe installed to provide a flow of air to or from a drain to prevent undue concentration of foul air in the drain. The main soil pipe or main waste pipe may serve as a drain ventilating pipe wherever its upper portions, which do not receive discharges, are extended to the roof level and let open to the air.
- **Dwelling**: It is a building — used, constructed, or adapted for use, wholly or principally for human habitation. It may include garages, other outhouses, etc.
- **Escutcheon**: A flat piece of metal for protection and often ornamentation, around a keyhole, door handle, or light switch.
- **Fitting**: It refers to the fixtures in the plumbing system to join straight pipes or any section of tubes. Examples include elbow, tee, socket, reducer, etc.
- **Fixture unit**: A quantity, in terms of which the load-producing effects on the plumbing system of different kinds of plumbing fixtures are expressed on some randomly chosen scale.
- **Flange**: It is a plate or ring to form a rim at the end of a pipe when fastened to the pipe. A flange joint is a connection of pipes, where the connecting pieces have flanges by which the parts are bolted together.
- **Float operated valve**: Ball valves or ball taps and equilibrium by valves
- operated by means of a float.
- **Floor area of a building**: The area of a horizontal section taken at the plinth or floor level of any storey of a building, inclusive of all projecting and overhanging

parts of the external walls, and of such portions of the partition walls as belonging to the building.

- **Flushing cistern**: It is a cistern with a device for rapidly discharging the contained water. It is used in connection with a sanitary appliance for the purpose of cleansing the appliance and carrying away its contaminated contents into a drain.
- **Fracture**: Due to heavy pressure or clogging, there is a broken or cracked portion in plumbing pipes, fixtures, or fittings, due to which leakage takes place.
- **Gasket**: Mechanical seals, generally ring-shaped and fitted for sealing flange joints.
- **General washing place**: A washing place provided with the necessary sanitary arrangement and common to more than one tenement, that is a multi-occupancy building of any sort.
- **Horizontal pipe**: Any pipe or fitting which makes an angle of more than 45° with the vertical.
- **Induced siphonage**: The extraction of water from a trap by a siphonage set up by the reduction of pressure at the outlet of the trap.
- **Insanitary**: Contrary to sanitary principles or injurious to health.
- **Main soil pipe (MSP)**: A pipe connecting one or more branch waste pipes to the drain.
- **Main soil waste pipe (MSWP)**: A pipe connecting one more branch of soil waste pipes to the drain.
- **Main ventilating pipe (MVP)**: A pipe that receives a number of branch ventilating pipes.
- **Main waste pipe (MWP)**: A pipe connecting one or more branch waste pipes to the drain.
- **Nipple**: It is a piece of pipe having thread at both sides, and It can also be used for connecting two fittings within a short distance.
- **O-ring**: An O-shaped ring that is attached to the faucet to prevent water from oozing out of the spout.
- **Period of supply**: The period of the day or night during which water supply is made available to the consumer.
- **Pipe ears**: Two wings cast integrally with the pipe socket provided with holes to take fixing nails or screws.
- **Pipe systems**: It is an assembly of various components put together with a method of joints, to transport water from the source to the destination. 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.
- **One-pipe system**: The plumbing system in which the waste connection from washbasins, baths, and the soil pipe branches are all collected into one main pipe which is 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 water seal.

- **Two-pipe system**: It is a discharge pipe system comprising two independent discharge pipes, one of which conveys soil directly to the drain, the other conveying wastewater to the drain through a trapped gully. The system may also require ventilating pipes.
- **Single stack system**: One-pipe system without trap ventilation pipework
- **Pipework**: Any installation of piping with its fitting.
- **Plinth**: The portion of a structure between the surface of the surrounding ground and the surface of the floor, immediately above the ground.
- **Plunger**: A tool for cleaning normal blockage in drains and pipes, washbasin, etc.
- **Potable water**: Water that is satisfactory for drinking, cooking, and domestic purposes and meets the requirements of the Bureau of Indian Standards (IS 10500:2012).
- **Premises**: It shall include passages, buildings, and lands of any tenure, whether open or enclosed, whether built on or not, and whether public or private in respect of which, a water rate or charge is payable to a designated authority or for which an application is made for the supply of water.
- **Public building**: A building used or intended to be used either ordinarily or occasionally as a church, temple, mosque, or any place of public worship, dharamshala, college, school, theatre, cinema, public concert room, public hall, public bath, hospital, hotel, restaurant, lecture room, or any other place of public assembly.
- **Sealing rings**: It is a type of gasket used in connecting any fixture or joints to create leakproof conditions.
- **Self-siphonage**: The extraction of water from a trap by siphonage, set up by the momentum of the discharge from the sanitary appliance to which the trap is attached.
- **Service pipe**: The pipe that runs between the distribution main in the street and the riser (in case of a multi-storeyed building, or the water in case of an individual house, and is subjected to water pressure from such a main.
- **Soil pipe (SP):** The pipe used to carry waste from the toilet and wastewater.
- Spindle: It is a metal unit that provides the link between the handle and the stem washer.
- **Stack**: The main vertical discharge or ventilating pipe.
- **Stopcock**: A cock fitting in a pipeline for controlling the flow of water.
- **Stop tap or faucet**: It includes a stop cock, stop valve, or any other device for stopping the flow of water in a line or system of pipe at will.
- **Storage cistern**: A cistern for storing water.

- **Stuffing box**: It is an assembly that is used to house a gland seal. It is used to prevent leakage of fluid, such as water or steam, between sliding or turning parts of machine elements.
- **Sullage**: The wastewater generated from the bath and kitchen (but not the wastewater from toilets known as excreta).
- **Supply pipe**: The pipes which lead from the distribution main of the water supply to the plumbing system of the house.
- **Supports**: Devices for supporting and securing the pipe and fittings to the walls, ceilings, floors, or any extra constructed unit.
- **Trap**: A fitting or device in a P-, U-, S- or J-shaped type. Traps are fitted near a plumbing fixture. The trap bend is fitted to prevent sewer gases from entering the building. It is so designed and constructed as to provide when properly vented, a liquid seal that will prevent the back passage of air without materially affecting the flow of sewage or water through. If the gases are inserted back into the home, then it could lead to people inhaling foul smells, which could cause illnesses. It could even explode.
- **Vertical pipe**: Any pipe which is installed in a vertical position or which
- makes an angle of not more than 45° with the vertical.
- **Warning pipe**: An overflow pipe so fixed that its outlet, whether inside or outside a building, is in a visible position where the discharge of any water from it can be readily seen.
- **Washout valve**: A device located at the bottom of the tank for the purpose of draining a tank for cleaning, maintenance, etc.
- **Water line**: A line marked inside a cistern to indicate the highest water level at which the supply valve should be adjusted to shut off.
- **Water main (street main)**: It is a pipe laid by the water undertakers for the purpose of giving a general supply of water as distinct from a supply to individual consumers. It includes any apparatus used in connection with such a pipe.
- **Water outlet**: As used in connection with the water distributing system, it is the discharge opening for the water (1) to a fitting; (2) to atmospheric pressure (except into an open tank which is part of the water supply); and (3) to any water-operated device or equipment requiring water to operate.
- **Water seal**: The water in a trap which acts as a barrier to the passage
- of air through the trap.
- **Water supply system**: It consists of the water service pipe, the water distribution pipes, and the necessary connecting pipes, fittings, control valves, and all fixtures in or adjacent to the building or premises.
- **Water undertaker**: The water service provider who owns the supply system and infrastructure and provides water to a defined geographic area.
- **Waterworks**: It refers to an establishment for managing a water supply. Waterworks for public water supply include a lake, river, spring, well, pump with

or without motor and accessories, reservoir, cistern, tank, duct whether covered or open, sluice, water main, and pipe.

1.5 Different types of water-lifting devices

According to power sources, water lifts can be classified as manual, animal, and power-operated devices. Here a brief description of power devices is as under: Powered Operated Water Lifting Devices: These devices are usually termed pumps, which are operated with the help of auxiliary power sources such as an engine or electric motor. These pumps are capable of lifting large quantities of water to higher heads for different uses.

Basically, there are four principles involved in pumping water: -
(1) Atmospheric Pressure
(2) Centrifugal Force
(3) Positive Displacement
(4) Movement of the column of fluid caused by difference in specific gravity.

Pumps are usually classified on the basis of operation, which may employ one or more of the above principles.
The pump can be classified as: -
1. Displacement pumps: Reciprocating and rotary
2. Centrifugal pumps: Volute, diffuser, turbine, propeller
3. Airlift pumps.

1. Displacement pumps: Displacement pumps are a type of fluid pump that transfer fluids by using positive displacement. Unlike dynamic pumps (such as centrifugal pumps), which rely on the kinetic energy of the fluid to move it, displacement pumps work by physically displacing the fluid from one location to another. This is achieved by trapping a certain amount of fluid in a specific volume and then forcing it out through an outlet.

Displacement pumps are widely used in various applications, including hydraulic systems, oil and gas industries, chemical processing, food and beverage processing, pharmaceuticals, and more. They are particularly suitable for pumping high-viscosity fluids, handling abrasive or shear-sensitive materials, and achieving precise flow control.

However, it's important to note that displacement pumps may have limitations in terms of maximum flow rates compared to dynamic pumps, and they can be more

sensitive to changes in pressure and viscosity of the pumped fluid. The selection of the right pump type depends on the specific requirements of the application and the properties of the fluid being handled.

There are two main types of displacement pumps: reciprocating pumps and rotary pumps.

A. Reciprocating Pump: Reciprocating pumps are normally used for drinking water supply in addition to irrigation. The main parts of the reciprocating pumps are the pump cylinder in which an airtight piston or plunger moves in and out with the help of a pump rod, handle for the operation of the pump, valves, pipe, and strainer. As the plunger rises, water is drawn through a non-return valve at the bottom of a cylinder into the cylinder, and on the downward stroke, the water is released to the upper side of the plunger. On the next upward movement of the plunger, water is raised to the pump head and discharged through the spout. By changing either the frequency of reciprocation or stroke length of the piston the discharge rate can be varied. The reciprocating pumps are available in various designs and models, which can be operated manually, with animal power and auxiliary power sources.

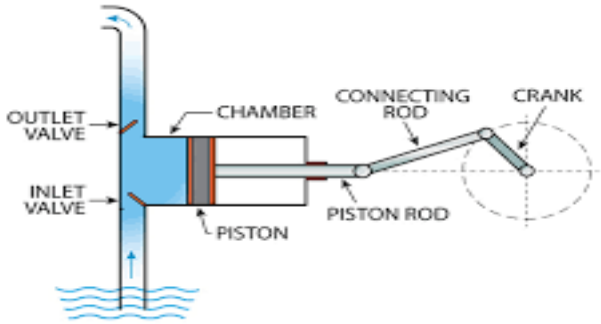


Fig.1.5: Reciprocating Pump

Uses: Reciprocating pumps are used to lift water from underground sources; therefore, if the water level is deep, the pump cylinder has to be lowered close to the water surface to reduce the suction head. The number of cylinders can be increased according to power sources.

Types of Reciprocating pump:

Piston Pumps: These pumps use a reciprocating piston to create a pressure difference that moves the fluid. When the piston moves in one direction, it creates a low-pressure area, causing the fluid to be drawn in. When the piston moves in the opposite direction, it compresses the fluid, forcing it out through the outlet.

Plunger Pumps: Similar to piston pumps, but instead of a piston, they use a reciprocating plunger to displace the fluid.

Diaphragm Pumps: These pumps use a flexible diaphragm to displace the fluid. When the diaphragm is flexed, it creates a vacuum to draw in the fluid, and when it returns to its original position, it pushes the fluid out.

B. Rotary pump: A rotary pump is a type of displacement pump that uses a rotating mechanism to transfer fluid from one place to another. These pumps work by trapping fluid in the pump's chambers or cavities and then forcing it through the pump to create a continuous flow. Rotary pumps are known for their efficiency, steady flow rates, and ability to handle various viscosities of fluids. They find applications in a wide range of industries, including oil and gas, chemical, pharmaceutical, and food processing.

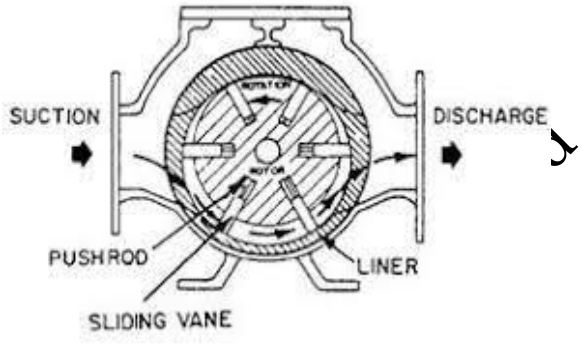


Fig.1.6: Rotary Pump

Types of rotary pumps:

1. **Gear Pumps**: Gear pumps consist of two meshing gears that rotate in opposite directions within a casing. Fluid is carried between the gear teeth and the pump casing, creating a smooth, continuous flow. Gear pumps are relatively simple, compact, and suitable for low to medium pressures and viscosity fluids.

2. **Vane Pumps**: Vane pumps use a series of vanes (blades) that slide in and out of slots in a rotating rotor. The vanes trap and move the fluid as the rotor turns, creating a pumping action. Vane pumps are known for their smooth flow, self-priming capabilities, and suitability for medium pressures and high viscosities.

3. **Screw Pumps**: Screw pumps use intermeshing screws or rotors to move the fluid along the screw threads. The rotating screws trap and move the fluid axially through the pump. Screw pumps are efficient and can handle high-viscosity fluids, making them common in applications like oil and lubricant transfer.

4. **Lobe Pumps**: Lobe pumps utilize two rotating lobes (similar to gear wheels) that mesh without actually touching each other. The lobes trap and transport

the fluid through the pump. Lobe pumps are known for their gentle handling of shear-sensitive fluids and sanitary applications.

5. **Peristaltic Pumps**: Also known as hose pumps, peristaltic pumps use a rotating roller or shoe to compress a flexible tube. This action creates a squeezing effect that propels the fluid through the tube. Peristaltic pumps are ideal for transferring delicate or viscous fluids and are often used in medical and pharmaceutical applications.

Rotary pumps have advantages such as a consistent flow rate, self-priming capability (except for certain designs), and the ability to handle thick and abrasive fluids. However, they may not be suitable for extremely high flow rates or ultra-high-pressure applications, where other pump types like centrifugal pumps might be more appropriate. The choice of the right pump depends on the specific requirements of the application, the characteristics of the fluid being pumped, and the operating conditions.

2. Centrifugal Pump: A centrifugal pump is a type of dynamic pump that uses centrifugal force to move fluid through a piping system. It is one of the most common types of pumps used in various industries for transferring liquids like water, chemicals, petroleum, and many others. Centrifugal pumps are widely used for their simplicity, efficiency, and ability to handle large flow rates. When the pump is turned on, the impeller starts rotating rapidly due to the power provided by the motor. As the impeller spins, it creates a low-pressure zone at its center, causing fluid to be drawn into the pump through the suction port. The impeller then accelerates the fluid radially outward towards the casing. The casing's shape and design convert this kinetic energy into pressure energy, increasing the fluid's pressure. Finally, the high-pressure fluid is discharged from the pump through the discharge port and sent into the piping system.

A. **Monoblock/Volute Pump:** It is one of the most common types of centrifugal pumps employed for irrigation. It consists of an impeller or rotor and progressively widening spiral or volute casing. The pump is directly connected to the prime mover, which may be an electric motor or engine. The direct coupling feature reduces transmission. losses. Upon rotation of the impeller, the wate r enters the eye, which is thrown radially outward to the periphery. Such an action causes a vacuum at the eye and thus more water enters the suction pipe to maintain the continuous flow. The impeller accelerates the water to a high

Fig.1.7: View of Monoblock Pump

velocity and the casing converts this velocity head into a pressure head due to the volute design. Volute pumps usually employ a closed type of impeller for irrigation, which has curved vanes for a smooth flow of liquid. There are other kinds of impellers like open, semi-open, and non-clogging impellers., but these are used for purposes other than irrigation.

B. **End Suction Centrifugal Pump**: End suction type centrifugal pumps are the most commonly used pumps for irrigation in agriculture. The pump can be coupled with an electric motor or engine. The pump consists of a casing, impeller, high tensile shaft, bearing pedestal, stuffing box, flanges, and coupling. Upon rotation of the impeller, the water enters the eye, which is thrown radially outward to the periphery. Such an action causes a vacuum at the eye and thus more water enters the suction pipe to maintain the continuous flow. The impeller accelerates the water to a high velocity and the casing converts this velocity head into a pressure head due to the volute design. Volute pumps usually employ a closed type 01 impeller for irrigation, which has curved vanes for a smooth flow of liquid.

Fig.1.8: View of End Suction Centrifugal Pump

Uses: The end suction pump is used for lifting of water from open wells and boreholes for irrigation and domestic and industrial applications.

C. **Self-Priming Centrifugal Pump**: The self-priming pumps are available in stationary and portable models. These pumps are primarily used where low discharge is needed at higher heads. Due to self-priming features, the pump can handle air and gases entrained in the water. These pumps are primarily designed for handling water. The pump does not require any foot valve. The pump has high suction lift characteristics and can suck water from a much lower depth. The construction of the pump is similar to other centrifugal pumps and has enclosed impellers and can have many stages. The pump can be coupled with electric motor or engine.

Fig.1.9: Self Priming Centrifugal Pump

Uses: The pump is used for water supply in hilly areas, small villages, and multi-storeyed buildings, sprinkler irrigation, domestic water supply, and general industrial use for pumping water.

D. **Turbine Pump**: These pumps are used in tube wells or in open wells where the water level is below the practical limit of centrifugal pumps. The vertical turbine pump consists of a driving motor with a discharge connection and the bottom suction centrifugal pump to which one or more impellers are attached. The impellers are of either the volute or mixed flow type. The pump unit remains submerged in water whereas the prime mover (motor or engine) is kept above ground level. The pump unit is connected to the motor with the help of a long vertical shaft supported on bearings, which may be water or oil lubricated. Although the turbine pump also operates on the centrifugal principle, it differs from the volute type as stationary guide vanes guide upward the water thrown by the impeller to the periphery. The gradual enlarging vanes guide the water to the casing, thus converting kinetic energy into potential energy. Therefore, the turbine pump generates heads several times that of a volute pump. Turbine pumps are most effective for tube wells, and applications requiring high heads and discharge. A well-maintained pump provides trouble-free service for several years.

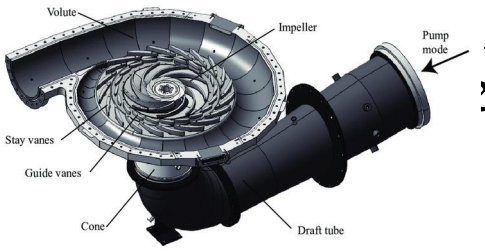


Fig.1.10: Cut- section view of turbine Pump

Another type of submersible pumps is D.I. Submersible pump, Let us discuss it in detail.

D.I. Submersible Pump: Submersible pumps are also turbine pumps where a long vertical shaft connecting the motor and pump unit is replaced by a short shaft and the prime mover and pump become closely coupled and submerged in water. Submersible pumps are suitable for tube wells having a bore of 100 mm or more. The impeller of the pump may be closed, semi-open, or open. For irrigation usually, closed types of impeller with bowls and stabilizing vanes are used. Several impellers may be used in series, which depends on the head and discharge. The discharge from one impeller is guided to the inlet of the second and so on and finally to the outlet. The complete assembly of the pumping unit is suspended from the discharge column. Submersible pumps consume less power for the same output and also require less space.

Fig.1.11: Submersible Pump

Uses: It is used for lifting of water from tube wells, open wells for irrigation, domestic and industrial applications.

E. **Jet Pump**: A Jet Pump is a diffuser pump that is used to lift water from both shallow and deep wells. During working, the output of the diffuser is split, and half to three-fourths of the water is sent back down the well through the pressure pipe. At the end of the pressure pipe, water is accelerated through a cone-shaped nozzle. The water goes through a venturi in the suction pipe. The venturi has two parts: the venturi throat, which is the pinched section of the suction tube; and above that is the venturi itself which is the part where the tube widens and connects to the suction pipe. The venturi speeds up the water causing a pressure drop which sucks in more water through the intake at the very base of the unit. The water goes up the suction pipe and through the impeller, most of it for recirculation around to the venturi.

Fig.1.12: Jet Pump

F. **Propeller Pump:** A propeller pump, also known as an axial flow pump or a mixed flow pump, is a type of pump used to move large volumes of fluid with relatively low head (pressure) requirements. It is specifically designed to create axial flow, where the fluid flows parallel to the pump shaft.

Working principle: The working principle of a propeller pump is similar to that of a boat propeller. As the name suggests, the pump has a propeller-like impeller that is typically mounted directly on the pump shaft. When the pump is activated, the impeller spins rapidly, drawing fluid in through the center of the impeller and then propelling it outwards along the axis of the shaft.

Fig.1.13: Propeller Pump

Unlike centrifugal pumps, where the fluid is accelerated radially outward, the propeller pump's impeller pushes the fluid in a direction parallel to the shaft. This axial flow pattern allows the propeller pump to move large quantities of fluid with relatively low energy consumption.

3. Air lift pump: An air lift pump is a type of pneumatic pump used to lift fluids, typically water or other liquids, from a lower level to a higher level using the principle of buoyancy. Unlike traditional pumps that use mechanical means to transfer fluids, air lift pumps use compressed air or gas to create the necessary flow.

The basic components of an air lift pump include a pipe or tube (riser), a supply of compressed air or gas, and a submerged section (down comer) in the liquid to be pumped.

Here's how it works:

- **Compressed Air Injection:** Compressed air is introduced into the bottom of the down comer, creating bubbles. The air bubbles rise through the down comer, reducing the density of the fluid within the down comer.
- **Buoyancy Effect:** As the air bubbles rise, they displace the liquid inside the down comer, reducing its weight. This creates a buoyant force that lifts the fluid column inside the down comer.
- **Fluid Lift:** The lighter fluid inside the down comer is lifted upward by the buoyant force, and as it reaches the top of the down comer, it discharges into the riser.
- **Discharge:** The fluid discharges from the top of the down comer into the riser, where it can be collected or directed to the desired location at a higher elevation.

Air lift pumps are commonly used in various applications, especially in situations where traditional pumps might be impractical or uneconomical. They are particularly useful in scenarios where the pumped fluid contains solids, such as in wastewater treatment plants and mining operations. Air lift pumps can handle abrasive and corrosive materials without the need for complex seals or moving parts.

However, air lift pumps have some limitations. They are generally not as efficient as mechanical pumps and may require a considerable amount of compressed air or gas to

achieve the desired lift. The lift height and flow rate of an air lift pump depend on factors such as the pressure of the injected gas, the depth of the down comer, and the characteristics of the fluid being pumped.

Overall, air lift pumps are a specialized solution for specific applications, offering advantages in certain situations but requiring careful consideration of their operational costs and efficiency compared to other pumping methods.

1.6 Indian standards like ISI/BIS applicable to the plumbing system

The ISI (Indian Standards Institute) is now known as the Bureau of Indian Standards (BIS). BIS is the national standards body of India, responsible for the development, maintenance, and certification of various standards across different industries, including plumbing.

When it comes to plumbing standards in India, the BIS has established several relevant standards. These standards cover different aspects of plumbing materials, fittings, and installation practices. Here are some key plumbing standards issued by BIS.

The Bureau of Indian Standards (BIS) is the national standards body of India responsible for the formulation and implementation of standards across various industries. In the case of plumbing, BIS has developed standards for different aspects of plumbing systems. Here are some relevant BIS standards for plumbing in India:

- **IS 1239**: Steel Tubes, Tubulars, and other Wrought Steel Fittings. This standard specifies the requirements for black and galvanized steel pipes, tubes, and fittings used in plumbing applications.
- **IS 4984**: High-Density Polyethylene (HDPE) Pipes for Potable Water Supply.
- This standard provides specifications for HDPE pipes used for transporting potable water in plumbing systems.
- **IS 7834**: Unplasticized Polyvinyl Chloride (UPVC) Pipes for Soil and Waste Discharge Systems. This standard defines the requirements for UPVC pipes used in plumbing installations for soil and waste discharge.
- **IS 778**: Specification for Solder for Use in Plumbing and Drainage Systems.
- This standard outlines the specifications for solder materials used in plumbing and drainage systems.
- **IS 775:** Code of Practice for Installation and Maintenance of Internal Plumbing Work. This standard provides guidelines and recommendations for the installation and maintenance of internal plumbing systems in buildings.

- **BIS IS 1239 (Part 1):2004** - This standard covers the requirements for steel tubes used in plumbing, water supply, and general engineering purposes. It specifies the dimensions, material properties, and manufacturing processes.
- **BIS IS 7834:1975** - This standard deal with the installation and testing of sanitary appliances and their associated fittings, including water closets, urinals, washbasins, and bidets.
- **BIS IS 5528:2006 -** This standard provides guidelines for the design and installation of internal water supply systems in buildings. It covers aspects such as pipe sizing, materials, fittings, and installation practices.
- **BIS IS 771:2016 -** This standard specifies the requirements for PVC (Polyvinyl Chloride) pipes used in plumbing systems. It covers dimensions, material properties, and testing methods.
- **BIS IS 7831:2018** - This standard outlines the installation requirements for domestic hot water (DHW) systems. It covers aspects such as pipe sizing, insulation, circulation systems, and safety considerations.

Table 1.1 List of ISI standard code of plumbing system

ISI Code	Title
4669: 1968 and 4905: 1968	Methods of test for polyvinyl chloride resins methods for random sampling
5382: 1985	Rubber sealing rings for gas mains, water mains, and sewers {first revision)
10148:1982	A positive list of constituents of polyvinyl chloride resins and its copolymers for safe use in contact with food stuffs, pharmaceuticals, and drinking water
10151:1982	Specification for polyvinyl chloride (PVC) and its copolymers for its safe use in contact with foodstuffs, pharmaceuticals, and drinking water
12231: 1987	Specification for UPVC (rigid) pipes for use in suction and delivery lines of agricultural pumps
12818: 1992	Unplasticized PVC screen and casing pipes for bore/tube - well - Specification {first revision)
ISO/161/1-1978	Thermoplastic pipes for the transport of fluids — Nominal outside diameters and nominal pressures — Part 1: Metric series
ISO/DIS 727-1985(E)	Fittings of unplasticized PVC, chlorinated PVC, or ABS with plain sockets for pipes under pressure — Dimensions of sockets — Metric series

ISO 2045: 1988	Single sockets for UPVC and CPVC pressure pipes with elastic sealing ring-type joints — Minimum depths of engagement
ISO 3127: 1994(E)	Thermoplastics pipes — Determination of resistance to external blows — Round-the-clock method
ISO 3603: 1977 F	Fittings for unplasticized polyvinyl chloride pressure pipes with elastomeric sealing ring type joints — Pressure test for leak proofness
ISO 4422: 1992	Unplasticized polyvinyl chloride pipes and fittings for water supply Specifications
ISO/DIS 4422-2-1996	Pipes and fittings made of unplasticized PVC for water supply—Specifications
ISO 9852: 1995(E)	Unplasticized PVC pipes—Dichloromethane resistance at a specified temperature

These are just a few examples of BIS standards related to plumbing in India. It's essential to consult the latest versions of the standards directly from the Bureau of Indian Standards or authorized sources to ensure compliance with the most up-to-date regulations. The BIS website (www.bis.gov.in) is a reliable source for obtaining the most up-to-date information on plumbing standards in India.

1.7 Basic building drawing

Making a basic building drawing entails representing the key attributes and configuration of a building in a straightforward and organised way.
Here is a step-by-step guide to assist you in drawing a simple building:

Step 1-
Decide on the scale: Choose an appropriate scale for your drawing. The scale illustrates the proportionality between the size of the building and the drawing. For instance, a drawing that is scaled at 1:100 means that each unit on the drawing corresponds to 100 actual units.

Step 2-
Assemble data: Gather all the necessary details about the building you want to depict. Architectural plans, measurements, elevations, and any particular design features or specifications may be included in this.

Step 3-

Start with the foundation: Start by sketching the building's foundation. The corners and outer edges of the building's footprint should be represented by straight lines. Make sure the foundation is correctly sized and in line with the scale you have selected.

Step 4-
Add walls: Draw the building's walls based on its architectural plans. The walls should be represented by straight lines, with openings for windows and doors. Be mindful of the sizes and ratios, and confirm that they are appropriate for your scale.

Step 5-
Include doors and windows: Use the appropriate symbols or basic shapes to represent the doors and windows. Use rectangles with lines or arcs to indicate the direction of swing for doors. Use rectangles or squares for windows.

Step 6-
Include supplemental elements: Include additional necessary components like stairs, balconies, or any other distinctive architectural features. Use appropriate symbols or straightforward shapes to accurately represent these features.

Step 7-
Include roof and roof details: Draw a sketch of the building's roof, considering its shape, slope, and any other standout characteristics. Use lines and shading techniques to depict the roof's composition (shingles, tiles, etc.). Include any vents or chimneys that are required.

Step 8-
Label and annotate: Add labels to the building to describe its various components, such as its rooms, floors, or distinctive features. Indicate dimensions, materials, or any other pertinent information using text or symbols.

Step 9-
Perfect the drawing: Check your drawing for clarity, proportions, and accuracy. Ensure that the building representation is logical and understandable by making any necessary alterations or corrections.

Step 10-
Finish the drawing: Once you are happy with it, go over the lines in ink or another darker medium to highlight the finished design. Remove any extra construction lines or rules.

1.8 Importance of keeping maps/records of plumbing drawing

A plumbing drawing is a type of technical drawing that provides visual representation and information relating to a plumbing system. It is used to convey the engineering design to plumbers or other workers who will use them to help install the plumbing

system. Following points showcases the importance of keeping maps of plumbing drawing :

- A plumbing drawing is used to show clearly the location of fixtures , sanitaryware, pipework, valves, and so the location of fixtures, sanitary wares, pipework, valves, and so on, and illustration how fresh water is to be supplied into a building and wastewater removed.
- To illustrate the separate hot and cold water supply, the pipe runs will usually be coloured red and blue respectively.
- Drainage pipes should be illustrated with the grade (slope) indicated. Where manholes are included, a manhole schedule should detail the name, invert level, cover level, and depth.
- Plumbing can also be detailed as a shop drawing, in which the pre-fabricated components are shown in terms of how they will be connected, interlinked, and so on.

1.9 Design of Water Supply System

Water supply systems are one of the most important part of any infrastructure buildings. The main purpose of water supply systems is the distribution of water to all its users. Water must be delivered in sufficient quantity and at acceptable pressure.

Requirements such as environmental protection, conservation of natural resources, and cost-effectiveness of the system set additional conditions in the design, construction, and maintenance of water supply systems.

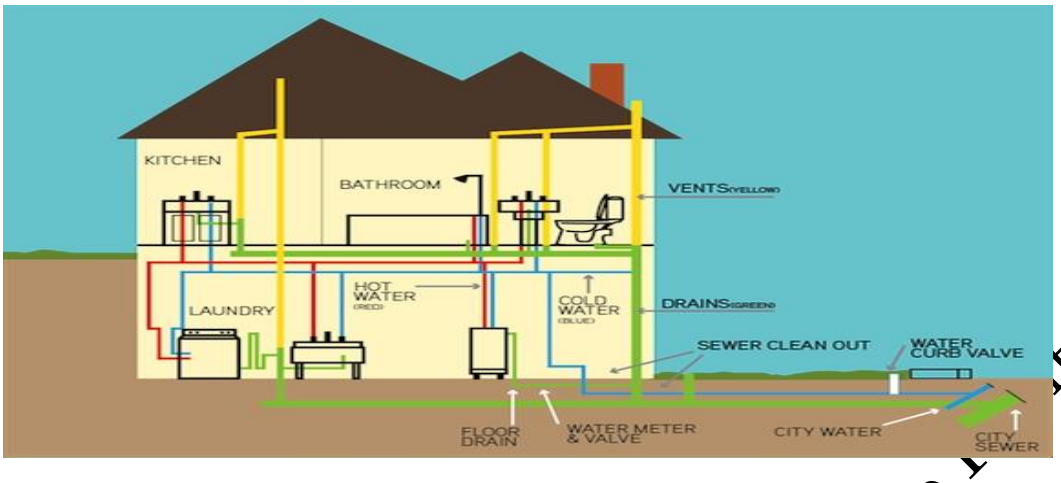


Fig. 1.14: Water Supply System in Residential Building

Purpose of Design

Water supply systems must be built to meet fire safety requirements in addition to the standard water consumption for industry and households. The price of building and maintaining water supply systems may increase significantly as a result of these requirements. The design of water supply systems follows the same guidelines and project types as other structures.

In order to maintain proper water pressure and flow and to prevent contamination of potable water, the water supply system must be designed.

- Water pressure
- Water flow rate
- Flow rate and pipe size Acceptable Solutions
- System layout
- Connection to the mains supply
- Backflow
- Mains connection
- Pipe materials

The system must be appropriate for the temperature of the water carried in addition to avoiding contamination and achieving the proper pressure and flow. In addition to being durable, a well-designed and installed system will also minimise noise from water flow and from issues like water hammer and support efficient water use.

To deliver water to building occupants, all water supply systems combine pipes (of varying lengths and materials), valves, and outlets. Pumps and storage tanks are also utilised by some water supply systems. To ensure that clean water is delivered to the user at the proper rate and temperature, it's important to get all of these components right when designing a water supply system.

- **Water Pressure**: The right water pressure is essential if the goal is to meet user needs while also using water wisely. Users of the building will experience inconveniences if the water pressure is too low, such as slow-flowing showers and lengthy fill times for bathtubs. Water will be wasted and the system will experience high wear and tear if the pressure is too high. In areas with a main water supply, new structures typically have mains pressure systems. Existing structures and those not connected to the mains water supply may have low pressure or uneven pressure systems (different pressures for the supply of hot and cold water).
- **Water flow rate**: According to the Building Code, sanitary appliances and fixtures must have an adequate water supply and flow rate. Flow rates are important, just like water pressure. A flow rate that is too high will cause water to be wasted, whereas a flow rate that is too low will prevent sanitary appliances and fixtures from operating as intended. Flow rate is affected by:
    - Water pressure
    - Pipe diameters
    - Water temperature
- **System Layout**: The plumbing system will largely follow the room layout during the design phase. However, there are a lot of factors to consider when it comes to code compliance, user comfort, and sustainability. The following factors must be considered when designing a water supply layout:
    - **Pipe lengths and runs**: Keep pipe runs as brief as you can. To reduce the number of branches and unnecessary elbows, tees, and joints, pass pipes close to fixtures. Less flow will occur, more heat will be lost, and more materials will be used as a result of longer pipe runs and more fixtures.
    - **Point of entry into the building**: This should be into an accessible isolating valve, line strainer and pressure limiting valve (if necessary) and be into a utility space like the garage or laundry.
    - **Water heating system**: Because longer pipe runs necessitate more water to be drawn off before hot water is discharged, locate centrally to shorten pipe runs to fixtures. For fixtures more than 10 metres away from the primary water heater, install a separate point-of-use water heater.
    - **Noise prevention**: Do not run pipes over or close to the living and sleeping areas.

- **Backflow:** The unintentional reversal of water (or water and contaminants) flow into the water supply system is known as backflow. Backflow contamination must be avoided by the system's configuration and use.

- **Mains connection**: The network utility operator is in charge of the water supplied to the property boundary where the water source is a mains supply. The pipework needed to bring water into the building must then be provided by the property owner. At the point of connection, an isolating valve must be installed to enable future maintenance and repairs of the building's water supply system.

- **Pipe materials**: The pipes used in a building must be suitable for the water pressure, flow rate, and temperature that they will be carrying and must not contaminate the potable water supply. This will depend on the materials employed as well as other elements, like the thickness of the walls.
  Durability, simplicity of installation, expense, and sustainability are additional factors. Copper, polybutylene (PB), polyethylene (PE), polypropylene (PP-3 or PP Type 3), and cross-linked polyethylene (PEX) are typical materials for domestic water supply.

There are following types of water supply system:

1 **Hot water supply system**: Hot water is required for the comfort of people in buildings. Hot water supply must be adequate in order to meet the occupant's demand. There are different ways of heating water.

