Draft Study Material

ASSISTANT PLUMBER GENERAL

(Qualification Pack: Ref. Id. PSC/Q0102)

Sector: Plumbing

(Grade IX)

PSS CENTRAL INSTITUTE OF VOCATIONAL EDUCATION
(a constituent unit of NCERT, under Ministry of Education, Government of 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 PLUMBING

Module Overview

This module will provide a brief to the plumbing sector and its significance. This module explains the roles and responsibilities of an Assistant Plumber General, highlighting the skills and personal attributes required for success in this profession. The module explores career development options in the plumbing field and the potential for growth. It also covers the common types of plumbing systems found in residential buildings and discusses the objectives of a good plumbing system, such as efficiency, durability, and hygiene. Through this module, learners will gain foundational knowledge essential for a career in the plumbing sector.

Learning Outcomes

After completing this module, you will be able to:

- Describe the plumbing sector and its importance in construction and maintenance.
- Explain the roles and responsibilities of an Assistant Plumber General.
- Identify the key personal attributes required for an Assistant Plumber General.
- Explore career development opportunities in the plumbing field.
- Understand the common types of plumbing systems used in residential setups.

Module Structure

1.1 Overview of Plumbing sector
1.2 Roles and Responsibilities of Assistant Plumber General
1.3 Personal attributes of Assistant Plumber General
1.4 Career development Options of Assistant Plumber General
1.5 Common types of plumbing systems installed in residential setups
1.6 Objectives of good plumbing system

Plumbing sector is a crucial part of the construction industry worldwide. The plumbing industry is responsible for the design, installation, maintenance, and repair of various systems that enable the safe and efficient transportation of water and waste within buildings.

In developed countries, the plumbing sector is well-established and highly regulated, with skilled professionals and modern technologies. In contrast, in many developing countries, including India, the plumbing sector is still largely unorganized, with limited regulation, low skill levels, and outdated equipment.

The plumbing sector in India has been growing rapidly in recent years, driven by the country's increasing urbanization, rising disposable income, and government initiatives to improve access to basic sanitation facilities. However, the industry still faces many challenges, including a shortage of skilled workers, limited access to modern technology, and inadequate regulation.

In terms of the global plumbing market, it is expected to reach a value of over USD 100 billion by 2027, driven by increased demand for modern plumbing systems in commercial and residential buildings. The Asia-Pacific region is expected to be the fastest-growing market, driven by urbanization and infrastructure development in countries such as China and India.

As the real estate in India is booming, people are spending more and more on bathroom fittings and luxuries than their drawing rooms. Plumbing is not merely fixing up a tap, with more complex buildings getting designed and constructed, there is a growing need of trained plumbers.

According to a National Skill Development Council survey, just 0.5% of plumbers in this country are trained. There is whooping requirement of 12 lakh trained plumbers by 2020 whilst currently available are only 2.5 lakh that too most of them are untrained/self-trained

Fig 1.1 Plumbing sector

1.1 OVERVIEW OF PLUMBING SECTOR

The plumbing industry encompasses a wide range of professionals and generally includes anyone who installs or repairs pipes that carry liquids or gases. Plumbers work in various settings and are often on call at all hours for situations such as leaks or pipe bursts that require immediate attention to prevent serious, long-term damage.

Typical tasks for plumbers can include fixing leaking pipes, installing household fixtures (e.g., sinks, showers and toilets), repairing or replacing water heaters and water conditioning equipment, and conducting lawn sprinkler system maintenance.

Plumbing refers to the system of pipes, valves, fixtures, tanks, and other equipment used to transport various fluids for a wide range of applications. While plumbing is commonly used for purposes such as heating and cooling (HVAC), waste removal, and delivery of clean water, its applications are not limited to these areas.

The term "plumbing" originates from the Latin word for lead, "*plumbum*," as the first pipes utilized in ancient Rome were made of lead. Plumbing infrastructure plays a critical role in maintaining public health and sanitation.

Fig 1.2 Plumber

Plumbers are technicians who handle various aspects of installing and maintaining plumbing systems. The scope of their work ranges from water supply and heating to sanitation and drainage. Plumbers may work in commercial and residential buildings, farms, parks and public spaces. Experienced plumbers may own and operate their own business and hire entry and mid-level plumbers.

1.2 ROLES AND RESPONSIBILITIES OF ASSISTANT PLUMBER GENERAL

Plumbers install, repair and maintain water/gas supplies, sanitation units and related appliances in commercial and residential buildings. They often assess plumbing systems, diagnose issues and implement workable solutions. The typical duties of a plumber include:

1. Solving plumbing issues in residential and commercial buildings
2. Estimating the cost of the work/project before starting work
3. Diagnosing issues in plumbing systems and suggesting long-term solutions
4. Analysing blueprints to plan new installations
5. Installing sinks, toilets and other related fixtures
6. Testing plumbing systems for weaknesses and durability
7. Repairing water supply and sanitation appliances
8. Cutting, assembling and welding tubes, pipes, fittings and other related fixtures
9. Sourcing and managing materials for different projects

1.3 PERSONAL ATTRIBUTES OF ASSISTANT PLUMBER GENERAL

To be successful as a brick mason, there are several personal attributes that are important to possess. These include:

1. **Physical skills:** Plumbing is a physically demanding job that requires flexibility, physical strength, excellent motor skills and good vision. For instance, plumbers often need to work in dark spaces and with small tools and equipment like gauges.

2. **Analytical skills:** Plumbers require knowledge of some practical applications of these subjects relevant to their field. Plumbers have to analyse how systems like water supply and sanitation work. They also have to conduct tests and inspections to determine the cause of errors and make detailed plans to rectify them.
3. **Problem-solving skills:** Plumbers should have the ability to identify the root cause of a problem and provide realistic solutions. Plumbers often need to solve complex problems within short time frames while projects are ongoing. This requires them to think creatively and logically.
4. **Administrative skills:** Plumbers may need to track expenses, make inventories, order supplies and plan project calendars. From time to time, a plumber may need to prepare reports and submit and explain those to clients or supervisors.
5. **Communication skills:** Plumbers may sometimes work with a wide variety of people as part of a single project and may need to communicate effectively with assistants, managers, business owners, material suppliers and homeowners.

1.4 CAREER DEVELOPMENT OPTIONS OF ASSISTANT PLUMBER GENERAL

As an assistant plumber general, there are several career development options that you can explore to advance your career in the plumbing industry. Here are some of the options:

1. **Apprenticeship:** Completing a plumbing apprenticeship program is a great way to gain practical, hands-on experience in the field while learning from experienced plumbers. This will help you develop the necessary skills and knowledge to become a licensed plumber in the future.
2. **Specialization**: You may choose to specialize in a specific area of plumbing, such as HVAC systems or water treatment systems. This will allow you to become an expert in your area of specialization and increase your earning potential.
3. **Continuing Education:** Pursuing additional training and education in areas such as business management, project management, and leadership can help you advance into managerial or supervisory roles within the plumbing industry.
4. **Certification:** Obtaining professional certifications, such as the Journeyman or Master Plumber certification, can help you demonstrate your expertise and advance your career within the plumbing industry.
5. **Entrepreneurship:** Starting your plumbing business can be a rewarding career development option if you have an entrepreneurial spirit. This will allow you to work for yourself, set your own hours, and take on projects that interest you.

1.5 COMMON TYPES OF PLUMBING SYSTEMS INSTALLED IN RESIDENTIAL SETUPS

Our residential buildings are made as per requirements of people. The residential setups may be single floor independent house as well as multi-storey apartments. Water is supplied to a house or a building from a storage tanks through pipes. Similarly, the waste water from kitchen and washrooms is drained out with the help of pipes.

Common types of plumbing systems for water supply are as:

- Lifting of water from storage tank to overhead water tank.
- Distribution of water from overhead tank to different outlets at like washroom, kitchen etc.

Most common types of plumbing systems are as follows:

1. **Single stack system**: In this system, there is a single vertical pipe that carries all the wastewater and sewage from all the floors of the building. The pipes from the toilets, sinks, and other fixtures all connect to the single stack, which then leads to the main sewer line. This system is common in high-rise buildings and requires careful design to ensure proper drainage and venting.

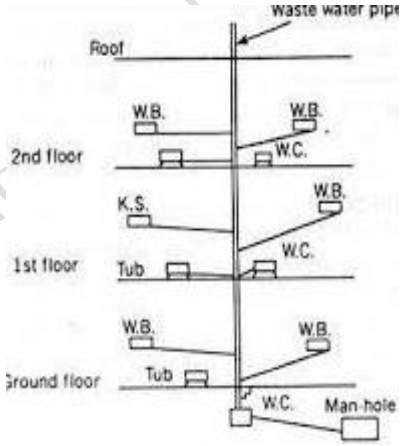


Fig 1.3 Single stack system

2. **Partially vented single stack system**: This system is similar to the single stack system, but it has additional vent pipes connected to the stack at certain points. The vent pipes help to release trapped air and prevent water from siphoning out of traps. This system is more complex than the single stack system and requires careful design to ensure proper venting.

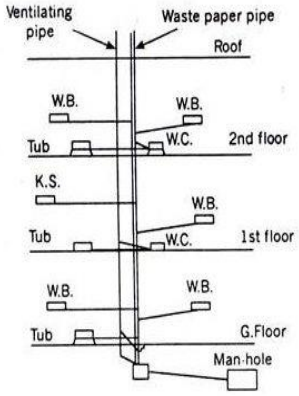


Fig 1.4 Partially vented Single stack system

3. **One-pipe system:** In this system, there is a single pipe that carries both hot and cold water to all the fixtures in the building. The hot water is usually produced by a central heating system and distributed through the same pipe as the cold water. This system is not very common in residential setups as it can lead to temperature fluctuations and is not very efficient.

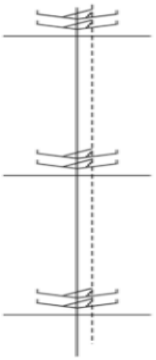


Fig 1.5 One-pipe system

4. **Two-pipe system:** This system consists of two separate pipes, one for hot water and one for cold water. Each pipe is connected to a separate source of water, and the hot water is usually produced by a hot water heater or boiler. This system is commonly used in modern residential setups as it ensures a consistent supply of hot and cold water and is more efficient than the one-pipe system.

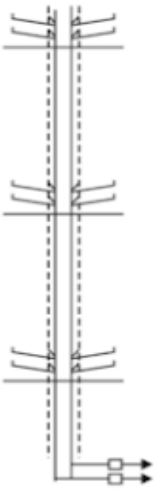


Fig 1.5 Two -pipe system

Another commonly used plumbing system on the basis of the water supply system network:

1. **Direct Water Supply System:** All water outlets of a house receive water directly from the mains. Potable water is available at all faucets. This is possible where water source delivers water 24 x 7 with high water pressure, sufficient enough to deliver water at an adequate pressure at all faucets (taps).

2. **Indirect Water Supply System:** Water from mains is conveyed to storage water tanks. Water is then delivered to house from water storage tank. This system is adopted where water supply from mains is not available throughout the day. It is also used when water pressure in mains is not sufficient enough to deliver water at all faucets with adequate pressure.

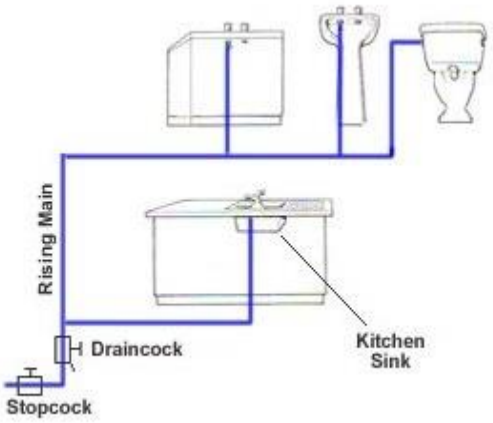


Fig 1.6 Direct Water supply system

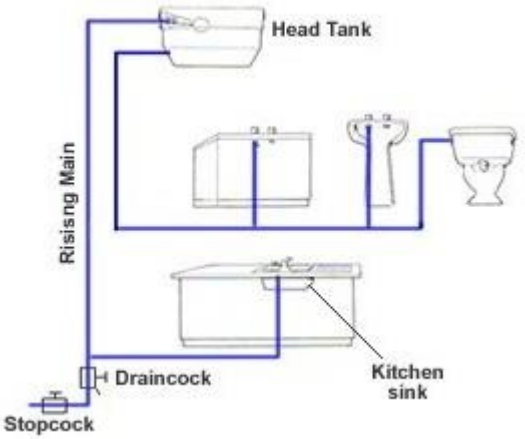


Fig 1.7 Indirect Water supply system

1.6 OBJECTIVES OF GOOD PLUMBING SYSTEM

Following are the objectives of good plumbing system:

- Supplying safe drinking water (potable water) in adequate quantities at the right pressure and in the right quantity.
- Check on leakages to minimise wastage of water or say zero leakage.
- In no case, potable water should get mixed with wastewater.
- Collecting and disposing wastewater from house efficiently.
- Preventing entry of foul gases in the home and allowing its easy escape.
- Drain pipe from the house should have access towards sewer lines or septic tank with a downward slope, minimum of a 1/4th inch per foot slope, i.e. 20mm per 1m and maximum of 3inch per foot, i.e. 80mm per 1m.

- Provision of manholes for cleaning of drain pipes.
- Plumbing appliances, materials and workmanship should conform to quality standards.

Three Essential Parts of Residential Plumbing System are:
Water Supply System (flow of water into a house)
Fixtures and Appliances (where water used for carrying out various activities)
Drainage system (collection and disposal of used (waste) water)

ACTIVITIES

Activity 1: Enlist the spaces in the school building where plumbing services are required and also enlist the components used there.

