PLUMBING

DESIGN AND ESTIMATE

SECOND EDITION

MAX B. FAJARDO JR.

PLUMBING DESIGN AND ESTIMATE

by

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PREFACE

What we are today is the result of continuous modifications and alterations this world have gone through numerous inventions and fresh discoveries in various fields. These new inventions and fresh discoveries that have constantly changed the world will always make tomorrow a little different from today.

Consequently, the introduction of new materials in the market and the acceptance of innovative ideas and concept in the field of Plumbing have necessitated the preparation of this edition. Likewise, numerous suggestions from friends, associates and readers have inspired the author to upgrade the book.

A new product and innovative concept in Plumbing called Sovent System was presented in one chapter. The system is fast gaining wide acceptance in the western world because of its special feature in eliminating the use of the traditional ventilation system.

Likewise, fire protection that is partly plumbing was also incorporated in this edition. However, extensive discussions were limited only to where plumbing principles and usages are concerned. Furthermore, discussions and presentation of each topic was expanded to improve the text. Nevertheless, this edition is an improvement of the second edition of which no effort is spared to come out with a better one.

Moreover, as repeatedly reiterated, the author does not claim that this book is in itself perfect, thus, he welcome suggestions and criticism from those who are more knowledgeable to further enrich the contents of this book.

For this editions, the author wishes to express his grateful appreciation to the countless friends here unnamed whose suggestions have greatly improved the content this book.

MBF

PREFACE TO THE FIRST EDITION

Plumbing Design and Estimate is presented for the use of Architecture, Civil and Sanitary Engineering students as well as those students taking vocational course in Plumbing. Along with the Simplified Construction Estimate, the first volume of this series, it provide inter-related topics in the what, how and when of the plumbing system.

The book contains a sufficient range of materials carefully chosen to provide for varied interest and activities of young students. The topics and lessons follow the inductive process of discussion-relation-integration and application. The basic underlying principles governing Plumbing and Estimate are stressed. Generalized concepts and outlines and appropriates practice and formulated precautions as well as cautionary measures are included. Specified examples and local experiences of the terms and fellow practitioners have been integrated in the general concepts and illustrations.

Hopefully, the varied activities and illustrations this volume offers will enable the students to understand and apply from experience and become increasingly aware of the technical meaning of the terms and theories linked with plumbing installations, estimate and other related topics are exhaustibly discussed and simplified in this text.

Because the study calls for the memory of terminologies, most students are likely to regard the subject with the feeling of drudgery and frustrations. This book like the first volume, tries the obviate this feeling by working on three assumptions. First, that the student is well oriented with the principles required in plumbing installation. Second, that mere recognition of plumbing elements and components are not enough unless the student is given opportunities to concentrate on using these elements in actual activities of his own. And third, that the students could make the Bill of Materials required for the plumbing system.

The use numerous and varied samples experiences and figures to illustrate the technical aspects of every topic are all integrated with the end view off providing the students and adequate grasp of the four main areas of life: Economic efficiency; Civic responsibility; Human and professional relationship and Values or Self-realization.

The author, in this volume wishes to express his gratitude to Dr. Lylia Corporal-Sena, Ph..D on curriculum and Science Education for her very capable editing and searching reviews of the early draft to Pepin Fajardo for his valuable contribution and to countless others here unnamed who in one way or another assisted in the presentation of this book.

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TABLE OF CONTENTS

CHAPTER 1

PLUMBING

1-1 Introduction

Plumbing is defined as the art and science of installing pipes, fixtures and other apparatus to convey and supply water in buildings and to dispose and discharge waste water and other liquids, gases and other substances out of buildings in a safe, orderly, healthy and sanitary way to ensure the health and sanitation of life and property.

In prehistoric times of a thousand years ago, man left traces of plumbing works. These primitive water supply and waste disposal methods, offered proof that even early man realizes the importance of plumbing. Indeed, these crude devices were considered as the forerunners of modern day plumbing.

The concept and importance of plumbing however, became more defined and appreciated only during the Greco-Roman civilization. The Romans who considered daily bathing as a must, elevated bathing to the level of a daily ritual. Their almost fanatical demand for a constant supply of clean water, found its expression in the ingenuity of the now famous Roman Aqueduct, a water system that continuously challenge the skill of the present crops of Engineers.

The word **Plumber** is a title given to a person who is skilled in the field of sanitation. It was derived from the ancient Roman word **Plumbarius** which was taken from the Latin word **Plumbum**.

Plumbarius refers to an individual who worked in the sanitary field of ancient Rome. **Plumbum** on the other hand, meant **lead**. A metal used as plumbing material by the Romans, preferred for its twin properties of malleability and resistant to acid.

The famous Goth invasion that brought about the disintegration and eventual collapse of the Roman Empire, hindered European progress in the field of plumbing and sanitation. It was only during the Renaissance period when Europe was plagued with epidemics decimating almost a quarter of the population that interest in sanitation, i.e. plumbing was again revived.

In the 17^{th} century, the English parliament passed the first plumbing apprentice law. France followed suit in 18^{th} century when it embarked in the building of water service facilities. The United States however, was a little slow to adopt the plumbing movement that was then sweeping the European continent because the US government concentrated its efforts in agricultural pursuit.

1-2 Plumbing in the Philippines

Before the decades of the 40's, household plumbing installation was considered as a luxury item available only to the upper crust of the society. Majority of the population, aside from not being able to afford plumbing installation in their homes, where still unaware of the importance of sanitation facilities in the form of an efficient water supply and waste disposal system. Most of the households, particularly in the rural areas, were adopting the indigenous and ingenious methods of water supply and waste disposal, unmindful of the ill effects brought about by poor sanitation.

Water Supply

In the absence of an efficient water supply and distribution system, water was provided through abundant rainfall, springs, wells, rivers, or creeks, conveyed either through improvised bamboo pipes, or carried either by man himself, or through animal drawn carts, or sleds and were stored in an earthen jars, wooden or bamboo containers and the like.

In those times, water was considered fit for consumption as long as it was visibly clear. There was no available means to test the water for purity and free from disease causing organisms. As a result, not a few died or were afflicted with digestive disorders. And those ailing were brought to quack doctors who usually diagnose the disease to be caused by evil spirits.

Waste Disposal

Majority of the households who cannot afford plumbing installation in their homes, availed of any possible means of convenience for their waste disposal. Some excreted in the rivers, seashores, creeks or any waterways, behind trees, bushes or any secluded place as long as during the time they excreted, their private parts were not seen in public.

Early attempts of promoting plumbing and sanitary waste disposals were accepted by few who could afford. In the rural areas however, constructed toilets were merely excavated pits covered with coconut trunks, bamboos or any suitable material provided with a slot where the user shoot his excretion. And some others were constructed along riverside where one would see his excretion splashing on the water below.

Those early sewage disposal practices were not only harmful to human health, but also to the environment particularly to the more populated areas. Indeed, it did not take long for a burgeoning urban population, to realize the importance of sanitation facilities in the form of an efficient water supply, and sewage disposal system. In the rural areas however, it took another decade and more government prodding to encourage the population to adopt the sanitary water supply and waste disposal system.

Due to the eminent outbreak of epidemics brought about by the worsening unsanitary condition prevailing, certain sector of the society and the government, introduced programs to address the situation. Massive education on proper sanitation was initiated. Water supply systems were constructed in some urban areas. Model toilets were built. Low cost concrete water seal closet was introduced to the rural residents backed up by local ordinances, requiring every residence to have a sanitary comfort room with proper sewage disposal system known as, Septic Tank.

1-3 Objectives of Plumbing

Plumbing has Two Main Objectives

1. To supply water to different parts of the building.
2. To remove and discharge human wastes and other substances out of building into the public sewer or septic tank.

Conditions for an Effective Water Supply in Building

1. To provide sufficient amount of water to supply each fixture.
2. To prevent back flow of used water into the water supply system.

The Drainage System should Accomplished the Following:

1. Fast removal of the waste with a minimum probability of leakage and stoppage of drains.
2. To prevent the entry of house vermin and obnoxious gases into the house from the piping system.

Mandatory Requirements for a Drainage System

All plumbing design and installations are governed by a set of rules and limitations prescribed by the National Plumbing Code, which provides that:

"All drainage system must conform with a set of requirements enumerated as follows":

1. That, all pipe joints must be well fitted and tightly connected with each other to prevent leakage of gas and liquid.
2. That, the drainage pipe should be graded or inclined properly for a downward gravity flow of water towards the main sewer line or to the septic tank.
3. That, the drainage pipe should be provided with adequate cleanout, accessible for repair in case of stoppage.
4. The drainage system must be provided with ventilation pipe that will convey gases to the atmosphere where it can do no harm to human health.
5. That, except for water closet, each fixture shall be provided with suitable trap that will prevent back flow of gases.
6. That, the drainage system must be vented, to avoid siphonage or back flow of the water seal.

1-4 Plumbing Design Unlimited

The design and layout of a plumbing system is governed by set of rules promulgated by the National Plumbing Code. The Code however, does not impose a fixed standard design of the piping layout, more particularly, the placing and location of the various plumbing fixtures. And to think of the unlimited design of these fixtures, goes with it the different types of plumbing system design.

While we subscribed to the health and safety requirements prescribed by the National Plumbing Code, unlimited designs are to be expected from various designers. The routing of the entire plumbing, the location of the outlets and cleanouts plus other related installations are subject to considerable freedom of choice and design.

1-5 The Drainage System

To anyone, the word plumbing connotes fixtures and piping installations that will supply water and dispose waste in various forms. Waste is classified into two types:

1. ***Solid Waste*** that is being discharged by water closet and
2. ***Liquid Waste*** that are coming from various fixtures.

These types of wastes are also conveyed and disposed of by two types of drainage piping.

a. The **Soil Pipe** and
b. The **Waste Pipe**

Any pipe that conveys waste from various fixtures other than water closet is called ***Waste Pipe***, and those pipes that convey waste coming from water closet is called ***Soil Pipe***.

Unlike the waste pipe, that is exclusively to receive discharges coming from the fixtures only, the soil pipe can accept both wastes from the water closet and the fixtures.

The Drainage Installation is Sometimes Referred to as DWV which means:

D - For drainage of solid waste.
W - For waste coming from various fixtures other than water closet
V - Refers to the ventilation of the piping system.

The study of drainage system as a whole consisting of various forms of waste and vent correlations forming One Unit System, is somewhat difficult to comprehend, because of strange terminologies used, plus the many complex considerations brought about by the effect of nature.

Indeed, plumbing terminologies even if defined, would be difficult to understand unless visualized in actual pipeline installations. And to begin with the study of the drainage system, an isometric drawing of pipe installation was presented in Figure 1-1 and Figure 1-2 for familiarization of the various parts of the plumbing unit system.

1-6 Definition of Terms

Air Gap - An air gap in a water supply system, is the unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or faucet supplying water to a tank, plumbing fixture, or other device and the flood level rim of the receptacle.

Back flow - Is the flow of water, or other liquid mixture or substances into the distributing pipes of a potable supply of water from any source, other than its intended source.

Back Siphonage - refers to the back flow of used contaminated or polluted water from a plumbing fixture or vessel into a water supply pipe due to a negative pressure in such a pipe.

Battery of Fixture - Refers to any group of two or more similar adjacent fixtures which discharges into a common horizontal waste pipe or soil branch.

Bib – Is synonymous with faucet, cock, tap, plug, etc. the word faucet is preferred.

Blind Flange - A flange that closes the end of a pipe. There is no opening for the passage of water.

Blow off - A controlled outlet on a pipeline used to discharge water.

Branch - Is any part of piping system other than the main riser or stack.

Branch Interval – Is the length of a soil or waste stack corresponding in general to a storey height, but in no case less than 2.40 meters within which the horizontal branches from one floor or storey of a building are connected to the stack.

Branch vent – Is a vent connecting one or more individual vents with a vent stack or stack vent.

Calking – Is plugging an opening with oakum, lead or other materials, that are pounded into the place or opening.

Circuit vent - Is a branch vent that serves two or more traps, and extends from the front of the last fixture connection of a horizontal branch to the vent stack.

Continuous Vent – Is a vertical vent that is a continuation of the drain to which the vent connects.

Combination Fixtures – Is a fixture combining one sink and tray or a two or three compartment sink or tray in one vent.

Combination Waste and Vent System – Is a specially designed system of waste piping embodying the horizontal wet venting of one or more sinks or floor drains

by means of a common waste and vent pipe adequately sized to provide free movement of air above the flow line of the drain.

Common Vent – Is a drain from two or three fixture connected to a single trap. It is also called a dual vent.

Cross Connection – Is any physical connection between two otherwise separate piping system, one contains potable water, and the other from unknown or questionable safety, whereby, water may flow from one system to the other direction of flow depending on the pressure differential between the two systems.

Dead End – Is the extended portion of a pipe that is closed at one end permitting the stagnation of water or air therein.

Developed Length – The length along the center of the pipe and fitting.

Diameter – Diameter of a pipe or tube refers to the nominal internal diameter (ID) of such pipe, except brass and copper tube where the term refers to the outside diameter (OD) of the pipe.

Drainage System – Drainage system includes, all piping within the public or private premises that conveys sewage, rainwater, or other liquid waste, to a legal point of disposal. It does not include the mains of public sewer system private or public sewerage treatment or disposal plant.

Dry Vent - A vent that does not carry water or water borne wastes.

Effective Opening – Is the minimum cross sectional area at the point of water supply discharge, measured or expressed in terms of diameter of a circle. If the opening is not a circle, the diameter of a circle that is equivalent to the cross sectional area. (This is applicable to air gap)

Existing Work – Shall apply to that portion of a plumbing system that has been installed and approved prior to the contemplated addition, alteration or correction.

Fixture Branch- Is a pipe connecting several fixtures.

Fixture Drain – Is the drain from the trap of a fixture to the junction of that drain with any other drain -pipe.

Fixture Supply – Is a water supply pipe connecting the fixture with the fixture branch.

Fixture Units – Is a quantity in terms of which the load producing effects on the plumbing system of different kinds of plumbing fixtures are expressed on some arbitrarily chosen scale.

Fixture Unit Flow Rate - Is the total discharge flow in gallons per minute of a simple fixture divided by 7.5 gallons that provides the flow rate of that particular plumbing fixture as a unit of flow. Fixtures are rated as multiple of this unit of flow.

Flood Level - Is a device located inside the tank for the purpose of maintaining water level for effective flushing of the water closet.

Ferrule - A metallic sleeve called or otherwise joined to an opening in pipe into which a plug is screwed that can be removed for the purpose of cleaning or examining the interior of the pipe.

Flush Valve - Is a device located at the bottom of the tank for flushing water closets and similar fixtures.

Flushometer Valve – Is a device which discharges a predetermined quantity of water to the fixture for flushing purposes activated by direct water pressure.

Grade - is the slope or fall of pipe in reference to a fraction of an inch per foot length of pipe.

Group Vent - A branch vent that performs its function for two or more traps.

Horizontal Pipe – Means any pipe or fitting which makes an angle of more than 45° with the vertical.

Invert - Is the lowest portion of the inside of any pipe or conduit that is not vertical.

Liquid Waste – Is the discharge from any fixture, ap-

pliance or appurtenance in connection with a plumbing system which does not receive fecal matter.

Local Vent Pipe – Is a pipe on the fixture side of the trap through which vapor or foul air is removed from a room or fixture.

Looped Vent – Is the same as Circuit Vent except that it loops back and connects with a stack vent instead of a vent stack.

Lateral – In plumbing, it is a secondary pipe. In sewage, a common sewer to which no other common sewer is tributary. It receives sewage only from building sewer.

Main – The main of any system of continuous piping is the principal artery of the system to which branches may be connected.

Main Sewer – Is a sewer line or system directly controlled by public authority.

Main Vent – Is the principal artery of the venting system to which vent branches may be connected.

Plumbing Fixtures - Are installed receptacles, devices, or appliances which are supplied with water, or which receives or discharges liquid or liquid borne waste, with or without discharge into drainage system which maybe directly or indirectly connected.

Plumbing System – The plumbing system includes the water supply distribution pipes, plumbing fixtures and traps; soil, waste and vent pipes; house drain and house sewers including their respective connections, devices and appurtenances within the property lines of premises; and water treating or water using equipment.

Relief Vent – A relief vent's primary function is to provide circulation of air between drainage and vent systems.

Re-Vent Pipe – A re-vent pipe (sometimes called individual vent) is that part of the vent pipeline which connects directly with an individual waste or group of wastes, underneath or back of the fixture, and extend either to the main or branch vent pipe.

Riser - Is a water supply pipe which extend vertically one full storey or more to convey water to branches or fixtures.

Rough-In - Is the installation of all parts of the plumbing system which can be completed prior to the installation of fixtures. This include drainage, water supply, vent piping and the necessary fixture supports.

Return Bend – An open return bend usually with inside threads, but applied also to 180° bend in pipe.

Public Sewer – Is a common sewer directly controlled by public authorities where all abutters have equal rights of connection.

Sanitary Sewage – The sewage containing human excrement and liquid household waste. It is also called domestic sewage.

Sanitary Sewer – A sewer intended to receive sanitary sewage with or without industrial wastes and without the admixture of surface water, storm water or drainage.

Secondary Branch – Any branch in a building drain other than the primary branch.

Sewerage of Sewage work – Is a comprehensive term including all construction or collection, transportation, pumping, treatment and final disposition of sewage.

Siamese Connection – is a **Y** connection used on fire lines so that two lines of hose maybe connected to a hydrant or to the same nozzle.

Standpipe – A vertical pipe usually used for the storage of water, frequently under pressure.

Side Vent - is a vent connecting to the drain pipe through a fitting at an angle not greater that 45° or to the vertical.

Soil Pipe – Is any pipe that conveys the discharge of water closets or fixture having similar functions, with or

without the discharge from other fixtures, to the building drains (house drain) or building sewer (house sewer).

Stack - Is the vertical main of a system of soil, waste or vent pipe.

Stack Group - Is a term applied to the location of fixtures in relation to the stack so that by means of proper fittings, vents may be reduced to a minimum.

Stack Vent - A stack vent is the extension of a soil or waste stack above the highest horizontal drain connected to the stack. It is sometimes called waste vent or soil vent.

Stack Venting - Is a method of venting a fixture or fixtures through the soil or waste stack.

Subsoil Drain - Are underground drain pipes that receive sub-surface or seepage water only and convey it to a place of disposal.

Sump - A pit or receptacle at a low point to which the liquid waste are drained.

Trap - Is a fitting or device so designed as to provide when properly vented a liquid seal that will prevent the back passage of air without materially affecting the flow of sewage through it.

Trap Seal - Is the maximum vertical depth of liquid that trap will retain, measured between the crown weir and top of the dip of the trap.

Vent Stack - Is a vertical pipe installed primarily for the purpose of providing circulation of air to different parts of the drainage system.

Vent System - Is a pipe or pipes installed to provide a flow or circulation of air within the plumbing system to protect trap seals siphoning and back pressure.

Vertical Pipe - Is a pipe installed in a vertical position or at an angle of not more than 45° with the vertical.

Waste Pipe – Is a pipe that conveys liquid waste from fixture that is free of fecal matter.

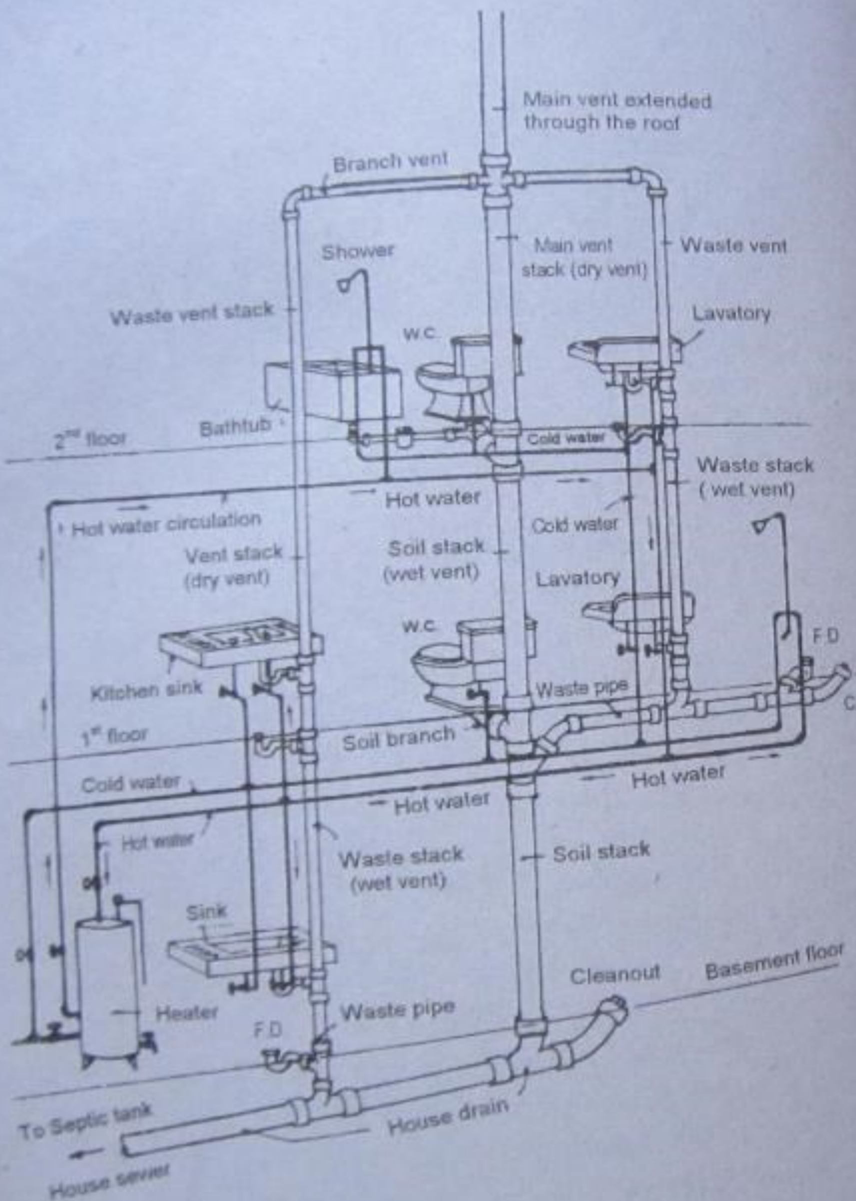


FIGURE 1-1
DWV WITH COLD AND HOT WATER SUPPLY

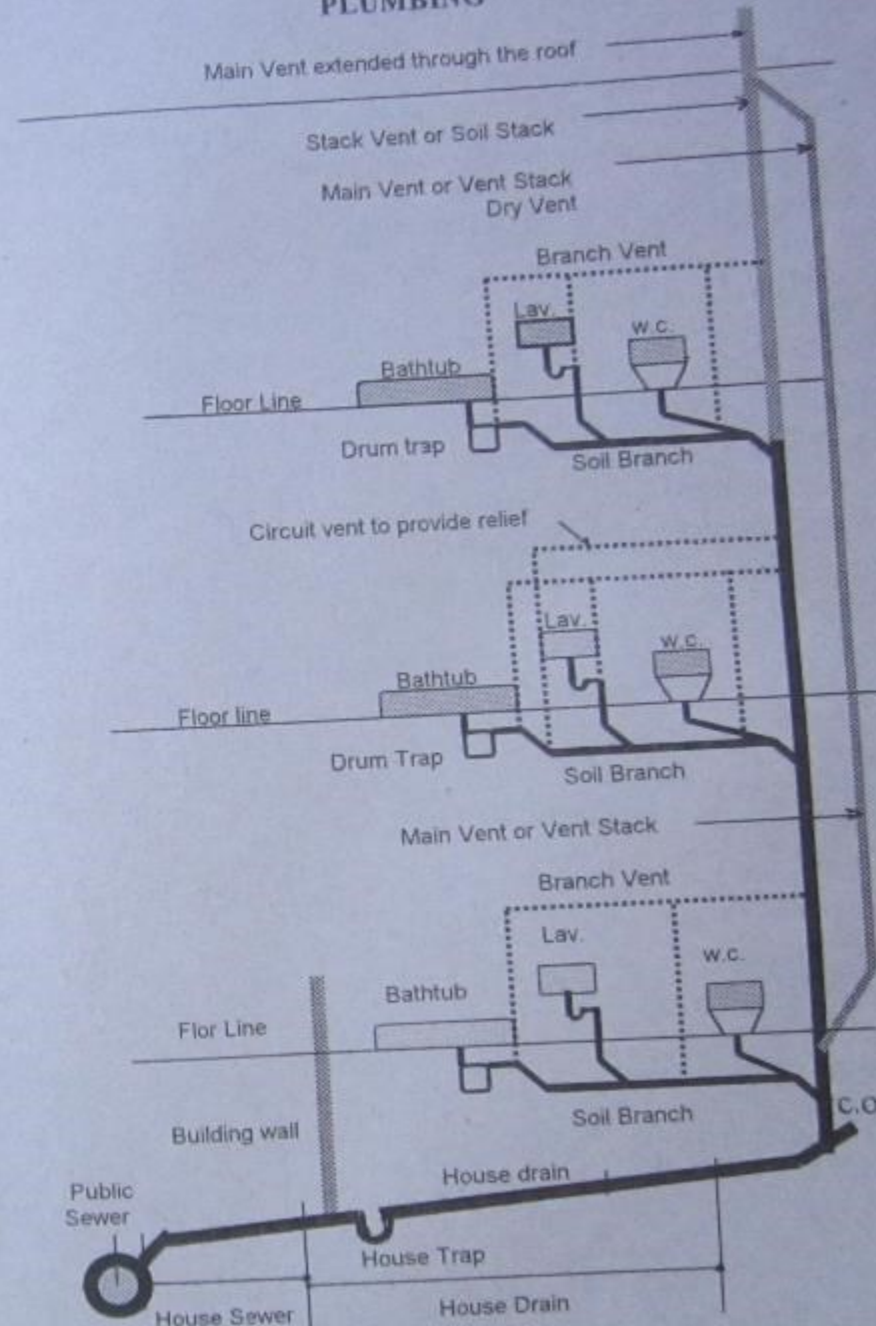


FIGURE 1-2
DWV CONNECTED TO THE MAIN SEWER LINE

Water Distributing Pipe – Water distributing pipe in a building or premises, is a pipe that conveys water from the water service pipe to the plumbing fixtures and other water outlets.

Water Service Pipe – Is the pipe from the water main or other source of water supply to the building served.

Water Supply System – The water supply of a building or premises consists of the water service pipe, the water distributing pipes, and the necessary connecting pipes, fitting, control valves, and all appurtenance in or adjacent to the building or premises.

Wet Vent – Is a vent that receives the discharge from wastes other than water closet.

CHAPTER 2

PLUMBING MATERIALS

2-1 Introduction

There are numerous kind of materials available for plumbing installation but so far, the most popular and commonly used are:

1. Cast iron soil pipe
2. Acid resistant cast iron pipe
3. Asbestos pipe
4. Bituminous fiber sewer pipe
5. Vitrified clay pipe
6. Lead pipe
7. Galvanized steel pipe
8. Galvanized wrought iron pipe
9. Brass pipe
10. Copper pipe
11. Plastic or synthetic pipe
12. Stainless steel pipe

Not all of these materials enumerated however, will be used in one plumbing system installation. The choice of the kind of pipe to be installed, depends upon the following considerations:

1. Quality and durability
2. Resistance to external and internal contact with foreign matters.
3. Resistance to acid waste and other chemical elements that will pass into it.
4. Cost of materials and labor.

Sometimes a combination of two or more types of plumbing materials, are used to suit the purpose intended for the installation, while availing of the advantages it offers to plumbing.

2-2 Cast Iron Pipe

For the past several decades, the most popular and generally specified material for drainage system in buildings is the cast iron pipe. It is durable, conveniently installed and answer to the most plumbing needs of all types of buildings less than 25 storey high. However, buildings taller than 25 storey do not specify the use of cast iron pipe because of constant vibrations which causes water leak of the pipe joints.

To a certain extent, cast iron pipe is also affected by corrosion caused by the action of carbon dioxide, sulfur oxide and methane gases forming solutions of carbonic acid and sulfuric acid. These acids attack the metallic material causing a slow chemical reaction or oxidation to take place forming ferrous oxide called rust.

Cast Iron Pipes are of Two Types

1. The **SV type** which is generally used for building installations and,
2. The **XV type** classified as extra duty pipe used for underground installations.

Cast Iron Pipes has Four Varieties

1. Standard pipe
2. Single Hub pipe
3. Double Hub pipe
4. Hubless pipe

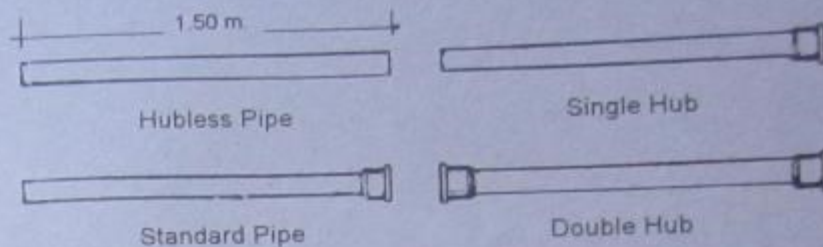


FIGURE 2-1 CAST IRON PIPE

TABLE 2-1 1/8 BEND (cm.)

	2"	2"x4"	2"x6"	2"x8"
A	6.9	6.9	6.9	6.9
B	24.4	29.5	34.4	39.4
C	5.0	10.0	15.0	20.0

	3"x2"	3"x4"	3"x6"	3"x8"
A	8.1	8.1	8.1	8.1
B	28.1	33.1	38.1	48.1
C	5.0	10.0	15.0	20.0

	4x2	4x4	4x5	4x8	5x2	5x4	5x6	5x8	6x2	6x4	6x6	6x8
A	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
B	30.0	35.0	40.0	45.0	31.3	36.3	41.3	46.3	31.3	37.5	42.5	47.5
C	5.0	10.0	15.0	20.0	5.0	10.0	15.0	20.0	5.0	10.0	15.0	20.0

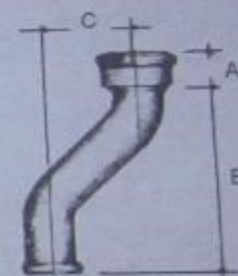


FIGURE 2-2 1/8 BEND OFFSET

TABLE 2-2 ¼ BEND SHORT SWEEP

	2"	3"	4"	5"	6"	8"
A	6.9	8.1	8.8	8.8	8.8	10.3
B	14.4	16.9	18.8	20.0	21.2	25.3
C	15.0	17.5	20.0	21.2	22.5	28.7

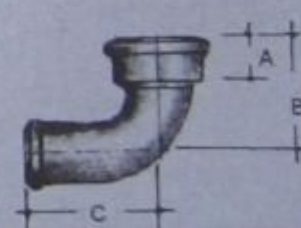


FIGURE 2-3 1/4 BEND

TABLE 2-3 SHORT SWEEP

	2"	3"	4"	5"	6"	8"
A	6.9	8.1	8.8	8.8	8.8	10.3
B	19.4	21.9	23.8	25.0	26.3	30.0
C	20.0	22.5	25.0	26.3	27.5	33.8

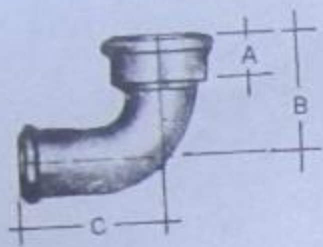


FIGURE 2-4 SHORT SWEEP

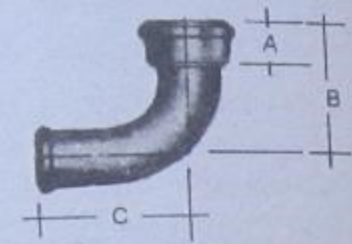


FIGURE 2-5 LONG SWEEP

TABLE 2-4 LONG SWEEP

	2"	3"	4"	5"	6"	8"
A	6.9	8.1	8.8	8.8	8.8	10.3
B	26.9	29.4	31.3	32.5	33.8	37.8
C	27.5	30.0	32.5	33.8	35.0	41.3

TABLE 2-5 SINGLE AND DOUBLE Y BRANCHES

	2"	3"	4"	5"	6"	8"	3x2	4x2	4x3	5x2	5x3
A	16.3	20.7	24.4	27.5	30.6	38.3	18.9	20.9	22.7	22.2	24.1
B	26.3	33.1	37.5	41.3	45.0	57.5	29.4	30.0	33.8	30.0	33.8
C	20.0	26.3	30.0	33.8	37.5	48.8	25.5	22.5	26.3	22.5	26.3
D	10.0	13.8	16.9	20.0	23.1	29.5	12.5	14.4	15.6	16.3	17.5

	5x4	6x2	6x3	4x4	6x5	8x2	8x3	8x4	8x5	8x6
A	25.8	23.6	25.3	27.0	28.9	27.2	28.9	30.6	32.5	34.2
B	37.5	30.0	33.8	37.5	41.3	35.0	38.8	42.5	46.3	50.0
C	30.0	22.5	26.3	30.0	33.8	26.3	30.0	33.8	37.5	41.3
D	18.8	18.1	19.4	20.6	21.9	31.3	22.5	23.8	25.0	26.3

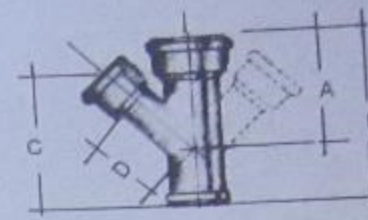


FIGURE 2-6 SINGLE AND DOUBLE Y BRANCHES

TABLE 2-6 SINGLE AND DOUBLE COMBINATION Y 1/8 BEND

	2"	3"	4"	5"	6"	3x2	4x2	4x3	5x2	5x3	5x4
A	18.4	24.4	30.0	35.0	39.7	20.6	21.9	25.6	23.1	26.9	31.3
B	26.3	33.1	37.5	41.3	45.0	29.4	30.0	33.8	30.0	33.8	37.5
C	20.0	26.3	30.0	33.8	37.5	22.5	22.5	26.3	22.5	26.3	30.0
D	12.2	17.5	22.5	27.5	32.2	14.4	15.6	18.8	16.9	20.0	23.8

	6x2	6x3	6x4	6x5
A	24.4	28.1	32.5	16.3
B	30.0	33.8	37.5	41.3
C	22.5	26.3	30.0	33.8
D	18.1	21.3	25.0	28.8

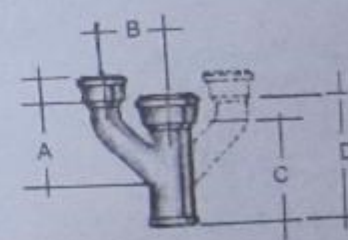


FIGURE 2-7 SINGLE AND DOUBLE UPRIGHT Y BRANCHES

TABLE 2-7 SINGLE AND DOUBLE UPRIGHT Y BRANCHES

	2"	3"	4"	5"	6"	3x2	4x2	4x3	5x2	5x3	5x4	6x2
A	26.3	33.1	37.5	41.3	45.0	29.4	30.0	33.8	30.0	33.8	37.5	30.0
B	11.3	13.8	16.3	18.8	21.3	12.5	13.8	15.0	15.0	16.3	17.5	16.3
C	20.0	26.3	30.0	33.8	37.5	22.5	22.5	26.3	22.5	26.3	30.0	22.5
D	15.0	18.6	21.7	24.7	27.7	16.9	18.1	19.9	19.4	21.1	23.0	20.6

	6x3	6x4	6x5
A	33.8	37.5	41.3
B	17.5	18.8	20.0
C	26.3	30.0	33.8
D	22.0	24.2	25.9

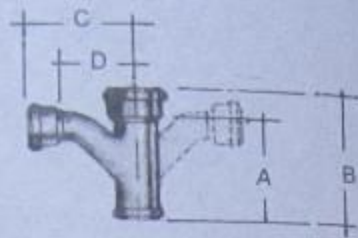
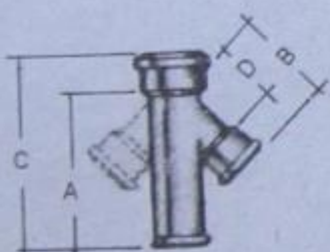


FIGURE 2-8 SINGLE AND DOUBLE COMBINATION Y 1/8 BEND

TABLE 2-8 SINGLE AND DOUBLE INVERTED Y BRANCHES

	2"	3"	4"	5"	6"	3x2	4x2	4x3	5x2	5x3	5x4
A	8.1	10.0	11.3	11.9	12.5	8.1	7.7	9.4	6.6	5.3	10.0
B	14.7	18.4	22.2	25.3	38.4	16.6	18.4	20.3	20.2	22.0	23.9
C	30.0	38.1	42.5	46.6	50.0	34.4	35.0	38.8	35.0	38.8	42.5
D	8.4	11.6	14.7	17.8	20.9	10.3	12.2	13.4	13.9	15.2	16.4



	6x2	6x3	6x4	6x5
A	5.5	7.2	8.9	10.6
B	21.9	23.8	25.6	26.9
C	35.0	38.8	42.5	46.3
D	29.5	16.9	18.1	19.4

FIGURE 2-9 SINGLE AND DOUBLE INVERTED Y BRANCHES

TABLE 2-9 DIMENSIONS OF SINGLE AND DOUBLE SANITARY BRANCHES

	2"	3"	4"	5"	6"	8'	3x2	4x2	4x3	5x2	5x3	5x4
A	10.6	13.1	15.0	16.3	17.5	21.9	11.9	12.5	13.8	12.5	13.8	15.0
B	13.1	16.9	18.0	20.0	21.3	25.3	16.3	17.5	18.1	18.8	19.4	20.0
C	26.3	31.9	35.0	37.5	40.0	51.3	29.4	30.0	32.5	30.0	32.5	35.0
D	20.0	25.0	27.5	30.0	32.5	42.5	22.5	22.5	25.0	22.5	25.0	27.5
E	6.0	10.0	11.3	12.5	13.8	16.6	10.0	11.3	11.3	12.5	12.5	12.5

	6x2	6x3	6x4	8x2	8x3	8x4	8x5	8x6
A	12.5	13.8	15.0	14.4	15.6	16.9	18.1	19.4
B	20.0	20.6	21.3	22.5	23.1	23.8	23.8	23.8
C	30.0	32.5	35.0	36.3	28.8	41.3	43.8	46.3
D	22.5	25.0	27.5	27.5	30.0	32.5	35.0	37.5
E	13.8	13.8	13.8	16.3	16.3	16.3	16.3	16.3

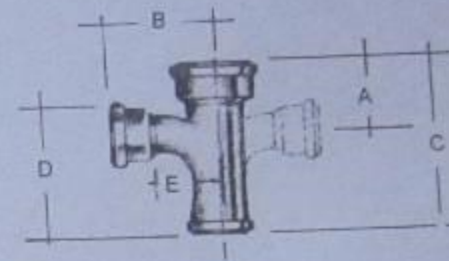


FIGURE 2-10 SINGLE AND DOUBLE SANITARY BRANCHES

TABLE 2-10 DOUBLE HUB

	2"	3"	4"	5"	6"	8"
A	2.5	2.5	2.5	2.5	2.5	3.1
B	15.0	16.2	17.5	17.5	17.5	20.6

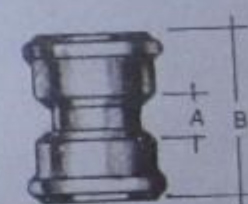


FIGURE 2-11 DOUBLE HUB

TABLE 2-11 REDUCER

	3x2	4x2	4x3	5x2	5x3	5x4	6x2	6x3	6x4	6x4	8x2
A	9.4	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	11.3
B	11.9	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	15.0
C	18.1	18.1	18.4	18.8	19.4	19.9	18.8	19.4	20.0	20.0	21.3

	8x3	8x4	8x5	8x6
A	11.3	11.3	11.3	11.3
B	15.0	15.0	15.0	15.0
C	21.9	22.5	22.5	22.5

FIGURE 2-12 REDUCER

TABLE 2-12 INCREASER

	2x3	2x4	2x5	2x6	3x4	3x5	3x6	4x5	4x6	4x8	5x6	5x8
A	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
B	29.4	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	38.8	30.0	38.8
C	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	30.0	22.5	30.0

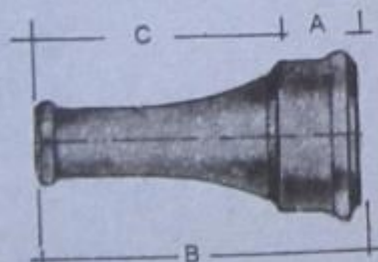


FIGURE 2-13 INCREASER

TABLE 2-13 ½ S-TRAP WITH OR WITHOUT VENT & CLEANOUT

	2X2	3X2	3X3	4X2	4X3	4X4	5X4	5X5	6X4	6X6	8X4	8X6
A	10.0	12.5	12.5	15.0	15.0	15.0	17.5	17.5	20.0	20.0	25.0	25.0
B	23.8	30.0	30.0	35.0	35.0	15.0	38.8	38.8	42.5	42.5	55.0	55.0
C	10.0	13.8	13.8	16.3	16.3	16.3	18.8	18.8	21.3	21.3	27.5	27.5

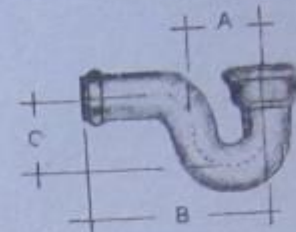


FIGURE 2-14 1/2 S STRAP WITH OR WITHOUT VENT AND CLEANOUT

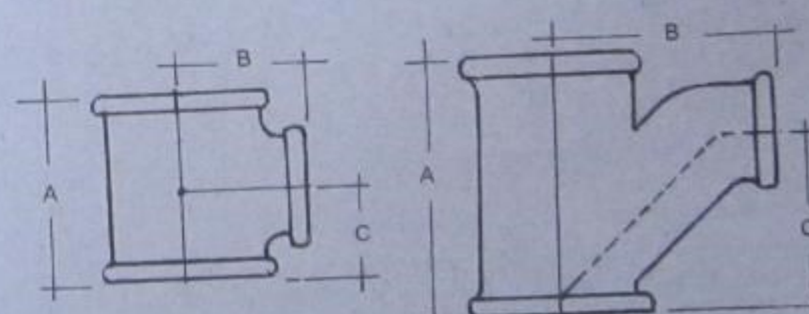
TABLE 2-14 REDUCING Y BRANCHES

A. Dimension of Reducing Short Tee Wye (mm)

	30x32	50x36	50x38	63x32	63x38	63x50	75x38	75x50	100x38	100x50
A	109	111	123	128	128	138	127	144	145	145
B	69	70	75	81	81	92	83	91	102	102
C	69	67	72	75	75	78	73	81	84	84

	100x63	100x75	125x38	125x50	125x75	125x100	150x50	150x75
A	184	184	139	153	194	231	158	231
B	119	119	109	113	130	145	130	148
C	108	108	80	92	113	131	92	136

	150x100	200x175	200x75	200x100	200x125	200x150
A	231	259	291	291	319	319
B	148	148	191	191	202	202
C	136	148	188	188	209	209



REDUCING SHORT T Y

REDUCING LONG T Y

FIGURE 2-15

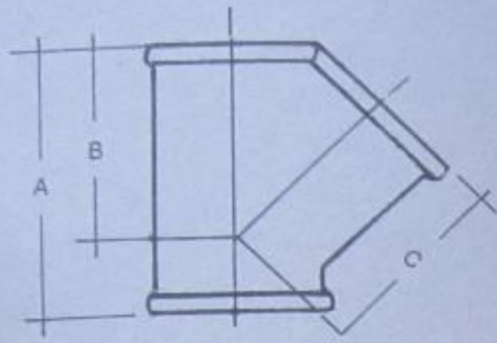


FIGURE 2-16 REDUCING 45° Y

B. Dimension of Reducing 45° Y

	38x32	50x32	50x38	63x38	63x50	75x38	75x50	100x38
A	136	145	145	145	206	147	166	175
B	105	113	113	113	155	131	138	159
C	97	113	113	113	152	114	113	128

	100x 50	100x75	125x38	125x50	125x75	125x100	150x50	150x75
A	175	231	184	184	238	278	169	222
B	159	194	167	167	211	236	169	181
C	128	163	141	141	175	198	111	156

	150x100	150x125	175x100	200x75	200x100	200x125	200x150
A	281	325	256	219	266	356	356
B	245	287	241	231	250	269	269
C	206	236	175	147	181	219	219

C. Reducing 45° Y

	38x32	50x32	50x38	63x38	63x50	75x38	75x50	75x63	100x38	100x50
A	131	148	148	159	159	166	169	209	191	166
B	86	106	106	119	119	127	231	150	141	147
C	86	106	106	119	119	127	131	150	141	147

	100x63	100x75	125x50	125x75	125x100	150x50	150x75	150x100
A	181	212	178	219	258	175	220	263
B	147	166	169	188	197	166	206	225
C	147	166	169	188	197	166	206	225

TABLE 2-15 WYE BRANCHES

A. Short T-Y (mm)

	32	38	50	63	75	100	125	150	175	200
A	95	108	144	166	181	219	156	200	244	381
B	55	63	80	97	105	130	155	178	216	228
C	55	63	80	97	105	130	155	178	216	228

B. Long T-Y (mm)

	32	38	50	63	75	100	125	150	175	200
A	119	136	163	206	225	269	325	256	400	436
B	91	105	128	155	175	209	255	269	303	331
C	86	97	116	152	163	191	233	256	281	291

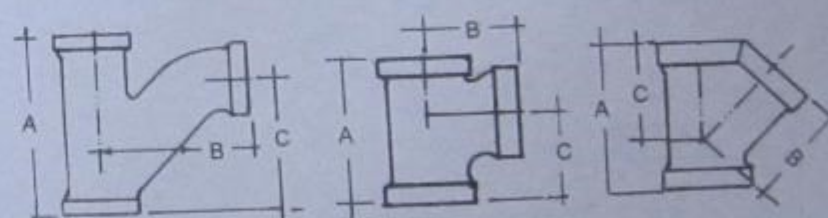


FIGURE 2-17 Y BRANCHES

C. 45° - Y

	25	32	38	50	63	75	100	125	150	175	200
A	100	130	130	156	200	200	272	284	331	381	413
B	67	86	86	103	131	150	192	209	250	281	309
C	67	86	86	103	131	150	192	209	250	281	309

Acid Resistant Cast Iron Pipe - is made from alloy of cast iron and silicon. It is widely used in chemical laboratories, industries and other installations where acid wastes are being discharge. Basically, this type of pipe is brittle in character and requires stronger support for each pipe installed horizontally to prevent sagging of joints.

2-3 Asbestos Pipe

Asbestos pipe is made of asbestos fibers and Portland cement. The thickness of the pipe is twice as that of the standard cast iron pipe. Asbestos pipe could be used as soil, waste, ventilation and downspout. This kind of pipe is remarkably superior for embedment in concrete structure for having the same material properties.

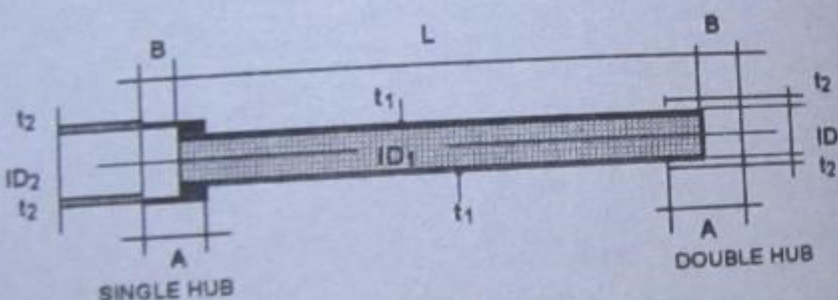


FIGURE 2-18 ASBESTOS SOIL PIPE

TABLE 2-16 ASBESTOS PIPE DIMENSIONS

Size	Dimensions in Millimeters					
	$1D_1$	$1D_2$	A	B	t_1	t_2
60	60	85	70	40	6	7
80	80	105	80	50	6	7
100	100	125	100	60	6	7
150	150	181	120	70	7	8
200	200	240	160	90	10	11
250	250	306	160	90	14	15
300	300	356	160	90	14	15

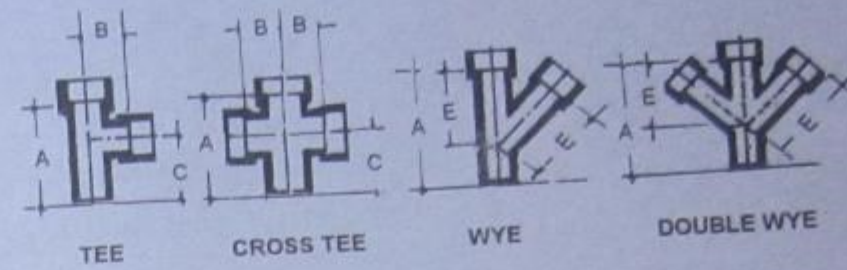
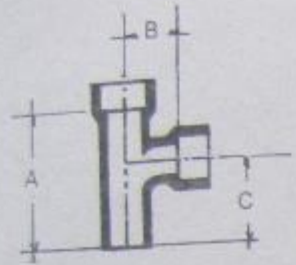


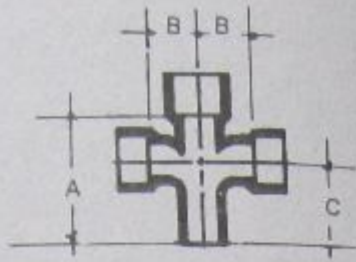
FIGURE 2-19 ASBESTOS SOIL PIPE

TABLE 2-17 TEE, CROSS TEE, WYE AND DOUBLE WYE

Size	Dimensions in Millimeters				
	A	B	C	D	E
60 x 60	222	111	111	260	180
80 x 60	232	121	116	300	210
80 x 60	252	126	126	300	215
100 x 60	262	131	131	300	210
100 x 80	282	136	141	329	255
100 x 100	302	151	151	357	250
150 x 60	292	156	146	334	258
150 x 80	302	162	151	353	265
150 x 100	332	177	166	381	390
150 x 150	374	187	187	455	325
200 x 60	380	191	190	396	305
200 x 80	400	197	200	432	325
200 x 100	420	215	210	472	382
200 x 150	474	225	237	536	380
200 x 200	524	262	262	614	425
250 x 60	390	221	195	438	325
250 x 80	410	226	205	478	378
250 x 100	430	242	215	510	396
250 x 150	484	252	242	580	428
250 x 200	534	283	267	665	475
250 x 250	600	300	300	738	522
300 x 60	410	251	205	473	392
300 x 80	430	267	215	498	405
300 x 100	450	283	225	535	424
300 x 150	520	293	250	602	460
300 x 200	570	320	285	693	516
300 x 250	632	329	316	770	556
300 x 300	682	341	341	843	596



SANITARY TEE



SANITARY CROS

FIGURE 2-20

TABLE 2-18 SANITARY TEE AND SANITARY CROSS TEE

Size	Dimensions (mm)			Approximate Weight per Piece in Kilogram	
	A	B	C	Tee	Cross Tee
60 x 60	215	82	132	1.38	1.89
80 x 60	232	121	116	1.71	2.22
80 x 80	252	126	142	1.98	1.89
100 x 60	215	102	132	1.22	2.73
100 x 80	282	136	141	2.50	3.20
100 x100	255	102	152	2.91	3.95

TABLE 2-19 DOUBLE HUB

Size	L	Approx. Wt. in Kg.
60	95	0.42
80	115	0.63
100	135	0.84
150	155	1.68
200	180	3.47
250	185	5.38
300	195	8.09

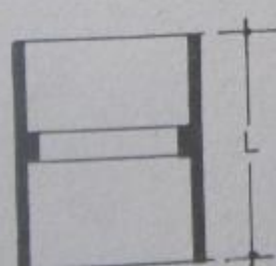


FIGURE 2-21 DOUBLE HUB

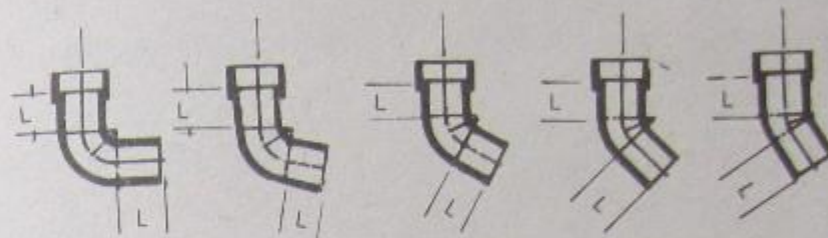


FIGURE 2-20 ELBOWS

TABLE 2-20 ASBESTOS ELBOWS DIMENSIONS

Dimensions			Approximate Weight per Piece in Kilograms				
Size	L	R	90° Bend	75° Bend	60° Bend	45° Bend	30° Bend
60	60	56	0.84	0.80	0.76	0.73	0.69
80	65	66	1.21	1.15	1.09	1.03	0.97
100	85	81	1.89	1.77	1.66	1.58	1.50
150	95	107	3.80	3.59	3.39	3.18	2.98
200	160	124	10.04	9.60	9.12	8.72	8.26
250	180	159	19.99	18.84	17.91	16.86	15.90
300	200	186	25.95	24.58	23.06	21.75	20.36

TABLE 2-21 TRAPS

	Dimensions			Approx. Weight / piece in Kilograms	
Size	L_1	L_2	L_3	P-Trap	Running Trap
60	86	177	78	1.59	2.07
80	102	211	98	2.73	3.55
100	124	211	121	3.57	4.57
150	160	257	171	8.14	9.84

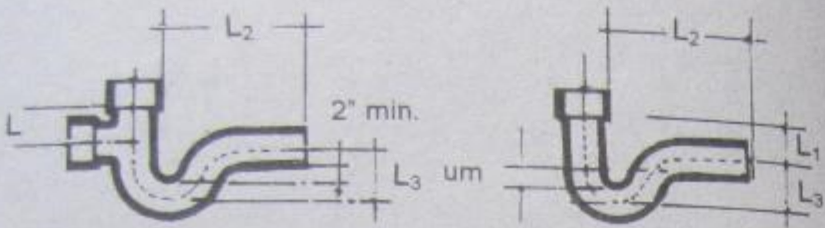


FIGURE 2-23 TRAPS

TABLE 2-22 INVERTED WYE

Dimension			Approx. Kg.
Size	H	E	per piece
60 x 60	260	180	1.63
80 x 60	300	210	2.12
80 x 80	300	215	2.38
100 x 60	300	210	2.55
100 x 80	329	255	3.03
100 x 100	357	250	3.48
150 x 60	334	258	4.30
150 x 80	353	265	4.71
150 x 100	381	290	5.35
150 x 150	455	325	7.28
200 x 60	396	305	9.10
200 x 80	432	325	9.95
200 x 100	472	352	11.00
200 x 150	536	380	13.30
200 x 200	614	425	18.20
250 x 60	438	350	16.54
250 x 80	478	378	17.84
250 x 100	510	396	18.96
250 x 150	580	428	22.16
250 x 200	665	475	28.33
250 x 250	738	522	36.62
300 x 60	473	392	20.41
300 x 80	496	405	21.44
300 x 100	535	424	22.91
300 x 150	602	460	26.29
300 x 200	693	516	33.09
300 x 250	770	558	41.58
300 x 300	843	596	47.22

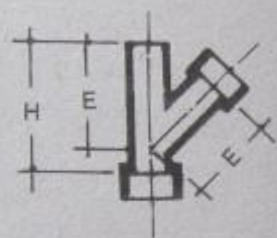


FIGURE 2-24 INVERTED Y

FIGURE 2-25 PLUG

TABLE 2-23 PLUG

Size	L	Approx. Wt. in Kilogram
60	55	0.40
80	65	0.60
100	75	1.10
150	85	2.40
200	132	4.00
250	132	5.10
300	132	6.20

TABLE 2-24 CLEANOUT PLUG

Size	L	Approx. Wt. in Kilogram
60	45	0.75
80	55	0.25
100	70	0.39
150	80	0.84
200	110	3.26
250	110	3.99
300	110	5.25

TABLE 2-25 REDUCER

Size	L	Approx. Wt. in Kilogram
80 x 60	128	0.87
100 x 60	160	1.24
100 x 80	142	1.31
150 x 60	253	2.72
150 x 80	239	2.81
150 x 100	221	2.83
200 x 80	354	6.54
200 x 100	342	6.59
200 x 150	303	6.64
250 x 100	395	11.32
250 x 150	362	11.53
250 x 200	328	16.28
300 x 150	435	14.92
300 x 200	392	15.91
300 x 250	348	16.70

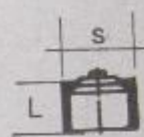


FIGURE 2-26 CLEANOUT PLUG

TABLE 2-26 ENLARGER

Size	L	Approx. Wt. in Kilogram
60 x 80	128	0.75
60 x 100	160	1.00
60 x 150	253	1.92
80 x 100	142	1.04
80 x 150	239	2.02
80 x 200	354	4.08
100 x 150	221	2.14
100 x 200	342	4.23
100 x 250	395	6.85
150 x 200	303	4.82
150 x 250	362	7.62
150 x 300	435	10.25
200 x 250	328	9.96
200 x 300	392	12.94
250 x 300	348	15.89

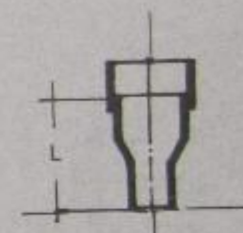


FIGURE 2-27 REDUCER

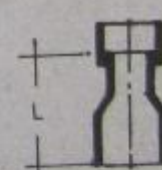


FIGURE 2-28 ENLARGER

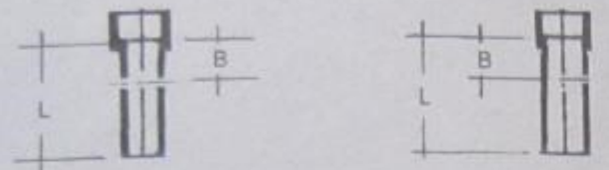


FIGURE 2-29 TEE AND TAP CROSS TEE

TABLE 2-27 TAP TEE AND TAP CROSS TEE

Size	Dimension		Approx. Wt. in Kilogram	
	L	B	Tap Tee	Tap Cross Tee
60	222	90	1.2	1.3
80	252	110	1.6	1.3
100	302	132	2.1	2.2

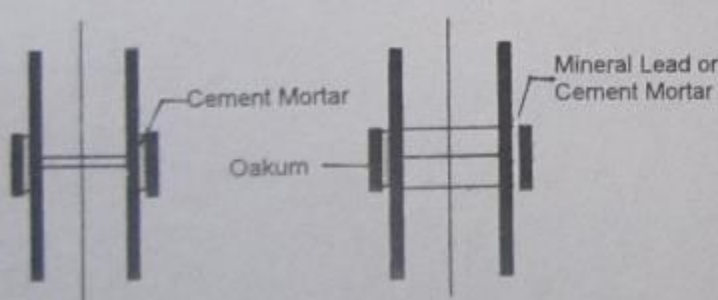


FIGURE 2-30 JOINING ASBESTOS PIPE

Joints

All joints are suitably grouted and firmly packed with oakum or old hemp rope. They are soaked in tar to be watertight and well secured with pure lead not less than 25 mm deep, well calked, or filled with cement mortar. For chimney joints, mineral lead is replaced with cement mortar.

TABLE 2-28 AMOUNT OF MINERAL LEAD AND OAKUM FOR ASBESTOS PIPE JOINTS

Size	Mineral Lead		Oakum	
	Grams per Joint	No. of Joint per kg.	Grams per Joint	No. of Joints per kg.
60	67	14.90	48.75	20.50
80	106	9.59	56.85	17.60
100	153	6.50	68.15	14.65
200	338	2.95	113.60	8.80
250	1210	0.83	170.20	5.88

2-4 Bituminous Fiber Sewer Pipe

Bituminous fiber sewer pipe is the cheapest among the sewer pipes. It is sometimes recommended for house sewer and for septic tank installation. This type of pipe is light in weight, slightly flexible which could take slight soil movement without danger of cracking or pulling out from its joint. However, excessive hot water or chemical flow may soften or damage the pipe.

2-5 Vitrified Clay Pipe

Vitrified clay pipe is one of the oldest materials used for sewer lines. It is made out from clay, cast into length of 75 centimeters treated with glazing compound. The pipe is heated in a large kiln under a temperature of 1370° C, making it impervious to moisture. Clay pipe is highly resistant to most acid wastes. It is a durable material for underground installations like public sewer, house sewer or storm drain. Being made of clay, its physical property is brittle. Hence, it should not be laid on unstable ground base.

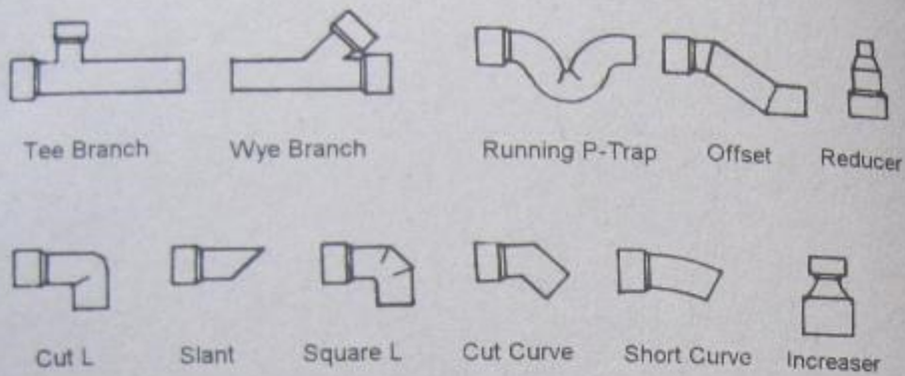


FIGURE 2-31 VITRIFIED CLAY PIPE

2-6 Lead Pipe

Lead Pipe is also one of the oldest plumbing materials used by the Egyptians, the Greeks and the Roman builders as soil and waste pipe. Lead is highly resistant to acid and is suitable for underground installation. But because lead is poisonous and injurious to human health, it is never used to convey water for human consumption.

TABLE 2-29 CLAY PIPE TECHNICAL DIMENSION (mm)

Inside Diameter	Laying Length	Depth of Socket	Thickness of Barrel
100	0.60	38	14
150	0.60	50	16
200	.60 – .90	56	20
250	.60 - .90	63	22
300	.60 - .90	63	25

2-7 Galvanized Steel Pipe

Galvanized steel pipe is made out from mild steel, drawn through a die and welded, cast into 6.00 meters long. This type of pipe is easily corroded by alkaline and acid water. The carbonic acid in water, attack the zinc coating and ultimately the steel itself. It is subject to deposits of salt and lime that gradually accumulate and finally choke the flow of water. Galvanized steel pipe deteriorate faster when used as hot water supply line.

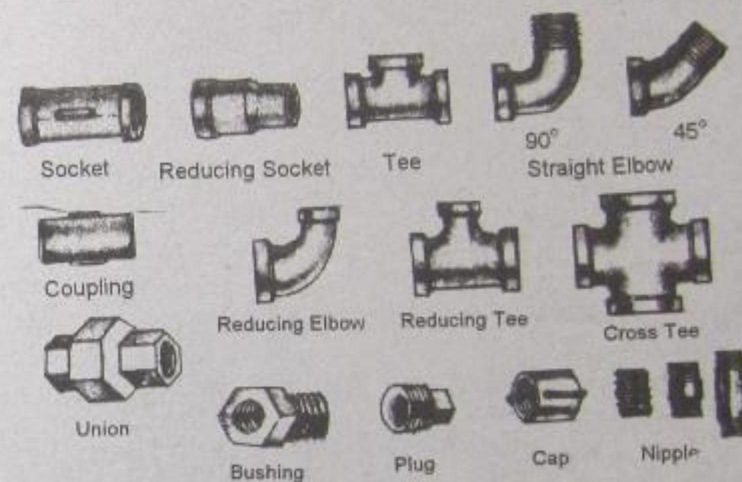


FIGURE 2-32 GALVANIZED STEEL PIPE FITTINGS

TABLE 2-30 GALVANIZED STEEL PIPE DATA in MM

Nominal Size Mm	In.	Outside Diameter	Inside Diameter	Thread per inch	Pipe Screwed into Fitting
10	3/8	16.87	12.20	18	12
12	½	21.00	15.55	14	12
20	¾	26.25	20.60	14	12
25	1	32.87	26.22	11.5	16
32	1 ¼	41.50	34.50	11.51	16
38	1 ½	47.50	40.25	11.5	16
50	2	59.30	59.61	11.5	20

2-8 Galvanized Wrought Iron Pipe

Galvanized wrought iron pipe is better in quality than the steel pipe for plumbing installation. Tests showed that wrought iron pipe is more resistant to acid waste than the steel pipe.

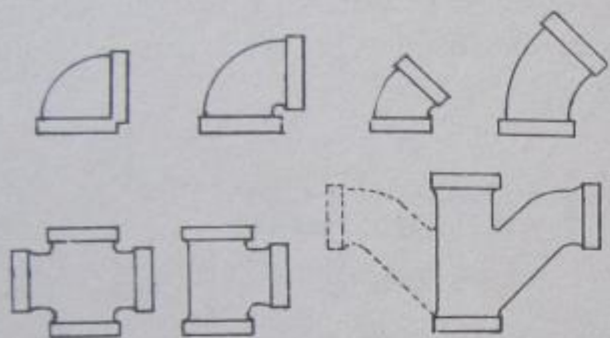


FIGURE 2-33 WELDED WROUGHT IRON PIPE

TABLE 2-31 WELDED WROUGHT IRON PIPE DIMENSIONS (mm)

Nominal Inside Diameter		Thickness mm	Standard Weight Pipe Number of Thread per Inch	Extra Strong Pipe Pipe Thickness mm
10	3/8	2.27	18.0	3.15
12	½	2.72	14.0	3.67
20	¾	2.82	14.0	3.85
25	1	3.32	11.5	4.47
32	1 ¼	3.50	11.5	4.77
38	1 ½	3.62	11.5	5.45

2-9 Brass Pipe

Brass pipe is one of the most expensive types of pipe. This pipe is made of an alloy or zinc and copper mixed at

15% and 85% proportion respectively. Because of its smooth interior surface and high resistance to acid, brass pipe become superior material for waste and water supply installations. Brass pipe fittings are of the recessed type similar in design with galvanized steel pipe.

2-10 Copper Pipe

Copper pipe is a durable and extremely corrosive resistant material. It is easy to install compared with other types of pipe. Copper pipe is classified into three types, depending upon its wall thickness.

1. The **K** type is the heaviest. It is suitable for underground installation.
2. The **L** type is lighter than the **K** type available in both the rigid and flexible form. It is commonly used in residential water supply line and for radiant heating installations.
3. The type **M** is the thinnest and available only in a rigid form. This type of copper pipe is specially designed for small water supply lines and for radiant heating installations.

Comparatively, copper pipe cost little more than the steel pipe, but its fittings cost lesser than that of the steel pipe. And because of its very smooth interior surface, one size smaller pipe could be used instead, without substantial reduction of liquid flow. For instance, where a 25 mm (1") diameter steel pipe is required, a 20 mm (3/4") diameter copper pipe is equally sufficient.

Special Features of Copper Pipe

There are some special features of copper pipe that are worthy to mention. They are:

1. Brass pipe could be used as drains and vent pipe.
2. It could be used as cold water supply line.
3. Copper pipe is remarkably excellent material for hot water lines.
4. It can replace rusted or choked-up sections of galvanized steel pipe.
5. No special tools required to install brass pipe nor threading is necessary.
6. It is bent easily. A flexible vertical line can offset existing structure. Underground lines can be re-routed around an obstruction.
7. Measuring is less critical.
8. It needs fewer joints and fittings.
9. It comes in longer length.
10. Copper pipe may be used one size smaller than a steel pipe.

In installing hot water line, the use of bigger pipe should be avoided because heat loss on larger pipe is higher than on a smaller one.