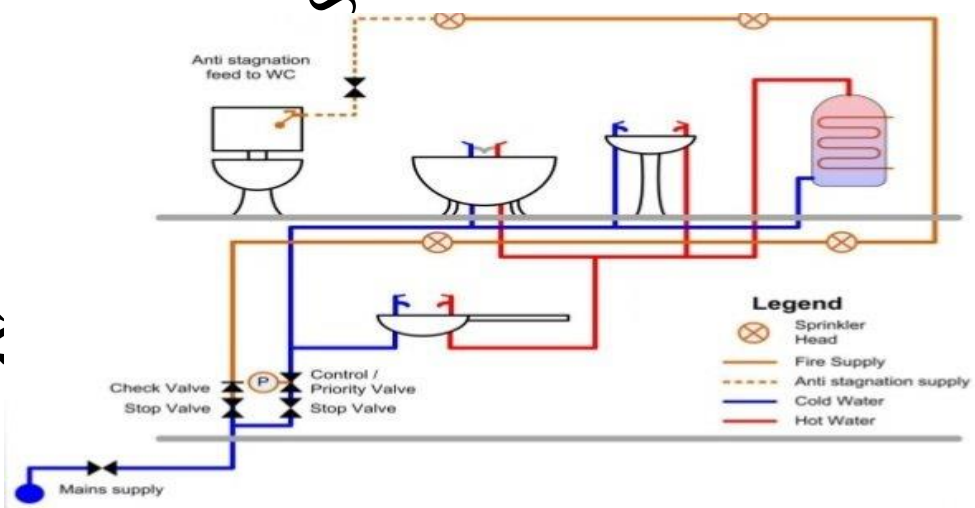


Fig. 1.15: Hot water supply system

Depending on the resources available the technologies used can be:

- Solar water heater
- Gas water heater
- Electric water heater
- Heat pumps

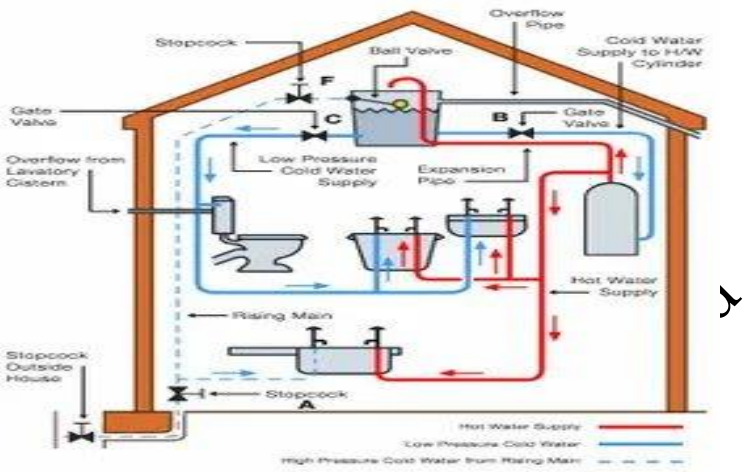


Fig. 1.16: Schematic view of hot water supply system

Hot -water systems typically have a central boiler, in which water is heated to a temperature of from 140 to 180oF (60-830C), and then circulated by means of pipes to some type of coil units, such as radiators, located in the various rooms.

2. **Cold water supply system**: Cold water is fed directly from the mains, is heated and fed directly to the point of use, without for water storage tanks. Since the water in the system will expand due to heating, an expansion vessel and a safety temperature and pressure relief valve are required.

Types of cold-water supply system-

1. **Direct water supply system**: Water is supplied direct from mains to fixtures.
2. **Indirect water supply system**: Water going to overhead tank and then the water is supplied to different floors by gravity.

1. **Direct water supply system**: All household appliances in a direct water supply system get their water from the rising main, which are the municipal supply mains. Pressured potable water is accessible at all faucets. There is no need for a cistern to first store water before making it usable. Only if the hot water system is a storage system is a cistern (tank) necessary. The cistern only stores hot water in this location. The rising main provides cold water. The main pipe from which water enters the house, known as the rising main, must have enough pressure so that water can reach fixtures without causing problems for users even on upper floors in order to install a direct water supply system.

   A pressure-reducing valve might be necessary to maintain the required water flow because the rising main pressure is high. By using this system, water contamination that results from underground or overhead tank storage is avoided.

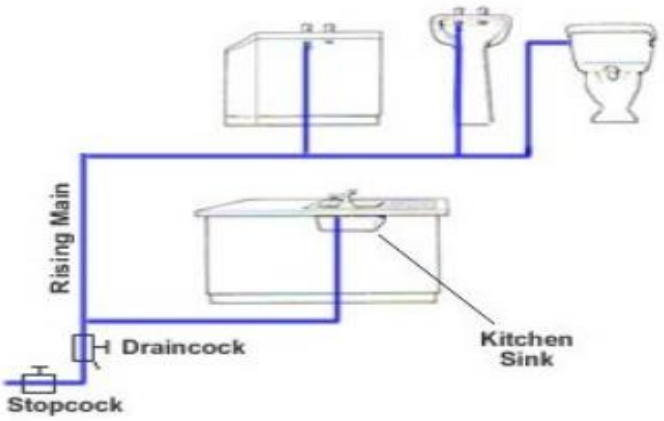


Fig. 1.17: Direct water supply system

2. **Indirect Water Supply System:** Water enters house from the rising main. After entering, it is branched off into kitchen sink and towards storage tank. Storage tank is first filled and then water is supplied to appliances from same. The location of storage tank should be at some height so that water flows down easily under gravity without any external pressure. Only Kitchen sink has portable water available. All other appliances have stored tank water. Indirect water supply system is flexible because when mains run out of water, stored water is a benefit till mains flow return.

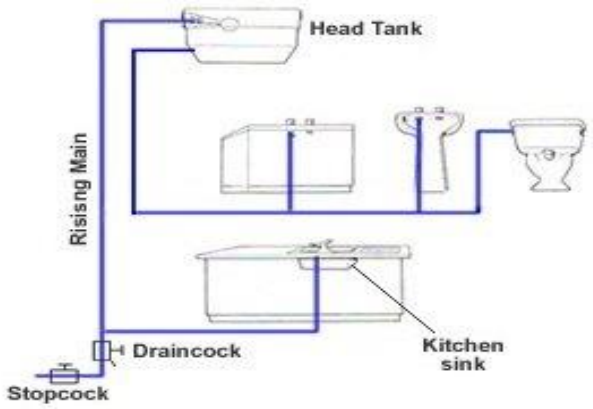


Fig. 1.18: Indirect water supply system

Water supply system in industrial setups:

Water is widely used in industry, whether it is encountered as raw water, process water, or wastewater. In order to ensure that the water's quality and properties will meet the requirements of the industrial process, it is frequently necessary to treat the water before it enters the process.

The water industry includes, among other things, water engineering, operations, the building of water and wastewater plants, equipment supply, and specialised chemicals for water treatment. The water industry serves other sectors of the economy, such as the food industry, which manufactures beverages like bottled water.

Water is used in hotels, motels, restaurants, offices, and other commercial facilities. It is necessary for the creation and production of paper, chemicals, automobiles, steel, food, the production of textiles and dyes, among other things. For cooling, power plants require a sizable amount of water.

Since water is a universal solvent, it is used in industrial production to dissolve a variety of compounds. It is frequently utilised as a solvent but less frequently as a catalyst. The use of water vapour is widespread in industry. Both smelting operations and oil refineries use water. Industrial uses of water are processing, diluting or fabricating a product.

1.10 Design of Drainage system in Building

Drainage system: Drainage is the system installed in a house or building for the collection or conveyance of wastewater through drain pipes, by gravity, to join either a public sewer or a domestic septic tank.

Components of drainage system

- Pipes
- Traps
- Sanitary fittings

- Chambers

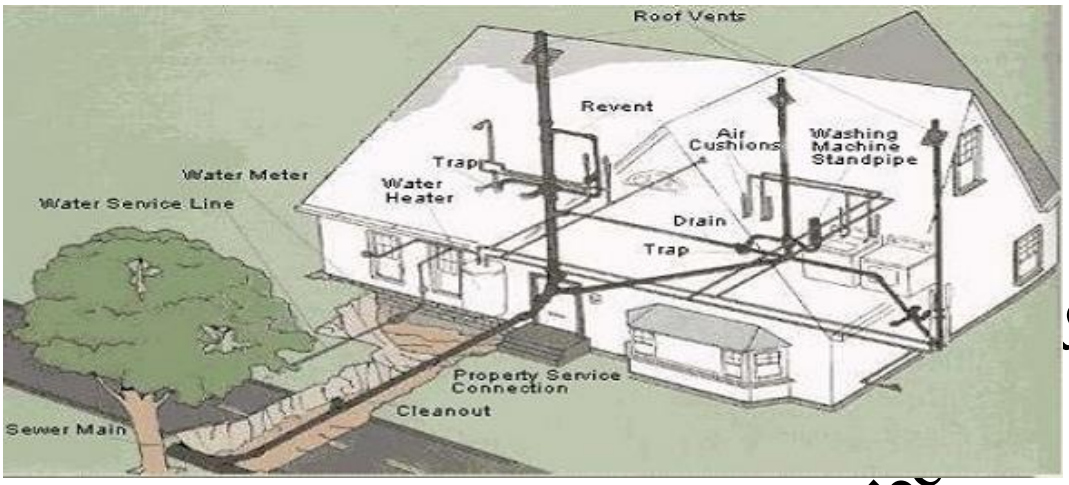


Fig. 1.19: Schematic View of House Drainage System

Type of drainage systems in buildings

The drainage system is a well-organized network of drainage pipes that is used to remove human waste. The drainage system pipes that are typically used are copper, CPVC, and HDPE pipes. These pipes are made of plastic, making them rust-free and lightweight. They require little maintenance and are simple to install. They are also affordable and practical.

Drainage systems in buildings are essential for removing wastewater, sewage, and rainwater to maintain proper sanitation and prevent flooding. Several types of drainage systems are commonly used in buildings, each serving a specific purpose.

Following are the main types of drainage system in building:

I. **Sanitary Drainage System:** This system deals with the removal of human waste (sewage) and wastewater from bathrooms, kitchens, and other plumbing fixtures within the building. It usually consists of a network of pipes that connect to the main sewer line or septic tank.

II. **Stormwater Drainage System:** This system is designed to handle rainwater and surface runoff. It helps prevent water accumulation around the building, which could lead to flooding and other water-related issues. Stormwater drainage systems include gutters, downspouts, and underground pipes that direct the water away from the building.

III. **Combined Drainage System:** Some older buildings or urban areas have combined drainage systems that handle both sanitary wastewater and stormwater. While cost-effective, these systems can be problematic during heavy rainfall as the high volume of water can overwhelm the sewer system, leading to overflows and pollution.

IV. **Ventilation System:** Though not a drainage system itself, ventilation plays a crucial role in plumbing to prevent pressure buildup, odors, and potential health hazards. Proper ventilation ensures that the drainage system functions effectively and prevents the entry of harmful gases back into the building.

V. **Floor Drainage System:** In commercial and industrial buildings, floor drainage systems are installed to handle spillages, washdowns, or any liquid waste that might accumulate on the floor. These drains are commonly found in areas like kitchens, laboratories, garages, and production facilities.

VI. **Sump Pump System:** In areas prone to flooding or where the building's foundation lies below the water table, a sump pump system may be installed. It collects water that seeps into a sump pit and pumps it away from the building to prevent water damage.

VII. **Downspout & Gutter Drainage System:** The gutter downspout is a vertical pipe that is attached to the building and facilitates the water's exit from the gutters while ensuring that all trash is safely segregated and channeled through the system. Additionally, the downspout guides water safely away from the building and toward the appropriate drainage location. They will guard the building's foundation from water damage if they are installed correctly and are free of clogs. When it rains, downspouts are frequently directed into driveways, which allow water to flow directly into the streets. Additionally, downspouts are linked to a pipe that either empties directly into the sanitary sewer or directs stormwater into the drainage system. Every 30 to 40 feet, on average, a gutter needs a downspout.The gutter system consists of two parts:

- Gutter channels that run horizontally along the roof edge.
- A downspout that carries the collected water down to grade level.

Step for designing of drainage system in buildings

Designing a drainage system in buildings involves careful planning and consideration of various factors to ensure efficient and effective drainage of wastewater.

Here are the general steps for designing a drainage system:

Step 1- First gather some information

- Determine the building's size, purpose, and occupancy type.
- Identify local building codes, regulations, and standards related to drainage system design.
- Obtain site information, including topography, soil conditions, and groundwater levels.

Step 2- Determine the type of drainage system

- Separate system: Design separate pipes for sanitary wastewater and stormwater drainage.
- Combined system: Combine sanitary and stormwater drainage in a single set of pipes.

Step 3- Calculate wastewater flow rates

- Estimate the peak and average wastewater flow rates based on the building's occupancy and usage.
- Consider potential future expansions or increased demand.

Step 4- Measure the size of pipes

- Using the calculated flow rates, select appropriate pipe sizes for each section of the drainage system.
- Ensure that the pipes have sufficient capacity to handle the expected flow without causing blockages.

Step 5- Plan the drainage layout

- Determine the location of fixtures (e.g., toilets, sinks) and connect them to the drainage system.
- Create a layout that minimizes the length of pipe runs and optimizes slope for efficient drainage.

Step 6- Consider the ventilation

- Include ventilation pipes (vent stacks) to prevent airlocks and allow the free flow of wastewater.
- Ventilation also helps prevent the buildup of sewer gases and odors.

Step 7- Calculation of slope

- Ensure that the pipes have the correct slope to facilitate the movement of wastewater by gravity.
- Typically, a minimum slope of 1/4 inch per foot (2% gradient) is used for horizontal drainage pipes.

Step 8- Include traps and cleanouts in design of drainage system

- Install traps under fixtures to prevent sewer gases from entering the building.
- Place cleanouts at strategic locations for easy access and maintenance of the drainage system.

Step 9- Select the appropriate materials

- Choose pipes and fittings made of materials suitable for the type of wastewater and the building's specific needs (e.g., PVC, cast iron, HDPE).

Step 10- Implement water conservation measures

- Consider incorporating water-saving fixtures and technologies to reduce wastewater generation.

Step 11- Rainwater management (for combined systems)

- If designing a combined system, plan for rainwater management to prevent flooding and overload during heavy rainfall.
- Implement features like rain gardens, retention ponds, or permeable surfaces.

Step 12- Review and get approvals

- Review the drainage system design with relevant stakeholders, including architects, engineers, and local authorities.
- Obtain necessary approvals and permits before starting construction.

Step 13- Construction and testing

- Oversee the construction to ensure that the drainage system is installed according to the approved design.
- Conduct tests, such as water pressure tests, to check for leaks and proper functionality.

Step 14- Maintenance of plan

- Develop a maintenance plan to regularly inspect and clean the drainage system to prevent blockages and ensure its longevity.
- It's essential to work with experienced architects, engineers, and plumbing professionals to design an efficient and code-compliant drainage system for buildings.
- Building codes and regulations may vary by location, so always consult with local authorities to ensure compliance with the latest guidelines.

Benefits of Drainage System in Buildings

It avoids water ponding, which can result in flooding. It helps to move water away from the structure and prevents water from piling up, which can increase mosquito breeding. Any region that is impacted by floodwater or precipitation can have access water removed thanks to a good system in a building. This system, known as a sewer system, successfully removes wastewater from the environment. The advantage of a drainage system is when waste and collected water are drained out in a systematic manner, resulting in the maintenance of a building's health. A drainage system also benefits from a strong network that eliminates undesirable clogging. Provides a better environment for plant growth. Following are the benefits:

- Helps to increase microbial decomposition.
- Improves the physical properties of the soil.
- Maintains proper soil temperature.
- Enhances better root system.

- It helps in the removal of toxic substances.
- May increase the life of the building.
- It helps to prevent water-borne diseases.

1.11 Design of Sewerage system in Building

Designing a sewerage system in a building involves planning and engineering a network of pipes and fittings to safely and efficiently transport wastewater from various fixtures and appliances to the main sewer or treatment facility.

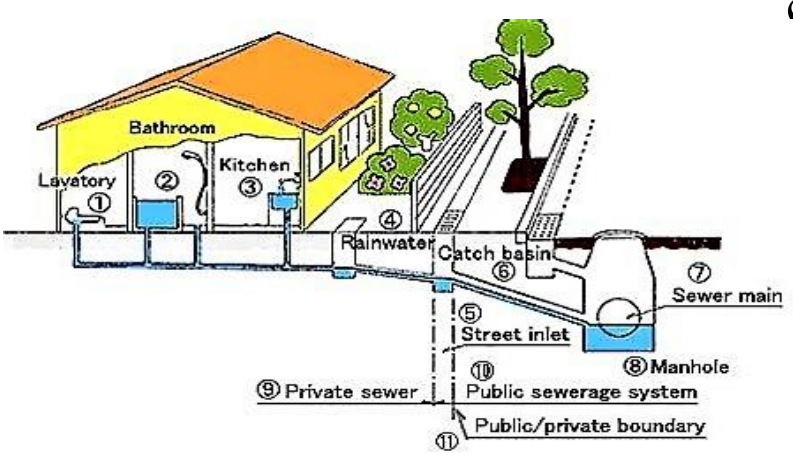


Fig. 1.20: Schematic View of House Sewerage System

Following are the steps for designing a sewerage system in a building:

Step 1- Building Information Gathering

- Determine the building's size, occupancy, and intended usage to estimate wastewater flow rates.
- Identify the locations and types of fixtures (e.g., toilets, sinks, showers) that will produce wastewater.

Step 2- Separate or Combined System

- Decide whether to implement a separate sewerage system (for sanitary and stormwater separately) or a combined system (both wastewater types in a single set of pipes).

Step 3- Sewer Pipe Sizing

- Calculate the anticipated wastewater flow rates from various fixtures and appliances.

- Select appropriate pipe diameters to accommodate the expected flow rates while maintaining adequate velocity to prevent clogging and sedimentation.

Step 4- Slope Calculation

- Ensure that the sewer pipes have the correct slope to allow gravity-driven flow of wastewater towards the main sewer or treatment facility.
- The minimum slope is typically 1/4 inch per foot (2% gradient) for horizontal sewer pipes.

Step 5-Ventilation Design

- Install vent pipes (vent stacks) to allow the release of sewer gases and prevent airlocks, ensuring proper flow within the system.
- Ventilation pipes should extend above the roofline and may be interconnected.

Step 6- Traps and Cleanouts

- Place traps under fixtures to prevent sewer gases from entering the building.
- Install cleanouts at strategic locations to provide access for maintenance and clearing blockages within the sewerage system.

Step 7- Material Selection

- Choose appropriate sewer pipes and fittings made of durable and corrosion-resistant materials (e.g., PVC, cast iron, HDPE) suitable for the type of wastewater and local regulations.

Step 8- Grease and Sand Interceptors

- For commercial buildings with kitchens, consider installing grease interceptors to capture fats, oils, and grease from wastewater.
- In areas with significant sand or sediment, sand interceptors can be used to trap such particles before they enter the sewerage system.

Step 9- Rainwater Management (for Combined Systems)

- In a combined system, incorporate rainwater management techniques (e.g., retention ponds, permeable surfaces) to control and reduce stormwater runoff.

Step 10- Compliance with Codes and Regulations

- Ensure that the sewerage system design complies with local building codes, health regulations, and environmental standards.

Step 11- Review and Approvals

- Review the sewerage system design with relevant stakeholders, including engineers, architects, and local authorities.
- Obtain necessary approvals and permits before construction.

Step 12- Construction and Inspection

- Oversee the construction to ensure the proper installation of the sewerage system according to the approved design.
- Conduct inspections and tests (e.g., water pressure tests) to check for leaks and functionality.

Step 13- Maintenance Plan

- Develop a maintenance plan to regularly inspect and clean the sewerage system to prevent blockages and ensure its smooth operation.
- Collaboration between architects, engineers, plumbers, and relevant professionals is crucial to designing a safe and effective sewerage system for any building. Additionally, adhering to the latest building codes and industry best practices is essential for a successful sewerage system design.

1.12 Application of various types of plumbing systems in domestic and industrial setups

Application of various types of plumbing systems in domestic setup: Plumbing systems are essential in domestic setups because they provide a consistent supply of clean water and effective drainage. Here are some significant domestic plumbing system applications:

- **Water Supply**: Water that is clean and suitable for drinking is distributed throughout the house by plumbing systems. They link various fixtures, including faucets, showers, toilets, and appliances like washing machines and dishwashers, to the main water line. Residents can access water whenever they need it because plumbing pipes deliver the water to these fixtures.
- **Fixtures and Appliances**: Plumbing systems make it possible for various fixtures and appliances to operate correctly. For instance, plumbing connections are necessary to provide a controlled flow of water for faucets and showerheads. Plumbing connections are needed for water supply and drainage in order to use appliances like toilets, washing machines, and dishwashers.
- **Drainage and Waste Removal**: Plumbing systems are in charge of efficiently removing sewage and wastewater from homes. Drainage pipes transport used water and waste to the main sewer line or a septic tank and are typically connected to sinks, showers, toilets and other fixtures. Unpleasant odours and dangerous sewer gases are kept out of the living spaces by plumbing traps like P-traps.
- **Ventilation**: Ventilation pipes and vents are a part of plumbing systems that support proper airflow and prevent the accumulation of sewer gas. Vent pipes that extend through the roof and are connected to the drainage system allow gases to escape while preventing water from traps from being syphoned. The healthy indoor environment is ensured by this ventilation system.
- **Hot Water Supply**: The distribution of hot water for bathing, dishwashing, and other household needs is made possible by plumbing systems. Commonly attached to the plumbing system, water heaters heat the water and send it

through hot water pipes to fixtures. In order to reduce heat loss and provide hot water on demand, these pipes may be insulated.

- **Irrigation System**: Garden irrigation in domestic settings also uses plumbing systems. The plumbing system is connected to outdoor faucets and hoses, making it convenient for homeowners to water their gardens, lawns, and other landscaping. In some instances, more sophisticated irrigation systems are installed, making use of plumbing pipes and valves to efficiently distribute water.
- **Maintenance and Repairs**: Plumbing systems require routine upkeep and sporadic repairs. This may entail repairing leaks, changing outdated pipes, unclogging clogged drains, and keeping up with water heaters. To address these problems and make sure the plumbing system runs smoothly, plumbers are frequently called upon.

Domestic setups require plumbing systems to ensure a steady supply of clean water, effective drainage, and other essential services. By ensuring that there is access to water and efficient waste management, they help to improve the comfort, convenience, and health of the community.

Application of various types of plumbing system in industrial setup: To enable the effective and secure transportation of fluids, gases, and waste materials in an industrial setting, various types of plumbing systems are employed. Following are some typical plumbing system types used in industrial settings:

- **Water Supply System**: This system makes sure that the facility has a steady supply of water. It consists of water storage tanks, pumps, valves, pipes, and valves. Water filtration and purification apparatus may also be a part of the water supply system.
- **Drainage and Waste System**: The industrial facility's wastewater and waste materials must be removed using this system. To ensure proper disposal and avoid pollution, it includes grease traps, drainage pipes, and sewer lines.
- **Process Piping System**: Transportation of particular fluids, chemicals, or gases is frequently necessary for industrial processes. Process piping systems are made to safely handle these substances. They may contain specialised fittings, valves, and pumps and are constructed from corrosion-resistant materials.
- **Compressed Air System**: Compressed air is used in numerous industrial operations for a variety of applications, including power tool operation, machinery operation, and pneumatic control systems. Air compressors, air storage tanks, distribution piping, and pressure regulators are all components of compressed air systems.

- **Fire Protection System:** Systems for fire protection are necessary in industrial buildings to protect people and property. These systems include water delivery pipes, fire hydrants, fire suppression systems, and fire sprinklers to put out fires when necessary.
- **Cooling and HVAC Systems**: Systems for cooling and ventilation are frequently needed in industrial settings to maintain ideal working conditions and avoid equipment overheating. To distribute chilled water or coolant, these systems make use of cooling towers, chillers, pumps, and a system of pipes.
- **Specialty Systems**: Additional plumbing systems might be needed, depending on the type of industrial facility. Chemical processing facilities, for instance, might have piping systems that are acid-resistant, whereas laboratories might have specialised systems for handling gases or vacuum lines.

It's important to remember that industrial plumbing systems must adhere to all applicable safety codes and rules. They are typically created by qualified experts who consider elements like material compatibility, pressure needs, flow rates, and potential dangers related to the involved industrial processes.

Activities

Activity 1: Make a list of the plumbing system in your house.

Material Required

1. Notebook
2. Pen
3. Pencil
4. Sharpener
5. Eraser

Procedure

1. Take a look around in your house.
2. Identify the plumbing items fitted in the house.
3. Make a list of the identified plumbing items.
4. Identify the material used in plumbing fittings and fixtures.

Activity 2: Draw the line diagram of water pumping system in your house or nearby.

Material Required

1. Notebook
2. Pen
3. Pencil
4. Sharpener

5. Eraser

Procedure

1. Identify the source of water and write it down in notebook.
2. Identify the pumping system.
3. Draw the line diagram of pumping system and label it.

Activity 3: Draw any five plumbing symbols used in a plumbing system.

Material Required

1. Notebook
2. Pen
3. Pencil
4. Sharpener
5. Eraser

Procedure

1. First read the manual of plumbing.
2. Identify the plumbing items.
3. Make a list of the identified plumbing items and their symbols.
4. Draw the line diagram of any five plumbing symbols used in the system.

Activity 4: Draw the line diagram of hot water supply in house or nearby.

Material Required

1. Notebook
2. Pen
3. Pencil
4. Sharpener
5. Eraser

Procedure

1. First visit any house or building.
2. Identify the location of hot water supply is fitted.
3. Make a list of components used in the hot water supply system.
4. Draw the line diagram of the hot water supply system in any house or building.

Activity 5: Identify the types of water pump used in your house or nearby.

Material Required

1. Notebook
2. Pen

Procedure

1. Identify the type of pump used in your house or nearby.
2. Enlist its specification and characteristics.
3. Write down the diameter of suction and delivery pipes.

Check Your Progress

A. Answer the following questions

1. Explain the term Advance plumbing.
2. What is the role of a plumbing technician.
3. Describe the water supply system in your house.
4. Write the application of plumbing systems in house/ industrial setups.
5. Write the importance of the plumbing symbol in plumbing work.
6. Explain the difference between direct and indirect water supply systems.

B. Fill in the blanks

1. The performance of plumbing systems can be …….. while using the least amount of water and water heating.
2. The development of …….. plumbing systems is a result of the Internet of Things (IoT) growth.
3. Before installation every plumber or technician should know about basic …….. and …….. used in plumbing work.
4. Water is …….. used in industry, whether it is encountered as raw water, process water, or wastewater.
5. A well-designed and installed system will also …….. noise from water flow and from issues like water hammer and support efficient water use.

C. Mark the correct option

1. Hot-water systems typically have a central boiler, in which water is heated to a temperature of from …… to ……. ^{o}F.
   a. 80 to 100
   b. 100 to 160
   c. 140 to 180
   d. 150 to 200
2. This system makes sure that the facility has a steady supply of water.
   a. Water supply system
   b. Drainage supply system
   c. Sewer supply system
   d. All the above
3. Water enters the house from the rising main. After entering, it is branched off into the kitchen sink and towards the storage tank is called……
   a. Direct water supply system
   b. Indirect water supply system
   c. Two-way water supply system

d. One-way water supply system

4. Salient feature of an advance plumbing technician:
   a. To assist in preparing Plumbing drawings (Water system cold, hot, sanitation & drainage.),
   b. Perform the installation and repair of waste, drainage, and venting systems.
   c. Install and repair plumbing fixtures (sinks, faucets, sanitary wares, toilets, etc.).
   d. All the above.

5. The unintentional reversal of water (or water and contaminants) flowing into the water supply system is known as …….
   a. Steady flow
   b. Non-steady flow
   c. Backflow
   d. Non-backflow

Module 2 Advance Pipe Fittings

Module Overview

The plumbing industry in India has undergone significant growth in recent years. The availability of better materials has improved, but so have the technologies and procedures, making the job of a plumber even more interesting. New materials and fixtures have taken the place of conventional materials used. Galvanised iron has been replaced by plastic. The advantages include cost-effectiveness, simplicity of use, and ease of installation. In this unit we will learn about the various types of pipes, pipe fittings and fixtures being used by plumbers.

Learning Outcomes

After completing this module, you will be able to:

- Identify different pipe fittings
- Understand the purpose of various fittings used in plumbing
- Describe different materials used in pipe fittings

Module Structure
2.1 Plumbing pipes
2.2 Pipe Fittings
2.3 Pipe Joints
2.4 Valves in Pipe fittings
2.5. Pipe Fixture Supports
2.6 Fastening Hardware
2.7 Various Adhesive Material
2.8 Marking Material
2.9 Cement Mortar/ Concrete (Application and Uses)
2.10 Basic and Advance plumbing tools
2.11 Lifting/load shifting equipments used at plumbing work sites
2.12 Soil Waste Rainwater
2.13 Different types of pipe fittings
2.14 Joining/installation methods of pipe
2.15 Pipe Supports
2.16 Deburring tool and Infrared thermometer and their application
2.17 Gas detection Leak instrument
2.17 Use of sink auger in the plumbing system
2.18 PVC pipe cutter and advance laser distance meter
2.19 Tankless hot water heater
2.20 Types of water meters and their application in domestic and industrial units

2.1 Plumbing Pipes

As you are aware, pipes are used for different purposes like transporting water for drinking, irrigation purpose, disposing of wastewater, etc. Plumbing pipes are manufactured in various sizes, mostly in a round shape. These pipes are made of various types of material as mentioned below.

Types of Plumbing Pipes

Commonly used pipes for plumbing systems are listed below.

- Cast Iron (CI) pipes
- Ductile iron pipes
- Steel pipes
- Galvanized Iron (GI) pipes
- Copper pipes

- Asbestos Cement (AC) pipes
- Concrete pipes
- Stoneware pipes
- PVC pipes

1. **Cast Iron pipes (CI pipes):** Cast iron pipe are made of grey cast iron. These are mostly used as pressure pipes for the transmission of water, gas, and sewage and as water drainage pipes (Fig. 2.1). These pipes are cheaper, more resistant to rust and corrosion and highly durable.

Fig.2.1: Cast Iron Pipe

2. **Ductile Iron pipes:** They are made of ductile iron and are an improved version of Cast Iron pipes having high tensile strength, more corrosion resistant and good yield strength (Fig. 2.2). These pipes are used for the transmission and distribution of potable water.

Fig.2.2: Ductile Iron

3. **Steel pipes:** These are popular due to their strength and lightweight, as compared to ductile iron pipes. Adequate preventive measures are required so as to save these pipes from adverse atmospheric conditions (Fig.2.3). Use of steel pipes in the water supply system is recommended when pipes are to bear more pressure (i.e., above 7 kg/cm^2) and when the diameter needs to be large.

Fig.2.3: Steel Pipe

4. **Galvanized Iron (GI) pipes:** These pipes are mostly used inside the building for water supply work. A zinc coating is made on wrought steel pipes. These pipes are manufactured in light, medium, and heavy grade categories, as per the thickness of the metal. For a 15 mm diameter GI pipe, the pipe thickness is kept as 2.0 mm, 2.65 mm, and 3.25 mm respectively for the light, medium and heavy categories. Most medium-grade type pipes are preferred for internal plumbing work in a building. Screw and socket joints are mostly applied in GI pipes (Fig. 2.4).

Fig.2.4: Galvanized Iron Pipe

5. **Copper pipes:** These are mostly used for hot water installation requirements. They have high tensile strength, excellent thermal conductivity, corrosion resistance and durability. These are made from thin copper sheets and can be folded easily. Chromium is coated on copper pipes for a better appearance (Fig. 2.5).

Fig.2.5: Copper Pipe

6. **Asbestos Cement (AC) pipes:** For removal of water (from the roofs), soil, and waste, and for purifying the air, asbestos cement pipes (Fig. 2.6) are used. Two types of AC pipes are made - one with beading around the socket (With Beading), and the other without beading around socket (Without Beading). The Without Beading around socket (WOB) type is mostly preferred over the one with beading. These pipes are available in the range of three meters in length. They are heavy and can break easily. The cost of these pipes is less than the PVC pipes. Nowadays, AC pipes are being replaced by PVC pipes.

Fig.2.6: Asbestos Cement Pipe

7. **Concrete pipes:** As the name suggests, concrete pipes are made of plain concrete (a mixture of broken stone or gravel, sand, cement, and water), which is considered to be one of the strongest and most durable building materials. Concrete pipes also come in different categories like unreinforced pipes, reinforced pipes, and pre-stressed pipes. While unreinforced pipes are made of only concrete, reinforced pipes contain iron mesh in addition to concrete, and pre-stressed pipes have iron rings at different intervals without any mesh. Small diameters of unreinforced pipes, reinforced and pre-stressed pipes of large diameters, are manufactured for various uses as well as for water supply. Small unreinforced concrete pipes are mostly used for the removal of water. For water supply works, pipes with bigger diameters are used (Fig. 2.7).

Fig.2.7: Concrete Pipe

8. **Stone Ware (SW) pipes:** These are made of clay, and are primarily used in sewerage systems for underground drainage, industrial drainage, irrigation, chemical industry for transporting the highly corrosive chemical, etc. Stone Ware (SW) pipes are mostly used to carry night soil and effluent water. These pipes are laid below the surface. The pipes should be laid on regular surfaces as they are rigid in nature (Fig. 2.8).

Fig.2.8: Stoneware Pipe

9. **PVC (Polyvinyl Chloride) pipes:** These pipes are mostly used for carrying water in the plumbing system and are light in weight, non-corrosive, cheaper in cost, and need not require any threading for joining connections. It makes them easily acceptable in the market (Fig. 2.9).

Fig.2.9: PVC Pipe

10. **Chlorinated PVC (CPVC) pipes:** These pipes can be used for higher temperatures up to 120 °C, and are therefore suitable for supplying hot water, and are mostly used in the industrial liquid applications.
11. **Polypropylene pipes:** These are manufactured with polypropylene 'random copolymer'. Polypropylene pipes are primarily used for carrying hot water and cold-water supply conduits, industrial pipelines, etc. (Fig. 2.10). following are the types of PVC pipes:
    a. Unplasticised PVC (UPVC) or rigid pipes are used for cold water.
    b. Plasticised PVC pipes are made with a mixing of rubber material. It has low strength and can work in low heat conditions than UPVC pipes.

Fig.2.10: Polypropylene Pipe

12. **PEX or XLPE Pipe:** This type of pipe is made of specialised polyethylene and is used in building services, pipework system, domestic water piping, transportation of sewage, slurries and chemical transportation as well as for natural gas and offshore oil applications. In water discharge system pipes, the thickness of the soil and waste discharge pipes should be larger than the pipes used for roof drainage. Mostly, hard PVC pipes are always used for the supply of water with temperatures less than 45°C. At a higher temperature, the strength of the pipes reduces. The strength of PVC pipes reduces

Fig.2.11: PEX or XLPE Pipe

due to ultraviolet radiations from the sun as well as changes in atmospheric temperature. PEX or XLPE pipes are costlier than AC pipes and cheaper than GI pipes (Fig. 2.11).

13. **Unplasticised Polyvinyl pipes:** These are primarily used in ventilation pipework, rainwater applications, and wastewater discharge systems (Fig. 2.12). High-Density Polyethylene (HDPE) material is used for making pipes for municipal and industrial water discharge systems.

Fig.2.12: Unplasticised polyvinyl Pipe

Polyethylene density is classified into three types:

- Low-Density Polyethylene raw material (LDPE)
- Medium Density Polyethylene raw materials (MDPE)
- High-Density Polyethylene raw materials (HDPE)

The properties of HDPE pipes are resistant to weather conditions, high resistance to tearing and pressure conditions, non-toxic in nature and suitable for carrying radioactive wastes.

2.2 Pipe Fittings

Pipe fittings are an important component of the plumbing system. Fittings are used 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.

Fig.2.13: Pipe Fittings

Any part used in connection with water supply, distribution, measurement, controlling, use, and disposal of water is known as a pipe fitting (Fig. 2.13).

2.3.1 Type of Fittings

- Collar
- Elbow
- Gasket
- Union
- Reducer
- Tee
- Nipple
- Trap

1. **Collar:** While joining two pipes of same diameter, collar is used. Collar is fitted in the end of pipe (Fig. 2.14).

Fig.2.14: Collar

2. **Elbow:** It is used to change the fluid direction by connecting two pipes with same or different nominal diameters. The fluid direction may be turned to a certain direction of 45° or 90°.

   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. 2.16).
   - **45° Elbow*:*** This is used when the change in direction required is 45° (Fig. 2.15).

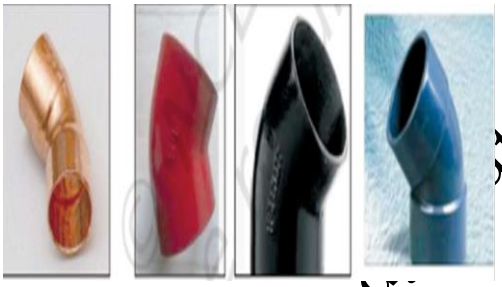


Fig.2.15: 45° Elbow (Bend)

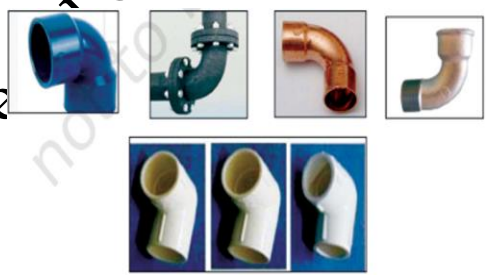


Fig.2.16: 90° Elbow (Bend)

3. **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 construction, materials, and features. Important gaskets used are non-metallic, spiral-wound, and ring-joint types (Fig. 2.17).

Fig.2.17: Gasket

4. **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.2.18).

Fig.2.18: Union

5. **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. 2.19).

Fig.2.19: Reducer

6. **Tee:** It is an important fitting with a side outlet at 900 to run off a 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.2.20–2.21).

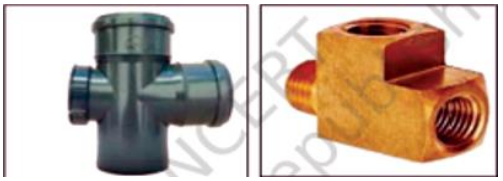


Fig.2.20: Single tee socket

Fig.2.21: Double tee socket

7. **Nipple:** It is a piece of pipe having thread at both sides, and could be used for short extension of plumbing lines. It can also be used for connecting two fittings within small distance (Fig. 2.22).

Fig.2.22: Nipple

8. **Trap:** It is a fitting in a P, U, S or J-shaped type (Fig. 2.23). 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.