Materials required:

1. Notebook
2. Pen

Procedure:

1. Visit different parts of the school building under the supervision of the teacher where you observe plumbing is implemented.
2. Enlist the places such as toilets, labs etc.
3. Note the type of plumbing system used in that area.
4. Mention the components of plumbing used.

CHECK YOUR PROGRESS

A. Answer the following

1. Explain meaning of plumbing.
2. State the importance of plumbing industry.
3. Name the common types of plumbing system for water supply.
4. List the responsibilities of Assistant Plumber General.
5. Differentiate between direct and indirect water supply system.

B. Fill in the blanks

1. In …….. pipe system, there is a single pipe that carries both hot and cold water to all the fixtures in the building.

2. Water from mains is conveyed to storage water tanks in …….. water system.
3. Provision of …….. should be there for cleaning of drain pipes.
4. The term "plumbing" originates from the Latin word for lead, known as ……..

Module 2	TOOLS FOR PLUMBING

Module Overview
This module focuses on the essential tools used in plumbing and their significance in achieving quality work. It provides an overview of the different types of plumbing tools and their specific applications. The module emphasizes the importance of safety precautions while handling these tools to prevent accidents and ensure smooth operations. Additionally, it highlights the proper maintenance techniques to extend the lifespan and effectiveness of plumbing tools, ensuring they remain in optimal working condition.

Learning Outcomes
After completing this module, you will be able to: • Understand the importance of plumbing tools in performing quality work. • Identify different types of tools used in plumbing and their applications. • Follow safety precautions while using plumbing tools to avoid accidents.

Module Structure
2.1: Importance of plumbing tools 2.2: Different types of tools used in plumbing 2.3: Safety precautions while using the tool 2.4: Maintenance of Plumbing tools

Depending on the nature of the job, a plumber may require a variety of tools, ranging from those needed to install plumbing fixtures, to those necessary for repairing pipes or faucets.

In the previous module, we have focused on understanding the significance of plumbing systems, as well as the duties and responsibilities of a plumber. Moving forward, our attention will be directed towards exploring the different tools that are necessary for a plumber to carry out their job effectively. Similar to any other industry, a plumber must possess extensive knowledge of the tools and equipment used in plumbing to effectively execute their tasks.

The proper use and careful handling of these tools is essential to ensure that the work is carried out correctly and to prevent any damage. After use, the tools should be placed in a designated location. The tools may be classified based on their purpose, such as holding tools, fitting tools, cutting tools, pipe threading and bending tools, etc.

2.1 IMPORTANCE OF PLUMBING TOOLS

Plumbing tools are crucial for any plumber to carry out their work effectively and efficiently. These tools enable plumbers to install and repair plumbing fixtures, pipes, and systems with precision and accuracy.
Here are some reasons why plumbing tools are important:

1. **Time-saving**: Plumbing tools are designed to help plumbers complete their tasks quickly and efficiently, saving them time and allowing them to take on more jobs.
2. **Accuracy**: Many plumbing tools are designed to ensure precise measurements and cuts, which are necessary for fitting pipes and fixtures together properly.
3. **Safety**: Using the right plumbing tool for the job can significantly reduce the risk of injury to the plumber and damage to the plumbing system.
4. **Durability**: Plumbing tools are made of high-quality materials that can withstand heavy use, ensuring that they will last for a long time.
5. **Versatility**: Plumbing tools are designed to be versatile, with many tools capable of performing multiple tasks, reducing the need for multiple tools.

2.2 DIFFERENT TYPES OF TOOLS USED IN PLUMBING

The major tools used in plumbing are categorised as:

1. Holding tools

(a) Bench vice (b) Pipe vice

2. Fitting tools

(a) Wrenches (b) Water-pump pliers

(c) Spanners

3. Cutting tools

(a) Pipe cutter (b) Hacksaw

4. Pipe bending tools

(a) Pipe bending machine (b) Threading dies

5. Other tools

(a) Chisel (b) Hammer
(c) Chain wrench (d) Screw driver
(e) Trowel (f) File
(g) Plier (h) Caulking tools
(i) Drill machine (j) Drill bit
(k) Hanger (l) Measuring tape
(m) Plumb bob (n) Spirit level
(o) Spade (p) Pickaxe
(q) Mortar pan (r) Masons' square
(s) Water level tube

1. **Holding Tools**

These tools are designed to hold pipes, fittings, and other components in place while the plumber works on them. Holding tools are essential for maintaining the correct positioning of components during installation or repair work.

(a) **Bench vice:** A vice is a work-holding tool used for holding an item for various work like filing, chipping, sawing, threading, bending of various jobs, fitting, tapping etc. (Fig. 2.1). The bench vice has two jaws, one of which is fixed and other is moveable. These jaws are fitted with plates for gripping the job. The vice size depends on the width of jaw. Bench Vice is fixed through bolt to a table or bench (Fig. 2.2). Vice is opened and closed with the help of an attached handle to a spindle. In this way, a material is held tightly. Bench vices hold the objects and allow use of other tools to complete a task.

Fig 2.1 Bench Vice

Fig 2.2 Bench Vice fixed on table

(b) **Pipe vice:** A pipe vice is a tool used for holding a pipe for carrying out assembly, disassembly, threading, cutting, etc. (Fig. 2.3) This vice is of two kinds: (i) Open side pipe vice (ii) fixed side pipe vice.

The pipes vice sizes are known by the opened size of the jaws. Standard sizes of vices are from 80mm, 105 mm, 130 mm, 170 mm, etc.

Fig 2.3 Pipe Vice

2. Fitting tools

Fitting tools are a category of tools used in plumbing to install and remove plumbing fittings. These tools are designed to provide a secure grip on fittings, making it easier for the plumber to tighten or loosen them as needed.

a) Wrenches: The wrenches are hand tools used for tightening and loosening of the nuts and bolts. These tools hold slippery or small nuts and bolts for loosening or tightening it. Mostly two types of wrenches – adjustable and non-adjustable are used. These are useful particularly for loosening and tightening of odd size nuts and bolts. These tools hold a pipe and pipe fittings for screwing or unscrewing. This is a very common tool especially for small diameter pipes up to 50 mm. (Fig. 2.4)

Fig 2.4 Pipe Wrenches

(i) Adjustable wrench: This wrench is also used to loosening and tightening the bolts and nuts of any odd and regular sizes. This tool is used for tightening and untightening of valves, cocks, geysers, flexible pipes, etc. It is a good maintenance tool for repair of plumbing items like valves, cocks, pumps, etc. Chrome vanadium steel is used for making this wrench. (Fig.2.5)

It contains a fixed flat jaw with a handle and a square-toothed screw. The movable flat jaw slides in the body of the fixed jaw with the support of a screw. The gap between the flat jaws is used to grip the material to be twisted for screwing or unscrewing.

Fig 2.5 Adjustable Wrench

(b) Water-pump pliers: Chrome Vanadium steel is used for manufacturing. It is available in only one standard size of 250 mm length with 40 mm capacity. The maximum capacity between the two jaws varies up to 40 mm. (Fig. 2.6)

Fig 2.6 Water-Pump Pliers

(c) Spanner: This tool is used for nuts and bolts tightening and loosening. Standard nut and bolt sizes are mostly used. The standard spanners used are:

(i) Ring Spanners: These spanners have full circular closed ring at both ends. It is difficult to slip and cause damage. It is made of chrome vanadium by the forging process with burnished finish or chrome-plated. It is mostly available in two types:

- **Open-ended Spanners:** These types of spanners are open from both side and used for tightening and loosening nut and bolts (Fig. 2.7). (Spanner has open-ended jaws which slide through the nut or bolt with square or hexagonal heads. The bolts or nuts are turned with the required force to screw or to unscrew. The two jaws have two consecutive sizes like 6 mm and 7 mm or 1/4" and 5/16", etc. (Fig. 2.7).
- **Combination Spanners:** These spanners are open at one end and closed at another end.

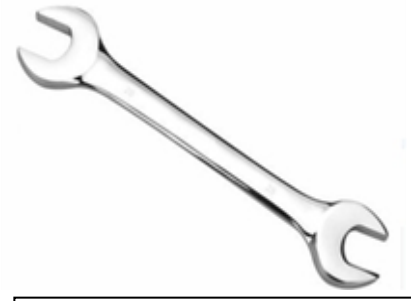


Fig 2.7 Open Ended Spanner

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

Fig 2.8 Bi hexagonal Ring spanner

3. **Cutting tools:**

Cutting tools are an essential category of tools used in plumbing for cutting pipes and tubes to the desired length. These tools come in various sizes and types, and each is designed for a specific type of pipe or tubing material.

(a) Pipe cutter: Pipe cutter is a manual tool to cut a pipe at the site, especially where it is difficult to use a hacksaw frame. This tool has a sharp, round cutting wheel which is pressed with to and fro rotary motion ad it results in the cutting of a pipe. (Fig. 2.9).

Fig 2.9 Pipe Cutter

(b) Hacksaw: This tool is a generally used with the both hands. It cuts the material like plastic pipe, steel rod, angle iron, sheets, iron pipes etc. It can be also used for cutting the bolt heads and nuts when jammed nut and bolt do not open with a tool. Important parts of hacksaw are handling, frame, blade and adjusting wing nut. (Fig. 2.10).

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

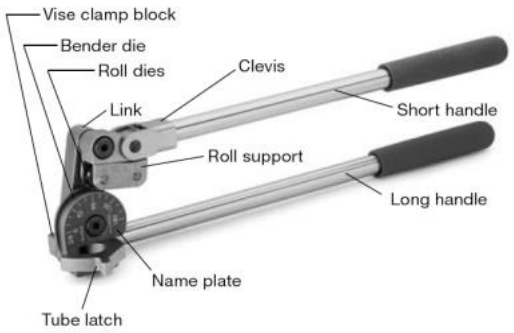
Fig 2.10 Hand hacksaw

Fig 2.11 Power hacksaw

4. **Pipe bending tools:**

Pipe bending tools are used in plumbing to create bends and curves in pipes, allowing them to be fitted into tight spaces or to follow the contours of a building. These tools come in various sizes and types, and each is designed for a specific type of pipe material and diameter.

(a) **Pipe bending machine:** This equipment is used to bend or turn a mild steel black or galvanized pipe. The size and strength of the machine depends upon the pipe diameter and the type of the pipe material to be bent. The mechanical or hand-operated pipe bending machines are available for 3/8" to 1" diameter pipes. For higher ranges, i.e. 1/2" to 2", 1/2" to 3", 1/2" to
4" and 2" to 6" hydraulic hand-operated machines are used. (Fig. 2.12)



(b) **Threading dies:** Threading dies tool is used to cut threads on the pipes in the workshop. (Fig.2.13)

Fig 2.13 Threading dies

5. Other tools:

(a) Chisel: The chisels are mostly used in plumbing for cutting and jointing works. Chisels cut concrete surface. The diamond point chisels create grooves at a pointed bottom. (Fig. 2.14). The different kinds of chisel are available which are used to cut through concrete. The diamond point chisel is used to give grooves appointed bottom.

Fig 2.14 Chisel (Chenni)

(b) Hammer: The hammers are general purpose workshop hand tools used for straightening of sections, riveting, striking of nails, inserting the component by

striking, inserting keyways and fitting by striking. The hammer consists of head made from hard and tampered steel and wooden handle.

The head has a flat striking face and the other side is called pein.

The peins are classified as per different shapes such as ball pein, cross pein and straight pein. The hammers made of hardened steel are known as engineer's hammers and are usually used for working with steel components. One-kilogram hammer is most commonly used. (Fig. 2.15)

Fig 2.15 Chisel (Chenni)

(c) Chain wrench: The chain wrench is used to hold a pipe and pipe fittings for screwing or unscrewing during the screw joint. It consists of a toothed block, a handle and a chain. The chain is round, grooved and held on the toothed end of the block. The chain grips the pipe fitting and screws or unscrews. The chain wrench is available in 3", 4", 6", 8" and 12" and their length is 475 mm, 585 mm, 834 mm, 1100 mm and 1360 mm, respectively. These sizes are designated by the maximum diameter of the pipe it can hold. (Fig. 2.16)

Fig 2.16 Chain wrench

(d) Screw driver: Screw drivers are tools often used by plumbers to fit into screws. Screwdrivers have a sharp tip which can be easily fitted into various screws. Different types of screwdrivers are used for various type of screw. Various types of heads of screw driver such as the Flat-head, Phillips, Robertson and hex are all used by plumber. (Fig. 2.17)

Fig 2.17 Screw Driver

(e) Trowel: trowel is a hand tool that is commonly used in the construction and building trades, including in plumbing. It is a flat, pointed tool with a handle that is used for spreading and shaping various materials such as mortar, plaster, and cement. In plumbing, trowels are often used for applying mortar to secure pipes and fittings in place, as well as for finishing concrete or other surfaces around pipes. (Fig. 2.18)

Fig 2.18 Trowel

(f) Files: Files are hand tools used for variety of work like removing of sharp edges, metal removal, shaping of jobs, smoothening of surfaces, finishing, producing different shapes etc. The file has five parts: tang, heel, face, edge and point or tip. Various types of files of different shapes like hand round, pillar, square, three square, half round, flat, knife edge, needle file are used as per work. (Fig.2.19)

Fig 2.19 File

(g) Pliers: Pliers is an important used for holding small objects for tightening or loosening various parts. Several types of pliers are used by a mechanic during work. Pliers can be used for cutting purpose also. The slip joint pliers are used for flat work pieces and holding round work. Various shapes and sizes of pliers are available in the market. Pliers of different types are shown here. (Fig.2.20)

Fig 2.20 Pliers

(h) Caulking Tools: For filling the gaps in wall or bathroom, caulking tools are used. This tool helps in filling and removal of material in building.
(Fig. 2.21)

Fig 2.21 Caulking Tools

(i) Drill Machine: Drill machine is one of the important tools used for making a hole in a metal or wood or concrete surfaces. Drill machine (Fig.2.22) is fitted with a cutting tool like a drill bit or a driver bit. The attachment is tightened with a key.