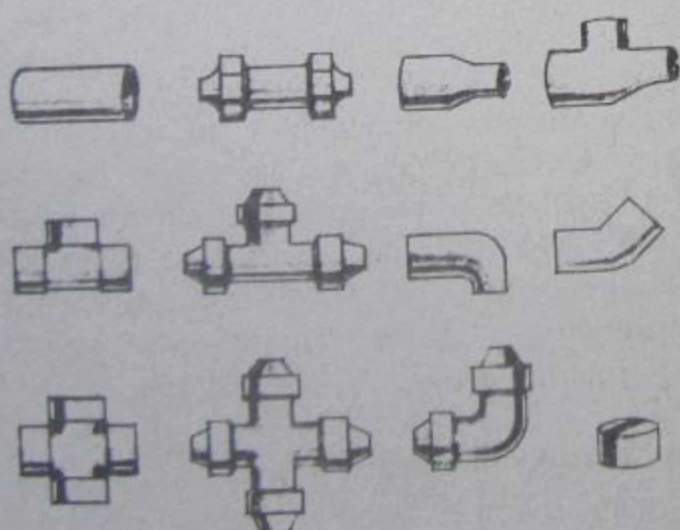
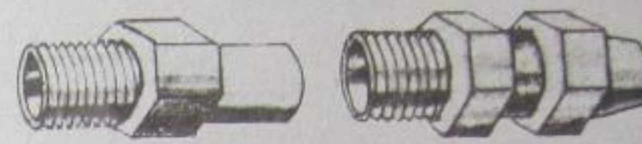
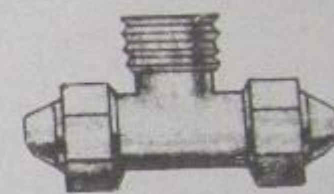


FIGURE 2-34 COPPER PIPE FITTING

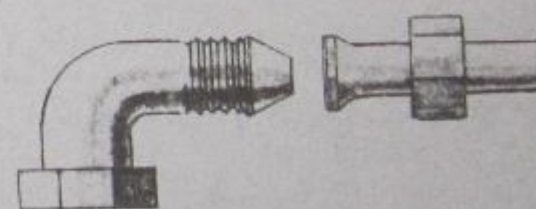
Copper Pipe Fittings



A. Spigot Joint Copper to Galvanized Steel
B. Flared or Compression Copper to Galvanized Steel



Flared or Compression Tee to Threaded Fitting



Flared Fitting

Slip Nut and Ferrule

FIGURE 2-35 COPPER PIPE FITTINGS

TABLE 2-32 COPPER PIPE TECHNICAL DIMENSIONS in MM

Nominal Size		Outside Diameter		Inside Diameter (mm)	
Mm	In	mm	Type K	Type L	Type M
10	3/8	12.0	10.00	10.75	11.25
12	½	12.2	12.62	12.62	14.23
20	¾	23.0	18.60	19.63	20.28
25	1	28.0	24.80	25.63	26.38
32	1 ¼	35.0	31.10	31.63	32.28
38	1 ½	41.0	37.10	37.63	38.18

2-11 Plastic or Synthetic Pipes

Plastic pipe is a new concept in the field of plumbing. It was introduced in the Philippines at the early part of 70's, although this type of materials was developed in Germany in the mid year of 1935.

Some Codes however, are still apprehensive in approving its use. According to Dick Demske:

"Many Codes have not been updated since the days when plastic was still in the test tube stage, and therefore do not make any mention of the type of plastic piping that are in widespread use today... Building authorities have a reputation for hard headedness and it is not unknown for them to require the tearing down of an installation that does not conform to their codes."

Plastic pipe has gained widespread acceptance after it has in many ways proven itself to be superior as sewer and cold water pipe line.

Types of Plastic Synthetic Pipes

a. The Rigid type
b. The Flexible type

The Rigid Type of Plastic Pipes are:

1. Polyvinyl Chloride (PVC)
2. Chlorinated Polyvinyl Chloride (CPVC)
3. Unplasticized Polyvinyl Chloride (uPVC)
4. Acrylonitrile Butadiene Styrene (ABS)
5. Polypropylene (PP)
6. Styrene Rubber Plastic (SR)

The Flexible Types are :

1. The Polyethylene (PE)
2. The Polybutylene (PB)

The PE and PB tubes are in coil form available at 30 meters long. The PB tube is manufactured with special length up to 150 meters long in coil form.

Recently, the plastic pipe being used for hot water lines are the Chlorinated Polyvinyl Chloride (CPVC), the Polyvinyl Dichloride (PVDC), and the Polypropylene (PP). It seems to be all right, but whether it could withstand hot water at 180° F or higher temperature, plus the pressure of hot water for years without any amount of substantial collapse or damage to itself, is still a matter of facts to be proven. Thus, extensive research is still going on to develop plastic pipes suitable for hot water.

Advantages of Plastic Pipe

1. Plastic pipe is more resistant to rust and corrosion.
2. Water conveyed by plastic pipe has no pipe tastes.
3. The extreme smooth interior surface prevents the buildup of scale, rust, and foreign material that often impedes flow through metallic pipes.
4. There is no turbulence of water and therefore, has a minimum resistance to flow.

5. PVC pipe and fittings weighs about 1/5 of the metal pipe. They are easily and quickly installed through solvent cementing.
6. Plastic pipes are cast in longer length and easy to cut as well as to install.
7. The Polyethylene (PE) pipe is flexible material that weights about 1/8 as much as the steel pipe. For instance, a 100 meters 25 mm diameter coil plastic pipe could be easily carried by one individual compared with metal pipes having the same length and diameter which could be hardly carried by 5 persons.
8. PVC pipe can be connected to existing metal pipe using a threaded adapter.
9. PVC is virtually acid proof to any chemical used in recommended strengths around the home.
10. No special tools are needed for installing PVC except a rule to measure and a saw to cut.
11. The best reason at all: - ***You can do it yourself.***

Certain chemicals such as methyl-ethyl-ketone (acetone), paint remover or paint brush cleaner should not be poured in PVC or any other drainage pipe.

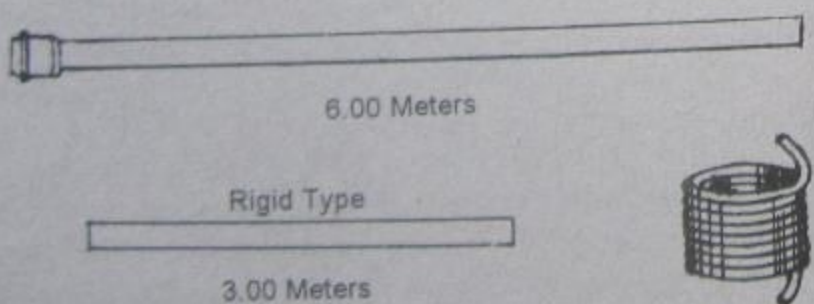


FIGURE 2-36 PLASTIC PIPES

TABLE 2-33 PLASTIC PIPE FITTINGS DIMENSION

90° THREADED TEES

a	b	A	B	C	D
20	13	30	27	11	14
25	20	35	33	14	17

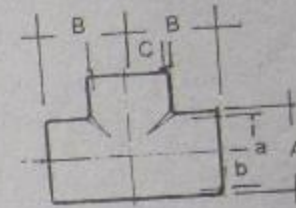


FIGURE 2-37 THREADED TEES

REDUCING TEES

a	b	c	A	B	C	D
40	25	50	50	49	42	23
50	32	50	62	59	50	28
63	40	63	77	72	60	34

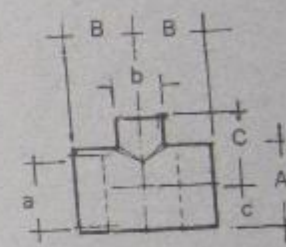


FIGURE 2-38 REDUCING TEES

90° TEES

a	A	C	D
20	27.5	27	11
25	33,4	33	14
32	42	39	17
40	50	49	23
50	62	59	28
63	77	72	34

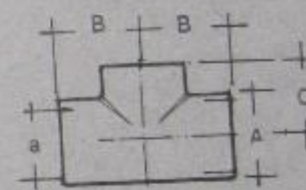


FIGURE 2-39 TEES

90° THREADED ELBOWS

a	b	A	B	C	D
20	13	30	27	11	14
25	20	35	33	14	17
32	25	45	39	17	22

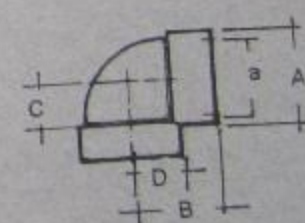


FIGURE 2-40 THREADED ELBOWS

90° ELBOW

a	A	B	C
20	26.5	27	11
25	32.5	33	14
32	40	39	17
40	49	49	23
50	60.5	59	28
63	75	72	34

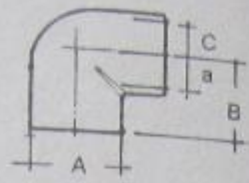


FIGURE 2-41 ELBOW

MALE THREADED ADAPTORS

a	b	A	B	C
20	13	40	24	32
25	20	44	25	36

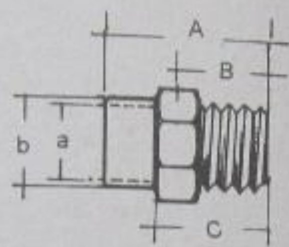


FIGURE 2-42 MALE THREADED ADOPTORS

FEMALE TREADED ADAPTORS

a	b	A	B	C
20	13	35	5	32
25	20	40	5	36
32	25	45	5	36
40	32	51	5	55
50	40	59	7	65
63	50	69	7	80

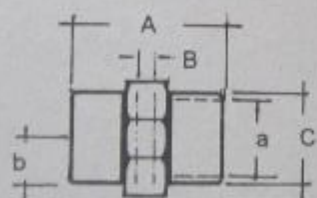


FIGURE 2-43 FEMALE THREADED ADOPTORS

UNIONS

a	b	A	B	C
20	25	30	27	14
25	32	35	33	17
32	38	45	39	22

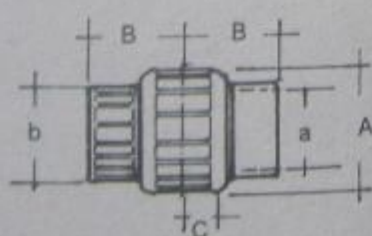


FIGURE 2-44 UNIONS

SOCKETS

a	A	B	C
20	27.5	35	3
25	33.5	41	3
32	40	47	3
40	51	55	3
50	59	65	3
63	75	79	3

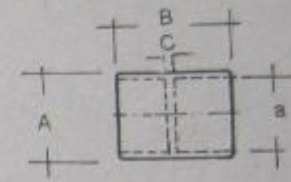


FIGURE 2-45 SOCKETS

REDUCING SOCKETS

a	b	A	B	C
40	32	49	51	3
50	40	60	60	3
63	50	75	72	3

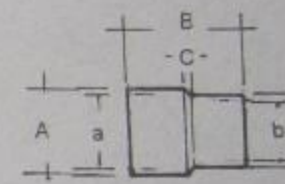


FIGURE 2-46 REDUCING SOCKETS

CAPS

a	A	B
20	29	34
25	35	28
32	44	32

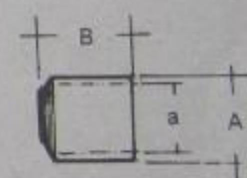


FIGURE 2-47 CAPS

REDUCER ADAPTORS

a	b	A	B	C
25	20	27	38.5	1.5
32	25	33	43.5	1.5

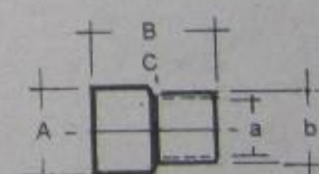


FIGURE 2-48 REDUCING ADAPTORS

PLASTIC PIPE FITTINGS

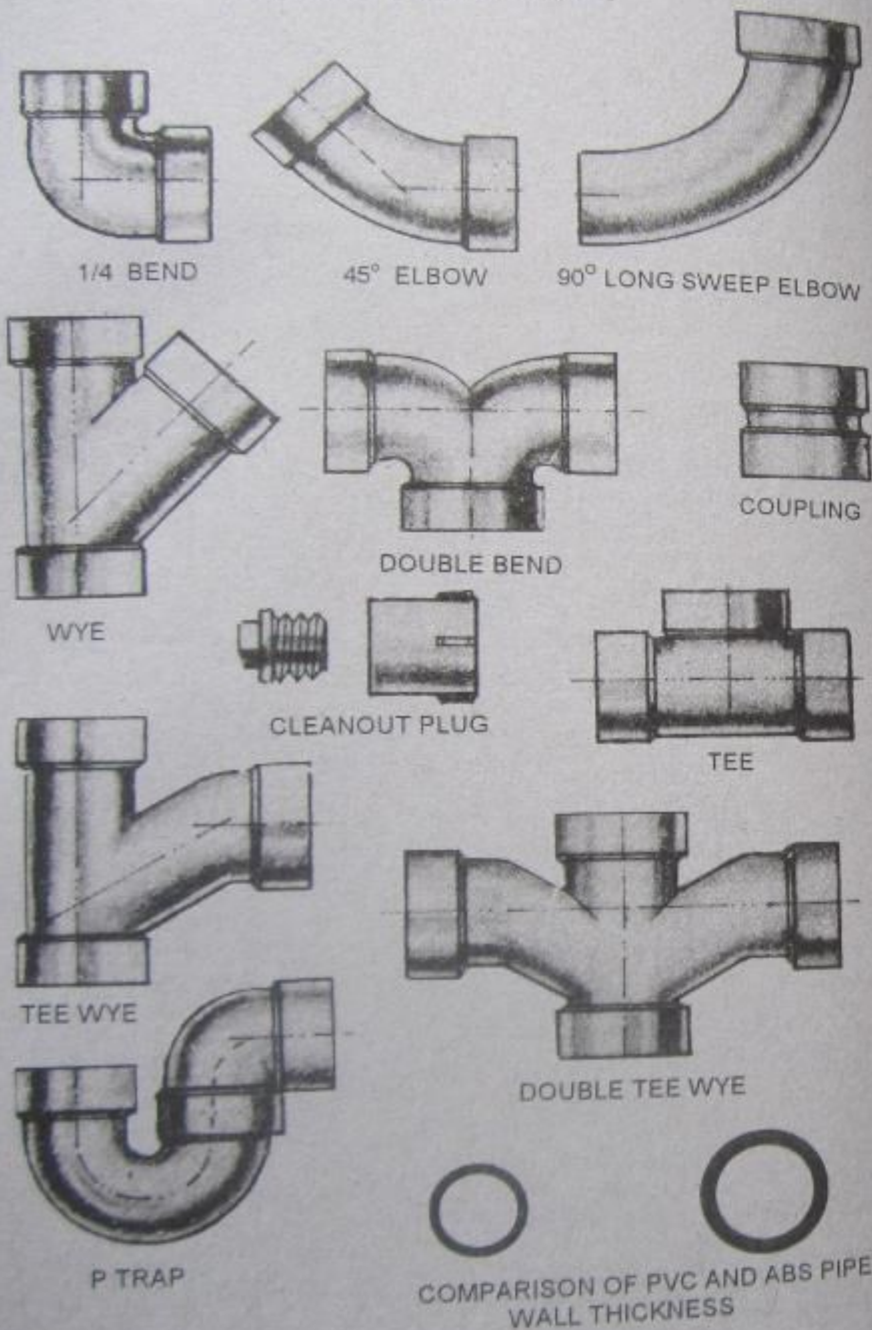


FIGURE 2-49 VRIOUS PLASTIC PIPE FITTINGS

Selecting Your Plastic Pipes

Although plastic pipe is considered superior material for drainage and water supply system, not all plastic pipes that are being sold in the market are suitable for plumbing installation. Reputable manufacturers of good quality plastic pipes are simply honest with their customers. The physical and mechanical properties of their manufactured pipes such as the specific gravity, hardness, impact strength, compression, shearing and tensile strength are published including the test results and the characteristic value of the materials. Not until such technical data is published for the users information, the use of said pipe is doubtful and risky for plumbing use.

Most of these plastic pipes and fittings are produced from synthetic resins. The chemistry of plastic is perplexing and the finished product could appear in a great variety of forms and colors. It is derived from coal and petroleum products.

The first plastic material introduced about 100 years ago was called Celluliod, followed by the Bakelite that was developed in 1905. And now, the polyethylene (PE) was remarkably successful in water piping services for more than 50 years. Extensive researches on plastic products towards standardization of quality have started in 1945 when various plastic materials were introduced for plumbing used.

In 1972, approximately 4,500 states, country, and city Codes permitted the use of plastic pipe for all or a portion of the plumbing system. The Plumbing Code that was promulgated by the ***Association of Plumbing Officials*** and the ***Plumbing Contractors*** was called **"Model Code."**

Support

PVC and CPVU installation must be supported when hanging from the ceiling, rafters or floor joists. The distances recommended between hangers are presented in the following table.

TABLE 2-24 RECOMMENDED DISTANCES OF HANGERS

Diameter of Pipe Inches	mm	Hanger Distance in Meter
½"	12	1.00
¾"	18	1.20
1"	25	1.50
1¼	31	1.80
1 ½	37	2.20
2"	50	2.50
3"	75	2.80
4"	100	3.00

The Model Codes that Approved the Use of Plastic Pipe for Plumbing Systems are:

1. The National Standard Plumbing Code
2. Building Officials and Code Administrations International
3. National Associations of Plumbing, Heating, Cooling, Contractors
4. Southern Standard Plumbing Code
5. Southern Building Code Congress
6. Uniform Standard Plumbing Code
7. International Association of Plumbing and Mechanical Officials

CHAPTER 3

MEASURING, CUTTING AND JOINING PIPES

3-1 Cast Iron Pipe

For so many years, cast iron pipes had been used for all types of plumbing installations. It was proven good and durable material for house sewer, house drain, soil, waste and vent pipe on various types of building.

The use of cast iron pipes however, was limited by the Code to less than 25-storey high building where constant vibration is present. Vibrations loosen the lead calk joint between the pipes causing unwanted sag and water leak. Cast iron pipe is affected to some extent by corrosion due to chemical action in the system that is impossible to control.

The commercial length of cast iron pipe is 150 centimeters long with various diameters ranging from 50 to 150 mm with the following types:

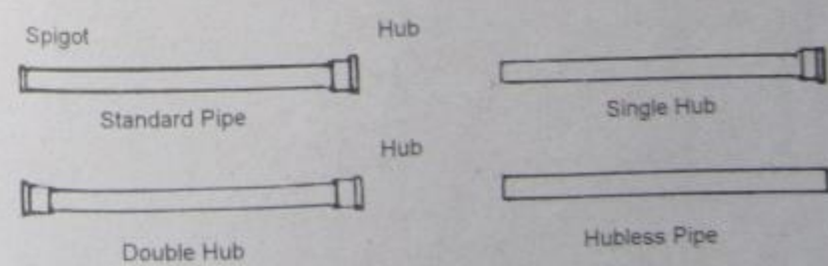
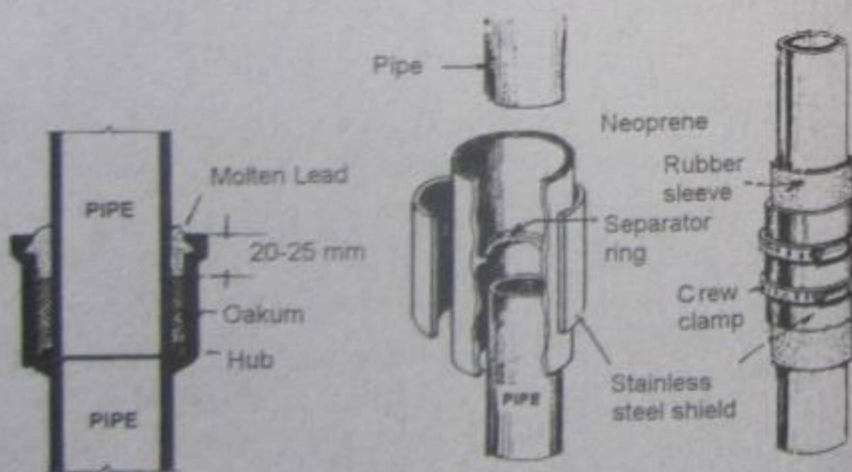


FIGURE 3-1 TYPES OF CAST IRON PIPE

Cost is always associated with the kind of pipe to be used. Thus, it is important to know the specific uses of each type.

Recommended Uses

1. The **Standard Pipe** is used for a well-fitted hub and spigot connections.
2. The **Single Hub** is recommended when the length of a pipe needed is more than 150 centimeters long wherein cutting is not necessary.
3. The **Double Hub** is preferred when a piece of pipe needed is shorter than 150 centimeters long. When the pipe is cut, both ends has hub to serve as joint connector.
4. The **Hubless pipe** is used in lieu of the single hub to do away with caulking of joints. It is cheaper and easily connected using a neoprene rubber sleeves.



JOINING HUBLESS CAST IRON PIPES

FIGURE 3-2

TABLE 3-1 WEIGHT OF SOIL PIPE 150 CM. LONG

Size mm	Size In.	Single Hub kg.	Double Hub Kg.
50	2	12.50	13.0
75	3	21.60	22.0
100	4	29.50	30.0
125	5	38.50	39.0
150	6	45.50	46.0

TABLE 3-2 EFFECTIVE LENGTH OF CAST IRON PIPE

Pipe Size		Laying Length in centimeter	
mm	In	Pipe with Hub	Hubless Pipe
50	2	143	150
75	3	143	150
100	4	142	150
125	5	142	150
150	6	142	150

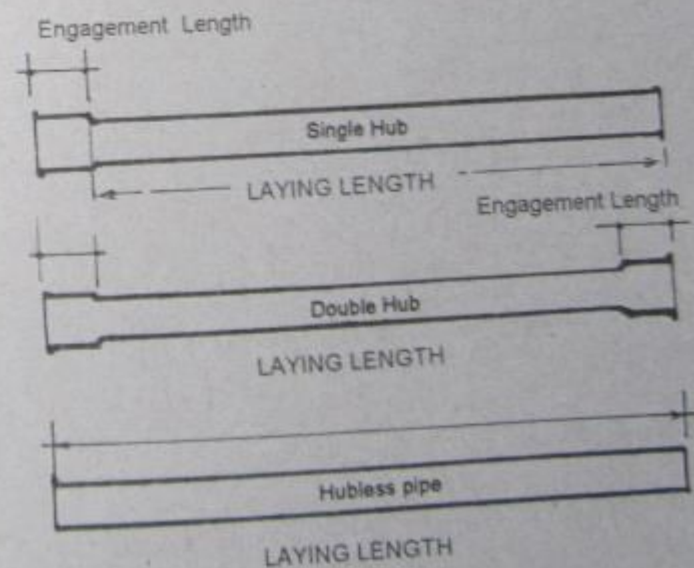


FIGURE 3-3 LAYING LENGTH OF CAST IRON PIPE

3-2 Measuring Length of Cast Iron Pipe

In measuring length of cast iron pipe, the end portion that will enter into the hub is added to the face length of the effective distance.

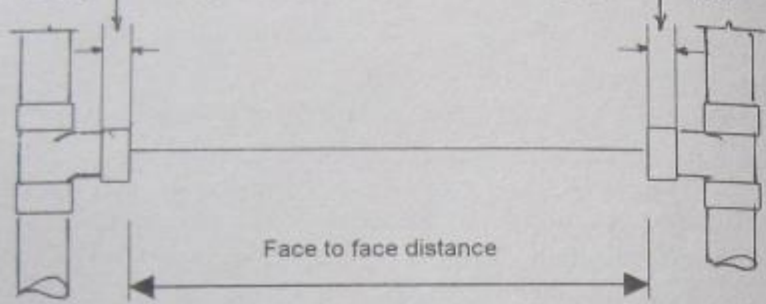


FIGURE 3-4 FACE TO FACE LENGTH

TABLE 3-3 ADDITIONAL LENGTH IN CUTTING CAST IRON PIPE

Pipe Diameter		Engagement Length	
mm	In	mm	cm
50	2	62	6.2
75	3	68	6.8
100	4	75	7.5
125	5	75	7.5
150	6	75	7.5

The additional length is for one end connection only. If both ends are inserted into the hub, the length should be doubled.

ILLUSTRATION 3-1

From Figure 3-5, find the length of the cast iron pipe required to connect the installation, and determine what type of pipe should be recommended and why?

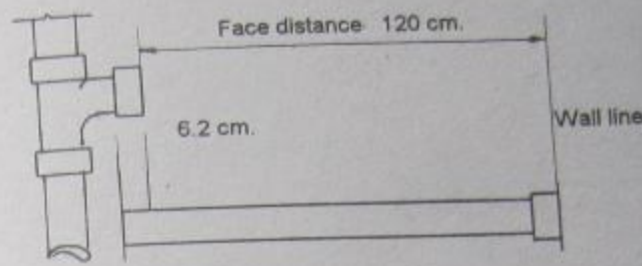


FIGURE 3-5

SOLUTION

1. The length of the face distance is 120 centimeters. Refer to Table 3-3, the additional length for a 50 mm (2") pipe is 6.2 centimeters.
   Add:

   $$120 + 6.2 = 126.2 \text{ centimeters}$$

2. This is the length of the pipe required to connect the installation. As to the type, double hub is appropriate because the length required is less than 150 centimeters. The excess pipe with hub after cutting could be used on other joint requiring hub.

ILLUSTRATION 3-2

From Figure 3-6, find the number and length of the cast iron pipe required using 100 mm (4") diameter.

SOLUTION

1. The face to face distance is 360 centimeters. From Table 3-3, the additional engagement length of a 100 mm (4") pipe is 7.5 cm., thus, the two end engagement length is:

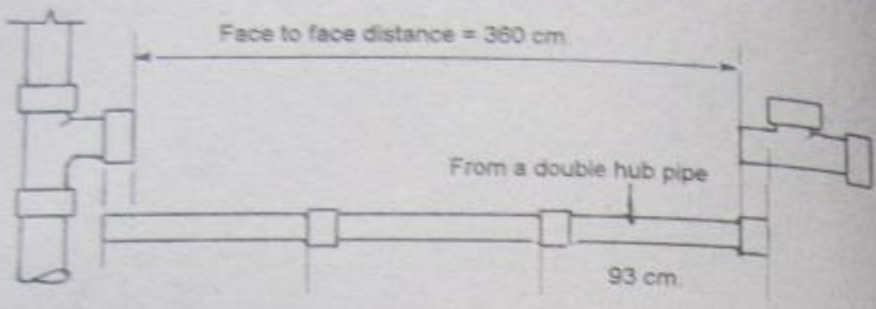


FIGURE 3-6

$$7.5 + 7.5 = 15 \text{ centimeters}$$

2. The total length required is:

$$360 + 15 = 375 \text{ centimeters}$$

3. Divide the total length by the **effective length** of one pipe.

$$\frac{375}{142} = 2.62 \text{ pipes}$$

4. The whole number 2 means two pipes at 150 cm. long. The amount of .62 means the fractional part to be cut or taken from one pipe. In short, this is less than one pipe length.

5. Therefore: the pipes required are :
   2 pieces 100 mm at 150 cm. = 3.00 meters
   1 piece 100 mm at .93 cm. = .93
   Total length............3.93 meters

ILLUSTRATION 3-3

The installation as shown on Figure 3-7 specify the use of 75 mm diameter **hubless pipe**. Find the number of pipes and the neoprene rubber sleeves including the accessories required.

SOLUTION

1. The installation distance is 6.50 meters. Refer to Table 3-2, the effective length of a 75 mm hubless pipe is 1.50 meters.

   Divide by the effective length

$$\frac{6.50 \text{ m.}}{1.50} = 4.33$$

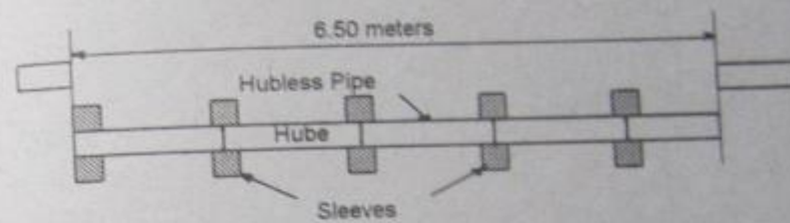


FIGURE 3-7 JOINING HUBLESS PIPES

2. The installation therefore requires 4 hubless pipes and (.33 x 150) length of one pipe is 49.5 cm long.

3. The total number of pipes required will be:

   4 pcs. 75 mm x 150 cm. hubless pipe and
   1 pcs. 75 mm x 49.5 cm. long

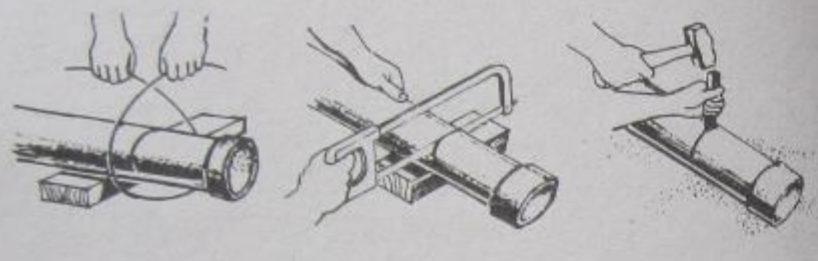
4. By direct counting, the neoprene rubber sleeves and other accessories are:

   5 pieces neoprene rubber sleeves
   5 pieces stainless steel shield
   10 pieces screw clamp

3-3 Cutting and Connecting Pipes

The procedures in cutting cast iron pipes are as follows:

1. A chalk mark is drawn around the pipe.
2. The pipe is laid on sand.
3. With the use of hammer and cold chisel, the scored line around the pipe is struck gently at first round, then continue striking harder and harder all around, until the pipe is cut or part off.



Mark Chalk Line Hacksaw Cut Cut with Chisel

FIGURE 3-8 CUTTING CAST IRON PIPE

TABLE 3-4 QUANTITY OF OAKUM IN PIPE JOINTS

Pipe Diameter cm.	In.	Weight of Oakum per joint in Kilograms
50	2	.05
75	3	.08
100	4	.15
125	5	.23
150	6	.35

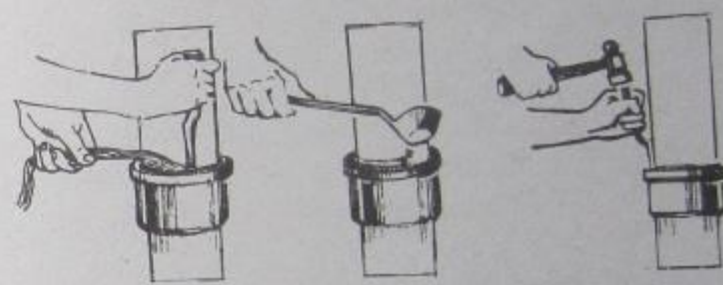
Calking Joints

Calking joints of cast iron pipe is done through the following steps.

1. Make sure that the pipes to be joined are perfectly aligned with the spigot centered inside the bell.

2. Wrap the oakum around the spigot neck filling the space around the inner hub. With the use of a yarning iron, drive the oakum into the bottom of the hub, then, compress firmly to make a solid bed providing 20 to 25 mm clearance from the top of the bell.

3. After packing, the joint is sealed with lead monolithically poured around the inner hub at about 3 mm above the bell. Then packed against the hub by the calking iron tamping it firmly to make a water-tight seal.



Packing Oakum Ladle Lead Packing with Caulking Iron

FIGURE 3-9 CALKING C.I. PIPE JOINTS

TABLE 3-5 QUANTITY OF LEAD PER PIPE JOINT

Pipe Diameter mm	Weight of Oakum in Kilograms
50	.50
75	.80
100	1.00
125	1.50
150	2.00

ILLUSTRATION 3-4

Determine the quantity of oakum and lead in kilograms required for a drainage installation with the following joints.

8 joints of 50 mm pipe
14 joints of 100 mm pipe having 20 mm lead packing.

SOLUTION

1. Refer to Table 3-4, and Table 3-5; multiply:

Oakum :	8 joints x .05 =	.40	kilograms
	14 joints x .15 =	2.10	kg.
Lead :	8 joints x .50 =	4.00	kg.
	14 joints x 1.0 =	14.00	kg.

2. Order : 2.50 kilogram oakum
   18 kilograms peg lead

3-4 Galvanized Steel Pipe

Working with galvanized steel pipe is somewhat difficult because of its rigidity and the threading processes involved, plus the joining operations. The face to face method is applied conveniently in measuring the length for a connection. However, allowance for the thread that will enter into the fitting should be provided. Working with galvanized steel pipe involve the following considerations:

1. Direct connection
2. Measuring and cutting
3. Threading operations
4. Sizing of the pipes.

Direct Connection refers to the manner of planning

the layout and re-routing of the pipes to reach the point of service. All pipelines should be installed as short and direct as possible. The number of fittings and pipe cutting plus the threading work can be reduced to the minimum required if the plumbing layout was planned carefully.

Measuring and Cutting. Errors committed in the measuring and cutting of pipes, may mean additional pipes and fittings, cost of labor, and the risk of water leakage. The face to face methods of measuring and cutting of pipe connection is considered the most reliable. The procedures were already explained in connecting cast iron pipes.

Cutting and Threading Operations. On cutting and threading operations, steel pipe should be held rigidly with a proper holding tools. Cutting is done by using a *14-teeth per inch hacksaw blade* applying forward strokes at the rate of about *one stroke per second*. Remember that fast cutting will overheat and break the blade.

After cutting, the burrs are removed from the inside edge of the pipe with files or reamers. Threading of steel pipe entail a very tedious process. Hence, it is important for one to know before hand the basic rules governing the threading operations enumerated as follows:

1. Never hold threaded parts with a wrench. It will surely damage the thread.
2. Put two nuts on them, lock tightly, and continue the threading operations.
3. During the process of threading, apply motor oil regularly to protect both the threader and the thread of the pipe.
4. To ensure tight and rigid connections, the threads should be slightly tapered so that the turning of the fitting will be harder the deeper you screwed.

5. Provide the threaded portion of the pipe with a Teflon tape in a *clockwise direction* before turning the fitting joint to obtain a water-sealed connection.
6. The use of ready made nipples ranging from 2 inches to 12 inches long was proven economical than fabricating them on site. The amount of cutting and treading as well as the time of installing is reduced substantially.

TABLE 3-6 LENGTH OF SCREWED PIPE INTO THE FITTING

Pipe Diameter mm	In.	Standard Fitting cm.	Drainage Fitting cm
12	½	1.2	-
20	¾	1.2	-
25	1	1.6	-
32	1 ¼	1.6	1.6
38	1 ½	1.6	1.6
50	2	2.0	1.6
75	3	-	2.2
100	4	-	2.5

Not all threads are screwed into the fitting, by forcing through may results in splitting of the pipe fitting.

ILLUSTRATION 3-5

From Figure 3-10 determine the length of galvanized steel pipe required to connect the installation using 12 mm or ½ inch pipe.

SOLUTION

1. The face to face distance is 4.30 meters. Refer to Table 3-6 the additional length of the screw inside the fitting for a 12 mm pipe is 1.2 centimeters.

1.2 cm. x 2 ends = 2.4 cm.

2. Add to the face to face clear distance

430 cm. + 2.4 = 432.4 centimeters.

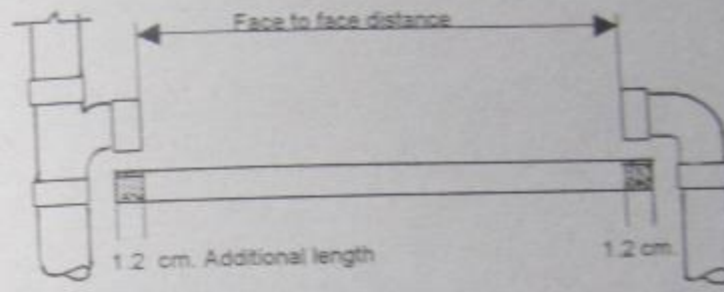


FIGURE 3-10

TABLE 3-7 PIPE DIAMETER EQUIVALENT IN MM

Circumference String Length	54	67	83	113	133	150
Pipe Size mm	10	13	20	25	32	38
Equivalent in Inches	3/8	½	¾	1	1 ¼	1 ½

Determining the G.I. Pipe Diameter

The size of galvanized iron pipe is the diameter of its hole not the outside diameter. In the absence of a measuring caliper, the *inside diameter* of a pipe can be known by measuring the *outside circumference* of the pipe with a string. With the aid Table 3-7, the inside diameter could be found easily.

TABLE 3-8 WALL CLEARANCE FOR PIPE INSTALLATION

Pipe Size	Pipe Alone	Pipe & Fitting	For Turning Fitting
38 1 ½	5.0 cm.	7.5 cm.	15.0 cm.
50 2"	6.3 cm.	8.8 cm.	17.5 cm.
75 3"	8.8 cm.	12.5 cm.	25.0 cm.
100 4"	113.0 cm.	15.0 cm.	30.0 cm.

TABLE 3-9 LENGTH OF TEFLON TAPE ON PIPE JOINT in METER

Number	Pipe Diameter in Millimeter						
of Turn	10	12	20	25	32	38	50
1	.054	.067	.083	.113	.123	.150	.200
2	.108	.134	.166	.226	.236	.300	.400
3	.162	.201	.249	.339	.350	.450	.600
4	.216	.268	.332	.452	.492	.600	.800
5	.270	.335	.415	.565	.615	.750	1.00
6	.324	.402	.498	.678	.738	.900	1.20
7	.378	.469	.581	.791	.861	1.05	1.40
8	.432	.536	.664	.904	.984	1.20	1.60

ILLUSTRATION 3-6

Determine the amount of Teflon Tape required for the following number of pipes and fitting connections specifying 5 rounds per joint.

12 mm. ------- 16 joints
20 mm . ------ 12 joints
25 mm. ------- 10 joints

SOLUTION

1. Summarize the joints according to the pipe size. Refer to Table 3-9. Multiply:

12 mm - 16 joints x .335 = 5.35 m.
20 mm - 12 joints x .415 = 4.98
25 mm - 10 joints x .565 = 5.65
Total length of Teflon tape = 15.98 meters

2. One roll of Teflon tape is 1 meter long, order 16 rolls

3-5 Copper Pipe

Copper Pipe is classified into two types:

1. The Rigid type and
2. The Flexible type

Copper Pipe Working Procedures

1. In measuring length of a rigid or flexible copper pipe, the face to face method is also applied. The depth of the soldering hub is added to the clear face to face length of the pipe.

2. Cutting of copper pipes with a suitable rotary tube cutter will give the best and satisfying result. In the absence of a rotary tube cutter, the hacksaw blade with 24 teeth per inch is used on heavy pipes and the 32 teeth per inch for the thinner one.

3. Cutting is done through a gentle light forward stroke. After cutting, the burrs are removed inside the pipe with a file or reamer.

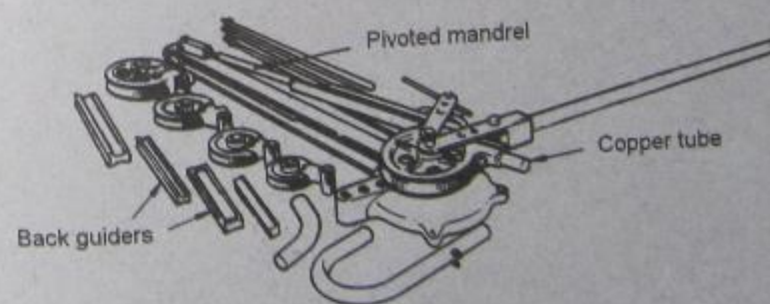


FIGURE 3-11 DRAW BAR BENDING MACHINE WITH PIVOTED MANDREL

4. Copper pipes are bent slowly on a wide radius to avoid kinking. Bending a pipe is easily done with pipe bending machine to produce a very satisfactory result. Another way of bending copper pipe is by using a steel spring inserted inside the pipe to produce a smooth clean curve.

Soldering Copper Pipe Joints

1. Clean thoroughly both ends of the pipe to a bright finish including the inside of the fittings with emery clothe or fine sand paper.
2. Apply a tin coat of non-corrosive flux or soldering paste to all cleaned surface of the pipe and fittings.
3. Place the fitting up to the hub and rotate for several times until the flux is evenly spread.
4. Wipe the excess flux around the fitting and solder in one operation only. With a propane torch, heat the fitting uniformly around the pipe.
5. Never allow the fluxed joint to stand for more than 3 hours before soldering.
6. During the process of cooling, avoid disturbing the pipe or the fitting for it might weaken or break the seal.

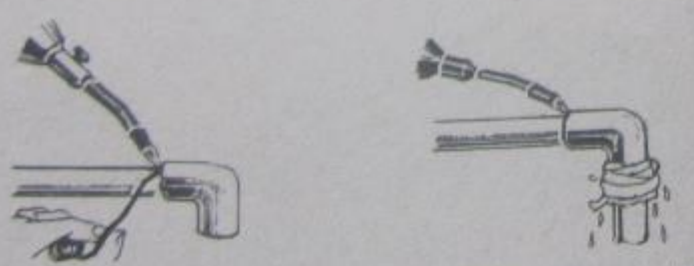


FIGURE 3-12 SOLDERING COPPER PIPES

7. Avoid soldering the pipe that contains water. Wrap other connections with wet rags in the same fitting before soldering to avoid melting of the finished joints.

TABLE 3-10 COPPER PIPES TECHNICAL DATA

Type	Diameter mm	Wall Thickness	Length in meter
Rigid K	12 to 300	Heavy duty	3 to 6
Rigid L	3.12 to 300	Medium duty	3 - 6
Rigid M	1.12 to 300	Light duty	3 - 6
Soft K	6.25 to 300	Heavy duty	9, 18, 30 m. coil
Soft L	6.25 to 300	Medium duty	9, 18, 30 m. coil
Rigid DWV	50 to 300	Light/Medium	6 meters

FIGURE 3-13 JOINING OF COPPER PIPES

3-6 Plastic Pipes

Plastic pipe is a new concept in plumbing for all types of building. Plastic pipe has been accepted worldwide after it has in many ways proven itself to be superior as sewer and cold water pipe line material.

The simplest way of joining plastic pipe is by cementing called *Solvent Welding*. Solvent welding takes only about ¼ the time it takes to assemble bell and spigot joints.

Working With Plastic Pipes

1. Measure the face to face distance of the fittings to be connected. Add the engagement length before cutting the pipe.

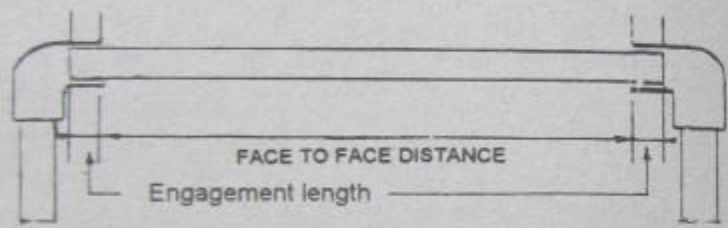


FIGURE 3-14

2. Some plastic pipes can be cut with a sharp knife, but all can be cut with hacksaw or handsaw. A rotary pipe cutter should not in any manner be used in cutting plastic pipes.

3. Be sure to cut pipe ends square or at right angle with the axis of the pipe. Work on one joint at a time. Solvent is very quick setting and unforgiving of mistakes. Once an error is committed, the only remedy is to cut the pipe and have it replaced.

4. After cutting, remove the burrs inside the pipe, ream and clean the end portion of the pipe until smooth to allow full contact with the fitting shoulder. Clean the pipe end with Methyl Ethyl Keton (MEK) or simply Acetone. However, depending upon the type

of plastic being used, there are solvent that needs no cleaning of the pipe before its application.

5. Apply solvent cement liberally using non-synthetic brush to the shoulder fitting and butt end of the pipe.

6. Insert the pipe into the fitting and give it a quarter turn or ¼ turn. The span of time from the cement application to the quarter turning should not be more than 30 seconds.

7. Do not disturb the pipe for several minutes after the quarter turn, Wait for about 2 hours before testing the line under pressure. Drying of the cement must be far enough advance from 15 to 20 hours to permit use of the line.

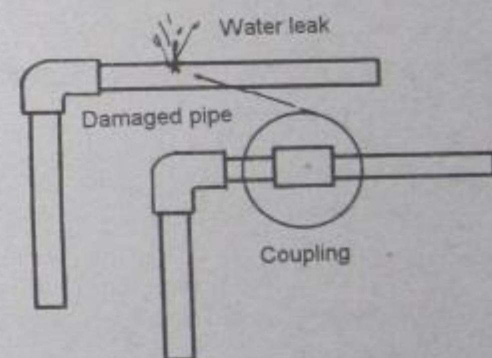


FIGURE 3-15 REPAIRING DAMAGED PLASTIC PIPE

8. In the process of bending, plastic pipe is packed with sand then heated using a flame torch or hot water. Apply pressure gently and gradually when the pipe is soft and ready for bending. Continue bending until the desired curvature of the pipe is arrived at. A metal spring for bending copper tube may be used to prevent flattering of the pipe.

9. Correction or repair of lines may be done by cutting the pipe at a reasonable distance away from the side of the fitting then connect with coupling or socket. (See figure 3-15).

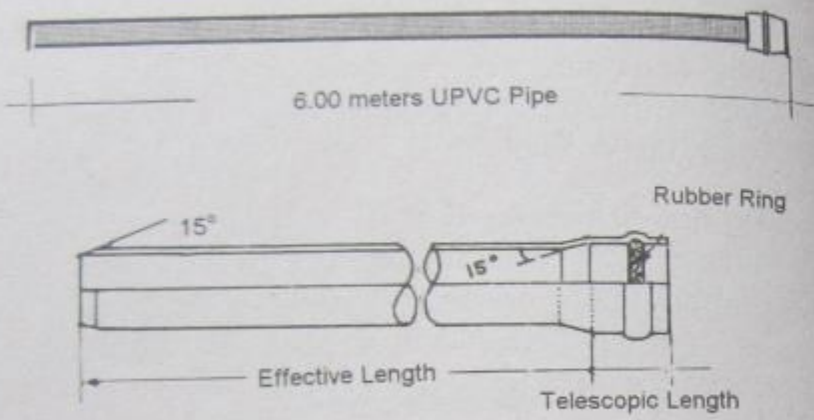


FIGURE 3-16

TABLE 3-11 ENGAGEMENT LENGTH OF A 3 METERS PIPE (mm)

Size of Fitting	20	25	32	40	50	63	90	115
Length mm	12	20	25	31	37	50	75	100

TABLE 3-12 ENGAGEMENT LENGTH OF A 6.00 METERS PIPE

Pipe Size mm	In.	Telescopic Length in Cm.	Effective Length In meter	Weight per Meter in kg.
63	2 ½	7.5	5.925	0.75
75	3	12.0	5.880	1.51
90	3 ½	13.0	5.880	1.90
100	4 ½	14.0	5.870	2.85
160	6 ½	16.0	5.840	6.03
225	9	18.0	5.820	11.87
280	11 ½	20.5	5.795	18.51

TABLE 3-13 QUANTITY OF SOLVEN CEMENT PER JOINT

Size of Pipe	20	25	32	40	50	63	90	115
Grams / Joint	1.0	1.5	2.0	2.5	3.5	5.0	10	16

ILLUSTRATION 3-7

List down the materials required to installed the drainage pipes using:
63 mm x 3.00 meters plastic pipes and
100 mm x 6.00 meters pipe as shown in Figure 3-17

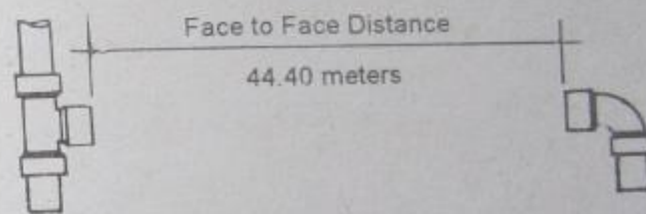


FIGURE 3-17

SOLUTION –1 (Using 3.00 meters plastic pipe)

1. The face to face distance is 44.40 meters. Divide by the length of one pipe 3.00 meters long.

$$\frac{44.40 \text{ m.}}{3.00} = 14.8 \text{ pcs.}$$

2. This simply mean we need 14 pipes at 3.00 meters long and .8 of one pipe. Multiply:

$$3.00 \times .8 = 2.40 \text{ meters}$$

3. From Table 3-12 the engagement length at 2 ends is:

$$2 \times 7.5 \text{ cm.} = 15 \text{ cm.}$$

4. Add the results of 2 and 3: 2.40 + .15 = 2.55 m.

5. Order: 14 pieces 63 mm x 3.00 meters
   1 cut at 2.55 meters
   13 pieces 63 mm coupling joints

6. Solve for the Solvent Cement. There are 28 joints. See Table 3-12, for 63 mm plastic pipe, multiply:

   28 joints x 5.0 = 140 grams

SOLUTION – 2 (Using a 100 mm x 6.00 meters pipe)

1. The face to face distance is 44.40 meters. Divide by the effective length of one pipe. Refer to Table 3-13

   $$\frac{44.40\text{ m.}}{5.870} = 7.56 \text{ pipes}$$

2. This simply mean we need 7 pipes at 6.00 meters long and .56 x 6.00 meters pipe. = 3.36 meters

3. Find the engagement length at the two ends. Refer to Table 3-12 along 100 mm pipe size, multiply:

   2 x 14.0 = 28 centimeters or .28 meters.

4. Add steps 2 and 3:

   3.36 + .28 = 3.64 meters.

5. Order : 7 pieces 100 mm x 6.00 meters pipe and
   1-cut at 3.64 meters long

ILLUSTRATION 3-8

As shown in Figure 3-18, a water supply line is to be installed using a 6.00 meters long plastic pipe with a diameter of 160 mm. List down the materials required.

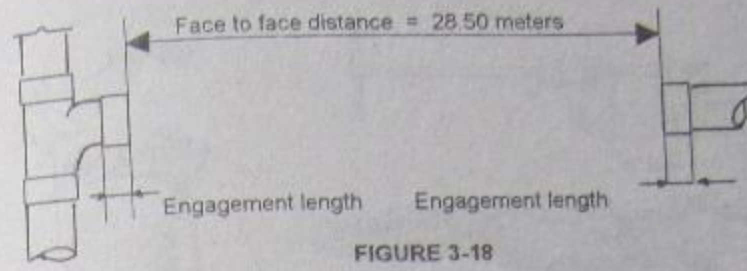


FIGURE 3-18

SOLUTION

1. The face to face distance is 28.50 meters.

2. The effective length of one 6.00 meters pipe is equal to the laying length minus the telescopic length. See Table 3-12.

   6.00 m. - .16 m. = 5.84 meters

3. Divide the face to face distance by the effective length of one pipe.

   $$\frac{28.50}{5.8} = 4.88 \text{ pipes}$$

4. This simply mean, we need 4 pipes at 6.00 meters long plus .88 of one 6.00 meters pipe.

   .88 x 6.00 m. = 5.28 meters.

5. Solve for the additional engagement length at the two ends. 16 x 2 = 32 centimeters or .32 meters

6. Add step 4 and 5: 5.28 + .32 = 5.60 meters

7. Therefore, the materials required are:

   4 pcs. 160 mm x 6.00 m. plastic pipe single hub and
   1 pc. 160 mm pipe cut to 5.60 meters hubless pipe.

FIGURE 3-19 VARIOUS PLUMBING TOOLS

Determining a Distance with Offset Angle

It is sometimes necessary to offset a run of pipe around a light fixture, a post or other obstruction. An offset can be made using 90° or 45° degrees elbows. The 45° is better because there is less friction and therefore less pressure drop when 45° fittings are used. Likewise, it is very easy to calculate the length of pipe needed for a 45° offset.

TABLE 3-14 RATIO OF OFFSET MEASUREMENTS

Offset Angle	Ratio of Travel to Offset	Ratio of Run to Offset
60°	1.555	0.577
45°	1.414	1.000
30°	3.000	1.732
22.50°	2.613	2.414
11.25°	5.126	5.027
56.25°	10.217	10.168

ILLUSTRATION 3-9

Find the travel distance of the pipe if the offset angle is 45° and the offset length is 30 centimeters.

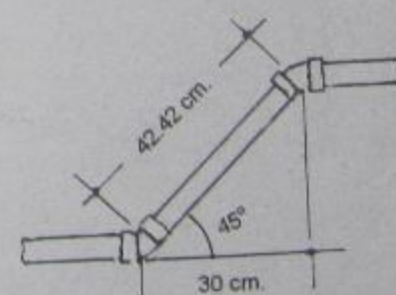


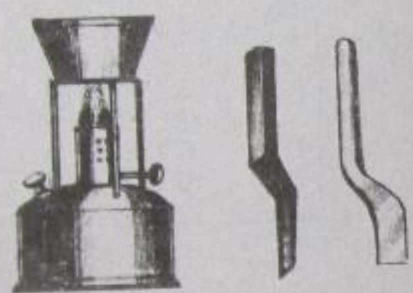
FIGURE 3-20

SOLUTION

1. Solve for the travel length, referring to Table 3-14 along 45o offset angle under column ratio of travel to offset the value is 1.414. Multiply:

$$\text{Travel length} = 30 \times 1.414$$
$$= 42.42 \text{ centimeters}$$

Propane Torch



Yarning & Calking Iron

Blow Torch

Melting Pot & Ladle

CHAPTER 4

SEWAGE DISPOSAL SYSTEM

4-1 The Sewage and its Disposal

The collection and safe disposal of human wastes are among the most critical problems of environmental health. Recent statistical reports revealed that most of the water borne diseases such as dysentery, typhoid, diarrhea and other intestinal disorders are prevalent in areas where there is no proper and scientific Sewage Disposal System.

It was reported that when human wastes are deposited in a pit, typhoid and dysentery causing organisms do not travel horizontally in the soil. These harmful bacteria neither move by themselves, they were carried in some way. These harmful organisms are carried somewhere through water flows, flies, rodents, cockroaches and other vermin which causes contamination.

The daily average volume of human waste or excreta per capita is about 80 grams of feces and 950 grams of urine. When diluted with water at the rate of 30 to 100 gallons per day to form sewage, the solid content becomes a very small portion expressed in milligrams per liter.

Of the total sewage solids, about 50% is organic and are subject to rotting. Small as it is in the sewage, and as decomposition continues, it become odorous and dark in color. And whether fresh or stale, it contains harmful organism that causes diseases.

It is therefore important not only to know the different types of sewage disposal systems, but also to understand the scientific value of the system.

Type of Sewage Disposal System

Sewage disposal system has four types:

1. The Cesspool
2. The Privy
3. The Septic Tank
4. The Public Sewer Line

The **Cesspool** is a hole in the ground curbed with stones, bricks, concrete hollow blocks, or other materials laid in such a manner as to allow raw contaminated sewage to leach into the soil. The organic wastes accumulate and finally disposed of by disintegration process.

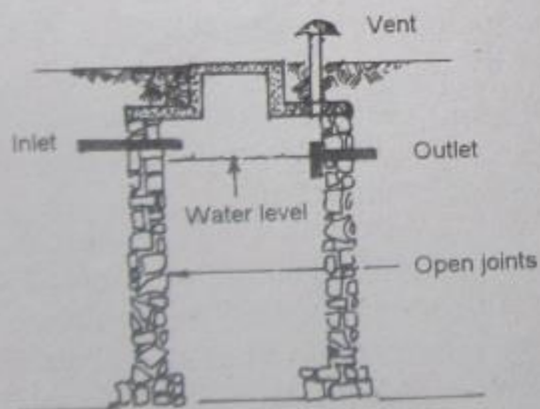


FIGURE 4-1 CESSPOOL

The **Privy** is a concrete sealed vault with a wooden shelter constructed for the collection of raw sewage. The disintegration of excrement is accomplished in the same manner as in a cesspool. It is objectionable because of the danger of contaminating the source of water supply.

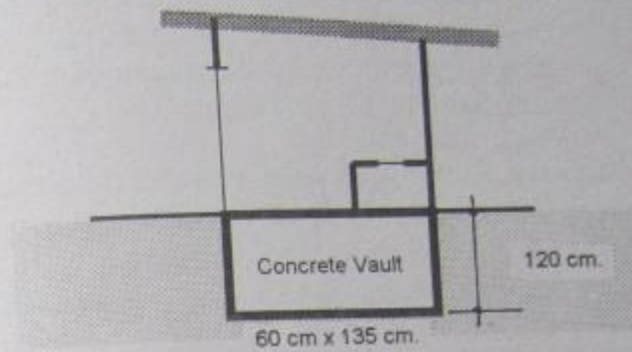


FIGURE 4-2 THE PRIVY

The **Septic Tank** is a device or receptacle used to expedite the decomposition of the elements contained in a raw sewage waste. Raw sewage consists of water, and settleable solid called organic materials that can be precipitated in a septic tank in a very short time.

The **Public Sewer Line** is a public sewage system, operated and maintained by the government consisting of a sewage treatment plant that conveys the raw sewage from buildings and houses to a disposal system.

Of these four types of sewage disposal, the cesspool and the privy are already obsolete. The prevailing types recommended by the sanitary authorities are the ***Public Sewer line and the Septic Tank.***

4-2 Public Sewer Line

The Public Sewer Line is classified into three types according to the kind of waste it disposes.

1. The Combination Public Sewer
2. The Sanitary Sewer
3. The Storm Drain

The **Combination Public Sewer** is the oldest type of public sewer that conveys both storm water and sanitary wastes. This type of public sewer is already obsolete and no longer allowed by sanitary authorities.

The **Sanitary Sewer** is a public sewer facility that carries regular sanitary wastes only. It terminates in a modern sewage dispersal plant. Rainwater is not permitted to enter into this type of public sewer.

The Sanitary Sewer is classified into two types:

1. The Intercepting or Trunk Line Sewer
2. The Tributary or Contributing Sewer

The **Intercepting Sewer** is a sanitary sewer that conveys sanitary waste to a dispersal plant. It is commonly made of concrete pipe that varies in sizes from 0.60 to 3.00 meters in diameter. The pipes are laid underground to a minimum depth of about 3 meters, depending upon the natural contour of the ground.

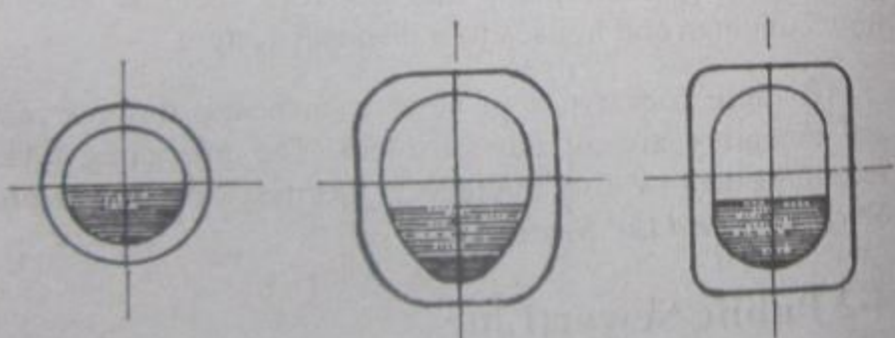


FIGURE 4-3 INTERCEPTING SEWER

The **Tributary Sewer** is classified as an intercepting sewer branch. The pipe is made of either vitrified clay or concrete pipe laid in an open trench. It is generally smaller in diameter installed not more than 3 meters below the street grade and terminate into the intercepting sewer.

The **Storm Drain** is another kind of public sewer line that carries storm water. It terminates in a natural drain such as canals, lakes or rivers.

Manhole is classified as a device of the main and storm sewer. It serves as man's access for inspection, cleaning and repair. It is constructed out of bricks, stone, adobe or concrete at an interval distance from 75 to 150 meters. The manhole diameter varies from 90 to 120 centimeters provided with iron rungs to serve as ladder for the maintenance crew to reach the bottom. It is provided with a well-fitted cover on top, leveled with the road surface.

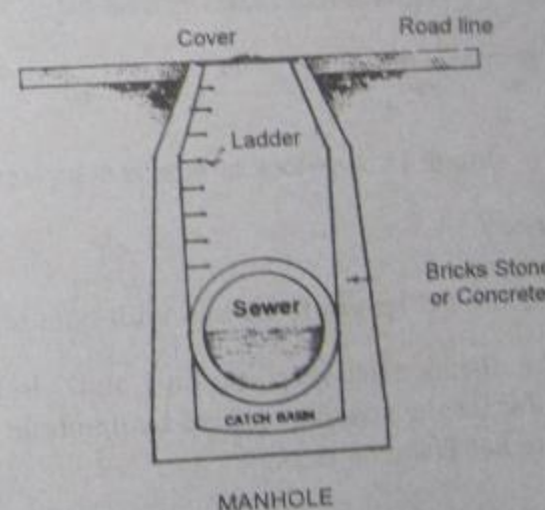


FIGURE 4-4 MANHOLE

The Materials required for the public sewer line could be determined under the following procedures:

1. From the plan of the public sewer line, find the net distance between manholes to be laid with concrete pipes. Total distance minus the space area occupied by the manhole.

2. The net distance found divided by the length of one pipe at 1.00 meter long regardless of its diameter.

3. Subtract 3% to 4% from the obtained number of pipes in order to get the exact number required.

ILLUSTRATION 4-1

As shown in Figure 4-5, determine the number of 60 centimeters diameter concrete pipe.

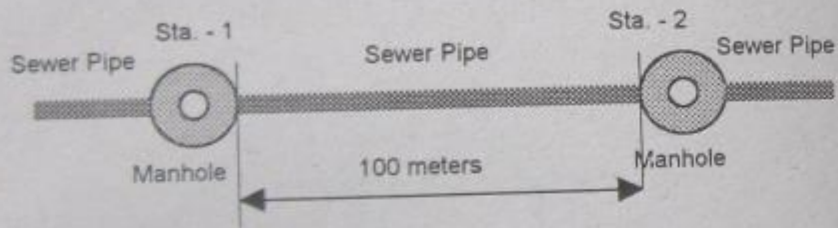


FIGURE 4-5 MANHOLE OF PUBLIC SEWER LINE

SOLUTION

1. Find the net length to be laid with concrete pipe.

   The distance between station 1 and 2 is 100 meters
   Subtract the space occupied by manhole <u>1 meter</u>
   The net distance is .... 99 meters

2. Divide the net distance by the length of one pipe.

   $$\frac{99\text{ m.}}{1\text{ m.}} = 99 \text{ pipes}$$

3. Subtract say 3% to get the exact number of pipes.

$$99.00 \times .03 = 2.97 \text{ say } 3.00 \text{ meters}$$
$$99.00 - 3.00 = 96 \text{ pipes}$$

4. If there are 96 pipes, only 95 joints will be grouted or plastered, because the two ends will terminate at the manhole.

5. Refer to Table 4-1. Concrete pipes with 60 cm. diameter needs .132 bags of cement and .0165 cubic meters sand per joint. Multiply:

   Cement: $95 \times .132 = 12.54$ say 13 bags
   Sand: $95 \times .0165 = 2.0$ cubic meters

Comments :

1. To some estimator, the number of sewer pipes needed for a certain distance or station is found by dividing the distance by the length of one pipe. An allowance of 3% to 5% is also added for alleged contingencies.

2. The idea of dividing the distance by the length of one pipe is acceptable, but the additional 3% to 5% is questionable. It would be interesting to note that in actual installation of concrete pipes, the end joints cannot be fitted exactly with each other. A small gap between the pipe joints cannot be avoided because the materials and installation are not precision made.

3. If the installation of the concrete pipe is done manually, handling of the materials inside a deep excavation is so difficult to make a well fitted joints. A gap of about 2 to 5 centimeters between the pipe joints cannot be avoided. However, it is usually corrected by means of cement grout or plaster.

4. Assuming that the gap between pipes is about 3 centimeters, and for a distance of 100 meters between the manhole, there will be a total gap of 99 joints. Multiplied by 3 centimeters is equal to 297 centimeters or about 3.00 meters.

5. The total gap of 3.00 meters long if subtracted from the net distance of 99 meters, the number of pipes required between manhole distance is only 96 pipes.

6. On the other hand, if the distance between manhole is 100 meters divided by the length of one pipe which is 1 meter plus the additional 5% allowance would mean a total of 105 pipes needed per station. With this manner of estimating, the additional 5% percent allowance for contingencies will only result to a bloated estimate.

7. Questions might be raised why the length of 99 meters per station was used instead of 100 meters? The distance indicated in the plan is measured from center to center of the manhole. Subtracting the space occupied by the manhole, the length to be laid with pipes will be 99 meters only not 100 meters.

8. The gap between pipes is of great significance in making estimate because it will materially affect the cost specially when the installation calls for a longer distance in terms of kilometers.

9. The values given in Table 4-1 assumed to complete the circumferential plaster joints of the pipe in accordance with the standard specifications.

10. For more detail on estimating, refer to the book Simplified Construction Estimate by Fajardo.

TABLE 4-1 QUANTITY OF CEMENT AND SAND PER PIPE JOINT

Concrete Pipe Size In Meters	Cement in Bags	Sand in cubic meter
0.60	.132	.0165
0.90	.198	.0247
1.20	.264	.0330
1.50	.320	.0400
1.80	.376	.0470
2.10	.443	.0554
2.40	.496	.0620
2.70	.558	.0620
3.00	.616	.0770

The values presented was based on the assumption that the grout or plaster completely surround the joints between pipes.

Sewage Ejector

Sewage ejector refers to the pump that will discharge waste in the sump and transfer it to the house drain installed overhead. Sewage ejector is necessary when the public sewer line was installed at a depth from 2 to 4 meters below the street level. Large buildings with basement may have a deeper excavation making it difficult to drain its waste towards the main sewer by means of gravity.

4-3 The Septic Tank

Septic Tank is a receptacle or vault used to collect organic waste discharged from the house sewer. The main function of a septic tank is to liquefy and precipitate solid waste purifying odorous materials.

Sewage that was discharged into the tank is retained. And during its retention period, about 60% to 70% of the suspended solid of the sewage is removed largely by sedimentation to form a semi-liquid substance called **sludge**. The sludge accumulates at the bottom of the septic tank. Parts of the solids are formed into floating **scum**. Both the scum and the sludge are processed by anaerobic bacteria and transforming them into liquid and gases.

This process is called **digestion**. The solid matter is reduced in sizes and consequently changed in character. The septic tank therefore, combines two processes; ***sedimentation*** in the upper portion of the tank and ***anaerobic decomposition*** of the accumulated sludge at the bottom.

Decomposition of organic matter from human waste is a bacteriological process caused by:

1. Aerobic bacteria called aerobes
2. Anaerobic bacteria called anaerobes
3. Facultative bacteria

The life process of Aerobic bacteria is in the ***presence of material oxygen***. The Anaerobic bacteria on the other hand, functions in the ***absence of free oxygen***. Likewise, Facultative bacteria also functions even ***with or without free oxygen.*** These three types of bacteria have no relation to disease. They thrive naturally in sewage, and will function when conditions are favorable in terms of:

1. Food Supply
2. Temperature
3. Moisture

However, even when conditions are favorable, these bacteria will cease to exist in the presence of antiseptics or disinfectants. And to discharge large amount or volume of waste and water containing disinfectants, oil and grease into the septic tank will affect and disturb the bacterial acti

ivities therein and may then destroy the purpose for which the septic tank is constructed.

The human waste or excreta are decomposed, until the organic matters are transformed into materials that could no longer be utilized by the bacteria in their life process. The ***process of decomposition*** is regarded as ***stabilization.***

Decomposition caused by anaerobic bacteria which is sometimes referred to as *putrefaction*, is accompanied by bad odors. On the other hand, aerobic decomposition is not accompanied by unpleasant odor. A sewage that turns dark and smell unpleasantly due to anaerobic decomposition is called ***Septic.*** Decomposition caused by aerobic bacteria is accomplished with no definite time and could be within a matter of hours.

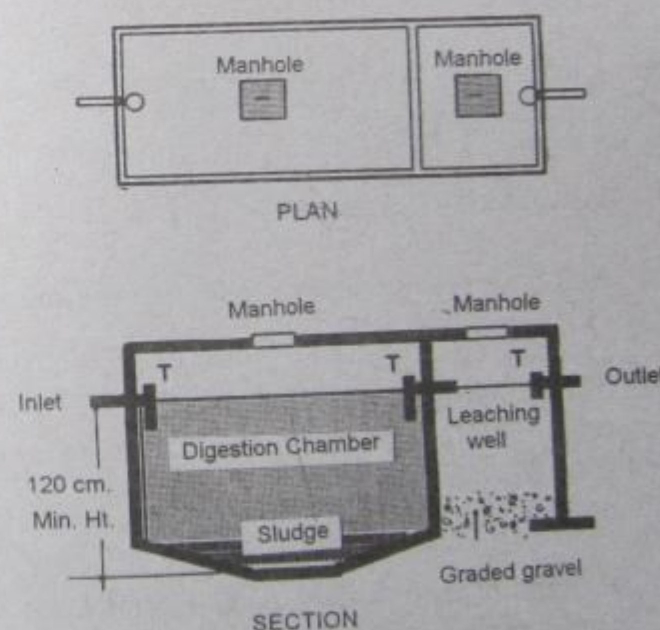


FIGURE 4-6 PLAN AND SECTION OF SEPTIC TANK

Gasses that are Produced Inside the Septic Tank

There are different gases produced inside the septic tank ranging from organic to non-organic gases. These are:

1. Methane gas (CH_4) is a combination of hydrogen and carbon, a principal component of natural gas.
2. Carbon Dioxide (CO_2) is a combination of carbon and oxygen. It is the simplest oxide of carbon.
3. Carbon Monoxide (CO) is a by-product of methane, classified as poisonous gas.
4. Hydrogen (H_2) evolves as a moist gas from organic waste.
5. Hydrogen Sulfide (H_2S) is a colorless gas with offensive odor.
6. Sulfur Dioxide (HO_2) is also a colorless gas having an irritating odor.