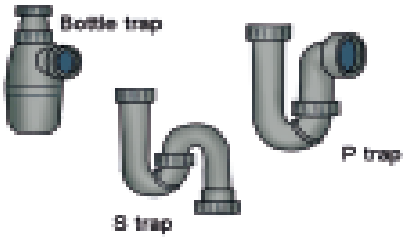


Fig.2.23: Types of Trap

9. **Cross:** When four pipes are joined, a cross is formed. It is also called a cross-branch line or a four-way fitting (Fig. 2.24). 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.2.24: Cross

10. **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. 2.25).

Fig.2.25: Offset

11. **Coupling:** A coupling is used to connect pipes of the same diameter. Couplings are also useful if the pipe is broken or leakage occurs. Generally, there are two types of couplings are available. Compression coupling and slip coupling. Compression coupling is a regular coupling that is connected between two pipes and it prevents

Compression coupling

Slip coupling

leakage by the arrangement of gaskets or rubber seals on both sides, otherwise, glue is provided. Slip coupling is easier to install and it contains two pipes that are arranged as one into another, the inner pipe can slide up to some length. So, we can fix long length damaged pipe by slip coupling (Fig. 2.26).

12. **Adaptors:** If the pipes are not having special ends or plain ends then adaptors make them threaded either male or female whichever is needed. Adopters are generally used for copper and PVC pipes. Male adapters contain male threads and female adapters contain female threads (Fig. 2.27). One end of the adapter is plain which is glued or welded or soldered to the plain pipe end.

Fig.2.27: Adaptor

13. **Olet:** Olets are used where standard sizes of fittings are not suitable for our requirements. When the inlet pipe size is larger compared to outlet pipes in t-sections, Olets are used (Fig. 2.28). Some important types of Olets are as follow:
    - Butt-Weld Olet
    - Socket weld Olet
    - Threaded Olet
    - Elbow Olet
    - Nipple Olet
    - Lateral Olet
    - Sweep Olet
    - Flange Olet

14. **Plug:** Plug is a component of plumbing component which is generally used to close pipe opening during inspections and repairs. Plug are generally containing male threads (Fig. 2.29).

Fig.2.29: Plug

15. **Cap:** A cap is a type of pipe fitting whose function is the same as a plug but the only difference is plug contains male threads and the cap contains female threads which are screws on the male thread of pipe. These are available in different materials like rubber, copper, steel, plastic etc (Fig. 2.30).

: Types of Olets

Fig.2.30: Cap

2.3 Pipe Joints

Pipes are connected with the help of joints. A variety of joints are used in the 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

The various types of pipe joints are as follows.

- Threaded joint
- Welded joint (butt welded, socket welded)
- Brazed joint
- Soldered joint
- Grooved joint
- Flanged joint
- Compression joint

1. **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. The threads are also made in various pipes like PVC, CI pipes, copper pipes, and GI pipes, etc. (Fig. 2.31). Threaded joints are used from 6 mm diameter to 300 mm diameter pipes.

Fig.2.31: Threaded Joint

2. **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. The cost of material is low, but the labour costs are more due to the non-availability of trained welders and fitters. (Fig. 2.32).

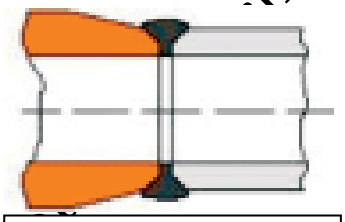


Fig.2.32: Welded Joint

3. **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. 2.33. Pipes having different diameters are suitable for this type of a joint. Socket-welded joint gives good results as compared to other joints.

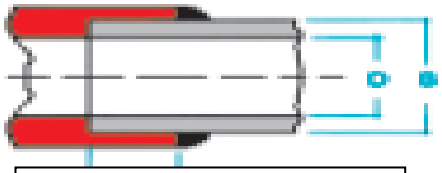


Fig.2.33: Socket-welded Joint

4. **Brazed joints:** When pipes are joined with the help of molten filler material at the temperature 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. 2.34).

Fig.2.34: Brazing

5. **Soldered joints:** Soldering and brazing are having similar mechanism. In soldering, the filler material melts at the temperature 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. 2.35).

Fig.2.35: Soldered Joint

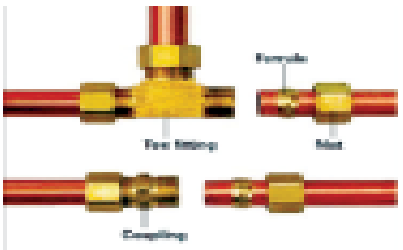
6. **Grooved joints:** When two pipes are joined together by making grooves (narrow cuts or depression) at the end of pipes with the help of sockets or couplings, such joints are called grooved joints. Due to the ease of assembly of the grooved joints, the labour cost is less. The piping system can be easily uninstalled and reinstalled frequently for maintenance (Fig. 2.36). These are mostly used for fire protection.

Fig.2.36: Grooved Joint

7. **Flanged joints:** This joint is commonly used for joining pipes in pumping stations, filter plants, hydraulic laboratories, and boiler houses, etc. (Fig. 2.37). These joints are preferred due to the 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 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.2.37: Flanged Joint

8. **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

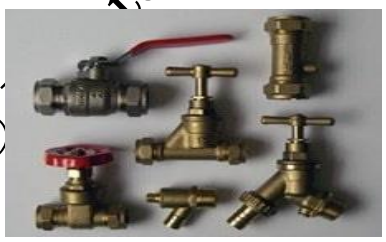


placed properly to check the flow pressure, otherwise, leakage may occur. These fittings are manufactured from different types of material. Selection of fittings is done as per requirement (Fig. 2.38).

Fig.2.38: Compression Joint

2.4 Valves in pipe fittings

Valves are components of the plumbing system that are used to stop or regulate the flow of fluid in its path. Different types of valves are available depending on their applications. 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. 2.39). Some important types of valves and its applications are listed below: -

Fig.2.39: Types of Valves

A. **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. 2.40 and Table 2.1).

Fig.2.40: Sluice Valve

Table 2.1: 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

B. Scour valve: This valve is provided at the lower level in a pipeline, so that such sections can be supplied and drained for maintenance purposes. 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. 2.41).

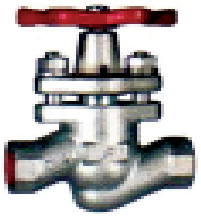


Fig.2.41: Scour Valve

C. 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. 2.42). 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.

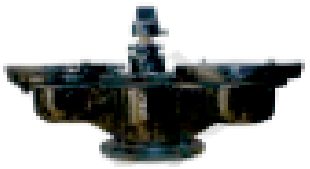


Fig.2.42: Air Valve

D. Gate valve: It is used for starting or stopping the flow. For a straight-line flow of fluid, minimum flow restriction can also be done with a 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. See Fig. 2.43 and Fig. 2.44.

Fig.2.43: Spilt taper non-rising gate valve

Fig.2.44: Rising spindle spilt wedge gate valve

E. Parallel slide valve: It has two discs without a spreading mechanism which slides between the two parallel body seats. The activation screw on the spindle and the spindle may be of the rising or non-rising type (Fig. 2.45).

Fig.2.45: Parallel slide valve

F. 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. 2.46).

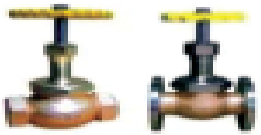


Fig.2.46: Globe valve

G. 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.2.47 and Fig. 2.48.

Fig.2.47: Angle valve-1

Fig.2.48: Angle valve-2

H. 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. 2.49).

Fig.2.49: Check valve

I. 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. 2.50–2.53).

Fig.2.50: Ferrule

Fig.2.51: Swing check

Fig.2.52: Horizontal check

Fig.2.53: Vertical check

J. **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 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. 2.54).

Fig.2.54: Foot valve

K. **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. 2.55).

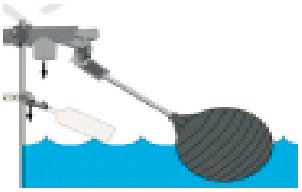


Fig.2.55: Float valve

2.5 Pipe Support Fixtures

A fixture is a work-holding or support device used in the manufacturing industry. Fixtures are used to securely locate (position in a specific location or orientation) and support the work, ensuring that all parts produced using the fixture will maintain conformity and interchangeability.

Different types of pipe support

1. **Support clamps and hangers** can help keep your pipes in place so that they don't shift around or break. They can also help you hang various items from the pipes, such as ceiling fans, light fixtures, and other household appliances. When working on a structure, it's essential to have the **right pipe supports** available. These pipe supports help keep your pipe firmly in place while

Fig.2.56: Support clamp and hanger

you work. If you're working on a job that requires precision, it's best to have support as well as stability (Fig. 2.56).

B. Pipe Support: When you're buying pipe supports, it's helpful to know what types of support are available to you. The following are the most common types of pipe supports:

i. Pipe Saddle Supports – Pipe saddle supports typically have a saddle shape and are made of aluminium. They are frequently used to support pressurised or extraordinarily long piping systems, like those for natural gas. Various sizes and materials are available for saddle pipe supports. They have a base that is attached by screws to a concrete foundation. They are relatively lightweight due to their aluminium construction, making it simple to move them around the job site (Fig. 2.57).

Fig.2.57: Pipe saddle support

ii. Pipe Stands – Pipe stands are used to support vertically or horizontally, straight and pressurized pipe. Pipe stands are mostly made of aluminium and are often used along with pipe saddles to support different pipe lengths. These are the most prevalent kind of pipe supports that are offered. Steel is typically used for pipe stands, which can hold pipes either vertically or horizontally. You can choose one that matches the weight of your pipes because of the wide range of sizes and materials that are available. Heavy loads can be supported by pipe stands. Although pipe stands made of stainless steel, zinc, and other high-temperature alloys are also available, aluminium pipe stands are the most common (Fig. 2.58).

Fig.2.58: Pipe Stand

iii. Pipe Hangers – Pipe hangers are used to suspend pipes from ceilings or walls. They can be made from galvanized steel, aluminium, stainless steel, or other materials. For use with pipe saddles and pipe stands, hangers are intended. They are mounted on a wall or ceiling and are made of sturdy steel Pipes can be suspended from walls or ceilings using hangers rather than screws or drilling into the building. There are numerous types, sizes, and materials for hangers. Round pipes, square pipes, and even rectangular tubing can all be fitted with hangers (Fig. 2.59).

Fig.2.59: Pipe Stand

iv. **Pipe Clamps** – Pipe clamps are used to hold pipes in place while they're under pressure. They're typically made of stainless steel, zinc, or other high-temperature alloys (Fig. 2.60).

Fig.2.60: Pipe Clamp

v. **Pipe support bracket**: These are the most prevalent kind of pipe supports that are offered. They are usually constructed of aluminium and are intended to be attached to a steel, metal, or wooden frame. You can maximise the value of your investment by using pipe brackets, which come in a variety of sizes and shapes. While other pipe support brackets can be used to hold up pipes above your head, some can be mounted on the ceiling. There are also pipe brackets that can hold both square and round pipes (Fig. 2.61).

Fig.2.61: Pipe support bracket

C. **Pneumatic Clamps:** These clamps fasten to threaded pipes, like those in a gas or water distribution system. Pneumatic clamps can be used to hold straps, hoses, and other objects that you attach to the pipes (Fig. 2.62).

Plumbing supply stores carry pneumatic clamps, which are primarily used in commercial settings. When a pipe is compressed, pneumatic clamps work by inflating a plastic bladder. The clamp opens as a result of this. Normally, you have to keep pumping air into the clamp until it stops, but if you want, it can run continuously.

Fig.2.62: Pneumatic clamp

The fact that pneumatic clamps are reasonably priced is by far their best feature. They are also not the strongest clamp. They frequently hold straps, but they don't hold threaded pipes well.

D. **Elbow Clamps:** Elbow clamps are majorly used in domestic plumbing. You can get a good seal on pipes thanks to the clamp's 90^0 bend at one end. Elbow clamps are available in a variety of sizes, allowing you to select the one that is best for your application. These clamps can typically be fastened to PVC, CPVC, and ABS piping. It is the easiest pipe support to use is an elbow clamp. They are simple to use and versatile enough to hold almost anything. Due to their wide grip, elbow clamps can also be used to hang items. They are also popular because of their low

Fig.2.63: Elbow clamp

cost. The main flaw with elbow clamps is how loosely they can hold pipes. They can also be damaged easily if they fall off the pipes (Fig. 2.63).

E. **Vertical pipe support:** Objects are hung from the ceiling using vertical pipe supports. To use one of these, first, join a rope or chain from the ceiling to a pipe beneath the item you wish to hang. The item should then be hung from the pipe using a pipe hanger. Hanging appliances and other fixtures benefit greatly from this kind of pipe support.
Vertical pipe supports come in a variety of forms, including chain, wire, and rail systems. The most popular types of systems use chains that are clipped to the ceiling. There are chains available with ratchet mechanisms that will automatically adjust to the height you set them at.

F. **Slip-on wrap:** You can choose the wrap that is best for your needs because they are available in a variety of sizes and shapes. They typically come in sets of five wraps, each of which has a specific function. To join two pipes together, to create a liquid barrier, or to secure a pipe in place are a few typical uses.
Slip-on wraps frequently cost more than other kinds of pipe supports. Due to the fact that they were created for a specific function, they are also not very versatile. They cannot be utilised to connect or secure pipes. Their adaptability is their best quality.

G. **Guard Hangers:** Guard hangers offer greater security than other pipe supports like slip-on wraps, chain systems, and rail systems. They are frequently used in public places like airports and schools. The best feature of them is their security; an additional rubber band around the middle prevents them from falling off the pipes.
Guard hangers' broad range of grip is another factor in why people favour them. They can be positioned practically anywhere along the pipe, from the surface to about 3/4 of the way down. This means that a guard hanger can be used on a variety of pipes. Guard hangers' primary disadvantage is that they are the most expensive kind of pipe support.

2.6 Fastening Hardware

A fastener is a piece of hardware that mechanically connects or fastens two or more objects. Fasteners can be used by engineers to build removable or detachable joints that are not permanent. Various hardware parts can be found in fastener assemblies or systems.

Different Types of Fasteners

Fastener used in plumbing system are as follows-

1. **Screws:** One of the most adaptable types of fasteners is the screw. Screw are threaded shaft with durable holding power. They have strong holding power thanks to their threaded shafts, and unlike a bolt, they don't need anything to hold them in place. Normally, a pilot hole is made in a material with a drill, and the screw is then driven in using a screwdriver. (Fig. 2.64).

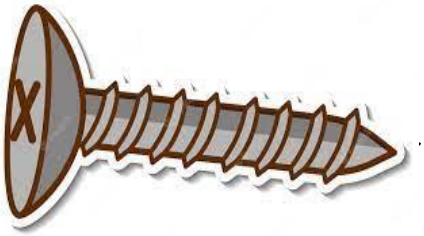


Fig.2.64: Screw

There are numerous types and sizes of screws. Some of the most common types of screws include:

- Wood screw
- Deck screw
- Drywall screw
- Sheet metal screw
- Machine screw
- Masonry Screw
- Board screw
- Exterior screw

2. **Nails:** A clear difference between a screw and a nail is that a nail does not have threading. Despite having less holding power than a screw, a nail has more shear strength, making it the better option in some situations. Finding the right kind of nail for a job can be simple because many nail varieties get their names from the uses for which they are best suited. Usually, they have particular qualities made to work with the materials or application at hand (Fig. 2.65).

Fig.2.65: Nails

Some common kinds of nails include the following:

- Common nail
- Box nail
- Brad nail
- Finishing nail
- Drywall nail
- Flooring nail
- Framing nail
- Roofing nail

3. **Nuts and Bolts:** Another common type of fastener is a nut or bolt. Together, these two parts hold components together. The bolt is inserted through the two pieces you want to connect, and it is then secured in place with a nut on the end (Fig. 2.66).

Fig.2.66: Nuts and Bolts

Some of the most common types of bolts:

- Carriage bolt
- Flange bolt
- Plow bolt
- Hex-head bolt
- Square-head bolt
- Allen bolt

Some of the most popular types of nuts are as follows:

- Coupling nut
- Flange nut
- Hex nut
- Lock nuts
- Slotted nut
- Square nut
- Wheel nut

4. **Washers:** Flat disc that distributes the fasteners load (Fig. 2.67).

Fig.2.67: Washer

Types of washers:

- Beveled washer
- Flat washer
- Lock washer
- Structural washer

5. **Anchors:** The reason why anchors are so named is because they perform a similar task to a boat's anchor, which imbeds itself in the ocean floor to prevent a ship from moving. The majority of the time, people will use these fasteners to attach something to plasterboard or concrete. They become enmeshed in the substance and secure the object you are fastening (Fig. 2.68).

Fig.2.68: Anchor

Some common types of anchors include:

- Internally threaded anchors
- Externally threaded anchors
- Masonry screw and pin anchors
- Screw anchors
- Hollow wall anchors

- Sleeve anchors
- Drive anchors

6. **Rivets:** A rivet makes a solid connection between two objects. They have a cylinder-shaped shaft with a head and a tail on either end. The tail is expanded with a special tool, ensuring that the rivet is retained. Compared to other types of fasteners, rivets are remarkably durable (Fig. 2.69).

Fig.2.69: Rivet

Some common types of rivets include:

- Blind rivet
- Semi-tubular rivet
- Solid rivet
- Split rivet
- Drive rivet

2.7 Various adhesive material

In plumbing systems various types of adhesive material are used for different purposes. Here are some adhesive materials like: -

1. **Sealing Material (Thread Seal Tape):** Thread Seal Tape or faucet is used for sealing pipe threads. It is manufactured from a poly tetra fluoro ethylene (PTFE) film. This tape is cut to the desired width and placed around the threads of a pipe, prior to fixing it in place (Fig.2.70).

Fig.2.70: Thread seal tape

2. **Plumber's Putty:** The putty is used as a sealant during plumbing (Fig. 2.71). It is a simple material needed for watertight seal around taps (also called faucets) and drains. The putty is one of the important components of a plumber's bag.

Fig.2.71: Plumber's Putty

3. **Sealing Adhesives:** These are used while joining plastic parts, fixtures, fittings, etc., and are mostly available in sanitary and hardware shops. These adhesives are made of chemicals. They can be used easily for effective sealing. It is applied locally with a brush. After application, the plumbing fitting should be fixed immediately so as to ensure a good grip (Fig. 2.72).

Fig.2.72: Sealing Adhesives

2.8 Marking Material

For the purpose of labelling industrial parts, goods, materials, and packaging, marking materials include inks, coatings, laser marking supplies, tapes, and other supplies. Marking materials come in a wide variety of shapes and are made for particular kinds of substrates.

You can learn how to use measuring and marking-out tools correctly by reading the following:

A. Knowing the best places to use certain tools.
B. Correctly reading dimensions from drawings or sketches.
C. Use the proper equipment for the job at hand and avoid compromising.
D. Have a thorough understanding of how to use tools.
E. Review all measurements and markings to make sure they are accurate.

2.9.1. Tools for measuring and marking out

The measuring and marking-out tools listed below are some of the various types used in the workshop for various tasks. It contains:

1. **Pencil:** One of the most popular marking-out tools is the pencil because it is simple to clean. For thin, light lines that won't engrave the workpiece, it should be used with an extremely lightly sharpened edge (Fig. 2.73).

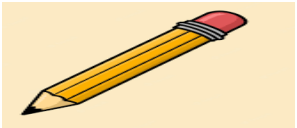


Fig.2.73: Pencil

2. **Steel rule:** These measuring instruments are made of steel and are used to create rigid straight lines on flat surfaces. It has a minimum length of 300 mm. The path becomes inaccurate if the measuring tools are not used properly (Fig. 2.74).

Fig.2.74: Steel Rule

3. **Measuring tape:** A measuring tape is a tool with a thin sheet in a rubber case that is marked with numbers. It can be used for large projects because it can be at least 5 metres long. The flexible sheet can twist and break if the user is not done carefully (Fig. 2.75).

Fig.2.75: Measuring Tape

4. **Marking gauge:** The marking indicators are different kinds of marking-out tools that draw parallel lines to edges so that debris can be cleaned off. For instance, a marking gauge can be used to scribe out the unwanted portion that will be removed with a chisel in a woodworking project where a small part needs to be cut off (Fig. 2.76).

Fig.2.76: Marking Gauge

5. **Engineer's square:** A perpendicular line can be drawn on a surface using a scribe and these hand tools. It is set down with the flat edge firmly touching the workpiece when it is placed on a workpiece surface. (Fig. 2.77).

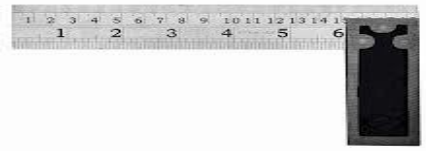


Fig.2.77: Engineer's Square

6. **Sliding bevel:** The required angle is created by adjusting the sliding bevel before using it to mark out a part. The line is then drawn on the material with a pencil (Fig. 2.78).

Fig.2.78: Sliding bevel

7. **Centre punch:** The centre punch aids in marking a drilling centre dot. The centre punch leaves a small surface impression in the metal after being driven into it with a hammer (Fig. 2.79).

Fig.2.79: Centre punch

8. **Odd-leg calipers:** The old-leg callipers help when marking a parallel line on plastic or metal. It has two legs, one of which has a foot and a guiding edge, and the other of which has a scribe point. The scribing edge marks a line parallel to the edge while the guiding side runs along the edge of the object to be scored (Fig. 2.80).

Fig.2.80: Odd-leg caliper

9. **Inside calipers:** These marking-out tools resemble the odd-leg callipers in appearance. On the inside of materials like tubes, they are used to measure distances. Additionally, these callipers have two legs, each with guiding feet that point outward. The braces are inserted into the substance or item to be measured and then extended until the feet contact the substance (Fig. 2.81).

Fig.2.81: Inside caliper

10. **Outside calipers:** The outside callipers make it easier to measure the outside diameters and thicknesses of materials. They are positioned around a material, their legs tightened so the guiding feet touch the workpiece, but they are not adjusted before removal. The length of the legs is then accurately measured against a steel rule (Fig. 2.82).

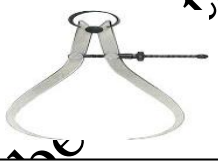


Fig.2.82: Outside caliper

11. **Micrometre:** This is used to provide an object's exact measurement. It can provide an accurate measurement of the material's outside edges and is a more accurate version of outside calipers (Fig. 2.83).

Fig.2.83: Micrometre

12. **Templates:** When several identical shapes or patterns need to be marked out, a template can be used. Any thin material, such as plywood or aluminium, or an item that is simple to draw around, can be used as a template.

2.9Cement mortar/concrete, applications and uses

The development of precast products as well as masonry work, plastering, repairing cracked or broken concrete, filling in or patching, rendering, and floor levelling all benefit from the versatility of cement mortar composite. Binder, sand, water, and fibres are the main components of the composite, with a maximum fine-grain material size of 2 mm Fig. 2.84).

Fig.2.84: Cement mortar/ concrete

While concrete is composed of cement, water, and aggregate made of lime, as opposed to concrete, which is made by mixing cement, water, sand, and gravel

in various ratios. Mortar is a more supplemental material than the primary building material for a project because it is not as long-lasting as concrete.

For all types of construction, including housing, roads, schools, hospitals, dams, and ports, as well as for decorative purposes (for patios, floors, staircases, driveways, pool decks) and objects like tables, sculptures, or bookcases, cement is primarily used as a binder in concrete.

2.10.1. Uses of Cement

- To make cement mortar.
- To make cement concrete.
- In grouting

2.10.2. Difference between mortar and concrete

Concrete is made up of cement, sand, and gravel while mortar is made up of cement and fine-binding powder.

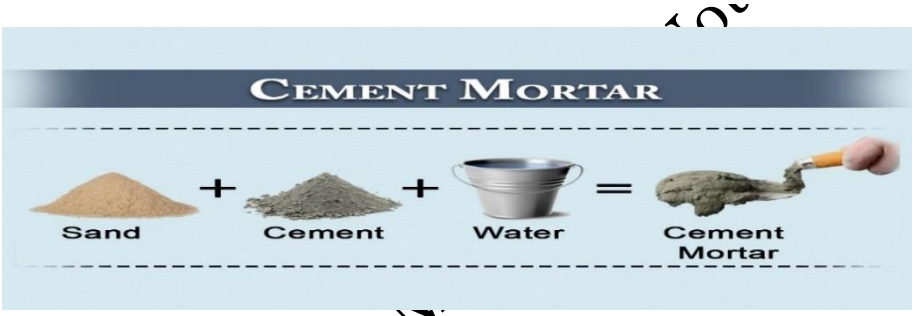


Fig.2.85: Cement mortar

Fig.2.86: Cement Concrete Composition

2.10 Basic and Advance Plumbing Tools

Basic and advance plumbing tools are as follows:

1. **Sink Auger:** A sink auger makes clearing and dislodging difficult clogs in tubs and sink drains much simpler. This tool has a stainless-steel flexible cable with a corkscrew tip at one end. To reach and unclog clogs, the cable is wrapped inside

a drum canister. This allows it to extend further into a drain. A thumbscrew secures the flexible cable to the canister, and the drum has a handle. When the cable is inserted into the drain and the handle is turned, the rotating drum snakes the cable through the drain pipe's various bends. As a result, the cable tip can easily remove the clogs in addition to penetrating them all (Fig. 2.87)

Fig.2.87: Sink Auger

2. **Hydro-Jetting Machine:** A blockage in the plumbing or sewer lines may be the primary cause of clogged drains and tainted water sources. Even the toughest clogs and accumulated debris can be removed by this high-pressure water system. These devices are used by advanced plumbing services to remove soap scum, hair that has become trapped, and other debris from pipes as well as to remove grease or sludge. Hydro-jetting machines ensure a thorough cleaning of the plumbing pipes in contrast to rodding, which involves using a tool to punch a hole through the debris. In addition, it can remove tree roots that have gotten into sewer drains as well as scale and mineral buildup. It is a typical problem for homeowners (Fig. 2.88).

Fig.2.88: Hydro-Jetting Machine

3. **Flex Shaft Drain Cleaning Machines:** One of the most advanced plumbing tools, high-speed flex shaft drain cleaning machines are a more recent innovation to plumbing technology. This machine mainly features chain knockers that are attached to a cordless drill-powered flexible cable. These drain-cleaning machines allow plumbing services to clear pipes very efficiently and quickly (Fig. 2.89).

Fig.2.89: Flex Shaft Drain Cleaning Machine

4. **Soldering Torch:** The purpose of a precision soldering torch is to form water-tight seals on pipes. When it comes to the gas used, MAPP gas or MAPP gas substitutes, instead of propane, makes for a safer choice (Fig. 2.90).

Fig.2.90: Soldering Torch

5. **Drain Inspection Camera:** Drain and Sewer Inspection cameras are essential to advanced plumbing service technology. They allow for a thorough inspection of the inside of pipes and sewer lines. These systems offer portability, high-definition video, long-lasting batteries, and self-levelling camera heads (Fig. 2.91).

Fig.2.91: Drain Inspection Camera

6. **PEX Plumbing Tools:** PVC and copper pipes used in plumbing are gradually being replaced with pipes made of PEX or cross-linked polyethylene. The material comes with a broad range of benefits, including direct pipe routes, flexibility, easier installation, and greater water pressure. It's also rust-proof and affordable. Introducing PEX into service offerings may require a few specialties plumbing tools, including PEX pipe expanders, and a PEX crimper (Fig. 2.92).

Fig.2.92: PEX Plumbing Tools Kit

7. **Metal Detectors:** A metal detector is a super handy tool that works wonders when it comes to making complicated plumbing tasks easy. A metal detector can help to locate well casing, buried iron, and steel objects, such as manhole covers, valve boxes, pipes, reinforced septic tanks, and more (Fig. 2.93).

Fig.2.93: Metal Detector

2.11 Lifting/load-shifting equipment used at plumbing work sites.

During the plumbing work, we require some lifting/load-shifting types of equipment to complete the task with accuracy. Here are some equipment used in the plumbing work site.

- **Ladder:** A ladder is a vertical or inclined set of rungs or steps used for climbing or descending. There are two types: rigid ladders that are self-supporting or that may be leaned against a vertical surface such as a wall, and rollable ladders, such as those made of rope or aluminium, that may be hung from the top (Fig. 2.94).

Fig.2.94: Ladder

- **Scaffolding:** A scaffold is a temporary structure made of bamboo or iron pipe to support workers to carry out the work. When scaffolds are not erected or used properly, falling hazards can occur (Fig. 2.95).

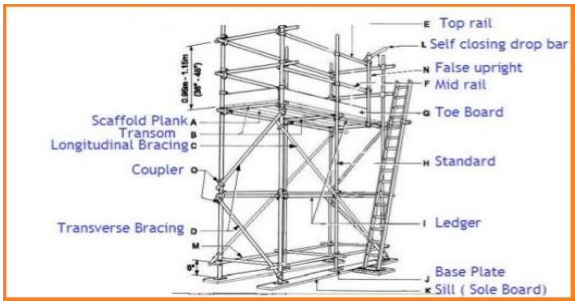


Fig.2.95: A. Scaffolding

Types of scaffolding

Fig.2.95: B. Types of Scaffolding

Precautions

i. Scaffold must be sound, rigid and sufficient to carry its own weight, plus four times the maximum intended load without settling or displacement. It must be erected on solid footing.
ii. Unstable objects, such as barrels, boxes, loose bricks or concrete blocks must not be used to support scaffolds or planks.
iii. The scaffold must not be erected, moved, dismantled or altered except under the supervision of person who supplies, installs and dismantles the scaffolding.
iv. The scaffold must be equipped with guardrails, mid rails and toe boards.
v. Scaffold accessories, such as braces, brackets, trusses, screw legs or ladders that are damaged or weakened must be immediately repaired or replaced.
vi. Scaffold platforms must be tightly planked with scaffold plank grade material or equivalent. A plank is timber that is flat, elongated and rectangular with parallel faces that are high and long.
vii. Synthetic and natural rope is used in suspension scaffolding, that is a hanging-type scaffolding. It must be protected from heat-producing sources.
viii. The scaffold can be accessed by using ladders and stairwells.
ix. The scaffolds must be at least 10 feet from electric power lines at all times.

- **Elevated work platform:** A machine or device with at least a work platform with controls, an extending structure, and a chassis is intended to move people, tools, and materials to working positions. An elevating work platform (EWP) is described in this learning guide as "a telescoping device, hinged device, articulated device, or any combination of these devices, used to support a platform on which personnel, equipment, and materials can be elevated to perform work."

Fig.2.96: Types of elevated work platform

EWP comes in a variety of forms, but they can all be categorised as either boom type or scissor type. Lifts for personnel or vertical masts are available in two variations (Fig. 2.96).

Operator of an EWP must ensure:

- Operation is authorised and in accordance with the safe work procedure.
- Mechanical faults are reported.
- Pre-operational checks are undertaken.

- Safe working load (SWL) or maximum rated capacity of the platform is not exceeded.

- **Hand trolley:** A vertical, L-shaped piece of transportation equipment with an upright handle, two wheels, and a small bottom ledge is called a hand trolley. These work best for moving bulk quantities of small, light items or small, heavy items that can't be lifted by hand. (Fig. 2.97).

Fig.2.97: Hand Trolley

- **Hoist:** A hoist is a tool used to raise or lower a load using a drum or lift wheel that a rope or chain is wrapped around. It can be manually operated, electrically or pneumatically powered, and it can lift objects using chain, fibre, or wire rope. The most common type is a lift, which uses a hoist mechanism to raise and lower the car. Most hoists use a lifting hook to connect to their loads (Fig. 2.98, Fig 2.99).

  A hoist is a mechanical tool used in the healthcare industry to move people with physical disabilities from one location or position to another. Due to the significant strains placed on the body during manual lifting and handling of a person, injuries (particularly back injuries) are frequently experienced.

Fig.2.98: Manual Hoist

Fig.2.99: Types of hoist

- **Jack:** A device for lifting heavy objects, especially one for raising the axle of a motor vehicle off the ground so that a wheel can be changed or the underside can be inspected (Fig. 2.100, Fig 2.101).

Fig.2.101: Hydraulic Jack

2.12 Soil Waste Rainwater

SWR pipes are a category of drainage pipes that are used for residential and industrial developments. SWR pipes and fittings are used for non-pressure plumbing applications, such as transportation of soil, waste and rainwater, non-pressure industrial drainage applications, and waste discharge systems in residential and commercial complexes, resorts, and hospitals. Types of Pipes: Type A — for use in ventilation pipe work and rain water harvesting applications. Type B — for use in soil and waste discharge systems (Fig. 2.102).

Fig.2.102: SWR pipes and fittings

2.13.1. Role of SWR in plumbing system: In addition to minimizing soil erosion and soil contamination by keeping pesticides, fertilizers, and animal waste out of the soil, SWR pipes are also used to keep water out of the soil. SWR pipe's primary function is to gather, store, and deliver rainwater from your home's rooftop to a certain destination. SWR stands for Soil, Waste & Rainwater, it is a collective term used for pipes and fittings that form a drainage system of either a residential or a commercial building. Soil part covers drainage from toilets and WC. Waste Part covers all outlets such as shower areas, Washbasins, kitchen sinks, floor drains. Rain part covers drainage of rain water from roof tops, balconies and other outdoor areas. Together the three elements cover the entire drainage requirements of any building.

2.13 Different types of pipe fittings

- **Ring fit pipe:** Pipes with both types of joints i.e. solvent cement type and rubber seal type are available. These pipes are used for a variety of applications like agriculture, irrigation, water supply, industrial process lines, etc. These pipes are superior to C.I., D.I., or R.C.C. pipes and offer a number of advantages like-lightweight, easy and fast installation, excellent corrosion and chemical resistance, high flow rates, long life, and economy (Fig. 2.103).
- **Seal fit:** The most common method of repairing leaking PVC pipes is pipe burst tape. This specialist repair tape is made from

Fig.2.103: Ring fit pipe

silicone and is self-fusing, meaning that it bonds to itself when wrapped around a damaged pipe to form a permanent bond over the leak area.

2.14 Joining/installation methods of pipe

When it comes to joining or installing pipes, there are several common methods used in various applications. The choice of method depends on the type of pipe material, the purpose of the installation, and the specific requirements of the project. Here are some commonly used methods for joining or installing pipes:

I. **Solvent Cementing Method:** Solvent cementing is commonly used for joining plastic pipes, such as PVC (polyvinyl chloride) or CPVC (chlorinated polyvinyl chloride) pipes. It involves applying solvent cement to the pipe and fittings, which softens the plastic and allows them to fuse together as the solvent evaporates.

II. **Push-Fit Connections Method:** Push-fit connections, also known as quick-connect or push-to-connect fittings, are popular for joining plastic or copper pipes. These fittings have a release collar that, when pressed, allows the pipe to be inserted, creating a secure and leak-proof joint without the need for tools or adhesives.

III. **Threaded Connections Method:** This method is commonly used for joining metal pipes. The ends of the pipes are threaded, and they are screwed together using fittings such as couplings, unions, or elbows. Threaded connections provide a secure joint but may require the use of sealants or thread tape to prevent leaks.

IV. **Welding Method:** Welding is a common method for joining metal pipes permanently. It involves melting the ends of the pipes and fusing them together using heat and pressure. Different welding techniques, such as arc welding, TIG (Tungsten Inert Gas) welding, or MIG (Metal Inert Gas) welding, may be used depending on the specific requirements and the type of metal being welded.

V. **Soldering/Brazing:** Soldering or brazing is commonly used for joining copper or brass pipes. It involves heating the joint area and applying a filler metal (solder or brazing rod) that melts and flows into the joint, creating a strong bond when it cools. Soldering is typically used for low-temperature applications, while brazing is suitable for higher-temperature applications.

VI. **Compression Fittings Method:** Compression fittings are used to join pipes without the need for heat or specialized tools. They consist of a compression nut, a compression ring (also known as a ferrule or olive), and a fitting body. The compression nut is tightened, compressing the ring onto the pipe and creating a watertight seal.

VII. **Flanged Connections Method:** Flanged connections are commonly used in large pipes or high-pressure applications. The ends of the pipes have flanges (flat or

raised collars), and they are bolted together using gaskets to create a secure joint. Flanged connections allow for easy disassembly and maintenance.

VIII. **Grooved Connections Method:** Grooved connections are widely used in commercial and industrial plumbing systems. They involve using grooved mechanical couplings that grip the pipe ends and create a joint by tightening bolts or fasteners. This method provides a reliable and easily assembled joint.

2.15 Pipe Supports

Pipe support is an essential component of piping systems, providing stability, alignment, and load-bearing capacity to pipes. Proper pipe support helps prevent sagging, excessive movement, and stress on the pipes, ensuring the integrity and longevity of the system. Here are some common types of pipe support:

I. **Pipe Hangers:** Pipe hangers are devices used to support pipes from overhead structures, walls, or other surfaces. They typically consist of a metal or plastic strap, rod, or clamp that secures the pipe in place. Pipe hangers come in various designs, such as clevis hangers, beam clamps, and suspension rods, and are selected based on the pipe size, weight, and location.

II. **Pipe Anchors:** Pipe anchors are used to restrain pipe movement in a specific direction. They are particularly important for handling thermal expansion and contraction of the pipes. Pipe anchors are usually installed at fixed points along the piping system and prevent excessive movement or displacement.

III. **Pipe Clamps:** Pipe clamps are used to hold and secure pipes to a fixed structure, such as a wall or a post. They are available in different configurations, including split clamps, U-bolts, and cushioned clamps. Pipe clamps provide stability and help distribute the weight of the pipe evenly along its length.