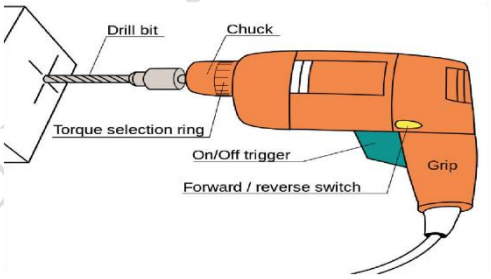


Fig 2.22 Drill Machine

(j) Drill bits: Drill bits are tools used to make cylindrical holes by cutting the material. Bits are fitted in a tool which rotates it and make the hole. For non-cylindrical-shaped holes specialized bits are used. (Fig. 2.23)

Fig 2.23 Drill Bits

Safety precautions:
Before installing the bit in drill machine, it should be sharpened. Key in the chuck should be removed after tightening.

(k) Hangers: Purpose of pipe hanger is to hold or support a pipe or group of pipes from a slab, beam, ceiling or other structural element. Common clamp and hangers like Clevis Hangers, Beam Clamps, C Clamps, Band Irons, Copper Clevis Hangers, Stud Brackets, Copper Straps, Galvanized Straps, are also used. (Fig. 2.24)

Fig 2.24 Pipe Hangers

(l) Measuring tape: Measuring tape is used for measuring length of an item. Tape is made of flexible steel tape, cloth tape, and PVC tape. The length range available is 1 meter, 2 meters, 3 meters, 5 meters, 10 meters, 15 meters, etc. (Fig. 2.25)

Fig 2.25 Measuring tape

(m) Plumb Bob: A plumb bob is a weight on a string that is used to establish a vertical line or plumb line. In plumbing, a plumb bob can be used to check that a pipe or other fixture is perfectly vertical, which is essential for proper drainage and water flow. The plumb bob is attached to the top of the pipe or fixture and the weight hangs down, indicating whether the object is perfectly vertical or not. (Fig. 2.26)

Fig 2.26 Plumb Bob

(n) Spirit Level: A spirit level, also known as a bubble level or plumb rule, is a commonly used tool in plumbing to ensure that pipes, fixtures, and other components are installed level. Plumbers use spirit levels to check whether a surface or pipe is perfectly horizontal or vertical, which is important for proper installation and water flow. The tool consists of a long, flat ruler with a bubble level attached to it. The level is a small, liquid-filled tube with an air bubble in it. (Fig. 2.27)

Fig 2.27 Spirit level

(o) Spade: A spade, also known as a spade shovel or trenching shovel, is a tool commonly used in plumbing for digging trenches and excavating soil (Fig. 2.28). It has a flat, rectangular blade that is typically made of steel and a long handle for leverage.In plumbing, a spade is used to dig trenches for installing pipes, drain lines, and other plumbing components. The blade of the spade is sharp enough to cut through soil, but also flat enough to create a straight, even trench.

Fig 2.28 Spade

(p) Pickaxe: A pickaxe, also known as a pick or a mattock, is a tool that is sometimes used in plumbing for breaking up hard soil or rocks. In plumbing, a pickaxe may be used in situations where the soil is too hard to dig with a shovel or spade. (Fig. 2.29)

Fig 2.29 Pickaxe

(q) Mortar pan: A mortar pan, also known as a mixing tray or a mud pan, is a shallow, rectangular tray that is commonly used in plumbing for mixing cement, mortar, or other building materials. In plumbing, a mortar pan is used to mix small batches of cement or mortar for tasks such as setting toilet flanges or installing tile. The shallow shape of the pan allows for easy mixing and spreading of the material, and the sloping sides make it easy to scoop out the mixture with a trowel or other tool.
(Fig. 2.30)

Fig 2.30 Mortar pan

(r) Manson's square: A Mason square, also known as a framing square, is a tool that is commonly used in plumbing for measuring and marking right angles and ensuring that pipes and other plumbing components are installed correctly. It consists of two arms that meet at a 90-degree angle and can be made of metal or plastic.

(Fig. 2.31)

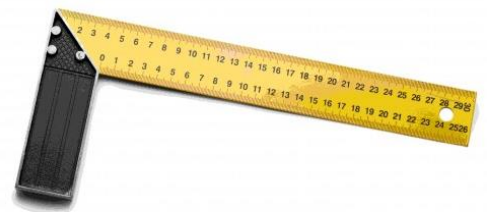


Fig 2.31 Mason's Square

(s) Water level tube: A water level tube, also known as a water level or water pipe level, is a simple and effective tool used in plumbing to measure the level of water between two points. It consists of a clear plastic tube filled with water and is typically between 25 and 50 feet in length. (Fig. 2.32)

Fig 2.32 Water Level tube

Using of water level tube:
In plumbing, a water level tube is used to determine the difference in elevation between two points or to determine if a surface is level. To use the tool, one end of the tube is placed at the s
starting point and the other end is moved to the end point. The tube is then held level, and the water will naturally settle to the same level in both ends of the tube. The difference in elevation between the two points can then be determined by measuring the distance from the water level in the tube to the ground at each point.
Water level tubes are useful in plumbing for tasks such as installing drainage pipes, ensuring that pipes are sloped correctly to promote proper water flow, and for determining the levelness of floors and other surfaces.

2.3 SAFETY PRECAUTIONS WHILE USING THE TOOLS

Precautionary measures to be taken for safe use of tools:

1. Use the correct methods which are given in instruction manual of tools while using it.
2. Use the appropriate tools required for specific work/job. For example, do not use pliers instead of hammer, use only hacksaw to cut.

3. Tools should be kept in good condition with proper maintenance.
4. Proper protective equipment should be provided.
5. Safety method should be followed while using electrical wires.
6. Kerosene oil should be used for removing dust from the rusty nuts.
7. Do not use tools without handle as it may not give you proper grip.
8. Remove burrs from head of chisels and edges of tools.
9. The operator should wear safety glasses during the use of power tools like drill machine.
10. Keep metal parts lightly lubricated.
11. Do not apply excessive pressure/force.
12. Don't horseplay, avoid distracting another worker.
13. Tools should be regularly inspected.
14. Use or wear safety gear (helmet, gloves, goggles, safety shoes, ear plugs, etc.)

2.4 MAINTENANCE OF PLUMBING TOOLS

Maintaining plumbing tools and equipment is essential to ensure they remain effective and safe to use. Proper maintenance can help prolong the life of the tools and prevent costly repairs or replacements. Here are some tips for maintaining plumbing tools and equipment:

1. **Clean tools after each use**: Wipe down tools with a clean, dry cloth after each use to remove any debris or moisture that may have accumulated. This can help prevent rust and other damage.
2. **Lubricate moving parts**: Apply a small amount of lubricant to any moving parts on tools such as wrenches or pliers to keep them working smoothly.
3. **Store tools properly**: Store tools in a dry, clean location where they will not be exposed to moisture or extreme temperatures. Use designated tool storage to prevent damage or loss.
4. **Check for damage**: Regularly inspect tools for any signs of damage such as cracks or bends. Damaged tools should be repaired or replaced immediately.
5. **Sharpen cutting tools**: Keep cutting tools such as saws and pipe cutters sharp to ensure they work effectively and prevent injury.
6. **Test equipment regularly**: Test equipment such as water pressure gauges or pipe cameras regularly to ensure they are working correctly.
7. **Follow manufacturer instructions**: Always follow the manufacturer's instructions for maintenance and care of tools and equipment.

By following these tips, you can help ensure that your plumbing tools and equipment remain effective, safe, and long-lasting.

One of the most deteriorating factors that affects the pipe age is Corrosion. The easiest and cheapest ways to prevent corrosion is to use barrier coatings like **paint, plastic, or powder**. Powders, including epoxy, nylon, and urethane, adhere to the metal surface to create a thin film. Plastic and waxes are often sprayed onto metal surfaces.

The most common materials to coat pipes externally are: Non-metallic pipe coating: Paints, varnishes, lacquers, bituminous coatings, resins, plasticizers, Greases, waxes, oils, Plastics (polyurethane, polyethylene, PTFE, PVC), Elastomers (various types), Vitreous enamel, Cement mortar.

The most commonly used pipes in plumbing are steel pipes made majorly of iron. Most common lining types on steel pipes are **FBE (Fusion Bond Epoxy) & Cement lining**. These coatings are widely used to protect the steel pipe used in pipeline construction, reinforcement steel, and on a wide variety of piping connections.
Whereas, PVC pipes are manufactured in such manner that it does not required any coating or painting.

ACTIVITIES

Activity: Objective: Familiarize students with some of the most common plumbing tools used in the plumbing industry.

Materials:

- Pictures or physical samples of various plumbing tools
- Worksheets with space for students to write the name of each tool and its purpose
- Writing materials

Procedure:

1. Start by introducing the class to the plumbing industry and explaining the importance of plumbing tools in performing plumbing tasks.
2. Show pictures or physical samples of various plumbing tools to the class, and briefly describe the purpose of each tool. You can include examples of holding tools, fitting tools, cutting tools, and measuring tools.
3. Provide each student with a worksheet that includes space for them to write the name of each tool and its purpose.
4. Allow students to examine the tools and discuss them with their peers. Encourage them to think about how each tool is used in plumbing tasks.

5. Have the students write down the name of each tool and its purpose on their worksheet.
6. Once all students have completed their worksheets, review the answers as a class and discuss any questions or comments that arise.
7. To wrap up the activity, have students reflect on what they have learned about plumbing tools and their importance in the plumbing industry.

CHECK YOUR PROGRESS

A. Answer the following:

1. Define the function of following tools:
   (a) Chisel (b) Spirit level
   (c) Caulking (d) Chain wrench
   (e) Files
2. Define the procedure of using water level tube.
3. State some tips for maintaining the plumbing tools.
4. What are safety precautions while using the drill bits and drill machine?
5. Name the types of spanners and its functions.

B. Fill in the blanks

1. ……are hand tools used for tightening and loosening of the nuts and bolts.
2. The most commonly used pipes in plumbing are…….pipes made mainly of iron.
3. A Mason square is a tool that is commonly used in plumbing for measuring and marking…….. angles.
4. A …… is used in a workshop for quick cutting of heavy pipes.
5. The…… wrench is used to loosening and tightening the bolts and nuts of any odd and regular sizes.

C. Match the following name of the tool with its image

	Name of tool		Tool image
1.	Water level Pipe	A.	

2.	Mortar Pan	B.	
3.	Pipe Hanger	C.	
4.	Plumb Bob	D.	
5.	Hand Hacksaw	E.	

Module 3	PLUMBING MATERIALS AND PIPES

Module Overview
This module focuses on the materials and tools essential for plumbing systems. It begins with unpacking and inspecting plumbing materials to ensure quality and readiness for use. The module introduces various plumbing tools and hardware, as well

as specific tools used for material application. It highlights the critical role of pipes in plumbing systems, explaining their importance in water flow and drainage. Lastly, the module discusses the different types of pipes commonly used in plumbing, detailing their characteristics and applications in various setups.

Learning Outcomes

After completing this module, you will be able to:

- Check and inspect plumbing materials for quality before use.
- Identify various tools and hardware used in plumbing.
- Use the correct tools for applying plumbing materials.
- Understand the importance of pipes in plumbing systems.

Module Structure

3.1: Unpacking and checking of plumbing material
3.2: Plumbing tools and hardware
3.3: Various tools used for application of materials
3.4: Importance of pipes in plumbing system
3.5: Types of pipes used in plumbing system

Plumbing materials and pipes are essential components of any plumbing system. Plumbing materials and pipes play a crucial role in the functionality and reliability of a plumbing system. With so many different materials and types of pipes available, it can be challenging to determine which ones are the most appropriate for a particular application.

There are various types of plumbing materials, including copper, PVC, PEX, and galvanized steel, each with its own advantages and disadvantages. Copper pipes are durable and long-lasting, but can be expensive, while PVC pipes are affordable and easy to install, but may not be suitable for hot water applications. PEX pipes are flexible and easy to install, but may not be approved for use in all areas. Galvanized steel pipes are strong and durable, but can rust over time.

When choosing plumbing materials and pipes, it is important to consider factors such as the type of water being transported, the location of the pipes, and the intended use of

the plumbing system. Proper installation and maintenance are also crucial for ensuring the longevity and efficiency of the plumbing system.

3.1 UNPACKING AND CHECKING OF PLUMBING MATERIAL

Unpacking and checking of plumbing materials and pipes is an essential step to ensure that all components are present and in good condition before beginning a plumbing installation or repair project. Here are the steps that should be followed to unpack and check plumbing materials and pipes as per manufacturer guidelines:

1. **Carefully remove all packaging material**: Start by carefully removing all packaging material from the plumbing materials and pipes. Be careful not to damage any of the components during this process.
2. **Verify that all components are present**: Check the manufacturer's list of components to ensure that all necessary parts are present. Count the number of pipes, fittings, and other components to make sure that nothing is missing.
3. **Inspect the pipes and fittings for damage**: Examine each pipe and fitting for any signs of damage or defects. Look for cracks, dents, scratches, or any other issues that could affect the integrity of the plumbing system.
4. **Check for any missing or damaged seals**: Check that all seals are present and in good condition. If any are missing or damaged, they should be replaced before installation.
5. **Look for any signs of corrosion or rust**: If you are using metal pipes or fittings, inspect them for any signs of corrosion or rust. Any corroded or rusted components should be replaced before installation to ensure the longevity of the plumbing system.
6. **Review the manufacturer's instructions**: Finally, review the manufacturer's instructions for any specific guidelines related to unpacking and checking the plumbing materials and pipes. Follow these guidelines closely to ensure that the installation process goes smoothly.