These gases are discharged into the atmosphere through the ventilation pipe.

4-4 Construction of the Septic Tank

Septic Tank is constructed from either of the following materials:

1. Reinforced concrete
2. Plastered concrete hollow blocks
3. Prefabricated asbestos
4. Thin metal and plastic

The most popular and widely used material for construction of septic tank is plastered concrete hollow blocks or reinforced concrete. Others have not gained acceptance due to cost and durability.

General Conditions in Constructing a Septic Tank

1. The concrete or masonry septic tank is usually constructed in a rectangular form. The reason is to retard the even flow of the waste, that is necessary, to avoid disturbing the decomposition processes inside the tank.
2. The minimum inside dimension of a septic tank is 90 centimeters wide by 150 centimeters long.

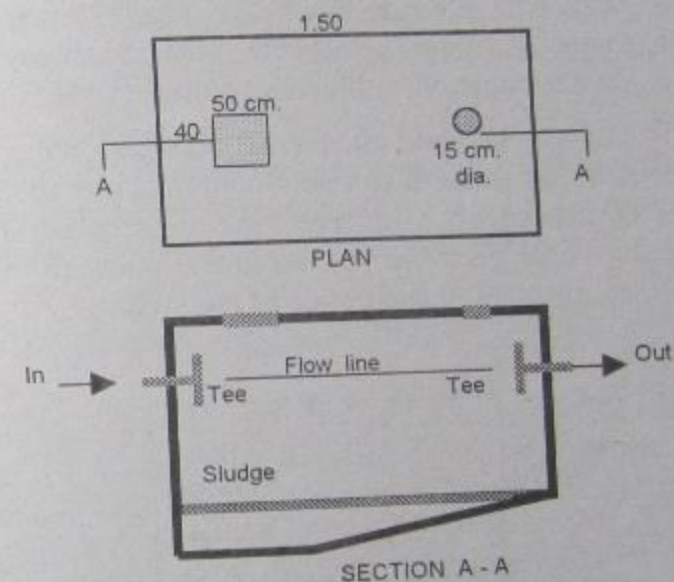


FIGURE 4-7 MINIMUM SIZE OF A SEPTIC TANK

3. For effective decomposition of the organic materials inside the septic tank, a 120 centimeters depth of the liquid content is necessary. It is not impractical though, to construct a tank of greater depth, provided, that the depth should not be deeper than the natural ground water table.
4. The inlet and outlet inverts of the septic tank shall

be long turn sanitary tee. The inverts are installed in the wall of the tank at least 120 centimeters from its bottom floor equally spaced from both sides.

5. The invert is extended down the liquid of the tank not more than 30 centimeters. This is to assure smooth delivery of the incoming sewage below the scum line. **Scum** refers to the lighter organic materials that rises to the surface of the water.

6. The bottom of the digestion chamber should be sloped to one low point. The purpose is to gather the settled organic materials into one mass to favor the propagation of the anaerobic bacteria.

7. The septic tank, should be provided with a manhole, extended a few centimeters above the surface of the soil to overcome infiltration of surface water. This manhole will serve the purpose of cleaning, inspection and repair of the tank.

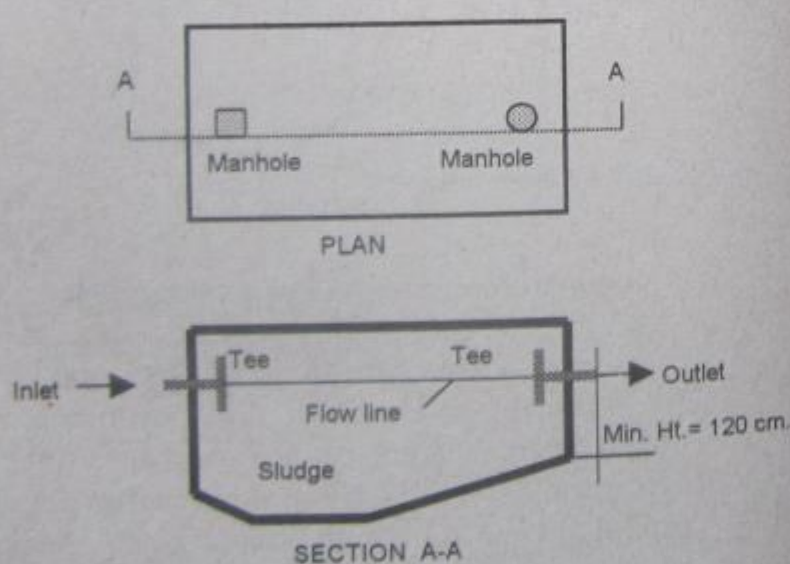


FIGURE 4-8 SINGLE CHAMBER SEPTIC TANK

8. Septic tank for large plumbing installations are provided with suspended compartment attached to the ceiling slab of the tank. The baffle plate is extended down the bottom of the tank about 40 centimeters below the scum line. Each compartment of the tank separated by baffle plate is provided with manhole.

9. The Septic tank, should be constructed near the surface of the ground, because the correction of the waste depends upon the extent of oxidation and the existence of anaerobic bacteria. Another kind of bacteria that split and digest the effluent is the ***aerobic bacteria***. A kind of bacteria that survive only in the subsoil not more than 150 centimeters below the surface. Oxidation of the effluent deeper than 150 cm. would become extremely difficult.

4-5 Size of the Septic Tank

So far, there is no mathematic formula ever formulated to arrive in determining a definite size of a septic tank. However, sanitary authorities agreed in principles that:

1. For a family of 6 persons, the minimum tank capacity should be approximately 1.3 cubic meters with a minimum size of 90 centimeters wide by 150 centimeters long and 120 centimeters depth.

2. A very large: tank is not advisable, because the bacterial activities would be retarded. The size of the tank is proportionally based on the number of persons expected to be served. In other words, the volume of the tank has a rational proportion with the volume of incoming waste for bacterial activities to be in favorable condition.

3. For residential installation, the practice is to allow 5 to 6 cubic feet of tank volume per person. Thus, a septic tank that will serve a family of 12 persons must have a liquid capacity of 6 x 12 = 72 cubic feet or 538 gallons. (one cubic foot is 748 gallons).

Technical Data in Determining Volume of Septic Tank

Minimum width	90 cm.
Minimum length	150 cm.
Minimum depth	120 cm.
For residential buildings to serve larger number of people, allocate .... of liquid per person	0.14 to 0.17 cu.m
For small residential house to serve up to 12 persons, the chamber should have a liquid content of not more than	2.0 cubic meters
For school, commercial and industrial establishments, the volume of the septic tank should not be less than .... more than	.057 cu. m. nor .086 cu. m./ person

Where large amount of water waste is coming from the shower bath, laundry and others, it is not advisable to permit entry of these waters into the septic tank. Likewise, all downspout collecting water from the roof, should not be allowed to terminate into the septic tank. Rainwater should be conveyed to the Storm Drain.

ILLUSTRATION 4-2

Determine the size of a septic tank to serve 200 persons in a commercial establishment.

SOLUTION

1. To determine the volume of a septic tank, refer to the Technical Data of information page 92. For a commercial establishment we find the value of .057 cubic meters. Multiply:

$$200 \text{ persons} \times .057 = 11.4 \text{ cu. m}$$

2. Assume 1.2 meter width of the tank per 100 persons. For 200 individuals multiply:

$$200 \times 1.2 = 2.40 \text{ meters width}$$

3. The maximum depth of a septic tank liquid is 1.50 meters. Solve for the length of the septic tank.

$$L \times \text{Width} \times \text{depth} = \text{Volume}$$

$$L = \frac{\text{Volume}}{\text{Width} \times \text{depth}}$$

$$L = \frac{11.4}{2.40 \times 1.50}$$

$$L = 3.20 \text{ meters}$$

4. The value of L is only for the length of the digestion chamber. Divide by 2 then add result to the value of L to include the leaching well.

$$\frac{L}{2} + L = \frac{3.20}{2} + 3.20$$

$$\text{Total length} = 4.80 \text{ meters}$$

Therefore, the size of a septic tank to serve 200 persons is 2.40 m. wide by 4.80 meters long.

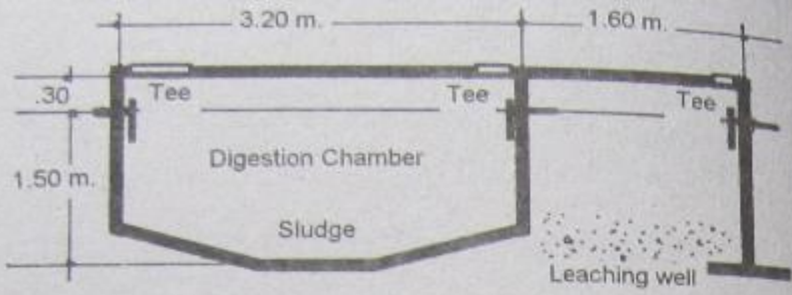


FIGURE 4-9 CROSS SECTION OF SEPTIC TANK

ILLUSTRATION 4-3

A motel with toilet and bath, and kitchen facilities will serve a maximum of 100 persons. Determine the capacity and dimensions of the septic tank.

SOLUTION

1. Refer to Table 4-2. Under motel with bath, toilet and kitchen, the waste per person per day is 50 gallons. Multiplied by 100 persons is 5,000 gallons a day.

2. Using the formula: $\mathbf{V = 1.125 + 0.75\,Q}$

   Where : V = Liquid volume of the tank in gallons
   Q = The daily sewage flow in gallons
   1.125 and 0.75 is constant value.

3. Substitute, $V = 1.125 + (0.75 \times 5{,}000 \text{ gallons})$
   $V = 3{,}751$ gallons.

4. There are 264 gallons in one cubic meter volume. Divide:

$$\frac{3{,}751}{264} = 14.2 \text{ cubic meters capacity of the septic tank}$$

TABLE 4-2 QUANTITY OF SEWAGE FLOW

Type of Establishment	Gallons per person per day
Small dwelling with seasonal occupancy	50
Single family dwelling	75
Multiple family dwellings (apartment)	60
Rooming houses	40
Boarding houses	50
Hotels without private bath	50
Hotels with private baths (2 persons per room)	60
Restaurants (toilet and kitchen wastes per patron)	7-10
Restaurants (kitchen waste per meal serve)	2.5-3
Tourist camps or trailer parks with central bath house	35
Tourist courts of mobile home parks with individual bath	50
Resort camps night and day with limited plumbing	50
Luxury camps	100-150
Work or construction camp	50
Day camps no meals serve	15
Day schools without cafeterias, gym. or showers	15
Day schools with cafeterias, gym and showers	25
Day schools with cafeterias, but no gym or showers	20
Boarding schools	75-100
Hospitals	150-250*
Institutions other than a hospitals	75-125
Factories (exclusive of industrial waste)	15-35
Picnic parks with toilet, bath houses	10
Swimming pools and bath houses	10
Luxury residences	100-150
Country clubs (per resident member)	100
Motels (per bed space)	40
Motels with bath, toilet and kitchen wastes	50
Drive in theaters (per car space)	5
Movie theaters (per auditorium seat)	5
Airport (per passenger)	3-5
Stores per (toilet room)	40
Service stations (per vehicle served)	10
Self service laundries (gallon per wash per person	50

* SOURCE: Manual of Septic Tank Practice. Public Health Service Publication 526.

5. To find the dimensions of the septic tank if the maximum depths is 1.50 m. and the width is assumed to be 3.00 meters, divide:

$$L = \frac{14.2 \text{ cu. m.}}{3.00 \times 1.50 \text{ m.}} = 3.50 \text{ meters}$$

TABLE 4-3 SUGGESTED SIZE OF SEPTIC TANK

No. of Persons served	Residential				Commercial or Industrial				
	1-5	6-10	11-15	16-20	21-30	31-40	41-50	51-75	76-100
Inside Width cm.	90	110	120	150	130	150	150	200	200
Inside Length Plus leaching well	150	200	270	300	210	250	300	330	360
Depth of Liquid	120	120	120	120	120	120	130	130	150
Inside Clear Height of Tank	150	150	150	150	150	150	160	180	200

TABLE 4-4 MAXIMUM ALLOWABLE SLUDGE ACCUMULATION IN A SEPTIC TANK

Capacity of Tank in Gallons	DEPTH OF LIQUID Distance from Bottom of Outlet Device to top of Sludge		
	90 cm	120 cm	150 cm
500	11	16	21
600	8	13	18
900	4	7	10
1,000	4	6	8

SOURCE: Manual of Septic Tank Practice: Public Health Service Pub. 526

4-6 Location of Septic Tank

Location of the septic tank shall observe the following considerations:

1. The septic tank may be located closer to the building it will serve, providing a minimum distance of 2.00 meters from the outside wall.
2. As much as possible, the septic tank should not be located closer to the doors or windows.
3. Septic tank should be at least 15 meters away from any source of water supply. The farther the better.

Requirements for a Satisfactory Disposal of Human Waste

1. There should be no contamination of ground surface that may enter into the spring or wells.
2. There should be no contamination of surface water.
3. The surface soil should not be contaminated.
4. Excreta should not be accessible to animals, flies, cockroaches, vermin and the like.
5. There should be no odor and unsightly conditions.
6. The methods used should be simple and economical in terms of construction operation.

4-7 Safety Precautions

In most cases septic tanks are poorly aerated or ventilated. It lacks free oxygen. Under this condition, an individual entering into a septic tank for making repairs or cleaning purposes, may meet almost instant death.

Septic tank may contain harmful and dangerous gases.

When repair work or cleaning is to be made, be sure that the septic tank is well ventilated, by removing the manhole cover few days in advance of the work. Another precaution is to supply fresh air inside the tank, while work is being done.

Remember that the tank may contain inflammable gases that might be ignited to cause a terrific explosion. If light is needed to work in the dark, an electric emergency light with properly insulated cord should be used. In the absence of electric supply, a flashlight powered by dry cell battery is equally safe.

4-8 Sewage Treatment

The effluent removed from the septic tank is still in the stage of objectionable matter. Although these organic matters have been removed, and many of the objectionable gases have been eliminated, still it contain countless number of harmful anaerobic bacteria and objectionable chemical compounds in solution that must be disposed of.

There are several methods and processes wherein sewages may be treated. And those that are most commonly used are the activated sludge process, and the trickling or sprinkling filter processes.

The detailed scientific analysis of sewage treatment is beyond the scope of this subject in plumbing. But in passing, it is worth mentioning that the treatment of municipal sewage is a complex problem involving scientific aspects outside the sphere of plumbing.

The design and construction of a modern sewage disposal plant requires engineering training in all the phases of natural science. Civil works for the design and construction of the structure, mechanical for the construction of equipment plus an extended knowledge of chemistry, physics and bacteriology.

CHAPTER 5

THE WASTE PIPE

5-1 Introduction

In the study of plumbing, it is important to know the different parts of the piping installations and their functions. The effectiveness of plumbing installation depends upon the strict observance of the natural laws of nature such as: gravity and the atmospheric pressure that affect the whole system. Most of the failures encountered in plumbing installation, were due to the ***non-observance of these natural laws,*** and the ***grave abuse of its function.***

Generally, **Waste Pipe** is smaller in size than the soil pipe. Smaller because of the kind of waste it receives from the various plumbing fixtures. Among the suspended materials found in the water waste are: grease, lint, matches, hair, garbage, and many other objectionable substances.

Plumbing fixtures are too often misused. Household's refuse of all kinds, are carelessly disposed of, by flushing them through the plumbing system. Indeed, the improper use of plumbing fixtures can only result in waste line stoppage, and deterioration of the pipeline.

The drainage installation of a plumbing system comprises three major component parts: the **Drainage,** the **Waste,** and the **Vent**, or simply called **DWV.**

The **Drainage Pipe** refers to an installation that receives and conveys discharges from water closet with or without waste coming from other fixtures.

The **Waste Pipe** is any pipe in a drainage installation that receives the discharges of any fixture ***except water closet*** and conveys the same to the soil branch, soil pipe or house drain. **Fixture** refers to slop sink, lavatory, urinals, bathtub and the like except water closet.

The **Vent Pipe** in a plumbing system functions as air passage or conduit to ventilate the drainage and waste pipe installation. As already discussed, solid human waste is discharged by water closet only to either the ***soil branch, soil pipe, soil stack or house drain.*** Categorically, any pipe that receives and conveys human waste is affixed by the word **"Soil"** such as; soil branch, soil stack etc.

Soil Branch refers to a horizontal pipe affixed by the word soil. The word soil connotes a pipe receiving discharges from water closet. On the other hand, if this soil branch does not receive discharges from water closet but from other fixtures only, it will be classified as ***Waste Pipe.***

Soil Stack is a vertical pipe installation where the soil branches terminate. The pipe is called ***stack*** being ***installed vertically***, and the word soil is affixed because it receives human waste from soil branch. Otherwise, it will again be classified as ***Waste Stack.***

When a waste pipe is not directly connected to a soil stack or house drain, it is called ***Special Waste.***

General Conditions for a Good Waste Pipe Installation

1. By making the right choice of materials.
2. By conservative use of fittings.
3. Right location of the cleanouts.
4. Right slope or grade of the pipelines.

5. Using the right size of pipe.
6. Correct manner of joining the pipes and
7. Providing stable and rigid support

5-2 The Right Choice of Materials

The materials intended for waste pipe installation, could be well selected from those that were enumerated in Chapter 2. The character of the waste to be drained, and the service to which it is intended for, dictates the kind of materials to be used.

For instance, any waste pipe line that conveys large amount of acid must specify acid resistant material. Example of which, are fixtures serving chemical laboratories, plating, engraving establishments and others that uses acid of various kinds. Refused that are coming from domestic and commercial kitchen, contains acid of different kinds, but considerably in small negligible quantity and therefore, does not require the use of an acid resistant pipe.

5-3 Conservative Use of Fittings

The smooth flow of waste inside the pipe is a primary consideration in all types of plumbing installations. Most of the waste pipe line failures were attributed to the unwarranted use of accessories and too many fittings, or because of using the wrong type of fittings in a given location. Conservative use of fittings refers to the right choice of the right kind of fittings for a particular change of directions, turns or offsets.

Injudicious use of fittings should not be allowed in plumbing installations. Short cuts that will not allow smooth passage of waste should be avoided.

Pipe joints and fittings were specially designed to make smooth changes of directions, turns or offsets. But sometimes, their application may not be in accordance with the purpose for which they were made.

There are many self-proclaimed plumbing experts who install pipes in what they called short cut method. The correct use of joints and fittings were not properly observed. It is maybe because they are so in hurry of the work and their pay as well. But the question is, how sure are we that the installations are clogged free?

Pipe installations that fails or break too soon, may have been due to any of the following causes:

1. The use of too many fittings and
2. The use of wrong type of fittings.

Recommendations:

1. Do not use short radius fittings on a vertical to horizontal directions or horizontal to horizontal changes.
2. Use long sweep fittings on horizontal changes.
3. For vertical to horizontal direction of changes, the Y and 45° fittings are most appropriate

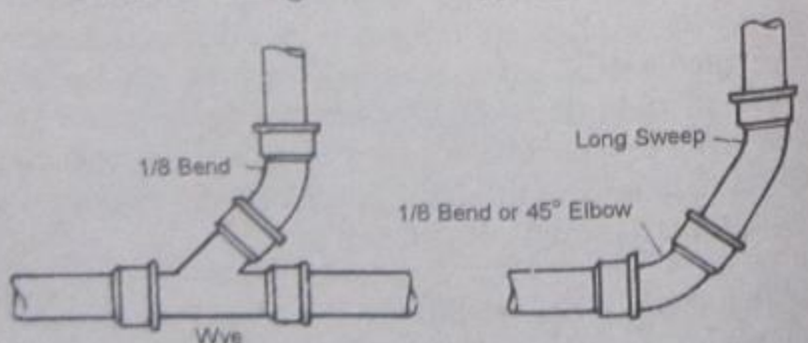


FIGURE 5-1

4. The **T** fitting was designed for vertical run with lateral branches only. Its use on horizontal installation will create a tilted or crooked joint connection called "**Premature Waste Line Defects.**"

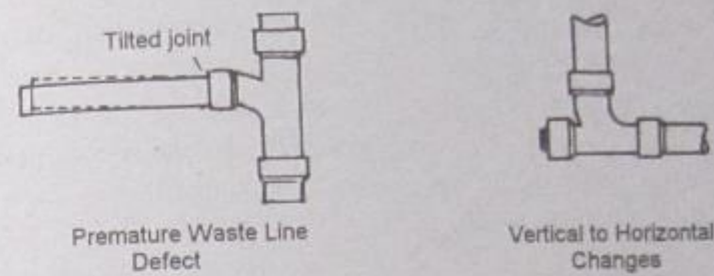


FIGURE 5-2

5-4 Location of Cleanout

The waste pipe installation must be provided with an ample number of cleanouts, strategically located, to be opened in case of pipeline trouble. Cleanout is a receptacle of the plumbing system accessible on floor, walls or ceiling. It is equipped with a plug or flush plate so designed as not to impair the aesthetical view of the room.

The location of cleanout must be indicated in the plan. It should be sized equal to the diameter of the waste pipe, where it is to be connected. This is to avoid interference in the rodding or cleaning process. Cleanout must be readily accessible to the plumber in case of waste line stoppage.

5-5 Right Slope or Grade of Waste Pipe

The ideal position of horizontal waste pipe, were those installed at 2% slope. Meaning, the pipe was installed with an inclined ratio of 2 centimeters per meter length.

for instance, a 3.00 meters pipe installed as a waste line will have an inclination of 3 x 2 = 6 centimeters.

Waste pipe must be of sufficient diameter to afford adequate velocity of flow in order to make them as nearly self-scouring as is practical. The latest scientific tests and experiments conducted by the National Bureau of Standards sponsored by the Housing and Home Finance Agency, showed that, wet venting and stack venting are safe in certain type of installations. The experiments revealed that the ***Trap Seal Loss*** occurs when the grade or slope of the pipe is increased from 2% to 4%.

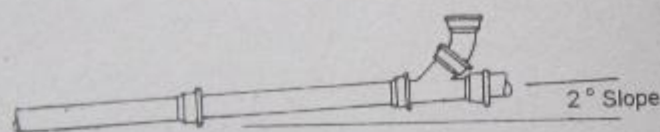


FIGURE 5-3 RIGHT SLOPE OF PIPE

Trap Seal Loss means the ***loss*** or ***escape*** of standing water inside the P-Trap. This is usually caused by siphonage induced by rapid flow of waste inside the pipe. It is also referred to as ***Water Seal Escape.***

Plumbing installations usually suffer grave abuse of function brought about by human elements. Record shows that, waste lines identically designed with the same size and grade, installed in different residences, but used by different persons, functions differently. The materials and methods used in food preparation, plus the habits of the housewife, accounts for this.

Some people use plumbing fixtures as a means of getting rid of almost any kind of unwanted waste. Waste such as garbage, grease, hair, lint, matches, cigar, paper and the

like are found in most clogged waste lines. Take note that, Plumbing installations are not intended to convey materials of this kind of unwanted waste.

5-6 Manner of Joining Pipes

Injudicious connection of fittings should not be permitted in any plumbing installation. Each kind of pipe has its own manner of joining recommended and specified by the manufacturers. For instance, cast iron pipes are joined by the use of oakum and lead at the hub and spigot connections. Likewise, plastic pipes clearly specify the use of solvent plastic cement, or by special fitting connector. Remember that any alteration or deviation from the manufacturer's specifications will only endanger the effectiveness of the pipe joints.

5-7 Determining the Size of Waste Pipe

The National Plumbing Code on the size of waste pipe provides that:

"The waste pipe diameter shall be adequate enough to serve the installation of fixtures in a general way, but the best way is to fit the diameters of commercial pipe into the fixture pattern in the most efficient manner."

The size of waste pipe intended to receive waste from the fixture must be of sufficient diameter. This is to accommodate the velocity of flow, making them as nearly ***scouring*** as necessary to prevent the silting of the pipe.

Scouring means to flush or wash out, to remove dirt or grease by flowing through. There are those who believed that by making the drainage pipe larger than what is necessary, will increase its service efficiency. This belief without scientific basis, has triggered disagreement among people in the plumbing industry. Disagreement on this matter however, was resolved when the Uniform Plumbing Code Committee formulated data as guide and references in determining the size of the waste and other drainpipes.

The data formulated by the Committee for incorporation in the Plumbing Code were product of countless tests and experiments conducted for years. In addition, installation experiences that were proven satisfactory in service compiled over a long period of time were also incorporated.

The Uniform Plumbing Code Committee's Findings are Enumerated Briefly as Follows:

1. By increasing the size of the drainage pipe, does not guarantee effective scouring action, or self-cleaning ability of the pipe. Self-cleaning ability is present, when the liquid and waste inside the pipe flow smoothly and simultaneously together.
2. Water flow inside a larger pipe is relatively shallow. The solid waste does not flow on shallow water but tend to remain at the bottom of the pipe. This is practically the most common cause of the many clogging problems of drainage installation.
3. Drainage pipe must be of the right size to have a liquid flow of about 50% of the pipe diameter. Meaning, that the flowing water inside the pipe must have a depth equal to ½ the pipe diameter.
4. For instance, if the pipe is 100 mm diameter, the water flow inside the pipe must have a depth of about 50 mm to attain the scouring action. This is where the 2% slope becomes effective.

5. On the other hand, too small pipeline is subject to overloading of flow. The tendency is to create back-pressure, siphonage, and floor flooding.

5-8 The Fixture Unit

The National Plumbing Code strongly indorsed the use of ***Fixture Unit Value*** as waste load in determining the size of the waste pipe. The Uniform Plumbing Code Committee, conducted numerous tests on various plumbing fixtures in order to determine the amount of water each fixture discharges in one-minute interval through their outlet orifices.

TABLE 5-1 FIXTURE UNIT VALUES

Kind of Fixture	Fixture unit
Bathtub	2
Floor drain	1
Kitchen sink	2
Residential sink	1.5
Lavatory or wash basin	1
Laundry tub	2
Shower bath	2
Slop sink	3
Sink, hotel or public	2
Urinal	5
Water closet	6
Combination fixture	3
One bathroom group consisting of water closet, lavatory, bathtub and overhead shower or water closet, lavatory and shower compartment	8
For every 15 square foot roof drain	1

The tests result showed that a wash basin being one of the smallest fixtures, discharge waste at approximately one cubic foot of water per minute interval. Based on their findings, the Committee finally decided to establish the "**Unit Fixture**" and called the water discharge as **One Fixture Unit** representing one cubic foot or 30 liters of waste discharged by the fixture in one minute interval.

TABLE 5-2 SIZE OF HORIZONTAL FIXTURE BRANCH AND STACK

Diameter of Pipe		Maximum number of fixture units that may be connected to			
		One Horizontal Branch	Not over 3 Branches	Stack with 3 or more Branches Intervals	
mm	In			In one Branch Interval	Total in Stack
32	1 ¼	1	2	1	2
38	1 ½	3	4	2	8
50	2	6	10	6	24
63	2 ½	12	20	9	42
75	3	20	30	20	60
100	4	160	240	90	500
125	5	360	540	200	1100
150	6	620	960	350	1900
200	8	1400	2200	600	3600
250	10	2500	3800	1000	5600
300	12	3800	6000	1500	8400

With the information just discussed and the data presented in Table 5-1, the student must be familiarized with the relation between the fixture unit values, and the size of the drainage pipe required.

How to use Table 5-1 and Table 5-2, one must determine first the number of each fixture involved, multiplied by the corresponding fixture units in Table 5-1, then refer to Table 5-2 for the size of the pipe.

ILLUSTRATION 5-1

Determine the size of a horizontal waste pipe to serve 5 urinals, 3 lavatories, 8 showers and 2 slop sinks.

SOLUTION

1. Find the ***fixture unit*** load of the above fixtures. Refer to Table 5-1, and multiply:

5 urinals x 5 units	25 units
3 lavatories x 1 unit	3 units
8 showers x 2 units	16 units
2 slop sink x 3 units	6 units
Total	50 units

2. Refer to Table 5-2. Under the column of ***one horizontal branch***, 50 units could be well served by a 100 mm or 4 inches pipe.

Comments:

Examining Table 5-2 under columns ***diameter of pipe*** and ***one horizontal branch***, it seems that the 100 mm (4") pipe with a capacity to serve 160 fixture units load is too large to serve the 50 fixture units as computed. However, since 50 fixture units fall under the parameter of 100 mm pipe as formulated by the National Plumbing Code, it has to be followed without question. Specify the use of 100 mm pipe diameter.

Your plumbing design particularly the sizing of the pipe should be determined by way of mathematical computation, using the Fixture Unit values. However, regardless of the results when it is smaller than what is promulgated by the Plumbing Code as presented in Table 5-1 and 5-2, the Code must prevail.

One probable solution for a person who is thinking of economy, is to install a graduated size of pipe from say 30 to 100 mm diameter in order not to violate the provisions of the Code. The idea is very good and acceptable on the premise of economy. However, it should be analyzed carefully considering the cost of cutting different sizes of pipe, providing reducers and various fittings plus the time delay and the high cost of labor. Otherwise, we might as well forget that idea towards unrealistic economy.

ILLUSTRATION 5-2

Determine the size of a horizontal branch waste pipe for one lavatory, one residential sink and one slop sink.

SOLUTION

1. The problem is to determine the size of the pipe that could effectively convey waste coming from the 3 fixtures as enumerated.

2. Refer to Table 5-1. Solve for the total fixture units.

1- lavatory	1 unit
1- Residential sink	1 ½ units
1- Slope sink	3 units
Total	5 ½ units

3. Referring to Table 5-2 under column ***one horizontal branch***, the 5½ fixture units is nearest to the value of 6.

4. Under column-1, a 50 mm pipe will be satisfactory to drain all the three fixtures. Use 50 mm diameter.

To compute the size of each fixture drain is not necessary because the manufacturer has already provided each fixture with the right size of drain.

Most plumbing installation frequently suffers from grave abuse of functions by human elements and behavior. Some people think and regard the installation as a means of disposing almost any kind of unwanted waste. On the other hand, people who observed proper disposition of their refuse seldom experience waste pipe problem.

5-9 Waste Pipe and Other Fixtures

Waste pipe is classified into two types depending upon the kind of fixtures it will serve.

1. Direct Waste and
2. Indirect Waste

Direct Waste is one with terminal directly connected to the plumbing system.

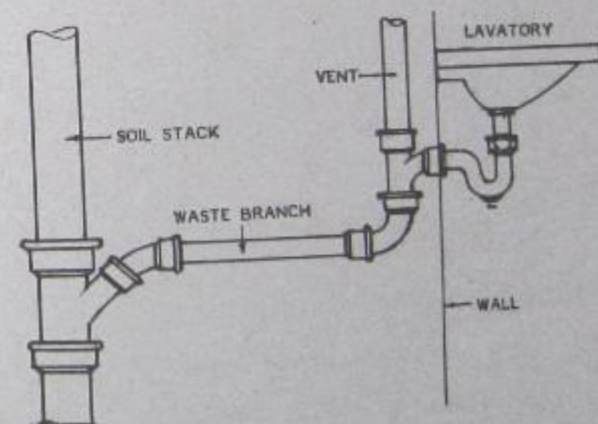


FIGURE 5-4 DIRECT WASTE

Different Types of Fixture Served by Direct Waste

1. **Urinals**
   a. Pedestal
   b. Stall
   c. Through
2. **Bathtub**
   a. Siltz
   b. Foot
   c. Bidet
3. **Lavatories**
   a. Wall hung
   b. Pedestal
   c. Two pieces

4. **Sink**
   a. Kitchen
   b. Pantry
   c. Slop
5. **Showers**
   a. Single stall
   b. Gang
6. **Drinking fountain**
7. **Laundry**
8. **Laboratory**
9. **Hospital fixture**

Indirect Waste refers to a connection with terminal not directly connected to the plumbing system. Fixtures served by Indirect Waste are:

1. Soda fountain
2. Bar waste
3. Refrigeration
4. Drinking fountain

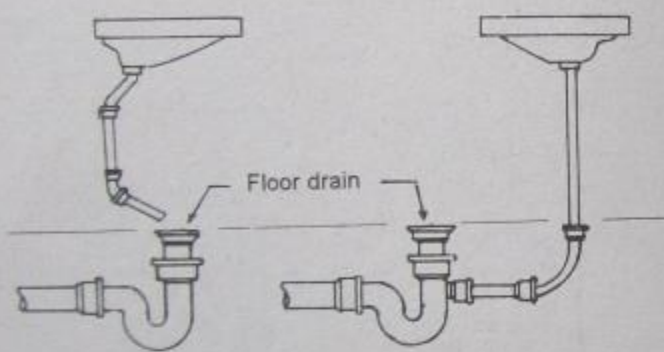


FIGURE 5-5 INDIRECT WASTE

Recommended Size of Waste Pipe

For a particular fixture either served by direct or indirect waste recommend the following sizes.

1. **Sink Waste**. The minimum size of waste pipe for sink is 38 mm or 1½", but because of the materials suspended in it, the practice is to use 50 mm or 2" pipe. The National Plumbing Code provides that:

   "the waste pipe must be short, direct, free from offsets and provided with ample cleanouts accessible for repair."

2. **Slop Sink**. Is tapped either on floor or walls. Traps on the floor shall be 75 or 100 mm. and 50 mm for traps installed on walls with a cleanout plug.

3. Scullary sink	50 mm
4. Pantry sink	38 mm
5. Factory wash up sink	50 mm
6. Bathtub	38 mm. min. to 50 mm.
7. Lavatories	50 mm
8. Shower Bath	50 mm.
9. Urinal	50 mm
10. Laundry tub	38 to 50 mm.
11. Drinking fountain	32 mm
12. Lavatory waste	50 mm
13. Hospital fixtures	50 mm

It is interesting to note that, some fixtures could be served well by using waste pipe of smaller diameter based on the volume of water it discharge in one minute interval. The Code however, regulated the use and size of pipe drain to maintain good sanitation through an efficient drainage system. One example is the urinal, wherein large amount of foreign materials are dumped, and subsequently lodged into the short run of the pipe.

Examples of foreign materials that are found in clogged pipes are gum, cigarette butts and filters, matches and many others. Likewise, the chemical action of uric acid of urine produces gelatinous substances that settle down and become objectionable sediments, which are difficult and extremely hard to remove.

This is only one of the so many reasons why the Standard Plumbing Code Committee, issued limitations on the diameter of waste pipe to serve plumbing fixtures. Generally, the 50 mm pipe is required for all types of urinals.

CHAPTER 6

THE SOIL PIPE

6-1 Soil Pipe

By definition, any pipe that receives and conveys discharges of water closet, with or without the discharge coming from other fixtures to the house drain or house sewer is called **Soil Pipe**.

The word **Soil** is affixed to pipe installation that carries human waste coming from water closet. Minus the waste coming from water closet, said installation is called Waste Pipe. Soil pipe installed vertically is called **Soil Stack** and **Soil Branch** when installed horizontally.

The National Plumbing Code on Soil Pipe Provides:

1. That, at least one of the vertical stacks in the plumbing system must extend full size through the roof for the following purposes:
   a. To ventilate and dispose off the sewer gas above the roof
   b. To prevent siphoning of the water trap seal by force of suction.
   c. To prevent the possibility of back pressure which may force the water seal off the fixture trap.
2. Any structure with a house drain installed, must have at least one soil stack or stack vent, extended full size above the roof not less than 30 cm long and

should not be less than 75 mm (3") diameter or the size of the drain whichever is smaller.

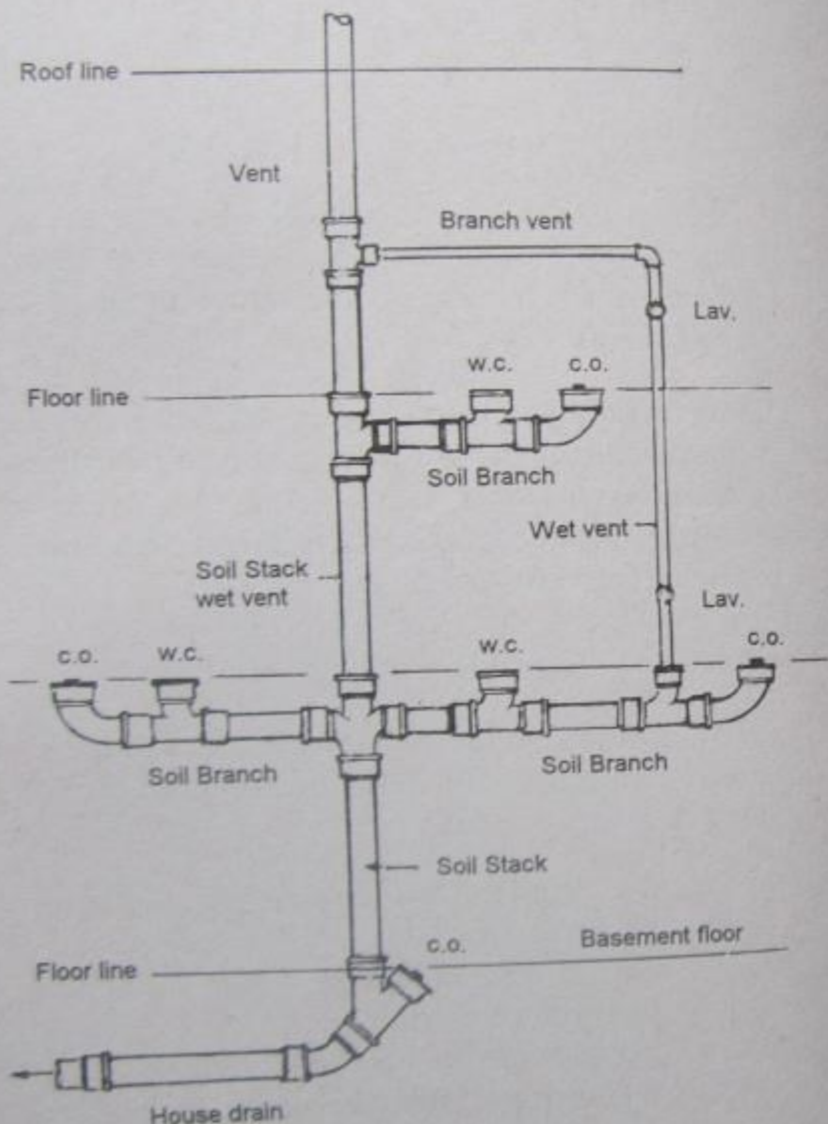


FIGURE 6-1 SHOWING THE SOIL STACK AND SOIL BRANCH

3. As a general rule, vent stack must be extended and terminate through the roof of the building. When the roof is to be used other than protection from the elements of weather, the vent stack should be extended no less than 2.00 meters above the roof.

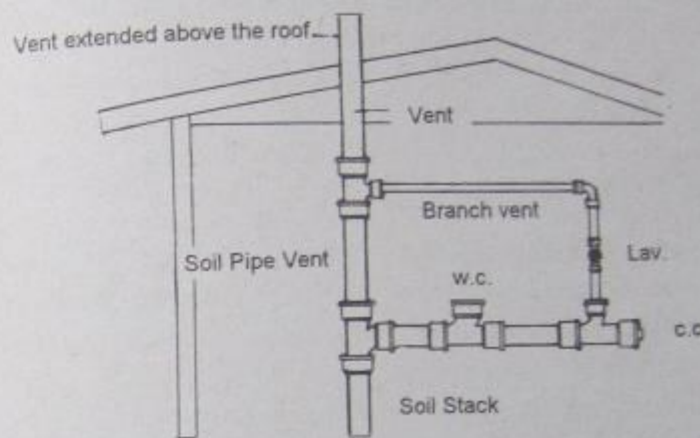


FIGURE 6-2 VENT STACK EXTENDED THROUGH THE ROOF

Installation Requirements

To start with the soil pipe roughing-in, the plan layout of the entire building installation must be prepared. This includes the location of fixtures, size of the partitions, location of doors and windows as well as the lowered ceiling that will conceal the soil and waste pipe branches.

Building designers do not always use good judgment in indicating the location of the soil pipe. Relocation of the soil or vent stack requires good judgment to accommodate the runs of associated vent, waste and water pipes in a more practical way. To do this effectively, the plumber's knowledge of the layout must be complete and adequate.

The location of electric outlets and boxes, cabinets and other building necessities has to be set up. The soil pipe is generally placed before the mounting of partitions. Passing the soil pipe through any of this facility unit would be a reflection on the mechanical ability of the plumber, and a fault that would be exceedingly hard to correct.

The Plumbing Code on Soil Pipe Installation Provides that:

1. The Soil Pipe shall be properly concealed or embedded in columns, walls or partitions, installed prior to the construction of the building.
2. The entire installations in building such as the location of fixtures, thickness of the partitions, location of doors and windows, drop ceiling, electrical layout and outlets and their relations with each other shall be considered in the pre-planning stages prior to the rough-in work.
3. The soil branch that will directly receive waste from water closet shall be short and direct as practicable.
4. Soil Pipe joints shall be tight and free from liquid or gas leak. Installation workmanship shall be strictly in accordance with the standard practice of the trade involved.
5. Soil pipes not embedded in concrete wall, columns or partitions shall be anchored rigidly by means of metal hangers.
6. That changes from vertical to horizontal directions shall be done by using:

   a.) ¼ bend
   b.) Long sweep ¼ bend

   c.) Two 1/8 bend or
   d.) Combination of Y and 1/8 bend

6-2 Size of the Soil Pipe

So far, there is no definite mathematical formula ever formulated to determine the size of the Soil Pipe required for a particular installation. This is maybe because of the variable conditions relative to its service.

For instance, who can foretell how often one is going to use a plumbing fixture in a given time interval? Likewise, it would be more difficult for a plumber to ascertain how often and what time a plumbing fixture might be used. And to determine the size of the soil pipe on the basis of maximum discharge of all the fixtures connected to it in a minute or an hour interval would be nobody's guess.

However, it would be certain that all fixtures connected to the plumbing system, would never be used or flush simultaneously at one point in time. And it would be more impossible for the soil pipe to be carrying a maximum load from all the fixtures connected to it in one single moment.

The Fixture Unit

In the absence of a definite formula to use in finding the size of a soil pipe, the Uniform Plumbing Code Committee formulated the Fixture Unit data as the maximum waste discharges per minute interval of a particular fixture. Indeed, the Code provides that, the fixture unit be the standard values in determining the size of all plumbing installations.

How to use the Fixture Unit values in Table 5-1, the following example is presented.

ILLUSTRATION 6-1

Determine the Soil Pipe diameter to serve 8 water closets, 3 shower bath, 4 urinals, 2 slop sinks and 3 wash basins.

SOLUTION

1. Refer to Table 5-1 and find the fixture units of:

8 water closets x 6 units ...	48 units
3 shower bath x 2 units	6 units
4 urinals x 5 units	20 units
2 slop sink x 3 units	6 units
3 wash basin x 1 unit	3 units
Total	83 units

2. Refer to Table 5-2, under Total in Stack, 83 units is between 60 and 500 fixture units which could be served by a ***100 mm or 4" pipe diameter***.

Comments:

1. The total sum of the fixture unit as computed is 83. Even if this number would be increased by 5 times, the 100 mm pipe that could serve up to 500 units will be more than sufficient to serve the 83 units.
2. It seems that the 100 mm pipe is over size to serve an 83 fixture units. However, since 83 units result of the computation falls under the parameter of 100 mm pipe diameter, the provisions of the Code must prevail. No choice, specify 100 mm pipe diameter.

ILLUSTRATION 6-2

Find the size of a soil stack to serve: 2 units water closet; 2-showers; 2-lavatories and 1-residential sink.

SOLUTION

1. Find the total number of Fixture Units using Table 5-1.

2 x 6 water closets	12 units
2 x 2 shower bath	4 units
2 x 1 wash basin	2 units
1 x 2 kitchen sink	2 units
Total fixture units.......	20 units

2. Refer to Table 5-2, under Total in Stack, the 20 fixture units is within the limit of 50 mm or (2") pipe diameter.
3. The 38 mm or (1 ½ ") diameter pipe could not be used because of the limitations set by the Plumbing Code which states that:

   "No water closet shall discharge into a drain less than 75 mm or 3 inches diameter pipe."

4. Therefore, a 75 mm pipe diameter will be specified, not the 50 mm, even if it was the result of our computation.

The Plumbing Controversy

At one time, the plumbing industry introduced radical changes from a traditional policy to one involving scientific principles for plumbers guide. One example is the old rule which says: **"six water closets, six wash basins and six bathtubs were considered the maximum load that a 100 mm or 4" soil pipe could possibly accommodate.**

The rule further stipulated that:

"In case one more water closet was added to the installation, a 125 mm or 5" soil pipe was required."

In so short a time, the regulation was amended increasing the allowable load from 6 to 10 water closets for a 100 mm pipe diameter. The new regulations triggered adverse opinion from the elders and conservative plumbers.

The old plumbers being traditionally minded were not ready to accept the changes. They were not aware of the fact that the amendment was based on the result of extensive practical tests using a transparent plastic pipes supported by mathematical calculations and computers conducted by the Uniform Plumbing Code Committee.

The experiment showed that a 100 mm diameter soil pipe could effectively serve up to ***840 Fixture Units or 140 water closets*** without overloading the pipe. Transparent plastic pipes were used during the testing, and it was found that even if these water closets were used continuously at the same time, ***flushing at one point in time is statistically improbable.***

Moreover, the experiment revealed that proper ventilation of the fixture traps, and careful installation of the pipe has contributed much to the efficiency of the system, rather than by increasing the size of the pipe. Under certain condition, more fixtures may be added to the system without harm. *(Report of the Uniform Plumbing Code Committee, a publication issued jointly by the Dept. of Commerce and the Housing and Home Finance Agency, Washington D.C.)*

The Experiments Conducted by the Uniform Plumbing Code Committee Revealed that:

1. Instead of increasing the diameter of the pipe, the ventilation of fixture traps should be looked into because it promotes efficiency of the entire plumbing installation.

2. The use of the right kind of fittings and proper installation, plus the strict observance of the prescribed slope of the pipe, contributed primarily to the effectiveness of the drainage system.
3. Under a certain condition, more fixtures may be added to the installation without fear of being overtaxed. (*see report of the Uniform Plumbing Code Committee of 1949.*)
4. The experiments further revealed that ***Wet Venting*** is safer under certain conditions. ***Stack Venting*** for one or more storey building has proven to be satisfactory.
5. Long drain wet vented bathtub are safe, provided that the pipe is installed with a slope not greater than 2% or 2 centimeters fall per meter length.

6-3 The Soil Branch

The Soil Branch is a soil pipe ***installed horizontally*** with lateral or vertical connections that receives the discharges of water closet with or without additional plumbing fixtures.

General Conditions in Installing Soil Branch

1. The Soil Branch being concealed in floors, partitions or lowered ceiling should be accessibly provided with sufficient number of cleanouts.
2. Cleanout should be installed wherever changes of soil branch directions are made.
3. Cleanout should be the same in diameter as the soil branch.

4. Cleanout should be located at the farthest end of the branch away from the vertical soil pipe.
5. The use of short radius fittings on soil branch when making a change of direction such as short sanitary Tee, ¼ bend and short **L** should be avoided.

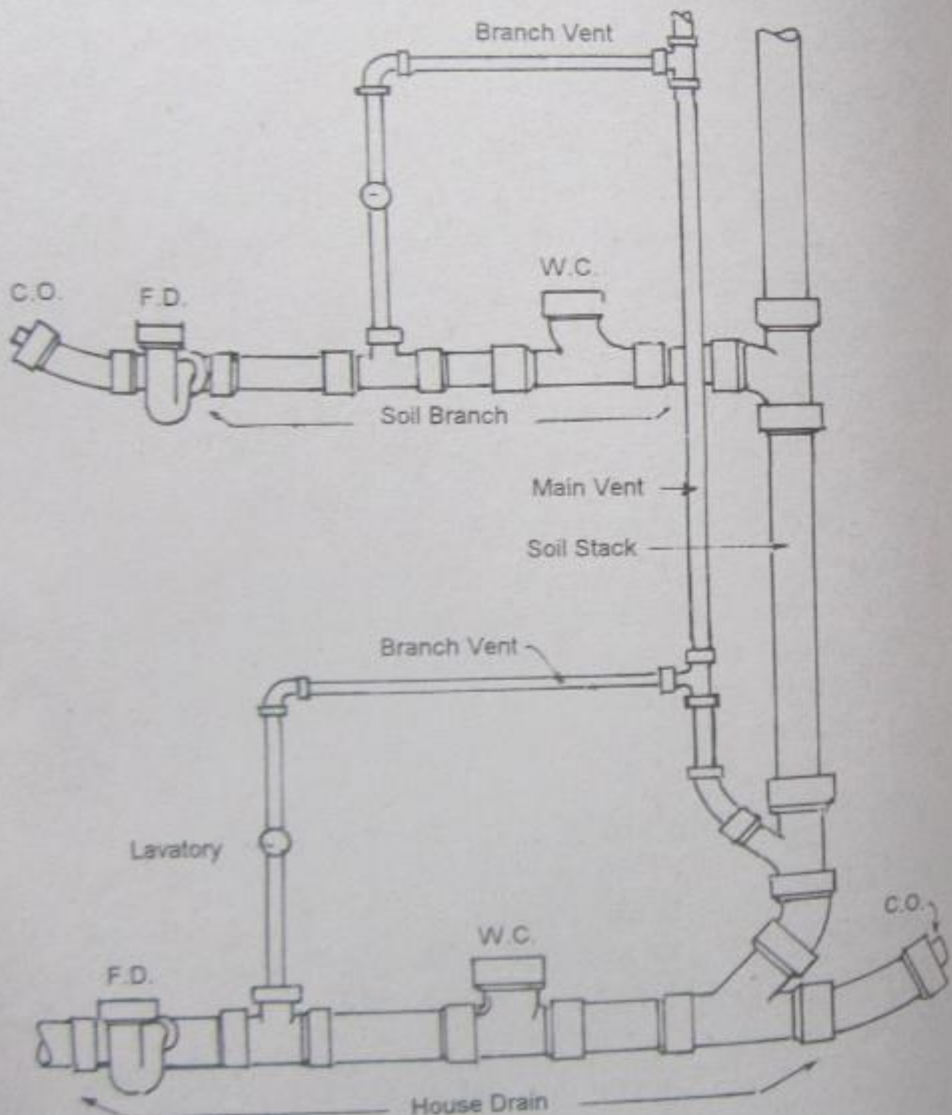


FIGURE 6-3 SOIL BRANCH

6. A long radius fitting shall be used for a horizontal to horizontal or vertical to horizontal change of direction. In some instances, the use of short radius fitting is only permitted on a vertical to horizontal change of direction.

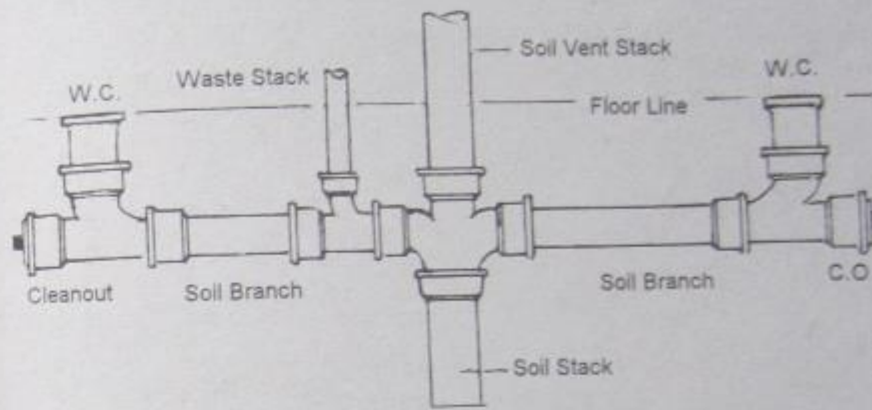


FIGURE 6-4 THE SOIL BRANCH AND CLEANOUT

7. Soil branch shall be graded properly and carefully aligned. Crooked joint should not be allowed.

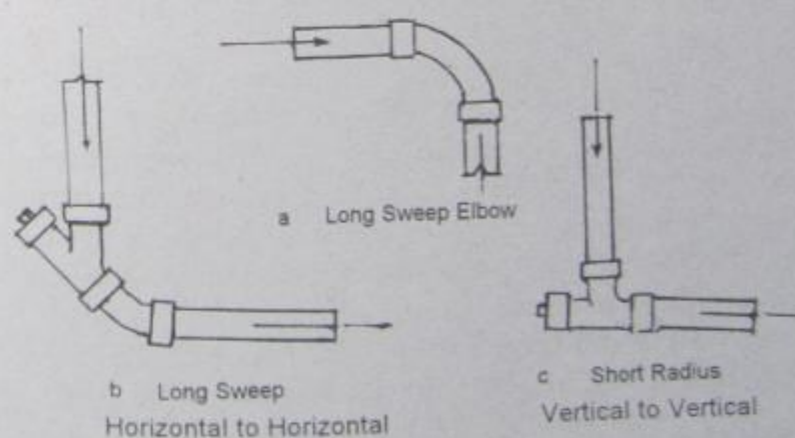


FIGURE 6-5 CHANGE IN DIRECTION OF SOIL BRANCH

8. The efficiency of a horizontal waste installation depends upon the **Scouring** or **Self-cleaning** action for every discharge of waste. Soil branch having a slope more than 2% fall has the tendency of separating the solid waste from the liquid. Water flows faster on high pitch leaving the suspended materials at the bottom of the pipe. On the other hand, pipes with grade less than 2% is also susceptible to stoppage due to retarded flow.

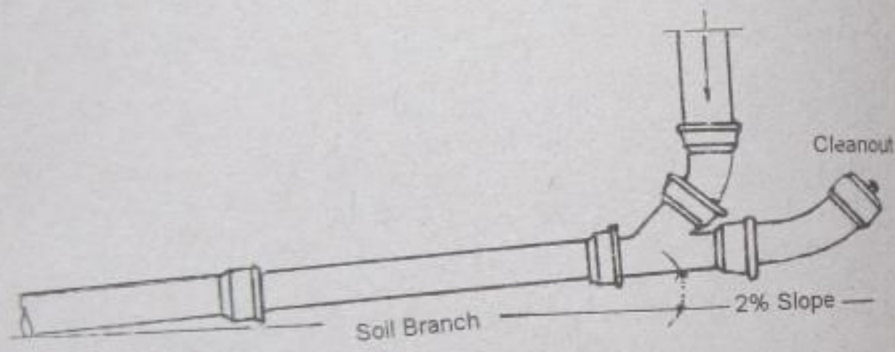


FIGURE 6-6 SLOPE OF SOIL BRANCH

6-4 Size of the Soil Branch

The flow of waste inside a horizontal pipe, particularly the soil branch, is much different from those inside the vertical stack. As previously explained, the expected efficiency of a liquid flow inside a horizontal pipe depends upon the scouring action for every discharge. If this action could be attained in every pipe installation, stoppage problem could be avoided. Fixture groups differ in design. And to provide a soil branch of the size just to serve each type of fixture would be more difficult and impractical.

Although scouring action is no longer a problem when 2% slope is followed, yet, satisfactory result may be obtained if pipe of ample diameter is provided with a minimum and maximum fixture limit. How to determine the required size of a soil branch with the aid of Table 5-1 and 5-2, the following example was presented.

ILLUSTRATION 6-3

What diameter of a soil branch is appropriate to serve a battery of 3 water closets?

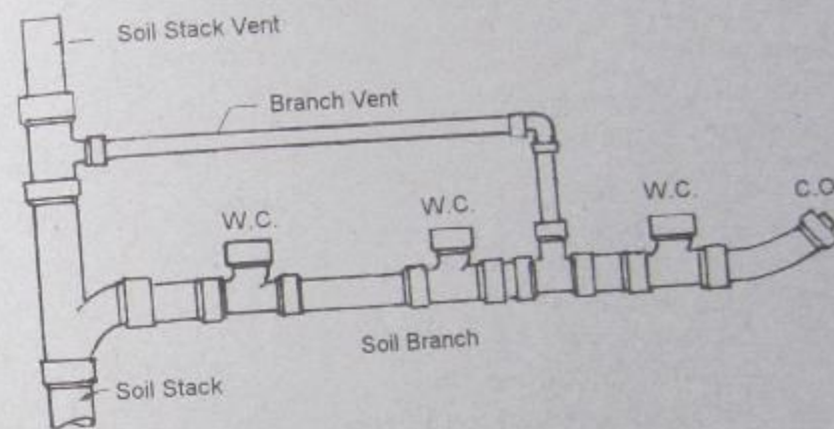


FIGURE 6-7 BATTERY OF 3 WATER CLOSETS

SOLUTION

1. Find the total fixture units of 3 water closets. Referring to Table 5-1, water closet has 6 fixture units. Multiply:

   6 units x 3 water closets = 18 units

2. Refer to Table 5-2, under column ***one horizontal branch*** a 75 mm diameter pipe could serve up to 20 fixture units. Thus, a 75 mm or (3") pipe could serve well the 18 units as computed. But the Plumbing Code on pipe size limitations states that:

"Not more than two water closets shall discharge into any 75 mm diameter horizontal soil branch, house sewer or house drain."

3. The Code must prevail. Specify a 100 mm diameter for soil branch, not 75 mm. as computed.

ILLUSTRATION 6-4

What diameter of soil branch will be satisfactory to serve a battery of 25 water closets?

SOLUTION

1. From Table 5-1, the total fixture units of 25 water closets is:

   25 x 6 units = 150 fixture units.

2. Refer to Table 5-2. Under one *horizontal branch* column, a 100 mm (4") diameter soil branch could serve up to 160 fixture units. Therefore:

3. Specify a 100 mm diameter soil branch to serve the 25 water closets.

Comments:

1. From the two illustrations just presented, it could be seen clearly that a 100 mm diameter pipe is required to serve 3 water closets, while it could satisfactorily serve 25 water closets. Much more, when the Plumbing Code Committee issued a report that a 100 mm pipe could effectively serve 840 fixture units coming from a 140 water closets without the danger of overloading.

2. Would it not be confusing to see disproportional computations like this? It might be confusing, but since the fixture unit was formulated by the Uniform Plumbing Code Committee, the Code must prevail.
3. However, considering the unending search for advancement in plumbing technology, this author believe that in the near future, this present Fixture Unit regulations, will again get updating as what had happened when the Committee amended the allowable fixture unit for several occasions.

Noise and Condensation

Noise is one among the serious problem of plumbing installation. It annoys the occupants. The water rushing down through the soil pipe within the wall creates various unwanted irritating noise. On the other hand, condensation causes the dripping of water inside the ceiling, the number one enemy of wood and other similar or related materials.

Solution to this Problem

1. Soil pipe should not be in contact with plastered walls or ceiling because it will create sounds that are magnified inside the room. Waste and Soil pipe not embedded in concrete must be insulated. Hair felt or mineral wall materials are packed around the waste or soil pipe as insulator to absorb noise.

2. Condensation may be overcome by applying a good quality anti-sweat covering materials to the soil pipe installation.

Prohibited Fittings and Connections

The National Plumbing Code on fittings and connections of soil pipe provides that:

A. Prohibited Fitting:

1. Double Hub, Double Tee or Double Y branch should not be permitted on soil pipes or horizontal lines.
2. The drilling and tapping of house drain, soil pipe and waste or vent pipes and the use of saddle hubs or bends are strictly prohibited.

B. Dead End Fittings

Dead-end connections in any drainage installation should not be permitted. This portion of the plumbing system will only accumulate waste and sludge.

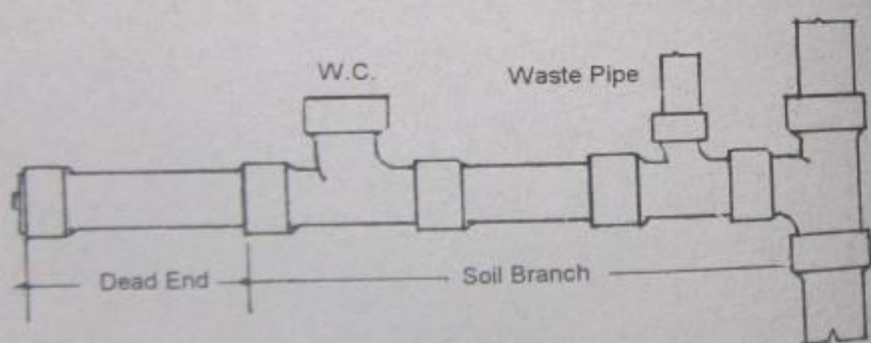


FIGURE 6-8 DEAD END CONNECTION

CHAPTER 7

THE HOUSE DRAIN

7-1 The House Drain

House Drain is that portion of the plumbing system that receives *discharges of all soil and waste stacks* within the building, and conveys the same to the House Sewer.

House Drain is sometimes referred to as the **Collection Line of a Plumbing System.** It can be installed underground, or maybe suspended below the floor or inside the ceiling. In large building, house drain is usually suspended from the basement ceiling to avail of the gravity flow of waste to the Main Sewer.

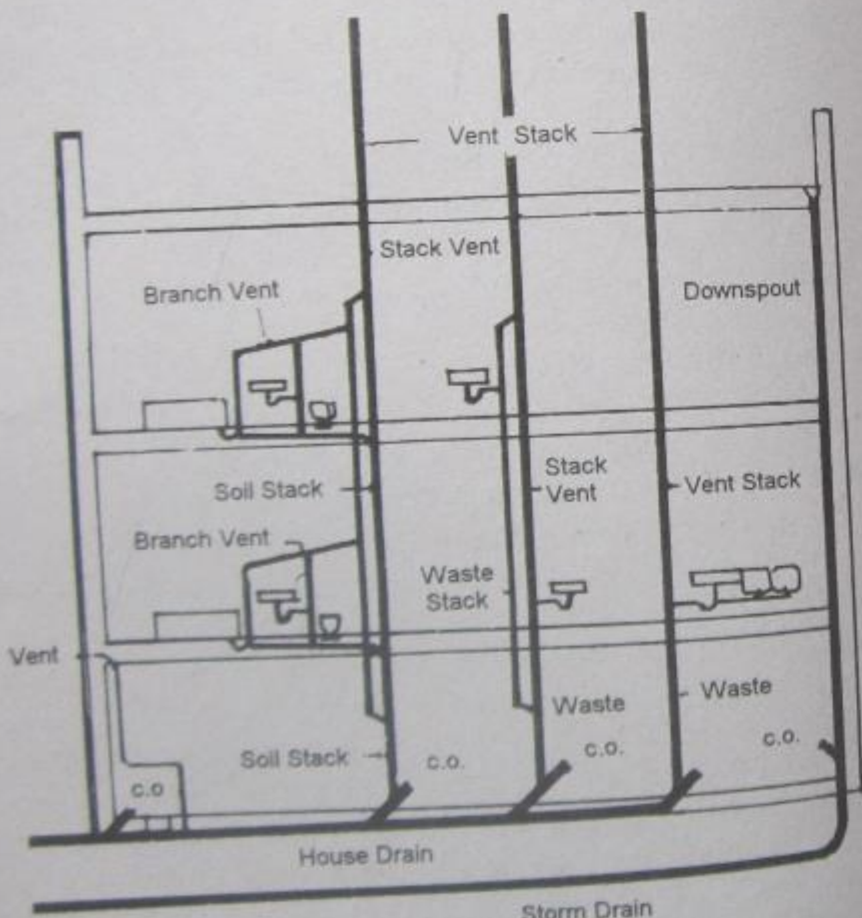
Many plumbers still believe that, by making the drain-pipe larger than what is necessary, will increase its efficiency. They may not know that scouring action will not work effectively by increasing the size of the house drain. The solid wastes are carried along the bottom of the pipe, and because the water flow within the larger pipe is shallow, and slow, they become separated from the water, and remains at the bottom of the pipe. The result is clogging of the drain branch, and ultimately, the entire house drain. To assure scouring action, the house drain should be size correctly to have a flow about 50% of the pipe diameter.

House Drain may be Classified into Four Types.

1. Combined drain
2. Sanitary drain

3. Storm drain
4. Industrial drain

Combined Drain is a type of house drain that receives discharges of sanitary waste as well as storm water. This is the oldest form of house drain when public sewers are of the combination design. This type of house drain however, is already phase out and no longer permitted.



Sanitary Drainage System with Separate Disposal of Storm Drain

FIGURE 7-1 SANITARY DRAIN

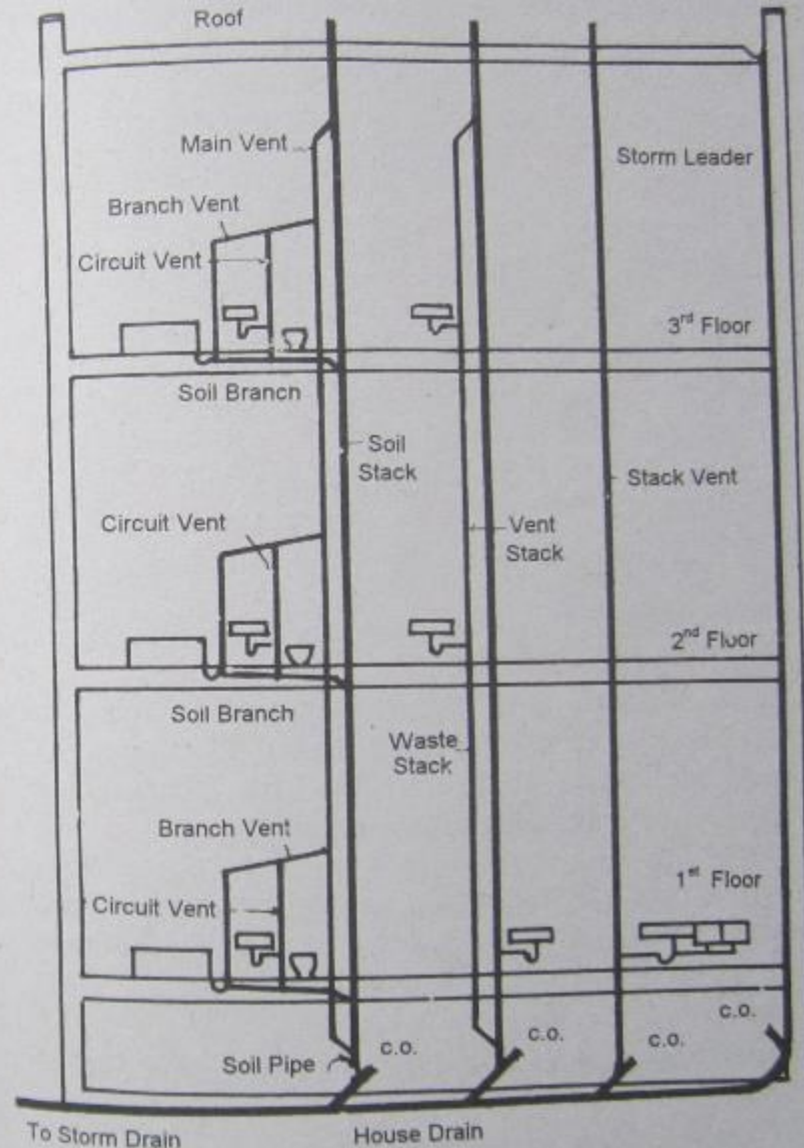


FIGURE 7-2 COMBINED STORM DRAIN

Sanitary Drain. This type of house drain receives the discharges of sanitary and domestic waste only. The waste is conveyed to a public sewer, or septic tank, by the house sewer. Storm water is not allowed in the sanitary drain.

TABLE 7-1 SIZE OF SANITARY DRAIN

Diameter of Pipe		Maximum No. of Fixture Units that may be connected to		
mm	In.	2% Slope	3% Slope	4% Slope
32	1 ¼	1	1	1
38	1 ½	2	2.5	3
50	2	5	7	8
63	2 ½	12	13	14
75	3	18	18	21
100	4	84	96	114
125	5	162	216	264
150	6	300	450	600
200	8	990	1392	2220
250	10	1800	2520	3900
300	12	3089	4320	6912

Industrial Drain is a house drain that receives discharges from industrial equipment that contain some objectionable acid wastes. Industrial drain that contains acid waste terminates into a separate drainage basin.

Storm Drain conveys all storm clear water, or surface water waste except sanitary wastes. Storm drain terminates into lake, river, dry run or natural basin.