IV. **Pipe Guides:** Pipe guides are installed at strategic locations along the pipe run to control and guide the movement of the pipe. They help prevent lateral movement, maintain alignment, and reduce stress on the system. Pipe guides may include roller supports, sliding supports, or wear pads.

V. **Pipe Shoes:** Pipe shoes are structural supports placed under the pipe to bear the weight and distribute it to the supporting structure. They are typically used in situations where the pipe rests on a support beam or a concrete pad. Pipe shoes may consist of a metal plate, pad, or roller, which helps to minimize friction and movement.

VI. **Spring Supports:** Spring supports are used to support pipes subjected to vertical loads or thermal expansion. They consist of a spring element that absorbs the load and allows vertical movement of the pipe. Spring supports are designed to provide constant support force despite pipe deflection or movement.

VII. **Vibration Isolators:** In situations where pipes are exposed to vibrations or dynamic loads, vibration isolators are used. These devices help minimize the

transmission of vibrations to the surrounding structure and prevent damage. Vibration isolators can be in the form of spring mounts, neoprene pads, or flexible connectors.

It's important to consider factors such as pipe material, weight, temperature, and the surrounding environment when selecting and installing pipe supports. Compliance with local building codes and consulting with a professional engineer or piping designer is recommended to ensure proper support design and installation.

Operation

The functionality of the equipment to which a piping system is connected determines how it operates. However, caution must always be exercised to ensure that:

- The piping is not used at pressures or temperatures above those specified in its design;
- All joints are routinely inspected for leaks, and if any found leaks are reported right away;
- Before beginning any maintenance work on the piping, it is properly isolated and purged, if necessary;
- If line markings are not visible, they are made again;
- Immediately report any unusual vibration, damage, missing supports, etc.

Inspection and Maintenance

Maintenance and inspection needed on piping systems installed on offshore Installations are determined by residential and commercial requirements. Even after installation, maintenance and inspection are required. The process operator is not in charge of making sure that these requirements are met. But when the maintenance and inspection are done, he will be involved in isolating, purging, etc.

2.16 Deburring tool and Infrared thermometer and their application

Deburring tool: Deburring tools are relatively simple to use and are used to remove extra material from the edges or surface of a raw, unfinished product. To remove the burrs and leave a smooth and even finish, simply slide the blade at an angle along the edge. Tools for deburring are employed in numerous product applications. Examples include their use in instrumentation, forgings, hydraulic valves, pneumatic valves, aluminium die castings, screw machine parts, and zinc die castings. There are three types of deburring and chamfering tools; manual, rotary, and deburring blades (Fig. 2.104).

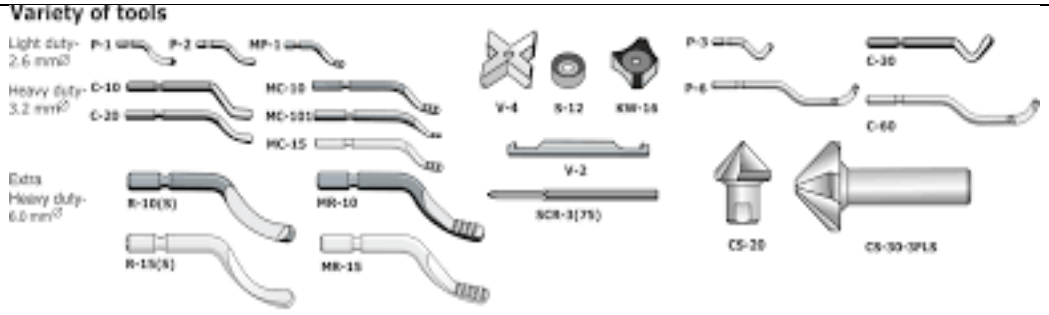


Fig.2.104: Types of Deburring Tool

- **Thermometer:** It is a tool for measuring temperature or a temperature gradient. Temperature gradient is a physical quantity that describes in which direction and at what rate the temp changes in a particular location. An instrument that measures temperature is a thermometer. It is able to gauge the temperature of solids like food, liquids like water, and gases like air. Celsius, Fahrenheit, and kelvin are the three most popular temperature measurement units. The metric system includes the Celsius scale (Fig. 2.105).

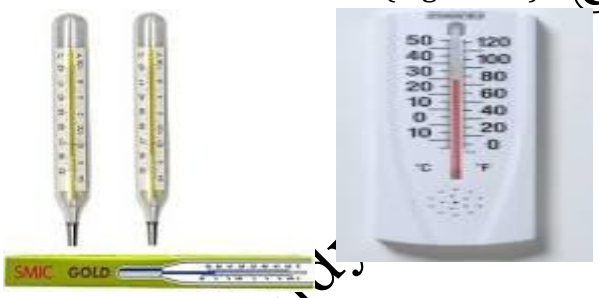


Fig.2.105: Types of Thermometers

2.17 **Gas Leak Detection Instrument**

A gas detector is a tool that checks for the presence of gases in a space, frequently as a safety measure. This kind of apparatus can interface with a control system to trigger an automatic process shutdown when it detects a gas leak or other emissions. Operators in the vicinity of the leak may hear an alarm from a gas detector, giving them the chance to leave. Oxygen depletion and toxic, flammable, and combustible gases can all be found using gas detectors. This kind of instrument is commonly used in industry and is found in places like oil rigs to monitor manufacturing processes and cutting-edge technologies like photovoltaics (Fig. 2.106).

Gas Leak Detection System

The process of locating potentially dangerous gas leaks using sensors is known as gas leak detection. When a dangerous gas is present, these sensors typically use an audible alarm to warn people. Painting, fumigation, fuel filling, construction, excavation of contaminated soils, landfill operations, entering confined spaces, and other activities can also expose workers to toxic gases.

Fig.2.106: Gas Detector

Combustible gas sensors, photoionization detectors, infrared point sensors, ultrasonic sensors, semiconductor sensors, and electrochemical gas sensors are examples of common sensors. Infrared imaging sensors have started to be used more recently.

Industrial facilities, refineries, pharmaceutical production facilities, fumigation facilities, paper pulp mills, ship and aircraft construction sites, hazmat operations, waste-water treatment facilities, vehicles, and indoor air quality monitoring facilities all use these sensors for a variety of purposes.

Gas leak Detection should consider the following factors:

- Human Factors;
- Objectives of gas leak detection systems;
- Types of gas leak detectors required;
- Maintenance of gas leak detectors; and
- Management of gas leak detector systems.

The Safety Report should address the following points:

Following points should be covered in the safety report:

- Failure of the detector should be identified in a timely manner (instrument response time, response to high readings, or alarm that fails to avert a serious accident);
- Detector malfunctions when an unsafe condition is not detected (reads zero);
- Protective devices, such as alarms and warning systems, stop working when needed,
- There's a leak that can't be found (because of the sensor's placement or the weather),
- Failure to follow maintenance instructions may result in a system that is less reliable or less efficient.

2.18 Use of Sink Auger in the Plumbing System

- **Sink auger:** A sink auger can be used to clear clogs in sinks and even bathtub drains that are clogged with hair (but not in toilets; for that, you may need a toilet auger or water closet auger). Other names for a washbasin auger include "canister auger" and "drum auger," as well as brand names like Flexisnake Drain Weasel, Brasscraft, Ryobi, and Ridgid. This is due to the auger's spinning drum canister, which is its largest component and aids in clearing clogs from drains. Few things can be as effective on a clogged drain as a sink drain auger, or drain snake, when it comes to homeowners dealing with clogs in the kitchen sink, bathroom sink or other sink drains. While using a plunger first can help clear the obstruction, using a plumbing snake to auger or "rooter" through tough clogs rather than chemical drain cleaners is preferable and possibly safer. The p-trap can be avoided by using the flexible drain snake auger, which can also reach clogs deeper inside the drain pipe (Fig. 2.107).

Fig.2.107: Sink Auger

Following steps to install sink auger in the plumbing system: -

- **Obtain a sink auger:** Purchase or rent a sink auger from a hardware store. Choose an auger suitable for the size of your sink drain.
- **Prepare the area:** Clear the area around the sink and remove any objects that may obstruct your access to the drain.
- **Insert the auger cable:** Extend the cable of the sink auger and insert it into the sink drain. Push the cable in slowly and steadily.
- **Rotate the auger:** Once the cable is inserted into the drain, start rotating the handle of the sink auger. This rotation helps the auger make its way through the clog.
- **Apply pressure:** As you rotate the auger, apply gentle pressure to push it through the clog. The cable should continue to advance as you rotate.
- **Break up the clog:** If you encounter resistance, continue to rotate the auger while applying more pressure. The cutting head or auger at the end of the cable will help break up the clog.

- **Retrieve the cable:** Once you feel that the clog has been cleared, retract the cable by rotating the handle in the opposite direction. Slowly pull the cable out of the drain.
- **Test the drain:** After removing the auger, run water down the sink to see if the clog has been cleared. If the water flows smoothly, the clog has likely been resolved. If not, you may need to repeat the process or consider calling a professional plumber.

  Remember to always follow the manufacturer's instructions when using a sink auger, and exercise caution to avoid damaging the plumbing pipes. If you're unsure or uncomfortable performing the task yourself, it's best to contact a licensed plumber for assistance.

2.19 PVC Pipe Cutter and Advance Laser Distance Meter

- **Pipe cutter:** Pipe cutters are instruments used to slit or cut pipes. Plumbing professionals frequently use them because of their dependability and effectiveness. Pipe cutters not only offer precise, expert-quality cuts but are also frequently more practical, quick, and user-friendly than alternatives like hacksaws.

  The best tool for this job is a PVC pipe cutter, also referred to as a tube cutter. Shears, ratchet, and C-shaped pipe cutters are the three most common designs for PVC pipe cutters (Fig. 2.108).

Fig.2.108: Pipe Cutter

  Plumbers use a particular kind of tool called a pipe cutter to cut pipe. Although it depends on the metal of the pipe, using the tool to cut pipe is frequently quicker, cleaner, and more convenient than using a hacksaw. Two different kinds of pipe cutters exist. For thinner pipes and tubes, such as sprinkler pipes, plastic tubing cutters, which resemble a pair of pruning shears, can be used. There is a pipe cutter with a sharp wheel and movable jaw grips for use on thicker pipes. These are applied by rotating it around the pipe and retightening it numerous times until it completely cuts through.

- **Laser distance meter:** A laser distance measurer or laser distance meter quickly and accurately calculates the separation between two points. The laser distance meter's predetermined measurement edge serves as the measurement's starting point, and the beam's endpoint serves as its second point (Fig. 2.109).

Fig.2.109: Laser Distance Meter

Steps involve in measuring distance from laser distance meter are as follows:

1. Hold the device firmly against your chosen starting point. This may be a wall, floor, or inside of a door frame. ...
2. Turn the laser distance measure on and point it where you would like to measure. ...
3. Press the measure button.
4. Keep the laser still until the measurement appears on the screen.

Use of a laser distance meter

Use to erect floor supports in sizable conference rooms. To determine how much paint is required, measure the size of the room. To determine how much floor covering is required, measure the space. To choose the right ladder, take a height measurement.

2.20 Tankless hot water heater

A tankless water heater, also known as an electric instant water heater or an instant water geyser, is different from a storage water heater and other traditional water heaters as it does not store hot water. Instead, it heats the water as you use it thus delivering instant hot water on demand (Fig. 2.110).

Fig.2.110: Tankless water heater

Following points about tankless water heaters:

- **How it works:** When a hot water tap is turned on, cold water enters the tankless water heater unit and passes through a heat exchanger. The heat exchanger rapidly heats the water using either electric heating elements or a gas burner. The heated water then flows out of the unit and to the tap or appliance where hot water is needed.

- **Energy efficiency:** Tankless water heaters are more energy-efficient compared to traditional storage tank water heaters. Since they heat water only when it's needed, they don't have standby heat loss, which occurs in tank-style heaters. This can result in significant energy savings over time.
- **Continuous hot water:** With a tankless water heater, you have an endless supply of hot water. As long as the unit can meet the demand, you won't run out of hot water during showers or other activities that require hot water.
- **Size and space requirements:** Tankless water heaters are typically more compact than traditional water heaters, as they don't require a large storage tank. This makes them suitable for small spaces and can be mounted on walls or installed in more convenient locations.
- **Flow rate and capacity:** The flow rate of a tankless water heater determines how much hot water it can supply. It is essential to select a unit that can meet your household's hot water demands. The capacity of tankless water heaters is measured in gallons per minute (GPM), which indicates the volume of hot water the unit can provide.
- **Installation considerations:** Installing a tankless water heater may require professional installation, especially when converting from a traditional storage tank system. You may need to consider factors such as the electrical or gas supply, venting requirements, and ensuring the unit is properly sized for your hot water needs.
- **Maintenance:** Tankless water heaters typically require less maintenance compared to traditional water heaters. However, it's important to perform periodic maintenance, such as descaling the unit to remove mineral buildup, to ensure optimal performance and longevity.

2.21 Types of water meters and their application in domestic and industrial units

Water meter: An instrument for recording the volume of water passing through a particular outlet. A water meter is a device that can be used to measure how much water flows through a particular point. For instance, a water meter might gauge how much water enters a building or a specific area of a building over a predetermined time period. This measurement can be used to gauge consumption and determine costs. Meters are frequently installed to track gas and electricity usage (Fig. 2.111).

Fig.2.111: Water meter

The building's entire water intake is measured. A built-in mechanism is spun by the water that flows through the water meter. The water meter measures a specific volume of water with each full rotation; the volume is displayed in cubic meters

on the display immediately afterward. Even though there are many different kinds of water meters, they all function by using the same fundamental parts. The Sensor, Transducer, Counter, and Indicator are these parts.

Types of a water meter

There are several types of water meters commonly used to measure the flow of water in residential, commercial, and industrial settings. The main types of water meters include:

I. **Mechanical Water Meters:** These are traditional water meters that use mechanical components to measure water flow. They typically consist of a chamber with a rotating impeller or turbine that spins as water passes through it. The rotation of the impeller or turbine is proportional to the volume of water flowing through the meter.

II. **Ultrasonic Water Meters:** Ultrasonic water meters use ultrasonic waves to measure water flow. They have two transducers that emit and receive ultrasonic signals. The time it takes for the signals to travel between the transducers is used to calculate the flow rate.

III. **Electromagnetic Water Meters:** Electromagnetic water meters operate based on Faraday's law of electromagnetic induction. They have a magnetic field that interacts with the conductive properties of the water flowing through the meter. This interaction generates an electric voltage that is proportional to the flow rate.

IV. **Static Water Meters:** Static water meters, also known as displacement meters, use a piston or nutating disk to measure water flow. As water passes through the meter, the piston or disk moves, and the displacement is used to calculate the volume of water.

V. **Vortex-Shedding Water Meters:** Vortex-shedding water meters utilize the principle of vortex shedding to measure flow. They have a bluff body or sensor that causes vortices to form as water passes through them. The frequency of vortex-shedding is proportional to the flow rate and is used to calculate the water volume.

VI. **Smart Water Meters:** Smart water meters incorporate digital technology and communication capabilities to provide real-time water usage data. They can be mechanical, ultrasonic, electromagnetic, or static meters with additional features like remote monitoring, leak detection, and data transmission.

Water meters used for domestic and industrial purposes are as follows:

1. Domestic Units

- **Billing and Consumption Monitoring:** Water meters accurately measure the amount of water consumed by households. This data is used for billing purposes, ensuring that individuals are charged according to their actual usage.
- **Water Conservation:** By providing real-time information on water usage, meters help homeowners identify excessive consumption and encourage

conservation efforts. This awareness prompts people to reduce water wastage and adopt water-efficient practices.

- **Leak Detection:** Water meters can detect even small leaks within a household's water supply system. Sudden spikes in water usage can indicate a leak, enabling prompt repairs and preventing water loss.

2. Industrial Units

- **Resource Management:** Industrial facilities often require significant amounts of water for manufacturing processes, cooling systems, or other operations. Water meters help industries monitor and manage their water consumption, optimizing usage and reducing waste.
- **Compliance with Regulations:** Many industries need to adhere to specific water usage regulations or permits. Water meters provide accurate data for reporting and demonstrate compliance with legal requirements.
- **Cost Control:** By tracking water consumption, industrial units can identify areas of high usage and implement strategies to reduce costs. Meters enable companies to monitor water-intensive processes, identify inefficiencies, and implement measures to increase efficiency.

Overall, water meters are essential tools for both domestic and industrial units. They promote water conservation, enable fair billing, facilitate leak detection, and assist in complying with regulations. By monitoring water consumption accurately, these meters contribute to sustainable water management practices and encourage responsible water usage in households and industries.

2.22.2. Installation procedure of water meter

Install meters horizontally at the specified location, with the arrow (usually displayed in the lower case) pointing in the direction of the flow of the meter. The meter must be installed with the indication device facing up and at a 90° angle to the flow being measured.

2.22.3. Procedure of installation of water meters

After tapping a connection from a pipeline flush the laid pipes thoroughly before installing a meter: -

1. Test the meter before installing it,
2. Install a meter in a way that the flow of water flows in a full bore in the meter,
3. Install the meter to the pipeline ensuring that the arrow on the meter body coincides with the direction of water flow,
4. Meter diameter and the pipe diameter that the meter will be installed should be of the same diameter,
5. Threaded meters must be installed using their meter liners/ connectors but not directly to a pipe fitting,
6. Locations that are subjected to severe shocks or hammers should be avoided,

7. For consumer meter installations, use a stop cock, and where the gate valve is used incorporate a non-return valve to protect the meter from reversing when rationing or emptying the pipeline. This is because all meters are not manufactured with in-build non return valves,
8. Where water is not free from debris strainer should be installed upstream of the meter to protect it at all times,
9. Avoid coupling a meter direct to the sluice valve, provide a straight pipe length equivalent to 10 times the diameter of the meter up and downstream to the meter,
10. Meter should not operate with a free discharge, there should always be some downstream resistance
11. Flanged meter when making a gasket to couple it to a flange make sure the internal diameter is precise to the meter's internal diameter,
12. Install a meter above the ground level to avoid it from being buried,
13. Protect the meter by covering it from direct rays.

Activities

Activity 1: Make a list of the plumbing pipe installed in your house.

Material Required

1.Notebook
2.Pen
3.Pencil
4.Sharpener
5.Eraser

Procedure

1.Take a look around your house.
2.Identify the plumbing pipes fitted in the house.
3.Make a list of identified plumbing pipes available in your house.
4.Write their name, specification and usage.

Activity 2: Make a list of plumbing fittings and joints used at work site

Material Required

1.Notebook
2.Pen
3.Pencil
4.Sharpener
5.Eraser

Procedure

1.Visit a work site.
2.Identify the plumbing pipes fittings and joints used at work site.
3.Make a list of identified plumbing pipe fitting and joint used
4.Write their specification.

Activity 3: Identify the sealing material in a shop.
Material Required
1.Notebook
2.Pen
3.Adhesive, Putty, and Thread seal tape
Procedure
1.First visit the hardware shop.
2.Collect the sealing material from a shop.
3.Read the content written on the packing.
4.Identify the purpose of this material.

Activity 4:Write down working of advance plumbing unit at your home.
Material Required
1.Notebook
2.Pen
3.Pencil
4.Sharpener
5.Eraser
Procedure
1.Identify and name the advance plumbing unit at your home.
2.Write down its uses and how it is different from traditional one.
3.Draw a line diagram
4.Explain its working.

Activity 5: Identify the measuring and marking tools available in a shop used in plumbing.
Material Required
1.Notebook
2.Pen
3.Pencil
4.Sharpener
5.Eraser
Procedure
1.First visit the hardware shop.
2.Collect the measuring and marking tools available in a shop used in plumbing.
3.Draw a figure of anyone measuring and marking the tool.
4.List the measuring and marking tools and write their use.

Activity 6: Write down steps involve in installation of Advance Plumbing System.
Material Required:
1. Notebook
2.Pen
3.Pencil
4.Sharpner
5.Eraser
Procedure:
1.Identify the advance plumbing unit in the house.
2.Name and write its uses
3. Draw the line diagram of it
4.Write down the steps involve in installation of Advance Plumbing System unit.

Check Your Progress

A. Answer the following questions

1. Explain the different types of plumbing pipes.
2. What do you mean by pipe fittings and their use.
3. Write the procedure of pipe laying.
4. Explain the pipe joint and their types.
5. What is the role of pipe support in plumbing work?
6. What is a fastener?
7. Describe the cement mortar/concrete and their application and uses.
8. Explain the different types of advance plumbing tools used in plumbing work.
9. Define the term SWR. Write its role in a plumbing system.
10. Explain the joining/installation process of the pipe.
11. Write the working principle of a gas leak detector.
12. What is the role of a pipe cutter in plumbing work?
13. What is a laser distance meter, and how it works?
14. What is the use of a tankless water meter.

B. Fill in the blanks

1. Mostly medium-grade type pipes are preferred for …….. plumbing work in a building.
2. …….. are components of the plumbing system that are used to stop or regulate the flow of fluid in its path.
3. Install the meter to the pipeline ensuring that the arrow on the meter body coincides with the …….. of water flow.

4. A …….. is a device that can be used to measure how much water flows through a particular point.
5. A laser distance meter quickly and accurately calculates the separation between …….. points.
6. The process of locating potentially dangerous gas leaks using …….. is known as gas leak detection.

C. Mark the correct option

1. It is a tool with a thin sheet in a rubber case that is marked with numbers.
   a) Scale
   b) Calliper
   c) Measuring tape
   d) All of above
2. These are traditional water meters that use mechanical components to measure water flow.
   a) Mechanical water meter
   b) Vortex water meter
   c) Electromagnetic water meter
   d) Smart water meter
3. This is a tool that checks the presence of gases in space, frequently as a safety measure.
   a) Water meter
   b) Liquid detector
   c) Temperature detector
   d) Gas leak detector
4. When two ends of pipes are joined, the pipe fitting used is called ……..
   a) Union
   b) Trap
   c) Cross
   d) Tee
5. These measuring instruments are made of steel and are used to create rigid straight lines on flat surfaces.
   a) Tape
   b) Steel rule
   c) Scale
   d) All of above
6. These pipes are mostly used inside the building for water supply work.
   a) Cast Iron pipe
   b) Galvanised iron pipe
   c) Concrete pipe
   d) Copper pipe

7. 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 ……..
   a) Trap
   b) Union
   c) Cross
   d) Offset

Module 3	Installation and Maintenance of Plumbing

Module Overview

In the previous units, we have understood the meaning of advance plumbing system along with the fittings and fixtures used in it. Besides knowing the benefits and suitability of material in various tasks, a plumber must also be efficient in the measurement of plumbing material with the help of measurement tools and should be able to manage the conversion of units easily. Similarly, a plumber should also be able to understand and read the various symbols used in plumbing drawings which is helpful easy to design a plumbing layout.

Plumbing materials are needed as per the requirement of the planned plumbing work. Plumbing fittings and fixtures are available in the market in different sizes and types. The size of the plumbing items can vary from inch to feet and metre in height. Plumbing items are also available as per volumetric capacity like water tanks, storage and flush tank, etc. Knowledge of various dimensions and sizes of plumbing items is crucial in the proper selection and purchasing of plumbing materials in the market. It is crucial for the plumber to be aware of all the rules and codes that must be adhered to when installing a plumbing system.

Learning Outcomes

After completing this module, you will be able to:

- Understand basic plumbing systems
- Recognize plumbing tools and materials
- Understand basic installation techniques
- Understand various maintenance practicces carried out in plumbing

Module Structure
3.1 Need of plumbing drawings
3.2 Measurements from plumbing drawings and plans
3.3 Importance of the planning of work schedule
3.4 Types of pipes, their installation, and fittings
3.5 Installation of drainage and venting systems.
3.6 Repair and maintenance of sanitary waste, drainage, and venting systems
3.7 Importance of grouting and its application in plumbing system
3.8 Installation of plumbing fixtures
3.9 Detecting water leaks and their repairs, and follow SOP
3.10 Concealing PVC pipes inside the wall
3.11 Installation of water tank alarm
3.12 Identification of major faults in a plumbing system
3.13 Scale formation of overhead tank, faucet, and other plumbing fittings

3.1 Need of plumbing drawings

Plumbing drawings are important because they provide a detailed plan for the installation and maintenance of the plumbing system. A plumbing drawing is a type of technical drawing that provides visual representation and information relating to a plumbing system. It is used to convey the engineering design to plumbers or other workers who will use them to help install the plumbing system. These drawings are used to show clearly the location of fixtures, sanitary ware, pipework, valves, and so on, and illustrates how freshwater is to be supplied into a building and wastewater removed. To illustrate the separate hot and cold water supply, the pipe runs will usually be coloured red and blue respectively. Drainage pipes should be illustrated with the grade (slope) indicated. Where manholes are located , a manhole schedule should detail the name, invert level, cover level, and depth. Plumbing can also be detailed as a shop drawing in which the pre-fabricated components are shown in terms of how they will be connected, interlinked, and so on.

Purpose- A plumbing drawing, a type of technical drawing, shows the system of piping for freshwater going into the building and waste going out, both solid and liquid. It also includes fuel gas drawings.

Plumbing Layout

Along with the planning for the construction of a building or house, you should also plan the layout of a plumbing system (Fig. 3.1).

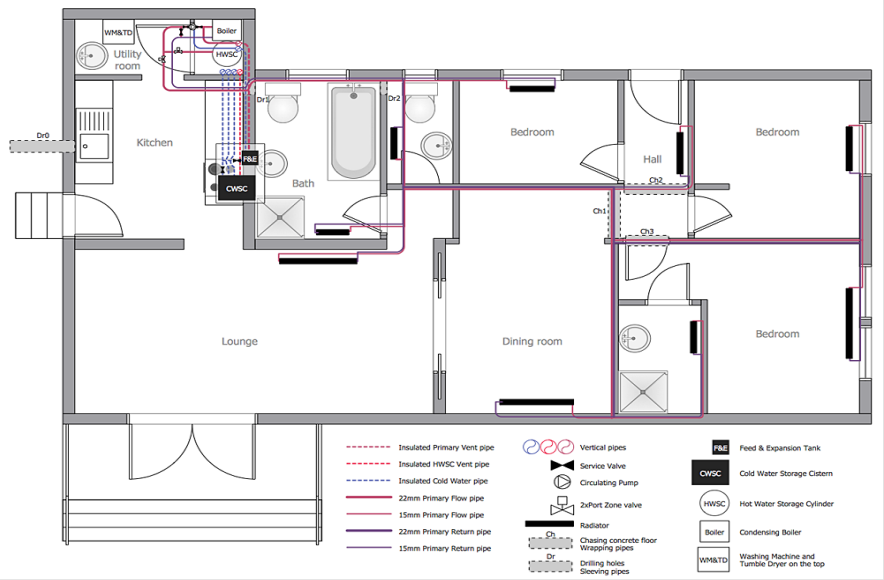


Fig 3.1: Layout of the residential plumbing system plan

3.2 Measurements from plumbing drawings and plans

A plumber must also be conversant with in the measurements such as length, width, thickness, diameter etc. of plumbing material with the help of measurement tools and should be able to manage the conversion of units easily. Similarly, a plumber should be familiar with various symbols.

3.3.1. Measurement of Length

A plumber uses the metallic tape, cloth tape, scale and foot rule for measurement of length of materials and works. For measurement, certified tapes must be preferred. In plumbing measurement, both metric system and FPS (Foot-Pound-Second) system are used. The symbol of feet is (′) and the symbol of inch is (″). For example, the meaning of 4′-9″ is four feet nine inches.

(a) In metric systems 1 metre = 10 decimetre (dm), 1 metre = 100 centimetre (cm), 1 metre = 1000 millimetre (mm), 10 millimetre = 1 centimetre (cm), 10 centimetre = 1 decimetre (dm), 10 decimetre = 1 metre (m)

(b) In the FPS system 1 feet = 12 inches 3 feet = 1 yard

(c) Inter-relation of Metric and FPS system: Both type of systems can be interrelated, for taking length, in the following manner : 1 inch = 25.4 mm = 2.54 cm 1 metre = 39.37 inches = 1.09 yard

Measurement of Weight

1 kilogram	= 1000 gram
100 kilogram	= 1 quintal
1000 kilogram	= 1 metric ton

3.3.2. Length Conversion

Length conversion is depicted in the following.

Measurement of Volume

Conversion Table for Volume:

10 litres= 1 decimetre (dl) = 2,6417 gal, or 1.135 pk
10 decilitres = 1 hectolitre (Hl) = 2.8375 bu
10 hectolitre = 1 kilolitre (kl) = 61027.0515 cubic inch or 28.375 bu
1 cubic foot = 28.317
1 gallon (American) = 3.7851
1 gallon (British) = 4.5431
1 gallon = 4.546 litre

Measurement of Density

Density conversion is depicted below:

1 1b/ft^3 = 16.018 kg/m^3
1 kg/m^3 = 0.0624 1b./ft^3
1 1b/in^3 = 27.68 g/cm^3

Measurement of Pressure

Pressure conversion is depicted below:

1 1b/ft^2 = 4.8824 kg/m^3 = 1 1b/metre^2 = 6.895 KgN/m^2
1 1b/inch^2 = 0.0703 kg/cm^3

Comprehensive Conversion Table

Millimetres	= 25.400	x inches
Metres	x 3.2809	= feet

Metres	= 0.3048	x feet
Kilometres	x 0.621377	= miles
Kilometres	= 1.6093	x miles
Square centimetres	x 0.15500	= square inches
Square centimetres	= 6.4515	x square inches
Square metres	x 10.76410	= square feet
Square metres	= 0.09290	X square feet
Square kilometres	x 247.1098	= acres
Square kilometres	= 0.00405	x acres
Hectares	x 2.471	= acres
Hectares	0.4047	X acres
Cubic centimetre	x 0.061025	= cubic inches
Cubic centimetre	= 16.3266	x cubic inches

Comprehensive Conversion Table

Cubic metre	x 35.3156	= cubic feet
Cubic metre	= 0.02832	x cubic feet
Cubic metre	x 1.308	= cubic yard
Cubic metre	= 0.765	x cubic yard
Litres	x 61.023	= cubic inches
Litres	= 0.01639	x cubic inches
Litres	x 0.26418	= U.S. gallons
Litres	= 3.7854	x U.S. gallons
Grams	x 15.4324	= grains
Grams	= 0.0648	x grains
Grams	x 0.03527	= Ounces, avoirdupois
Grams	= 28.3495	x Ounces, avoirdupois
Kilograms	x 2.2046	= pounds
Kilograms	= 0.4536	x pounds
Kilogram per squre centimetre	x 14.2231	= 1b. per sqin
Kilogram per squre centimetre	= 0.0703	x 1b. per sqin
Kilogram per squre cubic metre	x 0.06243	= 1bper cuft
Kilogram per squre cubic metre	= 16.01890	x 1bper cuft
Metric tons (1000 kilogram)	x 1.1023	x tons (2000 1b)

Metric tons (1000 kilogram)	= 0.9072	x tons (2000 1b)
Kilowatts	x 1.3405	= horse power
Kilowatts	= 0.746	x horse power

3.3 Importance of Planning of the work schedule

A work schedule is a plan that outlines when and how work tasks should be completed. It can also include information about designated work hours, breaks, lunch times, and any other details related to work activities that need to be done.
A work schedule is necessary for any team that wants to provide the highest quality of service possible. By defining the right number of staff you need, redistributing workloads, and preventing your team from becoming overwhelmed with work, you can ensure that everyone is at the correct place and time in order to meet customer needs.

Scheduling is the art of planning your activities so that you can achieve your goals and priorities in the time you have available. When it's done effectively, it helps you: Understand what you can realistically achieve with your time. Make sure you have enough time for essential tasks.

A schedule establishes a predictable routine that reduces stress and improves efficiency. It makes decision-making easier, eliminates uncertainties, and builds healthy habits to manage your time and energy better. It can be a part of productivity planning and goal management. Meticulous planning of work schedule is half way through completion of the specified work.

3.4.1. Features for a perfect work schedule

A work schedule should encompass the following qualities to be deemed successful:

- **Proper planning ahead of time:** A work schedule is most effective when it's planned in advance. This allows enough time to work out changes that may be needed and to ensure the best work-life balance for each employee.
- **Communication:** Clear communication is essential to ensure work schedules are properly communicated and understood by all parties involved. All instructions and expectations should be clear from the start to avoid any confusion or issues later down the line.
- **Each shift is staffed properly:** Ensuring each shift is properly staffed will ensure workflows are not disrupted and employees know what's expected of them.
- **Equal distribution of shifts:** Every employee should be given a fair chance to work the shifts they prefer, so work schedules should be designed with this in mind.

- **Clear policies for overtime:** Setting clear policies and procedures for overtime work is necessary to avoid any misunderstandings or abuse of the system.
- **Suitable timing for breaks and lunch periods:** All work schedules should include designated break and lunch periods to ensure workers are given enough time to rest and refuel throughout the day.
- **Not overworking any employee:** It is important to keep work schedules consistent and avoid overworking any employee in order to prevent burnout.
- **Monitoring schedule adherence:** Regularly monitoring work schedules helps to ensure that employees are following the rules and not taking any shortcuts.

Work related information is a system that helps people in an organization share, access, and update business knowledge and information. An effective workplace knowledge system reduces the costs of inefficiency by making company knowledge more available, accessible, and accurate.

Basic work-related information in plumbing

Here's some basic work-related information about plumbing.

a) Plumbers are skilled professionals who install, repair, and maintain systems used for water supply, drainage, and sewage in residential, commercial, and industrial buildings. They work with pipes, fixtures, valves, and other plumbing equipment to ensure the proper functioning of plumbing systems.

b) Many plumbers receive their training through apprenticeship programs, which combine on-the-job training with classroom instruction. These programs typically last for several years, during which apprentices learn various aspects of plumbing, including safety practices, blueprint reading, pipefitting, and plumbing codes. Some plumbers also acquire formal education through technical schools or community colleges.

c) Plumbers are often required to obtain a license to work in their jurisdiction. Licensing requirements vary by location but generally involve passing an exam that assesses the plumber's knowledge and understanding of plumbing codes and regulations. Certification from professional organizations, such as the Plumbing-Heating-Cooling Contractors Association (PHCC) or the National Inspection Testing and Certification Corporations (NITC), can also enhance a plumber's credentials.

d) Successful plumbers possess a wide range of skills and qualities.

e) Plumbers should have a solid understanding of the various types of pipes, fixtures, and valves used in plumbing systems, as well as their installation and repair methods.

f) Plumbing issues often require troubleshooting and problem-solving skills to identify and fix problems efficiently.

g) The job of a plumber can involve working in confined spaces, lifting heavy objects, and standing or kneeling for long periods. Good physical fitness is essential.

h) Precision is crucial in plumbing to ensure proper connections, avoid leaks, and comply with building codes and regulations.
i) Plumbers frequently interact with clients, contractors, and other professionals. Clear communication is essential to understand clients' needs and relay information effectively.
j) Plumbers work in various settings, including residential homes, commercial buildings, construction sites, and industrial facilities. They may work indoors or outdoors, depending on the project. Plumbers often work full-time and may be required to handle emergency repair calls outside of regular working hours.
k) With experience, plumbers can advance to supervisory or management roles, overseeing teams of plumbers or starting their own plumbing businesses. Continuing education and staying updated on industry advancements are important for professional growth.

3.4 Types of pipes, their installation, and fittings

In plumbing work different types of pipes are used, here some of the types of pipes are focused.

PVC pipe: These pipes are mostly used for carrying water in the plumbing system and are light in weight, non-corrosive, cheaper in cost, and need not require any threading for joining connections. It makes them easily acceptable in the market. PVC is commonly used material in the manufacture of pipe (Fig. 3.2). PVC comes in two varieties: UPVC and CPVC.

Fig.3.2: PVC Pipe

A. **UPVC (Unplasticized Polyvinyl Chloride) Pipe**: These pipes are made from rigid polyvinyl chloride resin, which is not plasticized with additives. These pipes are typically joined using solvent cement or threaded fittings, depending on the application. Commonly these pipes are used for cold water supply, drainage, and venting systems in residential and commercial buildings (Fig. 3.3).

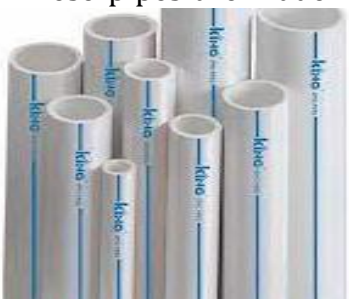


Fig.3.3: UPVC Pipe

FEATURES OF UPVC PIPE

- Manufactured from quality raw material
- World class machining

- Longevity of life cycle
- Easy handling, transportation, and installation
- Manufactured under stringent quality standards
- Lead-free
- Excellent chemical resistance
- Cost effective as compared to CPVC pipe.

B. CPVC (Chlorinated Polyvinyl Chloride) Pipe: These pipes are made from polyvinyl chloride resin that has been chemically modified with chlorine. CPVC pipes offer enhanced temperature resistance compared to UPVC pipes. They can withstand higher temperatures, making them suitable for both hot and cold-water applications and are also resistant to corrosion, chemicals, and scale build-up (Fig. 3.4). These pipes are commonly used for hot water supply systems, including residential plumbing, commercial buildings, and industrial applications. These pipes are typically joined using solvent cement, which chemically bonds the pipes together.