The key aspects of plumbing pipe material that should be checked during unpacking:

- **Size and Type**: Check that the pipes are the correct size and type for the intended use in the plumbing system.
- **Material**: Determine the material of the pipe, which can be made from materials such as copper, PVC, PEX, or galvanized steed.
- **Quality and Condition**: Check the quality of the pipes and ensure that they are in good condition.

- **Compatibility**: Make sure that the pipes and fittings are compatible with each other.
- **Pressure Rating**: Determine the pressure rating of the pipe, which is an important factor to ensure that the pipe can handle the water pressure in the plumbing system.
- **Certification and Compliance**: Check that the pipes meet industry standards and comply with local plumbing codes.

3.2 PLUMBING TOOLS & HARDWARE

Following are the hardware used in the plumbing work:

Fastener: A fastener is a broad range of mechanical tools/elements used to hold two or more objects together as a rigid attachment. Fasteners allow to separate or dismantle the pieces without suffering any damage. However, they can be used as permanent joints as well. Screws, nuts, bolts, nails, washers, etc are different types of fasteners.
Types of Fasteners: There are different types of fasteners that are used in industrial applications. The most common types of mechanical fasteners are:

- Nuts and Bolts
- Washers
- Screws
- Nails
- Anchors
- Rivets
- Pins
- Retaining Rings

- **Fasteners Type- Nuts and Bolts**

Nuts and bolts are one of the most common types of fasteners available for industrial use. They work together in tandem and hold two or more components together. The bolt is inserted through the bolt holes between the components and then the nut is fastened on the other end. There are various types of nuts and bolts as mentioned below.

Types of Nuts:

Nuts have internal threads and are always used with a mating bolt. The most popular types of nuts are:

- **Hex Nuts:** The most common variety of nuts, Hex Nuts consist of a hex shape (six-sided) with internal threads. They can be easily tightened or loosen with a wrench accessing from any angle.

Fig 3.1 Hex Nuts

- **Coupling Nuts:** They are also hex-shaped nuts. This hollow threaded fastener joins two male threads together and also known as extension nuts. They are widely used for installing plumbing pipes.

Fig 3.2 Coupling Nuts

- **Lock Nuts:** Locknuts are specially designed fasteners to prevent loosening due to vibrations. Also known as prevailing torque nuts, lock nuts find uses in automotive and washing machines where vibration problems have the tendency to loosen parts.

Fig 3.3 Lock Nuts

- **Square Nuts:** Feature a square shape, square nuts are the oldest type of nuts with four sides. They are the best for the greater surface area making the fastener stronger and reducing damage from rough edges. Usually, square nuts are used in furniture and metal channel applications

Fig 3.4 Square Nuts

- **Flange Nuts:** Having a wide, serrated flange on one end, flange nuts serve a similar function as a washer but it does not provide any added movement. They are also known as Tee nuts.

Fig 3.5 Flange Nuts

- **Wing Nuts:** Having two projected pieces, wing nuts can be easily loosened or tightened using hands without tools. This type of fastener is good for applications requiring frequent tightening and loosening.

Fig 3.6 Wing Nuts

- **Slotted Nuts:** In slotted nuts, sections are cut out to create a locking mechanism with the help of a cotter ping.

Fig 3.7 Slotted Nuts

- **U-Nuts**: Reliable and strong, U-nuts are made from one piece of rolled thread. They are used to hold metal sheet panels together.

Fig 3.8 U-Nuts

- **Speed Nuts:** Speed nuts have two metal pieces that work as one. Also known as sheet metal nuts, speed nuts do the job of both a nut and a locking washer.

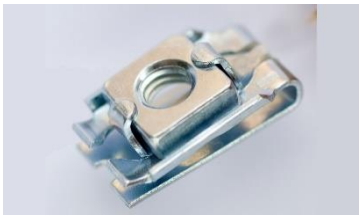


Fig 3.9 Speed Nuts

- **Push Nuts:** Push nuts can distribute loads easily that reduces surface stresses. They are installed with a special nut driver and used to secure unthreaded bolts and other fasteners.

Fig 3.10 Push Nuts

- **Jam Nuts:** Jam nut is small size nut that is half as tall as hex nuts. They are widely used where space has limitations to use hex nuts. They can easily be fastened onto a bolt without applying torque or force.

Fig 3.11 Jam Nuts

- **Axle Nuts:** Also known as cap nuts or dome nuts, axle nuts hide the bolt edges and provides a seamless appearance. It provides a nice surface finish and finds use in electrical panels, stereo cabinets, etc.

Fig 3.12 Axle Nuts

- **Castle Nuts:** Castle nuts have notches at one end through which a pin can be inserted to fix the nut's position. They are used when the torque requirements are low.

Fig 3.12 Castle Nuts

Some other types of nuts are - Rivet Nuts, Weld Nuts, Barrel Nuts, Shear Nuts, Tri-Groove Nuts, Keps-K Lock Nuts, Knurled Thumb Nuts, Wheel Nuts, etc.

Types of Bolts

Many different types of bolts are available in the market. The most common types of bolts that are used for industrial applications are:

- **Carriage Bolts:** Having domed or countersunk heads, Carriage bolts use a square component under the head to keep the bolt from moving (pulling through) while tightening the nut. Carriage bolts are self-locking bolts and are usually used to attach metals to wood.

Fig 3.13 Carriage Bolts

- **Hex Bolts:** They have six-sided heads with machine threads extended halfway or up to the bolt head. Hex bolts find wide construction and machinery applications as they can be easily tightened using a wrench. Also, popular as hex cap screws, hex bolts work with a tapped hole or a nut.

Fig 3.14 Hex Bolts

- **U-Bolts:** U-bolts are shaped like the letter "U" and have screw heads on both ends. The bent section of the U-bolt is unthreaded. They are extensively used in piping, plumbing, and HVAC works to secure the position of pipes and tubes without making any holes in them.

Fig 3.15 U-Bolts

- **Lag Bolts:** These bolts are used independently without a nut. Extremely sturdy and tough Lag bolts can handle a lot of weight. They are used for heavy-duty jobs like installing frames, framing lumber, etc.

Fig 3.16 Lag Bolts

- **Fasteners-Washers**

Sometimes washers are added in between nuts and bolts to distribute the fastener's load evenly over the material surface. A washer is a flat circular disc with an opening in the centre. Washers can be metallic or can be made from non-metals. Other main purposes of washers are:

- Isolation of Components
- Reduction of leakage
- Alleviation of friction, and

Fig 3.17 Different types of washers

- Prevention of loosening during vibration.

Some common types of washers are:

- **Plain washers**: These are used for load distribution and isolation purposes. Plain washers can be of various types like round and thin Flat Washers for general use; Torque Washers for use in woodworking project; Fender Washer used in car fenders; Finishing Washers used with countersank screws, and C-washers.

- **Spring Washers:** These types of fasteners act like a spring as they develop axial flexibility to make the joint more elastic. This can avoid unintended loosening during vibration.
- **Lock Washers:** This type of washer uses various mechanisms to prevent nuts, screws, and bolts from loosening. Lock washers are much better than spring washers.

- **Fasteners-Screws**

Screw fasteners are the most versatile types of fasteners. It's very simple to use. One needs to drill a pilot hole in a material and then using a screwdriver the screw can be easily installed in place. They generally have male threads that start from the tip. Screws are usually self-threading and create the thread during installation.

Fig 3.18 Screws

They come in various types and sizes like:

- **Self-Drilling Screws:** Also, popular as self-tapping screws, self-drilling screws create the required internal thread while installing it. It contains a fully threaded shaft.
- **Machine Screws:** These types of fasteners are most widely used for machinery applications. It comes in a variety of tip shapes and heads with a slotted socket on the head to tighten it. They are of uniform thickness and don't taper off at the bottom.
- **Sheet Metal Screws:** With an extremely sharp tip, sheet metal screws are used to fasten two metals together. They have a flat or rounded head.

Nails as Mechanical Fasteners

Nails are the oldest types of fasteners used since ancient times. It is still used as an everyday household item. Nails do not have threads and usually have less power than screws.

Fig 3.19 Nails

Anchors as Industrial Fasteners

Anchors are a particular type of fastener that is used to connect something to a material like concrete or drywall. They embed themselves in the material and hold the object in place. Various types of anchors are used to serve different types of functions.

Fig 3.20 Anchors

Mechanical Fasteners-Rivets

Rivets create a permanent joint between objects and are hence known as permanent fasteners. Consisting of a cylindrical shaft with a head on one end and a tail on the other, Rivets offer great support against shearing forces. This type of fastener is lightweight and remarkably durable. A unique tool popular as a rivet gun is required to install rivets. Rivets can not be reused after removal.

Fig 3.21 Rivets

Fastener types-Pins

Pins are unthreaded mechanical fasteners usually inserted through preformed holes.

Retaining Rings

Retaining rings are a non-permanent type of metallic fasteners used to hold multiple parts together. It usually consists of spiral, semi-circular metal pieces. Retaining rings are employed in many applications in machinery.

Fig 3.22 Retaining Rings

1. **Pipe Hanger or pipe support**: A pipe support or pipe hanger is a designed element that transfer the load from a pipe to the supporting structures. The load includes the weight of the pipe proper, the content that the pipe carries, all the pipe fittings attached to pipe, and the pipe covering such as insulation.

Fig 3.22 Pipe Hanger

How do you attach a pipe to a wall?

Place the pipe clip back over the pipe and align the screw holes with the holes drilled into the wall. Insert a screw into each hole, ensuring the tip of the screw enters the center of the screw plug. Use a screwdriver to drive the screws home until they securely anchor the pipe clip to the wall.

2. **Pipe restraint:** It is a structural element used to constrain or limit the thermal movement of a piping system.

Fig 3.23 Pipe restraint

3. **Pipe support:** It is a structural element or assembly that is required to absorb the piping system weight loads and contain the sustained longitudinal stress within the allowable limits.

4. **Pipe anchor:** A pipe anchor is a pipe support that's designed to control movement and stop a pipe from shifting in three dimensions. Essentially, traditional pipe anchors are meant to fix pipes to a spot and stop pipes from moving.

5. **Studs:** Studs form walls and may carry vertical structural loads or be non-load-bearing, such as in partition walls, which only separate spaces. They hold in place the windows, doors, interior finish, exterior sheathing or siding, insulation and utilities and help give shape to a building.

3.3 VARIOUS TOOLS USED FOR APPLICATION OF MATERIALS

The major tools used in plumbing are categorised as:

1. Holding tools

(a) Bench vice (b) Pipe vice

2. Fitting tools

(a) Wrenches (b) Water-pump pliers

(c) Spanners

3. Cutting tools

(a) Pipe cutter (b) Hacksaw

4. Pipe bending tools

(a) Pipe bending machine (b) Threading dies

5. Other tools

(a) Chisel (b) Hammer

(c) Chain wrench (d) Screw driver

(e) Trowel (f) File

(g) Plier (h) Caulking tools

(i) Drill machine (j) Drill bit

(k) Hanger (l) Measuring tape

(m) Plumb bob (n) Spirit level

(o) Spade (p) Pickaxe

(q) Mortar pan (r) Masons' square

(s) Water level tube

The detail about each of the tools were discussed in Unit 2.

3.4 IMPORATNCE OF PIPES IN PLUMBING SYSTEM

Plumbing pipes are an essential component of modern plumbing systems, which are responsible for the distribution of water, gas, and sewage in buildings. The importance and use of plumbing pipes can be summarized as follows:

- **Water distribution**: Plumbing pipes are used to distribute potable water throughout a building. These pipes are made of materials like copper, PVC, and PEX and are designed to transport water under pressure. They are connected to fixtures such as faucets, toilets, and showers.
- **Drainage**: Plumbing pipes are also used to remove wastewater and sewage from a building. These pipes are designed to transport wastewater and sewage away from the building and into the municipal sewage system or septic tank. They are usually made of cast iron or PVC.
- **Gas distribution**: Plumbing pipes can also be used to distribute natural gas or propane throughout a building. These pipes are made of materials like copper and black iron and are designed to transport gas at high pressure. They are connected to appliances like stoves, water heaters, and furnaces.

- **Heating and cooling**: Plumbing pipes are often used in heating and cooling systems. For example, in radiant floor heating systems, hot water is circulated through pipes installed in the floor to provide warmth. In air conditioning systems, refrigerant is circulated through pipes to remove heat from the air.

3.5 TYPES OF PIPES USED IN PLUMBING SYSTEM

Plumbing is the system of pipes, drains fittings, valves, valve assemblies, and devices installed in a building for the distribution of water for drinking, heating and washing, and the removal of waterborne wastes.

There are various types of materials that are used for manufacturing pipes include:

1. Cast Iron Pipe
2. Ductile Iron Pipe
3. Galvanized Iron Pipe
4. CPVC Iron Pipe
5. PEX or XLPE Pipe
6. Polypropylene Pipe
7. Stone ware Pipe
8. Un-Plasticized Pipe
9. Copper Pipe
10. Stainless Steel Pipe

1. Cast Iron Pipe - Cast Iron Pipe is used as a pressure pipe for transmission of water, gas and sewage, and as a water drainage pipe. These are available with flanged ends or one end with socket & other with spigot.

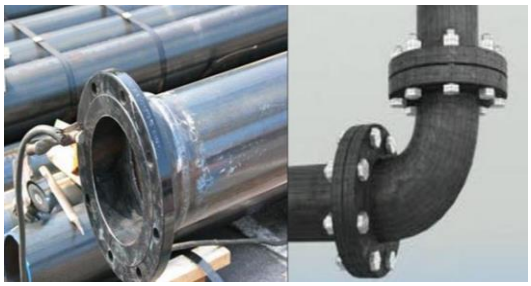


Fig 3.24 Cast Iron Pipe

2. Ductile Iron Pipe - Ductile Iron Pipe is commonly used for potable water transmission and distribution. It is made of ductile iron. These pipes are improved version of Cast Iron Pipes.

