Plumbing

Typical Plumbing System

Introduction

Plumbing is the system of pipes, drains, fittings, valves, and fixtures installed for the distribution of potable water for drinking, heating and washing in a building, and drainage of wastewater and storm water from the building.

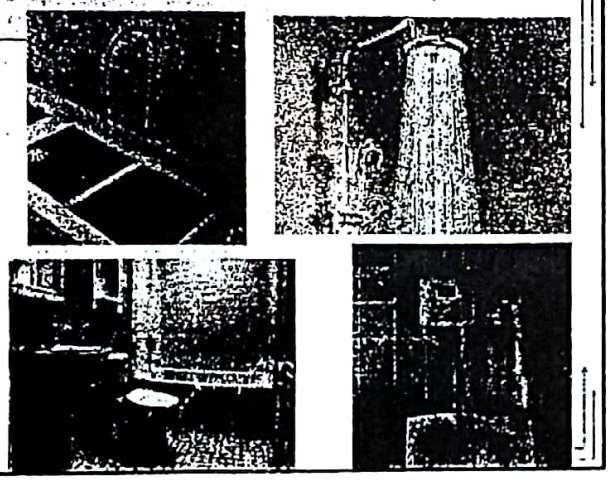
The water supply system must accomplish two objectives:

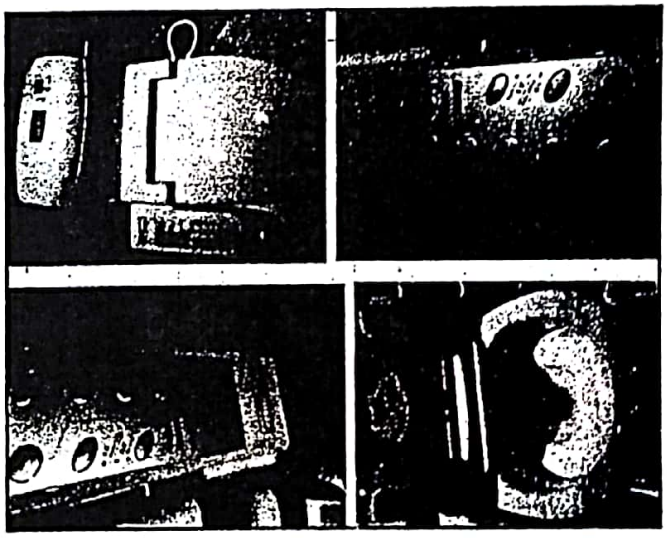
- provision of sufficient amount of water to serve each fixture.
- provision of no opportunity of backflow of used water into the water supply pipes.

The drainage system must accomplish two objectives:

- wastewater must be removed quickly with minimum chance for stoppage of drains or leakage.
- entrance of vermins and. sewer gas or foul smelling air from the drainage system into the house must be prevented.

Plumbing Fixture: A plumbing fixture is an exchangeable device which can be connected to a plumbing system to deliver and drain water.



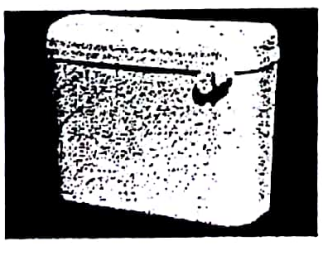


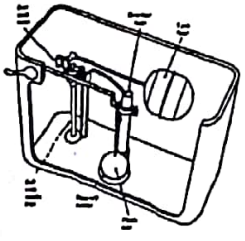
Fixture Unit

A fixture unit (FU) is a quantity in terms of which the load producing effects on the plumbing systems of different kinds of plumbing fixtures are expressed on some arbitrarily chosen scale.

Flush Tank/Flushing Cistern

A chamber in which water is accumulated and then discharged rapidly for flushing out water closets and urinals.

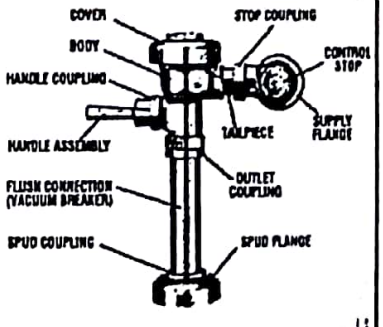




Flush Valve:

A flush valve is a self-closing valve designed to release a large volume of water when activated. This mechanism is often used to flush a toilet or urinal. Water for flushing must all come from the water supply pipes. This type of fixture requires more pressure and larger pipes to flush.





Typical Water Distribution System

Introduction

The fresh water in a water distribution system comes from a public works. It is first purified and then sent under pressure through pipes to the water service line that runs directly into houses, or other types of buildings at pressures of 55, 60, or 75 psi and ranging as high as 100 psi.

Measuring Water Pressure

Screw a pressure gauge on to the sill cock located outside of the house, and then turn on the faucet making certain no other faucets in other parts of the house are open.