Fig.3.4: CPVC Pipe

Feature of CPVC Pipe

- Ideal for Hot and Cold Water
- ISI Certified Product
- UV Resistance
- Low Thermal Expansion
- Corrosion-Free
- Bacteria Free

The primary distinction between UPVC and CPVC is that UPVC is produced without the addition of plasticizers, whereas CPVC is produced with the addition of plasticizers and chlorination. When it comes to temperature resistance, however, CPVC can withstand a larger degree of heat than UPVC.

3.4.1. STEPS FOR CPVC AND UPVC PIPES INSTALLATION

STEP 1:Measuring: First measure the length of the pipe in an accurate manner and make a marking using the pen to make a required and neat joint. Make sure that the pipe and fittings are adaptable (Fig. 3.5).

Fig.3.5: Measuring the length of pipe

STEP 2: Cutting: Cut the pipe with a sharp saw/cutter as squarely as possible (at 90^0) which provides optimal bonding area within a joint. Check and inspect pipe ends thoroughly before making a joint. If you see a crack then cut off a minimum of 25 mm beyond the noticed crack before proceeding (Fig. 3.6).

Fig.3.6: Cutting the pipe

STEP 3:Deburring/Beveling: If there are burrs in and on the end of the fittings during the assembly then it can obstruct the proper contact between the pipe and socket. The burrs should be removed from both in and outside of the pipe. A slight bevel on the pipe's end will make it easier to insert the pipe into the fitting socket. (Fig. 3.7).

Fig.3.7: Deburring/Beveling the pipe

STEP 4: Fitting Preparation: Wipe the dirt and moisture from the fittings, sockets, and pipe by using a clean dry cloth. Dry fit the pipe to ensure a complete entrance into the bottom of the fitting socket and create a visible marking with a dark marker. (Fig. 3.8)

Fig.3.8: Fitting preparation of pipe

STEP 5: Solvent Cement Application: You can use solvent for the perfect solvent weld joint. Apply an even coat of cement on the end of the pipe and also inside the fitting socket while making a joint. The solvent should have a flowing consistency like syrup. Avoid lumpy or thickened solvent cement (Fig. 3.9).

Fig.3.9: Solvent application of pipe

STEP 6: Assembly: Insert a pipe into a socket just after applying solvent cement. Rotate the pipe 1/2 or 1/4 while inserting. Maintain even distribution of cement within the joint during motion or rotation. Align the fittings properly and leave it for 10-20 seconds to make the joint set-up (Fig. 3.10).

Fig.3.10: Assemble of pipe

3.4.2. Pipe Laying

Pipe laying is the process by which long sections of pipe are installed and aligned so that they can be connected together. Pipelines may be laid in above ground, below ground, concealed in structures and under water. A pipe layer is a skilled tradesman who lays pipe, such as for storm sewers, sanitary sewers, drains, and water mains.

Many industries use pipeline as a means of transporting various materials, such as oil, water, natural gas, and city sewage. These sections of pipe must withstand weather stress and significant amounts of pressure, as they are often located miles beneath the ground or ocean. It is an important process in plumbing.

The steps involved in laying of pipes are:

1. Before installation of a new pipeline in the building, a layout plan of water distribution of the pipes from the storage water tank is prepared.
2. Line of alignment of the pipes are maintained properly.
3. Chalk marking or powdered marking is done with the help of a thread or rope, on the proposed area of wall.
4. Pipes are fixed horizontally or vertically as required from the source of main water.
5. Threading in the pipelines is carefully done so that joints are well settled and leakage is prevented.
6. Jute and white paste are properly applied over the threaded portion to prevent leakage and for having watertight joints.
7. Efforts are made to keep the number of joints on the pipeline as minimum as possible.
8. The size of the pipes is selected according to the length of the service pipeline, minimum pressure of water in the distribution main, type of plumbing fixtures, i.e.,

elbows, bends unions, t-joints used in the building, rate of flow and highest point of delivery above the distribution main.

Precautions during work

1. Pipes should be cut to the required length.
2. The thread seal tap/sealing adhesive should be wrapped on threaded portion of the pipe.
3. The packing material should be wrapped around the joint.
4. The pipe should be properly aligned.
5. Zinc oxide should be applied gently.

3.4.3. Cast iron pipe cutting or joining

Cutting process of Cast Iron pipe: Cast iron pipes were used before the invention of PVC pipe and was the choice for main stacks and waste drains. Many older houses still have these pipes and you may need to replace them. Following steps for cutting a cast iron pipe:

METHOD 01: USING SNAP CUTTER

A. **Use chalk to mark cut lines on the pipe:** Make the lines as straight on the pipe as possible (Fig. 3.11).

Fig.3.11: Marking of pipe

B. **Wrap the chain of the snap cutter around the pipe as evenly as possible:** Ensure that there are as many cutting wheels as possible against the pipe (Fig. 3.12).

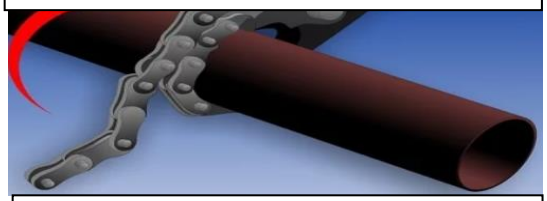


Fig.3.12: Wrap the chain on pipe

C. **Apply pressure onto the handles of the cutter so the wheels cut into the pipe:** You may need to score the pipe several times before you can make the final cut. You may need to rotate the pipe slightly before making the final cut if you are cutting replacement pipe on the ground.

D. **Repeat these steps at all other chalk lines.**

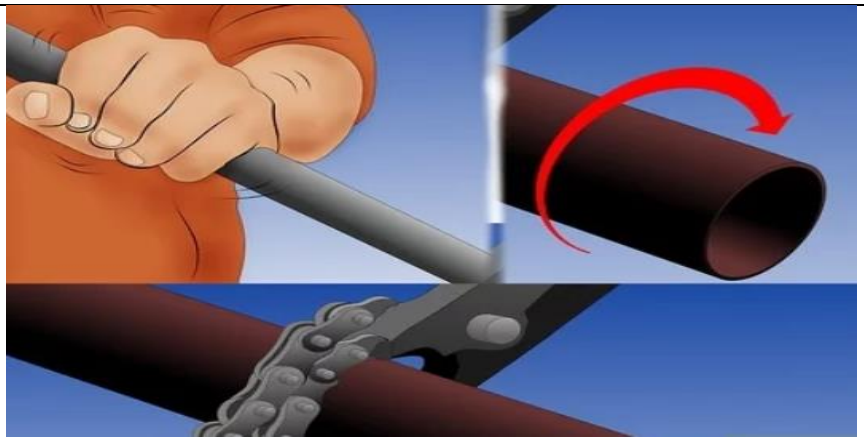


Fig.3.13: Cutting process of CI pipe by snap cutter

METHOD 02: USING A RECIPROCATION SAW

A. **Fit your saw with a long metal cutting blade.** Many of these blades are made with carbide grit or diamond grit for cutting through hard items (Fig. 3.14).

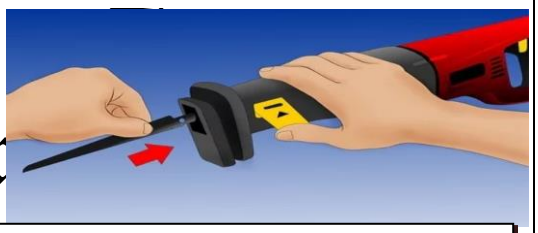


Fig.3.14: Fitting of cutting blade

B. **Use chalk to mark your cut lines.** Mark the lines as straight as possible. Hold the pipe firmly in place. It may be easier to have another person hold it in place for you (Fig. 3.15).

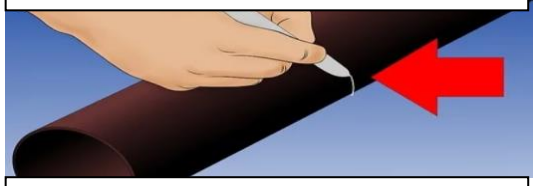


Fig.3.15: Marking of pipe by chalk

C. **Set your saw at low speed and let the blade do the work for you.** Avoid applying undue pressure on the saw that can cause the blade to snap (Fig. 3.16).

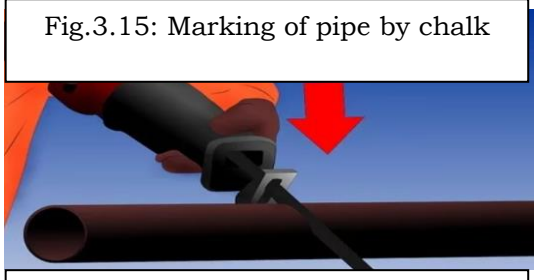


Fig.3.16: Cutting process by cutting blade

METHOD 03: SOLVENT CEMENTING

- **Solvent cementing:** Also known as solvent welding, solvent cementing is a chemical process that uses a primer, or the cement itself, to soften the surface of a plastic pipe and fittings in order to weld, or fuse them together. When applied, the solvents soften and dissolve the top layer of the pipe and fitting material, loosening its molecular structure. A taper in the fitting socket creates an interference fit that ensures contact between the pipe and fitting. This allows the material to fuse to itself when the two pieces are connected. Solvent cementing is a fast, easy and highly reliable process that produces a joint, stronger than either the pipe or fitting alone.It is the most popular kind of chlorinated polyvinyl chloride joining method.

Fig.3.17: Solvent cementing method

PVC glue is used as a solvent cement. It is an adhesive that is used to create an airtight seal that holds the PVC pipe and connection fittings together. Considering that the majority of piping installation failures are the result of improper cementing techniques, an understanding of the proper techniques required for joining, saves both time and money.

Procedure for solvent cementing

1. Inspect the pipe and fittings for overall appearance and compatibility. Obvious defects such as cracks, burrs and incompatible materials must be addressed as required. The joining surfaces must be clean and dry. In addition, the cement for the type and size of pipe and fittings should be determined. Also, remember both temperature and humidity may be issues to consider. Another detail that is often overlooked is the need to have the correct size applicator for the size of pipe. The size of the applicator should be about half the size of the pipe diameter in order to ensure proper and timely solvent cement coverage.
2. Cut the pipe with a cutter or saw in square to provide optimal bonding area.

3. De-burr the pipe with a chamfering tool or file to ensure proper contact between pipe and fitting. Remove all burrs from both the inside and outside of the pipe with a knife, file or reamer. Burrs can scrape channels into pre-softened surfaces or create hang-ups inside surface walls. Remove dirt, grease and moisture. A thorough wipe with a clean dry rag is usually sufficient.
4. Apply a heavy, even coat of CPVC primer (if necessary) to the fitting. Use the right applicator for the size of pipe or fittings being joined. The applicator size should be equal to 1/2 the pipe diameter. It is important that a satisfactory size applicator be used to help ensure that sufficient layers of cement are applied.

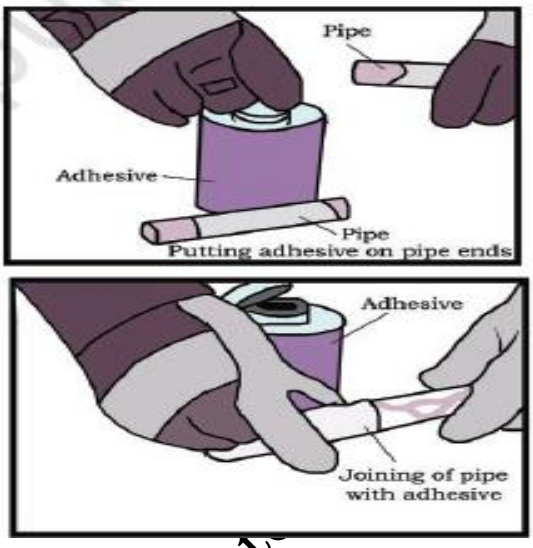


Fig.3.18: Joining of elbow after application of solvent

5. Apply a heavy, even coat of primer (if necessary) to the pipe end. The purpose of a primer is to pierce through and soften the surfaces so they can fuse together. The proper use of a primer and checking its softening effect provides assurance that the surfaces are prepared for fusion in a wide variety of conditions. Check the piercing or softening on a piece of scrap before you start the installation or if the weather changes during the day. Using a knife or other sharp object, drag the edge over the coated surface. Proper piercing has been made if you can scratch or scrape a few thousandths of the primed surfaces away. Because weather conditions do affect priming and cementing action, repeated applications to either or both surfaces may be necessary. In cold weather, more time is required.
6. Apply a heavy, even coat of CPVC cement (if necessary) to the fitting. Then apply to the pipe end. Stir the cement or shake can before using. Using the proper size applicator for the pipe size, aggressively work a full even layer of cement onto the pipe-end equal to the depth of the fitting socket. Do not brush it out to a thin paint type layer, as this will dry within a few seconds.
7. Insert the pipe into the fitting socket, rotating ¼ to ½ turn. Hold the pipe for 10 seconds, allowing the joint to set. A merit of using plastic pipes is that if you make a mistake, you can cut the section out and re-do it.
8. The joining is finished. The cure (drying) time depends on pipe size, temperature and relative humidity. If local codes permit, successful joint can be made without a primer using cement alone, but extra care must be taken during the installation. It is important that a good interference fit exists between the pipe and fittings. It is for this reason that we recommend that joints being made without a primer be

limited to systems 2" and smaller for pressure applications (water systems only) or 6" and smaller for drain waste vent (DWV) or non-pressure applications. Extra care must also be taken in applying the cement to make sure proper piercing (insertion) and softening of the pipe and fitting surfaces is achieved.

9. Joint strength develops as the cement dries. In the tight part of the joint, the surfaces will tend to fuse together; in the loose part, the cement will bond to both surfaces. These areas must be softened and pierced through. Piercing and softening can be achieved by the cement itself, by using a suitable primer or by the use of both primer and cement. For certain materials and in certain situations, it is necessary to use a primer. A suitable primer will usually slip into and soften the surfaces more quickly than cement alone.

3.4.4. Stoneware pipe laying

The following process of stoneware pipe laying such as: -

3.5.4.1. Trenching

Trenching is a construction method that involves digging a narrow excavation in the ground for the installation, maintenance, or inspection of pipelines, conduits, or cables. Following point should be keep in mind during trenching-

- The trench for laying of stoneware pipes shall be excavated to the required alignment and required depth.
- When the pipeline is under a roadway, a minimum cover of 90mm is recommended.
- The trench shall be so shored and drained in such a way that the workmen can work therein safely and efficiently.
- The discharge of the trench de-watering pumps shall be conveyed either to drainage channels or to natural drains.
- The excavation shall be carried out with manual labor or with suitable mechanical equipment as approved by the engineer.
- Unless otherwise specified by the engineer, the width at the bottom of the trenches for different diameters of pipes laid at different depths shall be as given below

a. For all diameters, up to an average depth of 120 cm, the width of the trench in cm = diameter of pipe + 30 cm.

b. For all diameters for depths above 120 cm, the width of trench in cm = diameter of pipe + 40 cm.

c. Notwithstanding (1) and (2), the total width of the trench shall not be less than 75 cm for depths exceeding 90 cm.

3.4.4.2. Laying of Stoneware Pipe

- All pipes shall be laid on a bed of cement or lime concrete with thickness and mix as specified, projecting on each side of the pipe to the trench's specified width.
- The pipes with their crown level at 1.20 m depth and less from the ground shall be covered with a 15 cm thick concrete.
- The concrete above the pipe's crown shall be sloped off to meet the outer edges of the concrete to give a minimum thickness of 15 cm all-around the pipe.

Fig.3.19: Laying of Stone ware pipe

- The pipes laid at a depth greater than 1.20 m at the pipe's crown shall be sloped off from the edges to meet the pipe tangentially.
- The pipe shall be carefully laid to the alignments, levels, and gradients shown on the plans and sections.
- Great care shall be taken to prevent sand etc. from entering the pipes.
- The pipes between two manholes shall be laid in a straight line without vertical or horizontal undulation.
- The pipes shall be laid with a socket up the gradient.
- The pipe's body shall rest entirely on an even bed of concrete, and places shall be excavated in the concrete to receive the socket of the pipe.
- Where pipes are not bedded on concrete, the trench floor shall be left slightly high and carefully bottomed up as pipe laying proceeds, so that the pipe barrels rest on firm and undisturbed ground.
- If the excavation has been carried too low, the desired levels shall be made up of concrete 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) for which no extra payment shall be made.
- If the trench floor consists of rock or very hard ground that cannot be easily excavated to smooth surface, the pipe shall be laid on a levelling course of concrete as desired.
- When stoneware pipes are used for stormwater drainage, no concreting will normally be necessary. The cement mortar for jointing will be 1:3 (1 cement: 3 fine sand).

3.4.4.3. Joining of stoneware pipes

- The tarred gasket of hemp yarn soaked in thick cement slurry shall first be placed around the spigot of each pipe, and the spigot shall then be slipped into the socket of the previously laid pipe.
- The pipe shall then be adjusted and fixed in the correct position, and the gasket caulked tightly to fill not more than 1/4th of the socket's total depth.

- **W = D+X**
- **where,**
  D is the external diameter of the pipe.
  X = 300 up to trench depth of 1200
  400 trench depth more than 1200
  T = 100 for pipes under 150, ¼th internal dia
  Subject to a min. of 150 and max. 300 for pipes more than 1500 dia.
  MWL = Maximum water level
- The socket's remainder shall be filled with a stiff mixture of mortar in the proportion of 1:1 (1 cement: 1 fine sand).
- When the socket is filled, a fillet shall be formed around the joint with a trowel forming an angle of 45 degrees with the pipe's barrel.
- After a day's work, any extraneous material shall be removed from the inside of the pipe.
- The newly made joint shall be cured for at least seven days.

3.4.4.4. Testing of Joints of Stoneware Pipe

- The stoneware pipes used for sewers shall be subjected to a test pressure of 2.5 m head of water at the highest point of the section under test.
- The test shall be carried out by suitably plugging the lower end of the drain and the ends of the connection, and filling the system with water.
- A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head, or the top may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.
- If any leakage is visible, the work's defective part shall be cut out and fixed.
- A slight amount of sweating, which is uniform, may be overlooked, but excessive sweating from a particular pipe or joint shall be watched for and considered as a defect and the jointing procedure shall be redone.
- Any joint found leaking or sweating shall be rectified or embedded into a 15 cm layer of cement concrete (1:2:4) 30 cm in length, and the section retested.

3.4.4.5. Refilling of Stoneware Trenches

- In cases where pipes are not bedded on special concrete, care shall be taken in refilling trenches to prevent the displacement and subsequent settlement at the surface resulting in uneven street surfaces and dangers to foundations, etc.
- The backfilling shall be packed by hand and rammed with a shovel and light tamper.
- This method of filling will be continued up to the top of the pipe.

- The refilling shall be carried out simultaneously on both sides of the pipe up to 60 cm without disturbing the pipe.
- No tamping should be done within 15 cm of the top of the pipe.

3.5 Installation of drainage and venting systems

1. Drainage system: Drainage or distribution system pipes generally used are GI, copper, HDPE, CPVC, mostly now a days CPVC plastic pipes are used as they don't get rusted, light weight, easy installation and maintenance and economic. It is the arrangement provided in a house or a building for collecting and conveying waste water through drain pipes by gravity to join a public sewer or a domestic septic tank is termed as building drainage or house drainage.
There are four different systems of plumbing: 1. One pipe system 2. Two pipe system 3. Single stack system 4. Partially ventilated single stack system.

A. One-Pipe system: In one pipe system only one pipe is provided for discharge waste water from wash basin, sinks, water closet, urinal and kitchen, etc. Such pipe is called soil cum waste pipe because it carries both sullage and night soil.

- A separate ventilation pipe is provided to all floor traps, gully traps are not provided in this system.
- This method is more economical and is used where all types of waste water taken together in a common sewer line to the place of disposal.
- While adopting this system the following points should be kept in mind: -
    i. Deep water seal of 75 mm depth should be provided in traps.
    ii. Diameter of ventilation pipe should not be less than 50 mm.
    iii. Air tight joint should be provided to the waste pipe.

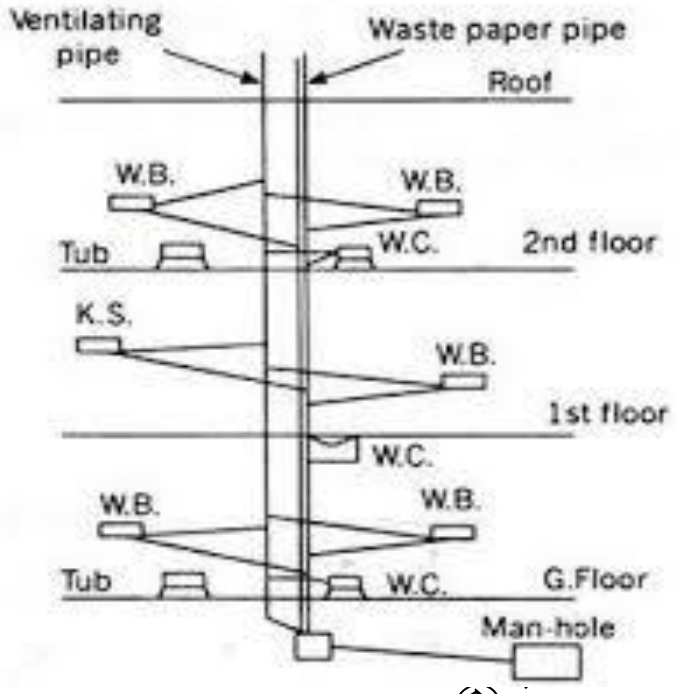


Fig.3.20: One -pipe system

B. Two-Pipe system: In this system, two pipes are provided, one pipe (i.e. soil pipe) discharges the foul material from W.C. and urinal whereas the other pipe (i.e. waste pipe) discharges waste water from kitchen, bath, wash basin and sink.

- The soil pipe is directly connected to the drainage system and waste pipe is connected to drainage system through gully trap.
- These two ventilation pipes are connected to each stack. Thus, in two pipes system four pipes are needed.
- In this system chances of blockage will be reduced.
- Four pipes required thus costly.
- They may be difficult to accommodate.

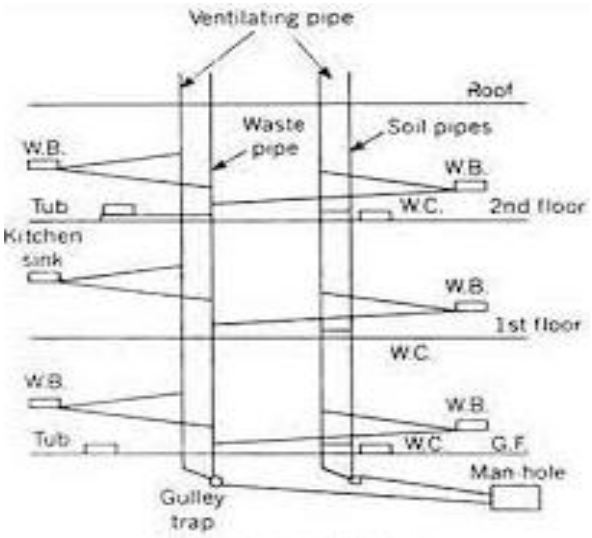


Fig.3.21: Two-pipe system

C. Single stack system: In this system only one vertical soil pipe is used. The same pipe is used to discharge waste from all sanitary and soil appliances. The single stack pipe is directly connected to the traps of toilets, sinks, and other fixtures. There is no separate pipe for ventilation in this system. As only one pipe needs to be provided, this system proves to be cost-effective. The water seal's depth is the lone factor that determines how well this system works. There should be no water seal that is shallower than 75 mm.

- It is a simplified form of one pipe system.
- This system is having a single pipe for night soil and waste without separate ventilation pipe.
- It uses only one pipe which carries night soil as well as sullage and the same pipe is extended 2 m above roof level with a cow.

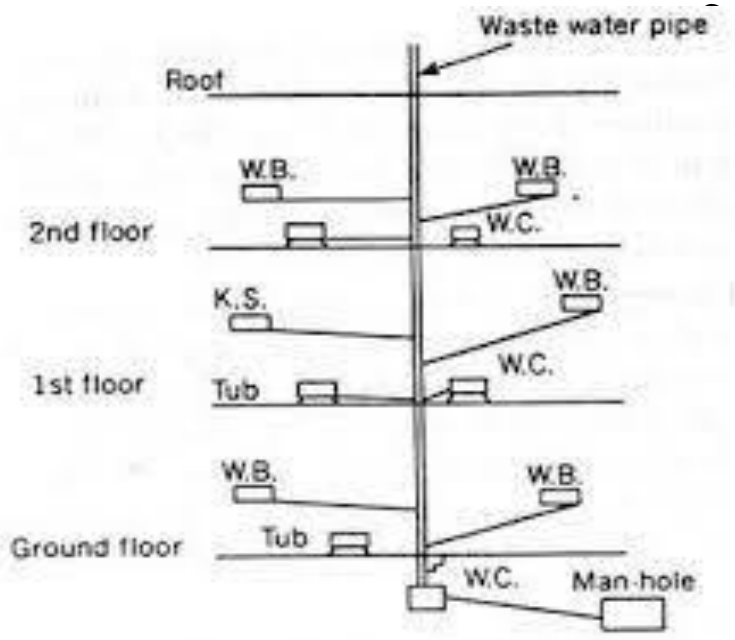


Fig.3.22: Sigle stack system

D. Partially ventilated single stack system: This is an improved form of single stack system. All the soil and waste fittings discharges waste water into a single soil cum waste pipe. In this system traps of soil fittings i.e. W.C. and urinal are ventilated through a separate ventilating pipe called relief vent pipe.

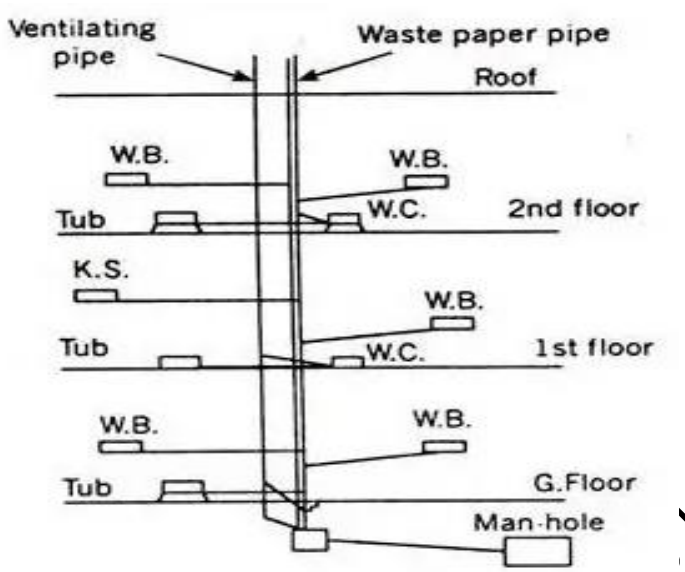


Fig.3.23: Partially ventilated single stack system

3.5.1. Steps to Install Drainage Pipe

Step 01: Mark Installation Area. Before you begin, clearly mark the path for the installation of the drainage pipe.

Step 02: Dig a Trench. Dig a deep trench where you plan for the drainage to end.

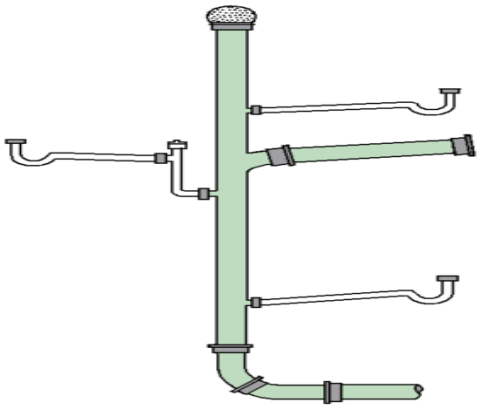
Step 03: Attach Pipe.

Step 04: Fill Trench.

2. Venting system: **V**ent system means that part of a piping installation which provides circulation of air within a drainage system. These *a system that controls the release of natural gas from the LNG storage system*.

In modern plumbing, a drain-waste-vent (or DWV) is a system that allows air to enter the plumbing system to maintain proper air pressure to enable the removal of sewage and greywater from a dwelling. Drain refers to water produced at fixtures such as sinks, and showers; waste refers to water from toilets. As the water runs down, proper venting is required to allow water to flow freely, and avoid a vacuum from being created. As the water runs down air must be allowed into the waste pipe either through a roof vent (external), or an internal vent.

Drain waste vent (DWV) systems maintain neutral air pressure in the drains, allowing free flow of water and sewage down drains and through waste pipes by gravity. It is critical that a sufficient downward slope be maintained throughout the drain pipes, to keep liquids and entrained solids flowing freely towards the main drain from the building.



Soil stack is connected to the sewer at the bottom and vented at the top, while each plumbing fixture has its own trap.

Fig.3.24: Venting system

In some situations, a downward slope out of a building to the sewer cannot be created, and a special collection pit and grinding lift "sewage ejector" pump are needed. By contrast, potable water supply systems operate under pressure to distribute water up through buildings, and do not require a continuous downward slope in their piping.

Every fixture is required to have an internal or external trap; double trapping is prohibited by plumbing codes due to its susceptibility to clogging. Every plumbing fixture must also have an attached vent. Without a vent, negative pressure from water leaving the system can cause a siphon which empties the trap. The top of stacks must be vented too, via a stack vent, which is sometimes called a stink pipe.

All plumbing waste fixtures use traps to prevent sewer gases from leaking into the house. Through traps, all fixtures are connected to waste lines, which in turn take the waste to a "soil stack", also known as "soil stack pipe", "soil vent pipe" or "main". At the building drain system's highest point, the drain-waste vent is attached, and rises (usually inside a wall) to and out of the roof. Waste exits from the building through the building's main drain and flows through a sewage line, which leads to a septic system or a public sewer. Cesspits are generally prohibited in developed areas. In the US, fixtures must have a vent (discharging into the "main stack" is not viewed as enough)

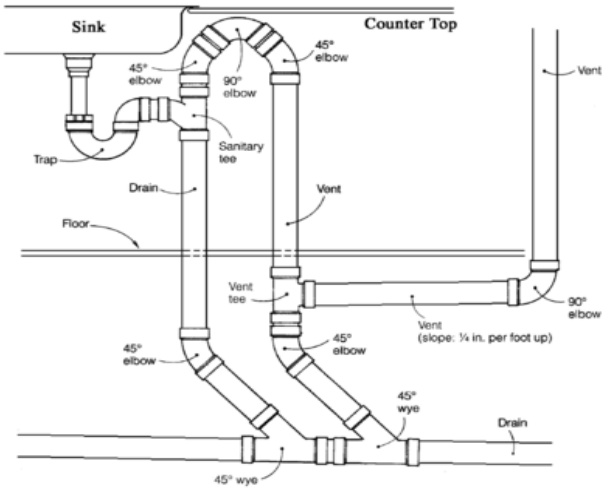


Fig.3.25: Drain waste vent system

The venting system, or plumbing vents, consists of a number of pipes leading from waste pipes to the outdoors, usually through the roof. Vents provide a means to release sewer gases outside instead of inside the house.

3.5.2. Maintain the DWV system

There are countless tools available for you to incorporate into a facility maintenance program. Here are just a few:

- **Camera inspection** allows you to see inside your piping system and identify issues that would otherwise remain hidden until it is too late.
- **Jetting, drain cleaning, cabling, or rodding** are also effective methods for cleaning, clearing and maintaining your DWV system.
- **Solenoid** may be installed to introduce water to dilute, wash or clean the DWV system where needed.
- **Installing vented running traps** to isolate the building's DWV system from the city sewer will prevent your municipality from relying on your building to vent gases into the city sewer system.
- **Follow the manufacturer maintenance recommendations** of any dilution tanks the building may have.
- **Identify and replace any aggressive cleaners** that the building cleaning or maintenance personnel may be using with a neutral pH cleaning alternative.
- **Consider installing upstream flush valves** on soda fountain lines for proper dilution.

3.6 Repair and maintenance of sanitary waste, drainage, and venting systems

Sewerage and drainage is the most important part for which special attention is required during planning, designing and construction of a sewerage and drainage system. The liquid wastes such as sanitary sewage; sullage or wastes from bathrooms, kitchen, washing places, etc. and storm or rain water collected within the premises are drained into the public sewer or to an individual waste disposal system through drainage. Sewer maintenance functions are too often neglected and given only as emergency arises. Considering the health hazards that the public at large has to face, it will be appropriate to provide sufficient funds to take care of men, material, equipment and machinery required for efficient maintenance. The maintenance that helps to protect the capital investment, to prevent serious health hazards when sewage backs up through the plumbing fixtures, ensures an effective and economical expenditure in operating and maintaining the sewerage facilities. It also helps to build up and maintain cordial relations with the public, whose understanding and support are essential for the success of this facility.

3.6.1 Necessity of Maintenance

The sewer system is a closed system of pipes from the waste receptacle to the final disposal point either on land or into a body of water under gravitational or free flow. When the flow is obstructed due to clogged sewer lines, it results in over flowing of manholes or backing up of sewage into a house or structural failure of the system. To

avoid such a situation, it is imperative to carry out necessary maintenance to prevent serious health hazards that the public at large has to face.

3.6.2 Types of Maintenance

There are two types of maintenance of sewerage systems – preventive and emergency.

A. Preventive (or routine) maintenance is more economical and provides for reliability in operations of the sewer facilities. It is carried out to prevent any breakdown of the system and to avoid emergency operations to deal with clogged sewer lines or over flowing manholes or backing up of sewage into a house or structural failure of the system. Proper inspection and preventive maintenance is a necessity.
B. Emergency maintenance (or repairs), which would be very rare if proper maintenance is carried out, will also have to be provided for.

3.6.3 Procedure for working in a Sewer

To ensure proper safety standards, the following steps should be followed:

Step 1 – Before leaving the depot a) collect and check all safety equipment and b) check working location with supervisor and list all known or potential hazards.

Step 2 – On arrival at the site a) set up adequate road markings and b) ventilate the system (guarding all openings) on a sewer opening up, 1. the working manhole 2. next manhole upstream 3. next manhole downstream.

Step 3 – Entry procedure a) check for gases (if in doubt – stay out) b) tie safety belt and rope before entering c) check ladders, step iron, etc., for defects (if in doubt, use a rope attached to the safety belt) d) keep safety ropes, spare lamps, breathing sets, close to working area for immediate use in case of emergency, and e) if considered safe, enter sewer.

Step 4 – Working inside the sewer a) check the gas every three minutes, and b) every three minutes the top man calls to the man working in the sewer. Every message shall be acknowledged.

Step 5 – Completion of the work a) top man informed and ready ganger (normally last man out) checks that all tools, ropes, etc are out and that the sewer is clear c) replace all grids, guardrails, manholes covers d) road signs to be removed and site cleared e) supervisor to be informed that work is completed, and f) wash thoroughly before eating or smoking.

3.6.4 Removal of stoppages and clearing out the deposits in Sewer Lines

Clogging may be due to grit deposition or other detritus, deposition of grease, penetration of roots from adjoining trees, growth of fungi or stagnation of sewage and improper working of pumping units. Sewers may be flushed by fire-hose from the nearest fire hydrant if conveniently located and if the stoppage is too stubborn to respond to flushing, it may be removed by rodding from the next manhole or it may be necessary to dig down to the point where the trouble exists.

3.6.5 Precautions during Sewer Maintenance

While assisting crews entering a deep manhole or sewer where dangerous gas or oxygen deficiencies may be present, the following should be taken:

a) Allow no smoking or open flames and guard against sparks

b) Erect warning signs

c) Use only safe gas- proof electric lighting equipment

d) Test for noxious gases and oxygen deficiencies to be conducted by - using lead acetate paper for presence of hydrogen sulphide and - using safety lamps for oxygen deficiencies

e) If the atmosphere is normal, workmen may enter with a safety belt attached and with two men available at the top. For extended jobs, the gas tests shall be repeated at frequent intervals depending on circumstances.

3.6.6 Safety Equipment's normally required in Sewer Maintenance work

The various safety equipment's that are normally required in sewer maintenance work are used for detection of various gases and oxygen deficiency.

Add images/figures

The sewer man should be equipped with the following equipment for own protection:

- Safety helmet preferably with cap lamp (explosion proof);
- Safety belt;
- Protective gloves;
- Overall, heavy coat or other heavy-duty protective clothing preferably waterproof;
- Knee or thigh length safety boots with toe protection and anti-spark studs;
- Gas masks and breathing apparatus;
- Eye protectors;
- Portable lighting equipment;
- Non-sparking tools;
- Portable air blowers;
- Gas test equipment, such as safety candle lamps, Davy's safety lamps, lead acetate papers and electronic gas detectors;
- Inhalators;
- Diver's Suit; and
- First aid equipment.

3.6.7 Periodical Cleaning of Drainage System

The following operations shall be carried out during periodical cleaning of a drainage system:

- The covers of inspection chambers and manholes shall be removed and the side benching and channels scrubbed.

- The interceptive trap, if fitted, shall be adequately cleaned and flushed with clean water. Care shall be taken to see that the stopper in the rodding arm is securely replaced.
- All lengths of main and branch drains shall be rodded by means of drain rods and a suitable rubber or leather plunger. After rodding, the drains shall be thoroughly flushed with clean water. Any obstruction found shall be removed with suitable drain cleaning tools and the system thereafter shall be flushed with clean water.
- The covers of access plates to all gullies shall be removed and the traps plunged and flushed out thoroughly with clean water. Care shall be taken not to flush the gully deposit into the system.
- Any defects revealed, as a result of inspection or tests shall be made good.
- The covers or inspection chambers and gullies shall be replaced, bedding them in suitable grease or other materials; and
- Painting of ladders/ rings in deep manholes and external painting of manhole covers shall be done with approved paints.