Fig 3.25 Ductile Iron Pipe

3. Galvanized Iron Pipe - Galvanized Iron Pipe is mainly used in water supply distribution. These pipes are made of different grade i.e. Light, Medium and Heavy depending upon the thickness of pipe used.
These are colour coded for identification - light – yellow band, medium – blue band and heavy – red band. Pipes with diameters in size from 15 mm to 150 mm are used in distribution.

Fig 3.26 Galvanized Iron Pipe

4. CPVC Pipe - Chlorinated Polyvinyl Chloride (CPVC) Pipe is primarily used for supplying hot and cold potable water It is also used in industrial liquid applications. Chlorinated polyvinyl chloride is a thermoplastic pipe material.

Fig 3.27 CPVC Pipe

5. PEX or XLPE Pipe - PEX or XLPE is a form of polyethylene with cross-links, formed into tubing. PEX Pipe is primarily used in - building services, pipe work systems, domestic water piping, natural gas and offshore oil applications, chemical transportation and transportation of sewage and slurries.

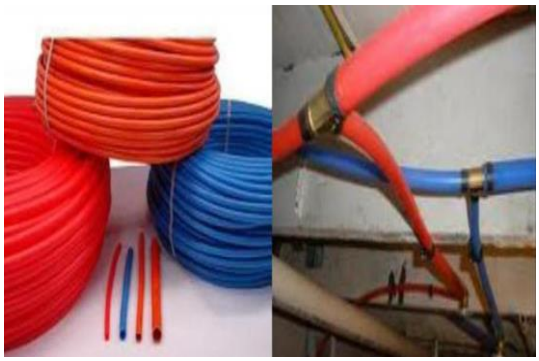


Fig 3.28 PEX/XLPE Pipe

6. Polypropylene Pipe - These are made of polypropylene "random copolymer". Polypropylene Pipe is primarily used for - inner hot water and cold-water supply conduits, industrial pipe-lines

Fig 3.29 Polypropylene Pipe

7. Stone Ware Pipe - Stone Ware Pipe are made of clay. They are s primarily used in - sewerage systems for underground drainage, industrial drainage, irrigation, chemical industry for transporting the highly corrosive chemical etc.

Fig 3.30 Stoneware Pipe

8. Un-Plasticized Pipe - Un-plasticized Polyvinyl (UPVC) Pipe is primarily used in - ventilation pipe work, rain water applications, soil and waste water discharge system.

Fig 3.31 Un-Plasticized Pipe

9. Copper Pipe - Copper Pipe as the name suggests are made up of copper. It is most often used in - supply of hot and cold tap water, as refrigerant line in HVAC systems. Copper offers a high level of resistance to corrosion however, it is becoming very costly.

Fig 3.32 Copper Pipe

10. Stainless Steel Pipe -Stainless Steel Pipe is used in marine environments where salt water would erode other metal pipe. These pipes are strong and highly resistant to corrosion. However, even more expensive than copper pipes.

Fig 3.24 Stainless Steel Pipe

The cost of plumbing pipes in India can vary depending on various factors such as the material, size, length, and location. Here's a general overview of the average costs of some commonly used plumbing pipes in India:

PVC Pipes: PVC pipes are the most commonly used pipes for plumbing in India and are also the most affordable option. The cost of PVC pipes can range from ₹10 to ₹50 per foot for standard 1/2-inch to 2-inch pipes. The cost increases with the diameter of the pipe and can range up to ₹200 per foot for larger diameter pipes.

CPVC Pipes: CPVC (Chlorinated polyvinyl chloride) pipes are a more durable and long-lasting option than PVC pipes and are also more expensive. The cost of CPVC pipes can range from ₹40 to ₹100 per foot depending on the diameter of the pipe.

Copper Pipes: Copper pipes are a high-quality option for plumbing but are also the most expensive. The cost of copper pipes can range from ₹200 to ₹800 per foot depending on the type and diameter of the pipe.

GI Pipes: GI (Galvanized Iron) pipes are also commonly used in plumbing in India and are more affordable than copper pipes. The cost of GI pipes can range from ₹50 to ₹150 per foot depending on the diameter of the pipe.

ACTIVITIES

Activity: Building a Simple Plumbing System Using PVC Pipes. This activity is designed to teach students about the basics of plumbing pipes and how to build a simple plumbing system using PVC pipes.

Materials:

- PVC pipes (1/2 inch to 1 inch in diameter)
- PVC pipe fittings (elbows, tees, couplings, etc.)
- PVC cement
- Water source (faucet or garden hose)
- Bucket or container to catch water
- Tape measure or ruler
- Marker or pen

Procedure:

1. Begin by explaining to students the different types of plumbing pipes and their uses. Show them examples of PVC pipes, copper pipes, and other types of pipes.
2. Have students measure and cut the PVC pipes to the desired length using a tape measure and marker. Use a saw or PVC cutter to make the cuts.

3. Use PVC fittings such as elbows, tees, and couplings to connect the pipes together. Apply PVC cement to the joints and press the pipes together firmly.
4. Build a simple plumbing system by connecting the pipes and fittings to a water source, such as a faucet or garden hose. Use a bucket or container to catch the water at the end of the system.
5. Test the plumbing system by turning on the water source and checking for leaks. If there are any leaks, adjust the joints and connections as needed.
6. Once the system is working properly, have students experiment with changing the layout of the pipes and fittings to create different configurations. Encourage them to think creatively and come up with their own designs.
7. Discuss the importance of proper installation and maintenance of plumbing systems to prevent leaks and other problems.

CHECK YOUR PROGRESS

A. Answer the following

1.What are the key aspects of plumbing pipe material that should be checked during unpacking?

2. Enlist any three factors that depicts the importance of pipes in plumbing system.

3. Which is the most affordable pipes? Enlist its properties and its uses.

4. Enlist the properties of XLPE pipes.

5. Write the uses of –

a) Pipe Hanger b) Mechanical fastener -Rivets c) Pipe restraint

B. Fill in the blanks

1. The pipe …… is a pipe support that us design to control movement.

2. …….. Pipe is used as pressure pipe for transmission of water, gas and sewage.

3…….. Pipe mainly used for water supply distribution.

4. The pipe ……..is a structural element used to limit thermal movement of a piping system.

5. …….. pipe used in marine environment where salt water will erode other metal pipe.

Module 4	MEASUREMENTS AND SYMBOL USED IN PLUMBING

Module Overview

This module introduces the basics of measurements in plumbing work, an essential skill for accuracy and efficiency. It covers the different measuring instruments used in plumbing and their applications. The module also explains common plumbing symbols used in drawings and diagrams to help understand and communicate plumbing layouts effectively.

Learning Outcomes

After completing this module, you will be able to:

- Understand the importance of accurate measurements in plumbing work.
- Identify and use various measuring instruments in plumbing.
- Recognize and interpret common plumbing symbols in drawings and layouts.

Module Structure

4.1: Measurements in plumbing
4.2 Measuring Instruments
4.3: Plumbing symbols

In the previous modules, we've explored essential topics in plumbing, including plumbing tools, materials, and pipes. In addition to understanding the benefits and appropriate applications of various materials, a skilled plumber must also possess the ability to measure plumbing materials accurately using measurement tools. Proficiency in unit conversion is also crucial for efficient work. Moreover, interpreting the various symbols commonly used in plumbing drawings is essential for a plumber to succeed in their craft.

Plumbing drawings, also known as plumbing blueprints or plumbing plans, are essential technical documents used in the design and construction of plumbing systems in buildings. These drawings provide a detailed visual representation of the plumbing layout, including the placement of pipes, fixtures, valves, and other components. They serve as a crucial communication tool between architects, engineers, contractors, and plumbers, ensuring accurate implementation of the plumbing system.

Plumbing drawings are typically included as part of the larger set of construction drawings for a building project. They are created by skilled drafters or designers using computer-aided design (CAD) software, which allows for precise and efficient drafting. These drawings are typically drawn to scale, showing the building's floor plans, elevations, sections, and details specific to the plumbing system.

Plumbing symbols are a crucial element of plumbing drawings, as they convey specific information about the plumbing system in a standardized and clear way. Plumbing symbols are used to represent various plumbing components, fixtures, appliances, and piping materials, allowing designers, contractors, and plumbers to accurately interpret the drawings and install the plumbing system accordingly

4.1 MEASUREMENTS IN PLUMBING

4.1.1 MEASUREMENT OF LENGTH

Plumber uses the metallic tapes, cloth tapes, scale, and foot rule for measuring. Metallic tape should be used for accuracy in the measurement. Meter and its divisions are printed on measuring tapes. The symbol of feet is (‘) and symbol of inch is (“).
For example, the meaning of 4’-9” is 4 feet 9 inches.
Both the systems i.e. metric system and F.P.S. are used in plumbing.

(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

Length conversion is depicted in the following:

1 millimeter (mm)	= 0.03937079 in., or about 1/25 in	
10 millimeter	= 1 centimeter (cm.)	= 0.3937079 in

10 centimeters	= 1 decimeter (dm.)	= 3.937079 in
10 decimeters	= 1 meter (m.)	= 39.37079 in., 3.2808992 ft., or 1.09361 yd
10 meters	= 1 decameter (Dm.)	= 32.808992 ft
10 decameters	= 1 hectometers (Hm.)	= 19.927817 rods
10 hectometers	= 1 kilometer (Km.)	= 1093.61 yd., or 0.621377 mit
10 kilometers	= 1 myriameter (Mn.)	= 6.21377 ml
1 inch	= 2.54cm.	1 foot = 0.3048 m., 1 yard = 0.9144 m
1 rod	= 0.5029 Dm.	1 mile = 1.6093 Km

Table no. 4.1 Length Conversion

4.1.2 MEASUREMENT OF WEIGHT

1 kilogram	= 10 hectograms
1 kilogram	= 100 decagrams
1 kilogram	= 1000 gram
100 kilograms	= 1 Quintal
1000 kilogram	= 1 metric ton
1 kilogram	= 2.2046 pounds

Table no. 4.2 Weight Conversion Table

4.1.3 MEASUREMENT OF VOLUME

Volume conversion is depicted in the following.

10 litres= 1 decilitre (dl) = 2.6417 gal, or 1.135 pk

10 decilitres = 1 hectolitre (Hl) = 2.8375 bu

10 hectolitres = 1 kilolitre (kl) = 61027.0515 cubic inch or 28.375 bu

1 gallon (American) = 3.785 litres

1 gallon (British) = 4.543 litres

1 gallon = 4.546 litre

4.1.4 MEASUREMENT OF DENSITY

Density conversion is depicted below.

1 lb/ft^3 = 16.018 kg/m^3

1 kg/m^3 = 0.0624 lb. /ft^3

1 lb/in^3 = 27.68 g/cm^3

4.1.5 MEASUREMENT OF PRESSURE

Pressure conversion is depicted below.

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

4.1.6 COMPREHENSIVE CONVERSION TABLE

Millimeters	= 25.400	x inches
Meters	x 3.2809	= feet
Meters	= 0.3048	x feet
Kilometers	x 0.621377	= miles
Kilometers	= 1.6093	x miles
Square centimeters	x 0.15500	= square inches
Square centimeters	= 6.4515	x square inches
Square meters	x 10.76410	= square feet
Square meters	= 0.09290	x square feet
Square kilometers	x 247.1098	= acres
Square kilometers	= 0.00405	x acres
Hectares	x 2.471	= acres
Hectares	0.4047	x acres
Cubic centimeters	x 0.061025	= cubic inches
Cubic centimeters	= 16.3266	x cubic inches
Cubic meters	x 35.3156	= cubic feet

Cubic meters	= 0.02832	x cubic feet
Cubic meters	x 1.308	= cubic yard
Cubic meters	= 0.765	x cubic yard
Liters	x 61.023	= cubic inches
Liters	= 0.01639	x cubic inches
Liters	x 0.26418	= U.S.gallons
Liters	= 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
Kilograms per sq.cm.	x 14.2231	= lb. Per. sq.in.
Kilograms per sq.cm.	= 0.0703	x lb.per.sq.in
Kilogram per cubic meter	x 0.06243	= lb.per.cu.ft.
Kilogram per cubic meter	= 16.01890	xlb.per.cu.ft.
Metric tons (1000 kilograms)	x 1.1023	x tons(2000 lb.)

Metric tons (1000 kilograms)	= 0.9072	x tons (2000 lb.)
Kilowatts	x 1.3405	= horsepower
Kilowatts	= 0.746	x horsepower
Calories	x 3.9683	= B.t.u.
Calories	= 0.2520	x B.t.u.
Francs	x 0.193	= dollars
Francs	= 5.18	x dollars

Table no. 4.3 Comprehensive Conversion Table

Tips:

- To find the circumference of a circle, multiply the diameter by 3.1416.
- To find the diameter of a circle, multiply the circumference by .31831.
- To find the area of a circle, multiply the square of the diameter by .7854.
- The radius of a circle x6.283185 = the circumference.
- The square of the circumference of a circle x .07958 = the area.
- Half the circumference of a circle x half its diameter = the area.
- The circumference of a circle x .159155 = the radius.
- The square root of the area of a circle x .56419 = the radius.
- The square root of the area of a circle x 1.12838 = the diameter.
- To find the diameter of a circle equal in area to a given square, multiply a side of the square by 12838.