7-2 Determining the Size of House Drain

The **Unit System** is the most practical method to use in determining the size of a house drain. It has been formulated from tests conducted by the Uniform Plumbing Code Committee, a body consisting of representatives of management, labor and government standard agencies.

Plumbing fixtures were individually tested. The amount of liquid waste discharged through their outlet orifices in a given interval was carefully measured. It was found, that a washbasin being the smallest type of plumbing fixture, would discharge waste approximately 7 ½ gallons in one-minute interval. This volume was found out to be closely one cubic foot of water.

The Code Committee has finally decided to adopt the washbasin discharge as **One Fixture Unit**. One fixture unit represents 30 liters of water. Other fixtures discharges were also tested and the corresponding results were established and listed in Table 5-1 called **Fixture Unit** values.

Before finding the size of a house drain, its service must be known first, whether the purpose is for sanitary waste or as storm drain.

a. If the purpose is for sanitary waste, the Fixture Unit load discharges will be the basis of computation with reference to Table 5-1.
b. If the purpose is for storm drain, the roof area that accumulates the major rainfall water will be the basis in determining the size of the pipe with reference to Table 9-1 and 9-2. It seems that the approach is quite complex, but simplified with the use of charts and data compiled for years from the installation experiences recorded by the Code Committee.

On House Drain, the Plumbing Code Provides that:

1. No water closet shall discharge into a drain less than 75 mm or 3 inches pipe diameter.
2. No more than two water closets shall discharge into any 75 mm horizontal soil branch, house drain or house sewer.

ILLUSTRATION 7-1

Determine the size of a Sanitary House Drain to serve 6 water closets, 5 urinals, 5 shower bath, 6 washbasins, 4 floor drains and 3 combined fixtures.

SOLUTION

1. The house drain is to serve *Sanitary Waste*. Refer to Table 5-1, the Fixture Unit values are:

6 x 6 water closets	36 units
5 x 5 urinals	25 units
2 x 5 shower bath	10 units
1 x 6 wash basins	6 units
1 x 4 floor drain	4 units
3 x 3 combined fixture ...	9 units
Total........................	90 Fixture units

2. Refer to Table 7-1, under column 2% slope, a 100 mm (4") pipe could serve 96 fixture units.

3. For a 90 fixture units, specify a 100 mm diameter house drain pipe.

7-3 Grade or Slope of the House Drain

Numerous tests proved that the sloped of a house drain has contributed much to the effectiveness of the plumbing system. The ***house drain*** being a ***horizontal pipeline*** must produce the necessary velocity and discharge capacity at a certain inclination, to attain scouring action. House drain must function without abnormal or subnormal pressure in the plumbing system.

It is recommended under any circumstances that, a 2%

slope for the house drain should be maintained. There are instances however, where less than 2% slope was adopted, under the following circumstances.

1. When the depth of the sewer line in relation with the depth of the basement floor is low.
2. Long sewer line would require lower pitch but should not be less than 1%.
3. In case the sewer line slope is very slight, installation of the pipe should be guided by leveling instrument for accuracy to prevent sags or trapped piping.

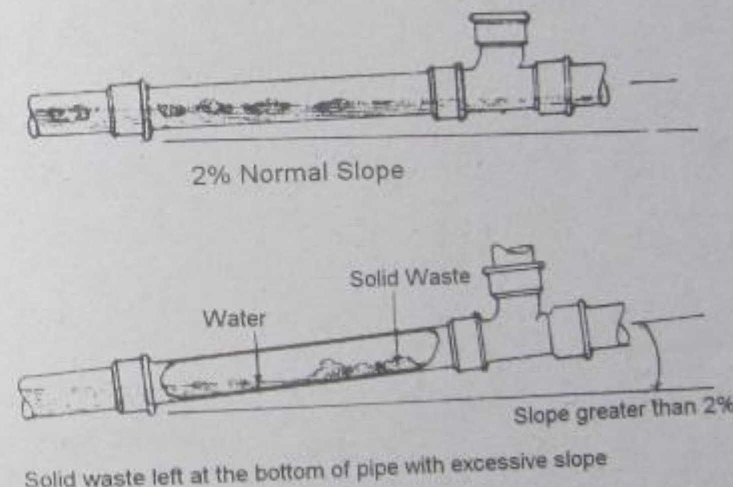


FIGURE 7-3 THE PROPER AND IMPROPER SLOPE OF HOUSE DRAIN

The grade or slope of the house drain could be estimated by dividing the total pitch in centimeters (*which is the distance between the house sewer and the elevation of the basement*) by the length of the longest branch in meter.

For instance, if the longest branch of a house drain is 8 meters, and the total drop is 16 centimeters, dividing 16 by 8 meters the value is 2%. A pitch or slope more than 2 %

percent, will increase the velocity and discharge capacity of the pipe, the effect could be:

1. A danger that it might decrease the depth of the water that is necessary to create a scouring action.
2. This might cause a minus pressure if the drain is over loaded to a flow capacity.

7-4 Change of House Drain Direction

Changes of house drain direction is also governed by the following conditions:

1. All changes in directions from horizontal to horizontal, or vertical to horizontal flow, should be done with long radius fittings. Short Tees, ¼ bends and short turn L fittings, should not be permitted.

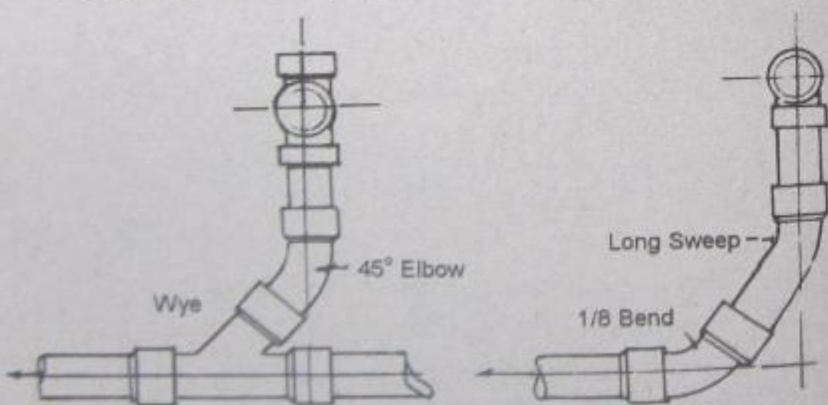


FIGURE 7-4 CHANGE OF DIRECTION

2. Soil branch should be run Right Angle to the main.
3. Fixture connection must run at Right Angle to the branch.

7-5 House Drain Cleanout

On House Drain Cleanout, the National Plumbing Code provides that:

1. The house drain shall be provided with adequate number of cleanouts to prevent breaking of the floor, in case of drain stoppage.
2. The location of the cleanout depends upon the good judgment of the plumber where it is readily accessible, in case of line trouble.
3. Any branch of the house drain terminating at a floor drain or fixture, shall be provided with 100 mm diameter pipe, extended at least 2 inches above the floor inserted in a 45 degrees Y branch in the direction of the drain flow.
4. The cleanout shall be equipped with threaded screw cover provided with a raised head that could be removed easily with a wrench.
5. A cleanout extended above the floor, shall not be utilized as a floor drain.

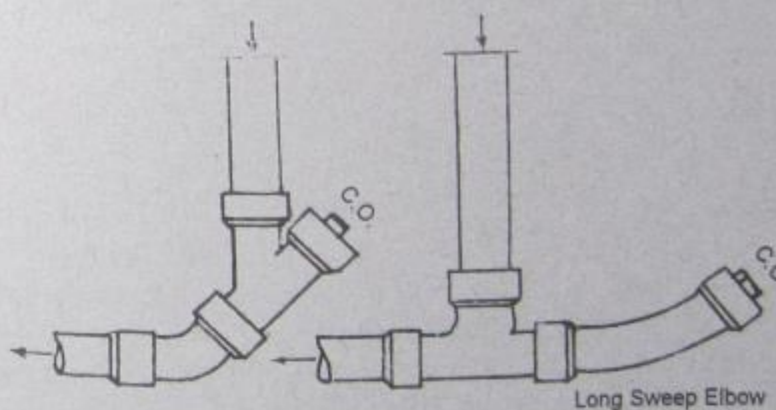


FIGURE 7-5 THE HOUSE DRAIN CLEANOUT

6. The trap of a floor drain shall be placed not more than 50 centimeters below the finished floor line, to facilitate cleaning in case of line trouble.

7. A cleanout shall be installed at every 20 meters interval distance, and also at the base of all soil and waste stack.

7-6 House Drain Appliances

House Drain appliances includes the following:

1. House Trap
   a. House trap assembly
   b. Back flow valves
   c. Balanced valve
   d. Unbalanced valve
2. Area Drain
3. Floor Drain
4. Yard Catch Basin
5. Garage Catch Basin

Garage Catch Basins Includes:

a. Drain tile receptor
b. Sewage ejector
c. Automatic water siphon
d. Sump pit
e. Grease basins

House Trap

House Trap is defined as a device installed in the house drain immediately inside the foundation wall of the building. It serves as a barrier and prevents the gases coming from the public sewer or septic tank in circulating through the plumbing system.

For so many years, the use of house trap has been a controversy that divided sanitary authorities. Some says that, its use is not necessary. Others contend that, it is necessary for the protection of life.

In either case, one point that must be accepted as a certainty is that, public sewers are filled with various gases which are common to the science of chemistry as: Oxygen (O), Nitrogen (N), Carbon dioxide (CO_2), Hydrogen (H), Hydrogen sulfide (H_2S), Methane (CH_4), Carbon monoxide (CO), and Sulfūr Dioxide (SO_2). Considering the different gases being produced inside the public sewer and septic tank, Sanitary Authorities advocating for the use of house trap contended that:

"Whenever an element that is dangerous to health or life is present, even though in small volume, adequate protective measures must be taken. Thus, where noxious gases are present, house trap must be installed on the house drain."

However, Public Authorities favor the elimination of the house trap because its presence adversely lessens the discharge capacity of the sewer. Sanitary authorities established an opinion that sewer gases and the manner how they occur are not detrimental to health, provided, that the plumbing system is properly installed.

They concluded further, that an aerated or ventilated sewer would not be gas-producing agency. A liberal attitude relative to the house trap and the advisability of its installation is recommended.

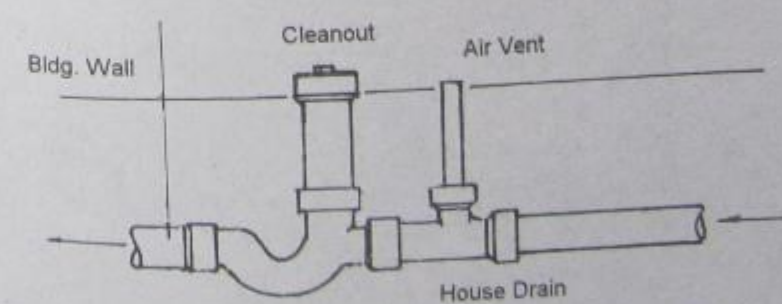


FIGURE 7-6 HOUSE TRAP AND FRESH AIR PIPE

Back Flow Valve

The Back Flow Valve is a device used in a drainage system to prevent the reversal of flow. It is installed in a house drain or branches of the house drain that are subjected to reversal flow of liquid. The back flow valve is installed on the house drain, just near the foundation wall or near the toilet room under floor. It is set in a level position to attain its full effectiveness.

Back flow valves are constructed in two patterns and are classified as:

1. The Balance Valve
2. The Unbalanced Valve

The Balance Valve is the most preferred, because it has the characteristics of non-interferences in the movement of air inside the drainage system. The interior mechanism consists of a brass-seat into which fitted a gate counter balanced with an adjustable cast iron weight.

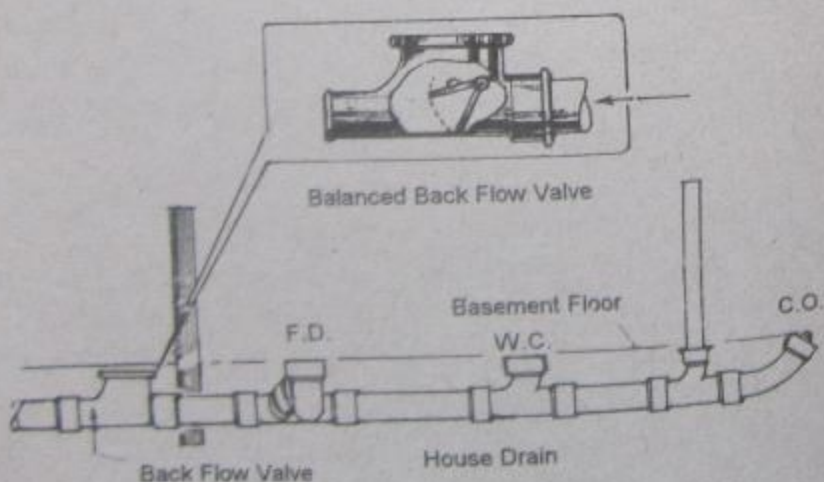


FIGURE 7-7 BALANCED BACK FLOW VALVE

The Unbalanced Valve is not illustrated here, but its appearance is similar to the balanced valve. This type of valve is not preferred because of its recorded poor performance in the past.

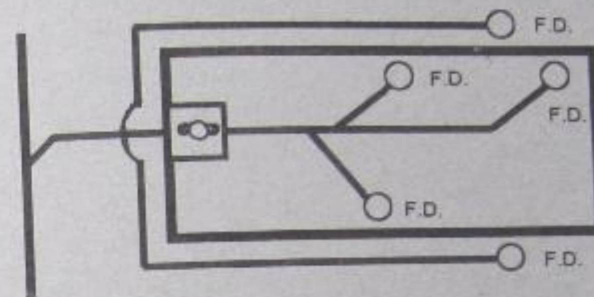


FIGURE 7-8 LOCATION OF BACK FLOW VALVE

Area Drain

The area drain assembly consists of a running trap installed under the basement floor to protect it from freezing. The trap is equipped with a cleanout. The minimum size of an area drain is 10 mm or 4" pipe to drain basement entryways, loading platforms, or driveways.

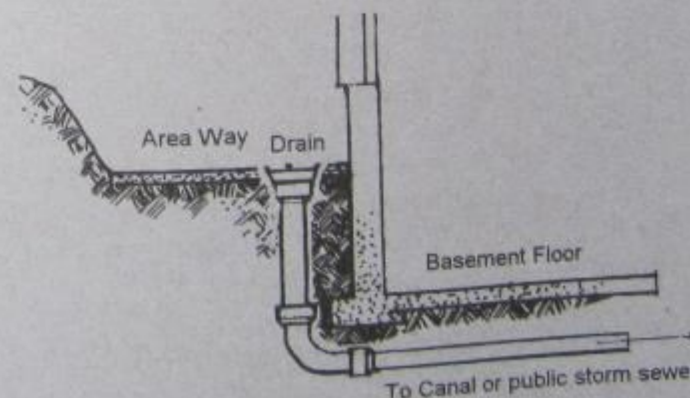


FIGURE 7-9 AREA DRAIN INSTALLATION

Floor Drain

A floor drain is defined as; a receptacle used to receive water to be drained from the floor into the plumbing system. Sanitary authorities recognized floor drain as plumbing fixture properly designed and located where to receive liquid floor waste.

On Floor Drain, the Plumbing Code Recommended the Following:

1. An average residence is provided with two floor drains. One located near the heating equipment, and the other in the vicinity of the laundry. In most instances, one floor drain is provided to serve the entire basement. Because of this false economy, the result is an annoying wet floor.
2. Every room where laundry equipment is used, shall be provided with adequate floor drain.
3. The drain proper must be located where the overflowing water will not travel a great distance over the floor before it enters the drain. It is recommended that the floor drain be located at one end of the laundry tub. This will assure a dry floor where one stands when using the fixture.
4. Every floor drain shall be supplied with running water from a fixture located nearby. If the fixture is less than 1.50 meters from the drain, it should be tapped but not necessarily vented.
5. Fixture drains which supply water to a floor drain, should be connected to the house side and never to the sewer side of the trap.

The most common and frequent trouble experienced by home owners is the water on the floor being rejected by the floor drain. One of its causes is the presence of sand and other objectionable wastes accumulated inside the P-trap. Sand and dirt are accumulated inside the floor drain gradually when cleaning the floor. And to remove this accumulated sand inside the P-trap is a real problem which has started from the time when:

1. The plumber failed to anticipate this problem. He installed a 50 mm or 2 inches P-Trap, which is too small for a human hand or tools to clean.
2. The P trap installed might have been too deep below the floor line despite of its being small in size.

Trouble in the plumbing installation is very certain to happen and therefore, must be anticipated. The plumbing layout as **Built-in Plan** must be kept for future reference in case of trouble. Without the Built-in Plan, hit and miss repair would be very difficult and costly.

Experienced plumber will not install P-Trap smaller than 75 mm diameter on floor drain. More so, when it will be installed underground or embedded in concrete slab. The difference in cost between a 50 and 75 mm waste pipe for a short distance floor drain and P-Trap is immaterial, compared with the risk and the inconveniences that will be encountered in case of drain trouble. Experienced plumber specify floor drain not less than 75 mm.

Reminders in Installing Floor drain.

1. Floor drain is usually installed on basement floor, near the heating equipment, below the kitchen sink, and vicinity of the laundry.
2. The 75 mm or (3") P-Trap is recommended mini-

mum size for floor drain. It should be installed not more than 20 centimeters below the floor line.

3. The P-trap should be Deep Seal type.
4. The low inlet hub pattern P-trap is commonly used as floor drain.

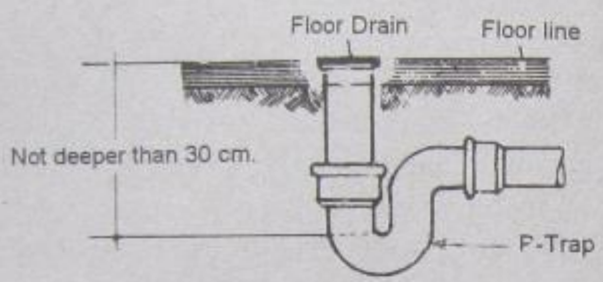


FIGURE 7-10 FLOOR DRAIN

Basement Floor Drain

The National Plumbing Code on Basement floor drain provides that:

"Cellar or basement floor drains shall connect into a trap so constructed that it can readily be cleaned and of a size to serve the purpose efficiently for which it is intended. The drain outlet should be so located that it is at all times in full view. When subjected to back flow pressure, such drains shall be equipped with an adequate Black Flow Valve."

Yard Catch Basin

Yard catch basin is defined as a receptacle used to catch surface water drained from cemented courts, driveways, and yards. It could be a terminal for drain tile installations used to drain water from athletic fields.

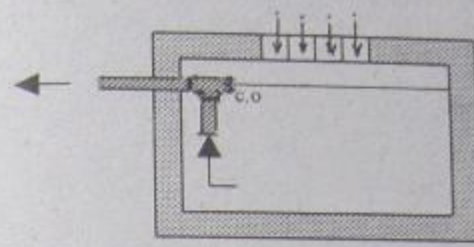


FIGURE 7-11 YARD CATCH BASIN

Garage Catch Basin

Garage catch basin is a device designed to convey wastes from garage, wash rack, grease pits and repair floors into the house drain. Wastes coming from these areas contain objectionable elements like grease, oil, grit and gasoline that are detrimental to the drainage installation as well as the sewage disposal system. These sediments cause stoppage and affect the operation of the sewage disposal plant.

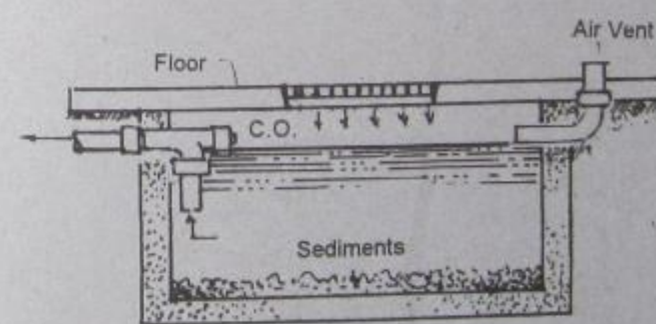


FIGURE 7-12 VITRIFIED CLAY GARAGE CATCH BASIN

Oil and grease adhere to the mechanical devices used in the treatment of sewage. These kinds of wastes may reduce the bacterial activity necessary to the process.

The function of garage basin is to retain these noxious materials and discharge the associated water into the house drain. The efficiency of the garage catch basin depends on how it is regularly cleaned.

Grease Basins

Most stoppage in the plumbing system were found to be caused by grease and oil contained in the waste discharges. This is more prevalent in large kitchens serving hotels, dining rooms, clubhouses and restaurants. To overcome this problem, a device known as a grease trap is installed on the waste line.

The efficiency of a grease trap is dependent on the attention given to it. Removal of the grease is done regularly to obtain the full benefit of the device. But removal of the grease is a disagreeable work, and, in most instances, is done only when the trap ceases to function. Big establishments clean their grease trap almost daily.

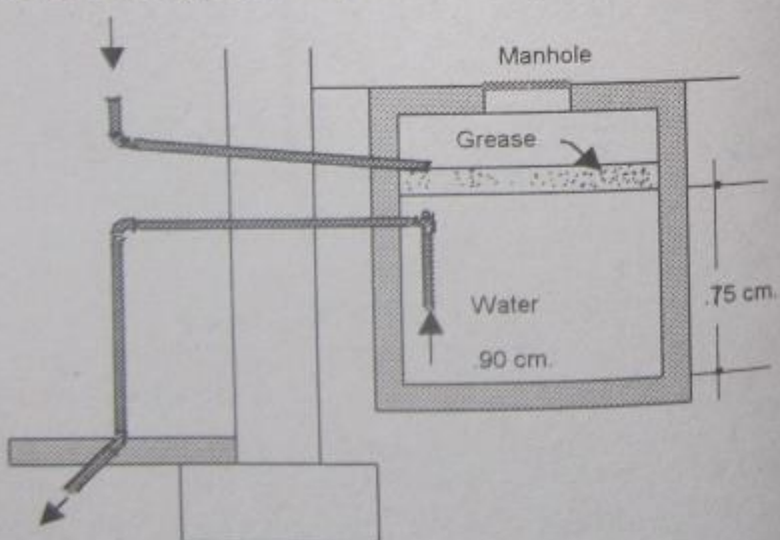


FIGURE 7-13 EARTH COOLED GREASE BASIN

Installing the Grease Basin

1. The grease trap shall be installed as close to the fixtures as possible. More than one fixture can discharge into the same trap, provided that the waste pipe is not very long and the trap has sufficient size.
2. A grease trap placed on the ground is earth cooled. Earth-Cooled Grease Trap is used on large installation and is most desirable type.
3. The basin width should not be less than 60 centimeters. The length should be from 3 to 4 times its width to attain a smooth and non-agitated flow.
4. The minimum depth of concrete grease trap should not be less than 120 cm. below the outlet invert.
5. The size of a grease trap is measured through the volume of fixture units to be discharged. It could be sized according to the number of meals served estimated at 4 to 5 gallons of liquid capacity for each meal. Experienced sanitarians estimated double the actual volume of waste to which the trap will serve.

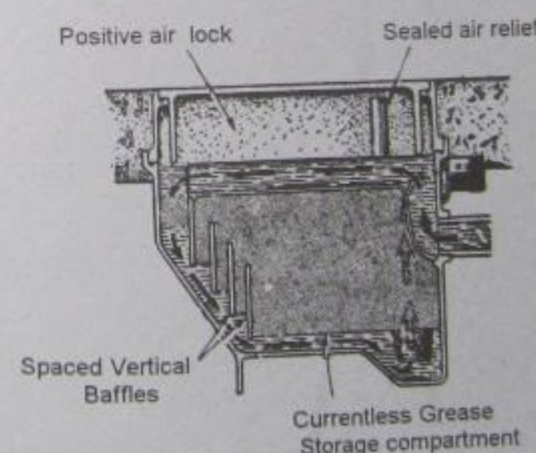


FIGURE 7-14 GREASE INTERCEPTOR FLUSH WITH FLOOR

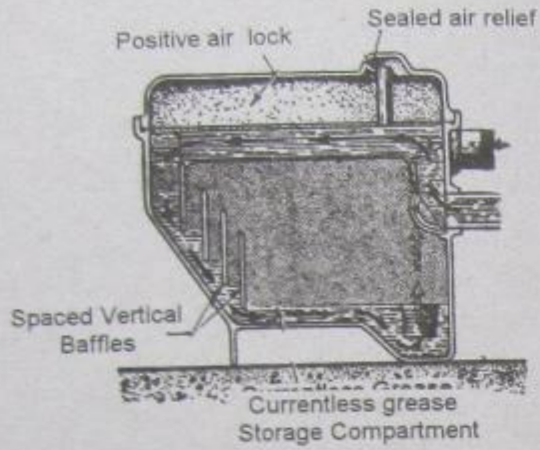


FIGURE 7-15 GREASE INTERCEPTOR RESTING ON FLOOR

CHAPTER 8

THE HOUSE SEWER

8-1 House Sewer

House Sewer is defined as, that portion of the horizontal drainage system, which starts from the outer face of the building and terminate at the main sewer in the street or septic tank.

Other code defined **House Sewer** as, that portion of the horizontal drainage system, which starts 90 centimeters from the outer face of the building. House sewer is sometimes called the ***Building Sewer***.

The **Main Sewer** line is financed and maintained by the government. Those houses along the street with main sewer line are required to connect their house sewers to the public sewer line.

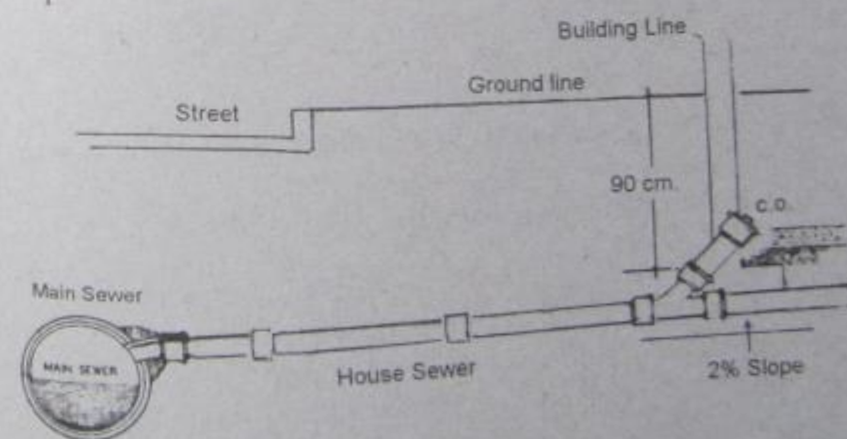


FIGURE 8-1 THE HOUSE SEWER

The efficiency of a drainage installation depends upon the performance of the house sewer, and efficiency would increase by making good connection at the main.

8-2 House Sewer Connection to Main Sewer

The house sewer is connected to the main sewer by boring a small hole through the concrete pipe, using a sharpened steel chisel or electric drill. The hole is gradually enlarged to receive the sleeve. Extra care should be exercised not to break the inside wall of the main sewer. The House Sewer pipe is connected to the Main Sewer entering at 45 degrees angle or directly from the top.

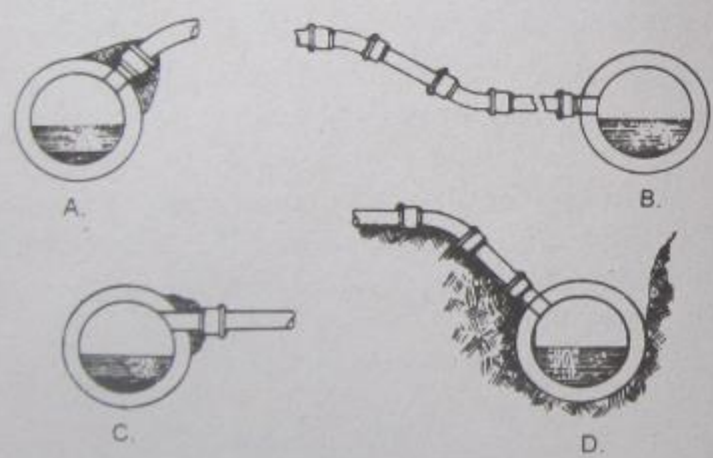
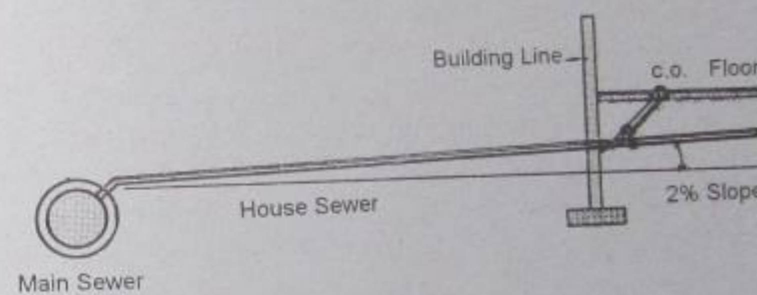


FIGURE 8-2 HOUSE SEWER CONNECTION TO THE MAIN SEWER

General Conditions in Installing Sewer Pipes

1. Secure permits from the sewerage authority.
2. Verify the depth of the house drain outlet.
3. Determine the depth of the connection with the main sewer in the street and the grade of the house sewer.
4. The depth is found by measuring the length of the longest branch of the house drain multiplied by the pre-planned pitch per meter.

5. Add the required 30 cm. ground coverings from the top of concrete floor or 40 centimeters of ground covering without concrete floor.
6. Verify the depth of the connection to be made with main sewer. Remove the manhole cover on both ends. Measure the depth using a meter tape or stick.
7. The grade of the house sewer could be found through the difference between the House Sewer and the depth of the Main Sewer. A leveling instrument will give a satisfactory result. Additional grade can be made with the use of 1/8 bend considered as the most practical method of establishing grade.



8-3 Size of the House Sewer

The size of house sewer for residential connection to the main or septic tank has been established by sanitary authorities, based on their records of installation tests, and mathematical conclusions.

The old practice is to use 150 mm or 6 inches diameter cement or vitrified clay pipe for house sewer. If plastic pipe or its interior surface texture equivalent is used, the diameter can be reduce to 100 mm diameter, subject to the standard rules, promulgated by the National Plumbing Code.

In selecting sewer pipe for hotels, apartment houses, commercial and industrial buildings, the total discharges in terms of fixture unit are considered. Likewise, the overlapping of discharges and the simultaneous use of the fixtures are also included in the calculations.

An example of which are illustrations presented under Section 7-2 - Size of the House Drain.

How to Find the Slope of House Sewer

Apply the formula: **Height of rise = Length x %**

If the distance is say 24 meters x 2% = .48 m

To find the slope; $\% = \frac{\text{Height}}{\text{Length}} \times 100$

$$\% = \frac{.48}{24\text{m.}} = 2\%$$

CHAPTER 9

THE STORM DRAIN

9-1 Storm Drain

Storm Drain is that unit of the plumbing system that conveys rain or storm water to a suitable terminal. Storm water is normally discharged into street gutter conveyed by public drain system and carried to some natural drainage terminal like canals, rivers, lakes and the like.

As a general rule, storm drain is not permitted to discharge into a septic tank or to the main sewer line. The collection and disposal of storm water is an important phase of plumbing system that should not be ignored, otherwise, water coming from the roof if not properly diverted might create problems like:

1. Settlement of the structure cause by erosion or washing away the soil from the foundation.
2. Subjecting the basement floor and walls to unnecessary ground water pressure and possible leakage.
3. Rundown water may create walls and window leakage.
4. Water may spill on people passing by or approaching entry door.
5. Erode the surrounding grounds and cause disfiguring of the landscape areas.

The disposal of storm water has become a major concern of the Local and National Government. Large amount of appropriation is regularly incorporated in the annual budget for drainage purposes. Among the government's priority program on infrastructure, is toward flood control. The trend is to provide a storm sewer line, to serve not only the commercial and industrial establishments, but also residential houses in disposing off storm water. Laws and Ordinances were passed making the connections of storm drain to the storm sewer line compulsory.

Splash Pan is a collector of water coming down from the downspout leading the accumulated water away from the house at a relatively low rate of flow.

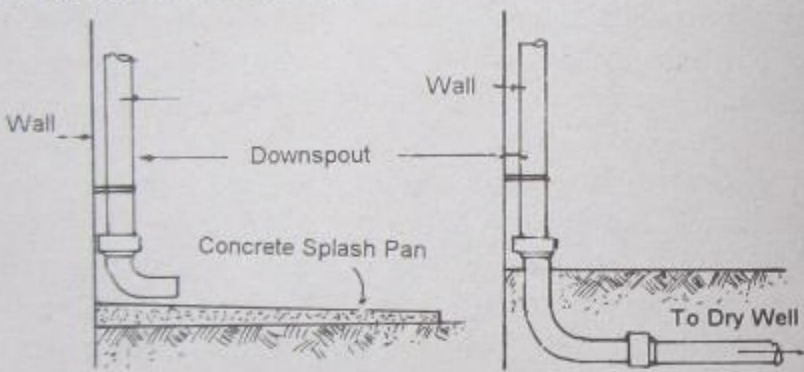


FIGURE 9-1 SPLASH PAN

9-2 Classification of Storm Drain

Storm Drain is classified into three types.

1. The Inside storm drain
2. Outside storm drain
3. Overhead storm drain

The **Inside Storm Drain** is sometimes located under the basement floor or within the walls of the building. This type of storm drain is commonly found in buildings constructed along congested business district, or building that occupies the entire frontage of the lot. The drainpipe is laid under the floor or walls of the structure.

For large building, storm drains are laid in two or more lines to convey not only the water coming from the roof, but also those waters accumulated from the inside court or open areas towards the street gutter or public storm drain.

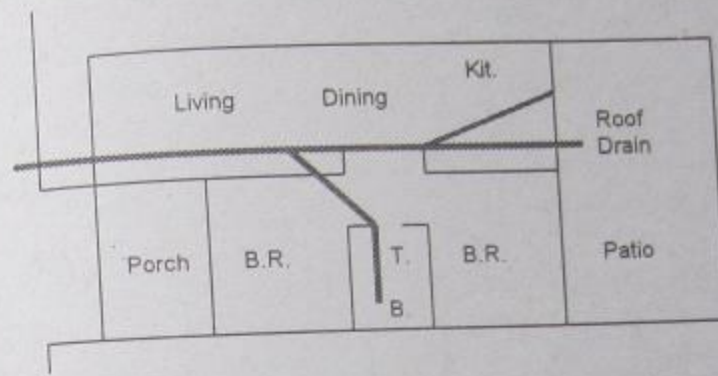


FIGURE 9-2 INSIDE STORM DRAIN

The **Outside Storm Drain** is installed outside the foundation wall of the building. This type of drainage is possible on location where the lot is not totally occupied by the building.

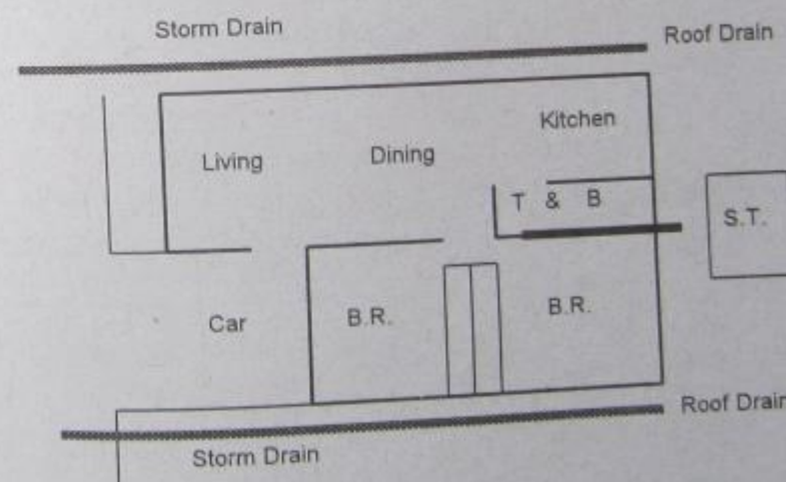


FIGURE 9-3 OUTSIDE STORM DRAIN

The **Overhead Storm Drain** is adopted when the street drainage is higher in elevation than the basement floor of the building. The purpose is to avail of the gravity flow of water. The pipe is well fitted and suspended inside the ceiling by suitable hangers spaced at closer intervals.

9-3 Size of Storm Drain

The size of Storm Drain is determined under the following considerations:

1. Gauging the rainfall over a given period, whether it is constant or exceedingly heavy shower of short duration.
2. Consider the varying roof areas, the slope, and the distance of water traveled before it reaches the conductors of the roof.
3. Water drain faster on high pitch roof. Hence, requires a larger drainage pipe than that of a flat roof.
4. The height of the building, contribute largely to the velocity of water falling inside a vertical pipe conductor. The velocity fall accelerate the flow of water entering into the storm drain.

TABLE 9-1 SIZE OF STORM DRAIN

Dia. of Pipe		Maximum Drained Roof Area		
mm	In.	2% Slope	3% Slope	4% Slope
75	3	114	142	170
100	4	242	315	388
125	5	438	566	694
150	6	700	903	1,105
200	8	1,463	1,888	2,313
250	10	2,563	3,309	4,055
300	12	4,100	5,290	6,480
350	14	5,576	7,203	8,830

5. The use of improper fittings and short offsets that will affect the flow of water must be avoided.

The conservative estimate of maximum rainfall in the Philippines is about 20 mm in a 5 minutes interval. Using this data, the approximate volume of water that will be accumulated on the roof in one minute can be readily computed using *Table 9-1, Size of Storm Drain*.

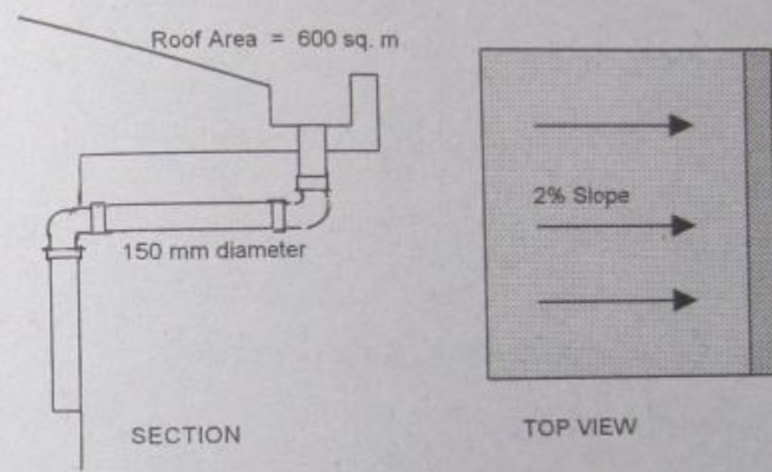


FIGURE 9-4 SIZE OF THE ROOF LEADER

ILLUSTRATION 9-1

What size of storm drain is adequate to serve a roof having a slope of 2% with a general dimensions of 20 x 30 meters?

SOLUTION

1. Solve for the roof area

$$\text{Area} = 20 \times 30$$

$$A = 600 \text{ sq. m}$$

2. Refer to Table 9-1. Under 2% slope, 600 sq. m. is within the limit of 700 sq. m. roof area which could be served effectively by a 150 mm. pipe diameter.

9-4 Grade and Change of Direction

The storm drain is installed providing a slope of not more than 2% per meter run A combination of Y and 1/8 bend or a long radius fitting is appropriate for any change in direction.

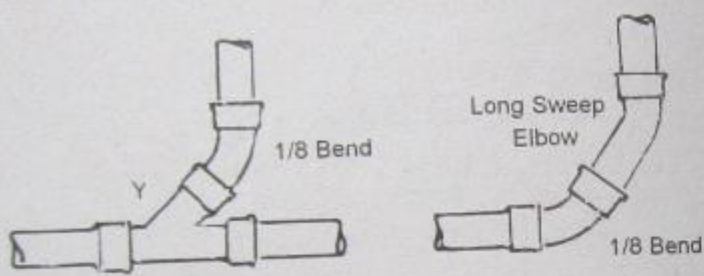


FIGURE 9-5 CHANGE OF DIRECTION

9-5 Roof Leader

Roof Leader is popularly known as water conductor or downspout either concealed or exposed type. It connects the roof terminal to the storm drain. The size of roof leader can be found easily with the aid of Table 9-2.

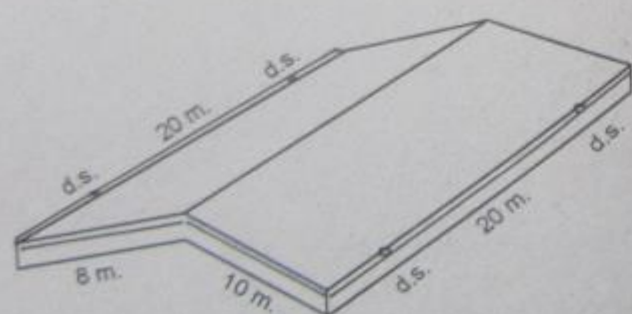


FIGURE 9-6 FINDING THE SIZE OF ROOF LEADER

ILLUSTRATION 9-2

How large is a downspout required to drain the roof with a general dimensions as shown in Figure 9-6

SOLUTION

1. Find the area of roof – **A**

   10 x 20 = 200 sq. m.

2. Refer to Table 9-2. Under column 1, the 200 sq. m. roof area is within the limit of 166 to 335. Thus, specify 100 mm or (4") diameter downspout

3. Find the area of roof - **B**.

   8 x 20 = 160 sq. m.

4. Refer to Table 9-2. The value of 160 sq. m. requires a 75 mm (3") roof leader.

5. Therefore, specify a 75 mm pipe diameter.

TABLE 9-2 SIZE OF ROOF GUTTER AND ROOF LEADER

Area of Roof sq. m.	Gutter Top Dimension (mm)	Roof Leader Diameter. (mm)
1 to 10	75	38
11 to 25	100	50
26 to 75	100	75
76 to 165	125	90
166 to 335	150	100
336 to 510	200	125
511 to 900	250	150

Comments:

1. From illustration 9-2, it appears that roof A requires a 100 mm pipe diameter and 75 mm for roof B. If only one roof leader will be installed in each roof, considering the 20 meters length of the gutter, the rainwater has to travel a long way before it reaches the roof terminal. Under such condition, the gutter might be overloaded and overflow is likely to occur.

2. The standard practice is to provide **two or more** terminals for roof leader to avoid clogging and over-flow. The found size of the pipe if installed on two terminals would be oversized and ex-pensive. Thus, it is necessary to select two smaller pipes with a hole area equivalent to 100 mm and 75 mm diameter respectively.

SOLUTION

1. The 100 mm or 4" diameter as found has a cross sectional area of:

$$\textbf{Area of a circle} = .7854 \times d^2$$

$$\text{Area} = .7854 \times 4^2 = 12.56 \text{ sq. in.}$$

2. Divide into two terminals = 6.28 sq. in.

3. The gross sectional area of a 75 mm (3") is 7.06 in^2 greater than 6.28. Therefore, specify 2 pcs. 75 mm diameter pipe.

SECOND SOLUTION

1. Area of the roof A = 200 sq. m.

2. Divide by 2 terminals = 100 sq. m.

3. Refer to Table 9-2. The 100 sq. m. area is within the parameter of 76 and 165 sq. m. therefore, specify 2 pieces 75 mm diameter pipe.

4. For roof area B = 160 sq. m.

5. Divide by 2 terminals = 80 sq. m.

6. Refer to Table 9-2, 75 mm pipe is sufficient.

7. Specify 2 pieces 75 mm downspout for roof B.

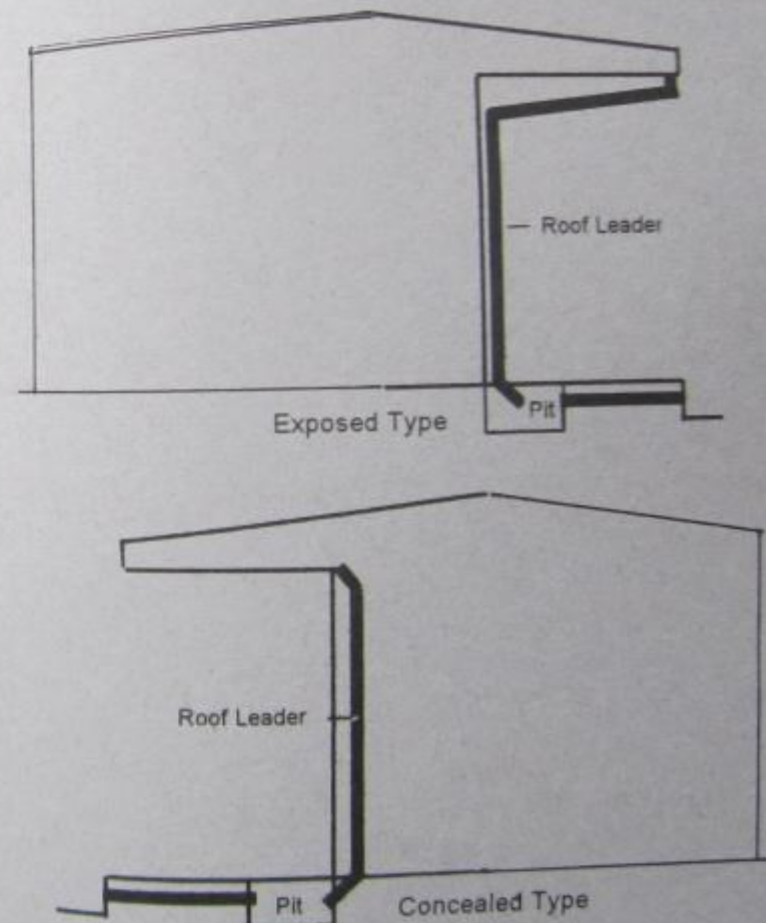


FIGURE 9-7 EXPOSED AND CONCEALED TYPE ROOF LEADER

TABLE 9-3 COMBINED STORM AND SANITARY DRAIN

Area of Roof In sq. m.	Number of Fixture Units											
	1 to 6	7 to 18	19 to 36	37 to 60	61 to 96	97 to 144	145 to 216	217 to 324	325 to 486	487 to 732	733 to 1098	1099 to 1644
1 to 10 sq. m.	17	10	6	4	3	2	2	1	1	9	.8	.8
11 to 20 sq. m.	15	9	5	4	3	2	2	1	1	.9	.8	.8
21 to 45 sq. m.	11	7	5	4	3	2	2	1	1	.9	.8	.8
46 to 70 sq. m.	7	6	4	3	2	2	1	1	1	.8	.8	.8
71 to 100 sq. m.	5	4	3	3	2	1	1	1	.9	.8	.7	.7
101 to 150 sq. m.	3	2	2	1	1	1	1	.9	.9	.8	.7	7
101 to 150 sq. m.	3	2	2	1	1	1	1	.9	.9	.8	.7	7
151 to 225 sq. m.	2	1	1	1	.8	.8	.8	8	.7	.7	.7	.7
226 to 340 sq. m.	.7	.7	7	.6	.6	.6	.6	.6	.6	.6	.6	.6
341 to 500 sq. m.	.2	.2	3	.3	4	.4	.4	.4	.4	.4	6	5
501 to 760 sq. m.	0	.2	.2	.2	.2	.2	.2	.2	.3	.3	.5	4
761 to 1140 sq. m.	0	0	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3
1141 to 1710 sq. m.	0	0	0	.2	.2	.2	.2	.2	.2	.2	.2	.2
1711 to 2560 sq. m.	0	0	0	0	.2	.2	.2	.2	.2	.2	.2	.2
2561 to 3800 sq. m.	0	0	0	0	0	.2	.2	.2	.2	.2	.2	.2
3801 to 5700 sq. m.	0	0	0	0	0	0	.2	.2	2	.2	.2	.2
Over 5700 sq. m.	0	0	0	0	0	0	.2	.2	.2	.2	2	2

CHAPTER 10

TRAPS FOR PLUMBING FIXTURES

10-1 Trap

A trap used on plumbing fixture is a device scientifically designed to prevent the back flow of gases coming from the septic tank or sewer line passing through the outlet of the fixture. These gases are identified as hydrogen, hydrogen sulfide, methane, or carbon dioxide and even a small amount of carbon monoxide considered dangerous to human health. The physical and chemical properties of the many gases found in the sewage systems are known, and their effect on human body is sometimes serious.

The basic function of the trap in a drainage system is to prevent those objectionable gases from entering the plumbing system. The principle is to form a mechanical barrier against the passage of sewer air.

In 1856, when the first patented trap in the United States was innovated, manufacturers offered various forms and design to the plumbing industry. Tests of these traps showed that, the most practical form ever developed is the P-Trap. Originally, this P-trap was called **Gooseneck** attributed to its form like the neck of a goose.

Analyzing the mechanical function of the P-Trap, it appears that, the only separation between the unhealthy gases in the sanitary drainage system, and the air inside the room is the water caught in the trap every after discharge of the fixture.

The column of water that is retained between the overflow and the dip of the trap is called **Trap Seal** or sometimes referred to as **Water Seal.**

Water Sealed P-Trap is Classified into Two

1. The common seal
2. The deep seal

The **Common Seal P-Trap** has 5 centimeters deep water seal between the overflow and the dip, that will offer resistance against abnormal conditions, only to the amount of pressure a 5 centimeters water will develop.

The **Deep Seal P-Trap** has from 7.5 to 10 centimeters column of liquid content between the overflow and the dip. This trap may be used under normal condition, but it is purposely designed for abnormal situations such as:

a. Extreme heat condition in the area.
b. Increase and decrease of atmospheric condition.
c. Circumstances where total ventilation cannot be obtained.

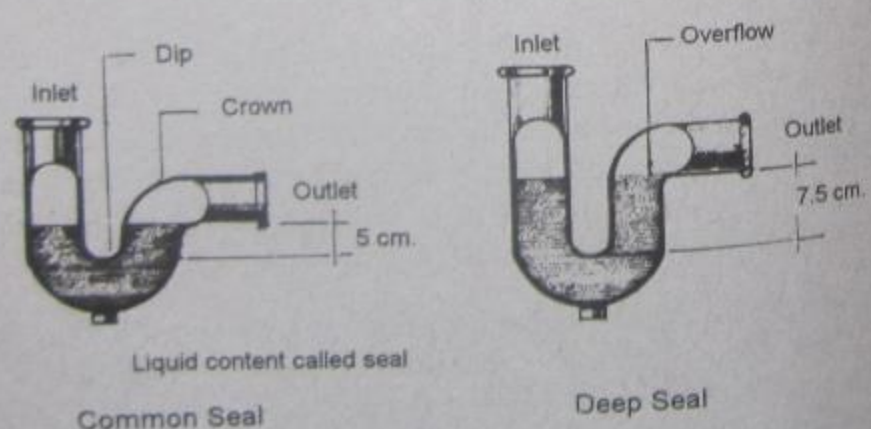


FIGURE 10-1 NOMENCLATURE OF A P-TRAP

One advantage of the Deep Seal over the Common Seal is its greater re-sealing quality. Re-seal is a term used to the scientific principle that water at rest tends to seek a level and maintain it.

When the liquid content of a deep seal is disturbed, the water tends to level itself sufficiently to seal the trap even partially. Meaning, because of the considerable height of the water seal up to 10 centimeters deep, even if disturbed by flushing from the fixture discharge, by partial resealing up to 50%, the trap seal is still maintained.

The P-Trap is the most common and practical shape available in various sizes from 32 mm to 50 mm diameter. These are common sizes for fixtures that are suspended from walls or supported on a pedestal such as:

1. Lavatories
2. Sinks
3. Shower bath with less amount of water discharge
4. Urinals
5. Drinking fountain

There are various forms of water sealed trap that could be used to serve plumbing fixtures. But among these various types, some are classified as ***Permissible Traps*** while others are identified as ***Objectionable Traps***.

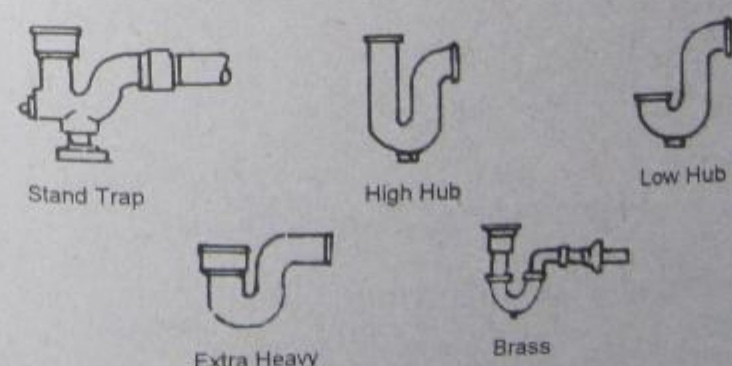


FIGURE 10-2 TYPES OF PERMISSIBLE TRAPS

The Permissible Type of Traps

1. The P-Trap
2. The Drum Trap

Other Type of Permissible Traps

1. Stand Trap
2. Brass trap
3. High Hub Trap
4. Low Hub Trap
5. Extra Heavy Type
6. Sink or Lavatory Type

Objectionable Traps that are Found Defective

1. The full size S and the ¾ S Traps
2. The bag traps
3. Mechanically sealed traps
4. Light metal partition traps

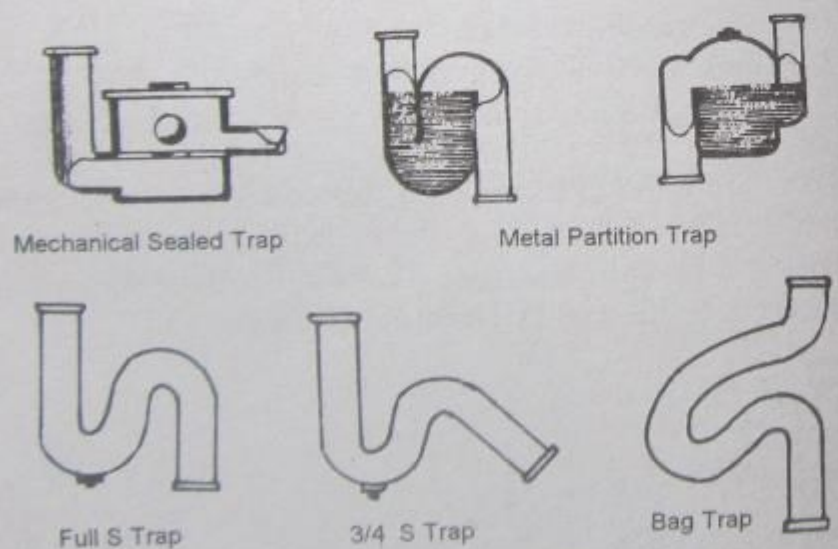


FIGURE 10-3 OBJECTIONABLE TRAPS

10-2 P-Trap Installation

The National Plumbing Code on P-Trap installation provides that:

1. All traps shall be self-cleaning. That is, capable of being completely flushed each time the trap operates and no sediments will remain inside to decompose.
2. P-Trap shall be installed as near the fixture as practical not to require too long vertical leg between the trap and the fixture proper.
3. Short vertical leg eliminates high velocity of water discharge that creates siphon, the major cause of trap seal loss.
4. P-Trap shall be installed within 60 centimeters of the fixture it serve. It shall be accessible for cleaning through the bottom opening closed by a screw plug.
5. All traps are subject to stoppage, hence, shall be provided with cleanout so designed that could be assembled and disassembled with little efforts.
6. Long Run Horizontal Pipe could be used only near the drain of the floor area or yard. It is also called *Running Trap* not provided with hand-hole cleanout.

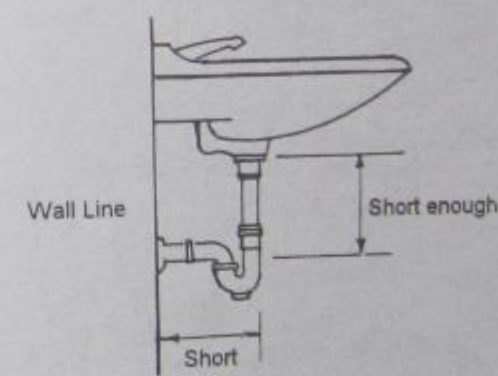


FIGURE 10-4 P-TRAP INSTALLATION

7. The dip portion of the trap shall be as short as possible to avoid retarded flow of water. Likewise, the horizontal leg connection to the waste pipe shall be reasonably short for effective ventilation.

8. Overflow pipe from fixture shall be connected to the inlet side of the trap.
9. Each fixture shall have its own trap. The following fixtures are exception to the rule.
   a. Two laundry trays and a kitchen sink connected to a single trap.
   b. Not more than 3 laundry tray using one trap.
   c. Three lavatories on a single trap.

10-3 Drum Trap

Drum Trap is also classified as a water seal device. The name was derived from its size being large in diameter. It has the following special features:

1. Drum trap is intended for fixtures that are set on the floor like bathtub, foot and sitz bath, and other similar fixtures.

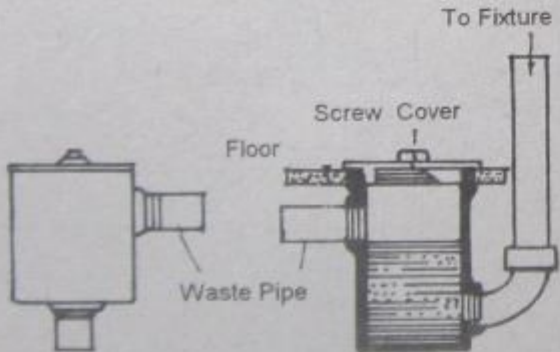


FIGURE 10-5 TYPES OF DRUM TRAP

2. Drum Trap is used on fixtures that discharges substantial amount of water. It is effective where trap-

seal loss is more prevalent due to the velocity of the flow in short intervals.

3. Drum Trap can also serve as terminal for soda fountain, bar wastes and any type of indirect waste.

4. Drum Trap has two types:
   a. The 100 mm. x 125 mm and
   b. The 100 mm. x 200 mm

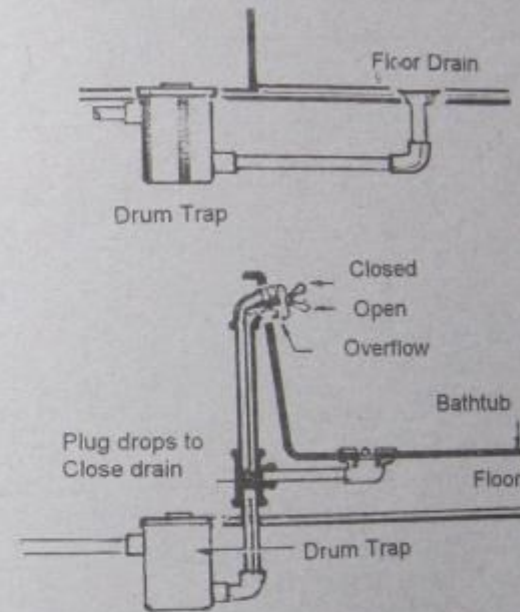


FIGURE 10-6 INSTALLATION OF DRUM TRAP

Advantages of the Drum Trap

1. Greater amount of water may pass through it in a shorter interval without the danger of trap seal loss.
2. It has a higher resealing quality than the P-Trap.

Disadvantages of the Drum Trap

1. It is large and cumbersome.
2. It is unsightly if the installation is exposed to view.
3. Cleanout cover mechanism is above the water seal.
4. To clean the drum trap needs lubricant and a fiber washer at the joint between the cover and the body of the trap.

TABLE 10-1 MINIMUM SIZE OF FIXTURE TRAP MM

Kind of Fixture	Trap and Branches Size	
Bath Tub	38	1 ½"
Bath shower stall	50	2
Bath sitz	38	1 ½
Bath foot	38	1 ½
Bidets	38	1 ½
Combination fixture	38	1 ½
Drinking fountain	32	1 ¼
Fountain cupsidors	32	1 ¼
Floor drains	50	2
Laundry trays	38	1 ½
Sinks, (kitchen of residence)	38	1 ½
Sinks, (hotel or public)	50	2
Sinks, (large hotel or public)	50	2
Sinks, (small pantry or bar)	32	1 ¼
Sinks, (dishwasher)	38	1 ¼
Sinks, Slop, with combined trap	75	3
Sinks, Slop, ordinary	50	2
Urinals Lip	38	1 ½
Urinals, through	50	2
Urinals, pedestal	75	3
Urinals, stall	50	2
Wash basin	32	1 ¼
Water closets	75	3

The National Plumbing Code on Traps Provides that:

"Every trap shall be self-cleaning. Traps for bath tubs, lavatories, sinks and other similar fixtures shall be of either lead, brass, cast iron, galvanized, porcelain or enameled inside or plastic."

*"**Traps Where Required.** - Each fixture shall be separately trapped by a water sealed trap placed as possible to the fixture except that a set of similar fixture consisting of not more than 3 wash basins, or a set of 3 laundry trays or a set of 3 sinks may connect with a single trap but in no case shall the waste from bathtub or other fixture discharge into a water closet trap. No fixture shall be double trapped."*

10-4 Size of Fixture Trap

The National Plumbing Code has regulated the minimum diameter of traps and drain to be installed. Likewise, the size of the pipe drain depends upon the class of users the installation will serve. And the minimum size of the trap and waste branch for a specified fixture shall conform to the values given in Table 10-1.

Fixtures to be Installed are Classified into Three:

1. **Class 1 - For Private Use** like fixtures in residential houses, apartment and private bathroom of hotels and similar installations.
2. **Class 2 - For Semi-Public Use** applied to fixtures in office buildings, factories, dormitories and the like, for occupant's use only.
3. **Class 3 - For Public Use** such as schools, gymnasium, hotels, railroad and bus terminals, public comfort rooms and other installation where several fixtures are installed for unrestricted use.

TABLE 9-2 MINIMUM TRAP AND DRAIN DIAMETER MM

Fixture and Class of installation	Min. Trap Diameter	Min. Drain Size	Fixture Unit
One lavatory or wash basin, Class – 1	32	32	1
One lavatory or wash basin, Class – 2 or 3	32	32	2
One water closet, Class – 1	75	75	3
One water closet, Class – 2	75	75	5
One water closet, Class – 3	75	75	6
One bath tub, Class – 1	38	38	3
One bath tub, Class 2 or 3	50	50	4
One shower stall, shower head only, Class – 1	38	38	2
One shower stall, multiple spray Class – 1	50	50	4
One shower stall, shower head Only, Class 2 or 3	50	50	3
One shower stall, multiple Spray, Class 2 or 3	75	75	6
One urinal, lip or each 2 feet of through or gutter	38	38	2
One urinal, stall or wall hung With tank of flush valve supply	50	50	4
One urinal, pedestal or blow out	50	75	5
One bathroom group consisting of 1 lavatory, 1 water closet & 1 bathtub with or without overhead or consisting of 1 lavatory, 1 water closet and 1 shower stall, Class – 1	50	50	6
One bathroom group consisting of 1 lavatory, 1 water closet 1 bathtub, and 1 shower stall in same bathroom, Class – 1	50	50	7
One sink, residence or apartment Kitchen sink, dishwasher, Butter's or pantry sink, C – 1	38	38	3
One sink, hotel or restaurant Pot sink	75	75	6
One sink, hotel or restaurant Vegetable sink	50	50	6
One sink, hotel or restaurant Glass sink	38	38	3
One sink, hotel or restaurant Silver sink	38	38	3
One sink, lunch counter bar sink	50	50	6
One sink, soda fountain bar sink	52	32	1.5
One sink, ordinary slop sink	50	50	3
One sink, siphon jet slop sink Flush rim or mop	75	75	6
One sink, bedpan sink or Bedpan washer	75	75	6
One sink, laboratory, 1 surgeon or medical sink	38	38	1.5
One sterilizer, instrument Utensil or water	32	32	0.5
One sterilizer, bedpan	75	75	6
One laundry tray	38	38	3
One combination fixture	38	38	3
One foot bath or sitz bath	38	38	2
One infant or baby clab bath	32	32	0.5
One bidet	38	38	3
One drinking fountain	32	32	0.5
One drinking fountain or dental	32	32	0.5
One floor drain, ordinary	32	32	0.5
One floor drain, receiving Overflow from tanks or Discharges from un-rated Fixtures and rated on the Estimated maximum flow For each gallon per minute	32	32	0.5
One sewage ejector, for each 25 gallon per minute discharge capacity	38	38	50

Section 56. *Traps, Kind, and Minimum Size of Recommended Minimum Requirements State that:* " Every trap shall be self-cleaning. Traps for bathtubs, lavatories, sinks, and other similar fixtures shall be made of lead, brass, cast iron, or of malleable iron galvanized, porcelain enameled inside or plastic pipes...traps shall have a full bore smooth interior waterway, with threads of solid materials of the same kind.

The nominal size (inside diameter) of trap and waste branch for a given fixture shall not be less than that given in *Table 10-1 Minimum Size of Fixture Trap.*

All traps are subject to stoppage. Hence, must be provided with a cleanout, or so designed that they can be disassembled with little effort.

Continued discharge of greasy wastes reduces the diameter of the pipe, and no benefits can be expected of the trap when these natural phenomena occur. Plumbing system that is well constructed cannot be depended upon to give satisfactory service over a long period. Therefore, the installation must be positive, and remain so during its expected life to be effective.

CHAPTER 11

PLUMBING VENTILATION

11-1 Ventilation

Ventilation of a plumbing system, is that portion of the drainage pipe installation, designed to maintain a balance atmospheric pressure inside the system to prevent problems like:

1. Trap seal loss
2. Retardation of flow
3. Deterioration of the materials

This portion of plumbing science is one of the most important, and yet, was not seriously regarded by most average plumbing mechanics. Some forty years ago, plumbing mechanics was of the opinion that, to have a functional plumbing installation, was to install a waste pipe of sufficient size to discharge the waste coming from the plumbing fixtures in a reasonable time. Likewise, to provide the waste pipeline with some kind of trap that will prevent sewer air from entering into the building.

Plumbing during those early period was not yet considered a scientific industry. The sanitary facilities in buildings were still few, and no serious problems arose from the improper waste disposal practices of that time. The owner as well as the plumber regarded plumbing system as a means of waste disposal only. They did not care about the health standard that could be affected by improper installation.

The average plumber did not know, or at least could not give intelligent reasons, why fixture traps has to be ventilated, despite of their working experience in ventilating traps for so many years. Plumbing practices during those period, followed the traditional patterns of installations, in the same manner, year after year.

Lately however, the construction of large buildings and the congestion in growing cities played an important role in bringing plumbing practice to a scientific level. The orthodox way of plumbing has changed radically and regarded plumbing as the work of professionals and experts. Ventilating a drainage system requires a thorough knowledge of the principles governing the natural laws of nature such as:

1. The principles governing the atmosphere
2. The principles of gravity
3. The principles of siphon, pressure, and vacuum.

Knowledgeable plumber must be able to correlate the principles of siphon, pressure, and vacuum with the vent pipe installation, so that, when the system operates, it will function indefinitely.

Tests conducted on plumbing ventilation proved that, a waste pipe of smaller diameter could serve more fixtures if a balanced atmospheric pressure is maintained inside the system at all times. Plumbing system as a whole, will pass through an important event in the next few years, and it is rather certain that more ventilation will be in demand.

Atmospheric Pressure and the Drainage System

According to scientific findings, the surface of the earth is subjected to an atmospheric pressure valued about

65.47 Newtons at sea level. Any elevation above or below the sea level would be subjected to minus or plus pressure as the total volume of air above it is lesser or greater accordingly. In short, a pressure less than one atmospheric pressure (65.47 Newton's) will create minus pressure, and that with greater than one atmospheric pressure, will create a plus pressure.

Compressibility is one of the properties of gas. Air can be compressed, or withdrawn from a space or container. When compressed, pressure greater than one atmosphere is developed. When withdrawn from a space or container it is called vacuum or partially vacuum depending upon the volume of air removed. A partial vacuum would indicate a pressure less than one atmosphere.

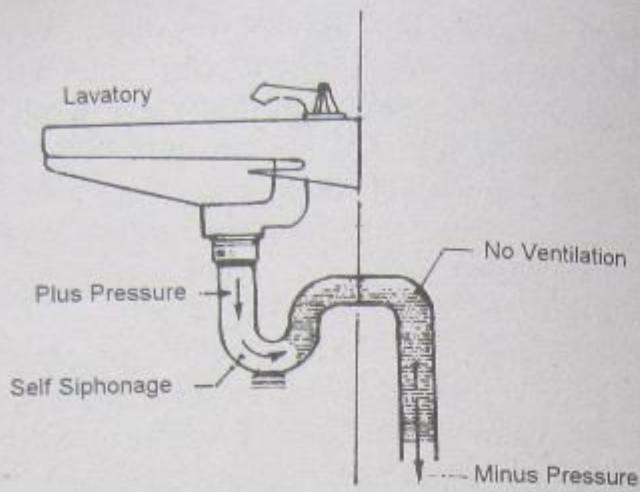
11-2 Trap Seal Loss

Among the most common and serious problem being encountered in a drainage system is the trap seal loss. **Trap Seal Loss** can be attributed to inadequate ventilation of the trap and the subsequent minus and plus pressures inside the system.