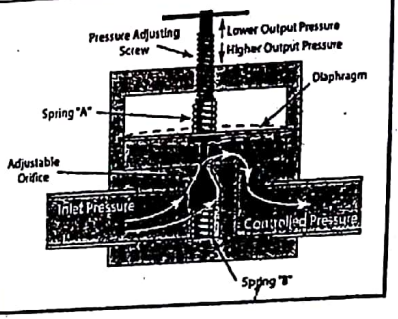
Disadvantages of High Water Pressure

- eventually damages faucets and fittings.
- causes water hammer.
- excessive loss of water.

Reduction of High Water Pressure

By installing a pressure-reducing valve near the point where the water enters the house, the high pressure in the pipe line can be brought down to a reasonable value.

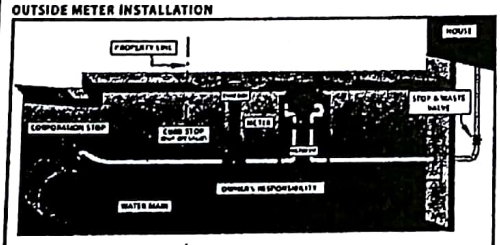




House Service

The house water service is that part of the water distribution system that runs from the street water main to the water meter that is usually inside the house.

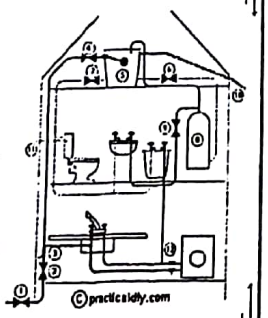
OUTSIDE METER INSTALLATION



- The *corporation stop* is a valve installed in the house service at the street water main. It can be turned on or off by the utility that supplies the water or the city, town, or village water depart-ment. If a building is to be demolished, the corporation stop is turned off.
- The *goose neck connection* is a 40 to 50 cm long flexible curved pipe made up of brass or copper or lead inserted in between the corporation stop and the service pipe. It is provided to accommodate the possible movement, displacement or settlement that may take place between the water main and the service pipe and prevent damage to the corporation stop.
- The *curb stop* is a valve on the house service line installed between the curb and the sidewalk. To get at the valve a cast iron, stop box is brought up to ground level. A long rod like wrench is used to turn the valve on and off. The water can easily be shut off when required.
- The *service pipe* connects the street water main through goose neck and corporation stop with a building to supply water.
- The *water meter* measures the volume of water coming through the house service. The meter is installed by, and is the property of the utility, city, town, or village. The meter is read regularly and the owner of the building is charged for the water used.

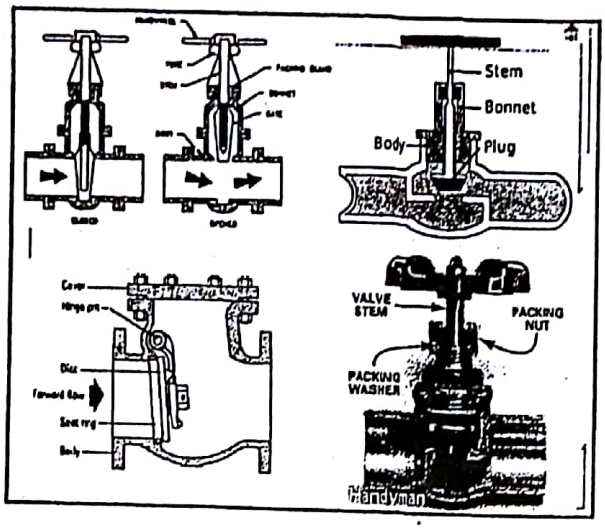
Inside Water Supply Distribution

- Water can be directly fed to the fixtures or stored in a building reservoir to be distributed to different fixtures and hot water heater.
- Hot water distribution system brings hot water to the fixtures.
- Both hot and cold water lines should run parallel, spaced at least 6 in. apart
- The hot water line should be run to the left side of each fixture as we face that fixture.



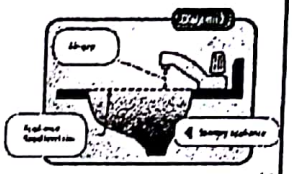
Use of Valves

- The water system is equipped with valves that are placed where they serve the best use.
- Valves are turned off to repair leaking pipes.
- There are different kinds of valves used for a water system.
  - gate valve is the on-off valve which operates by raising and lowering a wedge or disk into the stream of flow.
  - globe valve is used for throttling the flow of water.
  - check valve prevents the backup of water.
  - fixtures have shutoff valves which are used when repairs are necessary or when emergencies occur.



General Considerations for Water Supply to Buildings

1. There should be absolutely no risk of contamination of water supply for domestic purposes. To ensure this, three things are necessary-
   - There should not be any cross-connection anywhere between a pipe containing potable water and pipe containing polluted water.
   - There should be no back flow from any cistern or appliance towards the source of supply.



- The water supply and the drainage pipes should not be laid very close to each other.

2. The pipes and fittings should be thoroughly water-tight in order to protect the building against possible damage due to leakage. Water-tightness of joints ensures minimum wastage of water and risk of contamination is also considerably reduced.
3. The pipe-work should be amply protected against any possible damage.
4. Water supply pipes should carry water inside buildings under adequate pressure in the water main. However, where available pressures are insufficient and it becomes necessary to pump water, underground storage tank, elevated storage tank(s) and pumping arrangement must be used.