- To find the side of a square equal in area to a given circle, multiply the diameter by .8862.
- To find the side of a square inscribed in a circle, multiply the diameter by .7071.
- To find the side of a hexagon inscribed in a circle, multiply the diameter of a circle by .500.
- To find the diameter of a circle inscribed in a hexagon, multiply a side of the hexagon by 1.7321.
- To find the side of an equilateral triangle inscribed in a circle, multiply the diameter of a circle by .866
- To find the diameter of a circle inscribed in an equilateral triangle, multiply a side of the triangle by .57735.
- To find the area of the surface of a ball (sphere), multiply the square of the diameter by 3.1416.
- To find the volume of a ball (sphere), multiply the cube of the diameter by .5236.
- Doubling the diameter of a pipe increases its capacity four times.
- To find the pressure in pounds per square inch at the base of a column of water, multiply the height of the column in feet by .433.
- A gallon of water (U.S. standard) weighs 8.336 pounds and contains 231 cube inches. A cubic foot of water contains 7½ gallons, 1728
- Cubic inches and weighs 62.425 pounds at a temperature of about 39ºF. These weights change slightly and below this temperature

4.2 MEASURING INSTRUMENTS

These are important tools in a workshop, which help the plumber to measure size and dimensions of various components of plumbing. Measuring tools are commonly used. A plumber should know the use and handling of these tools. The important measuring tools are steel rule, calliper, screw gauge, pressure gauge, etc.

1. **Steel ruler** - It is used to measure lengths and to draw straight lines. A steel ruler is a useful tool in plumbing for measuring and marking pipes, fittings, and other components accurately. Its durable construction makes it resistant to bending or warping, ensuring precise measurements. Plumbers commonly use steel rulers to determine lengths, diameters, and angles during pipe installations, cutting, or fabrications. (Fig 4.1)

Fig 4.1 Steel ruler

2. **Calliper** - It is a tool used to determine the shorter lengths between two sides of an item. The tips of the calliper are kept to the distance to be measured; the calliper is then removed and the distance is measured between the tips with the ruler.
The main difference between inside and outside callipers lies in their specific applications and the direction in which they measure. inside callipers are used for measuring internal dimensions, while outside callipers are used for measuring external dimensions. (Fig 4.2 and Fig 4.3)

Fig 4.2 Inside calliper

Fig 4.3 Outside calliper

3. **Screw gauge (Micro metre)** - It is a device incorporating a calibrated screw used widely for precise measurement of small lengths. Proper handling of this tool is important in measuring any dimension. (Fig 4.4)

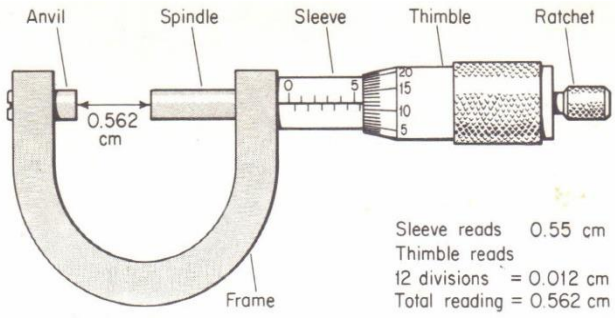


Fig 4.4 Screw Gauge

4. **Measuring tape** -It is used for measuring the dimension of plumbing items. Tapes are available in various lengths like 10 metres, 20 metres, etc. (Fig 4.5) Plumbers use measuring tapes to accurately determine the lengths of pipes, fittings, and other materials during installations or repairs.

Fig 4.5 Measuring tape

5. **Pressure gauge** - It is the instrument used for measuring the pressure. A pressure gauge is a crucial tool in plumbing for measuring and monitoring the pressure of fluids within a plumbing system. It helps plumbers ensure that the pressure is within the desired range and identify any potential issues or anomalies.

Fig 4.6 Pressure Gauge

6. **Vernier calliper** -The metre scale is used to measure the length to the nearest millimetre only. Vernier calliper is a precision instrument used to measure the internal and external lengths. It is usually a manual calliper.

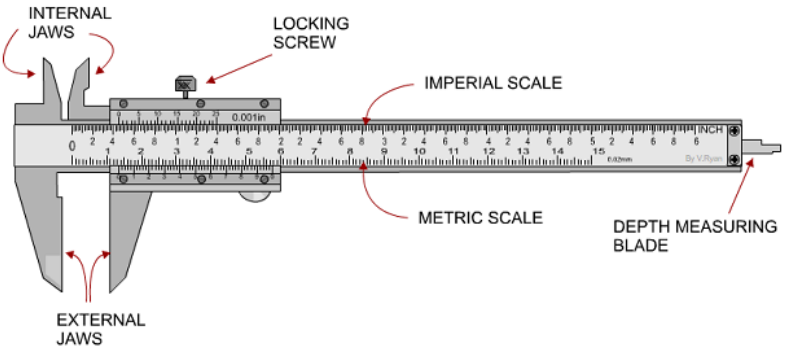
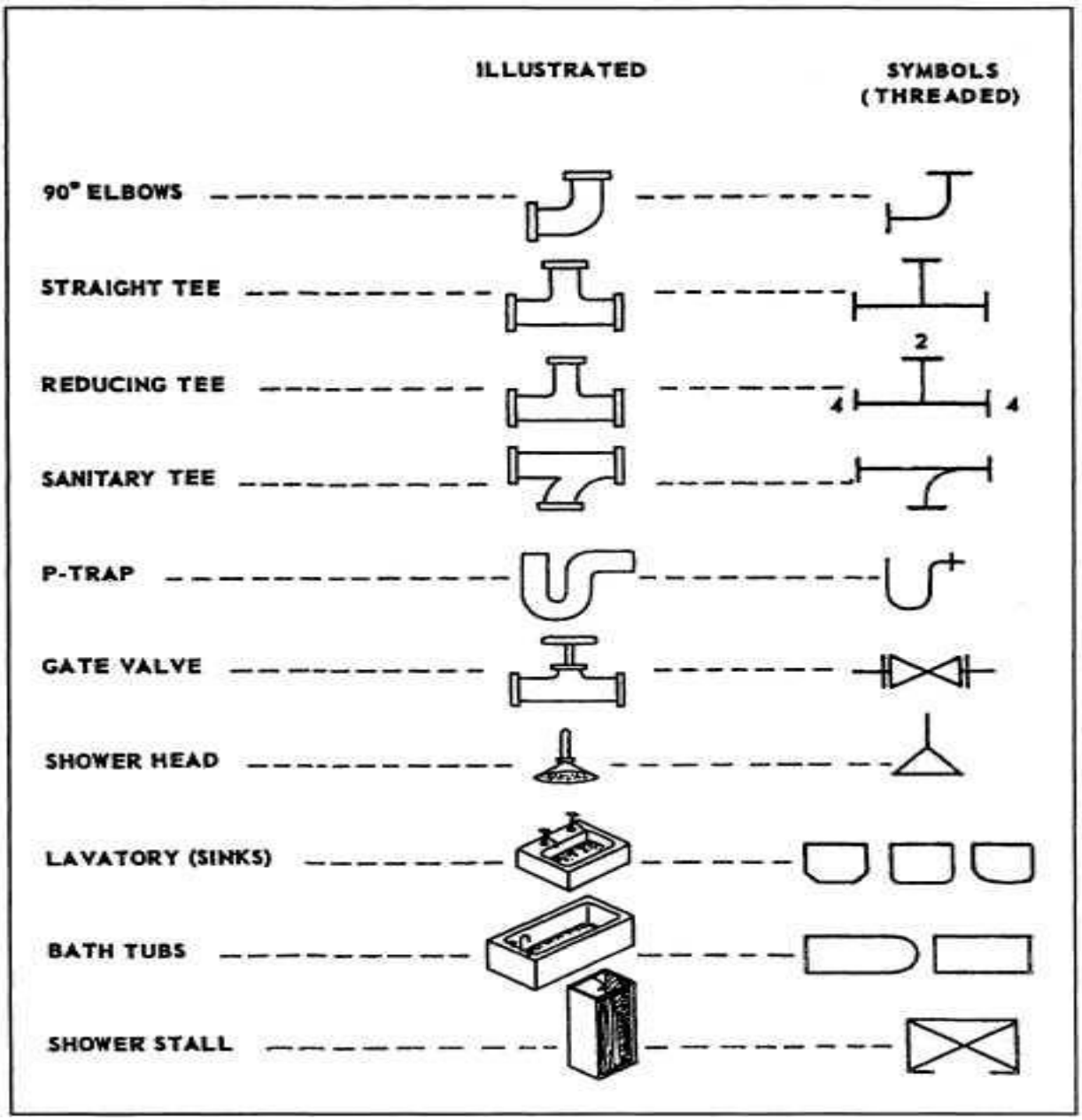


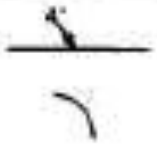
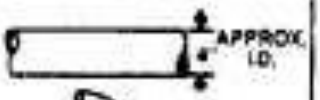
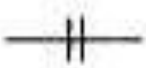
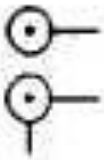
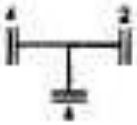
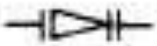
Fig 4.7 Vernier Calliper

4.3 PLUMBING SYMBOLS

4.3.1 Importance of plumbing symbols

A well-trained plumber does the installation of the fittings and fixtures as per the drawing given in the assembly sheet of the plumbing fixtures in the manufacturer's catalogue. These drawings consist of symbols, assembly of fixture and installation method. Identification of the symbols given in the drawings of fixtures makes the installation work easy for the plumber. Plumbing symbols are given in this Unit. The students should identify and learn the symbols so that it will be helpful in 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		

ACTIVITIES

Activity 1: Measure the length, width and height of a room.

Material Required

1. Measuring tape
2. Copy
3. Pencil

Procedure

1. Collect the measuring tapes and scale.
2. Identify a room in which measurement can be made.
3. With the use of a measuring tape and scale, measure the length, breadth and height of the room.
4. Draw a rough drawing of the room and note down the dimensions.
5. Measure the dimensions in metres and convert into feet.

Activity 2: Measure the weight of a brick and cement bag

Material Required

1. Weighing unit
2. Brick
3. Cement bag
4. Notebook
5. Pencil

Procedure

1. Collect the brick and cement bag.
2. Check and calibrate the weighing unit.
3. Measure the weight of the brick and the cement bag separately.
4. Note down the weight of items in the copy.

Activity 3: Draw the plumbing symbols

Material Required

1. Plumbing symbols
2. Copy
3. Pen

Procedure

1. Draw the plumbing symbols given in this book.
2. Level the figure symbols.

CHECK YOUR PROGRESS

A. Answer the following questions

1. Calculate the circumference of a circle of radius of 12cm.
2. A 4,800 litre water tank is ¾ full.
(a) How much water is there in the tank?
(b) How much is the empty space?
3. List the different types of material in which plumbing fittings are available.
4. Draw the figures of bends and reducing tee.

B. Fill in the blanks

1. 1 feet = ……inches
2. 1 metre = ……yards
3. 1 kilogram = …….. pounds
4. 1 gallon = ……litre
5. 1 lb/in3 = …….. g/cm3
6. 10 decametres = …….. hectometres

C. Mark the correct option

1. The function of a Vernier Calliper is to_____.
(a) measure depth of a large container
(b) measure diameter of a pipe
(c) measure weight
(d) measure pressure

2. Which of the following is a unit of length?
(a) kg
(b) m
(c) minute
(d) mL

3. Which of the following is a unit of area?
(a) m^2
(b) cm^2
(c) Hectare
(d) All of the above

Module 5	PLUMBING FITTINGS, JOINTS AND VALVES

Module Overview

This module focuses on pipe fittings and plumbing joints, essential components of any plumbing system. It introduces various types of pipe fittings and their uses in connecting pipes. The module explains the procedures for fixing these fittings and creating strong, durable plumbing joints. It also covers step-by-step methods for installing different types of plumbing joints, ensuring efficient and leak-free connections in plumbing systems.

Learning Outcomes

After completing this module, you will be able to:

- Identify different types of pipe fittings and their applications.
- Understand the procedure for fixing pipe fittings correctly.
- Recognize various types of plumbing joints and their uses.

Module Structure

5.1: Pipe Fittings
5.2: Procedure for fixing the pipe fittings
5.3: Plumbing joints
5.4: Procedure for fixing different types of plumbing joints

Plumbing fittings, joints, and valves are vital components in plumbing systems that enable the safe and efficient flow, control, and direction of water and other fluids. These elements work together to create a functional and reliable plumbing infrastructure in residential, commercial, and industrial settings.

Plumbing fittings encompass a wide variety of connectors, adapters, and couplings that join pipes, fixtures, and appliances. They ensure leak-proof connections, allowing for the smooth passage of fluids throughout the plumbing system.

Joints in plumbing refer to the methods used to connect pipes together. The selection of the appropriate jointing technique depends on factors such as the pipe material, system pressure, and accessibility.

Valves play a crucial role in regulating and controlling the flow of water or other fluids within a plumbing system. They allow for isolation, shut-off, and flow adjustment at specific locations.

Understanding plumbing fittings, joints, and valves is essential for plumbers, contractors, and even homeowners involved in plumbing projects. Proper selection, installation, and maintenance of these components ensure the integrity, efficiency, and longevity of the plumbing system.

In this chapter, we will study a comprehensive overview of plumbing fittings, joints, and valves. We will explore their functions, types, materials, installation techniques, and considerations for various plumbing applications. By gaining knowledge in this area, you will be equipped to make informed decisions and effectively manage plumbing projects, ensuring optimal performance and reliability.

5.1 PIPE FITTINGS

Fitting is used in pipe plumbing systems to connect straight pipe or tubing sections, to adapt to different sizes or shapes, and for other purposes, such as regulating or measuring fluid flow.