Trap Seal Loss maybe attributed to any of the following factors:

1. Siphonage
2. Back pressure
3. Evaporation
4. Capillary action

Siphonage is the result of ***minus pressure*** in the drainage system. If the trap of a common seal is open and exposed to the atmosphere, both the inlet and the outlet orifices will be under balance atmospheric pressure. As such, the tendency of water seal to move is remote.



DIRECT OR SELF SIPHONAGE

FIGURE 11-1 TRAP SEAL LOSS

Closing one end of the trap by connecting a pipe without ventilation will create an unequal atmospheric condition. When large amount of water flow rapidly through the trap, self-siphoning will occur and the water content of the trap will be discharged. When the water seal escape from the P-trap, it is called **Trap Seal Loss.**

When the water seal is lost, gases coming from the public sewer line or septic tank will flow back into the trap. The gases will find its way to the fixture drain outlet and spread into the house or room.

Siphonage is Classifieds into Two Types:

1. Direct or Self Siphoning
2. Indirect or Momentum Siphoning

Direct or Self Siphoning occur in unventilated traps which serves as oval bottom fixtures like lavatories or slop

sink. Self siphonage is created when a rapid flow of water passing through the pipe siphon down the water seal inside the traps with no vent provision.

Indirect or Momentum Siphoning is the result of a minus pressure in the pipe created by heavy discharge of water from a fixture installed on a line serving another fixture at a lower floor.

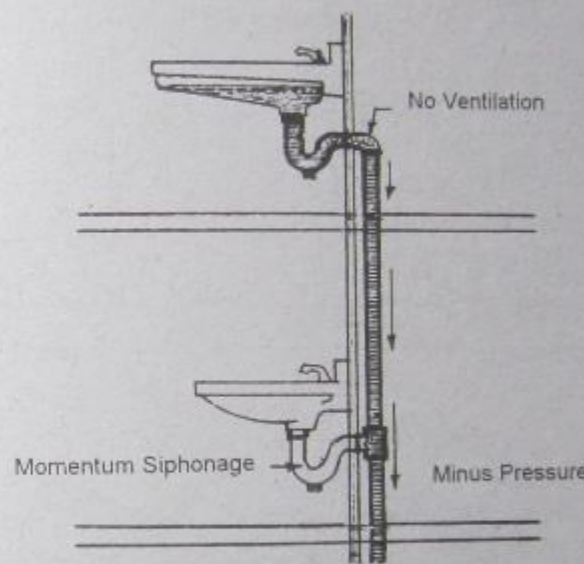


FIGURE 11-2 INDIRECT OR MOMENTUM SIPHONAGE

Back Pressure is caused by plus pressure. When large amount of water flow drops downward rapidly forming a slug like, the air inside the pipe will be compressed downward. In the absence of adequate ventilation, the compressed air will be forced to find its away out through a weaker point. The trap seal being the weakest point, will give way and blow out of the fixture.

Evaporation. This process is considered a minor problem and is less probable to drain the water inside the trap. Evaporations however, happen only on floor drain which are not regularly used to admit water, but exposed to extreme temperature. Example of which is the P-Trap on a floor drain of a basement where there is no regular water flowing in it.

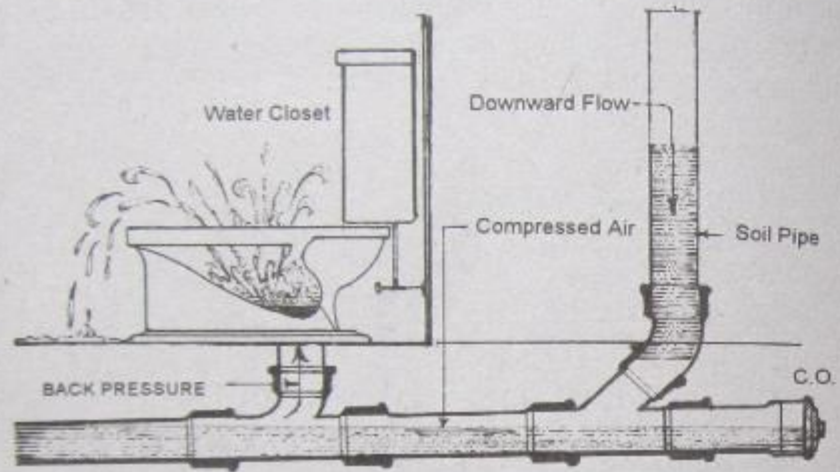


FIGURE 11-3 BACK PRESSURE

Wind Effect. A wind velocity passing over the top of the soil pipe may affect the trap seal. This kind of trap seal loss is one improbable thing to happen by removing the entire water seal inside the P-trap.

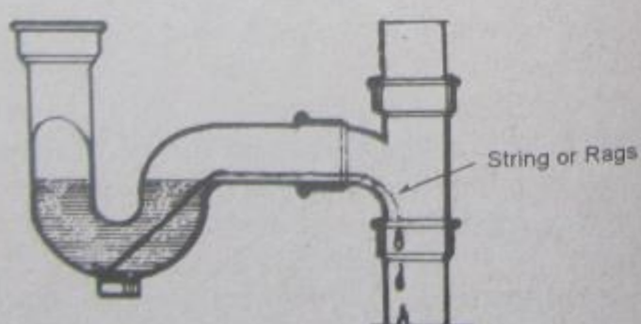


FIGURE 11-4 CAPILLARY ACTION

Capillary Action. This kind of trap seal loss also seldom happen and is rarely experienced by homeowners. Capillary action is draining of the water seal caused by foreign objects like thread or string suspended and extended over the outlet arm of the trap.

11-3 Retardation of Flow

Retarded water flow inside the pipe is due to the effect of atmospheric pressure and or gravity. One good example is our experience of pouring liquid milk from a tin can. When only one hole is punched on the can, the liquid milk would hardly flow out of the container, but when another hole is made on the other side of the can, the container is ventilated and the liquid milk flow smoothly out of the container.

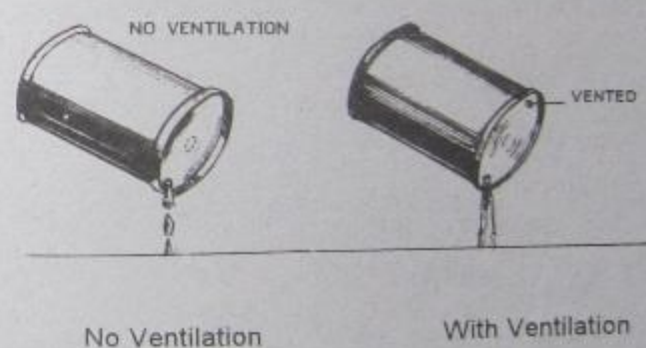


FIGURE 11-5 EFFECT OF THE ATMOSPHERIC PRESSURE

Retardation of the flow was corrected when the atmospheric pressure inside the container was balanced by creating additional hole on the other side of the can. The same principle is also applied in the plumbing system by providing ventilation pipes to equalize or balanced the atmospheric pressure inside the plumbing installation.

11-4 Ventilating the Drainage System

A plumber can adopt many ways and forms of ventilation in the plumbing system. The ways and form depends upon the location of the fixtures or how they are combined or grouped. And to think of ventilating all fixture traps individually, is a very costly undertaking. However, for the sake of economy, various methods of ventilation could be adopted by group venting. Group venting is permitted, provided, that every trap is ventilated using the proper size of vent pipe as recommended by the National Plumbing Code presented in Table 11-1

Types of Ventilation in the Plumbing System

1. Main soil and waste vent
2. Main vent
3. Individual vent
4. Unit vent
5. Circuit or loop vent
6. Relief vent
7. Yoke vent
8. Wet vent
9. Looped vent
10. Local vent
11. Utility vent

Each type of ventilation, has a definite function to perform in a complete plumbing system that may be grouped into two major classifications:

1. The vent pipe used to ventilate the soil and waste pipes are the **Main Soil and Waste Vents**.
2. The main vent and other subsidiary form of relief vents, are classified according to the functions they perform, and they are called **Relief** and **Yoke Vent**. This type of ventilation, only serve the fixture trap indirectly. Their main function is to maintain the balance atmospheric pressure inside the waste pipe system.

Other types of ventilation whose main purpose is to protect the trap seal against back pressure and siphoning are called.

1. Individual or back vent
2. Unit vent
3. Circuit or Loop vent
4. Wet vent
5. Looped vent

11-5 Main Soil and Waste Vent

By definition, the main soil and waste vent is that portion of the soil stack above the highest installed fixture branch extending through the roof. It serves as the terminal for the main vent and other vents of the system.

General Conditions in Installing the Main Soil and Waste Ventilation

1. That, it must be installed as direct as possible.
2. Short radius fittings should be avoided, because it reduces the flow of air.
3. As much as possible, long horizontal line must be avoided.
4. Generally, it should have the same diameter as the soil or waste pipe.

The ***National Plumbing Code*** on Extension of Soil or Waste Stack to the Roof Provides that:

" All roof extensions of soil or waste stack shall run full size at least 30 centimeters above the roof and when the roof is used for other purposes than weather protection, such extension shall not be less than 2.00 meters above the roof... the roof terminal of any stack or vent, if within 3.00

meters of any door, window, scuttle, or air shaft, shall extend at least 1.00 meter above the same."

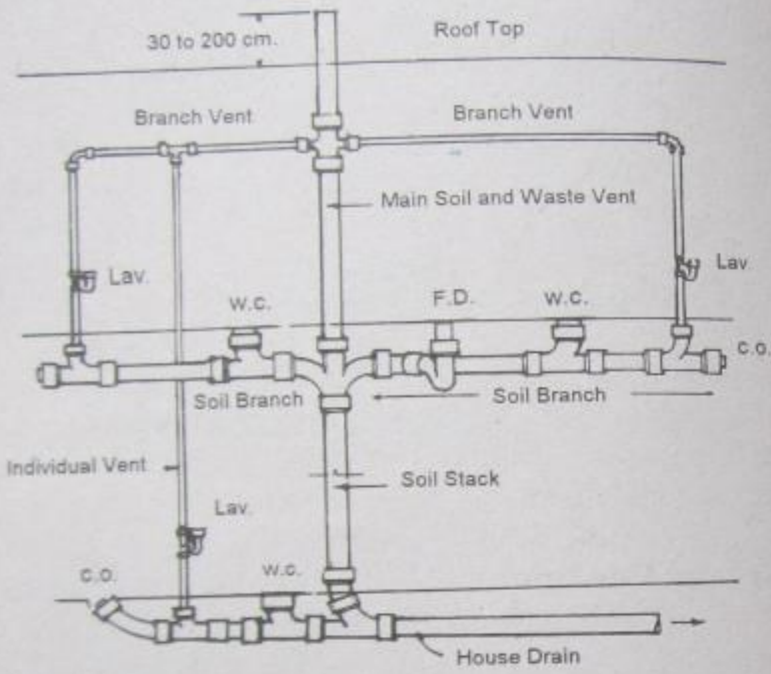


FIGURE 11-6 MAIN SOIL AND WASTE VENT.

11-6 The Main Vent

The main vent is that potion of the vent pipe system, serving as terminal for the smaller forms of individual and grouped fixture trap ventilation. It is sometimes referred to as **Collecting Vent Line.**

The main soil vent is the source through which air is admitted to the plumbing system. It serves as a means of eliminating objectionable odors.

The drainage system is a combination of **waste pipe, vent pipe**, and **water supply**. The efficiency of one is dependent on the other. There is no portion of the drainage

system so unimportant as to excuse indifferent attention on the material and workmanship. Poor workmanship of the vent pipe may disrupt the proper function of waste pipe.

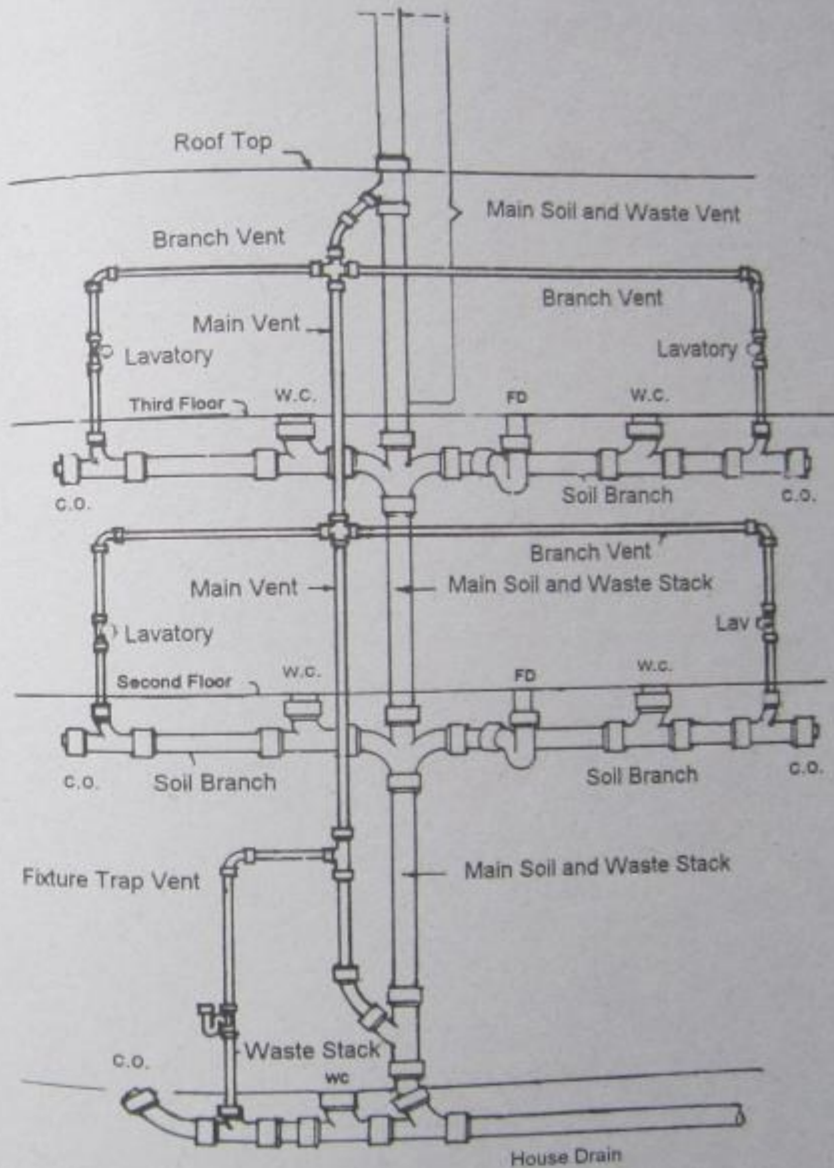


FIGURE 11-7 MAIN VENT INSTALLATION

TABLE 11-1 MAXIMUM PERMISSIBLE LENGTH OF VENTS FOR SOIL AND WASTE STACKS IN METERS

Size of Soil or Waste stock	No. of Fixture Units	Diameter of the Vent Pipe (mm)							
		32	38	50	63	75	100	125	150
32 mm	1	13.5							
38	up to 8		18.0						
50	up to 18		15.0	27					
63	up to 36		13.5	22.5	31.5				
75 mm	up to 12		10.2	36.0	54.0	63.6			
75	up to 18		5.4	21.0	54.0	63.6			
75	up to 24		3.6	15.0	39.0	63.6			
75	up to 36		2.4	10.5	28.0	63.6			
75	up to 48		2.1	9.6	24.0	63.6			
75	up to 72		1.8	7.5	19.5	63.6			
100 mm	up to 24			7.5	30.0	60.0	90.0	102	
100	up to 48			4.7	19.5	34.5	90.0	102	
100	up to 96			3.6	13.5	25.2	90.0	102	
100	up to 144			2.7	10.8	21.6	90.0	102	
100	up to 192			2.4	9.0	19.2	84.6	102	
100	up to 264			2.1	6.0	16.8	73.5	102	
100	up to 384			1.5	5.4	14.1	61.8	102	
125 mm	up to 72				12.0	19.5	75	117	132
125	up to 144				9.0	14.1	54.0	117	132
125	up to 288				6.0	9.6	37.2	117	132
125	up to 432				4.8	7.2	28.2	96	132
125	up to 721				3.0	4.8	21.0	67.5	132
125	up to 1020				2.4	3.9	17.4	54	132
150 mm	up to 144					8.1	32.4	102	153
150	up to 288					4.5	21	66	153
150	up to 576					3.0	12.9	45	127
150	up to 864					2.1	9.9	37.5	95
150	up to 1294					1.8	7.5	27.6	72
150	up to 2070					1.2	6.3	22.5	56
200 mm	up to 350						12.6	43.2	120
200	up to 640						9	25.8	78
200	up to 960						6.6	18	59
200	up to 1600						4.8	12	36
200	up to 2500						3.6	8.4	27
200	up to 4160						2.1	6.6	19
200	up to 5400						1.5	5.1	16

General Conditions for the Main Vent Installation

1. The main vent shall be in full size at their base to the main soil or waste pipe or below the lowest fixture branch. It shall be extended undiminished in size above the roof, or shall be connected with the main soil vent, at least 1.00 meter above the highest fixture branch.
2. The main vent shall also serve as a relief vent for any anticipated backpressure. It must be free from offsets to allow free movement of air and well supported on each floor, if not embedded in concrete column, walls or partitions.

11-7 Size of the Main Vent

Sizing of the main vent pipe has created puzzling problems similar to those encountered in sizing the soil and the waste pipe. The condition in every plumbing system operates differently, and it would be impossible to set up a sizing method for every installation. The volume and velocity of waste flowing inside the pipe is one problem that cannot be ascertained definitely. The reason is that no one individual can control this element. A large volume of water flowing through the waste pipe, require a greater quantity of air moving at higher velocity to maintain atmospheric pressure.

Long runs of vent pipe, reduces the flow and volume of air, because of the friction between the air in motion, and the interior surface of the pipe. These phenomena must be studied carefully, and it is essential that the sizing method be established by experience, and actual installation tests. The most logical methods in finding the size of vent pipe, is through the Unit System, as established by the Sub Committee on Plumbing presented in the Recommended Minimum Requirements, Table 11-1.

Table 11-1, gives an average requirement and therefore, the size of vents selected will in most cases, larger than seems necessary, but certainly safe.

How to use Table 11-1, is presented in the following examples.

ILLUSTRATION 11-1

Determine the size of the main vent that will serve 30 fixture units.

SOLUTION

1. Referring to Table 11-1, It appears that a 63 mm (2-½") pipe could serve up to 36 fixture units.
2. Therefore, specify a 63 mm. diameter pipe for the main vent pipe.

ILLUSTRATION 11-2

How large is the main vent required for various fixtures consisting of 4 water closets; 4 lavatories; 3 showers and 2 kitchen sinks installed on the first floor of a two storey building 6.00 meters high?

SOLUTION

1. Solve for the Total Fixture Units with the aid of Table 5-1.

6 x 4 water closets	24 units
1 x 4 lavatories	6 units
2 x 3 showers	6 units
2 x 3 kitchen sink	4 units
Total	36 units

2. Referring to Table 11-1, a 100 mm (4") soil or waste stack could serve maximum 48 units.
3. Under Column "*Diameter of vent pipe*" a 63 mm pipe could ventilate 48 fixture units as high as 19.50 meters.
4. Therefore: Specify a 63 mm diameter vent pipe.

ILLUSTRATION 11-3

Determine the size of the main vent required, for a drainage installation serving 90 fixture units installed on the first floor of a 5 storey building 20 meters high.

SOLUTION

1. Refer to Table 11-1. Under column one, a 100 mm soil or waste stock could serve 96 fixture units.
2. Under column "*Diameter of Vent*" a 75 mm (3") pipe could ventilate 96 fixture units as high as 25.2 meters.
3. Therefore, specify a 75 mm (3") diameter main vent pipe.

11-8 Individual Vent

Individual vent is sometimes referred to as **Back Vent**. It is that portion of the vent pipe system that serves as a single trap. It is connected closer to the trap directly underneath and back of the fixture, and reconnected into the main vent above the overflow line of the fixture it serves.

So far, individual venting, is the most effective means of venting fixture trap to prevent minus or plus pressure.

However, the idea of venting each trap individually, is very costly, but economy could be attained through group venting which is allowed under the following conditions, provided that, it will not affect the efficiency of the system

1. It must be connected as close as possible to the fixture traps.
2. It should be directly located underneath or back of the fixture.
3. It must be connected to the main vent above the overflow line of the fixture.

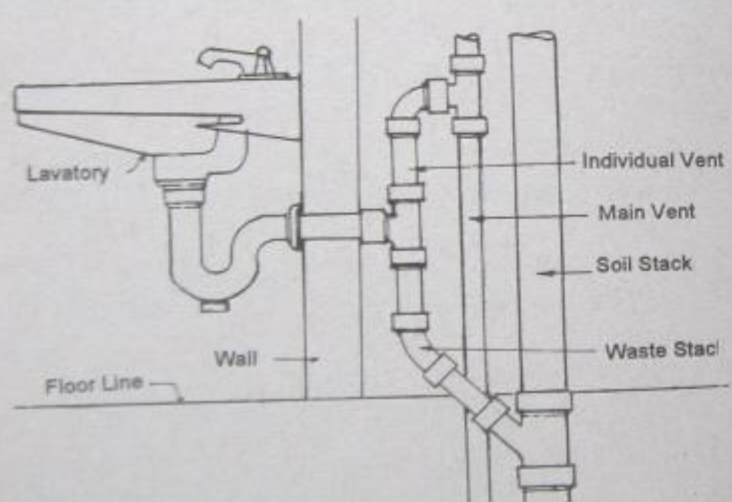


FIGURE 11-8 INDIVIDUAL VENT FOR LAVATORY, SINK ETC.

The **National Plumbing Code** on distances of vent from trap seal provides that:

1. No trap seal shall be placed more than 1.50 meters horizontal developed length from its vent.
2. The distance should be measured along the central

line of the waste or soil pipe from the vertical inlet to the trap to the vent opening.

3. The vent opening from the soil or waste pipe, except for water closets and similar fixtures, should not be the dip of the trap.

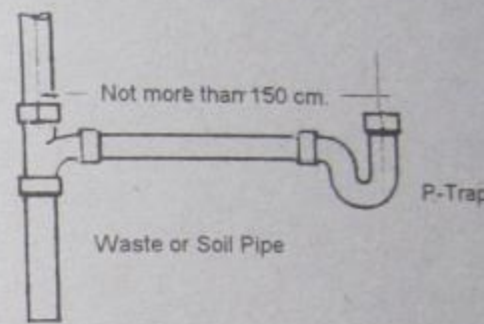


FIGURE 11-9 HORIZONTAL DEVELOPMENT LENGTH

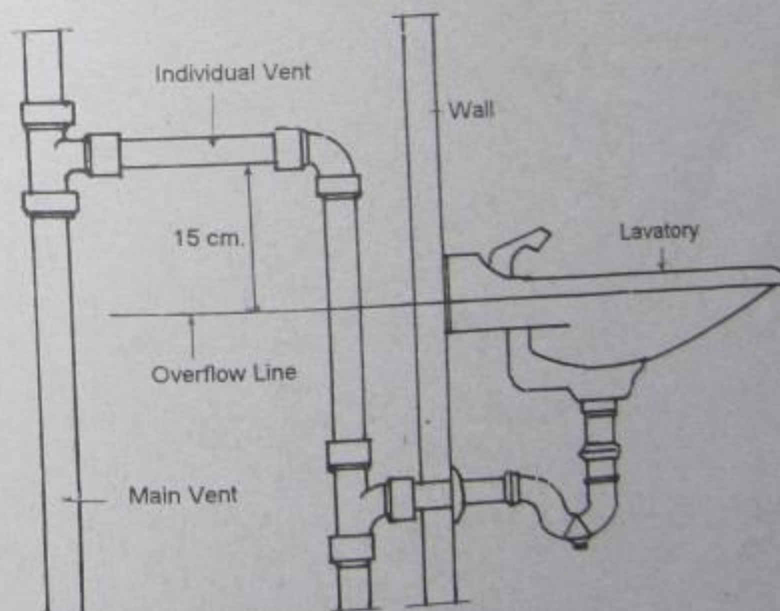


FIGURE 11-10 INDIVIDUAL VENTING

TABLE 11-2 SIZE OF INDIVIDUAL OR BACK VENT

Type of Fixture	Minimum Size		Unit Value
Lavatory	32	1 ¼	1.0
Drinking fountain	32		0.5
Sink	38	1 ½	2.0
Shower	50	2	2.0
Bathtub	38	1 ½	2.0
Laundry tub	38		2.0
Slop sink	50	2	3.0
Water closet	75	3	6.0

TABLE 11-3 PERMISSIBLE NUMBER OF FIXTURE UNIT

Size of Pipe	Number of Fixture units Allowed
32 (1-1/4)	1
38 (1-1/2)	8
50 (2")	18
63 (2-1/2)	36
75 (3")	72
100 (4")	384

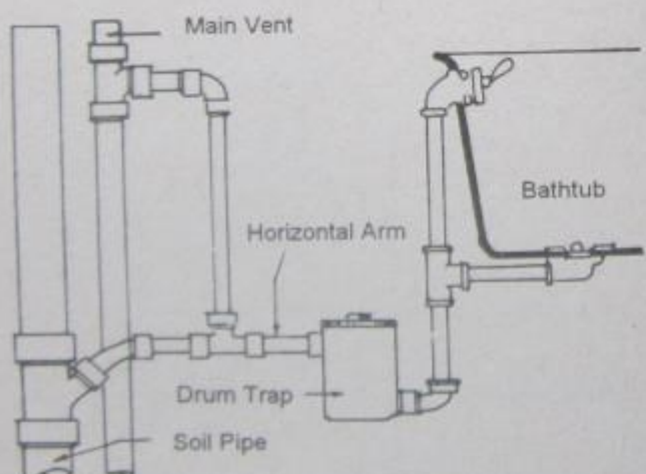


FIGURE 11-11 INDIVIDUAL VENT FOR BATHTUB AND SHOWER

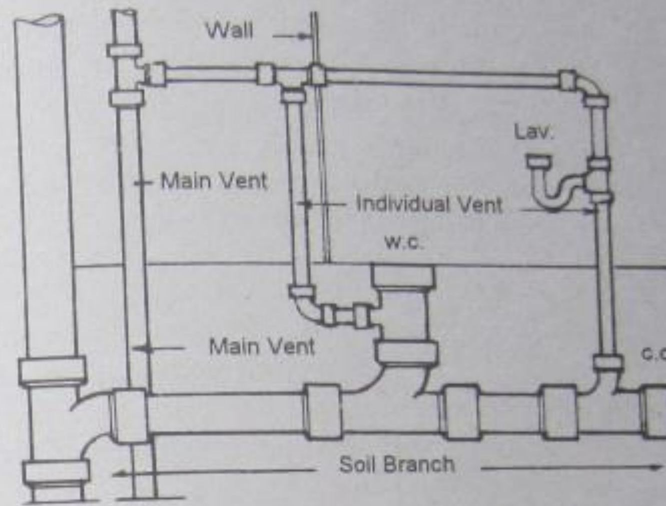


FIGURE 11-12 INDIVIDUAL VENT FOR WATER CLOSET

TABLE 11-4 SAFE LENGTH OF ARM BETWEEN TRAP AND VENT

Size of Fixture Drain	Permissible Length in Meter			
	Sanitary Tee Slope		Long Turn Tee Y or Combination Y and 1/8 Bend	
	2%	4%	2% Slope	4% Slope
32 (1-1/4)	1.20	0.75	0.45	0.30
38 (1-1/2)	1.35	0.90	1.20	0.60
50 (2")	1.50	1.20	1.35	1.20
75 (3")	1.80	1.80	1.80	1.80
100 (4")	2.40	2.40	2.40	2.40

On Branch and Individual Vent, the Plumbing Code Provides that:

"No vent shall be less than 38 mm (1½") diameter except for a 32 mm (1¼") diameter waste pipe. The vent pipe shall be of the same diameter size as the waste pipe, and in no case must a branch or main vent have a diameter less than ½ that of the soil or waste pipe served,

nor shall the length of a branch vent of given diameter exceed the maximum length permitted for the main vent serving the same size of vent stack."

On Vent Pipe Grades and Connections, the Code Further States that:

"All vents and branch bent pipes shall be free from drops or sags and shall be so graded and connected so as to drip back water to the soil or waste pipe gravity. Where vent pipes connect to a horizontal soil or waste pipe, the vent branch shall be taken off above the center line of the pipe and whenever practicable, the vent pipe must rise vertically or at angle 45° to the vertical up to the point of 15 centimeters above the fixture it is venting before offsetting horizontally or connecting to the branch main waste or soil vent"

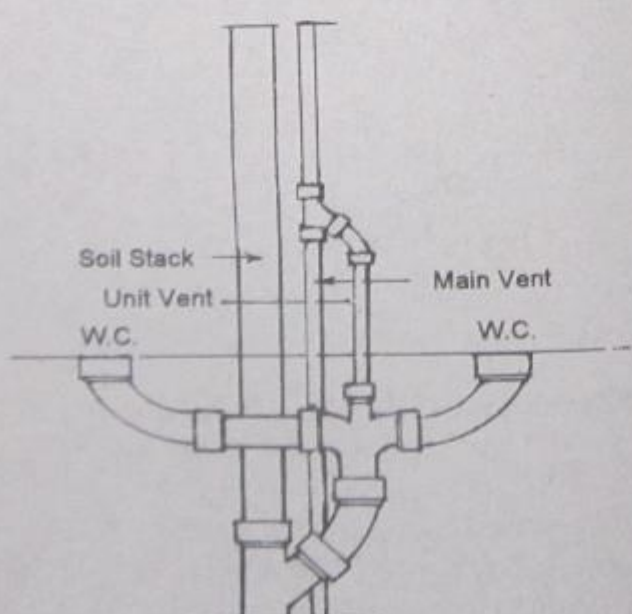


FIGURE 11-13 UNIT VENT OF WATER CLOSETS

11-9 Unit Venting

Unit vent is defined as; that portion of a vent pipe system that ventilates two fixture traps that discharges into a sanitary cross with deflectors. It is classified as another form of individual vent, with identical form of back venting, having the same principles in functions. This type of venting is common to fixture trap serving apartment and hotel toilet particularly, on fixtures with identical position and measurements.

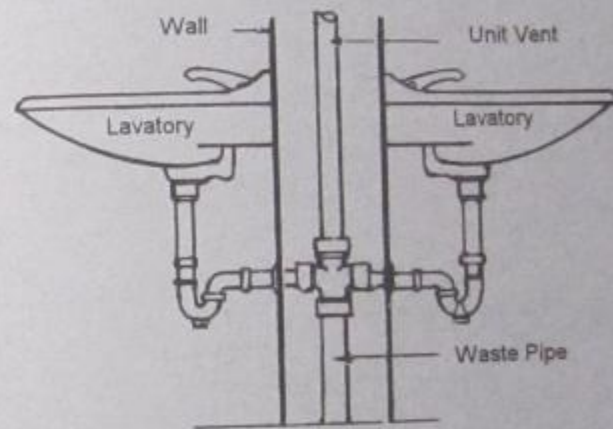


FIGURE 11-14 UNIT VENT OF WALL HUNG FIXTURE

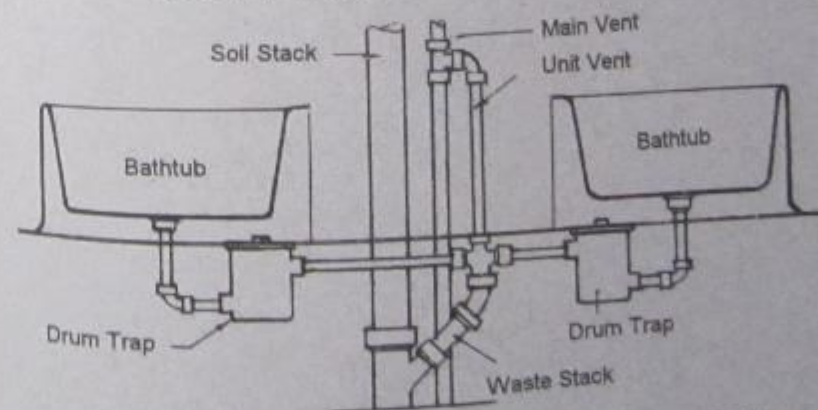


FIGURE 11-15 UNIT VENT FOR BATHTUB INSTALLATION

11-10 Circuit or Loop Vent

Circuit or Loop Vent is employed where two or more fixture traps are installed on a horizontal soil or waste branch. Generally, the use of circuit vent reduces the cost of plumbing installation. This type of ventilation is commonly used in buildings with more facilities, and battery of fixtures.

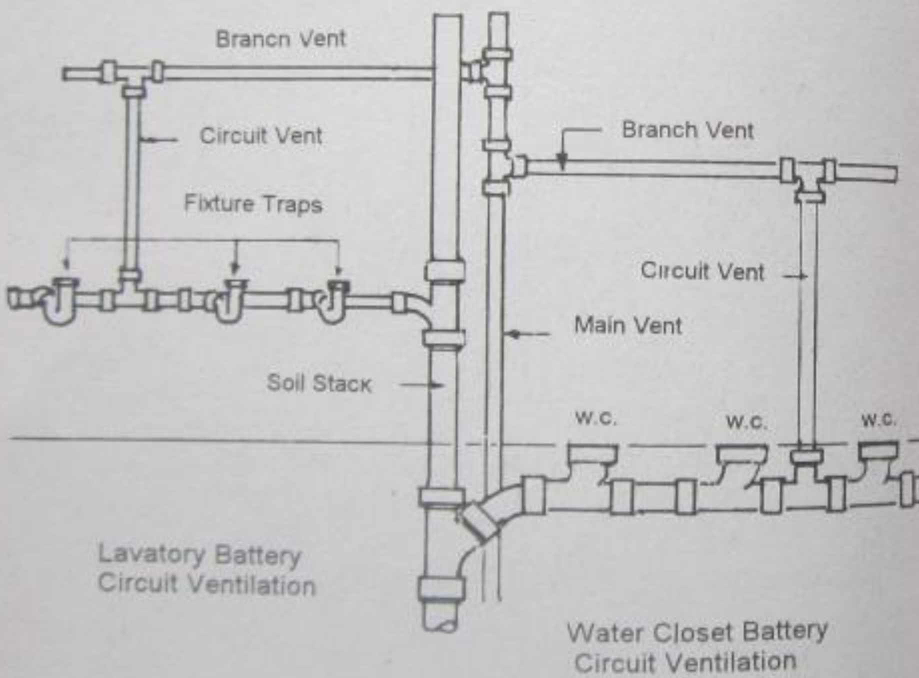


FIGURE 11-16 CIRCUIT VENT FOR A BATTERY OF FIXTURES

ILLUSTRATION 11-4

A group of 5 lavatories is to be circuit vented. Find the size of the circuit vent pipe.

SOLUTION

1. Solve for the total fixture units of the 5 lavatories. Refer to Table 5-1; 5 lavatories x 1 unit = 5 units
2. Refer to Table 11-3. Under 2nd column 8 fixture units requires 38 mm vent pipe.
3. Specify 38 mm diameter circuit vent pipe.

The circuit vent necessary to serve a battery of water closets could be ascertained on Table 11-5.

TABLE 11-5 SIZE OF CIRCUIT VENT FOR A BATTERY OF WATER CLOSETS

Number of Water Closets Installed in series	Diameter of Circuit Vent mm	In.
2	50	2"
3 to 6	75	3"
7 or more	100	4"

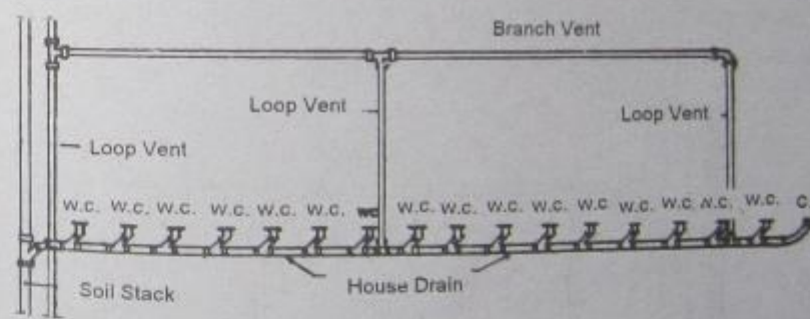


FIGURE 11-17 CIRCUIT VENT FOR A BATTERY OF 16 WATER CLOSETS

On Circuit Vent for a battery of water closets, the Code says that: *"No more than 8 water closets or other fixtures shall be allowed on any circuit or loop vent. If there are 14 or 16 water closets which are to be vented, two pieces of 100 mm pipe should be installed."*

For **Circuit** or **Loop Vents**, the Code also provides that: **Circuit or Loop Vent** *is permitted provided that a branch soil or waste pipe to which two and not more than 8 water closets, pedestal urinals, trap standard slop sinks, or shower stalls are connected in a series, may be vented by a circuit or loop vent, which should be taken off in front of the last fixture connection.*

Where fixtures discharge above such branch, each branch shall be provided with a Relief Vent one half the diameter of the soil or waste stack, taken off into front of the fixture connection.

11-11 Relief Vent

Relief Vent is installed to ventilate the soil and waste pipe and the connecting branches rather than the fixture traps. As to where it will be connected, no specific rules have been formulated yet. Thus, the installation of a relief vent depends upon the good judgment of the plumber, to wherever backpressure is most likely to occur.

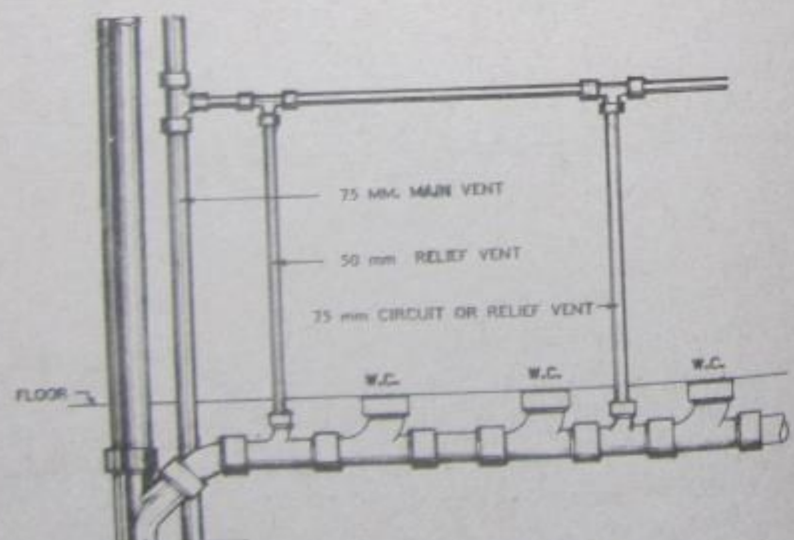


FIGURE 11-18 CIRCUIT – RELIEF VENT ON SOIL BRANCH

The installation of a relief vent could be determined outright, at the very start if the plumbing layout was properly planned, and carefully analyzed on the drafting table. For tall building, it is a must that the plumbing system be properly planned with complete details.

On Relief Vent, the Plumbing Code Provides that:

1. Waste branches which are circuit vented, shall be provided with relief vent.
2. The base of the soil stack on tall building installation is susceptible to back pressure, due to the large volume of water rushing down inside the pipe. Hence, a Relief Vent in this portion of the installation is necessary.
3. Relief Vent may be installed at interval on the soil pipe having changes in directions.

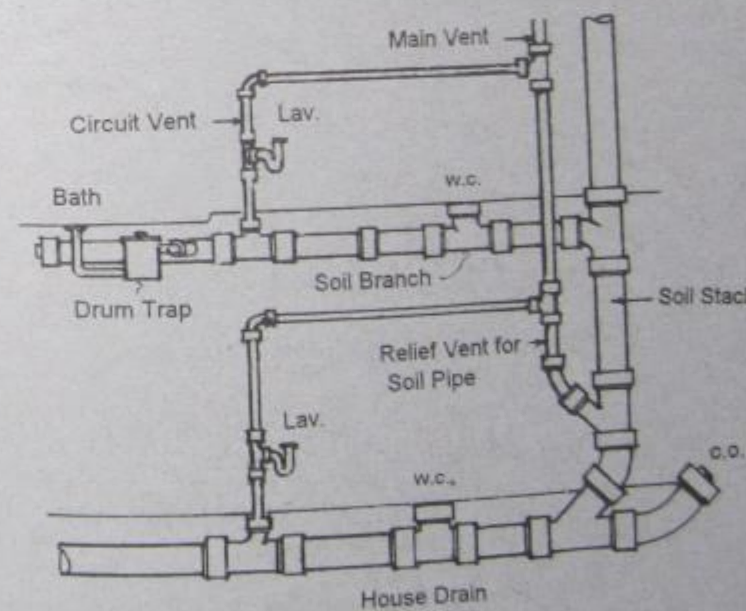


FIGURE 11-19 RELIEF VENT FOR TALL BUILDING

4. On long vertical soil pipe, a Relief Vent is installed at 3 to 5 floor intervals. In this manner of installation, the relief vent is sometimes referred to as **Yoke** or **By-Pass Ventilation**.

5. Relief Vent serving a circuit vented branch, should have at least one half (½) the diameter of the said soil pipe, but in no case, be less than 38 mm diameter. For instance, if the soil pipe is 100 mm. the relief vent is 50 mm but in no case, be less than 38 mm diameter.

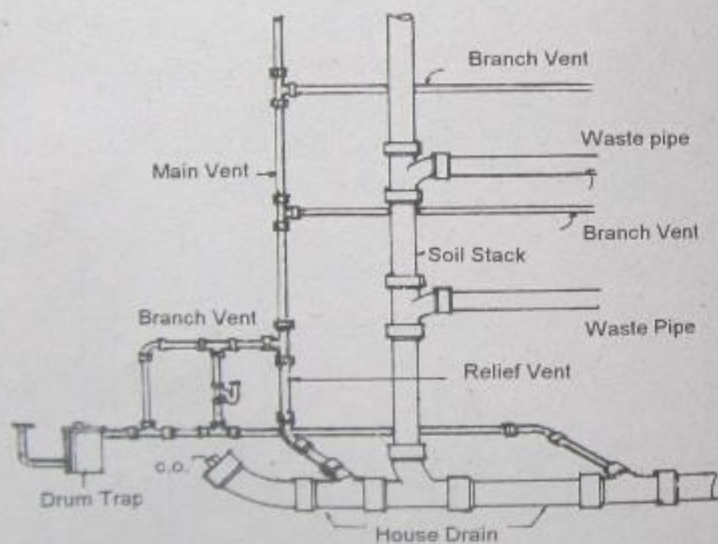


FIGURE 11-20 RELIEF VENT FOR HOUSE DRAIN

6. A Relief Vent used on a change of direction, and at the base of the soil pipe, shall have a diameter equal to the main vent, and in no case, the relief vent be less than 50 mm diameter.

7. Yoke Vent between the main vent and the soil pipe at 5 floor intervals must have equal pipe diameter, as the main vent.

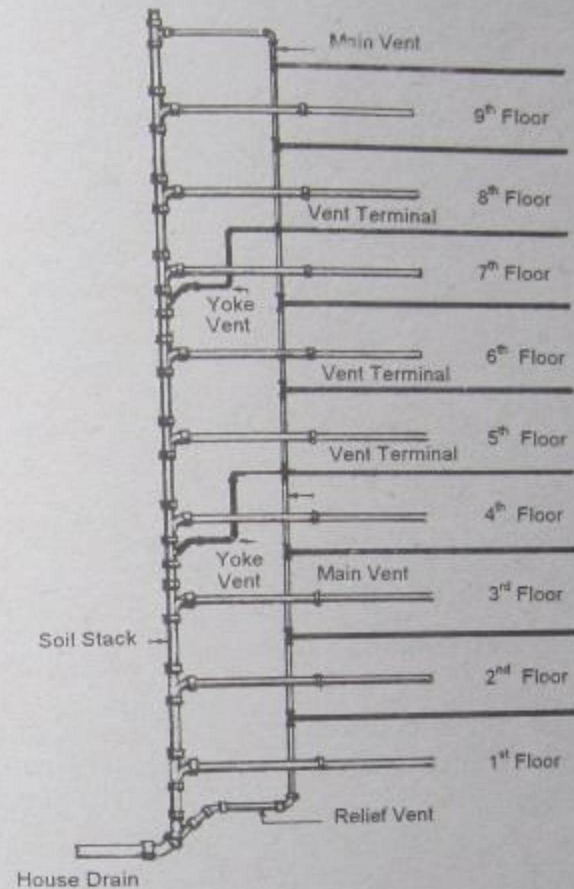


FIGURE 11-21 THE RELIEF AND YOKE VENT

11-12 Looped Vent

Looped Vent is one type of ventilation use on fixtures in a room away from partitions. This is common to beauty parlor, barber shop, dental clinic and operating room. The use of looped vent is not practical, but sometimes tolerated, only when other methods of ventilation could not be possible.

The size of looped vent is also determined in the same manner as that of the individual vent.

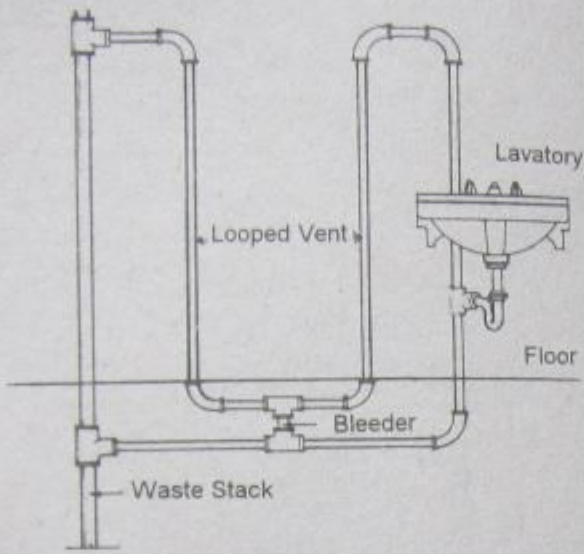


FIGURE 11-22 LOOPED VENT

11-13 Wet Ventilation

Wet ventilation is considered as one interesting topic for arguments, because both the affirmative and the negative sides, argue with sense and merit, but will end with nothing more than exchanging of salivated opinion, and waste of time.

The Federal Authority in their recommended minimum requirements, have permitted the use of wet ventilation. It appears in their findings after several tests using a clear plastic pipes that wet ventilation is also satisfactory.

Many states have used it for years and apparently have experienced no regret, or continuous amount of trouble with it. Wet venting had been proven effective installation on building of moderate height, wherein the horizontal branch vent are connected to the vertical soil stack. Under this type of installation, the main vent is eliminated, and naturally, cost is also reduced.

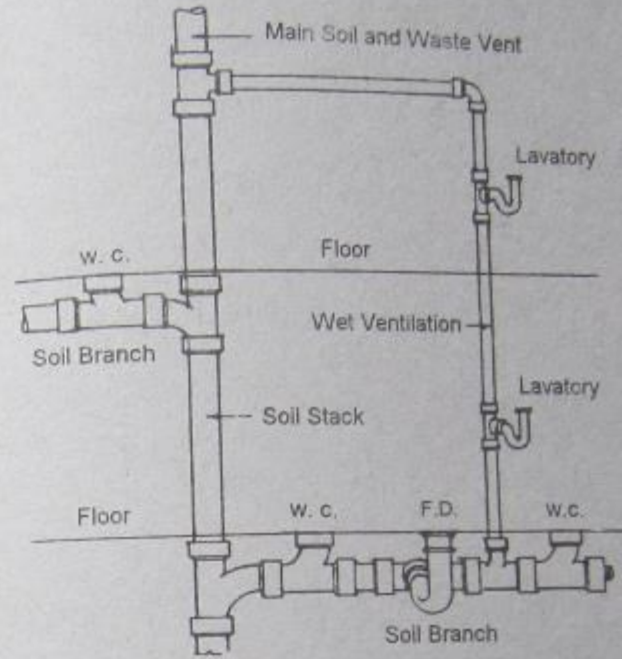


FIGURE 11-23 WET VENTILATION

Those advocates against wet venting contended that, a minus and plus pressure may be developed, when large amount of discharges from the upper floor fixtures rushed down rapidly inside the soil stack.

The velocity of this large waste, rushing down from the upper floor, will form like slug inside the pipe and consequently, compress the air down the house drain. The compressed air will create a plus pressure to blow off the trap seal. Likewise, a minus pressure will be created at the upper portion of the slug developing a siphon effect and subjecting the trap seal to a suction force. The ultimate effect is Trap Seal Loss.

Wet Ventilation is defined as that portion of the vent-pipe system where liquid waste regularly flows.

The wet vent method has long been used for small group of bathroom fixtures. Many plumbing installations have used this type for so many years and yet, have not experienced a great amount of trouble with it. However, it is not advisable to drain a kitchen sink, or similar fixtures into the vent pipe considering the kind and variety of waste matter it discharges.

A Circuit Vent installation could be used as a waste for small group of fixtures such as: lavatories, washbasin, drinking fountain, and other similar type of fixtures, except kitchen sink. The water that these fixtures waste into the circuit vent increases the scouring efficiency of the installation.

To determine the size of the Wet Vent Pipe, consider the following example:

ILLUSTRATION 11-5

Determine the size of the wet vent necessary to ventilate a group of fixtures consisting of: One water closet, two lavatories, and one bathtub.

SOLUTION

1. Refer to Table 11-1, the Unit Fixtures are.

6 x 1	Water closet --------------	6 units
1 x 2	lavatories -----------------	2 units
2 x 1	Bathtub ------------------	2 units
	Total	10 Fixture units

2. Refer to Table 11-1. A 38 mm diameter can only ventilate up to 8 units. Therefore, a 50 mm (2") pipe shall be used.

CHAPTER 12

THE SOVENT SYSTEM

12-1 Introduction

Man's constant struggle to make life better, has resulted to the countless achievements and development that have made life convenient, and a better place to live. Although these developments have its corresponding after effect, one cannot deny the pleasure of enjoying the fruits of his achievements.

Plumbing as part of this development struggle has experienced numerous transition, which culminated in the improvement of the past primitive plumbing practices. From the primitive waste disposal of prehistoric man, plumbing evolved to the present intricate and complex installations that are today.

Before, the average plumber believed that for a plumbing installation to function effectively, one has to install pipes of larger size. This concept is without regard to the effect of the natural laws of nature, like gravity, and atmospheric pressure on the flow of liquid inside the pipe. The traditional installation practices adopted year after year was the so called, **One Line Piping** which serve water closets and several fixtures.

Lately, when the magnitude of plumbing installation increases to meet the demand in taller buildings, problem on stoppage, floor flooding, back flow of gases, and other related inconveniences were discovered.

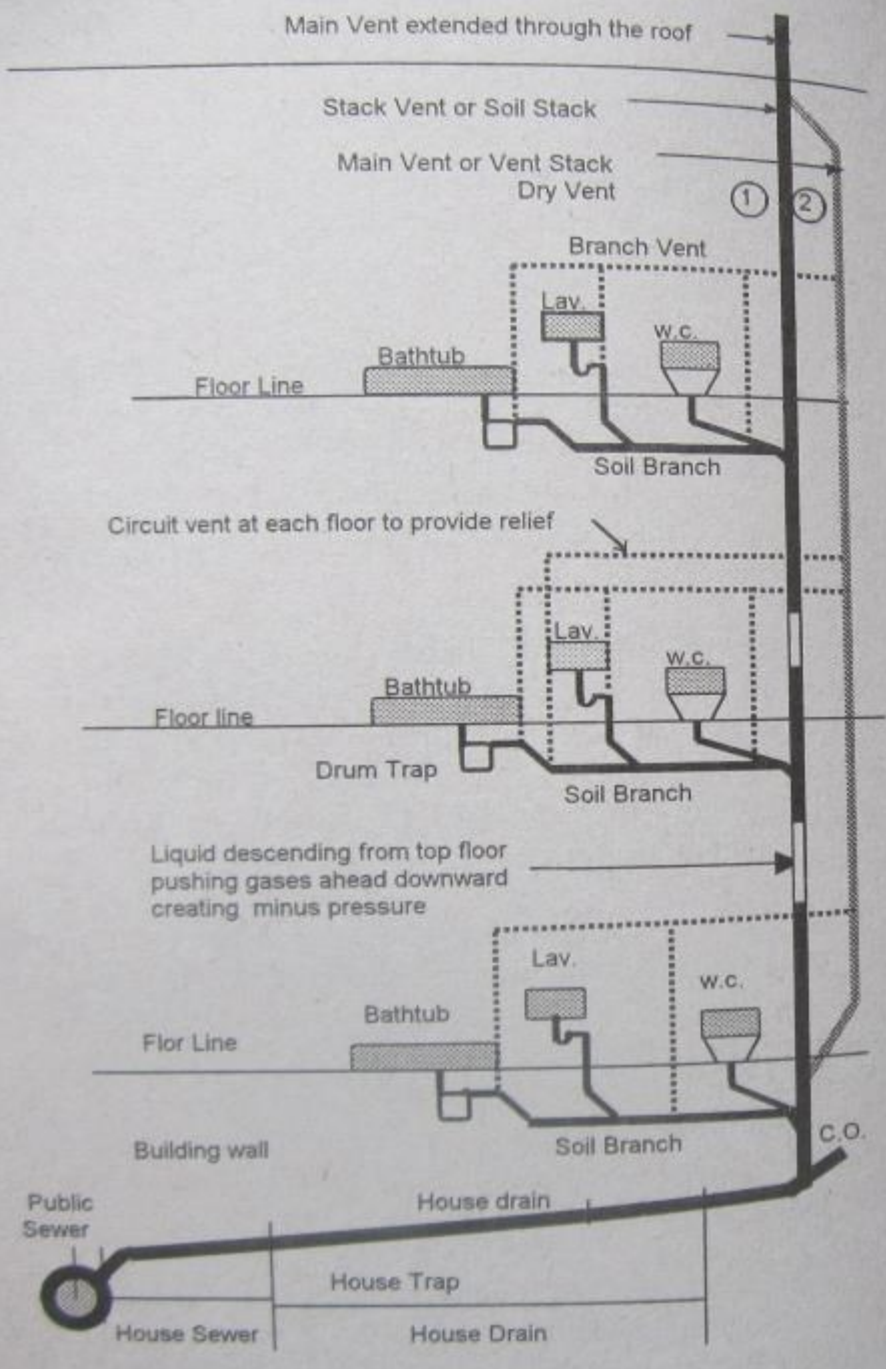


FIGURE 12-1 TRADITIONAL TWO LINE DRAINAGE SYSTEM

Sanitary authorities and plumbing mechanics realized the importance of the natural laws of nature, for having direct effect, on the flow of liquid inside the pipe. The unexpected problem must be resolved. All plumbing plans were required to provide air passages, to maintain a balance atmospheric pressure inside the pipe. Ventilation pipe was conceived and came into existence, giving birth to the ***Double Line Drainage System.***

The Two Line Drainage System is sometimes referred to as DWV, which means: *Drainage, Waste* and *Vent.* The installation has proven itself as efficient plumbing system. It was universally accepted for years, and now, referred to as the ***Traditional Two Line Drainage System.*** Traditional as so called, because of its existence for centuries now.

The incorporation of the **Vent Pipe** in the plumbing system, although promoting efficiency of the installation services, has also brought some of the problems enumerated as follows:

1. The routing and re-routing of the different types of vent pipe.
2. Additional cost for materials and labor.
3. Space requirements.

In order to address these problems, a new concept of plumbing science, called **Sovent System**, was introduced.

12-2 The Sovent System

The **Sovent System** is a recent development in drainage installation suitable for tall buildings. This new concept in plumbing, has almost completely eliminates the vent stack and other forms of ventilation, but still attained, the desired functions and effectiveness.

The **Sovent System** was introduced by Fritz Sommer of Switzerland. It was first presented in 1962, when tested on a 10 storey drainage tower which resulted in a satisfactory performance. From the time of its introduction in 1962, more than 100 tall buildings in Europe and Africa, adopted its use. Likewise, Sovent System was used in the habitat apartment of Canada, in the 1967 Montreal World's Fair.

In 1968, the Sovent System was first introduced in the United States construction of the Uniment Apartment in Richmond, California. Thereafter, in the same year, the Sovent System was granted Plumbing Code acceptance in Richmond California, U.S.A.

Today, the Sovent System is already accredited by major Plumbing Code Models of major cities of large countries.

12-3 Mechanics of the Sovent System

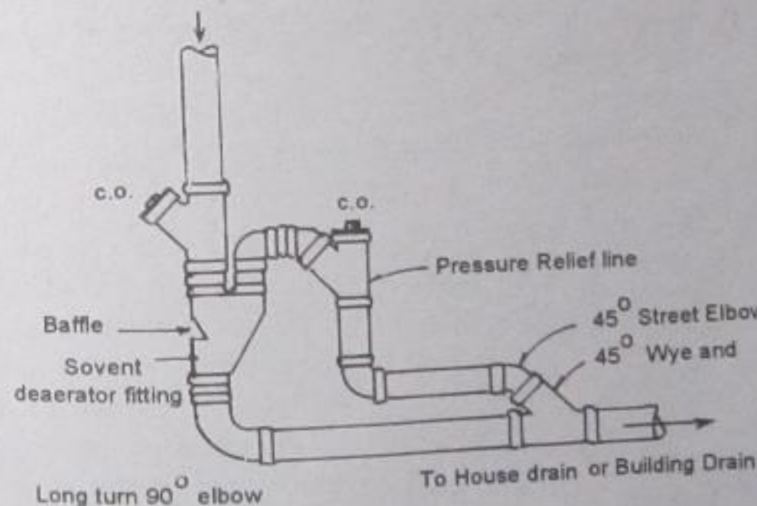
The introduction of ***Sovent System*** is an improvement of the traditional ***Two Line Drainage System***. While the later maintain a separate line of ventilating the system, the former to the contrary, eliminate the use of this ventilation line, but still maintained the balance atmospheric pressure required inside the pipe.

How the Sovent System Functions

1. A large amount of waste and sewage discharges from the upper floor fixtures could form a slug-like *(bullet)* pressing or pushing the air downward the pipe creating two kinds of forces: **pressure** and **suction.**
2. The downward force classified as **plus pressure,**

will induce back flow of water seal inside the P-trap of lower fixtures. Likewise, the suction force called **minus pressure** will siphon and pull down the water seal of the fixtures and create a **trap seal loss.**

3. The Sovent function is to change the solid nature of the effluent by scattering them into drops or small blobs to fall like liquid in a shower.
4. Although the effluent rarely fills the soil pipe completely, still it has the action of plunger. Gases are push down ahead of it creating a suction or negative pressure above it.
5. This negative pressure has to be neutralized. Otherwise, it will create a suction force to pull or siphon the water seal inside the fixture traps.



The deaerator consist of an air separation chamber with an internal nose piece, a stack inlet, a pressure relief outlet at the top, and a stack outlet at the bottom. The deaerator fitting functions in combination with the aerator fittings above to make a single stack self venting. The deaerator is designed to overcome tendency of the falling waste to stock up excessive back pressure at the bottom of the stack when the flow is decelerated by the bend into the horizontal drain.

FIGURE 12-2 SOVENT DEAERATOR

6. The **Sovent System** being a **Single Soil Stack Drainage System** (see figure 12-2) reduces the positive and negative pressure, to bring down the atmospheric value down below the holding capacity of the water inside the trap. Therefore, installation of the vent piping is not necessary.
7. The Sovent action, of reducing the positive and negative atmospheric pressure, is done at each floor where the **Aerator** is installed. By action of the aerator, foam was produced, avoiding the possibility of filling the pipe entirely by the liquid effluent. By creating a sift plunger, pressure variations in the **Single Soil Stack,** is minimized.
8. The effluent that was already exposed to air, falling down from the upper floors, is diverted in the soil stack at each lower floor. The aerated fitting device, accommodate the passage of this diverted flow, including the air space wherein the effluent from local soil branch or waste pipe can drop.
9. The **Aerator,** spatters or scatters the effluent in drops or small blobs wherein they are mixed with the air, forming a rarefied mixture of air and liquid. The effluent, which is already converted into small blobs and mixed with air falling at the base of the soil stack, cannot produce either plus, or minus pressure of more than 25 mm water gauge. Therefore, a water seal 50 mm high is safe against siphoning or back flow.
10. At the bottom portion of the Single Stack Sovent, the aerated effluent is compacted. A process that is supported by baffle in the aerator fittings. Air that is piling up at this point may cause pressure in the stack at the first floor, but it is relieve by providing an air discharge pipe.

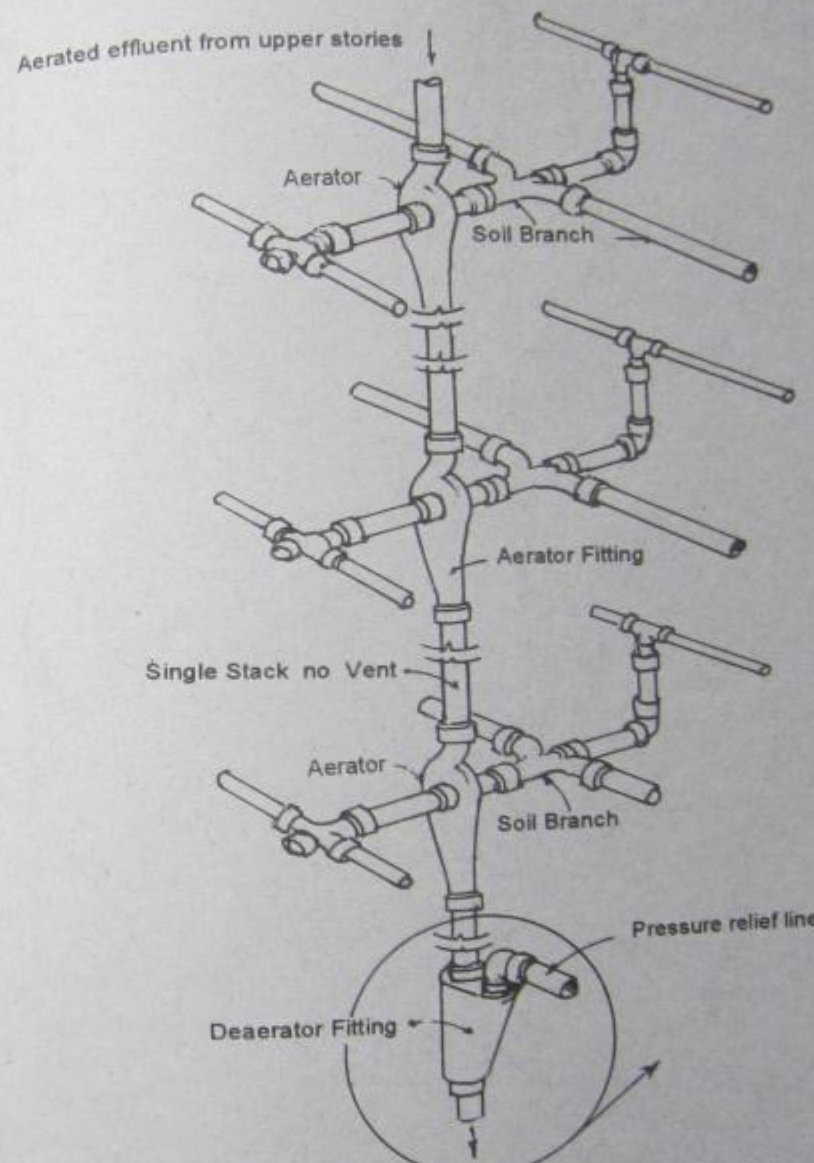


FIGURE 12-3 THE SOVENT DRAINAGE STACK SYSTEM

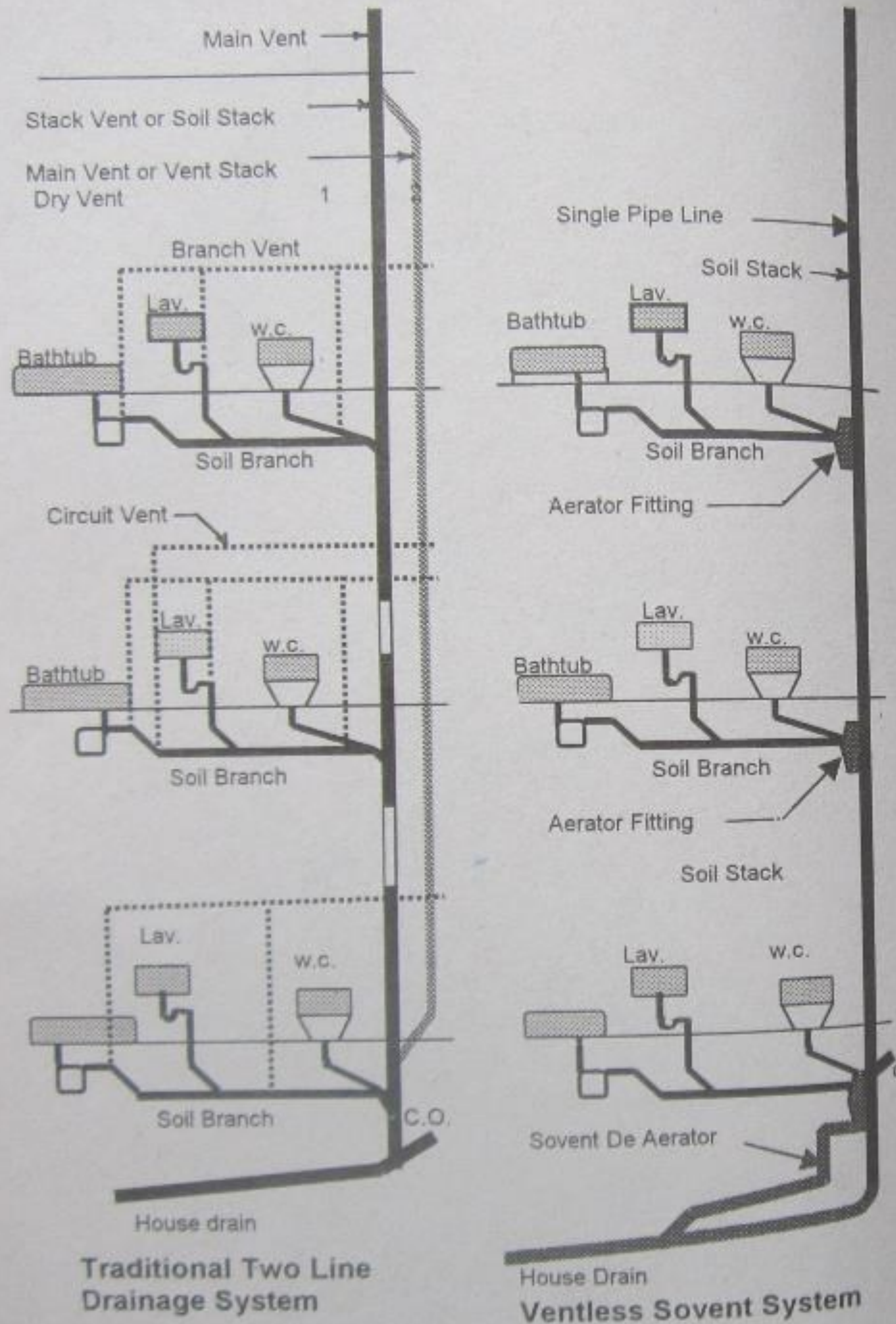


FIGURE 12-4 COMPARATIVE PIPING LAYOUT OF THE TRADITIONAL TWO LINE DRAINAGE SYSTEM AND THE VENTLESS SOVENT SYSTEM

The Sovent Deaerator Consists of:

1. Air separation chamber with internal nose piece
2. A stack inlet,
3. A pressure relief outlet at the top, and
4. A stack outlet at the bottom.

The deaerator fittings, functions in combination with the aerator fitting above, to make a single stack self venting. The deaerator is designed to overcome tendency of the falling waste to stock up excessive back pressure at the bottom of the stack when the flow is decelerated by the bend into the horizontal drain.

12-4 Materials and Design

The original material used for Sovent is copper, attributed to its proven record of quick and trouble free installation. The same material used for the 21 storey Hyatt Hotel in Phoenix now serving more than 50,000 dwelling units in the United States mainly on high rise structures.