3.7 Importance of grouting and its application in plumbing system

Grouting: Grouting is the process of using grout to fix issues such as concrete cracks, tile gaps, joint seals, soil stabilisation, etc. It is used to give a building's foundation and structure more strength. Grouting is the process of using grout to fix issues such as concrete cracks, tile gaps, joint seals, soil stabilisation, etc. And it is used to give a building's foundation and structure more strength. Additionally, it is used to patch up tile gaps, stabilise soils, and fix concrete cracks.

3.7.1. Types of Grouting

Depending on the pile foundation, ground anchor, under reaming, dam construction, road construction, and building waterproofing, etc., different methods of preparing the grouting material are used in building construction. The various grouting varieties are as follows:

1. Cement Grouting: For high permeability land, cement grouting is used, and the grout is made with water, sand, and cement.

Fig.3.26: Cementitious Grouting

Use of cement grouting

Numerous structures, including bridges, marine applications, dams, and rock anchors, can be strengthened and stabilised using cement grouting.

The material for the grout is then injected under high pressure in liquid form to fill the hole and a predetermined radius around the grouting area. When necessary, the

water-cement ratio is decreased to increase the viscosity of the grout material. Once the primary holes have been made, a second hole is made between them to ensure that the entire area has been grouted.

2. Chemical grouting: Permeation grouting is a type of chemical grouting. Typically, this kind of grouting mixture contains sodium silicates, acrylamides, polyurethanes, acrylates, and epoxy (Fig. 3.27).

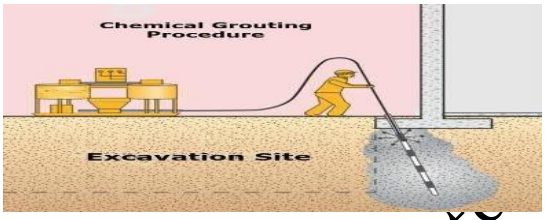


Fig.3.27: Chemical Grouting

There are two main processes of chemical grouting:

I. **Two-shot Process**: In this process, a drill is used to insert the pipe into the ground. Following that, the chemical substance is pumped through the pipe one after the other into the soil. So that the soil can quickly take on a solid form during a chemical reaction.

II. **One-shot process**: This method involves making a chemical grouting material mixture in advance and then pouring it underground. The structure hardens over time through this process. For boreholes, chemical grouting is applied in a single step.

3. Structural Grouting: A structure is constructed at the site to be mined. Structural grouting is used to fill the gaps between concrete and rock structures and fill the voids between mined materials. In addition, rock joints and cracks are filled in underground tunnels using structural grouting (Fig. 3.28).

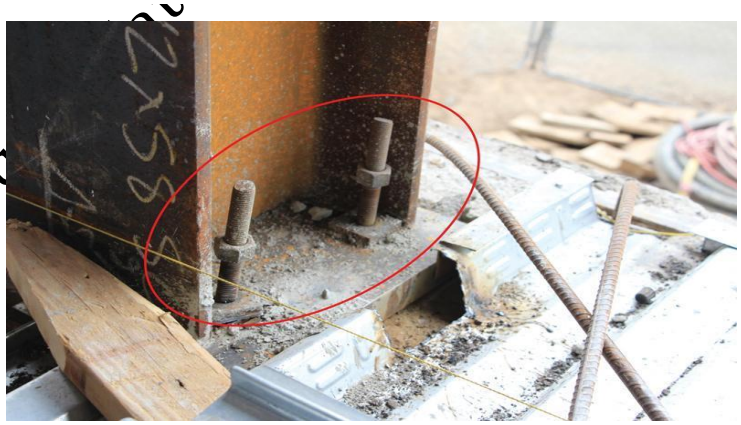


Fig.3.28: Structure Grouting

4. Bentonite Grouting: The main ingredient in drilling muds or fluids used in rotary drilling is bentonite. When hydrated, sodium bentonite expands to 15 times its dry volume, making it an excellent grouting material. It is ideal for filling gaps between the casings due to its swelling and gel-like permeability property (Fig. 3.29).

Fig.3.29: Bentonite Grouting

Use of bentonite grouting

Common applications for sodium bentonite grout include water-proofing, enclosing abandoned wells, and sealing earthen structures. This grout is appropriate for grouting the annular space between boreholes made during sound construction because of its high montmorillonite content and capacity to swell upon water absorption. Montmorillonite is an aluminium-rich clay mineral of the smectite group that also contains some sodium and magnesium.

5. Bituminous grouting: Hot bitumen grouting is a special type of grouting in which molten hot coral is used as the grouting material (Fig. 3.30).

Fig.3.30: Bituminous Grouting

Use of hot-bitumen grouting

High volumes of underground water flow are frequently reduced using hot-bitumen grouting. The temperature-dependent viscosity of hot bitumen grout is its key feature.

6. Resin grouting: Reactive resin grouts are another name for epoxy grouts. This particular grouting substance is created using a cement-based mixture. Although it is not waterproof, it can absorb water when damp (Fig. 3.31).

Fig.3.31: Resin Grouting

Use of resin grouting

It is appropriate for the majority of usable places, including hospitals, worktops, kitchen counters, and facilities for the production of food, due to its stain resistance, durability, and hygienic property. Ceramic floor and wall tiles that have been sealed work best.

3.7.2. Advantages of grouting

Following are the advantages of grouting:

- Almost any type of land can benefit from grouting.
- Grouting in structures either doesn't vibrate or can be controlled to ensure that the structures can't possibly deform.
- Grouting enhances the site's structural integrity.
- Grouting helps with slab jacking, which involves lifting damaged structures and supporting their weight.
- Grouting is useful for caulking pillar and wall cracks.
- It assists in regulating groundwater flow, leakage, and hazardous waste.

3.7.3. Application of grouting

Following are the applications of grouting:

- In prefabricated buildings, it is used to fix machine foundations, base plates, load-bearing joints, and pillar joints.
- Concrete structures can have gaps and cracks filled with grout.
- Used to fix the ground beneath foundations and footpaths.
- Grouting is used to patch cracks in concrete and masonry.
- Used to stabilise soil.
- Used to stop water leaking from underground structures such as dams, mines, and tunnels.
- Repairing unusual and challenging geotechnical and structural issues with grouting
- Utilised to facilitate excavation.

3.7.4. Process of grouting

Mechanical methods like high-pressure water jetting, breakers, blast cleaning, scribbles, etc. are used to ensure the fundamental arrangement of grouting. After that, clean water must be continuously applied to the concrete layer for 2 to 6 hours. In the course of grouting, this results in a dry layer of concrete that has absorbed water (Fig. 3.32).

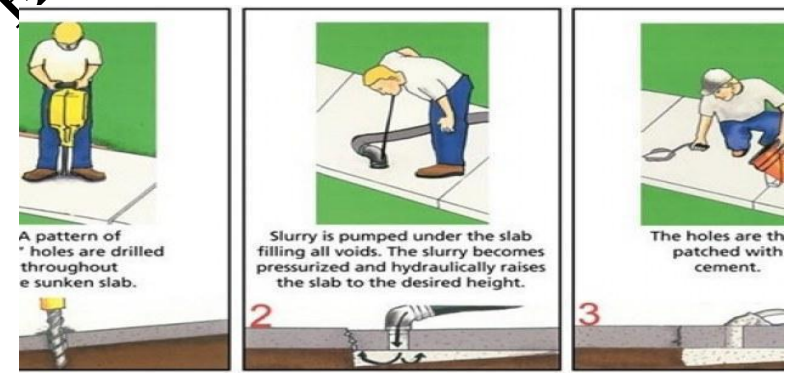


Fig.3.32: Process of Grouting

A. Mixture preparation

- **Surface spread/disperse ratio**
  Water: Powder = 0.14 to 0.16 by weight (4.2 liters to 4.8 liters of water per 30 kg bag).
- **Ratio of surface mix**
  Water: Powder = 0.12 to 0.14 by weight (3.6 liters to 4.2 liters of water per 30 kg bag).

B. Mixing equipment

- Mix the grout powder with water in the correct ratio using an instrument with a low speed (maximum 500 rpm) electric drill, so as not to allow too much air to enter the mixture.
- Pour about 80 to 90% of the water into the mixing drum. Then add the remaining water.
- Depending on the desired consistency and flowability, the mixing ratio can be adjusted. Do not use a concrete tilting mixer.

C. Application process

- Pour the grout mixture right away onto the prepared surface so that the trapped air bubbles can easily escape and prevent the grout from having a firm grip on the surface.
- In order to keep the grout flowing while grouting a wet porous substrate saturated surface, a base plate, etc. in a dry environment, make sure that a constant and sufficient pressure is maintained.
- To make sure the grout is applied evenly throughout the surface and used to improve the surface's grip. Pour the grout as quickly as you can—in no more than 15 minutes—using the grout mixture.

3.8 Installation of Plumbing Fixtures

Following are common sanitary fittings and fixtures:

- **Bathtub:** Installed in a bathroom, it is made of vitreous material, enamelled iron, plastic, marble, etc. Its length varies from 1.7 m to 1.85 m, the width is 70 cm × 75 cm and the depth varies from 43 cm to 45 cm to the outlet end. Cold and hot water taps are provided for filling the tank, and an overflow pipe is provided for excess water drainage. A waste coupling with a waste seal trap is provided at the drain with a rubber plug as in the washbasin (Fig. 3.33).

Fig.3.33: Bathtub

- **Washbasin:** It is provided for washing hands, face, etc. These are generally made of vitreous china, burnt fireclay, ceramic, enamel over steel, marble, glass, etc. Washbasins are available in different shapes, sizes and colours (Fig. 3.34).

Fig.3.34: Washbasin

- **Water closet:** It is provided to receive human excreta directly from the user. It is connected through a suitable trap to the soil pipe and finally to a municipal sewer or septic tank (Fig. 3.35). The excreta is flushed with the help of water from the cistern tank. There are two types of water closets.
  1. Indian type 2. European type

Fig.3.35: Water closet (1. Indian type and 2. European type)

- **Faucet:** It is a device that controls the flow of liquid, especially water, from a pipe. It is also called a water tap. It is available in a bathroom, kitchen or sink, as per use. (Fig. 3.36).

Fig.3.36: Faucet

- **Sink:** It is a rectangular, shallow, waterproof tank made of concrete, vitreous china, fireclay, or stainless steel. It is used for cleaning utensils, clothes, etc. The flow a sink is provided with a hole for fixing a waste coupling and a waste pipe (Fig. 3.37).

Fig.3.37: Sink

- **Flushing cistern:** It is a small tank holding water for flushing urinals and water closets. It is made of cast iron, glazed earthenware, glazed vitreous, or any other material. Depending upon its size, a cistern can hold the following quantities of water—5 litres, 10 litres and 15 litres. A 10-litre cistern is the most common (Fig. 3.38).

Fig.3.38: Flushing Cistern

- **Geyser:** It is used for heating water. It is available in different capacities, up to 50 litres, as per requirement (Fig. 3.39).

Fig.3.39: Geyser

Installation

It refers to the act of placing or fixing in position a plumbing fixture such as a washbasin, a water closet, etc. Installation is an important step in fixing the components of a system as per the design. During the installation of plumbing system in a building, home or a housing colony, planning is done as per the standard procedure of designing. A good installation system prevents water leakage, allows optimum installation of the money spent and enhances the life of the plumbing fixtures. Instructions for installation are given either by the manufacturer on one's own or the specifications in the construction map. If the standard procedure is followed during the installation of plumbing system, it allows for smooth and efficient functioning of the system.

3.8.1. Inclusion of some advance

Important points before installation

A. Read the plumbing drawing

Study the drawing of the bathroom, washroom, kitchen or other places where installation is to be done. The drawing will help the Plumber General to understand various aspects of plumbing fittings, fixtures, distance and height to be maintained during installation.

B. Install the basic sanitary fixture

Fittings (faucets and valves) are used more often than any other part of the plumbing system. The best modern fittings selected should use chrome-plated brass as it bears the effect of water quality and has a high durability. They can be cleaned easily with soap and warm water.

C. Protection against backflow

The supply lines and fittings for every plumbing fixture should be installed in such a way that there is no backflow. There may be a backflow due to improper design.

D. Access for cleaning

Plumbing fixtures should be installed in such a way that they can have easy access for cleaning, for both the fixture and the area around the fixture.

E. Check for alignment and setting

The fixtures must be set level in proper alignment with the adjacent walls. As per the Indian Plumbing Association Code, a water closet, lavatory or bidet should not be set closer than 15 inches (381 mm) from its centre to any sidewall, partition, vanity or other obstruction, or closer than 30 inches (762 mm) centre-to-centre between toilets or adjacent fixtures. An 18-inch (457 mm) distance must be in front of the water closet or bidet to any wall, fixture or door. Water closet compartments should not be less than 30 inches (762 mm) wide and 60 inches (1524 mm) deep. There must be at least 18 inches (457 mm) clearance in front of a lavatory to any wall, fixture or door. A urinal shall not be set closer than 15 inches (381 mm) from the centre of the urinal to any sidewall, partition, vanity or other obstruction, or closer than 30 inches (762 mm) centre-to-centre between urinals.

F. Make floor and wall drainage connections

Connections between the drain and floor outlet plumbing fixtures must be made with a floor flange. The flange shall be attached to the drain and anchored to the

structure. Connections between the drain and wall-hung water closets should be made with an approved extension nipple or horn adapter. The water closet must be bolted to the hanger with corrosion-resistant bolts or screws. Joints should be sealed with an approved elastomeric gasket or setting compound.

G. Check for floor flanges

Floor flanges for water closets or similar fixtures shall not be less than 1/8 inch (3.2 mm) thick for brass, ¼ inch (6.4 mm) thick for plastic, and not less than a 2-inch (51 mm) caulking depth for cast-iron or galvanised malleable iron. Floor flanges of hard lead shall weigh not less than 0.7 kg and shall be composed of lead alloy with not less than 7.75 percent antimony (a chemical element which is a brittle, silvery-white metalloid) by weight. Closet screws and bolts shall be of brass. Flanges shall be secured to the building structure with corrosion-resistant screws or bolts.

H. Secure floor outlet fixtures

Floor outlet fixtures must be secured to the floor or floor flanges by screws or bolts of corrosion-resistant material.

I. Secure wall-hung water closet bowls

Wall-hung water closet bowls should be supported by a concealed metal carrier that is attached to building the structural members so that strain is not transmitted to the closet connector or any other part of the plumbing system.

J. Make water-tight joints

All the joints of fixtures close to the wall or floor must be sealed to prevent water from entering or passing through.

K. Plumbing in mental health centres

In mental health centres, pipes or traps should not be exposed, and fixtures must be bolted through walls.

L. Design of overflows

Where any fixture is provided with an overflow, the waste should be designed and installed in such a way that standing water in the fixture will not rise in the overflow when the stopper is closed, and no water will remain in the overflow when the fixture is empty.

M. Connection of overflows

The overflow from any fixture should be discharged into the drainage system on the inlet or fixture side of the trap. The only exception exists in case of the

overflow from a flush tank serving a water closet or urinal, which should be discharged into the fixture served.

N. Access to concealed connections

Fixtures with concealed slip-joint connections should be provided with an access panel or utility space at least 12 inches (305 mm) in its smallest dimension or other approved arrangement so as to provide access to the slip connections for inspection and repair. Where such access cannot be provided, access doors shall not be required, provided that all joints are soldered, solvent cemented or screwed so as to form a solid connection.

3.8.2. Installation of a wall hung fixture

Step 1. Install the mounting board between the studs at the proper height, using the same method as for a wall-hung flush tank.

Step 2.Attach a hanger bracket on the finished wall using the proper length of wood screws at the recommended height. The metal bracket must be level.

Step 3. Place the lavatory on the bracket and push down. Make sure the lavatory is level.

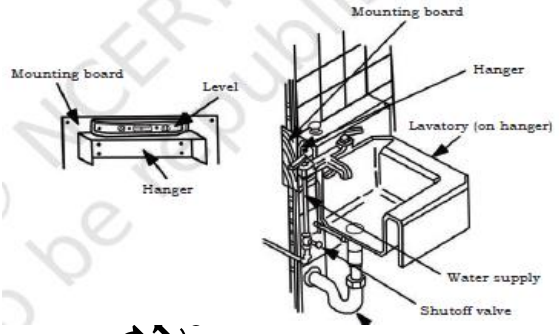


Fig.3.40: Wall-hung lavatory Installation

3.9 Detecting water leaks and their repairs, and follow SOP

A water leak can cause a major disturbance in the plumbing system. Leaks from water pipes, plumbing fixtures and fittings are a sizeable source of water wastage in our homes. Sometimes, considerable water leakages from the system may cause problems related to pressure moulding and significant water losses. Thus, as soon as a leak is found, its repair becomes an absolute necessity. When you find a leakage in the plumbing fixtures, it is necessary to repair it as soon as possible to avoid damage to structures or surroundings, and to possibly make it cost effective in the long run. Some leaks can be visible, and some cannot be seen with the naked eye. The result could be an unusually high water consumption, which will also reflect in your water meter.

3.9.1. Cause of plumbing leak

Determining the specific cause of a plumbing leak requires a proper inspection by a professional plumber. However, I can provide you with some common reasons why plumbing leaks occur:

- Over time, pipes can corrode, especially if they are made of metal. Corrosion weakens the pipes, leading to small cracks or holes that can result in leaks.
- Excessive water pressure can strain the plumbing system, causing leaks at joints or weak points in the pipes.
- Clogs can lead to water pressure buildup, which can cause pipes to burst or joints to leak.
- Older plumbing systems are more prone to leaks as materials deteriorate over time.
- If pipes or fittings were not properly installed, they may be more susceptible to leaks.
- Tree roots can infiltrate underground pipes, causing damage and leaks.
- Extreme temperature changes can cause pipes to expand and contract, potentially leading to leaks.
- Highly corrosive water can accelerate pipe deterioration, leading to leaks.
- Accidental damage or impact to pipes, such as during renovations or construction work, can cause leaks.
- Weak seals or faulty joints in plumbing connections can result in leaks.

3.9.2. How to detect point of leakage

- First, check those areas where leaking in fixtures is common, that is, joints.
- If the leak is inside the house, check the toilets, sinks, faucets, and showerheads. It is possible that the leak is minor enough for you to notice it.
- Leaking toilets and kitchen faucets are the most common and most unnoticed leaks. Even when you cannot see a leak in the pipes, you might be able to hear or observe it. Move slowly to each and every point of the distribution system, starting from the lowest level and working your way up.
- Listen to the pressurised sound of water or dripping. Look for a small pool of liquid or water stain under the floor or up on the ceiling. Water damage on wood panelling, cabinets, drawers, or wallpaper can all be signs of an 'invisible' leak too.
- If the leak is from outside, we can check the spigots. Double check to make sure they are fully tightened. Listen for the sound of dripping or running water. Underground leakage can be found by a wet surface or swelled surface due to excessive moisture.
- If you think you have found the leak and can get to it, you could try to fix the problem. Most toilet and faucet leaks can easily be fixed by replacing the O-ring or tightening the fixtures.
- If you can reach a fractured pipe, you could apply the plumber's tape as a temporary solution until you have the chance to change the pipe.

3.9.3. Sources of Leakage

A. **Water supply line leaks:** Sometimes, there are leaks in the water supply line coming to home from the meter. These are often difficult to detect because the supply pipe is usually buried at least 3 feet below the ground. Sometimes, the leaking water will travel along the pipe. Another common exact point for the leaking water might be where the supply line rises above the ground and enters the house or building. If the soil is constantly damp at these locations, it might indicate a leak. In case of sewer leaks, the water will sweep up towards the ground surface, usually directly above the path of the underground pipe.

B. **Leaks due to pipe corrosion:** Pipe corrosion is a process that results in a reduction of thickness of the wall of a metal pipe, caused by electrolysis (chemical breakdown by electric current), junk, or acidity of water. Galvanic corrosion (resulting from a direct current of electricity) is created in a plumbing installation system in which two different kinds of metal pipes are joined, such as galvanised and copper pipe.

   The principal indication of corrosion might be a leak in the framework inside the walls or floors of the structure. Water may appear a few dimensions beneath the leak. Use a piece of wood as a resonator to recognise and amplify the sound of the leak. Spot one end of the wood against your ear and the opposite end against the pipe and follow the sound. There will be more sound while drawing nearer to the leak.

3.9.4. Remedies

Following are the remedies -

A. **Galvanised pipes:** After locating the leak, cut and replace the corroded pipe.
   Step 1. Close the water at the nearest valve below the leak, and drain the pipe.
   Step 2. When the fittings on both sides of the leak are not readily available, cut out the leaking section. One plumber should hold the pipe with a wrench to prevent its turning in the adjoining fitting, while another plumber cuts a thread on it.
   Step 3. Replace the cut-out section with a desired coupling, a pipe section of the given length, and a similar union.

B. **Copper pipes:** Copper pipe resists corrosion, except when attacked by acids. However, if a leak occurs in the copper pipe, then the steps listed below must be followed:-
   Step 1. Close the water at the nearest valve below the leak, and drain the pipe.
   Step 2. Replace it with either soldered or compression joints. We can also go with some more alternatives before and after, to prevent leakage. It can also be achieved by reducing corrosion. The following can be done to reduce corrosion.

C. **Use of di-electric unions:** These are fixed in the hot and cold water take-offs from the tank and it reduces the galvanic corrosion of water tanks. A di-electric union consists of a fibre washer, which shields or insulates the tank from the rest of the plumbing installations, preventing the flow of current from the tank to the system.

D. **Use of magnesium rods:** These are also used in a few geysers, such as the gas operated type, to save against rust and corrosion. They act as electrolytic cells in which the magnesium dust goes into the solution, flows through the water, and is stored on the metal to be protected. The electrolytic action (electrolysis) diffuses the rods. The maximum life of the rods is 1½ years; then they must be changed.

E. **Leaks in valves:** All valves should be checked regularly for leaks. Most leaks are from washers or bonnets.

F. **Leaks in faucets** A faucet is a device that allows you to turn the flow of water on and off. Since faucets help dispense water, thus, keeping them in working condition is very important. The typical causes for a leaky faucet include corrosion, mineral deposit on the internal parts or defective gaskets, O-rings or washers. Before repairing any faucet, drain it by turning the water off at the fixture of the shut-off valve.

G. **Compression faucets:** These faucets have separate hot and cold water handles and their action requires you to tighten the handle down to turn the water flow off. Such faucets use a compression stem, which is a type of screw with a washer at the end of it pressing against a valve seat. While repairing compression (or washer) faucets, first check the valve seat. If it is chipped or rough, reface it with a refacing tool or replace it.

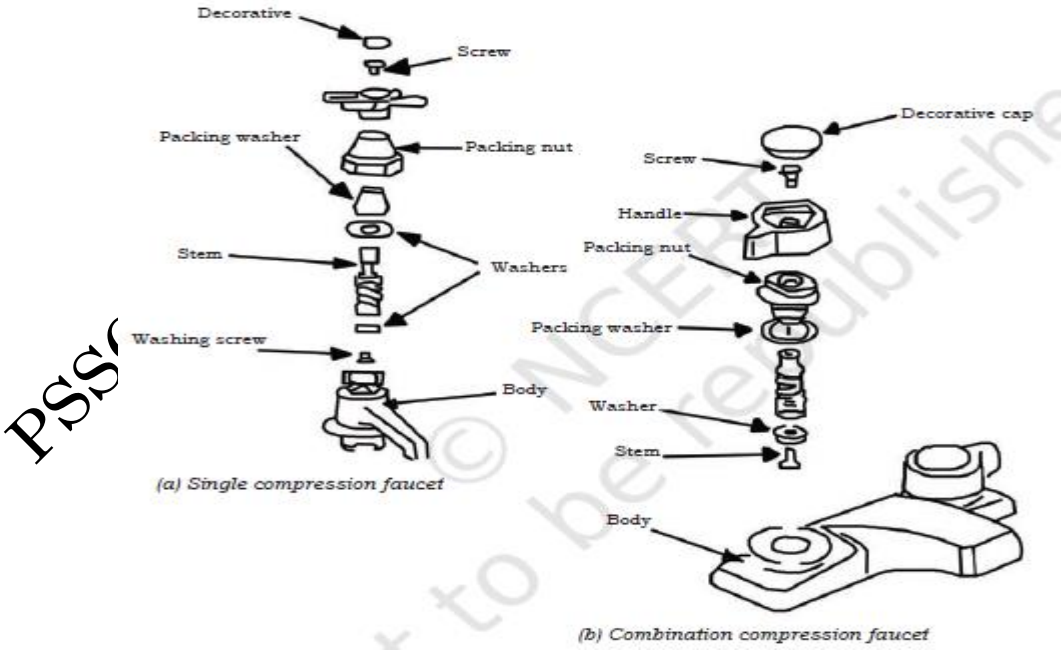


Fig.3.41: (a,b) Compression Faucets

3.9.5. Use the following procedures to repair single compression faucets.
During disassembly, check all parts for wear and replace as needed:

i. ***Leak at the stem and the packing nut and washer***

Step 1: Turn the water supply off at the shut off valve, and remove the cap, screw and handle.
Step 2: Remove the packing nut with a wrench, the old packing material and the washer.
Step 3: Place a new washer onto the stem's lower end, and reassemble all parts in order.
Step 4: Turn the water supply on and check for leaks and proper operation.

ii. ***Leak at the spout***

Step 1: Turn the water supply off at the shut-off valve. Remove the cap, screw and handle.
Step 2: Remove the packing nut with a wrench; then remove the stem from the body.
Step 3: Remove the screw and washer from the bottom of the stem.
Step 4: Place a new washer onto the bottom of the stem.
Step 5: Check the valve seat inside the body. If it is chipped or rough, reface the seat with a refacing tool. If the seat is even, place the stem into the body. Replace if needed.
Step 6: Reassemble all the parts in the proper order.
Step 7: Turn the water supply on and check for leaks and proper operation.

iii. ***Leak at the base of the body***

Step 1: Turn the water supply off at the shut-off valve. Remove the cap, screw and handle.
Step 2: Remove the packing nut with a wrench.
Step 3: Remove the worn washer from the packing nut.
Step 4: Slide a new washer into the packing nut for a snug fit.
Step 5: Reassemble the parts in the proper order.
Step 6: Turn the water supply on and check for leaks and proper operation.

NOTE: Before repairing a faucet, drain it by turning the water off at the shut off valve. During disassembly, check all parts for wear and replace as needed.

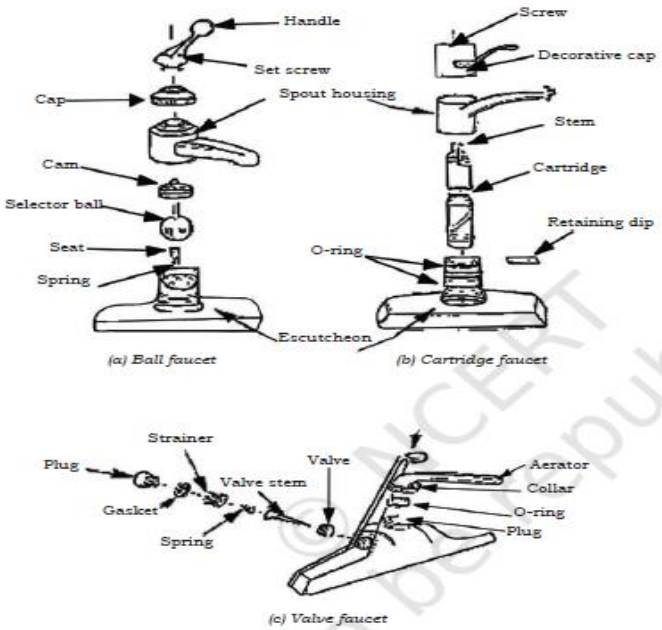


Fig. 5.2 (a, b, c) Components of faucets

Fig.3.42: (a,b,c) Components of Faucets

H. Non-compression faucet repairs

i. Ball faucets: Commonly used in kitchen sinks, these washers less faucets can be identified by their single handle that regulates a special plastic or metal ball inside the faucet body. Because of the number of parts which make up this type of faucet, ball faucets tend to leak more than other washer less faucets such as cartridge or disk faucet. Leaks in this type of a faucet can be caused by a corroded or gouged selector ball or by worn rubber valve seats.

Step 1: Remove the handle by loosening the set screw.

Step 2: Remove the cap and pull out the ball with the cam assembly.

Step 3: Use needle nose pliers to remove the two rubber valve seats and springs.

Step 4: Replace the rubber seats and/or the selector ball.

Step 5: Reassemble the faucet, ensuring that the slot in the ball aligns with the metal protection on the housing. Check for leaks.

ii Metal cartridge faucets: Such faucets look quite identical to a compression washer faucet. However, the action to turn off the water flow is smoother and more consistent in such faucets. The faucet turns off without additional pressure being required as in case of a compression faucet. Leaks in these faucets are usually caused by two O-rings in the faucet body. Replacing the O-rings should eliminate the leaks.

Step 1: Remove the screw and push a screwdriver down the hole to keep the stem in place while removing the handle and cover.
Step 2: Unscrew the retaining nut and remove the spout. The body of the faucet is exposed to get to the O-rings.
Step 3: Replace the O-rings.
Step 4: Reassemble the faucet and check for leaks.

iii Ceramic-disk cartridge faucet: Such faucets can be identified by their single lever over a wide cylindrical body. The disk faucet mixes hot and cold water inside a mixing chamber. Such faucets generally use in up-down motion to regulate water flow and left-right motion to control temperature. In the ceramic disk, leaks are caused by a worn out or corroded disk.
Step 1: Press the tile handle all the way back to remove the set screw.
Step 2: Remove the handle and the two set screws under the spout.
Step 3: Disengage the stopper mechanism under the lavatory and remove the ceramic cartridge, which is held by two brass screws.
Step 4: Replace the cartridge.
Step 5: Reassemble the stopper mechanism and the faucet. Check for leaks.
NOTE: If the faucet malfunctions due to corrosion or wear, use the manufacturer's instructions to make repairs.

iv Valve faucets: Leaks in this type of faucet can be caused by a worn O-ring at the base of the spout or by other worn internal parts.
Step 1: Remove the spout and lift off the escutcheon (shield). Remove the plugs on each side by turning them counter clockwise and pulling out the gasket, strainer, spring, valve stem, and valve seat.
Step 2: Remove the seat with a seat-removal tool or Allen wrench.
Step 3: Reassemble the faucet and check for leaks.

I. **Shower heads:** It is one of the main components of a shower that allows water to dribble through it. Shower heads deteriorate due to the following reasons.
Mineral build-up: This causes clogging, resulting in reduced water pressure.
Rust and leak: This reduce the life of the shower head, leading to reduction in pressure and unnecessary dripping. This creates the need to replace or repair the shower head.

Procedure for changing shower heads

1. **Turn off the water —** First, turn off the main pipeline, which is normally located at the basement towards the front of the home or near the water tank.
2. **Clean the shower arm —** Use a toothbrush to clean the shower arm's threads.

3. **Install the shower arm —** Wrap the head of the shower arm in Teflon or pipe-thread tape and screw it into the pipe opening in the wall or ceiling.
4. **Prepare the shower arm —** Slide the backing onto the shower arm and wrap the open end in tape.
5. **Install the shower head —** Screw on the shower head by hand until it is snug. Wrap the shower arm and head in rags and use adjustable wrench to tighten the shower head further.

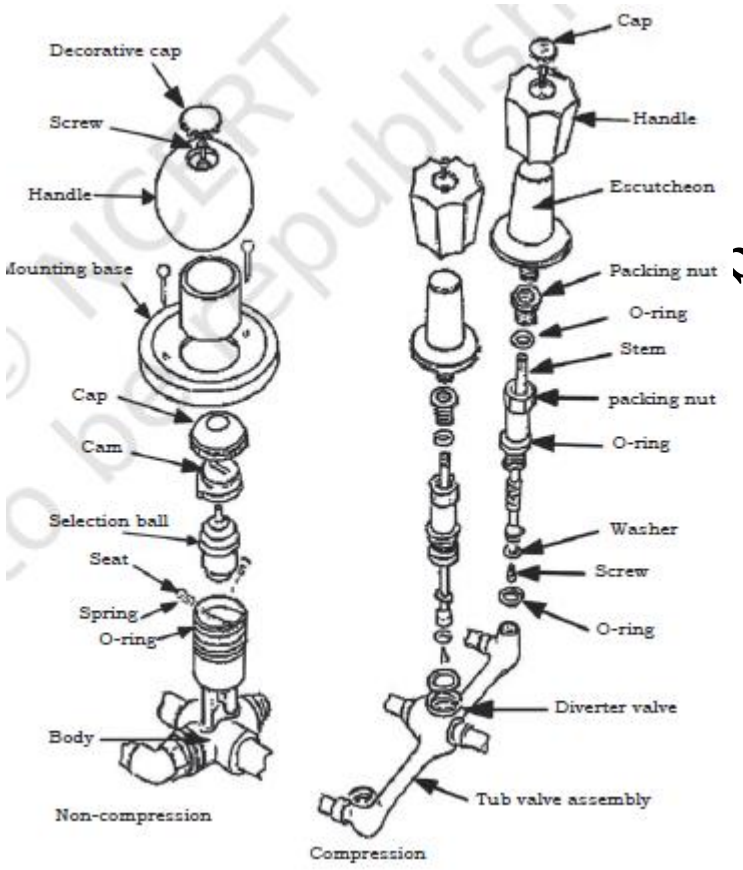


Fig.3.43: Bathtub and shower faucet breakout

J. **Shower faucets:** These faucets function the same as compression and non-compression faucets on sinks and lavatories. Although bathtub and shower faucets are developed differently than sink and lavatory faucets, yet the repairing methods are similar. Showers use various types of faucets. These include—
   1. Single-handle/single valve faucet
   2. Double-handle faucet
   3. Three-handle faucet

1. Single-handle faucets: Single-handle faucets are commonly used. Valve cartridges in faucets are cylindrical devices that use O-rings to control the flow of water. Replacement is the easiest way to fix cartridge-related problems.

Fig.3.44: Single-handle faucet

The procedure to replace single-handle faucet is given here.

- Turn off the water.
- Locate the set screw under the handle or cap at the front of the unit. Remove the screw and pull.
- Use a screwdriver to remove the retainer clip at the top of the cartridge housing. Be sure not to lose this piece.
- Remove the cartridge by gently pulling with pliers.
- Take the old cartridge to the hardware store to ensure you get the right replacement. Cartridges are specific to faucet make a model.
- Insert the new cartridge.
- Replace the retaining clip and reassemble your faucet. Turn the water back on to make sure your faucet does not leak.

2. Two-handle faucet: These faucets also have a mechanism that uses threaded handles and rubber seals to open and close water lines (Fig.3.45). Installing a new stem is the easiest way to fix a malfunction, but we can also replace faulty hardware like seals and O-rings.

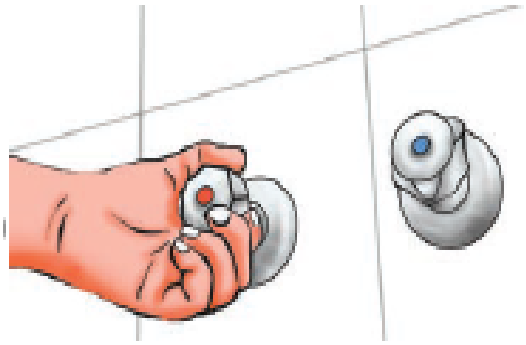


Fig.3.45: Two-handle faucet

3. Three-handle and diverter faucets: These faucets have temperature stems (hot and cold handles) and diverter stems (Fig. 3.46). The procedure for repair has been discussed below.

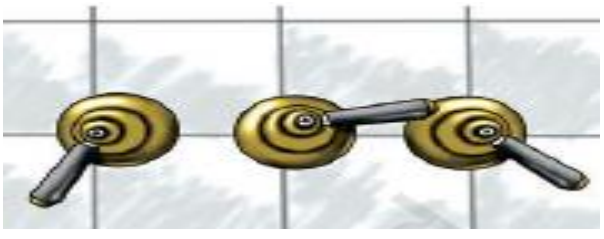


Fig.3.46: Three-handle and diverter faucet

(i) Temperature stems

We can fix temperature stem issues the same way, we would a two-handle faucet.

a) Pry away the index cap at the front of the handle to access the handle screw. Remove the screw and pull. Use a handle puller if it is stuck. Use pliers or a deep-socket wrench to gently turn the stem counter clockwise.
b) Wrap Teflon tape around the base of your stem and screw it into place.
c) Replace the handle hardware.

(ii) Wall diverter stems

This is usually the third handle in a three-handle valve. Replacing the faulty diverter valve is the easiest way to solve the problem. The steps to replace are given here.

a) Remove the cap and handle as in the single handle guide. Gently remove it, being careful not to mar the finish.
b) With a socket wrench, remove the old valve.
c) Wrap Teflon tape around the threads of the new valve, leaving the first few threads bare to ensure a grip.
d) Insert the new diverter and give it an extra quarter turn after it is tight. Do not force it.
e) With the handle, turn it and test the water to make sure it only comes out of where it is supposed to. This is also a good time to shine a flashlight into the valve and make sure there are no leaks.
f) Reassemble the diverter handle.