Fitting are small component used in plumbing system. Fitting is used in pipe plumbing system to connect straight pipe or tubing section, to adapt to different sizes or shapes and for other purposes, such as regulating or measuring fluid flow. We can say that the water-supply fittings like elbow, tee, socket, reducer, etc., are used to change the direction of flow, distribute the water- supply from the main pipe to other pipes of equal size or lower size, etc. There are various types of fittings used in plumbing work. (Fig. 5.1)

Fig 5.1 Different fittings of pipe

5.1.1 Types of Fittings

1. Collar
2. Elbow
3. Gasket
4. Couplings
5. Union
6. Reducer
7. Tee
8. Nipple
9. Valve
10. Trap
11. Ferrule
12. Cross
13. Offset

1. **Collar:** A pipe fitting in the form of a sleeve for jointing the spigot ends of two pipes in the same alignment is known as collar. (Fig 5.2)

Fig 5.2 Collar

2. **Elbow:** An elbow is a pipe fitting installed between two lengths of pipe or tubing to allow a change of direction, usually a 90° or 45° angle. The ends may be machined for butt welding, threaded (usually female), or socketed, etc. When the two ends differ in size, the fitting is called a reducing elbow or reducer elbow.

   Elbows are categorized based as below:

   Long Radius (LR) Elbows–radius is 1.5 times the pipe diameter

   Short Radius (LR) Elbows–radius is 1.o times the pipe diameter.

   90° Elbow–where change in direction required is 90° (Fig 5.3)

   45° Elbow–where change in direction required is 45° (Fig 5.4)

Fig 5.3 90° Elbow

Fig 5.4 45° Elbow

3. **Gasket:** Gaskets are mechanical seals, usually ring-shaped, which seal flange joints. Gaskets vary by construction, materials and features.
   Commonly used gaskets are non-metallic, spiral-wound and ring-joint. (Fig 5.5)

Fig 5.5 Gasket

4. **Coupling:** A coupling connects two pipes to each other. If the size of the pipe is not the same, the fitting may be called a reducing coupling or reducer, or an adapter. A pipe piece with inside threads for connecting two pieces of pipes having screwed ends. (Fig 5.6)

Fig 5.6 Coupling

5. **Union:** A pipe fitting used for joining two ends of pipes neither of which can be turned. A standard union pipe is made in three parts consisting of a nut, a female end, and a male end. When the female and male ends are joined, the nuts then provide the necessary pressure to seal the joint. Since the mating ends of the union are interchangeable, changing of a valve or other device can be achieved with a minimum loss of time. (Fig 5.7)

Fig 5.7 Union

6. **Reducer:** A reducer is used for a change in pipe size to meet hydraulic flow requirements of the system. (Fig 5.8)

Fig 5.8 Reducer

7. **Tee:** A tee, the most common pipe fitting, is used to combine (or divide) fluid flow. It is available with female thread sockets, solvent-weld sockets or opposed solvent-weld sockets and a female-threaded side outlet. Tees can connect pipes of different diameters or change the direction of a pipe run. Available in a variety of materials, sizes and finishes, they are used to transport two-fluid mixtures. Tees may be equal or unequal in size, with equal tees the most common. (Fig 5.9)

Single 'TEE' with door

Double 'TEE'

Fig 5.9 Tee

8. **Nipple:** A nipple is a short stub of pipe, usually male-threaded steel, brass, chlorinated polyvinyl chloride (CPVC) or copper (occasionally bare copper), which connects two other fittings. A nipple with continuous uninterrupted threading is known as a "close nipple". Nipples are commonly used for plumbing and hoses. A tubular pipe with both the ends threaded and less than 300 mm length for connecting the pipe. (Fig 5.10)

Fig 5.10 Nipple

9. **Valves:** For proper functioning of the pipe line, the valves are used in the water-supply mains. Valve are designed to stop or regulate flow of any fluid (liquid, gas, condensate, stem, slurry, etc.) in its path. Valves are categorized depending on their applications like isolation, throttling, and non-return.

   Various type of valves is available depending upon the type of construction as follows:

   (i) Sluice Valve: It is placed at an important place like any entry to a pipe. It may be the start of a new pipe from a tank or a number of branches from the tank or main the header. This valve isolates the water-supply as and when required. The sluice valve is specified by the nominal bore of the water-way. The standard sizes are 50 mm, 65 mm, 80 mm, 100 mm, 150 mm, 200 mm, 250 mm and 300 mm. The sluice valves are classified as Class 1 and Class 2. (Fig 5.11)

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

Table 5.1 - Test pressure in sluice valve

Fig 5.11 Sluice Valve

(ii) Scour Valve: This valve is provided at the lower level in a pipeline, so that such sections can be supplied and drained for maintenance purpose. The water is discharged into natural drains. It is basically a sluice valve and the very nature of its use has created the difference in name. (Fig 5.12)

Fig 5.12 Scour Valve

(iii) Air Valve: An air valve 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 is a valve fixed at the end of a communication pipe and which controls or stops the supply of water. The valve is specified by the nominal bore of the socket or pipe outlet to which the valve is fitted. The standard sizes are 8 mm, 10 mm, 15 mm, 20 mm, 25 mm, 32 mm, 40 mm and 50 mm. (Fig 5.12)

The body components and washer plate are made of cast brass or leaded tin bronze. The spindle, glands, handle, etc. are made of a brass rod extruded or rolled. The washers are made of or fiber, leather, rubber or nylon. This valve is available in two types: internally threaded and externally threaded.

Fig 5.13 Air Valve

(iv) Gate Valve: It is a valve through which the flow of water (fluid) is controlled by a gate in the form of a wedge or disc between the body ends which are in line with each other. The gate is actuated by a spindle whose axis is at right angles to that of the body ends. In the gate valve, the water pressure acts on one side of the gate and there is no change in the direction of the flow.

Types of Gate valve

Gate valves have gates of wedge type, solid or split type, or gate of double disc or parallel type. The actuation of the gate shall be by the internal or external screw on the spindle. The spindle may be of the rising or non-rising type. See figure given below. (Fig 5.14)

Split taper non-

Rising spindle

Fig 5.14 Types of gate valve

Parallel slide valve

It is essentially a gate valve in which the gate consists of two discs without spreading mechanism except for a spring which slides between the two parallel body seats. The activation of the valve discs is by the internal and the external screw on the spindle and the spindle may be of the rising or non-rising type.

Fig 5.13 Parallel Slide valve

(v) Globe valve: It is a valve having generally a spherical body in which the body ends are in line with each other and in which the disc is lifted from, or lowered on to, the body seat by a spindle whose axis is at right angles to that of the body ends. In this valve, the pressure acts on the under-side of the valve disc and there is a change of the direction of the flow inside the valve body. (Fig 5.15)

Fig 5.15 Globe Valve

(vi) Angle valve: It is a valve generally having a spherical body in which the body ends are at right angles with each other and in which the disc is lifted from, or lowered on, the body seat by a spindle whose axis is in line with that of one body end. The valve is actuated by the internal or external screw on the spindle. The spindle may be of the rising or non-rising type. See Fig.5.16

Fig 5.16 Angle Valve

(vii) Check valve or non-return valve: It is a check valve which permits (fluid) water to flow in one direction but checks all returning flow. It is operated by pressure above, having no external means of control. (Fig 5.17)

Swing Check valve

Horizontal check valve

Vertical check

Fig 5.17 Check Valve

(viii) Foot Valve: A foot valve works as a one-way valve, that allows water to be sucked through the valve with a pump and when the water flow stops the seal stops the backflow of the water. The foot valve has a strainer on the outside which prevents obstructions and a check valve that closes when pump stops. See Fig 5.18.

Fig 5.18 Foot valve

(ix) Float valve: A float valve is a mechanism for filling water tanks as well as flush toilets. It avoids overflow and backflow. Float valve is fitted in roof water tank or other places. It is used for stopping the water when water tank or flush toilets is filled and it stops overflow. (Fig 5.19)

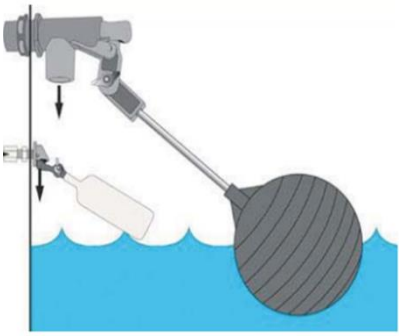


Fig 5.19 Floot valve

(x) Trap: In plumbing, a trap is a P, U, S, or J-shaped pipe located below or within a plumbing fixture (Fig 5.19). The bend is used to prevent sewer gases from entering building. If the gases were allowed back into the home, not only would they smell, but they could cause illnesses and have even been known to explode.

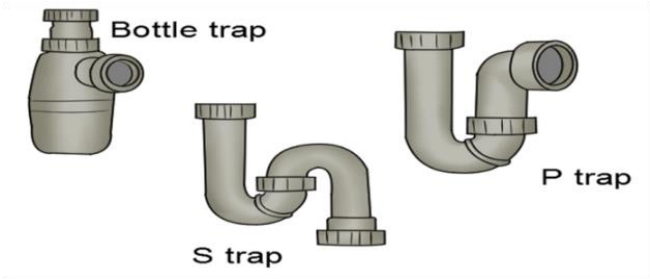


Fig 5.19 Trap

(xi) Ferrule: It is a pipe fitting for connecting a service pipe to the water main. It is usually made of non-ferrous metal and screwed to the main pipe

Fig 5.20 Ferrule

(xii) Cross: A pipe fitting used for connecting four pipes crosses, also known as four-way fittings, cross branch lines. A cross has one inlet and three outlets (or vice versa), and often have solvent-welded socket or female-threaded ends. Cross fittings may stress pipes as temperatures change, because they are at the centre of four connection points. See in Fig 5.21.

Fig 5.21 Cross

(xiii) Offset: A combination of elbows, which bring the pipe out of line but parallel with it.

Fig 5.22 Offset

5.2 PROCEDURE FOR FIXING THE PIPE FITTINGS

The procedure for fixing various plumbing fittings may vary depending on the specific type and material of the fitting. However, here is a general overview of the steps involved in fixing commonly used fittings:

1. **Elbow:**

   Step 1: Measure and cut the pipe to the required length.

   Step 2: Clean and deburr the cut ends of the pipe.

   Step 3: Apply plumber's tape or thread sealant to the male threads of the elbow fitting.

   Step 4: Thread the elbow onto the pipe by hand, ensuring a tight connection.

   Step 5: Use a pipe wrench or adjustable wrench to tighten the elbow firmly but avoid over-tightening, which can damage the fitting or pipe.

2. **Gasket:**

   Step 1: Ensure the mating surfaces of the two components (such as pipes or fittings) are clean and free from debris.

   Step 2: Place the gasket evenly on one of the mating surfaces.

   Step 3: Align the mating surfaces and press them together firmly, sandwiching the gasket between them.

   Step 4: Depending on the specific gasket type, additional steps like tightening bolts or clamps may be required to secure the connection.

3. **Couplings:**

   Step 1: Measure and cut the pipes to the desired length.

   Step 2: Clean and deburr the cut ends of the pipes.

   Step 3: Slide the coupling onto one of the pipes, ensuring it is centred.

   Step 4: Apply solvent cement or adhesive to both the pipe end and the inside of the coupling.

   Step 5: Insert the pipe end into the coupling, twisting slightly to ensure even distribution of the cement.

   Step 6: Hold the joint in place for the recommended curing time specified by the cement manufacturer.

4. **Union:**

   Step 1: Measure and cut the pipe to the desired length.

   Step 2: Clean and deburr the cut ends of the pipe.

   Step 3: Apply plumber's tape or thread sealant to the male threads of the union fitting.

   Step 4: Thread one end of the union onto the pipe by hand.

Step 5: Thread the other end of the union onto the other pipe or fitting, also by hand.
Step 6: Use pipe wrenches or adjustable wrenches to tighten both ends of the union firmly but avoid over-tightening.

5. **Reducer:**
Step 1: Measure and cut the pipes to the required lengths.
Step 2: Clean and deburr the cut ends of the pipes.
Step 3: Apply solvent cement or adhesive to the outside of one pipe end and the inside of the reducer fitting.
Step 4: Insert the pipe end into the larger opening of the reducer, ensuring a secure and snug fit.
Step 5: Hold the joint in place for the recommended curing time specified by the cement manufacturer.

6. **Tee:**
Step 1: Measure and cut the pipes to the desired lengths.
Step 2: Clean and deburr the cut ends of the pipes.
Step 3: Apply plumber's tape or thread sealant to the male threads of the tee fitting.
Step 4: Thread the tee fitting onto one of the pipes by hand.
Step 5: Thread the remaining pipes onto the other openings of the tee, also by hand.
Step 6: Use pipe wrenches or adjustable wrenches to tighten the connections firmly but avoid over-tightening.

7. **Nipple:**
Step 1: Measure and cut the pipe to the desired length.
Step 2: Clean and deburr the cut ends of the pipe.
Step 3: Apply plumber's tape or thread sealant to both ends of the nipple.
Step 4: Thread one end of the nipple into the desired fitting or component.
Step 5: Thread the other end of the nipple into another fitting or component, if necessary.
Step 6: Use pipe wrenches or adjustable wrenches to tighten the connections firmly but avoid over-tightening.

5.3 PLUMBING JOINTS

Pipes are connected with the help of joints. There are many types of joints used in pipes assembly. Connecting two or more pipe together is called fitting. Different pipe joints are

used for different pipes as per need. Pipe joints are major components of plumbing system provided to connect multiple pipes. Pipe joint provided should withstand pressure of each pipe

5.3.1 Types of Pipe Joints in Plumbing

Different types of pipe joints used in plumbing system are as follows.