Aerator and Deaerator

When the Sovent System was introduced, the material used for the **Aerator** and **Deaerator** fittings was copper.

The Aerator is used as terminal of the soil branch in each floor, and the Deaerator is installed at the bottom portion of the soil stack where the house drain is connected to receive the discharge from the Aerator.

The Sovent System is ***nothing more than the use of aerator and deaerator fittings incorporated into the ordinary plumbing pipe installations.***

What is new here is the **total elimination of the second piping line system called ventilation** which substantially occupy valuable spaces and added cost of construction.

According to the Copper Development Association

"Because the Sovent Plumbing drainage system is self aerating, it eliminate the usual separate vent pipe installation, thereby proven economical, speed of installation, space saving and has the greater design freedom."

The Sovent System has not yet reached our drafting tables in the absence of the **aerator** and **deaerator** fittings in the local market. The market and cost of copper is maybe one aspect of consideration. But eventually, considering the versatility of plastic material in terms of unlimited shapes and forms at lower cost, very soon, our market will be flooded with Aerator and Deaerator fittings for the adoption of the Sovent System in our future construction of high rise buildings.

CHAPTER 13

COLD WATER SUPPLY IN BUILDING

13-1 Water

Water is a combination of two chemical elements called Hydrogen and Oxygen. It appears in its natural state as liquid, solid (ice) or gas (water vapor or steam). Water in its liquid form is 839 times heavier than air, but in its gaseous state, or in the form of vapor, it is 133 times lighter than air. Water in its liquid form weights approximately 3.77 kilograms per US gallon, or 1,000 kilograms per cubic meter.

Water that appears in public or private water supplies, have been exposed to pollution while falling as rain, running or flowing on the ground, flowing in the streams or rivers or precipitating in the soil. The unabated use of streams, rivers and other waterways for waste disposal, had been detrimental to water supply, more particularly, to surface and ground water. Likewise, the problem is further aggravated by the increasing use of synthetic organic chemicals in household cleaners. As a result, there is now an increasing concern about water supply, due to the dwindling source of unpolluted water.

The Three Sources of Water are:

1. Rain Water
2. Natural surface water from streams and rivers.
3. Underground water

13-2 Impurities in Water

Pure or uncontaminated water is not found in nature. Water in the form of rain, absorbs dust and gases of carbon dioxide and oxygen. Similarly, water in the ground is exposed to pollution by organic matter, including animal and human wastes.

The Common Impurities in Water are:

1. Entrained gases
2. Dissolved minerals
3. Suspended and colloidal materials
4. Radioactive materials

Entrained gases are carbon dioxide, hydrogen sulfide methane, oxygen and nitrogenous and organic compounds.

Dissolved minerals are calcium, magnesium sodium, iron and manganese and other carbonates and silicates, alkyl benzene sulfate from detergents and synthetic organic from insecticides and pesticides.

Suspended and colloidal materials such as bacteria, algae, fungi, silt, protozoa and other colloidal matters making the water colored and acidic.

Radioactive materials by entrainment of radioactive substances from mining or processing ores, by wastes from industrial use of radioactive materials.

Among the minerals present in water through artificial means is **Lead.** Lead pipe should not be used for distribution of soft acid water, or for water having a high concentration of dissolved oxygen or chlorides. The solution of lead and water with such characteristics may cause **Lead Poisoning.**

13-3 Public Water Supply

In any source of public water supply, the following conditions shall be strictly observed, to avoid the possibility of contamination.

1. Wells that are supplying water for public use should be located at a minimum distance of 100 meters radius from residential areas.
2. All residents within this zone limit shall be strictly required to have sanitary sewage facilities.
3. There should be no concrete sanitary sewers existing within the 15 meters radius of the well.
4. No outdoor privy, cesspools, septic tank or drain fields, shall be located within 45 meters radius from the well.
5. The area shall be well drained to divert surface water from the well, and to minimize the possibility of flooding.
6. All abandoned wells near the site chosen for a new well, should be plugged and properly sealed, to prevent possible contamination of the ground water formation.

13-4 Spring Water

Spring water, is nothing more than a very shallow well with water, taken from a water stratum composed of cervical limestone, sand or gravel, lying a few meters below the earth. Contrary to common belief, spring water is not always free from contamination. Indeed, it is uncertain to conclude that spring water is protected from surface water contamination by impervious formation of the soil. Therefore extreme precautions should be exercised in developing water intended for drinking and household use.

Spring Water

Spring water for drinking and household purposes should be protected from:

1. Surface or Runoff water
2. Dust
3. Insect
4. Wildlife
5. Stock

The fissure wherein the spring water will flow, should be enclosed completely with a reservoir of concrete, tile, steel or other impervious materials under the following considerations:

1. The depth of the reservoir walls shall penetrate downward the impervious formations beneath the water producing stratum
2. The reservoir cover shall be insect proof, free from dust and rainwater.
3. A manhole of the raised curving type, with overlapping cover on its edges terminating in a downward direction, shall be provided with facilities for locking.
4. The reservoir should be disinfected with a chlorine solution, and then flushed thoroughly prior to the submitting of samples for laboratory test.
5. Water from the spring reservoir, shall be declared safe, only after the result of bacteriological test.

Different Types of Individual Well Spring

1. Dug wells
2. Bored wells
3. Driven wells
4. Drilled wells

13-5 Bottled Water

The production of bottled drinking water, must be regulated and looked into by the Health Authorities. For the safety of the drinking public, the Health Department should adopt regulations that will govern the processing and handling of bottled drinking water.

Health Regulations on Bottled Water Shall Include:

1. The source of water shall meet the prescribed standard of the Health Department service for drinking water.
2. Frequent bacteriological tests of the water delivered, shall be conducted, and the results must strictly comply with the health standard requirements at all times.
3. A complete chemical analysis for each type of water sold, shall be made at least twice a year.
4. The food and Drug Authorities shall prescribe rules on:

   a. Washing and disinfecting of the container.
   b. Methods of handling and delivery of the water.
   c. Sanitizing the building and other facilities.
   d. Maintaining the cleanliness of the employees.
   e. Labeling the container as to the type of water either:

      1. Distilled
      2. Demineralized
      3. Spring water

f. Therapeutic or medical clause printed on the label should not be permitted.

13-6 Manufacture of Ice

Ice is frequently used on food, beverages, and drinking water. As such, commercial Ice should be free from contamination. The Health Department shall strictly adopt rules governing the manufacture of ice such as:

1. Water used for the manufacture of ice must comply with the standards of the Department of Health for drinking water as to chemical and bacteriological quality.
2. Conduct bacteriological test of the ice to determine defects in freezing and handling.
3. Ice containing foreign matter should not be sold for human consumption
4. The ice plant must be free from entry of any foreign matter.
5. That, only authorized attendants shall be allowed to enter and walk on the tank floors using shoes exclusively for that area only.
6. Ice storage should be kept clean, and no ice shall come in contact with meat, fish or any food items.
7. Ice must be kept covered during delivery. Delivery trucks must be cleaned and free from any kind of contamination.
8. Crushing or grinding of commercial ice for human consumption, should be done in a sanitary manner and methods prescribed by the Health Authorities.

13-7 Water Distribution in Building

Planning the water distribution in buildings for a satisfactory chemical and bacteriological quality includes:

1. The system must provide adequate supply of water, with adequate pressure up to the extremities of the system.
2. The safety and quality of the water should not be impaired by defects in the system. It should be provided with sufficient valves and blow off's, to allow repair work without undue interruption of service to some areas, and to allow the flushing of the system.
3. There should be no unprotected open reservoir, or cross connections with inferior water system to enter the distribution system.
4. The water system should be tight against leakage. The main and branches connection should not be submerged in surface water, or subjected to any source of contamination.
5. The water system design, shall afford effective circulation of water with minimum number of dead end mains.
6. The system shall be guarded against contamination in any parts of it resulting from repair works, replacement or extension of the mains.
7. When new mains are installed, or old mains repaired, they should be filled with strong chlorine solution of 40 to 60 mg. per liter for at least 24 hours, and then flushed with water supplied normally from the main.
8. As much as possible, water main should be laid above the elevation of concrete sanitary sewers, or crossover points, and at least 3 meters horizontally from such sanitary sewer when they are parallel. Should this be impossible for some reasons, the sewer main must be encased in concrete.

Public Water Distribution is Classified into

1. Direct pressure distribution
2. Indirect pressure distribution

Direct Pressure Distribution. This type of water distribution, obtain its supply of water through a large intake pipe, installed in the lake basin extended down the water. Water is drawn from the lake, to a receiving well by force of gravity, passing through the filtration plant. The water inside the reservoir is pumped by a centrifugal, or piston pump into the water main with sufficient pressure to serve specific needs.

Indirect Pressure Distribution is when the water drawn from a drilled distribution is done by indirect pressure. For this type, a turbine pump is employed mounted on top of the standpipe extended down the well below the water table.

13-8 Household Water Supply

Water is a prime necessity in all types of households. It is conveyed from the main to the household or buildings by means of pipes classified as:

1. House service
2. Riser
3. Branches

House Service refers to the pipe connection from the public water main or any source of water supply to the building served.

Riser refers to the vertical supply pipe which extend upward from one floor to the next.

Branches are horizontal pipes that serve the faucets or fixtures.

Water Main

Water Main refers to the public water connection which are laid underground along the streets where the house service is connected.

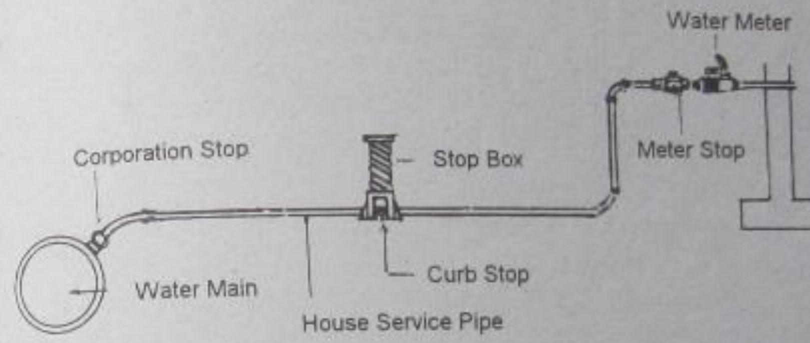


FIGURE 13-1 THE WATER SUPPLY SERVICE CONNECTION

The water service pipe is connected or tapped to the water main by personnel of the waterworks authority only. The connection is made with a special tapping device accomplished without necessarily shutting off the city or municipal water supply. Tapping of water supply service requires the use of corporation cock, curb cock, meter stop and water meter.

13-9 Types of Cold Water Distribution

Cold Water Distribution in Building is classified into three types:

1. By normal water pressure from the public main.
2. By overhead feed system
3. By air pressure distribution system

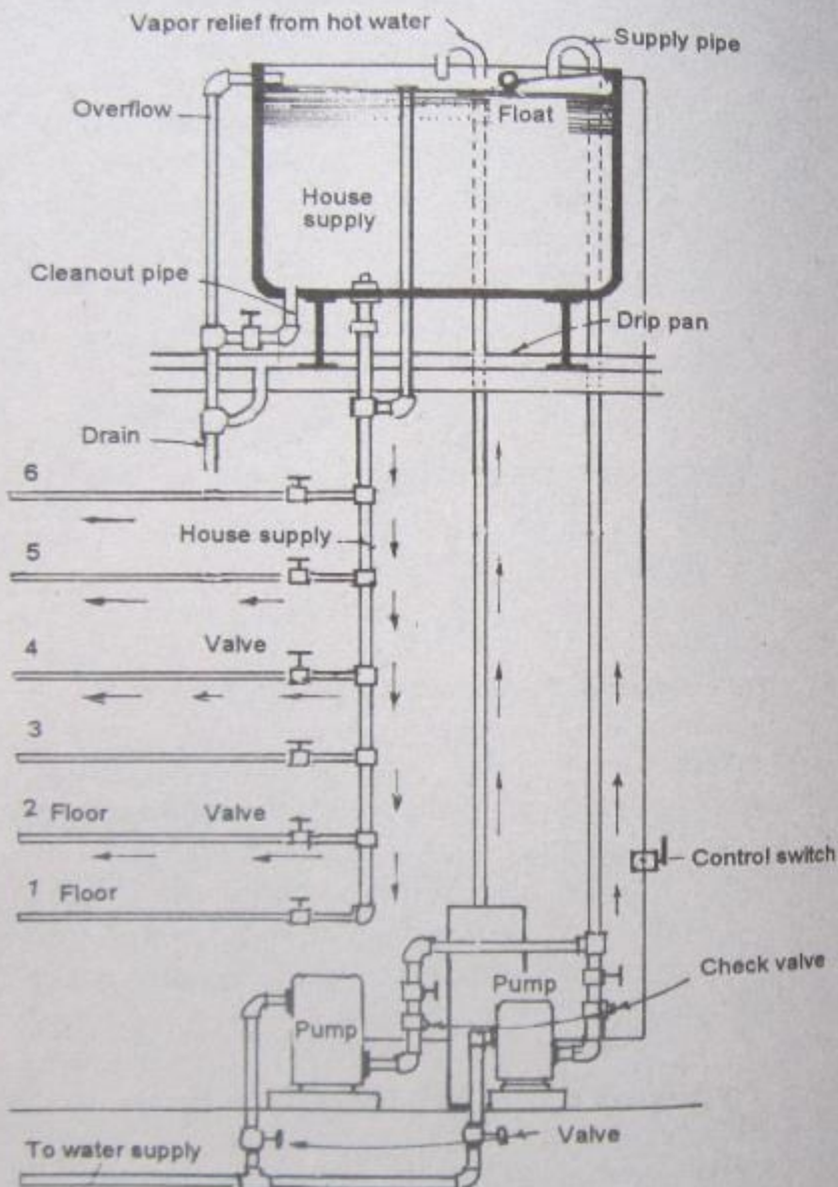


FIGURE 13-2 OVERHEAD FEED WATER SYSTEM

The normal water pressure from the public water main is normally inadequate to serve buildings. The alternative solution is either by the *Overhead Feed System* or by the *Air Pressured Distribution System.*

13-10 The Overhead Feed System

The Overhead Feed System supplies water to the plumbing fixtures by means of gravity. The water is pumped to a large tank on top of the building and distributed the water to the different fixtures. This type of water distribution is one of the oldest types. However, many planners and builders still favor its use, because of the following advantages it offers:

1. Because of the water stored inside the tank, water supply distribution is not affected by the peak load hour even if the pressure at the water main becomes considerably low.
2. Power interruptions will not in any manner affects the water supply inside the building.
3. In case the pumping unit breaks down, the time required to replace parts will not affect the regular supply of water.

This type of water distribution in building is fast becoming unpopular because of its disadvantages to wit:

1. The water inside the tank is exposed to the natural elements of weather, subject to contamination.
2. The water distribution unit has many working parts that require higher maintenance cost.
3. The pumping unit and the entire installation throughout the building occupies valuable spaces.

4. It requires stronger foundation and other structure to sustain the heavy load of the tank and its water content.

13-11 Air Pressured Water Distribution

The Air Pressured water distribution system is a new concept in water distribution where compressed air is used as the delivery agent. This type of water distribution is fast superseding the other types due to the many advantages it offer such as:

1. It has a compact pumping unit that requires a limited space.
2. The water chamber being air-tight makes the system a sanitary one.
3. The oxygen in the compressed air passing through the water line, serves as purifying agent, making the water more palatable.
4. It offers economic advantages by installing a smaller pipe diameter.
5. It has few working parts and therefore, less initial construction and maintenance cost.
6. Air pressurized water distribution system is well accepted for small, medium and large buildings.
7. Air pressured water distribution system serves zones of about 10 storeys or floor intervals in buildings of extreme height.

Disadvantages of the Air-Pressured Water Distribution System

The only disadvantage of the air pressurized water distribution system is the interruption of water supply. In case of power failure, water supply is greatly affected by the loss of air pressure inside the tank. But with the provision of a stand-by generator, power problem is overcome.

With the additional installation of stand-by generator, it seems that the system would become very costly. But on the basis of cost analysis, the air pressured water distribution system equipped with stand by generator is still cheaper than the initial cost and maintenance of an overhead feed system.

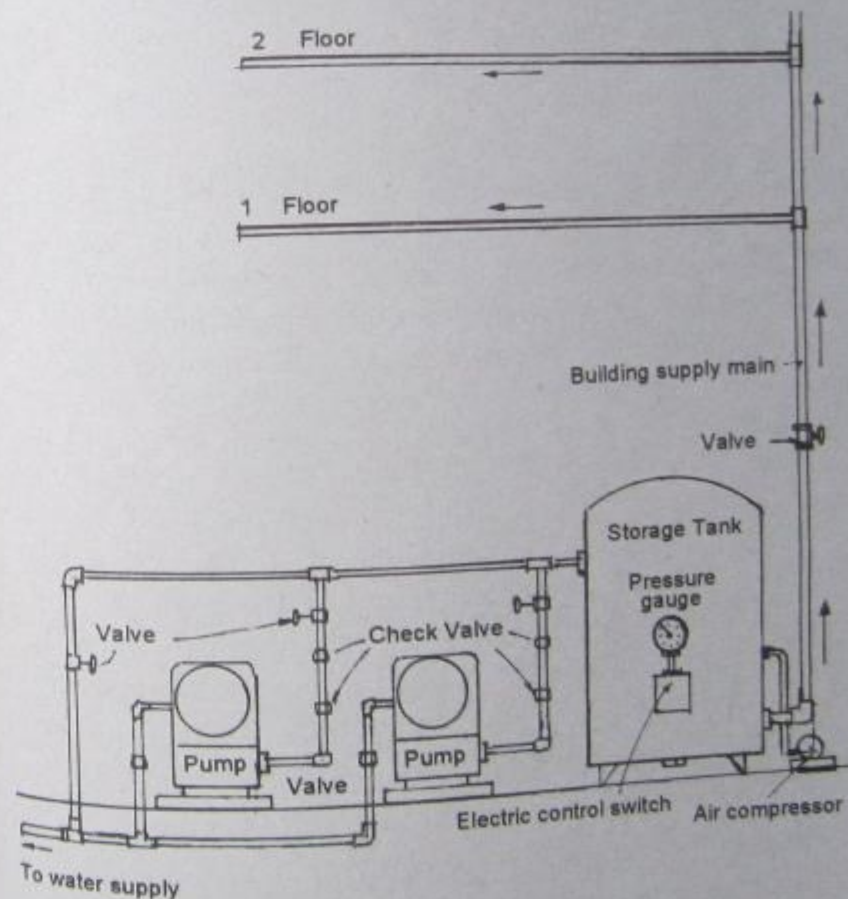


FIGURE 13-3 AIR PRESSURED WATER DISTRIBUTION SYSTEM

There are four mechanical devices used in air pressurized water supply system.

1. A large Storage Tank, with all tapping required
2. A single or duplex centrifugal pump
3. An air compressor
4. An automatic pressure control switch

For small unit water supply installations, a piston pump is generally used.

Operating Principle of an Air Pressured Water Distribution System

The operating principle of an air pressured water distribution system was based on the theory in physics that *"air is elastic or compressible, and water is inelastic or non compressible"*. Thus, when air is compressed into a closed compartment under atmospheric pressure to the extent of one half its volume content, the pressure will increase up to 15 pounds per square inch. This pressure inside the tank is capable of elevating water up to 10.50 meters high.

Should additional water be pumped into the tank to the height of 2/3 its content, a pressure of about 30 psi. will register on the pressure gauge. If additional water is pumped into the tank up to ¾ of its content, the pressure will rise up to about 45 psi. Theoretically, the 45 psi is capable of elevating water up to 31.70 meters equivalent to 10 storey building.

By compressing the original pressure inside the tank is not enough. The slightest draw of water from the faucet will substantially decrease the pressure and there is a possibility of water clogging inside the tank.

To overcome this water distribution deficiency, an air compressor unit is installed so that the volume of air inside the tank will be increased to a pressure of one half the minimum required. Air compressors however, will operate only when a part of the air inside the tank has been released.

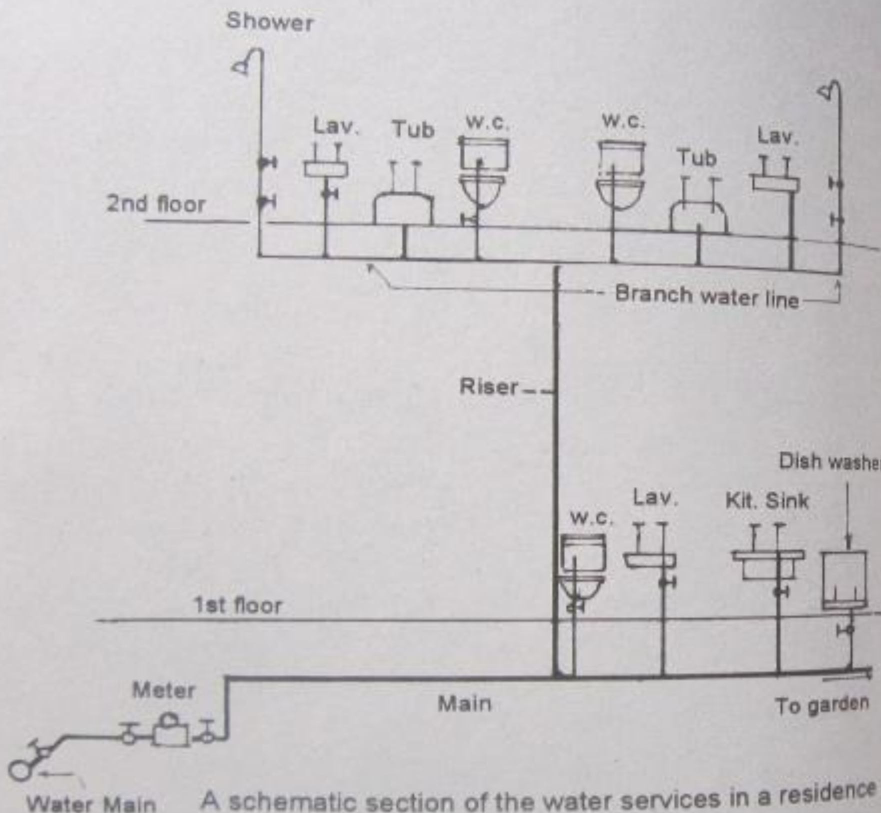
The admission of water inside the tank will proportionally increase the pressure by displacing a portion of the tank's air content. This will allow more extended draw of water from the distribution system. The ideal air pressure range is from 20 to 40 psi. The tank is provided with an automatic pressure switch control that regulate the starting and the stopping of the motor pump.

13-12 Direct Up-feed Pumping System

The Direct Upfeed Pumping System is an innovation of the air pressurized water distribution. This type of water distribution is used on tall building that could not be served adequately by the street main. This sophisticated process could deliver water at varying rates needed from two, three or several faucets up to the full demand of the entire building fixtures.

The direct Up-feed Pumping System is a **Triplex Pump** installed to operate in sequence according to the volume of demand. One pump is larger than the other one. The principle of operation is simple. When the water demand is small, the small pump called jockey will operate. As the water consumption increases to the point that the jockey pump could no longer cope with, the second larger pump starts automatically to replace the operation of the jockey.

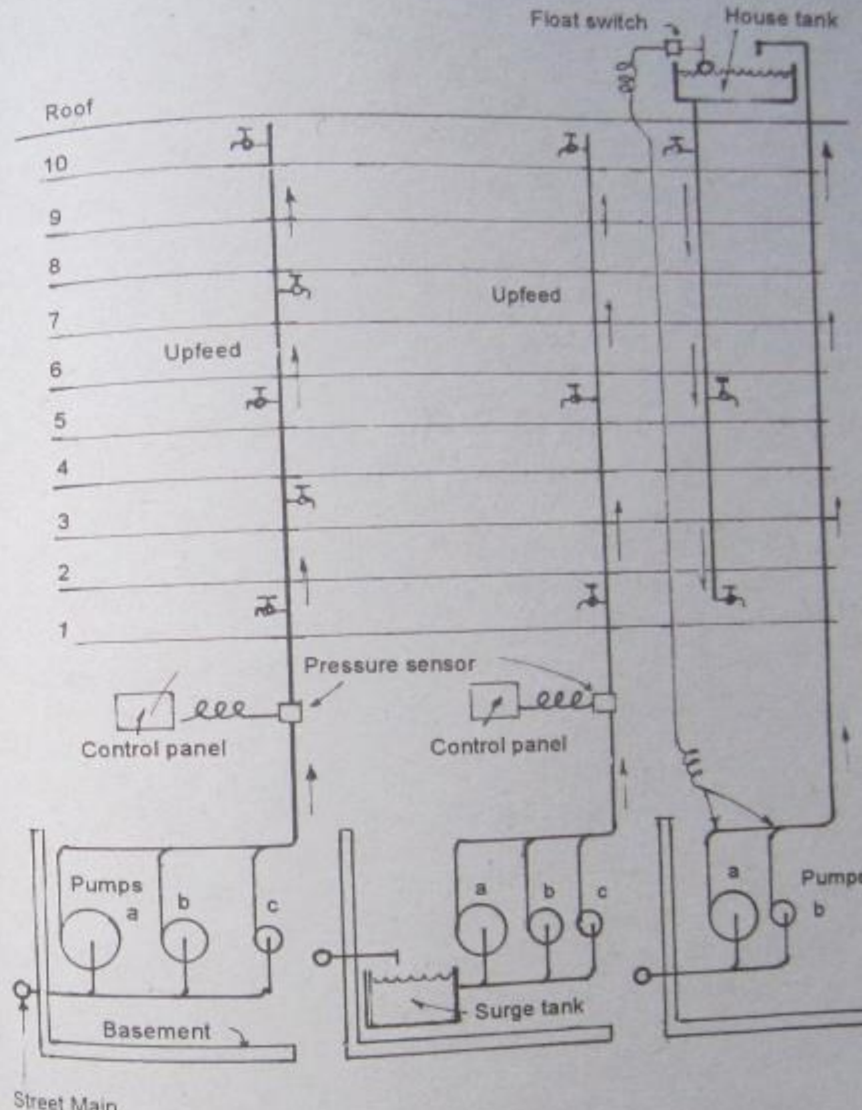
As demand increases further to reach its peak, the third largest pump with full capacity to supply the entire building, will automatically operate to replace the second pump. Under this principle, only one pump operates at a time, depending upon the volume of water demand.



A schematic section of the water services in a residence

FIGURE 13-4 UPFEED DISTRIBUTION BY STREET MAIN PRESSURE

Each pump is equipped with **Sensor,** programmed at a minimum and maximum operating pressure with automatic on and off switch depending upon the volume of demand. Under this concept of direct up-feed pumping distribution, the water supply pressure is nearly constant, and the third largest pump operate less frequent, and therefore, less in maintenance cost.



a. Constant Pressure

b. Same as (a) with Surge Tank

c. Conventional Roof Tank

FIGURE 13-5 DIRECT UPFEED SYSTEM – TRIPLEX PUMP

Advantages of the Direct Up-feed Pumping System

1. Eliminate the construction of large house water tank.
2. Avoid cost of heavy structures to carry the house tank
3. Eliminate periodic cost.

The direct up-feed pumping system is dependent on the supply of electricity. A standby power generator will operate in case of brown out or power failure.

13-13 Friction in Water Supply and Distribution System

Friction when alluded to in the plumbing system refers to the resistance produced by the flowing water with the fittings and interior surface of the pipe. In water supply distribution, friction is defined as the resistance between the molecules of water.

Friction in water supply and distribution system can be minimized under the following conditions:

1. All water pipes should be installed straight and direct as possible.
2. The use of turns, offsets, and traps, should be minimized if cannot be avoided.
3. Pipes with plain and smooth surface should be used.
4. The use of fittings, stops, and other devices connected to the distribution lines, should be minimized.
5. All fittings and joints must be connected properly.

Pressure. In plumbing, pressure is the force required to

move the water inside the pipe. It is the only means necessary to overcome friction. The pressure exerted by the water at rest is called **Static Pressure**. The pressure exerted by water at the base of a service pipe when the water is not in motion, is one example of static pressure.

Normal Pressure refers to the pressure range measured over a period of 24 hours. Normal pressure for a residential house ranges from 30 to 40 psi. Lower than this value may result to insufficient flow of water, especially, during simultaneous use of the fixtures. On the other hand, water pressure greater than 50 psi. may cause pipe hammering or even bursting of pipe joints.

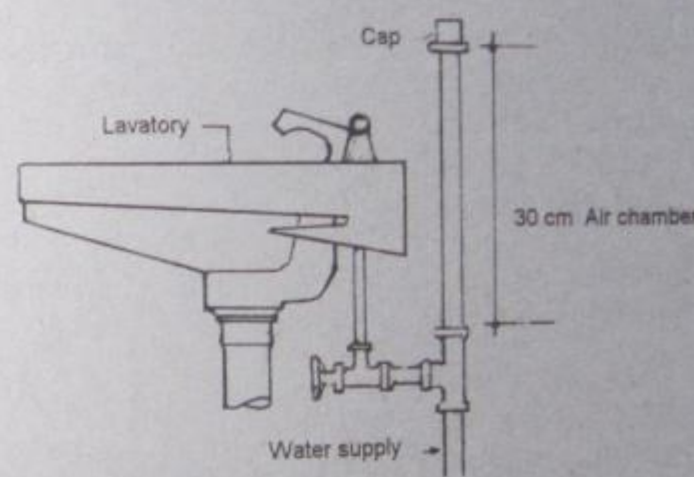


FIGURE 13-6 AIR CHAMBER TO PREEVENT WATER HAMMERING

An excessive water pressure can be minimized, by installing a **Pressure Reducing Valve.** This valve will keep the pressure constant at 40 psi or can be reset to any other pressure desired. Water vibration and hammering, can be checked by installing an air chamber pipe at the back of the faucet. The compressed air inside the pipe chamber serves as cushion to prevent water hammering.

Critical Pressure refers to the maximum and minimum pressure at which proper function of the water supply system can be maintained.

Head Loss by Friction or Friction Head Loss is the loss in rate of flow, due to friction between the water and the walls of the pipe.

Pressure Loss refers to the variations in pressure between the water main and the outlet end of the water service. Pressure loss is generally caused by friction.

Other Causes of Pressure Loss

1. Simultaneous draw or use of water
2. Height or distance to which the water must flow
3. Fluctuation of water pressure in the water main
4. Mineral elements in water that adhere to the interior of the pipe reducing the diameter.
5. Inadequate size of the pipe

Water supply coming from the public water main is also affected by water pressure fluctuations caused by:

1. Peak load
2. Emergency draw
3. Breakdown of lines or pumping unit
4. Insufficient water level at the water system reservoir

13-14 Maximum and Probable Demand

Maximum Demand refers to the maximum water discharge of fixtures in terms of fixture units (as explained in the previous chapters.) *The maximum demand of water is equal to the Total Fixture Units in the plumbing system, where one unit is valued at 8 gallons of water discharge per minute interval.*

Example:

One water closet is valued at 6 fixture units (see Table 5-1). Therefore, 6 x 8 = 48 gallons

ILLUSTRATION 13-1

A residential house has 3 water closets, 3 lavatories, one kitchen sink and 3 shower baths. Determine the ***maximum demand*** of water.

SOLUTION

1. Solve for the total fixture units using Table 5-1

6 units x 3 water closets	18 units
1 units x 3 lavatories	3 units
2 units x 1 kitchen sink	2 units
2 units x 3 shower bath	6 units
Total............................	29 units

2. The maximum water demand is:

29 units x 8 = 232 gallons.

Probable Demand or **Peak Load.** This is one factor to be considered in determining the size of the water service pipe. The question of how many fixtures will be used simultaneously at one point in time is difficult to ascertain, but according to statistical survey;

"the fewer the number of fixtures installed, the higher the percentage of probability of their simultaneous use, and the greater the number of fixtures installed, the lower the percentage of probable simultaneous use."

It is presumed that, *"if a fixture can discharge, only a given quantity of water, wherein the water supply may not be overtaxed above this amount of water without causing overflow of the fixtures being used, then, the maximum demand of water is the total sum of its fixture units wherein each fixture unit represents 8 gallons of water."*

TABLE 13-1 PROBABILITY OF SIMULTANEOUS USE OF FIXTURES

Number of Fixture Units	Percentage of Simultaneous Use
1 to 5	50 to 100%
6 to 50	25 to 50%
51 or more	10 to 25%

The **Probable Demand** is not likely to exceed 25% of the **Maximum Demand**, especially for average size residential buildings. This figure may be used, to establish the size of water service pipe.

ILLUTRATION 13-2

Determine the probable demand of the following fixtures installed: 2 water closets; 1 lavatory; 1 bath tub; 1 shower bath and 1 kitchen sink.

SOLUTION

1. Find the number of Fixture Units then multiply by 8.

2- water closets	2 x 6 =	12 units
1 lavatory	1 x 1 =	1 units
1 bathtub	1 x 2 =	2 units
1 shower bath	1 x 2 =	2 units
1 kitchen sink	1 x 2 =	2 units
Total		19 units

2. Multiply:

   19 units x 8 gal. = 152 gal. **maximum demand**

3. The 152 gallons of water maximum demand is likely to be consumed in one minute. Thus, it may be reduced by 25% to 50% to get the probable demand.

4. Assume 30% reduction of 152 gals = 45 gals.

5. Subtract from maximum demand of 152 gallons.

   152 – 45 = 107 gal. **probable demand.**

TABLE 13-2 GALLONS OF WATER PER MINUTE ON IO MM DIAMETER GALVANIZED IRON OR PLASTIC PIPE

Water Pressure at Main or Tank		LENGTH OF PIPE IN METERS									
Pounds	Newton	6	12	18	24	30	36	42	48	54	60
10	44.5	9	5	4	3	3	3	2	2	2	2
20	89.0	10	6	5	4	4	3	3	3	3	2
30	133.4	10	8	6	5	4	4	4	3	3	3
40	178.0	10	9	7	6	5	4	4	4	3	3
50	222.4	10	9	7	6	6	5	5	4	4	4

TABLE 13-3 GALLONS OF WATER PER MINUTE ON 12 MM PIPE

Water Pressure at Main or Tank		LENGTH OF PIPE IN METERS									
Pounds	Newton	6	12	18	24	30	36	42	48	54	60
10	44.5	10	8	5	5	4	3	3	3	3	3
20	89.0	14	10	8	6	6	5	5	4	4	4
30	133.4	18	12	40	8	7	7	6	6	5	5
40	178.0	20	14	11	10	8	8	7	7	6	6
50	222.4	20	16	13	11	10	9	8	7	7	7

TABLE 13-4 GALLONS OF WATER PER MINUTE ON A 20 MM PIPE

Water Pressure at Main or Tank		LENGTH OF PIPE IN METERS									
Pounds	Newton	6	12	18	24	30	36	42	48	54	60
10	44.5	22	14	12	10	8	8	7	6	6	6
20	89.0	30	22	18	14	12	12	10	10	10	8
30	133.4	38	26	22	18	16	14	14	12	12	10
40	178.0	38	30	24	22	19	17	16	16	15	13
50	222.4	38	34	28	24	22	19	18	7	16	15

TABLE 13-5 GALLONS OF WATER PER MINUTE ON A 25 MM PIPE

Pressure of Water at Main or Tank		LENGTH OF PIPE IN METERS									
Pounds	Newton	6	12	18	24	30	36	42	48	54	60
10	44.5	40	28	22	18	16	15	14	13	12	11
20	89.0	55	40	32	27	24	22	20	19	18	16
30	133.4	70	50	40	34	30	27	25	23	22	20
40	178.0	80	58	45	40	35	32	29	27	25	24
50	222.4	80	65	50	45	40	36	33	31	29	27

TABLE 13-6 GALLONS OF WATER PER MINUTE ON A 32 MM PIPE

Pressure of Water at Main or Tank		LENGTH OF PIPE IN METERS									
Pounds	Newton	6	12	18	24	30	36	42	48	54	60
10	44.5	80	55	45	37	35	30	37	26	25	24
20	89.0	110	80	65	55	50	45	42	38	36	34
30	133.4	110	100	80	70	60	56	50	47	45	43
40	178.0	110	110	95	80	72	65	60	56	52	50
50	222.4	110	110	107	92	82	73	68	63	60	58

TABLE 13-7 GALLONS OF WATER PER MINUTE ON A 38 MM PIPE

Pressure of Water at Main or Tank		LENGTH OF PIPE IN METERS									
Pounds	Newton	6	12	18	24	30	36	42	48	54	60
10	44.5	120	90	70	60	55	50	45	40	40	35
20	89.0	170	130	100	90	75	70	65	60	55	50
30	133.4	170	160	130	110	100	90	80	75	70	65
40	178.0	170	170	150	130	110	100	90	90	80	80
50	222.4	170	170	170	140	130	120	110	100	90	90

TABLE 13-8 GALLONS OF WATER PER MINUTE ON A 50 MM PIPE

Pressure of Water at Main or Tank		LENGTH OF PIPE IN METERS									
Pounds	Newton	6	12	18	24	30	36	42	48	54	60
10	44.5	240	160	130	110	100	90	80	80	80	70
20	89.0	300	240	200	160	150	140	130	120	110	100
30	133.4	300	300	240	200	180	160	150	140	140	130
40	178.0	300	300	280	240	220	200	190	160	160	150
50	222.4	300	300	300	280	240	220	200	200	180	160

On Water Wervice Pipes for large buildings, the National Plumbing Code provides that: *" The minimum size of water service pipes from the curb to the building shall be 38 mm (1 ½) diameter for the following fixtures"*

1. Sill Cock
2. Hot Water boiler
3. Laundry tray
4. Sink
5. Lavatories
6. Bathtub
7. Water closet

TABLE 13-9 RIGHT FLOW AND PRESSURE REQUIRED FOR VARIOUS FIXTURES

Fixture	Flow Pressure	Gallons Flow per Minute
Ordinary basin faucet	8	3.0
Self closing basin faucet	12	2.5
Sink faucet-10 mm diameter	10	4.5
Sink faucet-12 mm diameter	5	4.5
Bathtub faucet	5	6.0
Laundry tub cock	5	5.0
Shower	12	5.0
Ball cock for closet	15	3.0
Flush valve for closet	10-12	15-40
Flush valve for urinal	15	15
Garden hose, 15 m. & sill cock	30	5.0

Flow Pressure refers to the pressure at the entrance of a particular fixture

TABLE 13-10 DEMAND WEIGHT OF FIXTURES IN FIXTURE UNITS

Fixture Group	Occupancy	Type of Supply Control	Weight in Fixture Units
Water closet	Public	Flush valve	10
Water closet	Public	Flush tank	5
Pedestal Urinal	Public	Flush valve	10
Stall or wall urinal	Public	Flush valve	5
Stall or wall urinal	Public	Flush tank	3
Lavatory	Public	Faucet	2
Bathtub	Public	Faucet	4
Shower head	Public	Mixing valve	4
Service sink	Office, etc.	Faucet	3
Kitchen sink	Hotel or Restaurant	Faucet	4
Water closet	Private	Flush valve	6
Water closet	Private	Flush tank	3
Lavatory	Private	Faucet	1
Bathtub	Private	Faucet	2
Shower head	Private	Mixing valve	2
Bathroom group	Private	Flush valve	8
Bathroom group	Private	Flush tank	6
Separate shower	Private	Mixing valve	2
Kitchen sink	Private	Faucet	2
Laundry tray 1-3	Private	Faucet	3
Comb. fixture	Private	Faucet	3

Source: ASHRAE Handbook of Fundamentals 1972

The size of water service pipe is based on the maximum and minimum probable water demand, but in no case shall it be less than 20 mm diameter. Refer to Table 13-1 to Table 13-8. A 20 mm service pipe, can supply 2 branches of 12 mm diameter. It can deliver water to the house up to 10 gallons per minute, sufficient to serve up to 10 fixtures.

Likewise, a 25 mm diameter service pipe could supply 2 branches at 20 mm diameter, capable of delivering up to 18 gallons of water per minute to serve up to 20 fixtures. Service pipe that is too small always result to abrupt slackening of water flow specially during simultaneous opening of the faucets.

Smaller pipe is also subject to noise, vibrations and hammering. Horizontal tube requires a rigid type of piping, neat looking, with no danger of sagging because in case of repair, water might be trapped and prevent full drain of the line. Flexible pipe is recommended where offsetting or re-routing of line is required.

13-15 Water Pumps and Lifts

Public water distribution system usually has an average water pressure of 50 psi. that is only adequate to serve building less than 5 storey high. Taller building requires additional pump equipment prepared by professional engineers who compute the probable demand and the pressure loss due to head and friction.

Types of Pump

There are two types of water pump commonly used for water distribution in building, they are:

1. The Piston Pump and
2. The Centrifugal Pump

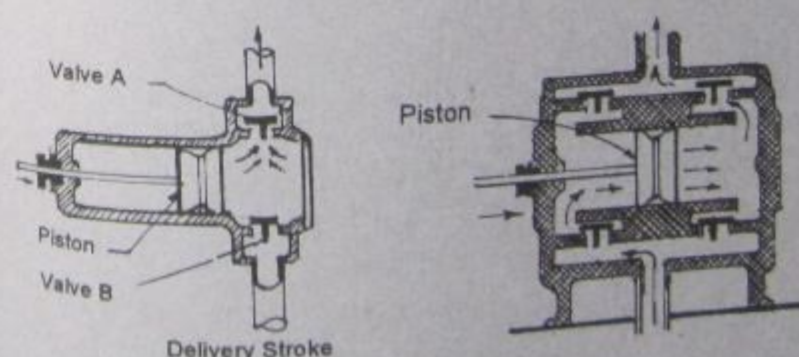


FIGURE 13-7 SINGLE AND DOUBLE ACTION PISTON PUMP

The **Piston Pump** is used on small water distribution system for elevating water in wells or other sources.

The Piston Pumps are of Three Types.

1. The Single Action pump
2. Double Action pump
3. Duplex or Twin Piston pump.

The **Centrifugal Pump** is associated with tall building water distribution system.

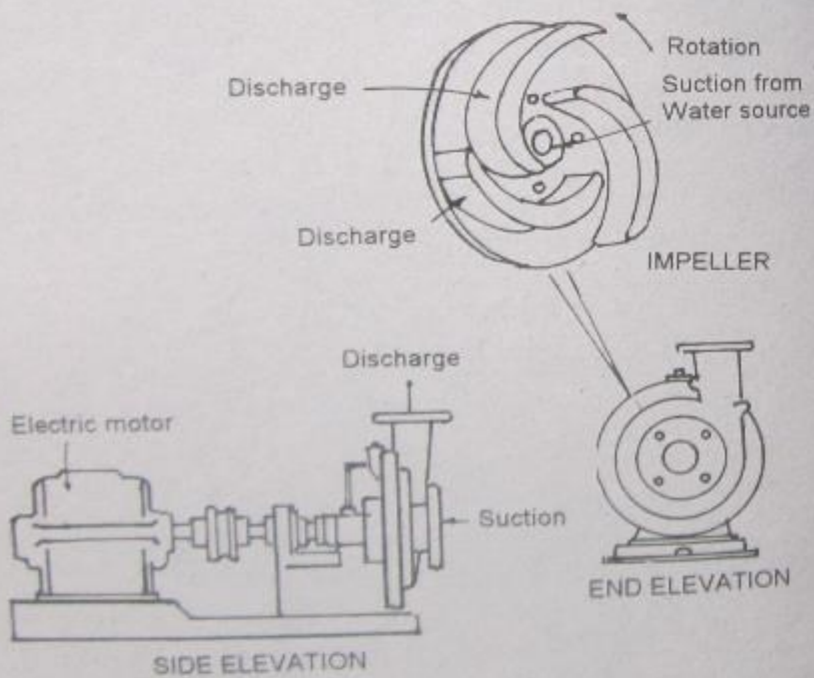


FIGURE 13-8 CENTRIFUGAL HOUSE PUMP

13-16 Water Service Fittings and Devices

Plumbing installations are subject to breakdown, because of their so many working parts. It is therefore necessary, that all types of water system be provided with sufficient number of valves, where they are mostly needed. Valve is necessary to avert serious damages of the installation in case of service breakdown.

Where there is insufficient number of valves installed, a major repair may require shutting off of the entire water system. It has been observed, that, in some installations, certain types of valves are used where they are not supposed to be. It is therefore necessary to know the different types of valves and their respective uses. The different types of valve used in water supply system are:

1. The gate valve
2. Globe valve
3. Angle valve
4. Check valve
5. Foot valve
6. Safety valve

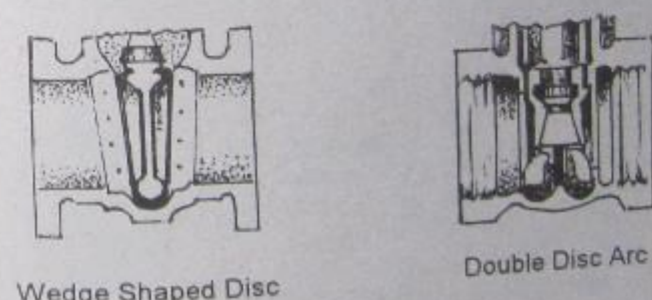


FIGURE 13-9 GATE VALVES

The **Gate Valve** is used to completely close, or completely open the line but not necessarily to control the flow of water. Gate valve is connected to the main supply and pump line wherein operation is infrequent.

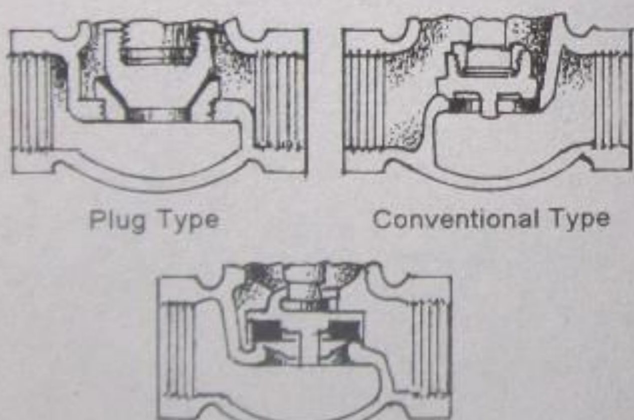
The name gate valve is taken from the gate-like disc that moves across the flow.

Gate Valve has Two Types:

1. The Wedged Shape or Tapered Disc
2. The Double Disc Valve

The **Wedged Shape** type is used where the stem must be installed pointing downward.

The **Double Disc Valve** type, closes in the same manner as the wedged type, except that its parallel faces drop in a vertical position, and are forced apart by the disc spreader. This type of valve is used in cold liquid and sewage disposal installation.



Plug Type Conventional Type

Composition Type

FIGURE 13-10 GLOBE VALVE

The **Globe Valve** is actuated by a stem screw, and hand wheel, suited on installation that calls for throttling. Globe valve affords greater resistance to flow than the gate valve because of the change in flow directions.

There are Three Types of Globe Valve.

1. The Plug Type Disc Valve
2. Conventional Disc Valve
3. Composition Disc Valve

The ***Plug Type Disc Valve*** has a wide bearing surface producing good resistance to the cutting effects of scale, dirt and other kind of foreign matter found inside the pipe.

The ***Conventional Disc Valve*** has a pressure tight bearing between the disc and the seat recommended for cold water and any temperature service.

The ***Composition Disc Valve*** is used for various types of services on oil, gasoline, steam, and hot or cold water.

The **Angle Valve** operates in the same manner as the globe valve. It is available in similar range of disc and seat design. Angle valve is used in making 90° turn in a line to reduce the number of joints.

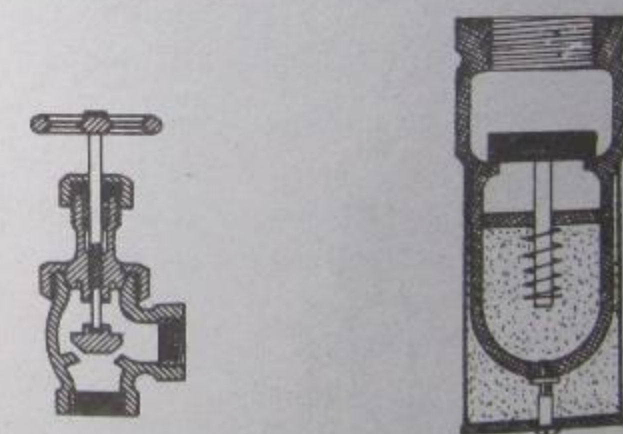


FIGURE 13-11 ANGLE AND FOOT VALVE

The **Foot Valve** is located at the lower end of the pump used to prevent loss of priming the pump. It is sometimes referred to as **Retention valve.**

The **Check Valve** main function is to prevent the reversal flow of gas or liquid in the line. It is principally used in industrial piping connections for gas, water, steam, air and other general vapor services.

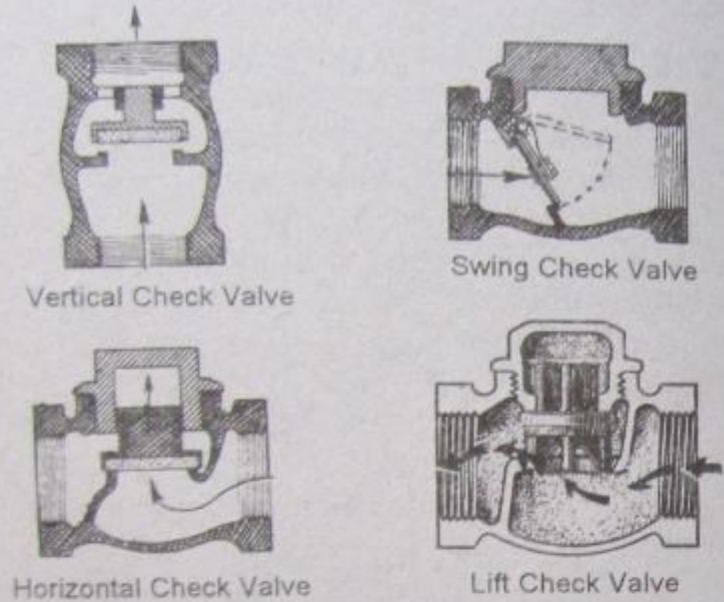


FIGURE 13-12 CHECK VALVES

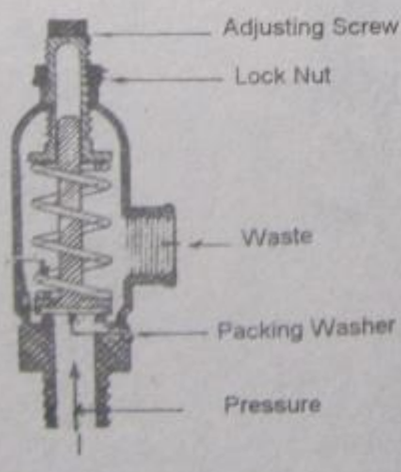


FIGURE 13-13 SAFETY VALVE

The **Safety Valve** is used on cold water systems, heating systems, compressed air lines, and other pipelines with excessive pressure.

Other Water Service Fittings and Devices

1. The Corporation stop
2. Curb stop
3. Curb stop box
4. Meter stop
5. Water Meter

The **Corporation Stop** is inserted into the water main. It serves as a control of the water service. And also serve as a shut off, when the service is disconnected.

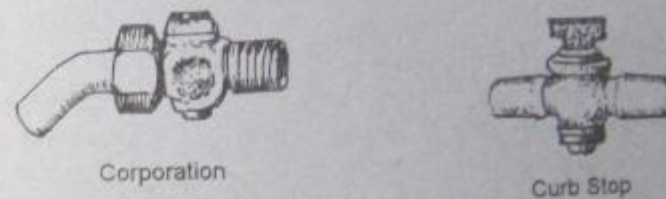


FIGURE 13-14 CORPORATION AND CURB STOP

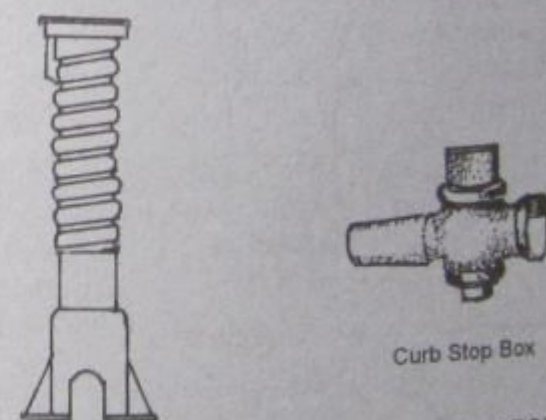


FIGURE 13-15 METER STOP AND CURB STOP BOX

The **Curb Stop** is installed between the curb and the sidewalk line accessible to cast iron stop box equipped with removable cover. It serves as control stop of the service between the curb and the building. It shut off water supply in case the basement becomes flooded.

The **Meter Stop** is a controlling stop of the entire water supply in building.

The **Water Meter** is a device used to measure the amount of water that passes through the water service.

WATER QUALITY PROBLEMS AND THEIR CORRECTIONS IN PRIVATE WATER SYSTEM

Hardness	Calcium and magnesium salts from underground flow	Clogging of pipes by scale, burning out of boilers and affects laundry & food preparation	Ion Exchanger Zeolite process
Corrosion	Acidity, entrained Oxygen & carbon Dioxide (low pH)	Closing of iron pipe by rust, destroy brass pipe	Raising the alkaline content
Pollution	Contamination by organic matter or sewage	Disease	Chlorination by sodium hypochlorite or chlorine gas.
Color	Iron and manganese	Discoloration of Fixtures and laundry t	Precipitation by filtration through manganese zeolite oxidizing filter
Taste or odor	Organic matter	Unpleasantness	Filtration through activated carbon purifier filtration

CHAPTER 14

HOT WATER SUPPLY IN BUILDING

14-1 Domestic Hot Water Supply

Sanitation standards required hotels, restaurants and other similar establishments to provide hot water facilities. Today, even the humblest small dwellings are enjoying this type of convenience for human comfort. The rudimentary principles behind the hot water supply in buildings are enumerated partially as follows:

1. When water is heated, its molecular particles expanded and move in a direction opposite with each other. As the molecular activity intensifies, the volume of water increases.
2. When the water reaches its boiling point under atmospheric pressure, its character changes. The expanded molecules become lighter, disintegrate, and evaporate as steam on the surface of water.
3. The movement of hot water in a distribution system is the result of expansion and contraction of the water molecules.

Heat increases the corrosive property of water that no galvanized iron metal could withstand its corrosive effect. The choice of materials for hot water installation is limited to copper tube, stainless steel pipe, or PVDC plastic pipe. Hot water supply system consists of a heater with storage tank and pipe connections to carry the hot water to the farthest fixtures with a continuous piping, to return the unused hot water back to the heater. Constant circulation of hot water should be maintained at all times, to be drawn at any time from the fixture.

Hot Water Distribution has Two Types

1. The Up-Feed and Gravity Return System
2. The Overhead Feed and Gravity Return system

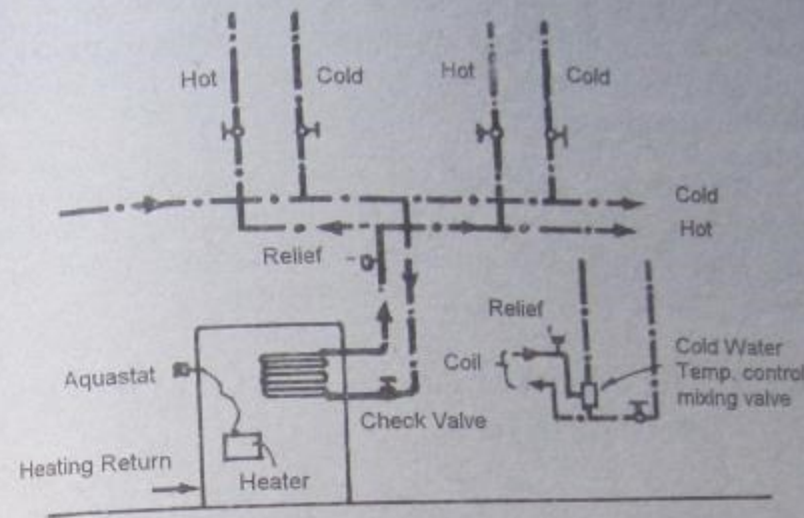
14-2 The Up-Feed and Gravity Return System

The Up-Feed Gravity Return System is commonly used in small residential houses and other industrial installations with the following service features:

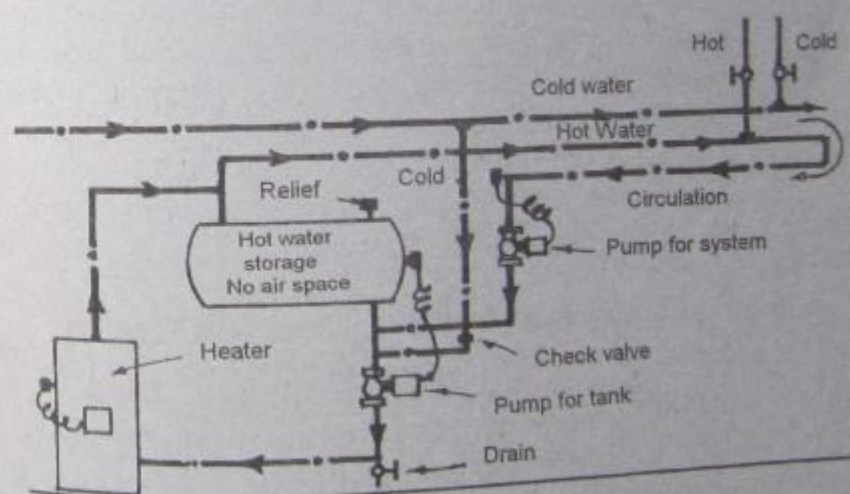
1. It provides constant circulation of hot water.
2. Hot water is quickly drawn from the fixtures at any time desired.
3. Provide economical circulating return of unused hot water.
4. Eliminate waste of water

Construction of the Up-Feed Gravity Return System.

1. The heating unit and the storage tank are placed below the distribution pipeline.
2. The heating unit should be near and accessible to serve the pipe system conveniently and efficiently.
3. The distribution main pipe is suspended from the ceiling of the basement. It is inclined upward from the storage unit. The risers are connected to the distribution main.
4. The distribution main pipe is connected to the tapping on top of the storage tank closer to the flow from the heater.



Schematic Diagram of Domestic Hot Water Supply from a tankless coil in a hot water heating boiler. This type is for small installation without hot water circulation



Source: ASHRAE Standard 90-75

Forced Circulation of Domestic Hot Water

FIGURE 14-1 UPFEED AND GRAVITY RETURN SYSTEM

5. The distribution main pipe and the flow risers are equipped with valve that is, of the Gate Type only.
6. The flow riser is provided with a drip at its base for draining.

The efficient and equal supply of hot water to different fixtures of varied heights and distances depends on ***how the riser is tapped to the main distribution.*** (See Figure 14-3 to 14-5)

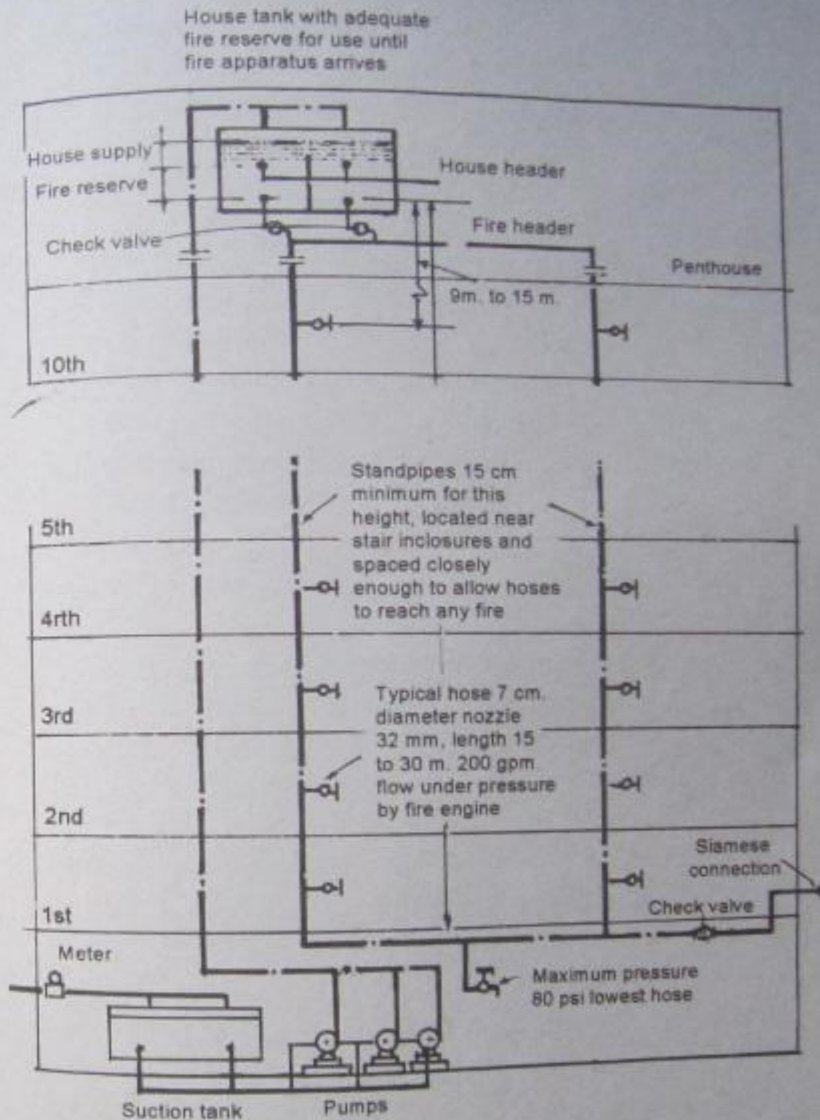
14-3 The Overhead Feed and Gravity Return System

The **Overhead Feed and Gravity Return System** is an efficient type of hot water distribution generally used in building of extreme heights. The operating principles are as follows:

1. That, water distribution is dependent on the expansion of hot water and gravity. In a closed pipeline system, water rises up to the highest point of the installation when heated. The natural force of gravity, return the water into the storage tank.
2. That, water will circulate, even if there may be defect in the mechanical construction.

Construction of the Overhead Feed and Gravity Return System

1. The storage heating unit is placed at the lowest point of the distribution pipe.
2. The overhead feed is connected to a tapping fitting located on top of the storage tank.
3. As much as possible, the riser should be extended direct and free from offsets. No fixture shall be connected directly to the riser.



Schematic Section of fire protection, part of a standpipe and hose system. Gravity tank downfeed to hoses for use by building personnel prior to the arrival of the firemen.

FIGURE 14-2 THE OVERHEAD FEED AND GRAVITY RETURN SYSTEM

METHODS OF TAPPING THE RISER TO THE MAIN DISTRIBUTION LINE

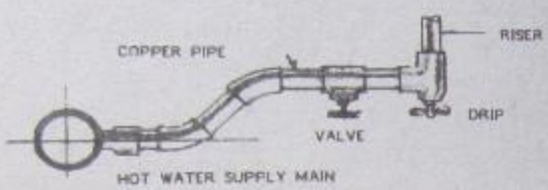


FIGURE 14-3 LONGER RISER IS CONNECTED HORIZONTALLY

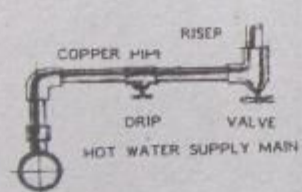


FIGURE 14-4 SHORT RISER CONNECTION

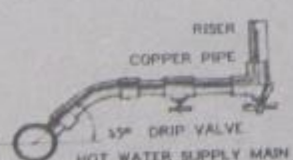


FIGURE 14-5 OTHERS ARE CONNECTED AT 45° ANGLE

4. The distribution pipe is connected to the top of the riser. It is sloped away from the riser to allow free flow of water to the last drop.
5. The horizontal runs of the riser should be short, direct, and equal in length as possible.
6. The horizontal riser branch is connected to the main distribution pipe, by a 45° fitting sloped to the vertical riser proper.
7. The horizontal riser branch is equipped with a valve installed closer to the main.
8. The riser is extended downward through the different storey of the building where the lavatories, shower bath, and the like are connected.
9. A gate valve and a drip are connected at the base.

Comparative Analysis

1. For **Overhead Feed System,** the large pipe of the installation is ***installed at the top of the riser***, and the diminishing pipe sizes, passes through the lower floors.

2. For an **Up-feed System,** the larger pipe is ***installed at the bottom of the riser*** and the diminishing sizes passes through the upper floors of the building.

14-4 The Pump Circuit System

The **Pump Circuit System** is a mechanical device used to circulate hot water to the plumbing fixtures. It is recommended for large building where difficulty of providing natural circulation of hot water is encountered. The centrifugal type of pump is used, because it is compactly designed, has few working parts, easily repaired in case of breakdown, and occupies limited space.

Unlike the *pulsating movement* produced by the ***piston pump***, the rotary motion of a ***centrifugal pump*** impeller creates *an even motion or flow of water* in the piping system. The circulating pump system is recommended on installation that has inefficient circulation of water due to:

1. Building defects compelling the plumber to trap runs on the main piping.
2. When scientific principles could not be applied to produce circulation.

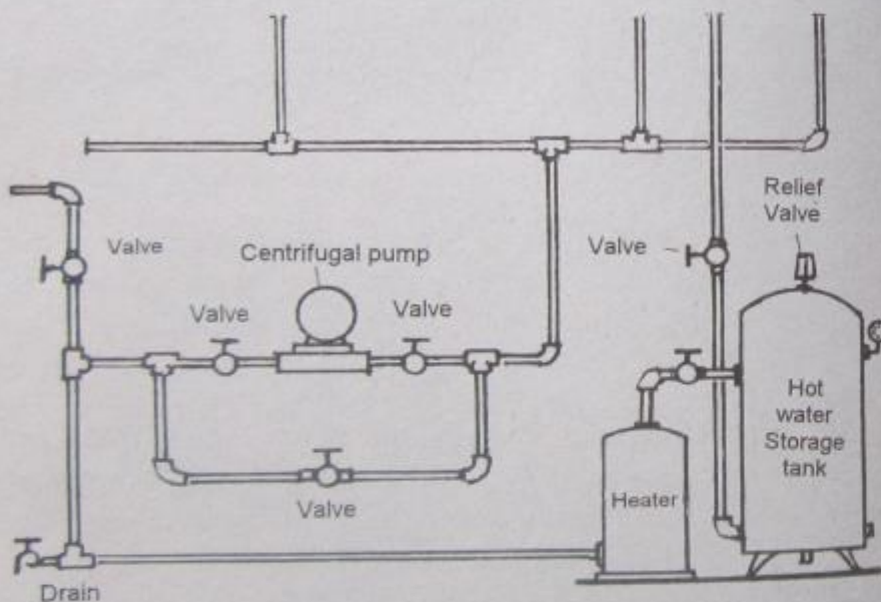


FIGURE 14-6 PUMP CIRCUIT SYSTEM

Advantages of using the Circulating Pump against the Overhead Feed or Up-feed System

1. Increased efficiency of the system.
2. Economical because the heated water is returned to

3. Faster circulation giving the occupants a better supply of hot water.

14-5 Location and Operation of the Pump

1. The pump is installed at the circulating return main.
2. It should be closer to the heating unit as possible.
3. The circulating return is connected to the inlet side of the pump.
4. The outer side of the pump is connected to the return and then to the heater.
5. Provide gate valve on each side of the pump.
6. The pump must be equipped with a by-pass, by inserting Tees of the same diameter as the circulating return ahead of the valves.
7. In case of pump trouble, the control valves are closed. Hot water will circulate to the pump into the return pipe of the heater.
8. When the pump is functioning, the valves on either side of the pump must be open at all times. When the by-pass is not in use, its valve must be closed.

14-6 Hot Water Tank

The purpose of a hot water tank is to serve the domestic hot water system. The tank should be strong enough to resist the high pressure of boiling water stored in it.

Hot Water Tank is Classified into Two Types:

1. The small hot water tank called **Range Boiler**
2. The large hot water tank called **Storage Boiler**

The **Range Boiler** is generally made of copper or stainless steel sheet. It is built into cylindrical shape with concave ends, welded or riveted to assure strength and durability. Range Boiler varies in sizes from 30 to 60 centimeters diameter and a length not more than 180 centimeters long, installed in either vertical or horizontal position.