It is important to ensure you routinely monitor any minor water leaks at home. This will prevent damages that will be costly to repair as well as lower our water bill. If you still cannot repair leakage due to severity of damage and it is required to stop leakage on urgent basis, we might look for some of the temporary repairs. Remember to not risk a serious injury in trying to inspect or repair it.

K. Repair of bathtub faucet

The following steps are to be followed for the repair of a bathtub faucet.

1. Disassemble the faucet — Removing the faucet handle is a difficult task. Due to corrosion, the handle gets jammed or weld the handle to the stem. Close the water supply to the faucet and open the valves to drain excess water present in faucet or tap. With the help of a thin blade of a pocketknife loosen the handle screw.

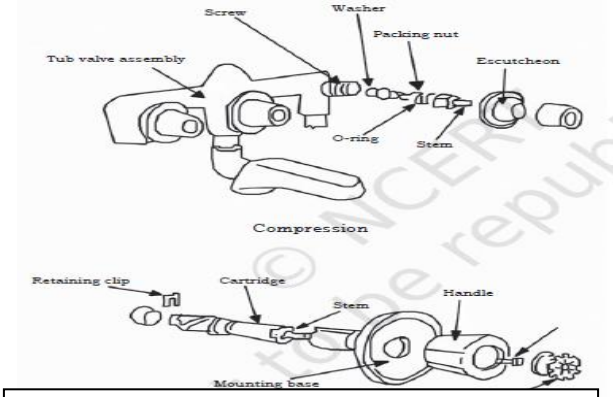


Fig.3.47: Bathtub faucet breakout

2. Remove the handle screw — Remove the handle screw. Then give a little jerk to the handle and pull it off. However, be gentle; if it is too hard, it may break, use a gentle push.

3. Loosen the handle — When the handle is not able to come out and we use force, it may break. Thus, use a special handle puller. Rotate the handle screw about halfway back into the stem. Fix the handle puller's post against the screw head and press the arms together behind the handle. Turn the post clockwise until the handle pops loose. Remove the handle screw and handle. Then pull off or unscrew the escutcheon plate.

4. Remove the stem — When the handle is removed, unscrew the escutcheon and stem assembly. The stem assembly is an important component which controls the amount and temperature of the water dispensed through the tub spout or shower head. The stem assembly is removed with a special bath socket wrench. Fix the bath socket with the stem bonnet and turn it counter clockwise so that it gets loosened. Unscrew and remove the stem.

5. Use a seat wrench — As you understand that leaks usually occur for two reasons, first the seat washer stiffens and would not seal properly. Sometimes, the water pressure gradually erodes the brass rim of the seat. Replace the seat using a special seat wrench.

6. **Replace the faucet stem parts —** Change the broken washer and apply.

3.10.6. Temporary repairs for minor leaks

Minor leaks in a fixture require temporary or emergency repairs. Before making any repairs, turn off the water and relieve the pressure from the distribution system. Pipes can be temporarily repaired using the following steps.

1. **Rubber hose or plastic tubing:** Cut the pipe on either side of the leak with a hacksaw or pipe cutter. The section damaged pipe may be removed and replaced with a similar length of rubber hose or plastic tubing. To do this, slip the ends over the pipe and fasten them with hose clamps. The inside diameter of the hose must fit the outside diameter of the pipe.
2. **Sheet rubber:** Wrap the leaking area with sheet rubber. Place two sheet-metal clamps on the pipe (one on each side). Then, fasten the clamps with nuts and bolts.
3. **Electrician's friction tape:** Wrap several layers of friction tape around the hole or crack, extending the tape about 2 inches above and below the leak.
4. **Wood plugs:** Small holes can be filled with wood plugs. Drive a wooden plug into the hole after it is drilled or reamed. The plug will swell as it absorbs water, preventing it from being blown out by water pressure.

   NOTE: It is always recommended that repair should be made as soon as possible to permanently replace the broken, weak or defective part. Replace it with a unit

(and insulation if used) that is the same size and quality as the original installation.

5. **Frozen pipes:** Water supply lines may freeze when exposed to temperatures below zero degrees Celsius. Outside pipes must be buried below the frost line. In northern zones, this may be 4 feet or more. If the temperature of a building deviates below freezing, inside pipes may also freeze, causing the pipe to break at the lowest point. Procedures for thawing above- and below-ground pipes are discussed in the paragraphs below:

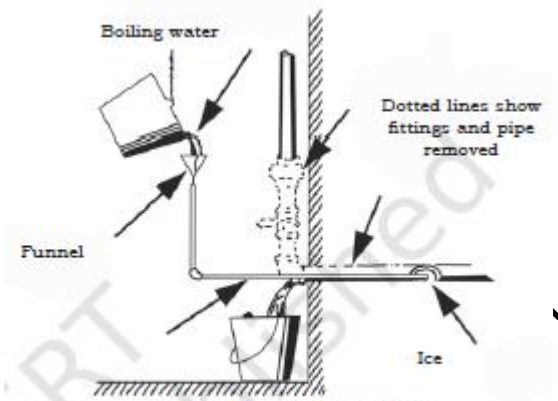


Fig. 5.8: Thawing frozen pipe

Fig.3.48: Thawing frozen pipe

6. **Exposed pipes:** A blowtorch is the best method to thaw the above ground pipes, but there is a risk of fire. Use the following steps when using a blow torch.
   Step 1: Open the faucets in the line.
   Step 2: Apply heat from the blowtorch at one end of the pipe and work along the entire length of the pipe.
   Step 3: Continue to heat the pipe until the water starts to flow freely.
   Pipes can be thawed by wrapping them with burlap or other cloth and pouring boiling water over the wrappings, thus transmitting heat to the frozen pipe. When internal freezing is due to a failure in the heating plant, the heating plant must be repaired; a high temperature should be maintained in the building until the pipes thaw.
   Note: Do not overheat as the solder joints will break loose when the solder melts.
7. **Underground pipes**
   Use the following steps to thaw a frozen underground pipe.
   Step 1: Remove the pipe fittings.
   Step 2: Place a small warm up pipe or tube into the frozen pipe.
   Step 3: Add an elbow and a piece of vertical pipe to the outer end of the warm up pipe.

Step 4: Keep a bucket below the opening to the frozen pipe.
Step 5: Insert a funnel into the open end of the vertical pipe.
Step 6: Pour boiling water into the funnel and as the ice melts, push the thaw pipe forward.
Step 7: After the flow starts, withdraw the pipe quickly. Allow the flow to continue until the thaw pipe is completely withdrawn and cleared of ice.
NOTE: A small pump may be used to clear a piece of pipe. However, excessive pump pressure can cause a backup; therefore, this procedure must be carefully monitored.

8. **Scale:** It is a deposit that is typically indicative of hard water. Scale can sharply reduce the flow of water to the fixtures. Calcium and magnesium compounds are found in hard water which prevent soap from lathering. This forms a scum, which slows down the flow of water. The scum deposits harden and form scale.

a) **Reducing scale:** In localities where water is unusually hard, a water softener is used to reduce the hardness. The softener normally contains zeolite, which should be recharged at regular intervals. Add sodium chloride (table salt) to the water to recharge. Water softeners are programmed to recharge at a set time each day. The softened water is then piped into the distribution system.

b) **Removing scum:** To remove scum that has formed on the inside of a pipe, do one of the following.

- Flush with hot water.
- Use lye, or lye mixed with a small quantity of aluminium shavings. Only cold water should be used with lye.
- Replace the entire pipe when there is a sharp reduction of water flow.

NOTE: Chemical cleaners should not be used in pipes that are completely stopped up because the cleaners must come in contact with the stoppage directly.

9. **Waste system stoppages:** A common problem in waste systems is a stoppage of waste. This stoppage can occur in any drain, like, floor drain, branch line, or main line. It can be due to stone, pulp, hair, grease, or other foreign matter that holds back or stops the flow of waste disposal. Use the path clearing tools to clear the such stoppages in water closets, lavatories sinks urinals, bathtubs, shower drains, branch, main waste lines, and grease traps.

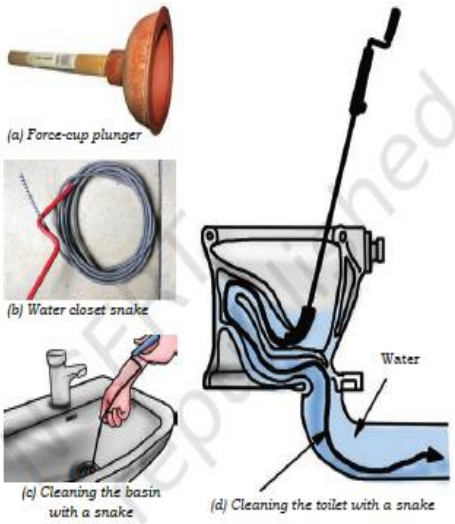


Fig.3.49:Water System Stoppage

10. **Water closet stoppages:** Such stoppages can be cleared using the following tools:

a) **Force-cup plunger:** Following are the steps to clear stoppages with a force cup plunger.

Step 1: Pump the plunger up and down until the water level drops.

Step 2: Place toilet paper in the bowl and flush the water closet to check if the stoppage is cleared.

b) **Water closet snake:** It is a long coil of wire with a corkscrew line tip that is inserted into the pipes till it reaches the stoppage. The following steps can be used to clear stoppages with a water closet snake.

Step 1: Push the snake into the bowl and turn the handle clockwise with a push-pull action until the water level drops.

Step 2: Check to see if the stoppage is cleared as in step 2 (like in the force-cup plunger above).

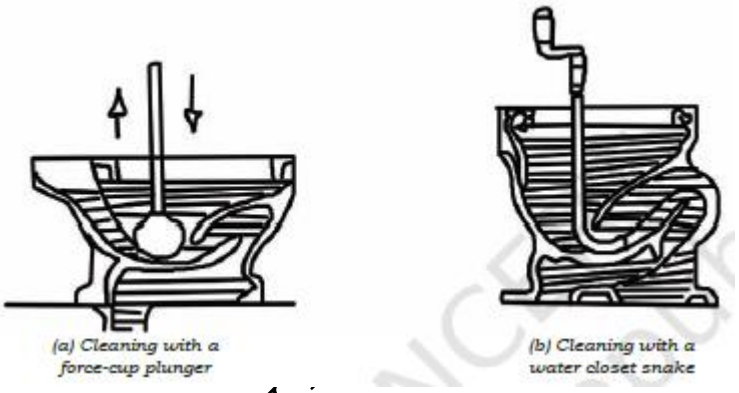


Fig.3.50: (a,b) Clearing water closet stoppages

11. **Lavatories and sinks:**

- **Clearing lavatory and sink P-trap stoppages**

a) **Plunger**

Step 1: Place a wet rag in the bowl's overflow opening. If the lavatory has a pop-up plug, remove the plug.

Step 2: Set a plunger over the waste outlet and push it up and down until the water completely drains out of the bowl.

Step 3: Remove the rag from the overflow opening and replace the pop-up plug, if necessary.

Step 4: Run water through the drain to ensure that the stoppage is removed.

b) ***Snake (¼ - to ½ - inch)***

Step 1: Remove the plug if the lavatory has a pop-up plug.

Step 2: Push the snake down into the waste outlet as far as it will go.

Step 3: Use a push-pull and turning action until the water completely drains out of the bowl.

Step 4: Remove the snake and replace the pop-up plug, if applicable.

NOTE: Stoppage in a P-trap can be removed by disassembling the trap, then removing the stoppage. Reassemble the P-trap after the stoppage is removed and flush with water to ensure good drainage of water.

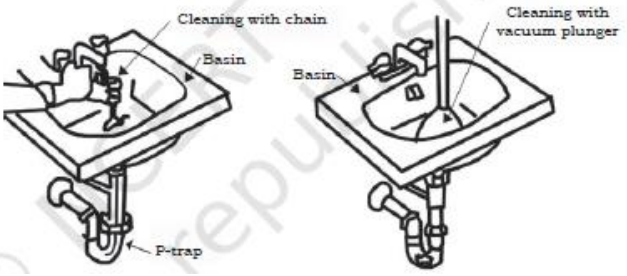


Fig.3.51: Clearing lavatory and sink stoppages

12. Clearing lavatory and sink drain line stoppages beyond the P-trap

a) Snake

Step 1: Place a container under the P-trap to catch the water spillage, then disassemble the P-trap.

Step 2: Push the snake into the drain line, turning it with a push-pull action until it moves freely.

Step 3: Remove the snake and replace the P-trap, then run water through the drain line to ensure that the water flows freely.

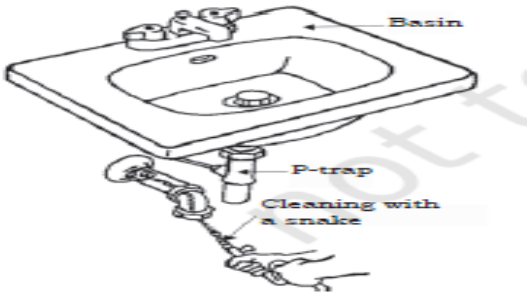


Fig.3.52: Clearing lavatory and sink stoppages beyond the p-trap

13. Urinals: A stoppage in a urinal with a water seal or an exposed P-trap is cleared the same as a lavatory (using a plunger and a ¼- to ½-inch snake).

14. Bathtubs: Use the steps below to clear bathtub P-trap stoppages.

Step 1: Remove the stopper linkage and the overflow cover.

Step 2: Push a ¼- to ½- inch drain snake into the overflow opening until it meets some resistance.

Step 3: Turn the snake using a push-pull motion until it turns freely.

Step 4: Remove the snake and run water through the drain to check if the stoppage is cleared.

Step 5: Replace the overflow cover and linkage.

NOTE: Stoppages can often be removed with a vacuum plunger. Try a plunger first; if the plunger does not work, use a snake.

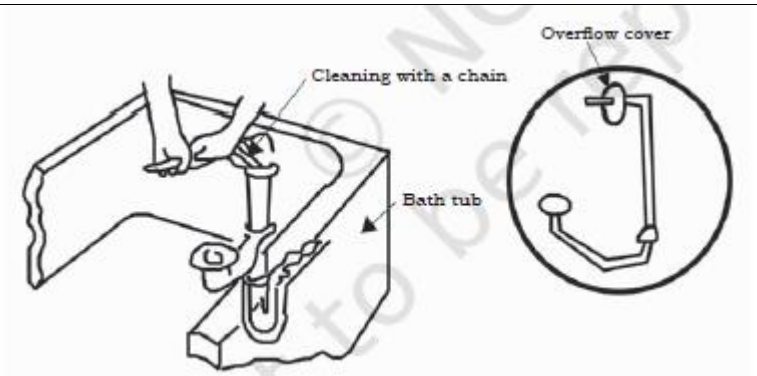


Fig.3.53: Clearing bathtub P-trap stoppages

15. Bathtub drum-trap stoppages

Use the following steps to clear drum-trap stoppages.

Step 1: Remove the drum-top cover and gasket and push a ¼- to ½- inch snake into the trap's lower line to search for the stoppage.

Step 2: If a stoppage exists, clear it.

Step 3: If there is no stoppage in the lower line, remove the snake and push it into the upper line.

Step 4: Turn the snake with a push-pull action to remove the stoppage and replace the gasket and cover.

Step 5: Run water through the drain to see if the stoppage is cleared.

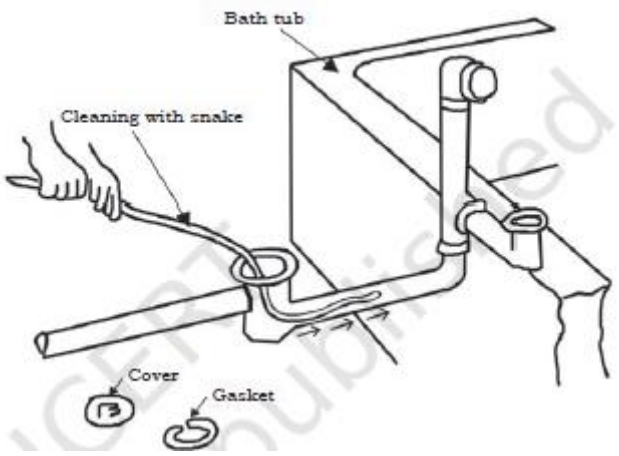


Fig.3.54: Clearing bath drum-trap stoppages

16. Shower drains

These can be cleared by using a hose. Use the steps below to clear drains.

Step 1: Remove the strainer from the drain.

Step 2: Attach the water hose to a source of water and place the other end of the hose into the drain.

Step 3: Stuff rags around the hose to form a tight seal.
Step 4: Turn the water on full force, then off and on again. The surge of water (pressure) will clear the stoppage.
Step 5: Replace the strainer.

17. Snake (¼ - to ½ - inch)

Step 1: Remove the strainer from the drain.
Step 2: Push the snake into the drain and turn the snake with a push-pull action until it moves freely.
Step 3: Remove the snake and replace the strainer.

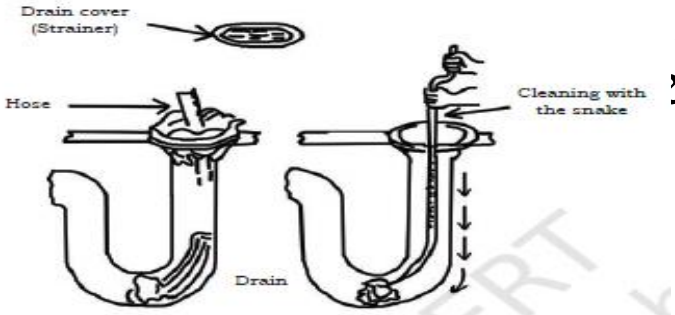


Fig.3.55: Clearing shower-drain stoppages

18. Floor drain stoppage: These stoppages are cleared the same way as shower drains. A floor drain may have the strainer cemented to the floor. If so, remove it by chipping the cement around the strainer. Once the stoppage is cleared, cement the strainer back in place.

19. Branch and main waste lines: Stoppages that occur in a branch or main waste line in a building are cleared through a cleanout plug. Following steps may be adopted for clearing branch lines:
Step 1: Open and remove the closest cleanout plug.
Step 2: Clear the stoppage with a snake.
Step 3: Replace the cleanout plug.
Step 4: Run water through the drain to ensure that the stoppage is cleared.

Clear main lines by using the following steps:
Step 1: Remove the closest cleanout plug.
Step 2: Clear the stoppage with a ¾- to 1-inch heavy-duty snake.
Step 3: Replace the cleanout plug.

20. Grease traps: All work is done on the principle that grease is lighter than water and will rise to the top of the water. Use the following steps to clear a grease-trap stoppage:
Step 1: Remove the top cover and dip out the grease with a ladle.

Step 2: Scrape the walls and bottom after the grease is scooped out.

Step 3: Flush with clear water.

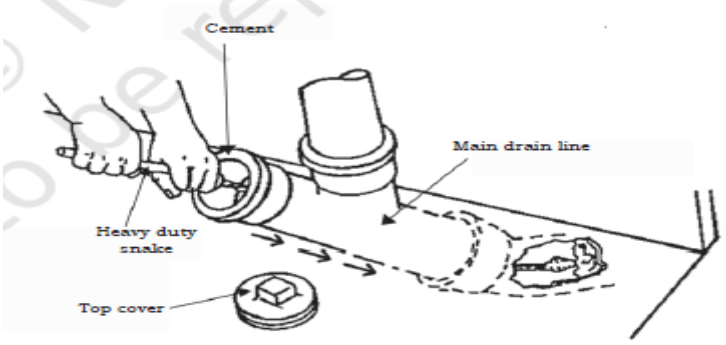


Fig.3.56: Clearing waste-line stoppage

3.10 Concealing PVC Pipes inside the wall

Plumbing systems that are installed during construction and hidden from view behind walls are considered concealed. Accessing them is only possible by deconstructing the wall or area where the concealed plumbing system is installed.

Wrapping your pipes in decorative coverings is a great option for those with small sections to disguise. You can purchase plastic or wooden pipe coverings at most hardware stores to match your decor. Simply spray some adhesive spray over the pipe and wrap your covering around it (Fig. 3.57).

Fig.3.57: Concealing of pvc pipe inside the wall

Procedure of Pipe-concealing

In concealing process of pvc pipe inside the wall, the following steps are as:

Step 1: Mark the track: First, ensure that the drinking water pipe and drainage pipe do not overlap by marking the tracks of pipe outlets such as the tap, shower, and washbasin with a spirit level (Fig. 3.58).

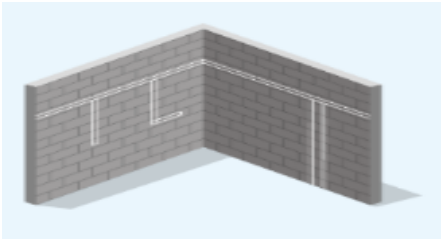


Fig.3.58: Mark the track

Step 2: Thickness of cut: Then, using a disc blade, cut the marked area, making sure that the cut is 4-6 mm larger than the thickness of the pipes. Make sure not to damage any of your home's beams or columns in the process (Fig. 3.59).

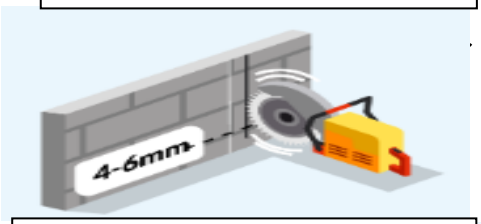


Fig.3.59: Thickness of cut

Step 3: Make perfect grooves: Create grooves in the marked area using a spade. Make sure not to break the entire marked area at once if the wall is a load-bearing wall (Fig. 3.60).

Fig.3.60: Make perfect grooves

Step 4: Fit the pipe: Fit the pipes into grooves with the help of nails (Fig. 3.61).

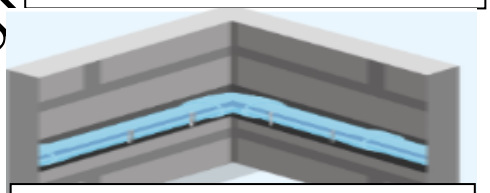


Fig.3.61: Fit the pipe

Step 5 : Filling the gaps: Cement and sand mortar should be used to fill in the spaces between the pipes and the walls (Fig. 3.62).

Fig.3.62: Filling the gaps

Step 6: Avoid Cracks: To prevent wall cracks, use a steel mesh. Put this in the groove and secure it with mortar and nails (Fig. 3.63).

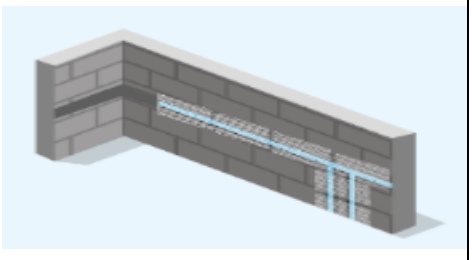


Fig.3.63: Avoid Cracks

3.11 Installation of water tank alarm

As we know that water requirement is increasing day by day in our houses/buildings for our daily life, therefore we have alert about the wastage of water by us. So installation of an alarm in a water tank is required to stop the losses (Fig. 3.64).

Procedure of installation of water tank alarm

1. Install a 9V battery (not included). Replace the battery once a year.
2. Select an indoor mounting location.
3. Install a mounting screw in the wall at the desired height and slip the keyhole on the back of the box onto the screw and pull it down.
4. Use another screw to fasten the bottom mounting cleat to the wall.
5. Use the cable tie supplied in the box to secure the float switch at the desired warning level in the tank (see diagram). Cut off excess material left from the cable tie and discard.
6. Now manually test the alarm by tilting the float switch up until you hear the alarm notification and you see the alarm light turn on.
7. Periodically test the unit by pushing the test button on the cover to make sure the unit is working properly.

Fig.3.64: Water Tank Alarm

3.12 Identification of major faults in plumbing system

Identify the root of common plumbing issues in the home. Specific components of your plumbing system are responsible for issues like low water pressure, excessive water use,

slow drains, noises, and other issues. The following procedures may assist you in identifying the cause of a plumbing issue and provide information on some of the most straight forward fixes for each problem type.

Some of the following issues as: -

1. High water usage (or water bills)

Inspection:

a) **Listen for dripping sounds**: Even though this step seems straightforward, it might be missed in a busy, noisy home. Even though it may not seem like a dripping tap wastes a lot of water, over the course of a day, each drop adds up to thousands of drops, or gallons, of water.
A time when there is little to no activity, such as early in the morning or late at night, when the house is very quiet, should be chosen.

b) **Look for evidence of a leak along the base board of walls near the location of your plumbing fixtures**: The loss of water can continue until the pipes are repaired if they become corroded, develop loose fittings, or crack due to freezing.

c) **Look under vanities and sinks for drips or similar evidence noted in the previous step**: Follow exposed pipes with a torch, keeping an eye out for water droplets that will collect at the bottom before falling off. You can also feel for moisture by running your fingertips along the exposed pipes.

d) **Listen for noises from your commodes/bathrooms, to determine if they are running at unusual intervals, when no one has recently flushed them**: In the event of a toilet seal leak, the tank will gradually empty over time until the water level is low enough for the float valve to open and refill the tank. As with dripping faucets, stuck flush valves and leaking seals in toilets can waste a lot of water because the flow, though possibly very small, is continuous.

e) **Check your water meter**: Turning off all faucets and water-using appliances will stop the flow of water into your home from municipal water systems, which use metres to measure how much water is used.
To check if water has passed through your water metre when none was being used in your home, locate your water metre, read the amount displayed, make a note of it, wait a few hours and then reread it. Very small leaks will be more difficult to find using this method because they won't appear to move the metre over a short period of time.

2. Drain/waste problems

Inspection:

a) Identify the problem that is occurring with your drains, specifically, the individual drains which are not functioning correctly. Some typical problems are these:
- Slow sink or tub drains.
- Water *backing up* in the bathtub, shower, or sink.

- Wet areas in walls or along floors in rooms adjacent to walls containing drain pipes.
- Wet areas in the lawn near drain piping.
- Unusual gurgling or bubbling sounds when water is draining.

b) Try to determine the extent of your "slow drain" problem: If the problem is restricted to a single washbasin or other fixture, it is likely confined to the specific pipe that joins that fixture to the main line.
To put it another way, if only the kitchen sink has a slow drain, the issue is likely with the sink trap or drain line that joins to the larger pipes that also transport water from other sinks, the toilet and the bathtub.

3.13 Scale formation of overhead tank, faucet, and others plumbing fittings

1. Cleaning (scale formation) of overhead tank

To clean scale formation in an overhead tank, you can follow these general steps:

a) **Empty the Tank:** Start by emptying the tank completely. This can be done by turning off the water supply to the tank and allowing it to drain out through a tap or drain outlet.

b) **Safety Precautions:** Before starting the cleaning process, ensure you take proper safety precautions. Wear gloves, protective eyewear, and a face mask to protect yourself from any harmful substances or fumes.

c) **Scrubbing the Tank Interior:** Use a scrub brush or a hard bristle brush to scrub the interior walls of the tank. Focus on areas where scale formation is more prominent. You can also use a mixture of water and a mild detergent or vinegar to aid in the cleaning process. Scrub thoroughly to remove the scales and any other debris.

d) **Removing Stubborn Scales:** If the scales are stubborn and hard to remove, you can use a descaling agent specifically designed for removing mineral deposits. Follow the instructions provided by the manufacturer for proper usage. Be cautious when using such chemicals and ensure proper ventilation in the area.

e) **Rinse Thoroughly:** After scrubbing or using a descaling agent, rinse the tank thoroughly with clean water. Ensure all traces of detergent or descaling agent are removed from the tank.

f) **Disinfecting the Tank:** Once the tank is clean, it is important to disinfect it to kill any bacteria or germs. You can use a chlorine-based disinfectant or a disinfectant recommended for water tanks. Follow the instructions provided by the manufacturer for proper dilution and contact time.

g) **Refill the Tank:** After disinfecting, close the drain outlet and refill the tank with clean water. Check for any leaks or issues with the tank's fittings during the refill process.

h) **Regular Maintenance:** To prevent future scale formation, consider implementing regular maintenance practices. This may include periodic cleaning, using water softeners if applicable, or installing filters to reduce scale buildup.

Remember, it's essential to consult local guidelines or regulations specific to your region regarding water tank cleaning and maintenance. Additionally, if you're unsure or uncomfortable performing the cleaning yourself, it's recommended to seek professional help from a water tank cleaning service.

2. Cleaning (scale formation) faucet

To clean scale formation on a faucet, you can follow these steps:

a) **Gather Supplies:** Gather the necessary supplies for cleaning, which may include white vinegar, a soft cloth or sponge, an old toothbrush, a plastic bag, and a wrench (if needed).

b) **Prepare Vinegar Solution:** Fill a plastic bag with white vinegar and immerse the affected parts of the faucet in the vinegar. If the scale formation is limited to the aerator or small components, you can remove them and soak them in a bowl of vinegar instead.

c) **Allow Soaking Time:** Leave the faucet or components to soak in the vinegar for at least 30 minutes to an hour. The acidic properties of vinegar help dissolve and loosen the scale buildup.

d) **Scrub the Faucet:** After soaking, use a soft cloth or sponge dampened with vinegar to scrub the faucet surfaces. For areas that are difficult to reach, such as the aerator or crevices, use an old toothbrush to scrub gently and remove any remaining scale.

e) **Rinse Thoroughly:** Once you have scrubbed away the scale, rinse the faucet or components thoroughly with clean water. Ensure there is no vinegar residue left behind.

f) **Check the Aerator:** If the aerator is the main source of scale buildup, inspect it for any remaining scale particles. Use a toothpick or small brush to remove any debris or scale clogging the aerator holes.

g) **Reassemble and Test:** If you disassembled any components, carefully reassemble them, ensuring they are properly aligned and tightened. Turn on the water and check for any leaks or issues. If the water flow is still restricted, you may need to repeat the cleaning process or consider replacing the aerator.

h) **Preventive Measures:** To prevent scale formation in the future, consider using a water softener or installing a whole-house water filtration system. These measures can help reduce mineral deposits in your water supply and minimize scale buildup on faucets and other fixtures.

It's important to note that the cleaning methods may vary depending on the type of faucet you have. If you are uncertain about disassembling or cleaning certain components of your faucet, it's recommended to consult the manufacturer's instructions or seek professional assistance.

3. Cleaning (scale formation) other plumbing fittings

To clean scale formation on other plumbing fittings, such as showerheads, pipes, or valves, you can follow these general steps:

A. Showerheads:

a) **Remove the showerhead:** Unscrew the showerhead from the shower arm. If the showerhead is fixed or difficult to remove, you can use a plastic bag and rubber band to create a vinegar soak (as mentioned in step 2 below).

b) **Soak in vinegar:** Fill a plastic bag with white vinegar and place the showerhead inside, ensuring it is fully submerged. Use a rubber band to secure the bag around the showerhead. Leave it to soak for at least 30 minutes to an hour.

c) **Scrub and rinse:** After soaking, scrub the showerhead with a soft brush or toothbrush to remove any remaining scale deposits. Rinse it thoroughly with clean water.

d) **Reinstall the showerhead:** Screw the cleaned showerhead back onto the shower arm, ensuring it is securely tightened.

B. Pipes and Valves:

Turn off the water supply: Locate the shut-off valve for the specific pipe or valve you want to clean and turn it off. This will prevent water flow and make the cleaning process easier.

a) **Disassemble if necessary:** Depending on the type of plumbing fitting, you may need to disassemble it to access the affected area. Use appropriate tools, such as a wrench or pliers, to loosen and remove the fittings if needed.

b) **Soak in vinegar or descaling solution:** Prepare a vinegar solution by mixing equal parts vinegar and water. If the scale buildup is severe, you can use a commercial descaling solution. Submerge the parts in the solution and leave them to soak for a period specified by the manufacturer or until the scale loosens.

c) **Scrub and rinse:** After soaking, use a brush or sponge to scrub the parts and remove the loosened scale. Rinse them thoroughly with clean water.

d) **Reassemble and test:** Once cleaned, reassemble the parts and ensure they are properly aligned and tightened. Turn on the water supply and check for any leaks or issues.

It's important to note that the cleaning methods may vary depending on the specific plumbing fittings and their materials. Always refer to the manufacturer's instructions or consult a professional if you are unsure about disassembling or cleaning certain components.

Activities

Activity 1: Make a list of different types of PVC pipes.
Material Required
1.Notebook
2.Pen
Procedure
1.First visit the hardware shop.
2.Identify the different types of PVC pipes are available in hardware shop.
3.Make a list of identified different types of PVC pipes are available in hardware shop.
4.Write their name and specification.

Activity 2: Make a list of plumbing system.
Material Required
1.Notebook
2.Pen
Procedure
1.First visit the work site.
2.Identify the plumbing system in work site.
3.Make a list of plumbing system in worksite
4.Write their name and specification.

Activity 3: Perform the Water tank overflow alarm system .
Material Required
1.Water tank overflow alarm device
2.Bucket
3.Plastic Water pipe
4.Tap
5.Notebook
6.Pen
Procedure
1.Fix the plastic water pipe with the tap.
2.Affix the water tank overflow alarm system at the top level of the bucket along with the necessary connections.
3.Start filling the bucket with the plastic water pipe.
4.Make sure the water tank overflow alarm system is in working condition.
5.As the water level in the bucket touches the mark, sensor gets activated and trigger the alarm.
6.You can set the alarm system at any level you want to have.

Activity 4: Removing scale formation from the plumbing fittings and fixtures

Material Required

1.Old plumbing fittings and fixtures
2.Scrubber/Brush
3.Vinegar
4.Wiping cloth

Procedure

1.Collect the plumbing fittings and fixtures to be cleaned as per availability (by disassembling or as available).
2.Collect them at a place.
3.Soak in Vinegar.
4.Scrub with the brush
5.Clean and wipe them with the cloth.

Check Your Progress

A. Answer the following questions

1. Why plumbing drawing is needed?
2. Write the importance of technical drawing in plumbing?
3. Explain the basic work-related information in plumbing.
4. Write the difference between CPVC and UPVC pipe.
5. What is grouting? Explain the types of grouting and its application in plumbing system.
6. Describe the grouting process.
7. Explain the testing of joints of SW pipe.
8. Write the step of installation process of drainage system in house.
9. Explain the cast iron pipe joining process.
10. Write the step of followed during PVC pipe installation.
11. Write down the step of installation of water tank alarm system in house.
12. Describe the cleaning (scale formation) of overhead tank, faucet, and others plumbing fittings.
13. Describe the Concealing process of PVC pipes inside the wall.

B. Fill in the blanks

1. A work schedule is a …….. that outlines when and how work tasks should be completed.
2. A plumbing drawing is a type of …….. that provides visual representation and information relating a plumbing system.
3. Precision is …….. in plumbing to ensure proper connections, avoid leaks, and comply with building codes and regulations.

4. Pipe laying is the process by which long sections of pipe are …… and ……., so that they can be welded together.
5. …….. leaks in a fixture require temporary or emergency repairs.
6. Pipe corrosion is a process that results in a …… of the wall of a metal pipe, caused by electrolysis, junk, or acidity of water.

C. Mark the correct option

1. These pipes are made from rigid polyvinyl chloride resin, which is not plasticized with additives.
   a)PVC pipe
   b)UPVC pipe
   c)CPVC pipe
   d)All of above
2. These pipes are made from polyvinyl chloride resin that has been chemically modified with chlorine.
   a)PVC pipe
   b)UPVC pipe
   c)CPVC pipe
   d)All of above
3. It is a small tank holding water for flushing urinals and water closets.
   a)Water tank
   b)Cistern
   c)Box cistern
   d)Flushing cistern
4. It is a rectangular, shallow waterproof tank made of concrete, vitreous china, fireclay, or stainless steel.
   a) Sink
   b)Trap
   c)Cross
   d)Tap
5. It is a device that controls the flow of liquid, especially water, from a pipe.
   a)Tape
   b)Steel rule
   c)Tap
   d)Faucet
6. It is sanitary fittings used for heating water.
   a)Water meter
   b)Geyser
   c)Tap
   d)Faucet

Module 4	Health and Safety at workplace

Module Overview

This module focused on how to manage health and safety in the workplace. Before starting any work, it is very important that a person should know and follow all rules and regulations about precautions. Health and safety at the workplace is a crucial aspects of ensuring the well-being and welfare of employees while they carry out their job responsibilities. Health and safety at a plumbing workplace is of utmost importance as plumbers often work in hazardous environments and deal with potentially dangerous tools, equipment, and materials.

Learning Outcomes

After completing this module, you will be able to:

- Understand various safety hazards
- Understand how to safely handle and use various plumbing tools
- Explaim the imporatnce of wearing appropriate PPE.

Module Structure

4.1 Safety and health-related problems faced in domestic and industrial units

4.2 Potential injuries and health problems associated with incorrect handling of tools and equipment

4.3 Various types of hazards

4.4 Importance of various types of Personal Protective Equipment

4.5 Various types of safety signs and their significance in the workplace

4.6Safety management and techniques at a plumbing work site

4.7 Rescue techniques during a fire hazard or electrocution

4.8 Basic First aid

4.9 Occupational Safety and Health practices

4.1 Safety and health-related problems faced in domestic and industrial units

Safety and health-related problems can be encountered in both domestic and industrial settings. Here are some common issues faced in each of these environments:

1. **Domestic Units:** Domestic Unit means a house, apartment, or other similar residential unit which is normally occupied by one family, or by a family and no more than four other persons who are not members of that family, or which is normally occupied by no more than six unrelated persons. The following safety and health-related points in domestic units are as-

   A. **Falls and injuries:** These injuries can make it hard for a person to get around, do everyday activities, or live on their own. Falls can cause broken bones, like wrist, arm, ankle, and hip fractures. Falls can cause head injuries (Fig.4.1). Falls are a leading cause of injuries in plumbing worksites, therefore plumbers should be aware of the danger. Falls are a leading cause of injuries in households, especially among children and the elderly. Tripping over objects, slippery floors, or inadequate lighting can contribute to these accidents.