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

1. **Threaded Joint**: Threaded joint means, pipes are connected by screwing with the help of threads provided for each pipe. See in Fig 5.23. One pipe having internal threads and the other one having threads externally.
   Cast iron pipes, copper pipes, PVC and G.I pipes are available with threads. Threaded joints are available from 6mm diameter to 300mm diameter pipes. They are preferable for low temperature areas and low-pressure flows. In the areas of high temperature, the joints may expand and leaked due to thermal expansion. Installation of threaded joint is easy but good maintenance required.

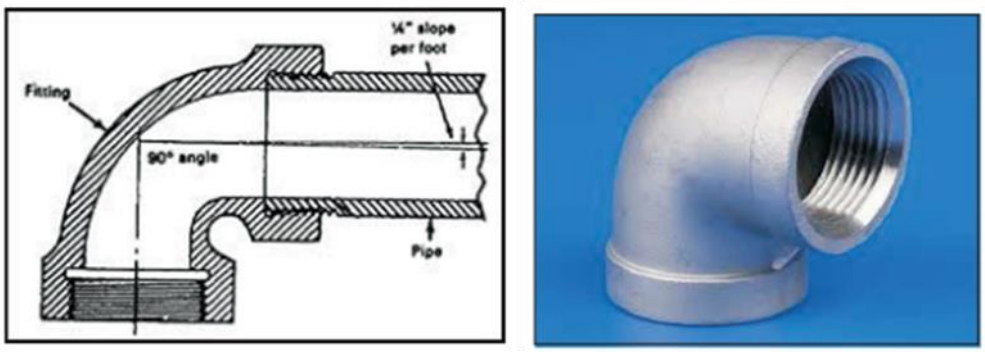


Fig 5.23 Threaded Joint

2. **Welded Joints (Butt-welded joints):** Butt-welding is the most common method of joining piping used in large commercial, institutional, and industrial piping systems. Material costs are low, but labour costs are moderate to high due to the need for specialized welders and fitters. The interior surface of a butt-welded piping system is smooth and continuous which results in low pressure drop. See in Fig 5.24.

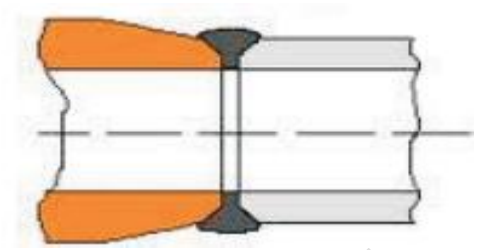


Fig 5.24 Welded Joints

3. **Socket-welded Joints**: Socket welded joints are used wherever there is a high chance of leakage in joints. Pipes are connected as putting one into other as shown here and welded around the joint. Pipes having different diameters are suitable for this type of joint. Socket welded joint give good results when compared with other mechanical joints. (Fig 5.25)

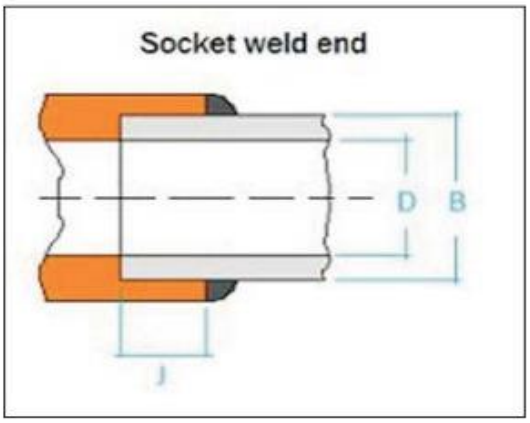


Fig 5.25 Socket-Welded Joints

4. **Brazed Joints:** Brazing is the process of jointing pipes using molten filler material at above 840^0 C. The filler material majorly consist tin which has great affinity towards copper. But because of its weak property tin is added to other materials like nickel, bismuth, silver and copper. The melting point of parent metal should be higher than filler metal. Mechanical strength of brazed joint is low compared to other joints. This type of joint is suitable in moderate range of temperature areas.

Fig 5.24 Brazed Joints

5. **Soldered Joint:** Soldering is also similar to brazing but the only difference is in case of soldering the filler metal melts at below 840°C. Soldering also used to joint copper and copper alloy pipes. Before proceeding to soldering flux called paste is applied to pipes and fittings to prevent them from oxidation from flame. Soldered joints are suitable for low temperature areas. These are having low mechanical strength as brazed joints.

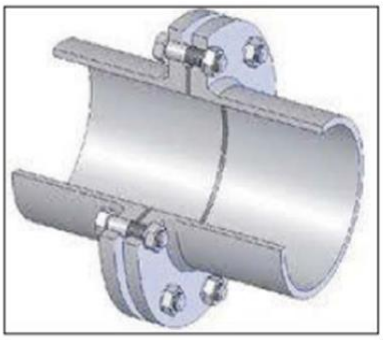
Fig 5.24 Soldered Joints

6. **Grooved Joints:** The main advantages of the grooved joints are their ease of assembly, which results in low labour cost and generally good leakage integrity. Grooved joints are used extensively for fire protection, ambient temperature service water, and low-pressure drainage applications such as floor and equipment drain systems and roof drainage conductors. Piping system can be easily disassembled and reassembled frequently for maintenance or process changes.

Fig 5.25 Grooved Joints

7. **Flanged Joints:** Flanged connections are used extensively in modern piping systems due to their ease of assembly and disassembly. These connections are costly. Flanges are normally attached to the pipe by threading or welding, although in some special cases a flange-type joint known as a lap joint may be made by forging and machining the pipe end. Flanged joints are prone to leakage in services that experience rapid temperature fluctuations.

8. **Compression Joints:** Compression sleeve-type joints are used to join plain end pipe without special end preparations. These joints require very little installation labour and as such result in an economical overall installation.



When the pipes have plain ended they are joined by installing some fittings at their ends then that type of joint is called compression joint. The pipe ends will be fitted with a threaded fittings or couplings hence they are connected.

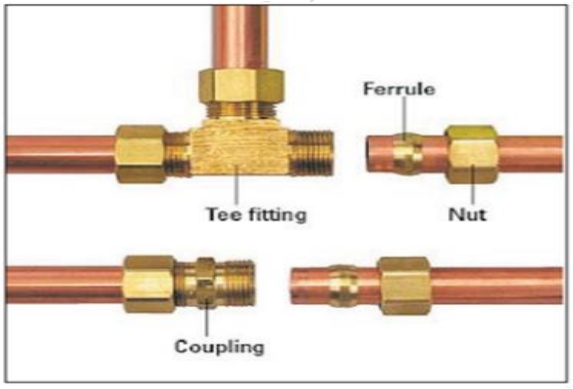


Fig 5.27 Compression Joints

5.4 PROCEDURE FOR FIXING DIFFERENT TYPES OF PLUMBING JOINTS

Below given step by step procedure for fixing the plumbing joints:

1. **Threaded Joint:**

Step 1: Ensure the male and female threads of the pipes or fittings are clean and free from debris.

Step 2: Apply plumber's tape or thread sealant to the male threads. Make sure the tape is wrapped in the direction of the thread.

Step 3: Screw the male threaded pipe or fitting into the female threaded counterpart.

Step 4: Use two pipe wrenches or adjustable wrenches, one to hold the fitting and the other to tighten the joint. Avoid over-tightening to prevent damage.

2. **Welded Joint:**

Butt Welded Joint:

Step 1: Prepare the pipe ends by cutting them square and ensuring they are clean and free from contaminants.

Step 2: Align the pipe ends to create a butt joint.
Step 3: Weld the joint using the appropriate welding method (such as TIG, MIG, or stick welding) and the recommended welding techniques.
Step 4: Follow proper welding procedures, including preheating, maintaining the correct welding temperature, and using the appropriate filler material.
Step 5: Allow the welded joint to cool and solidify according to the specific welding procedure before putting it into service.

3. **Socket Welded Joint:**
Step 1: Clean and deburr the pipe ends and the inside of the socket fitting.
Step 2: Apply flux to the pipe end and the inside of the socket fitting.
Step 3: Insert the pipe end into the socket fitting, ensuring proper alignment.
Step 4: Heat the joint using a suitable heat source, such as a welding torch, until the flux melts and the material reaches the proper temperature.
Step 5: Remove the heat source and allow the joint to cool and solidify, forming a strong bond.

4. **Brazed Joint:**
Step 1: Clean and flux the pipe and fitting surfaces that will be joined.
Step 2: Assemble the joint, ensuring a snug fit between the pipe and fitting.
Step 3: Heat the joint using a torch or brazing equipment, applying heat evenly to avoid overheating.
Step 4: Introduce the brazing filler material (such as brazing rod or wire) to the heated joint, allowing it to flow into the gap by capillary action.
Step 5: Allow the joint to cool gradually, ensuring the brazing material solidifies and forms a strong bond.

5. **Soldered Joint:**
Step 1: Clean and flux the pipe and fitting surfaces that will be joined.
Step 2: Assemble the joint, ensuring a snug fit between the pipe and fitting.
Step 3: Heat the joint using a soldering torch or soldering iron, applying heat evenly.
Step 4: Apply solder to the joint, allowing it to melt and flow into the gap between the pipe and fitting.
Step 5: Ensure proper solder penetration and a complete soldered joint.
Step 6: Allow the joint to cool and solidify before handling or putting it into service.

6. **Grooved Joint:**
Step 1: Prepare the grooved pipe ends by cleaning and ensuring they are free from debris.

Step 2: Install the grooved coupling or fitting onto one of the grooved pipe ends.
Step 3: Insert the other grooved pipe end into the coupling or fitting until it fully engages the grooves.
Step 4: Secure the joint by tightening the bolts or clamps on the coupling, following the manufacturer's instructions.

7. **Flanged Joint:**
Step 1: Ensure the flange faces of the pipes and fittings are clean and free from debris.
Step 2: Align the flanges, ensuring the bolt holes are properly matched.
Step 3: Insert bolts through the bolt holes and secure them with nuts.
Step 4: Tighten the bolts in a crisscross pattern, gradually and evenly, to create a uniform and leak-free seal.
Step 5: Use a torque wrench to achieve the recommended tightening torque as specified by the flange manufacturer.

8. **Compression Joint:**
Step 1: Cut the pipe to the desired length and ensure the cut ends are clean and free from burrs.
Step 2: Slide a compression nut, followed by a compression ring (also known as a ferrule or olive), onto the pipe end.
Step 3: Insert the pipe into the compression fitting body until it reaches the stop.
Step 4: Slide the compression ring and nut toward the fitting body and hand-tighten the nut onto the fitting body.
Step 4: Use two wrenches, one to hold the fitting body and the other to tighten the compression nut. Avoid over-tightening to prevent damage.

ACTIVITIES

Activity: To understand joint Assembly and undergo leak testing
Objective: To understand the process of assembling different types of plumbing joints and performing leak testing.

Materials needed:
1. Various plumbing fittings (elbows, couplings, tees, etc.)
2. Pipes of appropriate sizes
3. Plumber's tape or thread sealant
4. Pipe wrenches or adjustable wrenches

5. Bucket or container for water

Procedure:

1. Divide the students into small groups and provide them with the necessary materials.
2. Instruct each group to select a specific type of joint and demonstrate the assembly process step by step.
3. Guide the students through the proper techniques for preparing the pipe ends, applying sealants or flux, and tightening the joint.
4. Once the joints are assembled, instruct the students to perform a leak test. Fill a bucket or container with water and submerge the joint in water.
5. Observe if any bubbles appear, indicating a leak. Encourage the students to troubleshoot and make necessary adjustments to achieve a leak-free joint.
6. Discuss the importance of proper joint assembly and leak testing in plumbing systems, emphasizing the need for secure connections to prevent water leaks and ensure efficient operation.
7. Valve Operation and Flow Control: To explore the function and operation of different types of valves used in plumbing systems.

CHECK YOUR PROGRESS

A. Answer the following

1. Explain the function and draw the diagram of the following fittings:
   (a) Ferrule (b) Cross
   (c) Union (d) Tee
2. What is the purpose of check valve?
3. Give steps of fixing an elbow.
4. Write the disadvantages of socket welded joint.
5. Where flanged joints are required? Write down its advantages.

B. Fill in the blanks

1. ……..welding is the most common method of joining piping used in large commercial, institutional, and industrial piping systems
2. …….. is used to joint copper and copper alloy pipes.
3. A combination of elbows, which bring the pipe out of line but parallel with it is called……
4. A foot valve works as a …….. Way valve, that allows water to be sucked through the valve with a pump and when the water flow stops the seal stops the backflow of the water.

5. Scour valve is provided at the …….. level in a pipeline.

ANSWER KEY

UNIT-01 – INTRODUCTION TO PLUMBING

B. Fill in the blanks

1. One
2. Indirect
3. Manholes
3. Plumbum

UNIT -02 TOOLS FOR PLUMBING

B. Fill in the blanks

1. Wrenches
2. Steel
3. 90 degree or Right
4. Power hacksaw
5. Adjustable

C. Match the following

1. D
2. A
3. B
4. E
5. C

UNIT-03 PLUMBING MATERIALS AND PIPES

B. Fill in the blanks

1. Anchor
2. Cast iron
3. Galvanized iron
4. Restraint
5. Stainless steel

Unit -04 MEASUREMENTS AND SYMBOL USED IN PLUMBING

B. Fill in the blanks

1. 12
2. 1.09361
3. 2.20462
4. 3.785
5. 0.000453
6. 1

C. Mark the correct option

1. (b) measure the diameter of pipe
2. (b) m
3. (d) All of the above

UNIT-05 – PLUMBING FITTING JOINTS AND VALVES

B. Fill in the blanks

1. Butt
2. Soldering
3. Offset
4. One
5. Lower

GLOSSARY

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

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

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

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

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

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

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

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

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

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

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