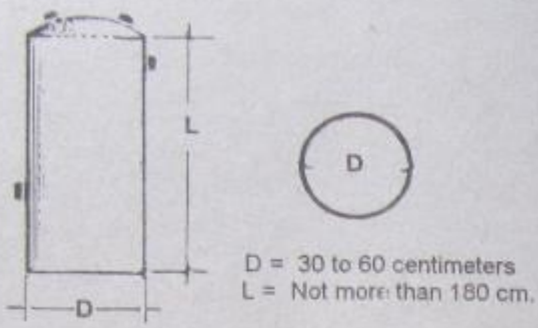


FIGURE 14-7 RANGE BOILER

The **Storage Tank** is made of heavy-duty stainless steel sheet of diameter varying from 60 to 130 centimeters and not more than 5 meters long. It is installed in either vertical or horizontal position.

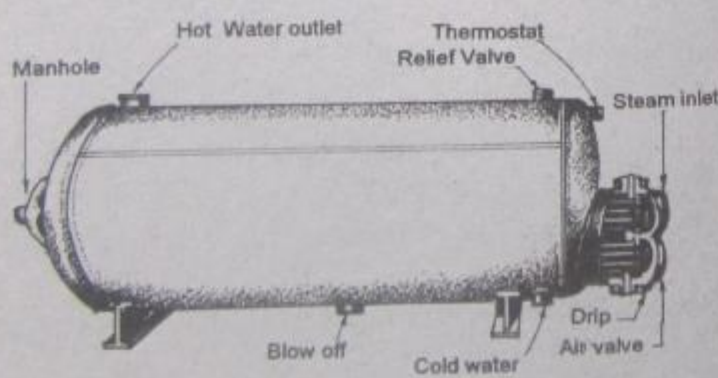


FIGURE 14-8 STORAGE TANK HEATER

When standard metal gauge is used, the working pressure is limited not to exceed 85 psi. Pressure greater than 85 psi. will require an extra heavy duty tank.

14-7 Size of Hot Water Tank

The size of hot water tank depends on the following considerations:

1. The kind of building served.
2. The expected number of occupants or users.
3. The heating capacity of the supply device.

The water heater must be of sufficient capacity to replace the discharged water in a reasonable time interval. If a tank installed is designed to serve 50 gallons of water in any one hour of the day, the heater must be able to replace the same in one hour. The rating or capacity of the water heater is indicated by the manufacturer in the label of their products.

Test results of hot water consumption per person ranges from 2 to 10 gallons per hour. Consumption depends upon the type of building served, and the purpose for which the water is used. A safe estimate of hot water consumption for hygienic and average use per person according to the type of building is presented in Table 14-1.

TABLE 14-1 HOT WATER CONSUMPTION

Kind of Building	Gallons per Person per Hour
Office buildings	4 to 5
School Buildings	2 to 3
Apartment buildings	8
Hotels	8 to10
Factories	4 to 6
Residential	10

14-8 Working Load of Hot Water System

The working load of hot water supply system in building is somewhat difficult to estimate, but experienced proved that:

1. For schools, offices or industrial type buildings, the average rated maximum consumption of hot water per person is about 25%.
2. For apartments and residences, the average working load is about 35%.
3. For Hotels, the working load is 50% of the rated consumption per person.

Example:

A 50 rooms hotel with an average occupant of two would require a storage tank according to the rated consumption per person of about:

50 x 2 x 10 gallons = 1,000 gal.

50% of this rated daily consumption per person is the safe load. Thus, 50% of 1,000 gallons is:

.50 x 1,000 = 500 gallons

500 gallons will be the basis in finding the size of tank.

TABLE 14-2 WORKING LOAD OF HOT WATER

Kind of Building	Average Working Load
School, Office and industrial type	25%
Apartments and Residences	35%
Hotels and Restaurants	50%

ILLUSTRATION 14-1

Determine the size of a residential boiler tank required to serve a family of 6 persons.

SOLUTION

1. Solve for the total rated hot water consumption. Refer to Table 14-1; multiply:

   6 persons x 10 gal. = 60 gallons

2. Refer to Table 14-2, under column *Residential House*, the working load is 35%, multiply:

   35 % x 60 gal. = 21 gallons

3. One cubic meter of water is equal to 264 US gallons, thus:

   $\frac{21}{264} = .08$ cu. m.

4. Find the dimension of the cylindrical tank. Assume a height of say 1.00 meter or 100 centimeters.

   $V = d^2 \times 0.784 \times \text{height}$

   $.08 = d^2 \times 0.784 \times 1.00$

   $d^2 = \frac{.08}{(0.784 \times 1.00)}$

   $d = \sqrt{0.102}$

   $d = .32$ m. or 32 cm. diameter of the tank

The tank will be 32 cm. diameter by 1.00 meter high.

Note: This solution could be simplified further by using the data presented on Table 14-3 and Table 14-4.

TABLE 14-3 RANGE BOILER SIZE AND CAPACITY IN GALLON

Height or Length in Meter	Diameter in Meter					
	.30	.35	.40	.45	.50	.60
1.00	18	25	33	42	52	74
1.20	22	30	40	50	62	89
1.40	26	35	46	58	72	104
1.60	30	40	53	67	83	119
1.80	34	45	60	75	93	134

TABLE 14-4 HOT WATER STORAGE TANK CAPACITY

Height in Meter	Diameter in Meter						
	.70	.80	.90	1.00	1.10	1.20	1.30
2.00	203	265	335	414	501	597	700
2.50	254	331	419	518	627	746	876
3.00	305	398	503	622	752	895	1051
3.50	355	464	587	725	878	1044	1226
4.00	406	530	671	829	1003	1194	1401
4.50	457	597	755	933	1128	1343	1576
5.00	508	663	839	1036	1254	1492	1752

TABLE 14-5 SIZE OF HOT WATER STORAGE TANK TAPPING

Tank Diameter in Meter	Tapping Diameter
0.50	38 mm 1 ½"
0.60	38 mm 1 ½"
0.75	50 mm 2"
0.90	50 mm 2"
1.00	50 mm 2"
1.20	75 mm 3"

ILLUSTRATION 14-2

Determine the size of a residential range boiler tank to serve a family of 8.

SOLUTION

1. Solve for the total hot water consumption

   8 persons x 10 gal. = 80 gallons

2. The rated capacity for a residential house is 35%, multiply:

   35% x 80 gal. = 28 gallons

3. Refer to Table 14-3. The size of the tank for 30 gallons is .35 m. diameter x 1.20 m. height

Range Boiler Specifications

Material................	Stainless Steel Sheet
Standard Pressure	378 N 85 psi
Extra Heavy	667 N 150 psi
Tapping	25 mm or 38 mm diameter

Hot Water Storage Tank Specifications

Materials...............	Stainless Steel Sheet
Manhole	27.5 cm. x 37.5 cm.
Standard Pressure	289 N 65 psi
Extra Heavy	449 N 100 psi
Tapping in each tank ..	6 pieces

14-9 Water and Energy Waste in Hot Water Line

In every household equipped with hot water installation, water waste and energy waste cannot be avoided. Hot water inside the pipe simply cools off between the time it was drawn and shut off. The next time hot water is drawn the cooled water inside the pipe is the first one to come out before the hot water reaches the faucet. Therefore, the volume of water standing in the pipe is just thrown away and wasted not withstanding the energy consumed when it was previously heated.

ILLUSTRATION 14-3

Find the monthly volume of water and energy *(in kilowatt hour)* wasted for a hot water installation serving the fixtures with the following data:

Fixtures	Min. number of use per day	Size of pipe	Distance from storage tank
Kitchen sink	3	12 mm	3.00 m.
Shower bath	2	12 mm	7.50 m.

SOLUTION

1. Refer to Table 14-6, water wasted is equal the number of times used multiplied by the volume of water wasted.
2. Solve for the water wasted in every fixture.

   a. **Kitchen sink :** 3 x 1.15 liters = 3.45
   For one month consumption ... x 30 days
   103.5 liters

   b. **Shower bath :** 2 x 2.85 liters = 5.70
   For one month consumption ... x 30 days
   171 liters

3. Add (a) and (b): 103.5 + 171 = 274.5 liters
4. Solve for the Energy wasted. Refer Table 14-6

   a. **Kitchen Sink:** 3 x 0.036 = .108 kwh.
   For one month consumption .. x 30 days
   Energy wasted for 1 month ... 3.24 kwh.

   b. **Shower Bath**: 2 x .090 = .180 kwh.
   For one month consumption ... x 30 days
   Energy wasted for 1 month .... 5.40 kwh

5. Add (a) and (b) to get the total energy wasted
   3.24 + 5.40 = 8.64 kwh.
6. Multiply by the rate per kilowatt hour, to get the amount of money wasted.

TABLE 14-6 WASTED WATER AND ENERGY IN HOT WATER LINE

Size of Pipe Mm	Length in Meter	Volume of Water drawn off to Obtain Hot Waterat Faucet	Equivalent Kw hr. Wasted
25 mm	3.00	3.15 liters	0.120
	7.50	7.57 liters	0.290
	15.00	14.49 liters	0.580
20 mm	3.00	1.83 liters	0.060
	7.50	5.29 liters	0.170
	15.00	10.60 liters	0.340
12 mm	3.00	1.15 liters	0.036
	7.50	2.85 liters	0.090
	15.00	6.67 liters	0.180
10 mm	3.00	0.85 liters	0.027
	7.50	2.13 liters	0.068
	15.00	4.26 liters	0.137

Table 14-6 shows the amount of water and energy wasted between the intervals of hot water level.

Suggestion How to Minimize Hot Water and Energy Waste

1. Hot water pipeline should be short as possible.
2. The hot water tank should be near and accessible to where most hot water is needed.
3. Use the smallest size of pipe that will provide a satisfactory supply. It is less expensive in terms of heat and water waste.
4. A 10 mm (3/8") cooper tube if not too long connection, is the most economical size to serve runs for sinks, lavatories, shower bath and other similar fixtures. Copper tube absorb less heat than steel pipe, thus, less insulation is required.
5. Pipe carrying domestic hot water, should be insulated to conserve fuel cost, and to assure a correct water temperature at the point of use. A 12 mm (1/2") thick fiberglass was proven efficient insulating cover.
6. Hot and cold water line running parallel with each other should be separated at a minimum distance of 15 centimeters to prevent heat interchange.
7. Small storage tank and heater is preferred.

TABLE 14-7 AVERAGE ENERGY WASTED ON LEAKING FAUCET

Number of Drops per Minute	Kilowatt Hour per Month
30	13.5
60	28.2
120	59.2
12 mm (1 ⅛) Solid stream	253.5
38 mm (1 ⅛) Solid Stream	550.5

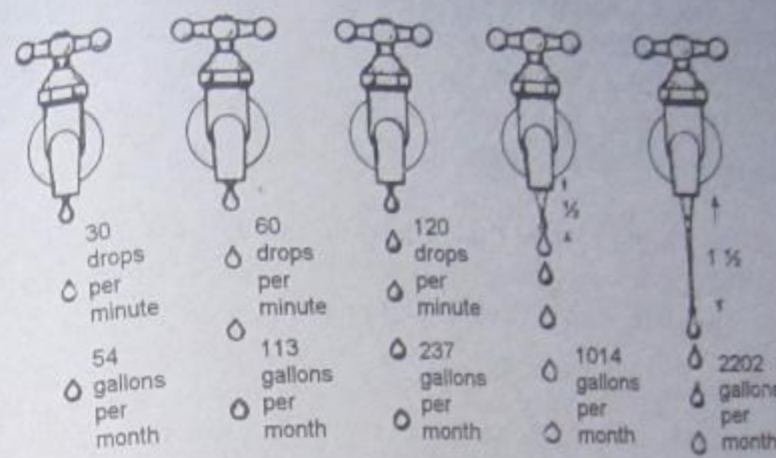


FIGURE 14-9 LEAKING FAUCET

14-10 Protection of the Hot Water Tank

Pressure and temperature if not controlled may cause serious damages to the hot water storage unit. Excessive pressure or temperature inside the tank may cause rupture or explosion of the tank. Protect your tank with **Temperature Pressure Relief Valve.**

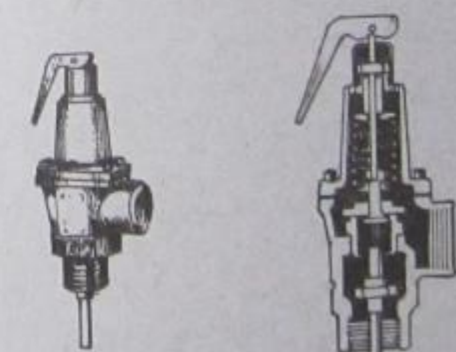


FIGURE 14-10 TEMPERATURE AND RELIEF VALVE

Install a **Temperature Pressure Relief Valve** on the hot water tank, or hot water supply line to protect the system. The pressure relief valve must be closer to the tank, provided with a drip pipe from the relief valve extending downward to the basement floor near the floor drain.

The purpose of **Steam Relief Valve** is to protect the hot *water space heating system*, while the **Temperature and Pressure Relief Valve** protects the *hot water supply system.*

There are Two Types of Water Heating System

1. The ***Hot Water Space Heating System*** where water is confined within a system at low temperature.
2. The ***Hot Water Supply System*** not in a closed system which operate on much higher temperature.

The settings of these Relief Valves were factory made. They should not in any manner, be tampered by the owner or his unauthorized technician.

CHAPTER 15

PLUMBING FIXTURES

15-1 Introduction

By definition, plumbing fixtures are receptacles intended to receive water, liquid or water-carried waste and discharge them into the drainage system. The latest concept in the design of plumbing fixture is to fit people rather than making people fit the fixture. The trend is to make the fixture an integral part of the room decorations.

Plumbing fixtures comes in varieties of style and accessories designed to match with the room for cosmetic reasons. Concomitant with this, it is imperative to buy plumbing fixtures of the best quality. Best quality carries with it the name or brand of reputable manufacturers. Quality fixtures are especially designed and built to take a lot of abuse, and yet, expected to last for years.

Quality is always associated with cost. But cost of this particular construction item is always considered a good investment. Comparatively, cheaper fixtures wear out faster than those that cost higher but last for years.

15-2 Water Closet

By definition, water closet is a plumbing fixture used to convey organic body waste to the plumbing system. Water closet is classified according to:

1. Design
2. Quality

3. Shape
4. Color

Design. With respect to design, water closet comes in various types, they are:

1. The Pail Flush type
2. The Squat type
3. Wash Down type
4. The Reverse type
5. The Siphon Jet
6. The Siphon Vortex
7. Direct Flush Valve type

Quality. With respect to quality, water closet must possess the following characteristics.

1. Flush down quietly
2. Flush down the liquid and waste completely
3. Must function efficiently
4. Must retain large amount of standing water surface area inside the bowl to prevent fouling and contamination

Shape. With respect to shape, water closets are classified into two types, a namely:

1. The **Round Type** is intended for installation on a limited space.
2. The **Elongated Type** is more comfortable but occupies a larger space. This type has a large amount of standing water inside the bowl that is more sanitary and easier to maintain.

Color. With respect to color, various kinds of pastel and bright colors are available for the designers and users freedom of choice.

The Pail Flush Type Water Closet

The pail flush type water closet is the cheapest, the smallest, and the simplest form of water closet designed without water tank. The flushing action can be agitated by a small quantity of water. Some called this type as mini-closet, intended for installation in a very limited space and budget.

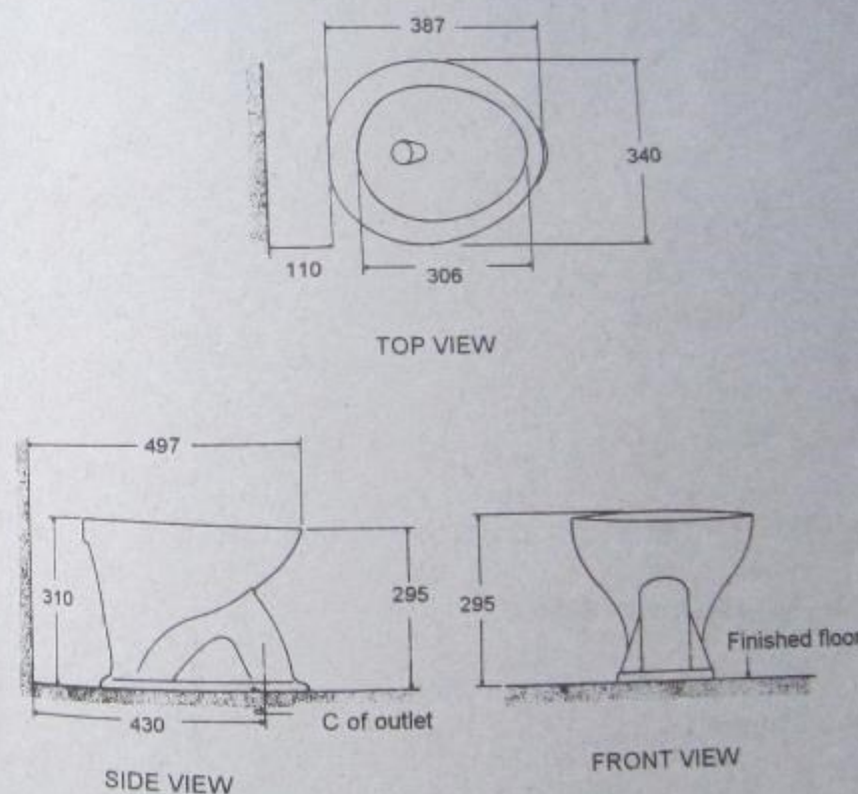


FIGURE 15-1 PAIL FLUSH TYPE WATER CLOSET

The Squat Type Water Closet

The squat type is another simple type of water closet without water tank installed flat on the floor.

The flushing action can be agitated with one half gallon of water similar with that of the pail flush type water closet. This type however, is commonly seen installed in a public toilet for ladies.

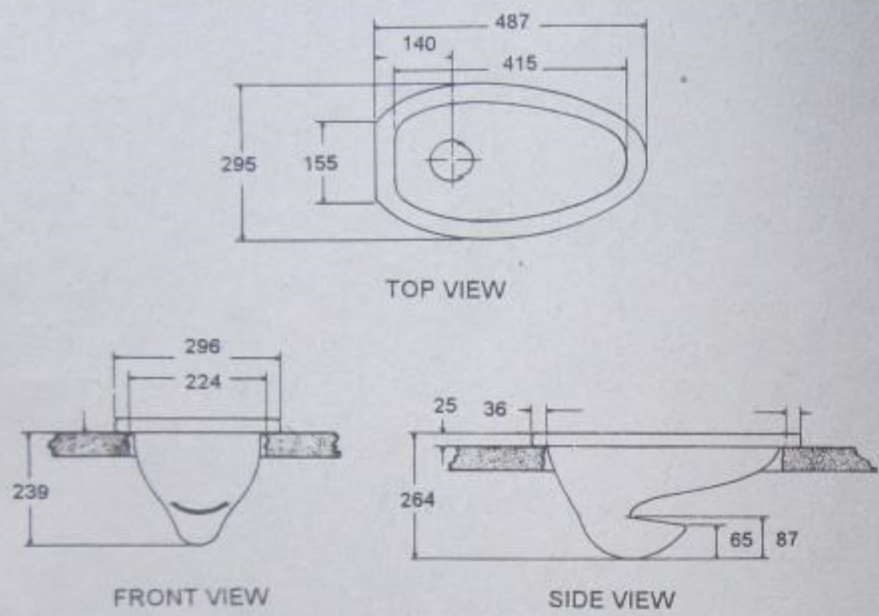


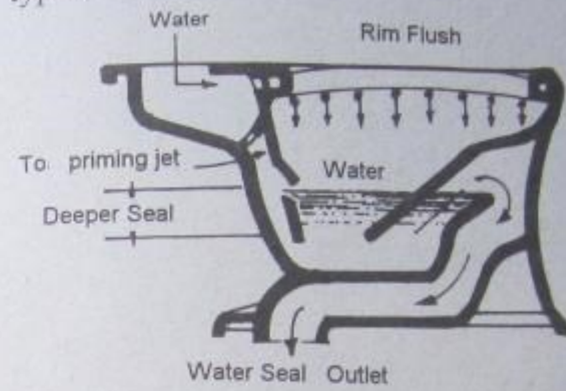
FIGURE 15-2 SQUAT TYPE WATER CLOSET

The Wash Down Type

The wash down type water closet has the following characteristics:

1. It flushes through a simple wash down action.
2. It discharge waste into a trap-way located at the front of the bowl.
3. It is more subject to clogging than the other types. The trap-way is irregular in shape because of its exterior design, and the methods of manufacturing.
4. It is recognized by the bulging shape in front.

5. It has small amount of standing water with large exposed surface at the inside front of the bowl. It is susceptible to fouling, staining and contamination.
6. It cost less but least efficient and the noisiest of all types.



FIIGURE 15- 3 CROSS SECTION OF WASH DOWN TYPE WATER CLOSET

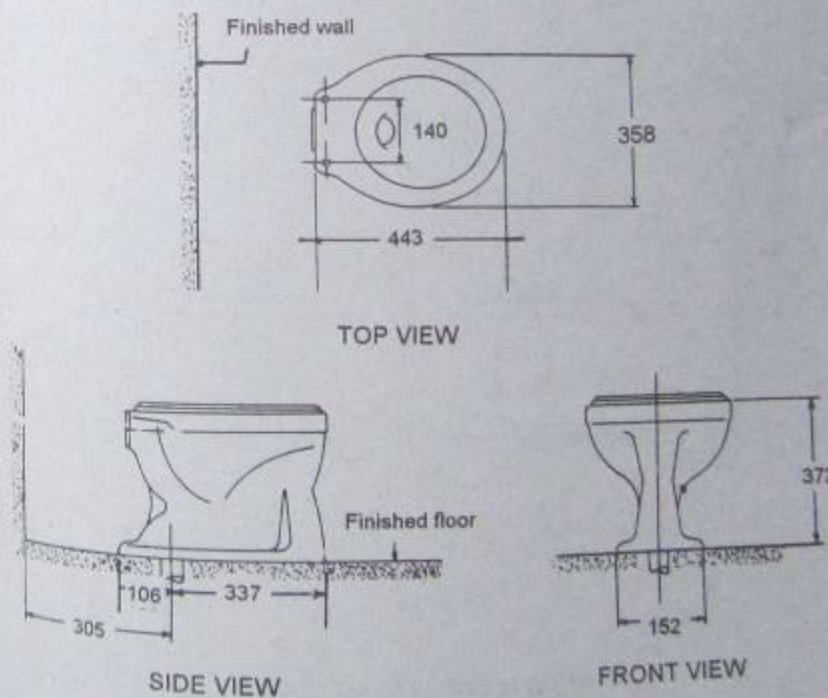
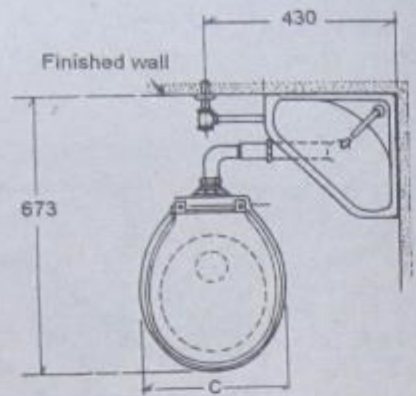
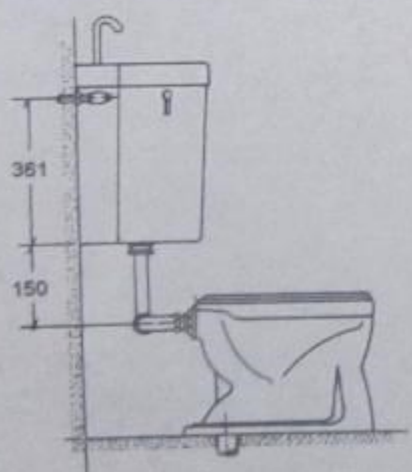


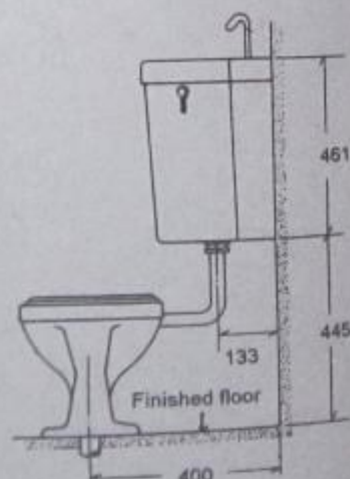
FIGURE 15-4 SIPHON ACTION WASH DOWN WITH JET



TOP VIEW



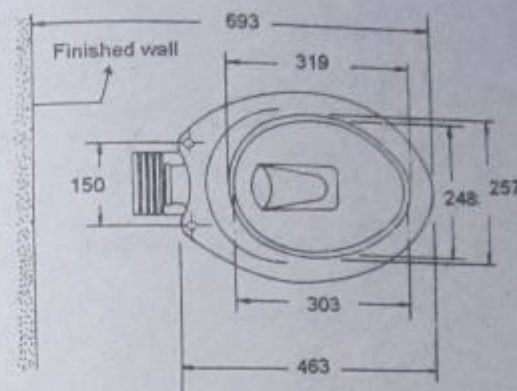
SIDE VIEW



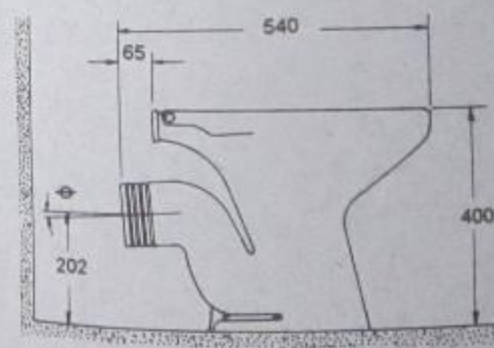
FRONT VIEW

WASH DOWN TOILET BOWL

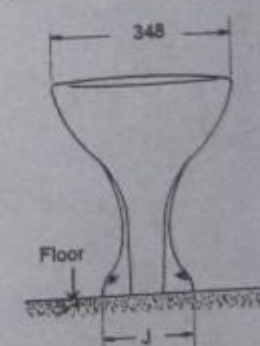
FIGURE 15-5



TOP VIEW



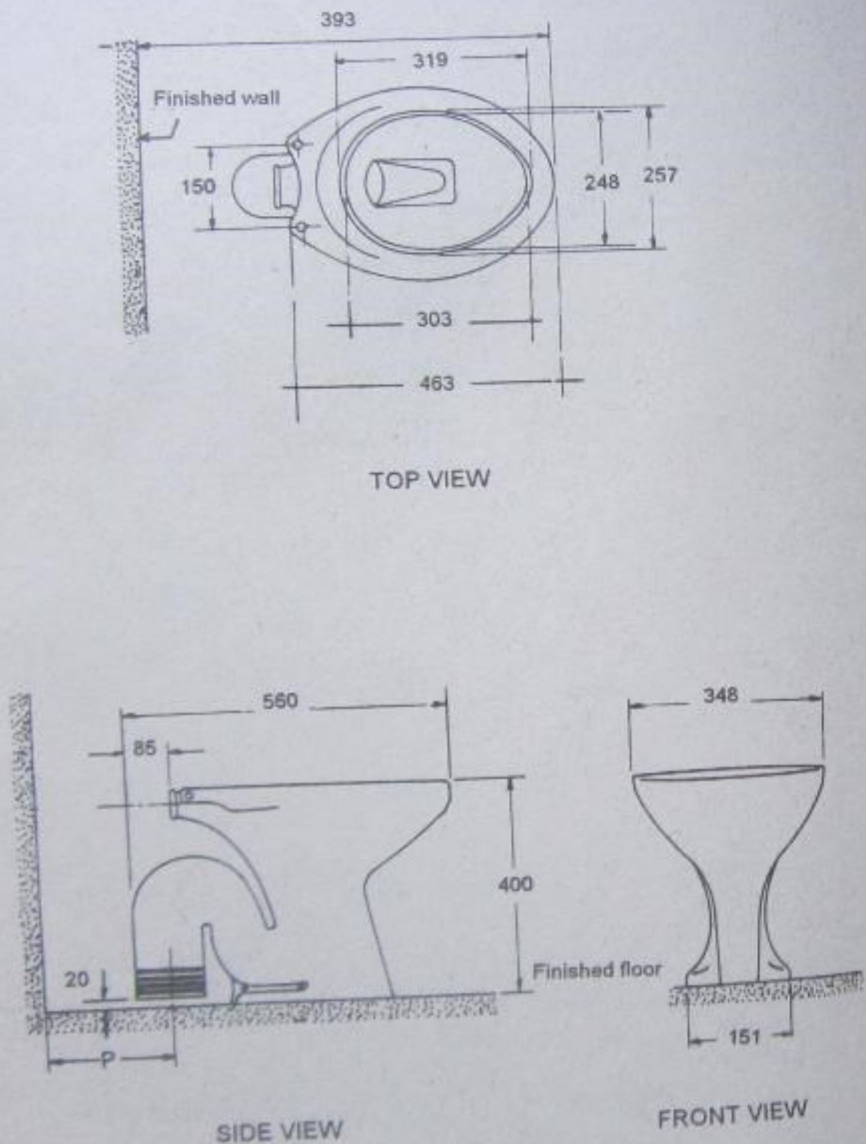
SIDE VIEW



FRONT VIEW

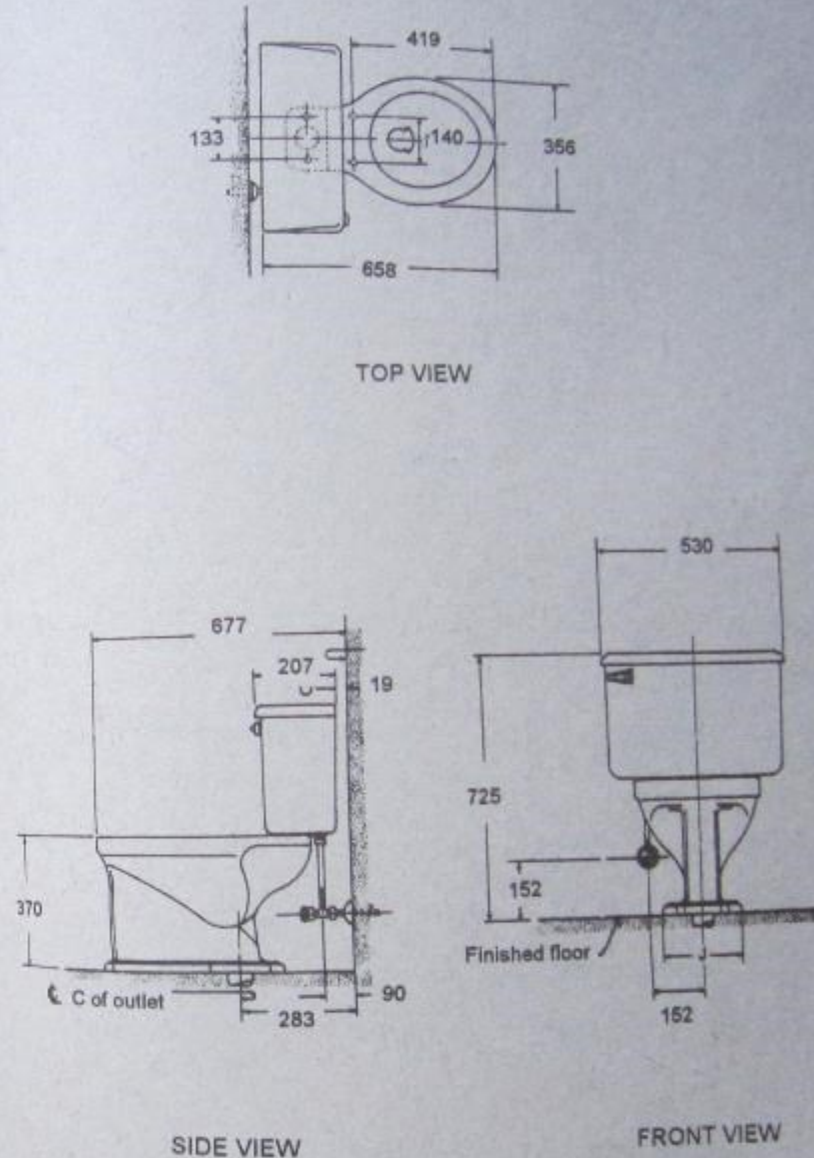
WASH DOWN TOILET BOWL

FIGURE 15-6



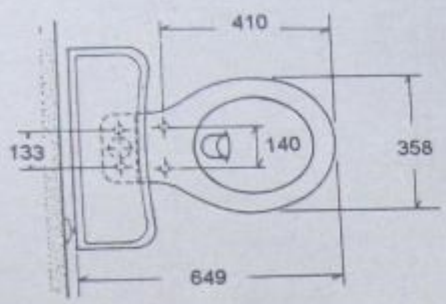
WASH DOWN TOILET BOWL

FIGURE 15-7

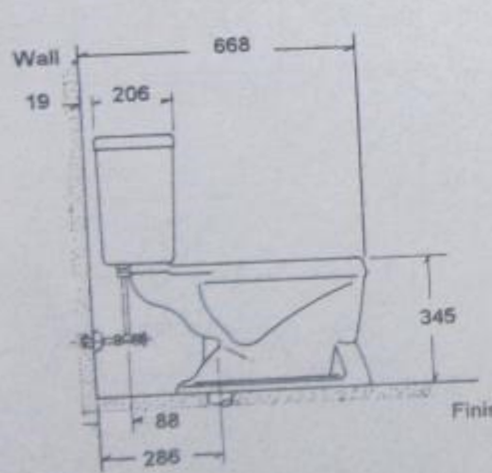


SIPHON ACTION WASH DOWN BOWL

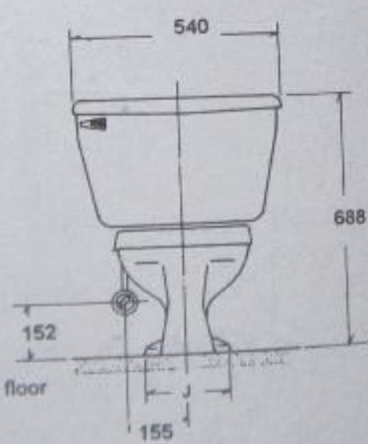
FIGURE 15-8



TOP VIEW



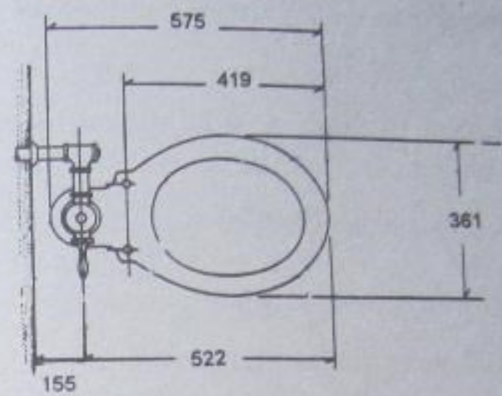
SIDE VIEW



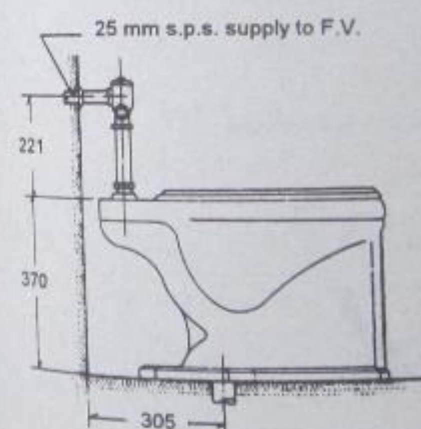
FRONT VIEW

WASH DOWN TYPE WATER CLOSET BOWL

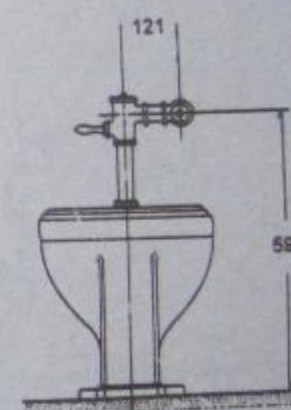
FIGURE 15-9



TOP VIEW



SIDE VIEW



FRONT VIEW

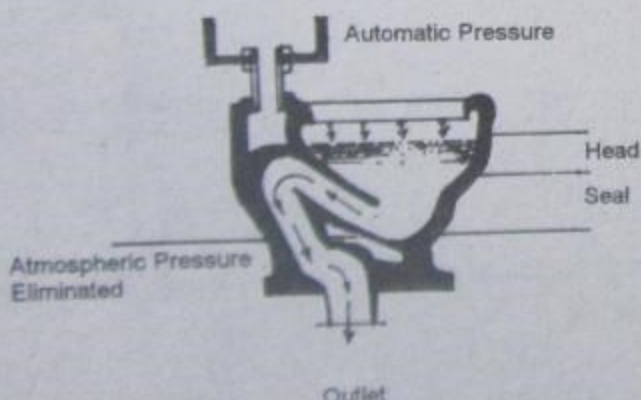
SIPHON ACTION WASH DOWN WATER CLOSET BOWL

FIGURE 15-10

The Reverse Trap

The reverse trap water closet has the following characteristics:

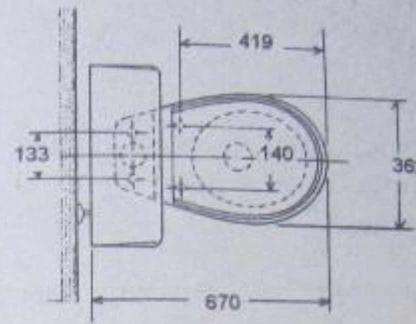
1. It flushes through a siphon action created in the trap-way located at the rear of the bowl.
2. It retain large amount of surface water as compared with the wash down type, fouling and staining of the interior bowl is unlikely to occur.
3. It is efficient but moderately noisy. The trap-way is round and less likely to be clogged.
4. This type of water closet is little more expensive than the wash down type.



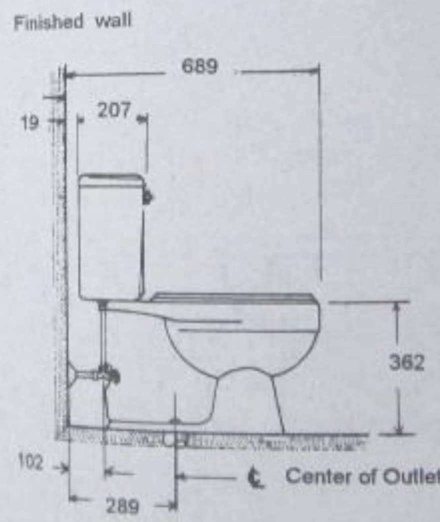
CROSS SECTION

REVERSE TRAP WATER CLOSET

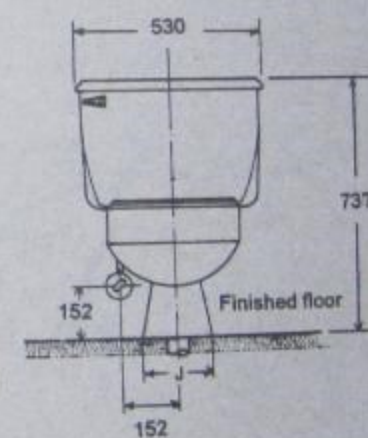
FIGURE 15-11



TOP VIEW



SIDE VIEW



FRONT VIEW

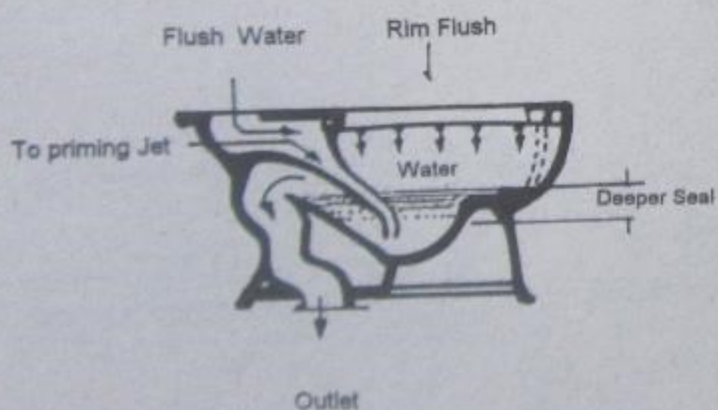
REVERSE TRAP WATER CLOSET TECHNICAL DATA

FIGURE 15-12

The Siphon Jet Water Closet

The siphon jet water closet has also the following characteristics:

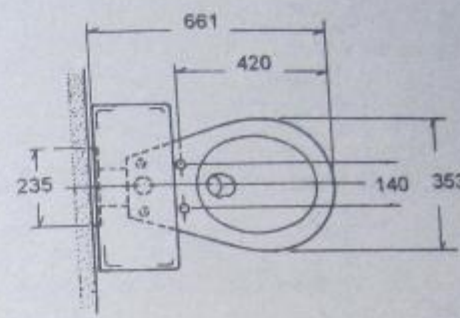
1. The siphon jet water closet is costlier than the wash down and the reverse trap type, but is more efficient in service.
2. Siphon jet water closet retain larger amount of standing water that mostly cover the bowl interior.
3. It has larger trap-way making it less likely to clog and the flushing action is silent than the other types.
4. It is very sanitary and easier to clean.



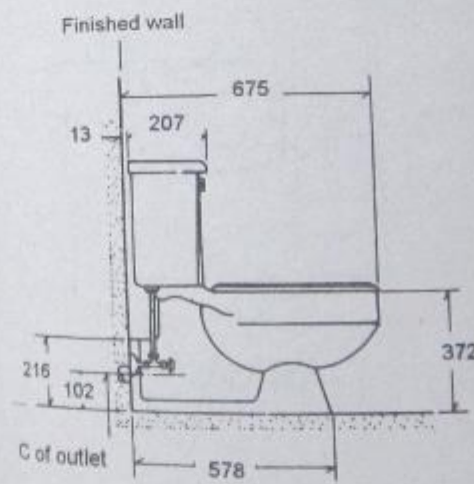
CROSS SECTION

SIPHON JET WATER CLOSET

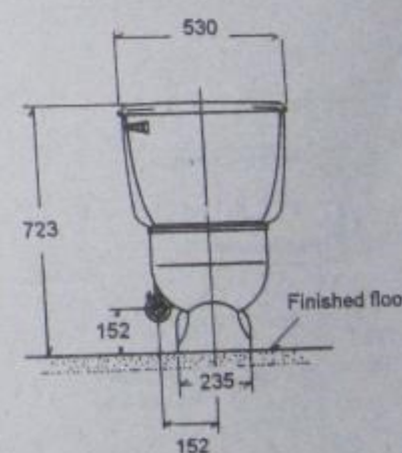
FIGURE 15-13



TOP VIEW



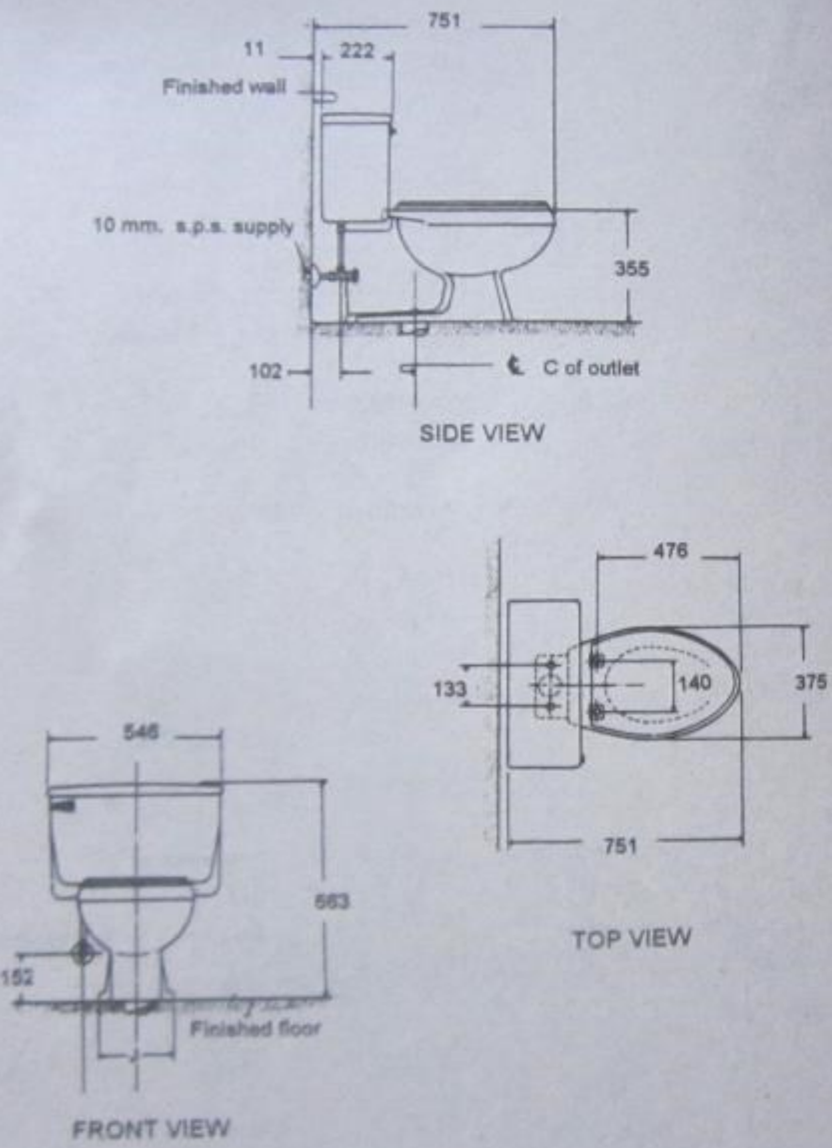
SIDE VIEW



FRONT VIEW

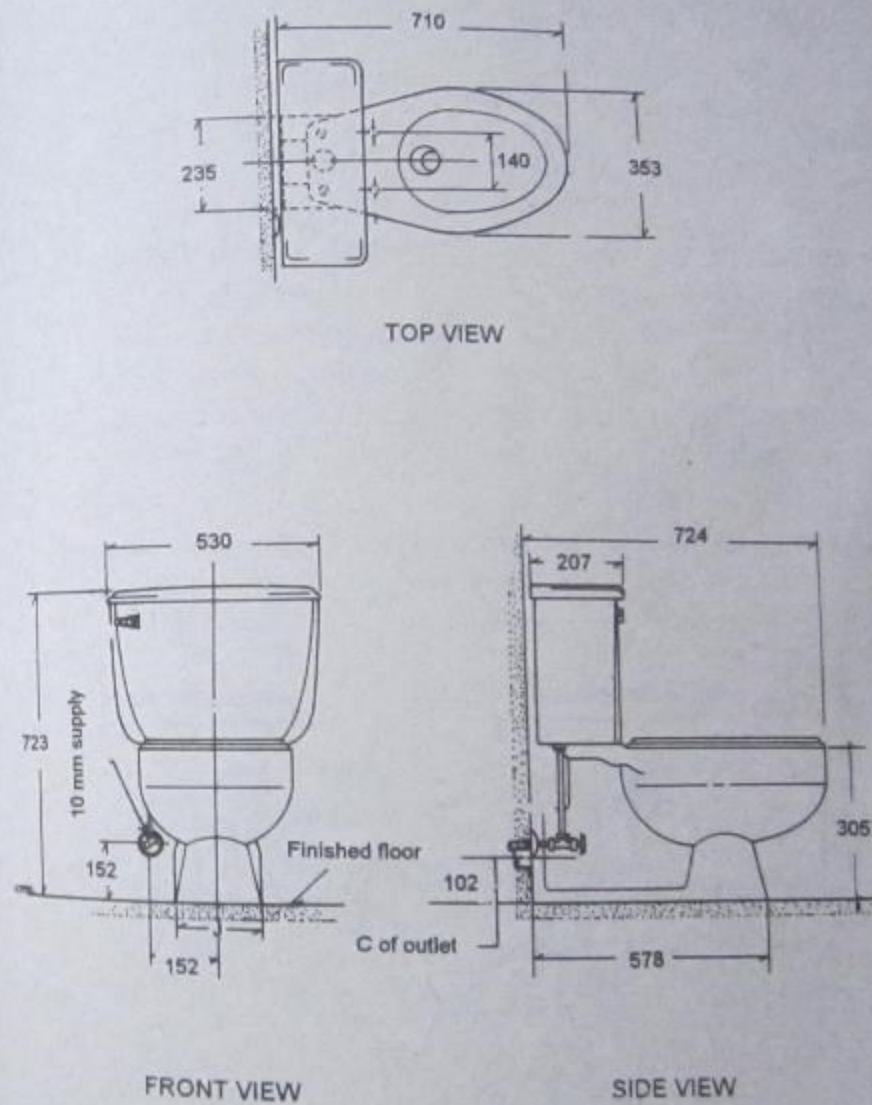
SIPHON JET TOILET BOWL

FUGURE 15-14



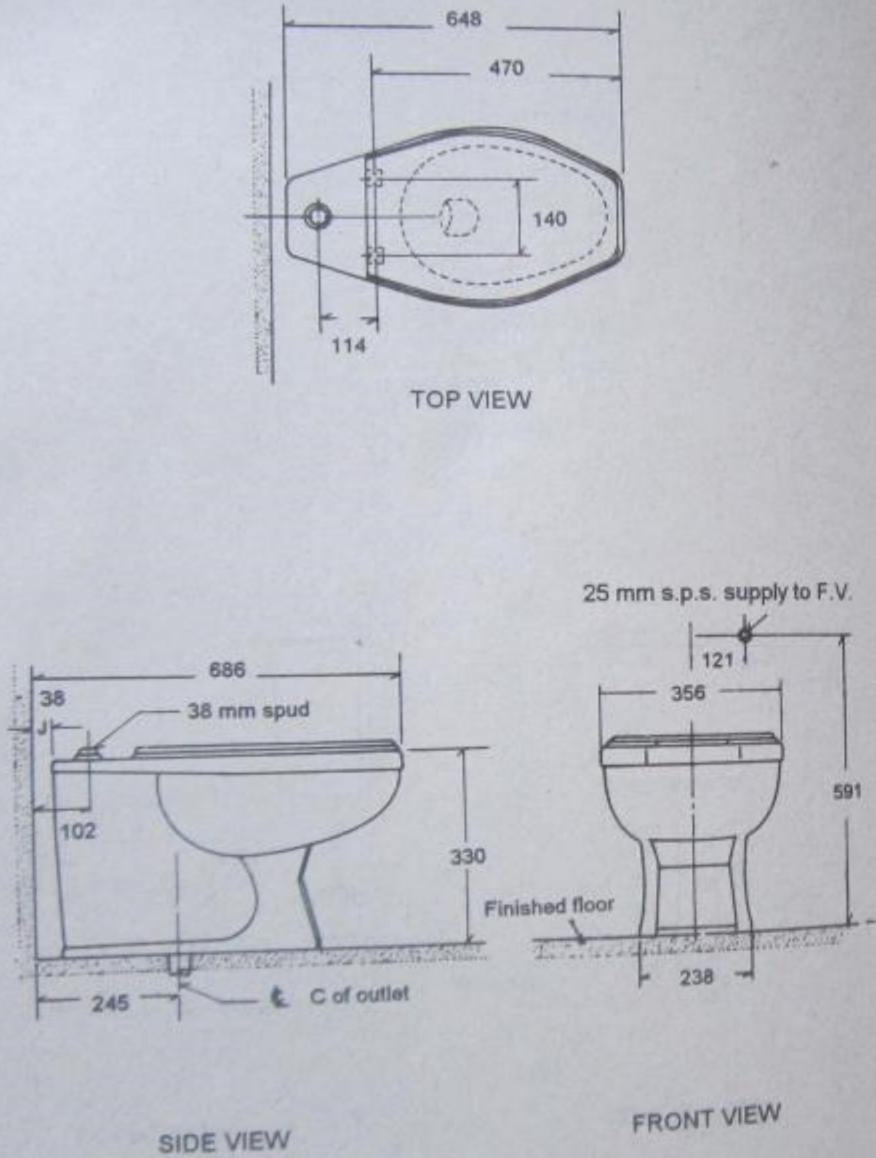
SIPHON JET TOILET BOWL

FIGURE 15-15



SIPHON JET TOILET BOWL

FIGURE 15-16



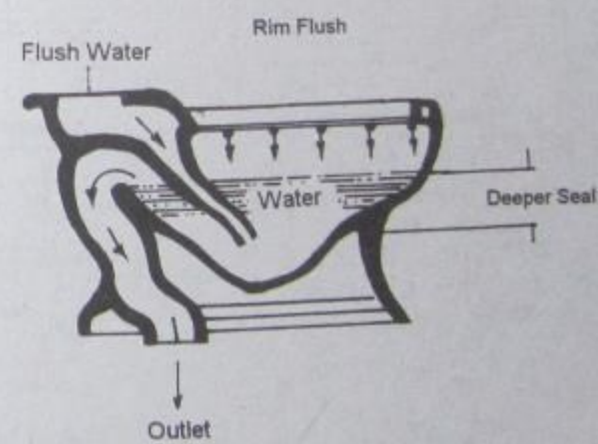
SIPHON JET ACTION BOWL

FIGURE 15-17

Siphon Vortex Water Closet

The Siphon vortex is another type of water closet considered as sanitary and efficient in service. It has the following characteristics:

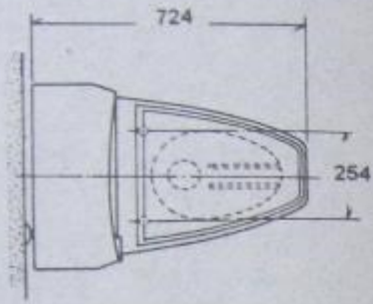
1. Although it is acceptably expensive type of water closet bowl, yet, proven to be less noisy and very efficient in its performance.
2. The flushing action of the siphon vortex water closet is through a whirlpool motion of water inside the bowl, followed by a flush down of the liquid and waste completely.
3. Siphon vortex retain a large amount of standing water covering almost the entire interior surface of the bowl.
4. Considering the large amount of standing water retained inside the bowl, it is very sanitary and easy to clean.



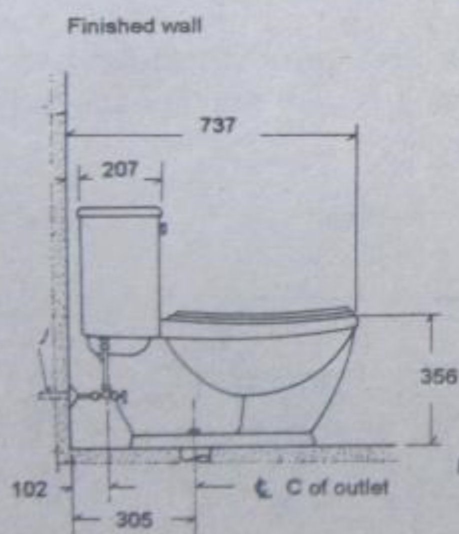
CROSS SECTION

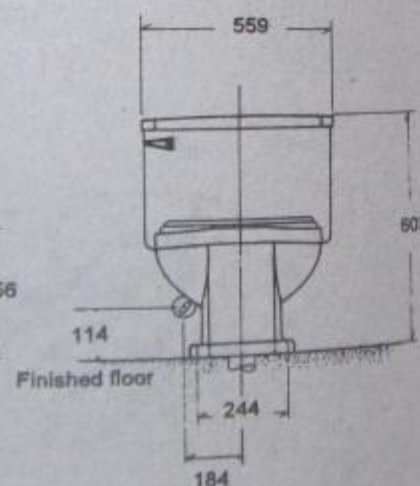
SIPHON VORTEX WATER CLOSET

FIGURE 15-18



TOP VIEW



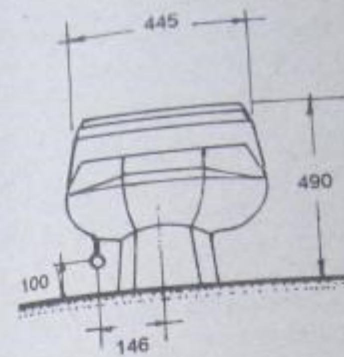


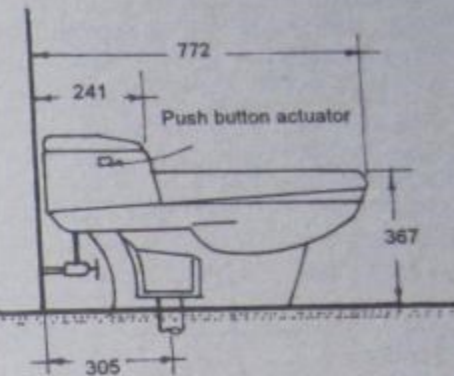
SIDE VIEW

FRONT VIEW

SIPHON VORTES WATER CLOSET

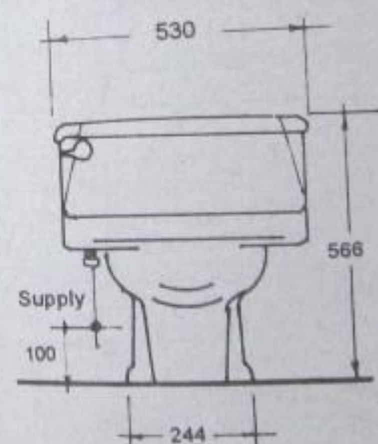
FIGURE 15-19

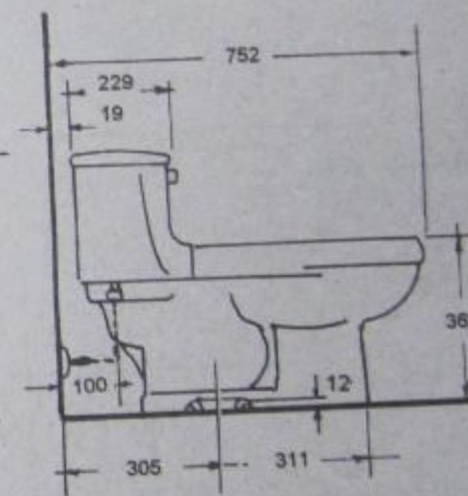




FRONT VIEW

SIDE VIEW





FRONT VIEW

SIDE VIEW

VITREOUS CHINA FREE STANDING ONE PIECE WATER CLOSET

SIPHON VORTEX FLUSH ACTION

FIGURE 15-20

TABLE 15-1 MINIMUM REQUIREMENTS FOR WATER CLOSET

Type of Building or Occupancy	Minimum Number of Water Closet Required	Kind and Number of Persons or Users
Dwelling or Apartment	1	Family
Schools Elementary	1 1	per 60 males per 35 females
Secondary	1 1	per 100 males per 45 females
Office or Public Building	1 2 3 4 5	for 1 to 20 persons for 21 to 40 persons for 41 to 60 persons for 61 to 80 persons for 81 to 100 persons
Theaters and Auditorium	1 2 3 1	for 1 to 100 male & female for 101-200 male & female for 201-400 male & female per additional 500 male and 300 females
5. Dormitories	1 1 1	per 10 males per 8 females per additional 20 persons
6. Industrial and Commercial	1 2 3 4 5 1	per 1-10 persons for 11-25 persons for 26-50 persons for 51-75 persons for 76-100 persons per additional 40 persons in excess of 100

The Direct Flush Valve Type Water Closet

This type of water closet is sometimes referred to as DFV. This type of water closet is installed in places where water supply is sufficient and pressurized. The DFV water closet eliminates the use of toilet water tank. It is preferred in commercial, hospitals, industrial and institutional comfort rooms for efficiency of service and ease of cleaning.

15-3 Lavatories

Lavatory is a bowl or basin used for washing face and hands. The basin of a lavatory may be of the following form:

1. Rounded
2. Square
3. Oval
4. Rectangular
5. Trapezoidal
6. Triangular

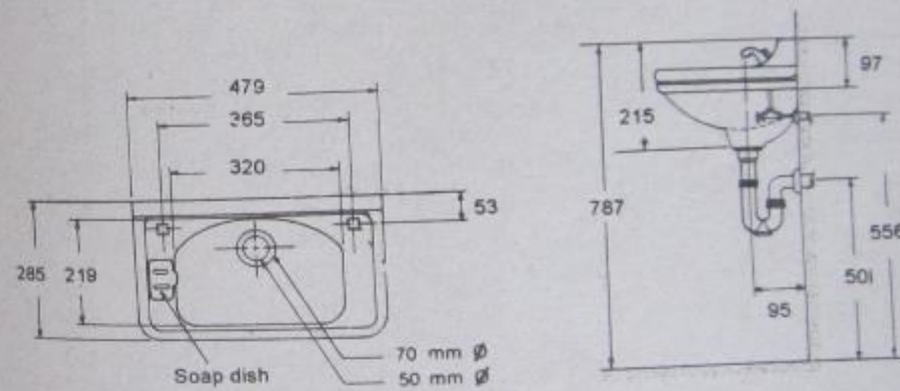


FIGURE 15-21

Sides Elevation is either

1. Shallow or deep
2. Nearly vertical or gradually sloping side

The Materials Could be Either:

1. Porcelain
2. Formed Steel
3. Enameled cast iron
4. Under counter lavatory

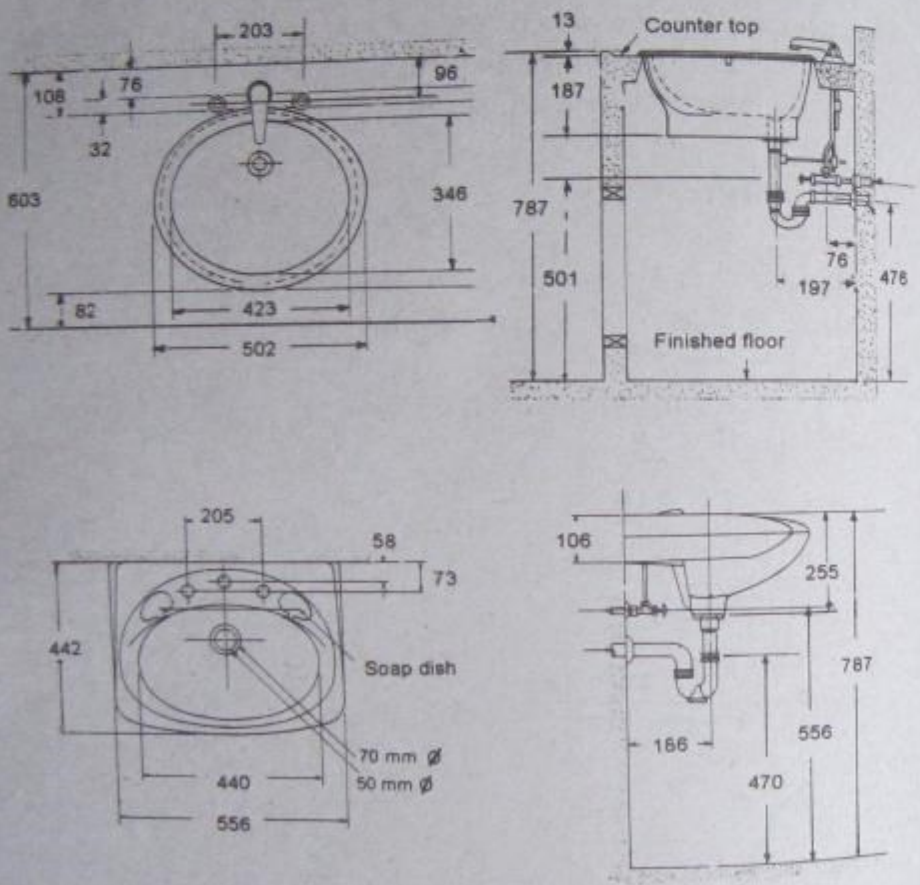


FIGURE 15-22 VARIOUS TYPES OF LAVATORIES

15-4 Bathtub

Bathing as an activity, is becoming gregarious. Bath tub which are large enough to accommodate couple bathing together are flooding the market. Even the traditional

one person bath tub is equipped with seats, shelves for soap and shampoo not to mention the non skid safety surfaces which had never been offered before.

The size of the tub, its form, and design had been greatly improved, including the color to suit the taste of the users. The lightest bathtub introduced in the market is the Fiberglass tubs. Although it is not as durable as the porcelain, it is also easier to clean and maintain. The surface is coated smoothly with attractive gel.

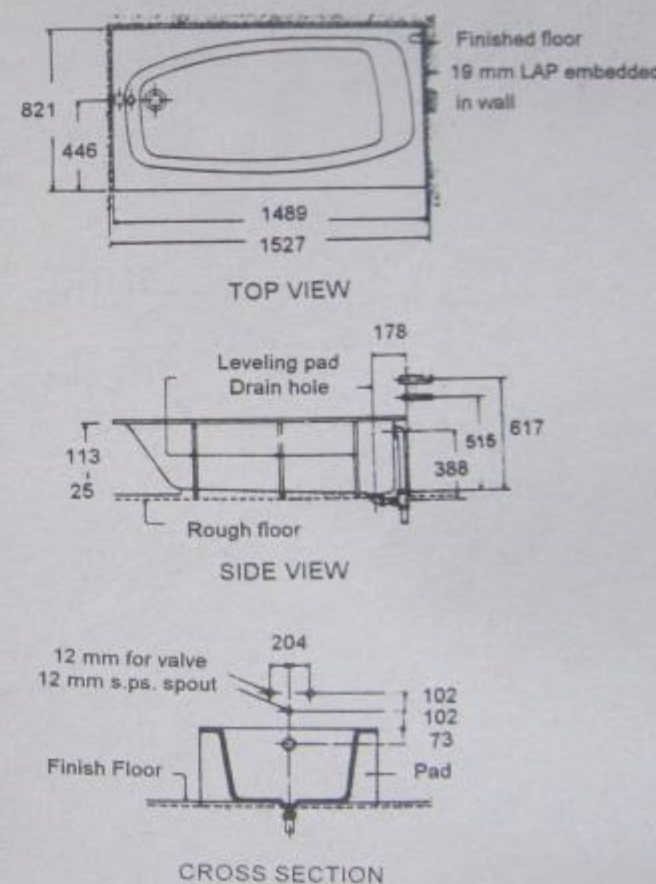
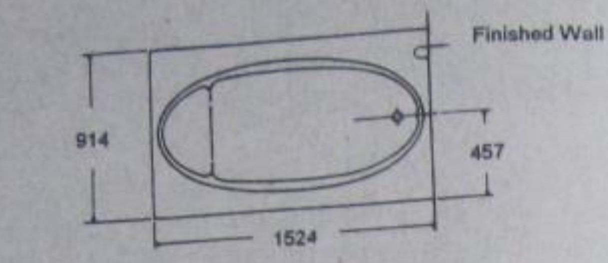
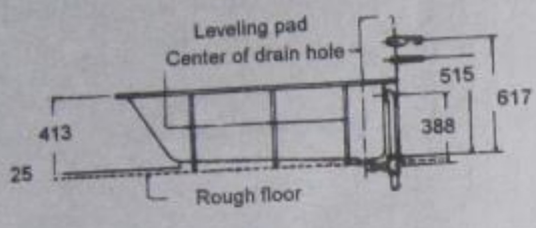


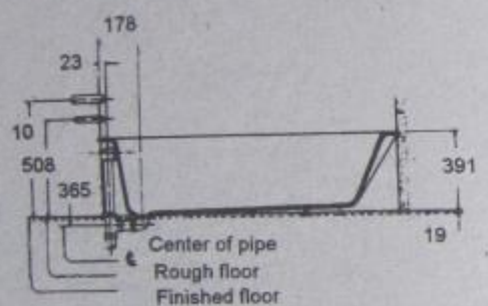
FIGURE 15-23 BATH TUB



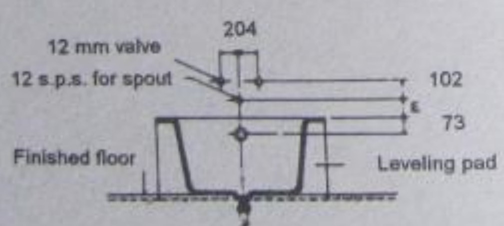
TOP VIEW



SIDE VIEW



LONGITUDINAL SECTION



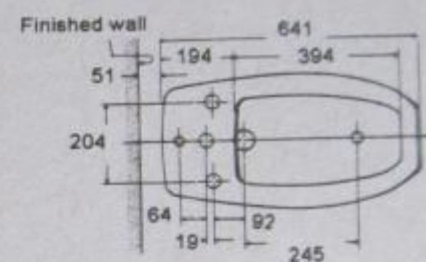
CROSS SECTION

FIGURE 15-24 TECHNICAL DATA OF BATH TUB

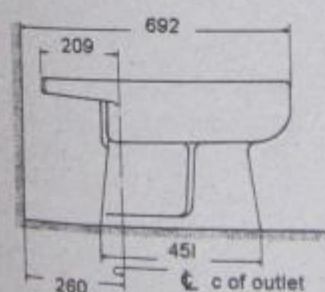
15-5 Bidet

Bidet is much more closely related to a shower than to a toilet although it appears more likely as a toilet bowl. Bidet is designed for cleaning the most precious, delicate and well-guarded parts of the female body. - The ultimate in personal hygiene.