Fig. 4.1: Fall and Injuries

   B. **Burns and scalds:** Household/Plumbing worksite accidents involving hot surfaces, open flames, hot liquids, or faulty electrical appliances can lead to burns and scalds (Fig.4.2).

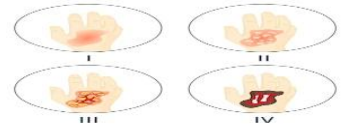


Fig. 4.2: Skin Burn

   C. **Poisoning:** Exposure to toxic substances such as cleaning chemicals , pesticides, or medications can cause poisoning, particularly when not stored securely or when consumed accidentally by children.

   D. **Fire hazards:** Electrical faults, overloaded power sockets, improper use of heating appliances, and unattended candles pose fire risks in homes/worksites (Fig.4.3).

Fig. 4.3: Fire hazard

   E. **Carbon monoxide poisoning:** Inadequate ventilation or faulty heating systems can lead to the accumulation of carbon monoxide, a colorless and odorless gas that can be fatal if inhaled.

   F. **Ergonomic issues:** Poorly designed furniture, improper posture, and lack of ergonomics in home offices can contribute to musculoskeletal problems such as back pain and repetitive strain injuries.

   G. **Indoor air quality:** Inadequate ventilation, mold growth, and exposure to allergens can affect indoor air quality, leading to respiratory issues and allergies.

2. **Industrial Units:** It means a single unit that may be on a separate parcel of land or may be part of a multi-unit complex and other premises. The following safety and health-related points in industrial units are as-
   - **A. Occupational hazards:** Industrial workplaces often involve heavy machinery, chemicals, and hazardous materials, leading to risks such as falls, trips, and being struck by objects. Exposure to harmful substances can cause respiratory problems, skin diseases, or long-term health issues.
   - **B. Noise pollution:** High noise levels in industrial settings can lead to hearing loss and other related health problems if proper hearing protection is not provided (Fig.4.4).

Fig. 4.4: Noise Pollution Sign

   - **C. Accidents during material handling:** Improper lifting techniques, lack of training, and inadequate equipment can contribute to injuries related to manual handling of heavy loads.
   - **D. Machine-related accidents:** Insufficient machine guarding, lack of proper safety protocols, and mechanical failures can result in serious injuries or even fatalities.
   - **E. Chemical exposures:** Workers in industries dealing with chemicals may face risks from toxic fumes, spills, or improper handling, leading to chemical burns, respiratory problems, or systemic health effects.
   - **F. Work-related stress:** Intense work pressure, long working hours, lack of work-life balance, and demanding job tasks can contribute to stress-related health problems among industrial workers.
   - **G. Lack of ergonomics:** Inadequate workstation design, repetitive motions, and poor ergonomics in industrial settings can lead to musculoskeletal disorders and injuries.

It's important to note that the specific safety and health problems faced in domestic and industrial units can vary depending on various factors such as the nature of the work, geographical location, and adherence to safety regulations. Implementing proper safety measures, providing training, and promoting a culture of safety can help mitigate these issues in both settings.

4.2 Potential injuries and health problems associated with incorrect handling of tools and equipment

Incorrect handling of tools and equipment can lead to various injuries and health problems. So it is very important that whenever the plumber should do work then he /she follows the rules and regulations. Here are some potential risks associated with improper handling:

A. **Cuts and Lacerations:** Mishandling sharp tools or using them inappropriately can result in cuts and lacerations. This can occur when tools are used without proper hand protection, in a careless manner, or when trying to force them through materials (Fig.4.5, A and B).

Fig. 4.5: A- Cut wound

Fig. 4.5: B- Laceration

B. **Strains and Sprains:** Lifting heavy objects or using tools with improper techniques can strain muscles, tendons, and ligaments. Awkward postures, repetitive motions, and overexertion can lead to sprains, strains, and musculoskeletal injuries.

C. **Hand-arm Vibration Syndrome (HAVS):** Prolonged use of vibrating tools, such as power drills or jackhammers, without proper breaks or using anti-vibration measures, can cause HAVS. It is characterized by symptoms like numbness, tingling, reduced grip strength, and loss of dexterity in the hands and arms.

D. **Back Injuries:** Incorrect lifting techniques, such as bending from the waist instead of the knees, can strain the back muscles and lead to back injuries. Lifting heavy objects without assistance or using inadequate equipment can increase the risk (Fig.4.6).

Fig. 4.6: Back Injury

E. **Eye Injuries:** Failure to use appropriate eye protection while using tools that generate particles, dust, or debris can result in eye injuries. Flying objects, sparks, or chemical splashes can cause serious eye damage or vision impairment.

F. **Respiratory Issues:** Working with tools that generate dust, fumes, or airborne particles without proper respiratory protection can lead to respiratory problems. Prolonged exposure to these hazardous substances can cause lung irritation, asthma, or other respiratory disorders.

G. **Electric shocks and Burns:** Mishandling electrical tools or equipment, such as faulty wiring, improper grounding, or overloading circuits, can result in electric shocks and burns. Inadequate training and failure to follow safety precautions increase the risk (Fig.4.7).

Fig. 4.7: Electric shocks

H. **Hearing Loss:** Operating loud tools and equipment without proper hearing protection can lead to noise-induced hearing loss. Prolonged exposure to high noise levels can damage the delicate structures of the inner ear.

I. **Crushing Injuries:** Mishandling heavy equipment or tools can lead to crushing injuries, especially when they are not properly secured, supported, or used in unstable environments. Accidents involving machinery or heavy objects can cause severe injuries or even fatalities.
It is crucial to receive proper training in tool and equipment handling, follow safety guidelines and instructions, use personal protective equipment (PPE), and maintain a safe working environment to prevent these injuries and health problems.

4.3 Various types of hazards

During plumbing installation and maintenance, several types of hazards can be present. Here are various hazards and the precautions/remedies associated with them:

1. **Physical Hazards:** Physical hazards are based on the chemical's inherent characteristics. It can be divided into five categories: explosive, flammable, oxidising, gases under pressure, and corrosive to metals. In this hazard, physical harm will happen to the body. The following are to be covered in physical hazards-
   - **Sharp objects:** Use appropriate hand protection, such as gloves, to avoid cuts and punctures.
   - **Falling objects:** Securely fasten pipes, tools, and equipment to prevent them from falling and causing injuries.
   - **Slips, trips, and falls:** Keep the work area clean and free of obstacles. Use non-slip footwear and maintain proper lighting.
2. **Mechanical Hazards:** Mechanical hazards are caused by the relative motions of human body parts and objects, such as tools or other work-related objects, which result in their contact. This contact may cause mishaps that result in injuries. The following points are as-

- **Moving machinery and equipment:** Ensure that all machinery and equipment are turned off and properly locked out/tagged out before performing any maintenance or repair work.
- **Pinch points and moving parts:** Be cautious of pinch points and moving parts while operating valves, pumps, or other mechanical devices. Use appropriate guarding and follow safe operating procedures.

3. **Fire Hazards:** A fire hazard refers to any situation, material, or condition that increases the risk of a fire occurring or amplifies the potential damage and danger associated with a fire. Fire hazards can exist in various environments, including homes, workplaces, public spaces, and outdoor areas. It is crucial to identify and mitigate fire hazards to ensure safety and prevent potential disasters. Here are some common examples of fire hazards:
   - **Ignition sources:** Keep flammable materials away from open flames, sparks, or hot surfaces. Use flame-resistant clothing and fire extinguishers in the vicinity.
   - **Electrical faults:** Ensure proper grounding and insulation of electrical equipment. Regularly inspect and maintain electrical connections to prevent short circuits or electrical fires.

4. **Chemical Hazards:** Chemical hazards refer to substances or materials that can cause harm to human health, property, or the environment due to their chemical properties. These hazards can be present in various settings, including workplaces, industrial facilities, laboratories, and even household environments. Chemical hazards can result from exposure to toxic, flammable, corrosive, reactive, or explosive substances. Here are some common types of chemical hazards:
   - **Hazardous substances:** Properly store and handle chemicals according to safety data sheets (SDS). Use appropriate personal protective equipment (PPE) such as gloves, goggles, and respirators when working with or around chemicals.
   - **Toxic substances:** Chemicals that are toxic can cause harmful effects on human health if inhaled, ingested, or come into contact with the skin. These substances include certain pesticides, heavy metals, asbestos, lead, mercury, and various industrial chemicals.
   - **Flammable and combustible materials:** Chemicals that are highly flammable or combustible can ignite and cause fires or explosions under certain conditions. Examples include gasoline, solvents, alcohol, oils, and some gases.
   - **Corrosive substances:** Corrosive chemicals are highly reactive and can cause severe damage to skin, eyes, and other materials upon contact. Common corrosive substances include acids, bases, strong alkalis, and certain cleaning agents.
   - **Reactive chemicals:** Reactive substances can undergo potentially hazardous chemical reactions when exposed to heat, pressure, or contact with other

incompatible substances. Some reactive chemicals include oxidizers, peroxides, unstable compounds, and reactive metals like sodium or potassium.

- **Irritants:** Chemicals that can cause irritation or allergic reactions when they come into contact with the skin, eyes, or respiratory system. Examples include certain cleaning products, detergents, and some solvents.
- **Explosive materials:** Chemicals that are inherently explosive or can become explosive under specific conditions pose a significant risk. These include certain unstable compounds, explosives, and reactive mixtures.

5. **Electrical Hazards**: Electrical hazards refer to potential dangers associated with the use, installation, maintenance, or repair of electrical systems and equipment. These hazards can occur in both residential and industrial settings and pose risks to individuals, property, and the surrounding environment. Electrical hazards can result in electric shock, electrical burns, fires, explosions, and other serious injuries or fatalities. Here are some common types of electrical hazards:
    - **Electric shock:** Contact with live electrical currents can result in electric shock, which can cause injuries ranging from minor discomfort to cardiac arrest and death. Factors that increase the risk of electric shock include exposed wires, faulty wiring, damaged insulation, and improper use of electrical equipment.
    - **Faulty wiring and poor electrical installations:** Inadequate or outdated electrical installations, improper wiring, and overloaded circuits can lead to electrical hazards. These issues can cause electrical fires, electrical arcing, and equipment failures.
    - **Overloaded circuits and extension cords:** Plugging too many devices into a single circuit or using extension cords inappropriately can overload the electrical system, causing overheating, electrical fires, and damage to electrical equipment
    - **Improper grounding:** Electrical systems and equipment should be properly grounded to provide a safe pathway for electrical currents. Inadequate grounding can result in electrical shocks and equipment malfunctions.
    - **Exposed electrical parts:** Exposed live wires, terminals, or electrical components increase the risk of electric shock and should be appropriately covered or insulated.
    - **Inadequate electrical equipment maintenance:** Failure to perform regular inspections, maintenance, and repairs on electrical equipment can lead to malfunctions, overheating, and electrical failures.
    - **Inadequate electrical safety training:** Lack of awareness and understanding of electrical safety practices among individuals working with or around electrical systems can increase the likelihood of accidents and injuries.

- **Outdoor electrical hazards:** Exposed electrical wires, overhead power lines, and equipment located in outdoor environments can pose risks, especially when in proximity to water sources or when damaged by weather conditions.
- **Electrocution:** Avoid working on wet surfaces or with wet hands. Insulate yourself from electrical currents and use appropriate PPE, such as insulated gloves and footwear.

Precautions and Remedies: The following precautions should be kept in mind during work time-

- **Adequate training:** Ensure that plumbers and maintenance personnel receive proper training on safety protocols, equipment operation, and emergency procedures.
- **Personal protective equipment (PPE):** Provide and enforce the use of appropriate PPE, including gloves, goggles, hard hats, and respiratory protection, depending on the specific hazards present.
- **Risk assessment:** Conduct a thorough assessment of the work area to identify potential hazards and implement appropriate control measures.
- **Safety signage:** Clearly label hazardous areas, equipment, and substances with appropriate warning signs and instructions.
- **Regular maintenance:** Inspect plumbing systems, machinery, and equipment regularly to identify and address potential hazards or malfunctions promptly.
- **Emergency preparedness:** Establish emergency response procedures, including evacuation routes, first-aid kits, and fire suppression systems. Ensure all workers are familiar with these procedures.

  It is essential to adhere to local safety regulations, industry standards, and best practices to prevent accidents and protect the health and well-being of plumbing professionals and maintenance personnel.

4.4 Importance of various types of Personal Protective Equipment

Personal Protective Equipment (PPE) plays a crucial role in ensuring the safety and well-being of individuals in various work environments. Personal protective equipment (PPE) is any wearable tool that an employee might use while on the job to avoid any workplace hazards. This can range from a full-body suit for a firefighter to gloves and an apron for a cook. Depending on the requirements of the job, PPE may include helmets, goggles, body armour, foot and hand protection, and any other tools that achieve the same objective. Employers are also responsible for making sure that workers follow instructions on how to use the proper personal protective equipment. Here are the importance and benefits of different types of PPE:

1. Head Protection: Hard hats protect against head injuries caused by falling objects, bumping into fixed objects, or accidental head contact (Fig.4.8). They are essential in construction, industrial, and manufacturing settings where there is a risk of falling objects, overhead hazards, or electrical hazards. Such injuries occur when we are not prepared to protect our heads. Serious head injuries can get fatal.

Fig. 4.8: Head Protection

It is a mandatory requirement to wear a safety helmet when working on construction sites of multistorey buildings or commercial housing, industrial building construction, etc. In addition, a safety helmet needs to be worn while working at heights or in a trench.

A safety helmet must

i. be properly adjusted to fit.
ii. be replaced if it becomes defective or damaged.

2. Eye and Face Protection: Safety glasses, goggles, and face shields protect against eye injuries caused by flying particles, chemicals, liquids, or harmful light radiation. They are vital in industries such as construction, welding, manufacturing, and laboratory work where eye hazards are present. It comes in the form of-

Fig. 4.9: Safety glasses (Eye Protection)

i. Safety glasses — a typical application could be during lead welding.
ii. Safety goggles — these provide a higher level of protection than safety glasses, as they fit closely to the face.
iii. Welding goggles — these include specialist coloured lenses.

3. Hearing Protection: Earplugs and earmuffs safeguard against noise- induced hearing loss and other auditory damage caused by excessive noise levels. They are necessary in industries with high noise levels, such as construction, manufacturing, aviation, and heavy machinery operation.

Fig. 4.10: Earplugs (Ear Protection)

4. Respiratory Protection: Respirators and masks protect against inhalation of harmful substances, such as dust, fumes, gases, and airborne contaminants. They are essential in industries involving chemical handling, construction, mining, healthcare, and environments with poor air quality (Fig.4.11).

Fig. 4.11: Respiratory Protection

6. **Hand Protection:** Gloves provide protection against cuts, punctures, burns, chemical exposure, and other hand-related injuries. They are critical in industries such as construction, manufacturing, healthcare, and laboratories where hands are exposed to hazards (Fig.4.12).

Fig. 4.12: Gloves (Hand Protection)

6. Foot Protection: Safety boots or shoes safeguard against foot injuries caused by falling objects, crushing, punctures, slips, or electrical hazards. They are essential in construction, manufacturing, mining, and industrial settings where foot-related hazards exist (Fig.4.13).

Fig. 4.13: Safety boot (Foot Protection)

7. Body Protection: Protective clothing, coveralls, and vests provide protection against various hazards such as heat, chemicals, flames, electrical arcs, and physical impacts. They are necessary in industries including construction, chemical handling, firefighting, welding, and electrical work.

The importance of PPE lies in its ability to mitigate and minimize the risks associated with workplace hazards. By wearing appropriate PPE, workers can significantly reduce the likelihood of injuries, illnesses, and long-term health effects. PPE acts as a physical barrier, shielding the body from harmful elements and ensuring a safe working environment. It is essential to select the right type of PPE based on the specific hazards present and to ensure proper fit, maintenance, and regular replacement to ensure its effectiveness.

4.4.1. Protection from Workplace Harms and Hazards

Personal protective equipment or PPEs can save lives by protecting workers from injury, illness, burns, lacerations, and other occupational an unlucky accidents from machines and materials that can cause severe damage. They also prevent the spread of infectious diseases like influenza and tuberculosis by covering the skin, mouth, and nose and reducing physical proximity between people.At a minimum, the must-have PPEs at your workplace include:

- Safety glasses or goggles for an eye injury.
- Gloves for hand injuries.
- Hearing protection for noise exposure from loud machinery or other sounds at work.

- A respirator for protecting workers against insufficient oxygen environments, contaminated air, harmful dust, smoke, sprays, etc.
- Special footwear that protects against hazards like tripping or slipping on wet floors.

4.5 Various types of safety signs and their significance in the workplace

Safety signs are visual communication tools used in the workplace to convey important safety information and provide guidance to workers, visitors, and emergency responders. Here are various types of safety signs commonly used and their significance:

1. **Prohibition Signs:** A sign prohibiting actions that are likely to heighten danger or create (such as no smoking) innate characteristics round form (Fig.4.14). A red diagonal line and edging surround a black pictogram on a white background, with the red portion taking up at least 35% of the sign's surface area.

Fig. 4.14: Prohibition Signs

   - **Symbol:** Red circle with a diagonal line over a black pictogram or text.
   - **Significance:** Prohibition signs indicate actions or activities that are strictly prohibited to prevent accidents, hazards, or health risks. They help in identifying areas or actions that are off-limits or unsafe.

2. **Warning Signs:** Personnel and visitors are made aware of additional health and safety risks by warning signs (Fig.4.15). Depending on the type of danger present, specific warning signs might be needed.

Fig. 4.15: Prohibition Signs

   - **Symbol:** Yellow triangle with a black pictogram or text.
   - **Significance:** Warning signs alert individuals to potential hazards, dangers, or conditions that require caution. They draw attention to specific risks and encourage people to take appropriate precautions or follow safety procedures.

3. **Mandatory Signs:** A sign prescribing specific behaviour (eg eye protection must be worn) (Fig.4.16).

Fig. 4.16: Mandatory Signs

   - **Symbol:** A blue circle with a white pictogram or text.
   - **Significance:** Mandatory signs indicate actions or behaviors that are required

to maintain safety standards. They provide instructions and guidelines that must be followed to prevent accidents or hazards.

4. Emergency Signs: The purpose of emergency signs is to direct people to or from an emergency facility (Fig.4.17). Typically, signs in this category are green with white text and icons. These signs can be produced on metal, aluminium, polypropylene, or corflute and come in a variety of standard sizes.

Fig. 4.17: Emergency Signs

- **Symbol:** Green rectangle or square with a white pictogram or text.
- **Significance:** Emergency signs provide information and directions related to emergency procedures, evacuation routes, first aid, emergency exits, assembly points, firefighting equipment, and other emergency-related facilities. They help in guiding people to safety during emergencies.

5. Fire Safety Signs: The purpose of fire safety signs is to communicate health and safety information, such as warnings of hazards, instructions, or safety information. (Fig.4.18). Safety signs come in a variety of colors—typically red, green, yellow, or blue—and may be written, graphic, or both.

Fig. 4.18: Fire Safety Signs

- **Symbol:** Red rectangle or square with white pictogram or text.
- **Significance:** Fire safety signs indicate the location and proper use of fire safety equipment, such as fire extinguishers, fire alarms, fire exits, and emergency evacuation routes. They assist in quickly identifying fire safety measures and procedures in case of a fire emergency.

6. Hazard **Signs**: The purpose of a hazard pictogram, which is an image on a label that combines a warning symbol with specific colours, is to inform us about the potential harm that a given substance or mixture may do to our health or the environment (Fig.4.19).

- **Symbol:** Yellow or amber background with a black pictogram or text.
- **Significance:** Hazard signs warn about specific risks, dangers, or hazardous materials present in the area. They help in identifying potential hazards such as toxic substances, electrical hazards, chemical storage areas, or radiation risks.

Fig. 4.19: Hazard Signs

7. Information Signs: A sign that informs or alerts of something necessary or deserving of attention is referred to as an informational sign (Fig.4.20). Warning signs, emergency vehicle entrances, hazardous materials, and pedestrian/school crossings are just a few examples of informational signs.

- **Symbol:** Blue rectangle or square with white pictogram or text.
- **Significance:** Information signs provide general information or guidance related to safety, hygiene, personal protective equipment (PPE), hygiene practices, rules, regulations, or specific workplace procedures. They help in promoting awareness and providing essential information to individuals.

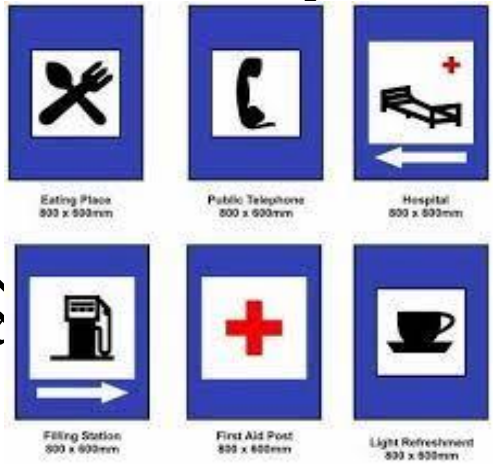


Fig. 4.20: Information Signs

The significance of safety signs lies in their ability to communicate important safety information quickly and effectively, regardless of language barriers. They help in preventing accidents, minimizing risks, promoting safe practices, and ensuring compliance with safety regulations. Safety signs serve as constant reminders, guiding individuals to take necessary precautions and maintain a safe working environment. It is important for employers to ensure that safety signs are properly placed, visible, and regularly maintained for maximum effectiveness.

4.6 Safety management and techniques at a plumbing work site

Different fire extinguishing techniques employ various methods and materials to combat different types of fires. Here are some common techniques and the materials used:

1. **Water-Based Techniques**: Direct Application: Using water directly from a hose or bucket to extinguish fires. Water cools the fire, reducing its temperature and suppressing flames.
   - Water Spray: Utilizing a fine water mist or spray to cool the fire and displace oxygen, preventing fire spread.
2. **Foam-Based Techniques:**
   - Foam Fire Suppression: Foam is a mixture of water, foam concentrate, and air. It forms a foam blanket, separating the fuel from oxygen and suppressing the fire.
   - AFFF (Aqueous Film-Forming Foam): AFFF extinguishes flammable liquid fires by creating a barrier that prevents the release of flammable vapors.
3. **Dry Chemical Techniques:**
   - ABC Powder: Dry chemical fire extinguishers containing ammonium phosphate-based powders are effective against Class A, B, and C fires. The powder smothers the fire and interferes with the chemical reaction.
   - BC Powder: Dry chemical fire extinguishers containing sodium bicarbonate-based powders are suitable for Class B and C fires. The powder inhibits the chemical reaction and smothers the fire.
4. **Carbon Dioxide (CO2) Technique:**
   - CO2 Extinguishing: Carbon dioxide is a clean, non-conductive gas that displaces oxygen, suffocating the fire. CO2 extinguishers are effective for Class B and C fires, but not suitable for Class A fires as they do not cool the fire.
5. **Halon Technique:**
   - Halon Fire Suppression: Halon extinguishers are effective for Class B and C fires. Halon gas interrupts the chemical reaction and suppresses the fire. However, due to its harmful environmental impact, Halon is being phased out and replaced with more environmentally friendly alternatives.
6. **Sand Bucket/Wet Blanket Technique:**
   - Sand or Soil: Sand or soil can be used to smother small fires by covering the burning material, cutting off its oxygen supply.
   - Wet Blanket: A wet blanket can be used to cover and smother small fires, especially in cases of clothing or grease fires.
7. Sprinkler Systems:
   - Automatic Sprinkler Systems: Sprinklers are activated by heat and release water or other fire suppressants when a predetermined temperature is reached. They help control and extinguish fires by cooling the area and suppressing flames.

It is important to note that the choice of extinguishing technique and material depends on the type and size of the fire, the available equipment, and the specific hazards involved. It is crucial to follow proper fire safety protocols, conduct regular equipment inspections, and ensure proper training for individuals responsible for fire extinguishing.

4.7 Rescue techniques during a fire hazard or electrocution

During a fire hazard or electrocution emergency, prompt and appropriate rescue techniques can be critical in ensuring the safety and well-being of the affected individual(s). Following are some rescue techniques to consider:

1. **Fire Hazard Rescue Techniques:**
   Alert Emergency Services: Immediately contact the local fire department or emergency services to report the fire hazard and provide accurate information about the location and situation.
- Evacuation: If it is safe to do so, evacuate the area and follow established evacuation routes. Assist others in exiting the building, prioritizing those who may require assistance, such as individuals with disabilities or limited mobility.
- Do Not Use Elevators: In the event of a fire, avoid using elevators as they may malfunction or trap individuals. Use stairs whenever possible.
- Close Doors: Close doors behind you as you evacuate to help contain the fire and limit its spread.
- Stay Low: If there is smoke, stay close to the ground where the air is less toxic and crawl to exit if necessary.
- Assist Others: Offer assistance to those who may be disoriented, injured, or in need of help during the evacuation process, but do not put yourself at unnecessary risk.

2. **Electrocution Rescue Techniques:**
- Ensure Safety: Prioritize personal safety and avoid direct contact with the electrical source or the affected person until the power is safely turned off.
- Call for Help: Notify emergency services or the appropriate authorities immediately to report the incident and request assistance.
- Power Isolation: If possible, turn off the power supply or unplug the affected equipment at the main switch or circuit breaker. If unsure or unable to do so safely, wait for qualified personnel to handle the electrical isolation.
- Use Insulating Materials: If the person is still in contact with the electrical source, use non-conductive materials such as wooden brooms, dry towels, or rubber gloves to separate the victim from the source of electricity without putting yourself at risk.
- Do Not Touch: Avoid direct contact with the affected person until you are certain the power is safely turned off. Touching an individual in contact with a live electrical current could result in an electric shock.

- Perform CPR and First Aid: If the victim is unconscious or not breathing, perform cardiopulmonary resuscitation (CPR) or provide appropriate first aid until professional medical help arrives.

  In any emergency situation, it is crucial to prioritize personal safety and notify the appropriate authorities for professional assistance. Following established emergency protocols, maintaining calm, and providing aid within your abilities are essential for effective rescue efforts.

4.8. Basic first-aid

The following are some basic first-aid treatments for various common conditions:

1. Shock:

- Call emergency services immediately.
- Help the person lie down on their back with their legs elevated, unless they have a head, neck, or back injury.
- Cover them with a blanket or coat to keep them warm.
- Monitor their breathing and vital signs until medical help arrives.

2. Electrical Shock:

- Ensure your safety by disconnecting the power source or using non-conductive materials to separate the person from the source.
- Call emergency services immediately.
- Check for signs of breathing and circulation. If absent, begin CPR.
- Cover any burns with a sterile dressing or clean cloth.
- Do not touch the person if they are still in contact with the electrical source.

3. Bleeding:

- Wear disposable gloves, if available.
- Apply direct pressure to the wound using a clean cloth, gauze pad, or your hand.
- Maintain pressure until the bleeding stops or emergency help arrives.
- If the bleeding is severe and cannot be controlled, apply additional dressings and elevate the injured area if possible.

4. Minor Burns:

- Cool the burn under cool (not cold) running water for at least 10 minutes to reduce pain and prevent further tissue damage.
- Cover the burn with a clean, non-stick dressing or sterile cloth.
- Avoid applying adhesive bandages directly on the burn.
- If the burn is larger or more severe, seek medical attention.

5. Poisoning:

- Call poison control or emergency services immediately.

- Provide information about the type of poison, if known.
- Follow the instructions given by the poison control center or emergency services.
- If the person vomits, position them on their side to prevent choking.
- Do not induce vomiting unless advised by medical professionals.

6. Eye Injuries:

- Encourage the person not to rub their eye.
- Gently flush the affected eye with clean, lukewarm water for at least 15 minutes.
- If an object is embedded in the eye, do not try to remove it. Cover the eye with a sterile dressing or clean cloth and seek medical help immediately.
- For chemical burns, continue flushing the eye while en route to medical care.

Remember, these are general first-aid guidelines. It's important to seek professional medical help for any serious or life-threatening condition, or if you are unsure about the appropriate first aid treatment. Stay calm, ensure your own safety, and provide assistance within your capabilities until professional help arrives.

4.9. Occupational Safety and Health Practices

OSH stands for Occupational Safety and Health, which encompasses the practices, guidelines, and regulations aimed at ensuring the safety, health, and well-being of workers in various industries and workplaces. Here are some important OSH practices to observe as precautions:

1. Risk Assessment and Hazard Identification:

- Regularly assess the workplace for potential hazards and risks.
- Identify and document potential hazards, including physical, chemical, biological, and ergonomic factors.
- Involve employees in hazard identification and encourage reporting of near misses or potential risks.

2. Training and Education:

- Provide comprehensive training on safety procedures, hazard awareness, and emergency protocols.
- Educate employees about their rights and responsibilities regarding safety and health.
- Ensure proper training for operating equipment, machinery, and hazardous substances.

3. Personal Protective Equipment (PPE):

- Identify and provide appropriate PPE based on the hazards present.
- Train employees on proper selection, use, and maintenance of PPE.

- Regularly inspect and replace damaged or expired PPE.

4. Safe Work Practices:

- Establish and communicate clear guidelines and safe work procedures.
- Promote good housekeeping to maintain clean and organized work areas.
- Encourage proper posture, ergonomics, and safe lifting techniques to prevent musculoskeletal injuries.

5. Emergency Preparedness:

- Develop and practice emergency response plans, including evacuation procedures, fire drills, and first aid protocols.
- Ensure the availability and accessibility of emergency equipment, such as fire extinguishers, first aid kits, and emergency contact information.
- Train employees on emergency procedures and designate responsible individuals for specific roles during emergencies.

6. Health and Hygiene:

- Implement measures to control exposure to harmful substances and provide appropriate ventilation systems.
- Promote regular handwashing and hygiene practices to prevent the spread of illnesses and infections.
- Encourage the reporting of health-related issues and provide access to medical care when needed.

7. Regular Inspections and Maintenance:

- Conduct routine inspections of equipment, machinery, and safety systems.
- Schedule regular maintenance and repairs to ensure the safe and efficient functioning of equipment.
- Keep records of inspections, maintenance activities, and corrective actions taken.

8. Communication and Collaboration:

- Foster a culture of open communication and encourage employees to report safety concerns or suggestions.
- Involve employees in safety committees or meetings to gather input and address safety issues collectively.
- Promote collaboration between management, supervisors, and employees to create a safe work environment.

Activities

Activity 1: List out the various health and safety precautions to be considered during plumbing work.

Material Required

1.Notebook
2.Pen

Procedure

1.First, read all manuals about fittings and fixtures used during plumbing work.
2.Identify the hazard and dangers at the work site.
3.Make a list of identified hazards and dangers at work site.
4.Enlist the health and safety precautions to be considered during plumbing work.

Activity 2: Make a sketch of various types of PPE.

Material Required

1.Notebook
2.Pen
3.Pencil
4.Eraser
5.Sharpener

Procedure

1.First, visit the hardware shop.
2.Identify, various types of PPE available in the shop.
3.Make a list of identified various types of PPE available in the shop.
4.Draw a sketch of any two PPE.

Activity 3: Draw the sketch of various types of safety signs and their significance in the workplace.

Material Required

1.Notebook
2.Pen
3.Pencil
4.Sharpener
5.Eraser

Procedure

1.First, read the manual for rules and regulations.
2.Second, search for different types of safety signs which is used in the plumbing work site.
3.Identify, different types of safety signs which is used in the plumbing work site.

4.Make a list of identified different types of safety signs which is used in plumbing work sites.
5.Draw a sketch of any various types of safety signs and write their significance in the workplace.

Check Your Progress

A. Answer the following questions

1. What safety and health-related problems are faced in domestic and industrial units? .How to handle the tools and equipment during plumbing work
2. List the various types of hazards during plumbing system installation and also write their precautions.
3. Explain the importance of PPE in plumbing work.
4. Describe the role of safety signs and their significance in the workplace.
5. Explain the fire extinguisher techniques.
6. What do you mean by electrocution?
7. Write the basic first aid treatment.
8. List the Awareness on occupation safety and health (OSH) related to the job.

B. Fill in the blanks

1. Lifting heavy objects or using tools with …….. techniques can strain muscles, tendons, and ligaments.
2. Halon extinguishers are effective for Class …… and ……. fires.
3. Chemicals that are …… can cause harmful effects on human health if inhaled, ingested, or come in to contact with the skin.
4. Personal Protective Equipment (PPE) plays a ……. role in ensuring the safety and well-being of individuals in various work environments.
5. Electrical hazards refer to …….. associated with the use, installation, maintenance, or repair of electrical systems and equipment.

C. Mark the correct option

1. This gas interrupts the chemical reaction and suppresses the fire.
   a)Nitrogen
   b)Oxygen
   c)Hydrogen
   d)Halon
2. These hazards are based on the chemical's inherent characteristics.
   a)Physical
   b)Chemical
   c)Fire

d)All of above

3.These hazards are caused by the relative motions of human body parts and objects, such as tools or other work-related objects, which result in their contact.

a)Physical

b)Chemical

c)Fire

d)Mechnical

4.These hazards refer to substances or materials that can cause harm to human health, property, or the environment due to their chemical properties.

a)Physical

b)Chemical

c)Fire

d)All of above

Answer Key

Unit 1: Introduction to Advance Plumbing

B. Fill in the blanks

1.maximised
2.smart
3.terminology and symbol
4.widely
5.Minimise

C. Multiple choice questions

1.(c) 140 to 180
2.(a) Water supply system
3.(b) Indirect water supply system
4.(d) All the above.
5.(c) Backflow

Unit – 02 Advance Pipe Fittings

B. Fill in the blanks

1.Internal
2.Valves
3.Direction
4.Water meter
5.Two
6.Sensors

C. Multiple choice questions

1. (c) Measuring tape
2. (a) Mechanical water meter
3. (d) Gas leak detector
4. (a) Union
5. (b) Steel rule
6. (b) Galvanised iron pipe
7. (d) Offset

Unit -03 Installation and Maintenance of Plumbing

B. Fill in the blanks

1. Plan
2. Technical
3. Crucial
4. installed and aligned
5. Minor

6. reduction of thickness

C. Multiple choice questions

1. (b) UPVC pipe
2. (c) CPVC pipe
3. (d) Flushing cistern
4. (a) Sink
5. (d) Faucet
6. (b) Geyser

Unit- 04 Health and Safety at Workplace

B. Fill in the blanks

1. Improper
2. B and C
3. Toxic
4. Crucial
5. potential dangers

C. Multiple choice questions

1. (d) Halon
2. (a) Physical
3. (d) Mechnical
4. (a) Chemical

Glossary

Backflow: Backflow is a term used in plumbing to describe the undesirable reverse flow of water or other substances in a plumbing system. This reverse flow can occur when the normal direction of water flow is reversed, causing potentially contaminated water to flow back into the clean water supply.

Clogging: Clogging, in the context of plumbing, refers to the blockage or obstruction of pipes, drains, or fixtures, preventing the smooth flow of water or waste through the plumbing system. Clogs can occur in various parts of the plumbing system, including sinks, toilets, showers, bathtubs, and main sewer lines.

Consumption: Consumption, in a general sense, refers to the act of using or utilizing something, often related to resources or goods.

Disposal: Disposal refers to the process of getting rid of or discarding waste, unwanted items, or materials that are no longer needed.

Flushing: Flushing, in the context of plumbing and sanitation, refers to the act of using water to clean and remove waste or debris from a fixture or plumbing system.

Grouting: Grouting is a construction and home improvement process used to fill gaps or spaces between tiles, stones, or bricks with a cement-based material called grout.

Joining: Joining refers to the act of connecting or bringing together separate components to form a unified whole.

Leakage: A leakage is an amount of liquid or gas that is escaping from a pipe or container by means of a crack, hole, or other fault.

Pedestal: It refers to a support or base upon which an object or structure is placed, often to elevate it or give it prominence.

Pipework: Pipework refers to the system of pipes and associated components used to transport fluids, gases, or other materials within a building, industrial facility, or infrastructure network.

Remodeling: It refers to the process of making significant changes or improvements to an existing structure, space, or building. It involves altering the design, layout, and functionality of the area to update its appearance, enhance its features, or adapt it to new needs and preferences.

Roof Drainage: Roof drainage refers to the system and process of effectively removing rainwater, snowmelt, and other precipitation from the surface of a roof to prevent water damage and flooding.

Sediment: Sediment refers to the solid particles that settle at the bottom of a liquid or are deposited by wind or water. These particles can be made up of various materials, such as sand, silt, clay, gravel, or organic matter.

Substance: In a general sense, a substance refers to any material or physical matter that has a distinct and measurable composition. It can be a solid, liquid, gas, or even plasma. For example, water, iron, oxygen, and carbon dioxide are all substances.

Threading: This refers to the process of creating a helical ridge (screw threads) on a cylindrical surface, like a bolt or a screw. This process is commonly used in manufacturing to create threaded fasteners and components

Threatening: Threatening is an adjective that describes behavior, actions, or statements that convey a sense of harm, danger, or intent to cause harm to someone or something.

Further Readings

1. **Indian Plumbing Association (IPA)**
   Website: www.indianplumbing.org

2. **Advance Plumbing Technician Course**
   https://www.nqr.gov.in/sites/default/files/COURSE%201023_Advanced%20Plumbing%20Technician.pdf