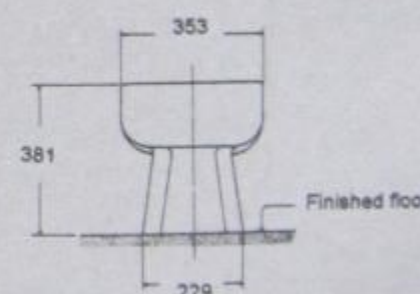
Bidet also serve as a foot bath or for any function that a lower set of bowl might perform. It is connected to a water supply and drain installation in the same manner as a bath-tub or shower stall.



TOP VIEW

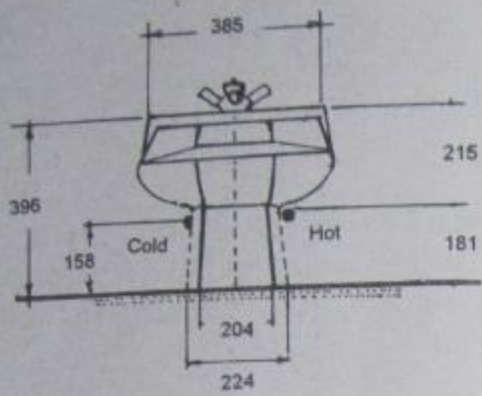


SIDE VIEW

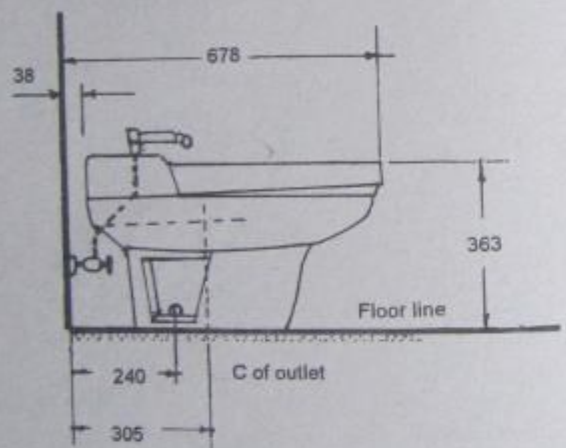


FRONT VIEW

FIGURE 15-25 BIDET



FRONT VIEW

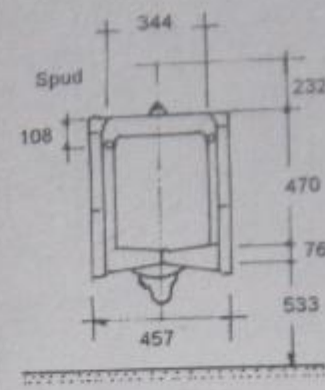


SIDE VIEW

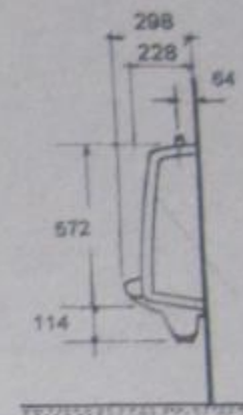
VITREOUS CHINA FREE STANDING BIDET WITH REAR OVER FLOW

FIGURE 15-26

15-6 Urinals



FRONT VIEW

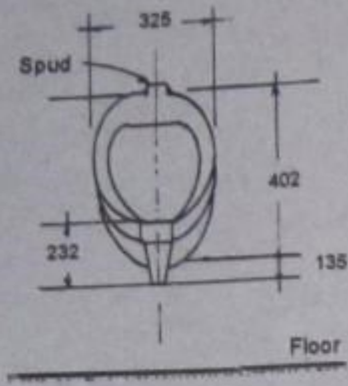


SIDE VIEW

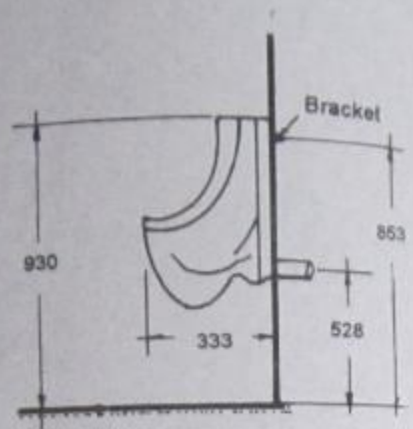
FIGURE 15-27 URINALS

TABLE 15-2 MINIMUM REQUIREMENTS FOR URINALS

Type of Building Or occupancy	Minimum Urinal required	Kind and Number of Persons or Users
1. School		
Elementary	1	per 30 males
Secondary	1	per 30 males
2. Office Bldg.,	1	per 40 persons
3. Dormitory	1	per 25 persons
	1	per 50 persons in excess of 150
4. Theaters and Auditorium	1	for 1-200 persons
	2	for 201-400 "
	3	for 401-600 "
	1	for 300 persons in excess of 600

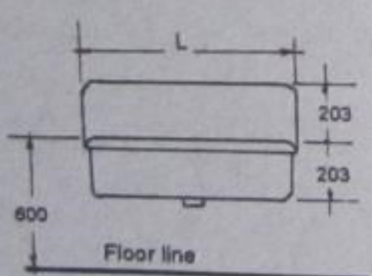


FRONT VIEW



SIDE VIEW

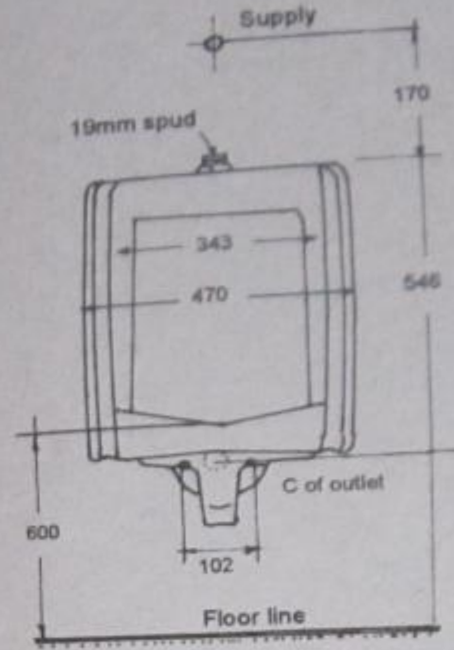
L = 900; 1200; 1500
W= 300; 400

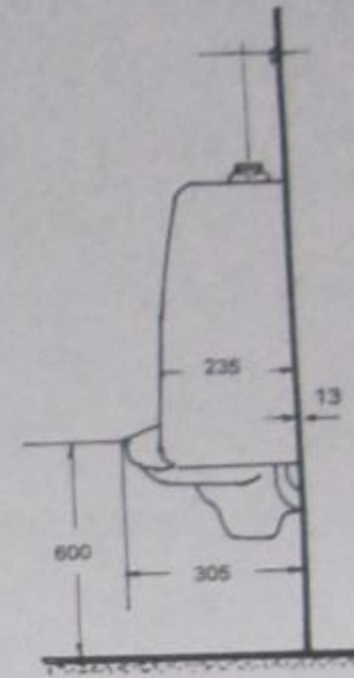


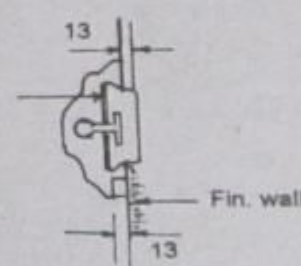
FRONT VIEW

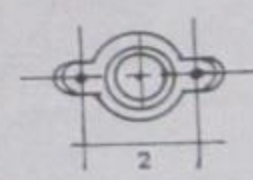
SIDE VIEW

FIGURE 15-28 URINALS









DETAIL OF OUTLET CONNECTION

VITREOUS CHINA WALL HUNG WASHOUT URINAL

FIGURE 15-29

15-7 Kitchen Sink

Kitchen Sinks are Made from either:

1. Cast iron enamel
2. Formed steel coated with porcelain enamel
3. Stainless steel

Kitchen Sink Configurations are

1. Single, double or triple well
2. Shadow or deep well

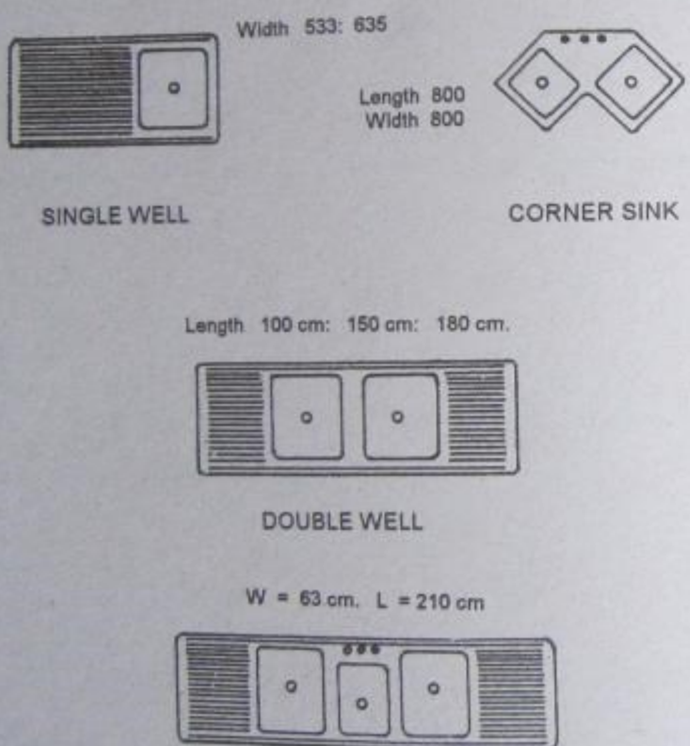


FIGURE 15-30 KITCHEN SINK

CHAPTER 16

FIRE PROTECTION IN BUILDING

16-1 Introduction

The protection of building structures from the hazards of fire is one utmost concern of the government. Hence, for a continued citizens awareness of damages brought by fire to life and property, the month of March was declared as fire prevention month.

Planners and builders have their own contributions in this campaign, by making their plans and constructions conform to the Fire Code Requirements. The owner on the other hand, is much more concern of his investment protection. However, despite the advancement in fire protection technology, fire is still common occurrence in buildings of all types. Records showed that the loss of life and damages to property is considerably enormous in every incident of fire.

Modern design and construction techniques, did not escape the blame for allegedly having increased the potential of fire, especially, in tall buildings attributed to the following:

1. Light material construction methods do not offer inherent protection against fire unlike the cement plaster or concrete.
2. Non-integrally constructed floors and walls provide fuse for fire and smoke.

3. False ceiling containing electrical, and other services, are hidden locations where fire can start unnoticed.
4. Punched-hole for installation of telephone and other related services, violates the design structural integrity.
5. The central air conditioning system can serve as passage for smoke.
6. The use of plastic materials for trim and covering of interior structures create potential ignition for fire and smoke.
7. Furniture style and materials plus interior designs could ignite or fuel fire.

16-2 Planning for Fire Protection

One of the many responsibilities given to Architects and Engineers by their **License to Practice,** is the protection of buildings against loss of life and damage to property from fire. The owner on the other hand, is very much concerned with the preservation of the structure and its contents from the destructive effect of fire.

As part of their responsibilities, planners and builders should look into all the facets of possible problems that may be encountered including fire safety.

Tall building presents variety of unique problems, more particularly on fire safety. Therefore, problems on fire safety must be addressed at the very start of the planning stage. Because the belief that these imposing structures of modern technology are totally immune to fatal fire, is hard to accept.

To some extent, a useful way to consider tall building is to define a high-rise building in terms of fire protection.

Fire Protection Problems on Tall Buildings are:

1. Too high to be completely accessible to fire fighting equipment from the ground.
2. Too high to make a complete evacuation of the occupants.
3. Tall enough to make possible chimney for air and smoke passage.

The **National Fire Protection Association** maintained a comprehensive set of standard rules in planning to minimize fire hazard. The guidelines include the equipment design for fire fighting which is mandatory.

The **Fire Code** on the other hand, considers the *building density in the locality and the flammability of the structures and its contents.* It also imposes the following requirements:

1. Fire resistance of the building and its contents
2. Limitation of volume to adjacent vulnerable buildings
3. Exits and fire tower stairs
4. Protection against defective electrical system
5. Lightning protection
6. Detection and alarm systems
7. Automatic sprinkler systems
8. Standpipe and hose systems
9. Automatic smoke and heat venting
10. Smoke and heat shafts
11. Control of air conditioning ducts
12. Communication in high rise buildings
13. Elevator control
14. Fire command station in tall buildings

The scope of this Chapter on **Fire Protection in Building** is limited only to the topics that are related to the subject of plumbing. Discussions will be limited to the following:

1. Water and water supply for fire fighting
2. Water pumping systems
3. Standpipe and hoses
4. Sprinkler systems

16-3 Water and Water Supply

Water is the number one enemy of fire. Even with the latest modern and sophisticated fire fighting equipment, gadgets, tools and other concoctions, water is still an essential requirement in combating fire.

On high rise building, water is supplied through:

1. Elevated water tank or
2. Underground reservoir

Elevated Water Tank

The Elevated Water Tank is a traditional design of storing water in an elevated reservoir for the following purposes:

1. To supply a constant pressure of water in the distribution lines.
2. To store sufficient water to balance the supply from the demand.
3. To prevent excessive starting and stopping of the pump.
4. To provide dependable supply for fire reserve.

The Elevated Water Tank has also the following disadvantages:

1. Unsightly appearance
2. High cost of construction
3. Requires massive structure and foundation for its tremendous weight.

Underground Water Reservoir

The underground water reservoir is one alternate to replace the elevated water tank. It is a reinforced concrete structure constructed on one side of the building, provided with a small vent rising above the ground. The reservoir is covered with earth from 60 to 90 centimeters blended with the lawn and landscape shrubbery. It completely eliminates the problem of unsightly appearance and weight.

Cost comparison would be difficult because of the number of factors involved. The savings for materials and other construction costs may be sufficient to cover the cost of an automatic pumping system.

The idea of storing large volume of water for a protracted fire fighting is impractical. A 30 minutes supply that could be used by the building personnel, in the meantime that the fire department has not arrived yet, is sufficient. Thereafter, the trained personnel of the fire department, will take over with their own water supply or drawn from the street fire hydrant.

Standby Power

In case of fire incidence, the power supply in the building is automatically cut off which could be a tragedy.

A standby diesel powered generator is a must. This unit and its fuel stock are separately housed in a fire resistant enclosure sufficiently away from the possible location of fire in the main building.

16-4 The Up-Feed Pumping System

The Up-feed Pumping System provides a continuous flow of water from the deep well through the domestic and fire reservoir. The continuous flow of water prevents it from becoming stagnant and rancid. The fire reservoir has the priority over the domestic reservoir by means of a simple weir. Even if the domestic reservoir is totally empty, the fire reservoir would remain full of water.

A small 20 gallons per minute jockey pump will supply the necessary pressure for the sprinkler system, and consequently, a signal from the sprinkler system will start the 750 gpm main pump. If this pump becomes inadequate for the demand, a diesel engine driven pump of equal capacity will automatically takes over.

The sensing unit which control the operations of the pumps are:

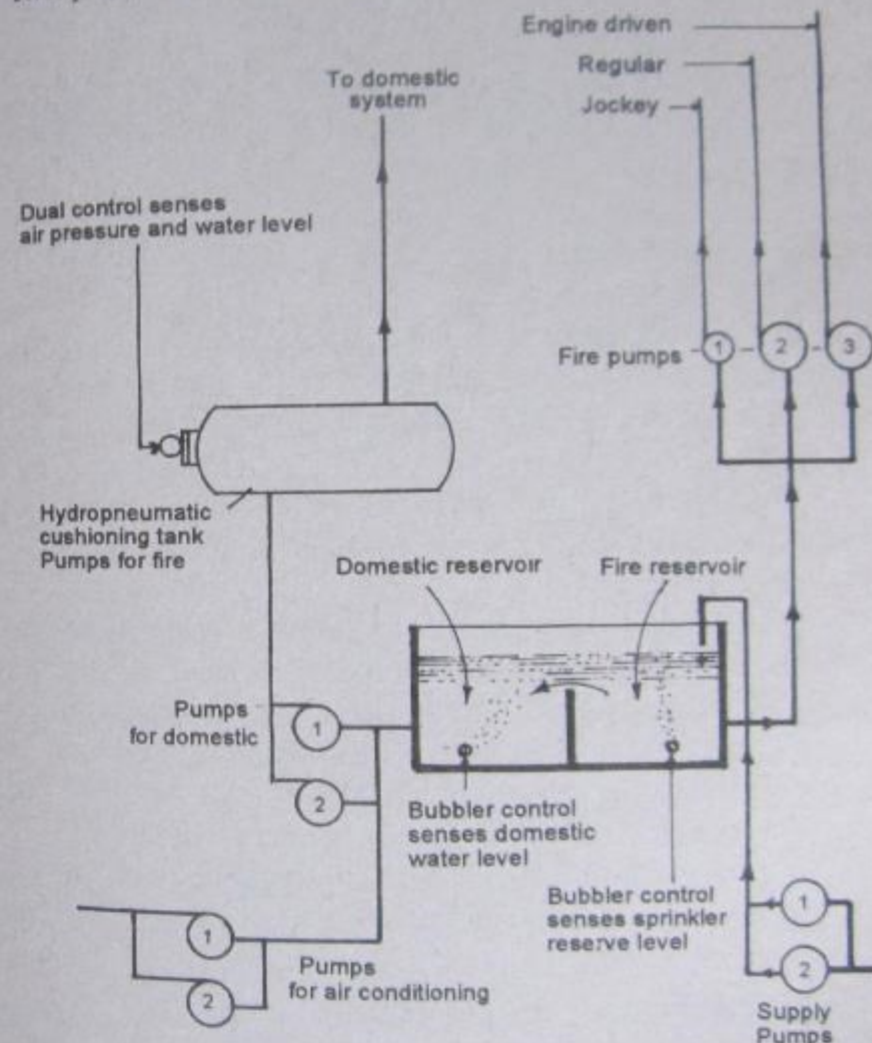
1. The **Bubble Control Units** in each of the two reservoirs.
2. The **Dual Control Unit** that regulates the supply for the pressure tank.

These controls are connected to a large central cabinet underground pump room adjácent the reservoir.

Hydropneumatic Tank

A hydropneumatic tank is used to store air under pres-

sure that will balance out-surge from the two domestic pumps and reduce the frequently starting, and stopping of the motor. It is an improvement of the closed system, where several pumps are sequenced automatically to supply an even pressure. It has the advantage of using only two pumps when necessary.



SCHEMATIC DIAGRAM OF UPFEED PUMPING SYSTEM FOR SUPPLY OF SPRINKLERS AND BUILDING DEMAND FOR DOMESTIC WATER

FIGURE 16-1

One disadvantage of this system is the difficulty in maintaining the ratio of 60% air to 40% water. Water from deep well to the tank becomes air bound as water stored therein gives up its absorbed air. The dual control installation eliminates the need for manual adjustment of this 60% to 40% ratio by employing two sensing devices within a single control.

A drop air pressure inside the tank will send signals to start the pump, and the rise of water level, automatically send signals to stop the motor.

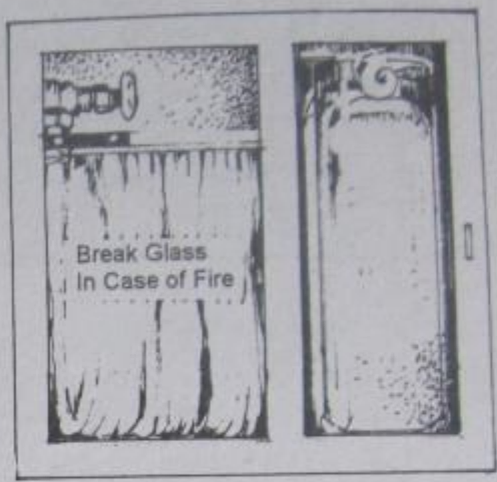
How the Control System Operates:

1. For correct time delay through the motor driven relays, the signal from the dual control and the double control units are processed in the central cabinet.
2. The central control system alternates the pumps to give them even wear, or run them together as demand requires.
3. In case of low suction, the control system automatically shut off to prevent motor damage.
4. At the same time after it shut off, it relays the alarm signal to the office of the Maintenance Engineer indicating the location of the trouble.
5. The system could run without human attendance to satisfy the heavy demand of air conditioning, domestic water supply, and fire control.

16-5 The Standpipe and Hose

The **Standpipe** is a pipe installed in buildings not as part of the water supply or disposal system, but primarily, for use as water conveyance in case of fire.

The **Fire Hose** is always located near the stairs for use by firemen in case of fire. It is incased in glass cabinets with the following label: ***Break Glass in Case of Fire***.

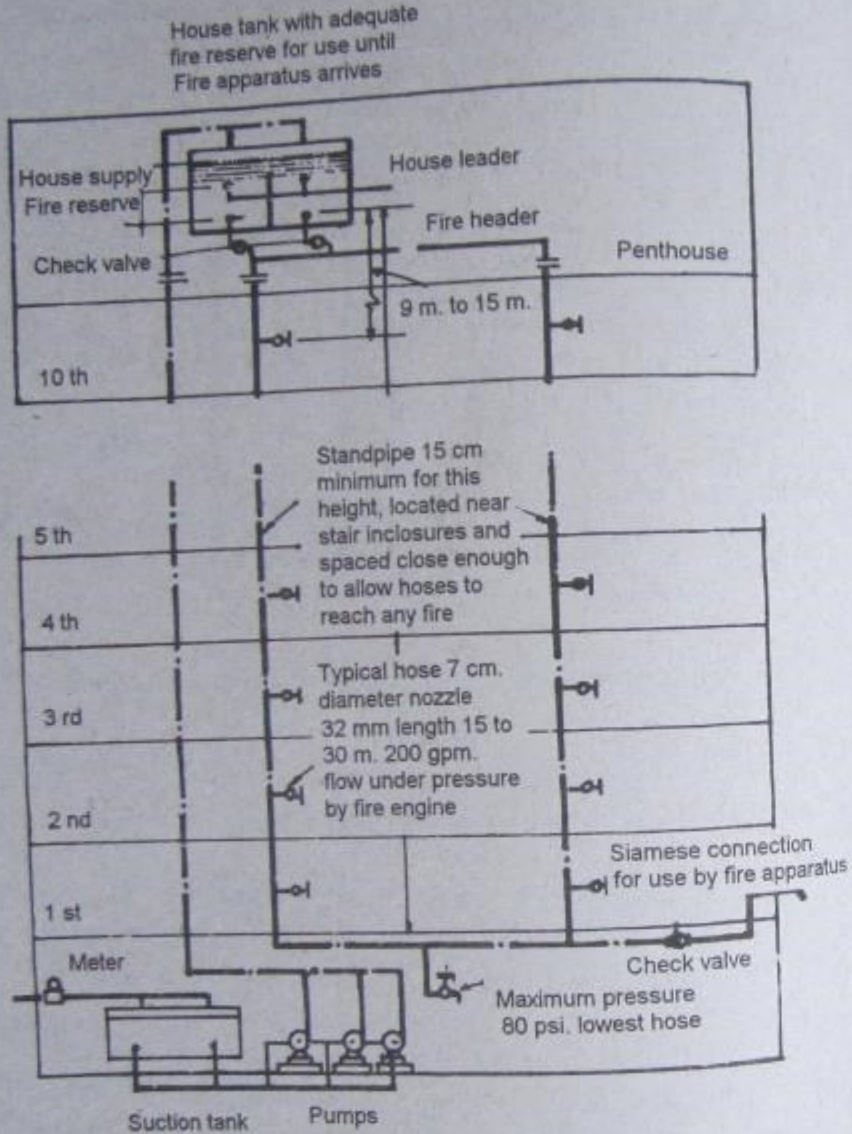


HOUSE RACK AND FIRE EXTINGUISHER IN CABENIT WITH GLASS

FIGURE 16-2

The Standpipe and Fire Hose Functions as follows:

1. Upon arrival of the firemen, the standpipe **Siamese Twin** is immediately connected to the street fire hydrant, or to any other water source by their fire hose.
2. The firemen would immediately goes up the building and connect their fire hose to the standpipe, freeing them from the inconvenience of carrying their hose to the upper floor of the building.
3. With the standpipe and hoses, the firemen were provided with an ever ready fire fighting tools and equipment that saves time and effort which may spell the difference in saving life and property.



Schematic section of fire protection. Part of a standpipe and hose system. Gravity tank downfeed to hoses for use by building personnel prior to the arrival of the firemen.

FIGURE 16-3

4. The length of the firemen hose is limited to a certain height, but because of the standpipe provision, the upper most floor of a tall building, could be reached by the fire fighters.

16-6 The Automatic Sprinkler System

The automatic sprinkler system consists of horizontal pattern of pipes placed near the ceiling of industrial and commercial buildings, warehouses, stores, theaters and other structures where fire hazard require their use.

These pipes are provided with outlet and sprinkler heads that open automatically at temperatures of 135° F to 160° F and emit a series of fine water sprays.

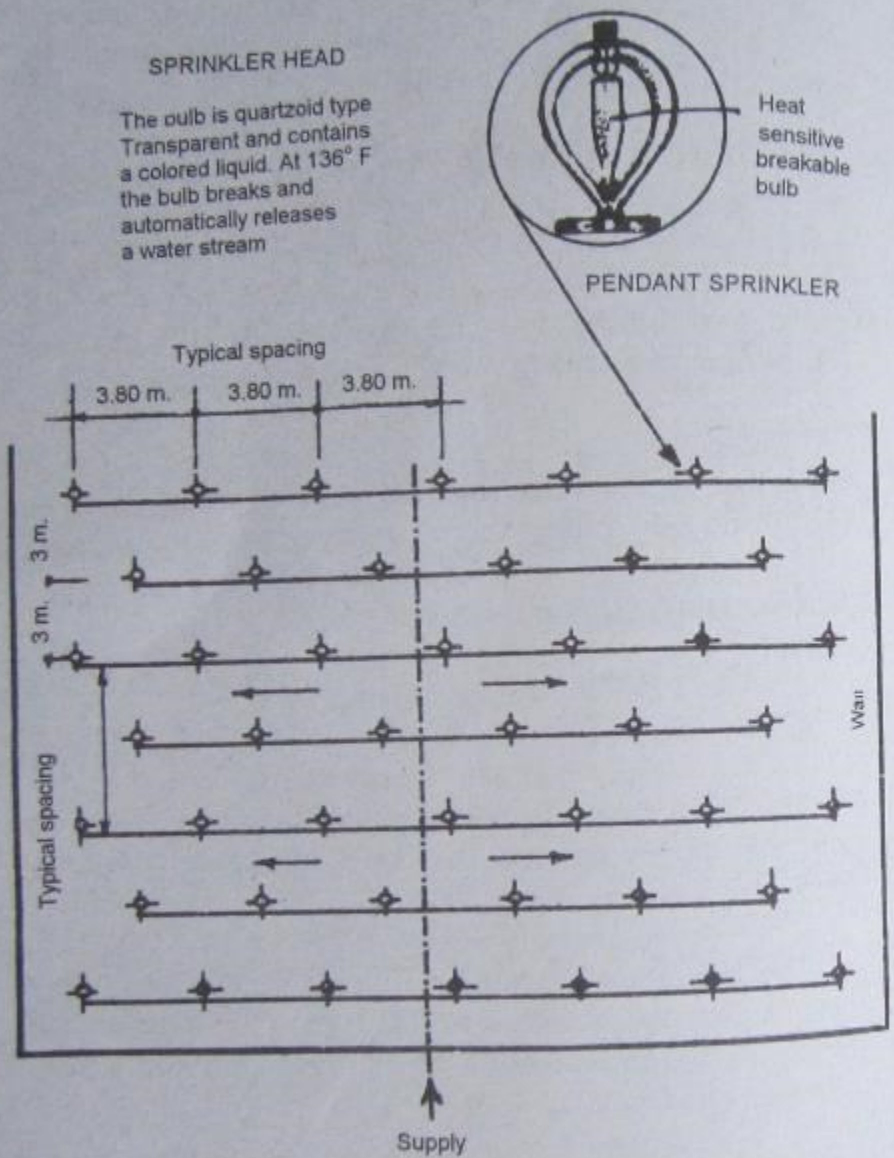
The Sprinkler System includes:

1. Wet Pipe
2. Dry Pipe

The **Wet Pipe** refer to the piping installations wherein both the mains and the distribution pipes are constantly filled with water.

The **Dry Pipe** refers to the piping installations where there is no water standing in the distribution pipe, except during the occurrence of fire. This is generally confined to unheated buildings.

Operations of the wet pipe system, depends upon the nozzles opening in the area affected by the sensitive elements within the nozzles themselves. Remote valves in the dry pipe system may be activated by sensitive element to admit water to sensitive heads.



PLAN OF SPRINKLERS ON COMMERCIAL AND INDUSTRIAL BUILDINGS

FIGURE 16-4

Spacing of the sprinkler heads

The spacing of sprinkler heads depends upon the following conditions:

1. Fire rating of the building
2. Constructions of the ceiling
3. Types of occupancy
4. Total area

The coverage of one sprinkler head varies from 20 square meters for light hazard occupancy to about 10 square meters for extra hazard condition. Nozzles are set about 2.40 to 3.60 meters apart on the supply pipes, and spaced about 3.00 to 4.00 meters apart at right angle exposed beams or panels.

Special Installation Requirements

1. At least one fire department connection on each frontage.
2. A master alarm valve control for all water supplies other than fire department connections.
3. Special fire walls between protected areas.
4. Sloping water proof floors with drains or scupper to carry away waste water.

When a gravity tank is used with sprinkler system, it must have enough water reserve for this purpose and enough water to operate at least 25% of the sprinklers for 30 minutes. This time is sufficient to give the fire department a chance to arrive and take over.

16-7 Other Requirements for Fire Fighting

In fire fighting operations, one of the initial steps by firemen is to create a ventilation or hole at a high point of the structure to relieve the building of smoke and hot gases. This will permit access to the fire at the height of its occurrence. In multi storey buildings, Vent Shaft is necessary to quickly relieve the burning building of smoke and hot gases. When automatic venting device is installed, this relief will be attained immediately. Undue delay will be avoided, and the firemen will not waste time chopping an opening for the exhaust of heat and smoke.

FIGURE 16-5

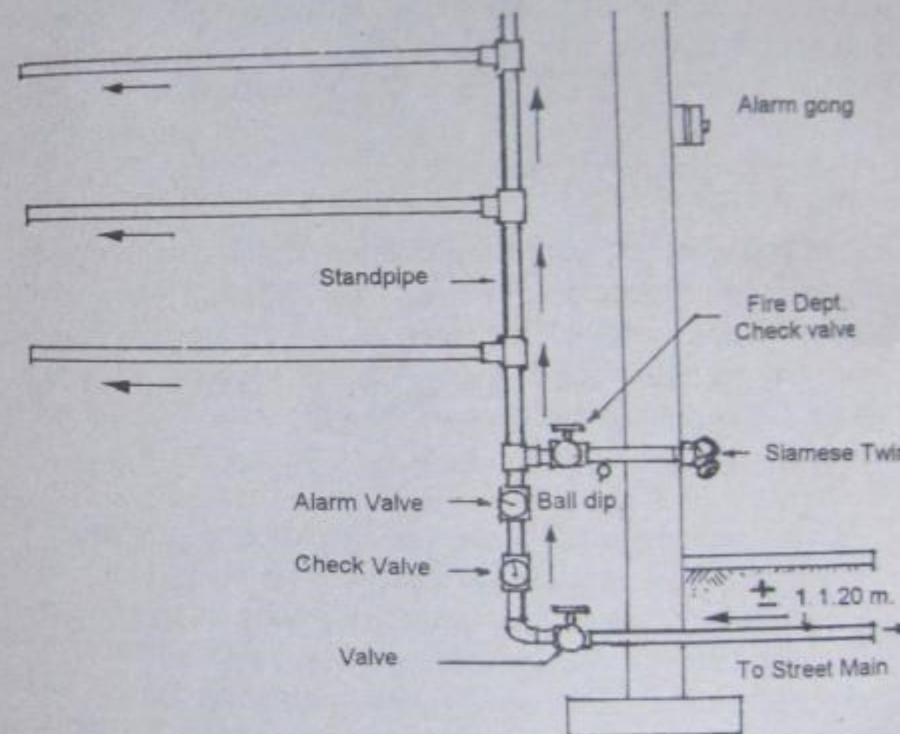
SIAMESE CONNECTION FOR USE BY FIREMEN'S PUMPING EQUIPMENT TO SUPPLY WATER TO THE STANDPIPE SYSTEM

Wet Standpipe and Siamese Connection

The wet standpipe with Siamese connection is one of the common types of fire protection installed in buildings. This kind of standpipe is connected to the water supply and distribution system. The disadvantage of this installation is when there is inadequate water supply for fire fighting. The firemen may decide to connect the Siamese connection to a river or drainage ditch. In such a case, cross

connection may occur contaminating the water conveyed into the water distribution system of the building.

A connection between the domestic water sys m and the fire distribution main must be provided with two check valves and a manually controlled gate valve. These devices will prevent contaminated water in entering into the water distribution system. The gate valve will serve as a safeguard that may be closed by the firemen in their routine operation.



SECTION OF SUPPLY CONNECTION TO STREET MAIN

FIGURE 16-6

CHAPTER 17

PLUMBING INSTALLATION AND MATERIALS

17-1 Introduction

Although the different parts of the plumbing system and their functions and correlations with each other were already defined and explained, yet, it would not be more meaningful and appreciated unless seen and put together into a one working unit system.

In this chapter, various plumbing layouts will be presented for the readers to see how the different parts were combined and installed together as a working unit. Likewise, the materials used were itemized to serve as visual aid to the plumbing designer in the preparation of the materials for costing.

Cost estimate is the determining factor of any project study where final decisions are based. The plan of any piping installations would not be considered complete unless accompanied with a listing of the materials to be used. As mentioned earlier, there are as many plumbing designs and layouts as many designers working in this field. But up to this point in time there is no specific rules ever formulated or which may be formulated fixing a definite line of routing or rerouting of the pipes to serve plumbing fixtures for a particular design or arrangement. Thus, any piping layout combination or arrangements will do beyond question

do and beyond question provided that, the Physical Laws of Nature relative to the plumbing system and the provisions of the Plumbing Code is not violated.

17-2 Single Unit Toilet and Bath

Speaking of a single unit toilet and bath connotes a small and simply well arranged comfort room equipped with one water closet and a lavatory with shower and service faucet or sometimes with small bathtub.

ILLUSTRATION 17-1

Presented in Figure 17-1 is a plumbing installation of a single unit comfort room with a general floor dimension of 120 centimeters wide by 200 centimeters long. Prepare the bill of materials required using plastic pipes and fittings for both DWV and water supply system.

SOLUTION

A. Materials for House Drain

1 piece 75 mm (3") long sweep elbow (for cleanout)
1 - 75 mm Cleanout cover
1 - 75 mm x 50 mm Reducer T (for lavatory waste)
1 - 75 mm x 50 mm Tee (for vent pipe connection)
2 - 75 mm Y (to receive W.C. and P-Trap)
1 - 75 mm P-Trap floor drain
1 - 100 mm floor drain strainer
1 - 75 mm long sweep elbow to receive W.C waste
1 - 75 mm x 3.00 meters Pvc. Pipe

B. Materials for Waste and Vent Pipe

2 - 50 mm x 50 mm Tee

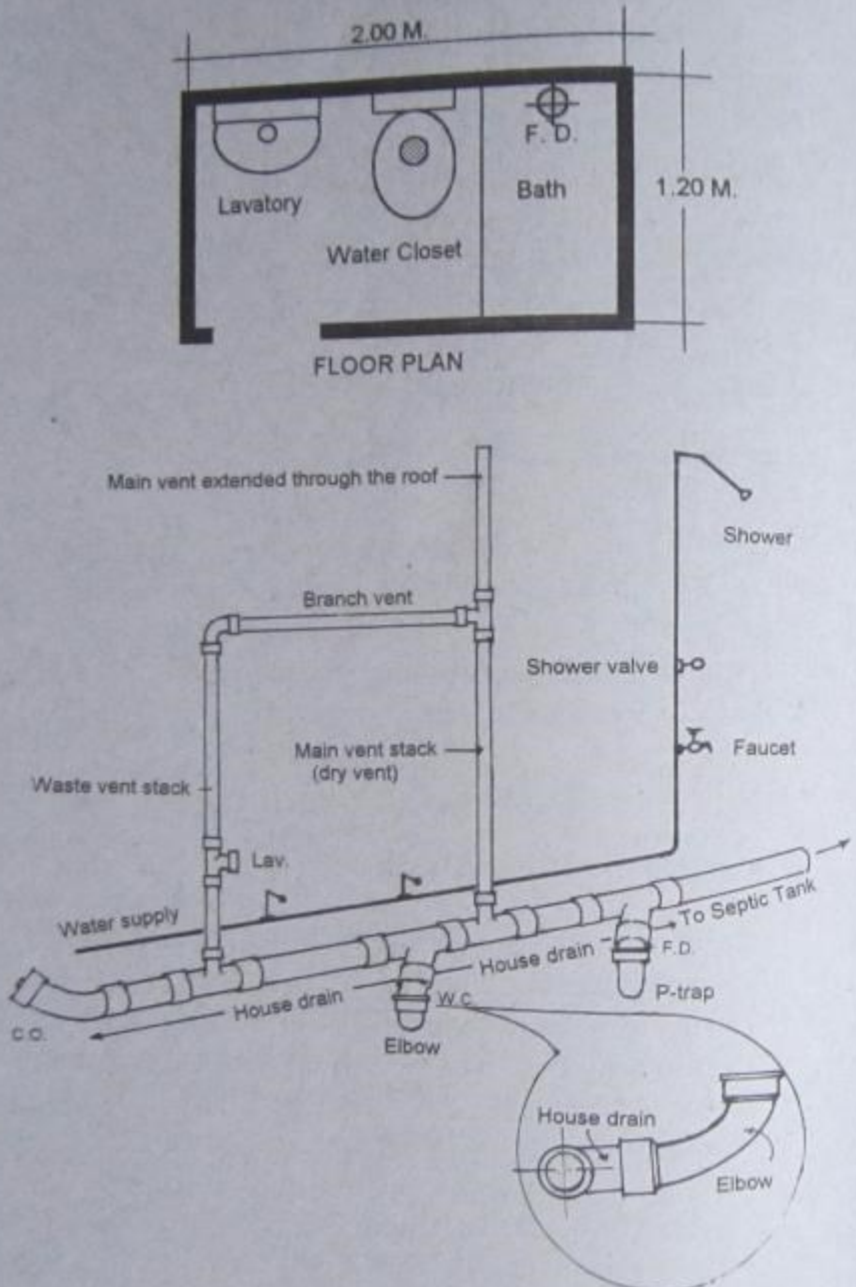


FIGURE 17-1 SINGLE UNIT TOILET AND BATH

Note: Materials listed is limited to those inside the comfort room only

1 - 50 mm ¼ bend elbow
2 - 50 mm x 3.00 meters Pvc pipe

C. Materials for Water Supply

2 pcs. 12 mm (½) x 3.00 meters Pvc pipe
1 - 12 mm plain Tee
1 - 12 mm plain Elbow
3 - 12 mm Elbow with one end threaded
(for w.c. supply and shower)
1 - 12 mm Tee, cross side with thread for faucet
1 - 12 mm Shower valve control
1 - 12 mm Shower head
2 - roll Teflon tape
½ - Pint solvent cement

D. Fixtures and Accessories

1 - set Water Closet with fittings and accessories
1 - set Control valve with flexible supply hose
1 - set Lavatory with P-trap, hanger and faucet
1 - set Control valve with flexible supply hose
2 - pcs. Soap holder
2 - pcs. Face towel bar
2 - pcs. Towel bar
1 - small Medicine Cabinet with mirror

The House Shower is determined by measuring the distance from the House Drain terminal point to the Main Sewer or to the Septic Tank.

An Accurate Estimate of Materials is based on a carefully prepared plan and isometric drawing. Any attempt to make or present a bill of materials for plumbing installation without these fundamental requirements should not be entertained. Plumbing work should not be entrusted to non- experienced plumbing technician.

17-3 Single Unit Toilet with Bathtub

ILLUSTRATION 17-2

Presented in Figure 17-2 is a plumbing installation for a single toilet with bathtub using plastic pipe. Prepare the bill of materials.

SOLUTION

A. Materials for House Drain

1 piece 75 mm (3") 1/8 bend elbow with cleanout cover
2 - 75 x 50 mm Tee for lavatory waste and vent stack
2 - 75 x 75 mm Tee for floor drain and water closet
1 - 75 mm 1/8 bend long sweep elbow for w.c.
1 - 75 mm P-trap
1 - 75 mm x 50 mm Y to receive drum trap
1 - 75 mm x 75 mm Tee to connect soil stack
2 - 75 mm x 3.00 meters Pvc pipe

B. Materials for Waste Pipe and Ventilation

2 - 50 mm x 3.00 meters Pvc pipes
1 - 50 mm x 50 mm Tee to receive lavatory waste
2 - 50 mm x ¼ bend elbow
1 - 75 mm x 50 mm Cross Tee or
2 pcs 75 mm x 50 mm Tee
1 - 75 mm x 3.00 Pvc pipe vent stack
1 - pint solvent cement

C. Materials for Water Supply

2 - 12 mm x 3.00 meters Pvc. pipe
3 - 12 mm plain Tee

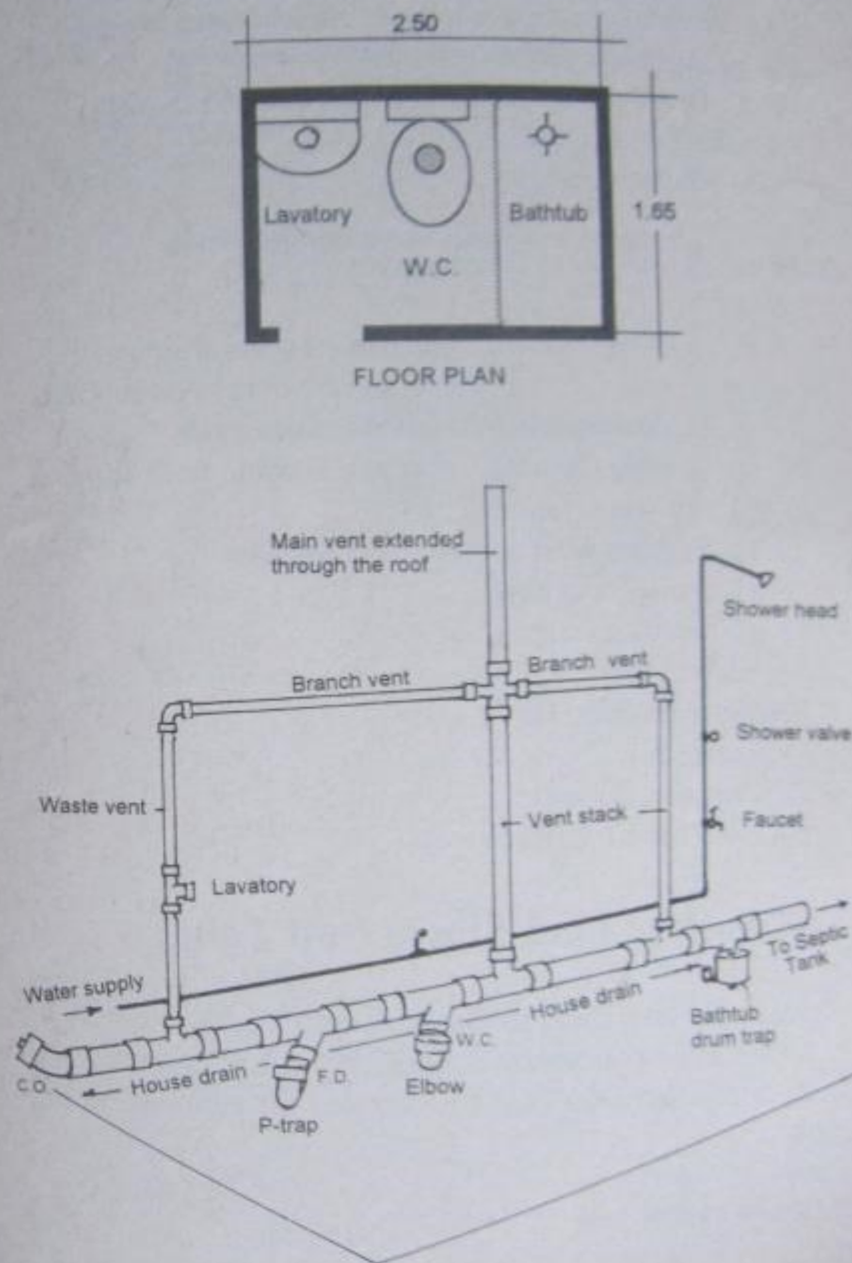


FIGURE 17-2 SINGLE UNIT TOILET AND BATHTUB

4 - 12 mm ¼ bend elbow one wide with thread for lavatory, faucet and water closet water supply
1 - 12 mm plain elbow ¼ bend
1 - 12 mm Tee with thread for shower and faucet
2 - rolls Teflon tape
1 pint solvent cement

D. Fixtures and other Accessories

1 - set Water Closet with accessories and fittings
1 - set 12 mm Control Valve and flexible hose supply
1 - set Lavatory with P-Trap and accessories
1 - set 12 mm Control Valve and flexible hose supply
1 - 12 mm water faucet
1 - set Bathtub with complete accessories
1 - 12 mm shower head
1 - 10 mm drum trap
2 - Soap holder
1 - Paper holder
2 - Towel bar
2 - Face towel bar
1 - Grab bar for bathtub

17-4 Back to Back Single Unit Toilet

A single unit Back to Back Toilet is a common layout in duplex type residential houses, and other types such as multi-door apartment, and row houses for economical reasons.

ILLUSTRATION 17-3

Shown in Figure 17-3 is an example of a plumbing installation for a back to back toilet using plastic pipes. Prepare the bill of materials required.

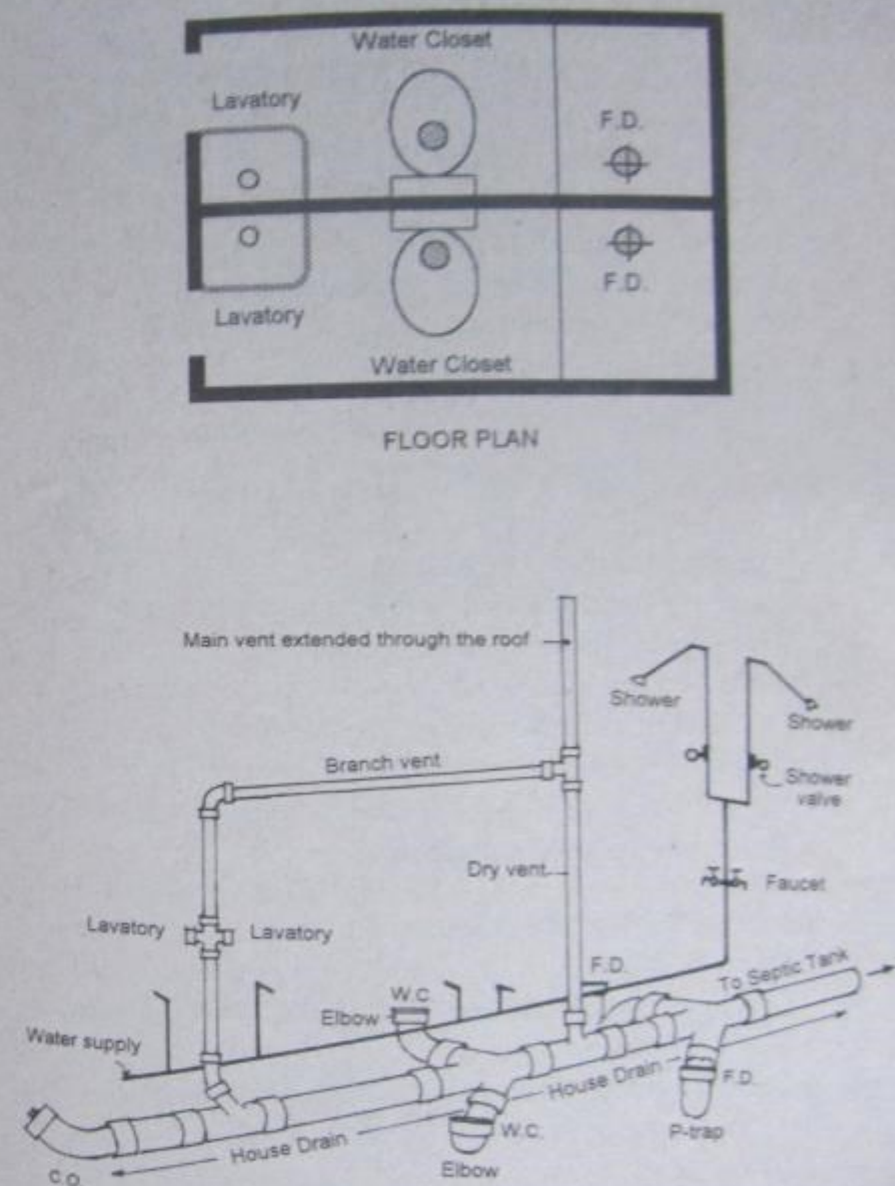


FIGURE 17-3 BACK TO BACK SINGLE UNIT TOILET

SOLUTION

A. Materials for the House Drain

1 piece 100 mm 1/8 bend long sweep elbow
1 - Cleanout cover 100 mm
1 - 100 mm x 50 mm reducer **Y**
2 - 100 mm double **Y** or 4 pcs. 100 mm **Y** for water closet and floor drain
1 - 100 mm x 75 mm Tee for vertical soil stack
2 - 100 mm 1/4 bend elbow to receive w.c. waste
2 - 100 mm P-trap floor drain
1 - 100 mm x 3.00 meters Pvc pipe

B. Materials for Main Vent, Waste and Branch Vent

1 - 75 mm x 3.00 meters Pvc pipe
1 - 50 mm 1/8 bend elbow to receive lavatory waste
1 - 50 mm cross Tee or 2 pcs. 50 mm Tee
1 - 50 mm ¼ bend elbow
1 - 75 x 50 mm Tee reducer
1 - 50 mm x 3.00 meters Pvc pipe

C. For Water Supply Installation

5 - 12 mm x 3.00 m. Pvc pipe
4 - 12 mm plain Tee
4 - 12 mm elbow with thread for control valve
4 - 12 mm plain elbow
2 - 12 mm Tee with thread for shower faucet
2 - 12 mm elbow with thread for shower head.
2 - Shower head
2 - Shower valve
2 - Water faucet
1 - Pint solvent cement
4 - Rolls Teflon tape

D. Fixtures and Accessories

2 set water closets with fittings and accessories.
2 set lavatories with faucet, P-trap, & accessories
4 pieces 12 x 10 mm control valve
4 - Water closet and lavatories flexible supply hose
2 - Floor drain strainer
2 - Soap holder
4 - Towel bar
4 - Face towel bar

Take note that the materials listed is limited to those inside the comfort room only. The house sewer and water supply main were not yet included in the list.

The flexible plastic water supply hose for lavatory and water closet is fast gaining acceptance, because the following physical properties:

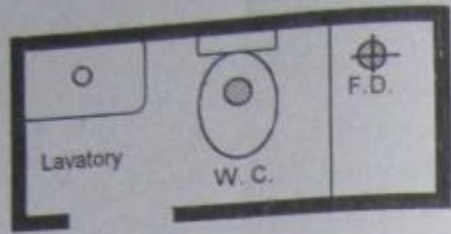
1. It is elastic
2. Adjustable and easier to install
3. Convenient to repair and replace defective parts
4. Less subject to water leak.

In short, ***"you can do it yourself."*** Similarly, shower control valve could be either made of brass, stainless or plastic materials now available in variety of forms, color and designs.

17-5 Two Storey Single Unit Toilet & Bath

ILLUSTRATION 17-4

Presented in Figure 17-4 is an example of a plumbing installation for multi-door two storey type building with up-feed water supply system. Prepare the bill of materials.



FLOOR PLAN

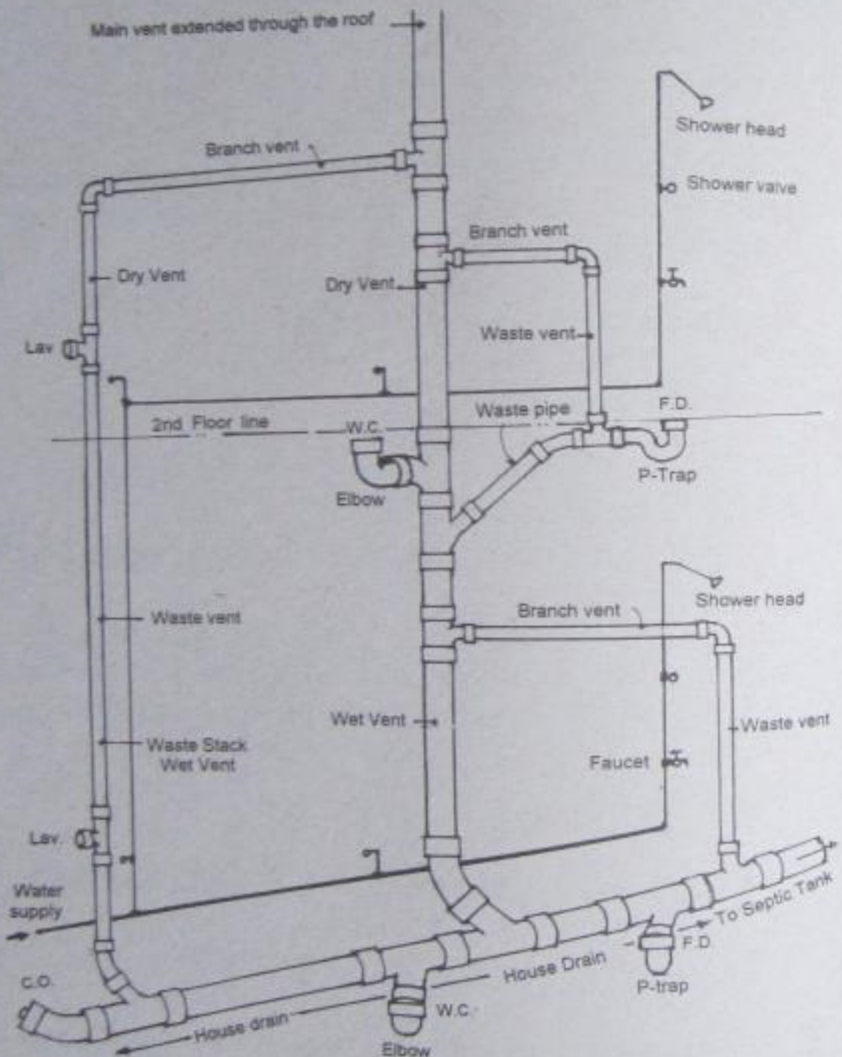


FIGURE 17-4 TWO STOREY SINGLE UNIT TOILET AND BATH

SOLUTION

A. Materials for House Drain

1 piece 100 mm long sweep bend elbow for cleanout
1 - 100 mm cleanout cover
1 - 100 mm x 3.00 m. Pvc pipe
1 - 100 mm x 50 mm Y reducer
3 - 100 mm x 75 mm Y reducer
1 - 100 mm x 50 Y reducer
1 - 100 mm x 50 mm Tee
1 - 100 mm Elbow
1 - 75 mm P-trap

B. Materials for Soil Stack and Soil Branch

1 - 100 mm 1/8 bend
3 - 100 mm x 50 mm Tee
1 - 100 x 75 mm Tee
1 - 75 mm Elbow
2 – 75 mm x 3 m. Pvc pipe

C. Materials for Waste and Vent Pipe

2 - 50 mm 1/8 elbow
3 - 50 mm Tee
3 - 50 mm Elbow
1 - 50 mm P-trap
4 - 50 mm x 3 m. Pvc. pipe

D. Materials for Water Supply

6 - 12 mm x 3 m. Pvc pipe
4 - 12 mm plain Tee
12 - 12 mm Elbow
4 - 12 mm socket one end threaded

3 - 12 mm Elbow one end threaded
2 - 12 mm Tee one side threaded
1 - pint Solvent cement

E. Fixtures and Accessories

2 - sets Water Closet with accessories and fittings
2 - 12 x 10 mm control valve
2 - sets Lavatories
2 - Lavatory faucets
2 - P - trap
2 - 12 mm control valve
4 - 12 mm Flexible supply hose
2 - Shower valve
2 - Shower head
2 – 12 mm faucet
4 - Soap holder
2 - Paper holder
4 - Towel bar
4 - Face towel bar

17-6 Two Storey Back to Back Toilet

ILLUSTRATION 17-5

Presented in Figure 17-5 is an example of a plumbing installation serving a back to back toilet and bath on the first and second floor. List down the materials required.

SOLUTION

A. Materials for House Drain

1 - 100 mm long sweep elbow
1 - 100 mm cleanout

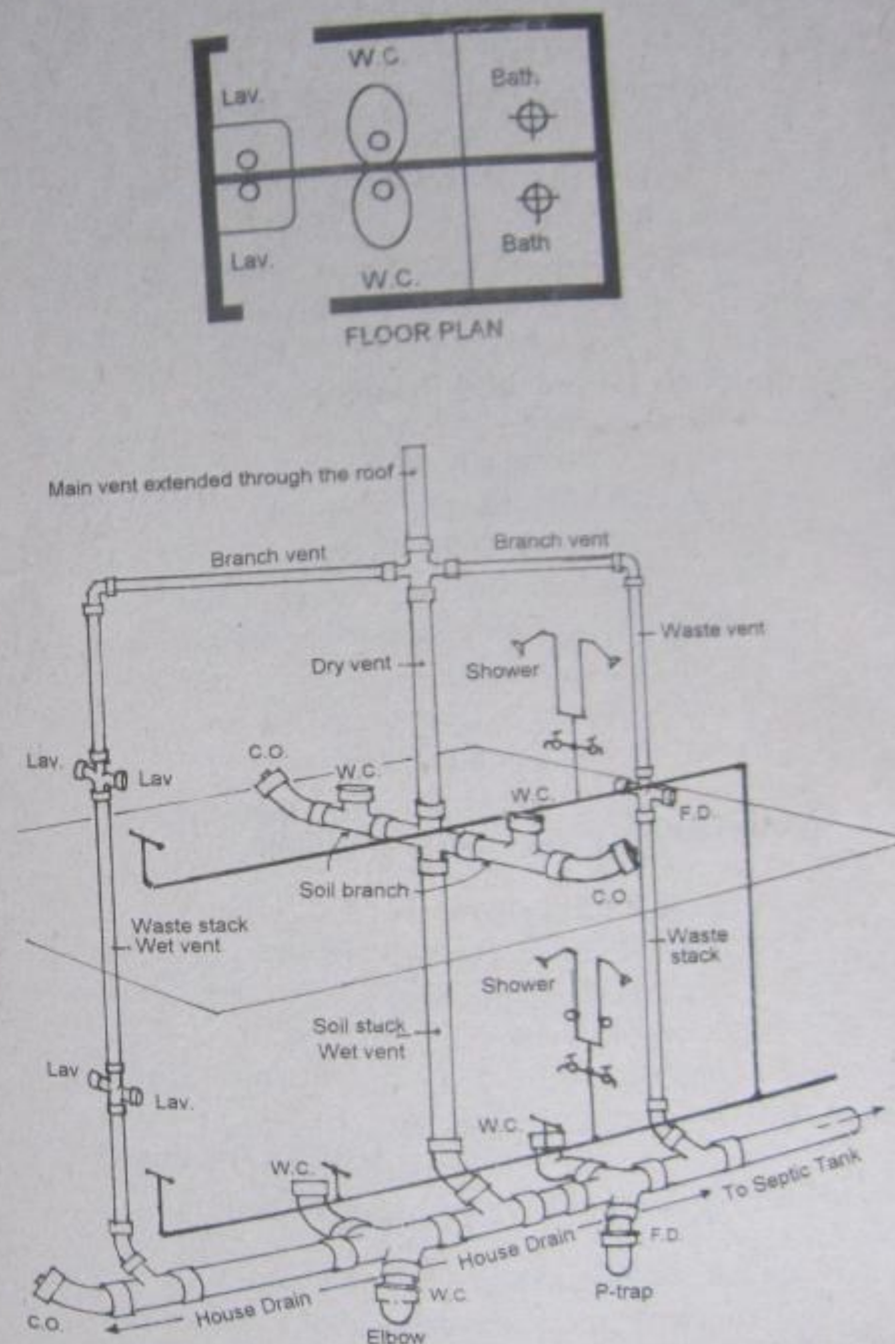


FIGURE 17-5 TWO STOREY BACK TO BACK TOILET AND BATH

1 - 100 mm cleanout cover
2 - 100 mm x 50 mm **Y**
2 - 100 mm x 100 mm cross **Y** or (4-100 mm **Y**)
1 - 100 mm x 100 mm **Y**
1 - 100 mm x 3.00 meters Pvc pipe
2 - 100 mm P-trap
2 - 100 mm floor drain strainer
2 - 100 mm elbow to receive w.c. waste

B. Materials for Soil and Branches Pipe

1 - 100 mm 1/8 bend elbow
2 - 100 mm x 3.00 meters Pvc pipe
1 - 100 mm x 75 mm cross Tee
2 - 75 mm Tee to receive w.c. waste
2 - 75 mm 1/8 bend long sweep elbow (c.o)
2 - 75 mm cleanout cover
1 - 75 mm x 50 mm reducer cross Tee or
2 - 75 mm x 50 mm reducer Tee

C. Materials for Waste and Vent Pipes

2 - 50 mm 1/8 bend elbow
3 - 50 mm x 50 mm cross Tee
2 - 50 mm socket or coupling
2 - 50 mm ¼ bend elbow
2 - 50 mm P-trap floor drain
2 - 100 mm floor drain strainer

D. Materials for Cold Water Supply pipes

2 - 20 mm x 3.00 meters Pvc supply pipe
1 - 20 mm x 12 mm Tee reducer
1 - 20 mm x 12 mm socket reducer
15 - 12 mm plain Tee
4 - 12 mm threaded Tee

10 - 12 mm socket one end threaded
4 - 12 mm elbow one end threaded
6 - 12 mm plain elbow
4 - 12 mm shower head
4 - 12 mm water faucet
8 - 12 mm control valve
8 - 12 mm flexible supply hose
6 - Rolls Teflon tape
2 - Pints solvent cement

E. Fixtures

4 sets water closet with fixtures and accessories
4 sets lavatories with fittings and accessories
4 - Soap holder
4 - Paper holder
8 - Towel bar
8 - Face towel bar

17-7 Drainage Installation with Hot and Cold Water Supply

A plumbing installation of a two storey building with basement is presented in Figure 17-6 showing the DWV including the hot and cold water supply system. List down the materials required.

A. Materials for House Drain

1 - 100 mm x 3.00 meters Pvc soil pipe
1 - 100 mm x 50 mm Tee to receive waste stack
1 - 100 mm x 100 mm Tee
1 - 100 mm long sweep elbow for cleanout

B. Materials for Soil Stack

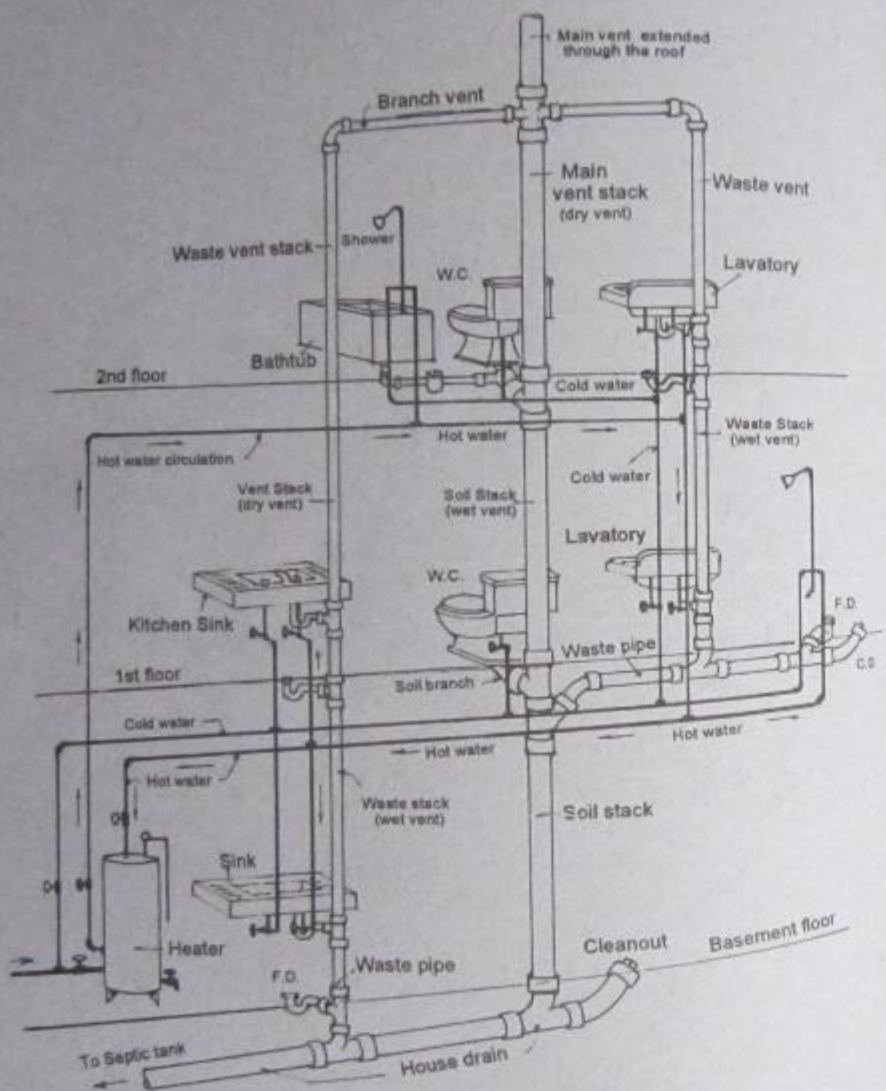


FIGURE 17-6 DWV WITH HOT AND COLD WATER SUPPLY

3 - 100 mm x 3.00 meters Pvc soil stack
1 - 100 mm x 50 mm Y
2 - 100 mm x 100 mm Tee
1 - 100 mm x 50 mm cross Tee

C. Materials for Soil Branch

2 - 100 mm long sweep elbow
2 - 100 mm Tee
2 - 100 mm for cleanout
1 - 100 mm x 50 mm Tee
1 - 38 mm x 50 mm reducer
1 - 38 mm ¼ bend elbow

D. Materials for Waste Branch

1 - 50 mm 1/8 bend elbow
2 - 50 mm Tee
1 – 50 mm long sweep elbow for c.o
1 - 50 mm cleanout cover
1 - 50 mm x 38 mm reducer
1 - 38 mm ¼ bend elbow
1 - 100 mm drum trap
1 – 38 mm x 3.00 meters Pvc. pipe

E. Materials for waste and Vent Pipes

7 - 50 mm Tee
2 - 50 mm ¼ bend elbow
7 - 50 mm x 3.00 meters Pvc pipe

F. Materials for Cold Water Supply

2 - 20 mm x 3.00 m. Pvc pipe
2 - 20 mm gate valve
1 - 20 mm Tee

1 - 20 mm x 12 mm elbow reducer
10 - 12 mm ¼ bend elbow plain
8 - 12 mm ¼ bend elbow one end threaded
8 - 12 mm Tee plain
2 - 12 mm Tee one end threaded
10 - 12 mm x 3.00 Pvc pipe
1 - 20 mm x 3.00 Pvc pipe
2 - pint solvent cement
5 - rolls Teflon tape

G. Copper pipe for Hot Water Supply

1 Set heater with relief valve, faucet and accessories
10 - 10 mm x 3.00 copper pipe
7 - 10 mm elbow
2 - 10 mm gate valve
8 - 10 mm Tee
4 - 10 mm elbow

H. Fixtures and Accessories

7 - 10 mm control valve and supply pipe
2 - Hot & cold mixing valve for shower and bath
2 - Hot & cold mixing valve for lavatories
2 - Hot & cold mixing valve for kitchen sink
2 - Sets Water Closet with tank and accessories
1 - Set Bathtub with drum trap and accessories
2 - Lavatories with p-trap and faucets
2 - Kitchen sink with p-trap and strainers
2 - Shower head

PLUMBING DESIGN AND ESTIMATE

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