Lay-out of Water Supply Pipes

1. The lay-out of water supply pipes should be simple and direct as far as possible.
2. The pipes should be laid as straight as possible. Alignment should also be good especially where joints are screwed and socketed.
3. The pipes should be fully protected against corrosion or frost.
4. The lay-out should be such as to admit of easy inspection and repair. Pipes may run through chases or recesses made in the walls or through vertical ducts. Burying of pipes in walls or floors should, as far as possible, be avoided.
5. The lay-out should be free from the occurrence of air pockets, sediment traps and noise transmission.

Design of Water Supply Piping

Underlying principles are:

1. A study is undertaken to obtain
   - water flow rates required for given occupancies and fixtures
   - probable maximum demand on fixtures
   - friction to flow offered by piping and fittings
   - available pressures
   - static head loss or gain
   - pressures required at fixtures
2. Knowing the flow rate on a section of piping, the allowable pressure drop is determined, and then the required pipe size is found using nomograph.

Water Supply For Tall Buildings

- Water in public mains under normal pressures cannot deliver water to the upper portions of tall buildings.
- Water main pressures range from 40 to 80 psi depending on the elevation of the main in relation to its source and the fluctuation in demand.
- The bottom of a column of water 1 ft high exerts a pressure of 0.434 psi. Thus, a main pressure of 40 psi can support a water column 40/0.434 or 92.2 ft high.
- If water is flowing, some pressure will be lost from frictional resistance to flow offered by pipe, fittings, and equipment.
- Also, about 10 psi should be available at a fixture.
- So it is evident that city main pressure will be used up in order to overcome the friction to flow and the static head loss and cannot deliver water to all parts of a building over 5 or 6 floors.

- The problem is solved by storing water in underground storage tanks from public mains and then pumping the water into elevated tanks.
- These house tanks supply water by gravity to a number of floors below (down-feed zones).
- The number of floors must be limited so that static pressures in piping at the bottom are not excessive. About 150 ft from tank to the lowest fixture is a suitable limit.
- For tall buildings, it will be necessary to zone the system to limit pressures.
- For example, in a building 32 floors high we might provide an up-feed zone for the bottom 6 floors. The remaining 26 floors could be 2 or 3 down-feed zones depending on the maximum allowable pressure in the distribution system.
- For intermittent supply of water, no up-feed is possible.

Example Problem

Given:

- 25 storey building, 10 ft floor to floor
- 50 psi at public main
- Men's and women's toilets on alternate floors
- 3 water closets or 1 water closet and 2 pedestal urinals, and 2 lavatories on each floor. Flush valve fixtures except on 24th and 25th floors where flush-tank fixtures are used.
- Maximum pressure at any fixture is not to exceed 50 psi

Required:

Riser pipe sizes

Solution:

Determine a reasonable zoning. The lowest floors can be upfeed from main pressure. Upper floors must be supplied by downfeed risers from elevated tanks. The maximum number of floors to be served by a downfeed zone depends on the maximum pressure to be permitted at the lowest fixture.

Minimum Permissible Fixture Pressure

- First, we must decide on minimum permissible fixture pressure.
- The pressure for a lavatory is 8 psi. A flush tank water closet can operate at this same pressure. When it is activated by a flush-valve, around 15 psi is the minimum fixture pressure.
- In a downfeed arrangement, the highest fixtures, or those nearest the elevated tank, receive the smallest pressure because they benefit least from static head gain.
- The minimum elevation of the tank above a flush-valve fixture is 15/0.434 = 35 ft plus a little extra for overcoming friction due to flow.
- The minimum elevation of the tank above a flush-tank fixture or lavatory is 8/0.434 = 18.4 ft plus a little extra for overcoming friction due to flow.

Hence, we can realize that flush-tank fixtures on the two top floors saves us about 18 ft of structures that would be required to support the tank at the necessary height above a flush-valve fixture.

Table 14-2. Rate of flow and required pressure during flow for different fixtures.

Fixture	Flow pressure[1]	Flow rate
	Psi	Gpm
Ordinary basin faucet	8	2.0
Self-closing basin faucet	12	2.5
Sink faucet, ½ inch	10	4.5
Sink faucet, ¾ inch	5	4.5
Bathtub faucet	5	6.0
Laundry-tub cock, ½ inch	8	5.0
Shower	12	5.0
Ball cock for closet	15	2.0
Flush valve for closet	10 to 20	15 to 40
Flush valve for urinal	15	15.0
Garden hose, 50 feet and sill cock	30	5.0

[1] Flow pressure is the pressure in the pipe at the entrance to the particular fixture considered.
[2] Wide range due to variation in design and type of flush-valve closets.

In an upfeed zone, the pressure available at the main must equal the frictional pressure loss through piping and equipment plus the static head loss plus the required pressure at the top fixture.

Expressing this mathematically, we obtain

$$P = p + 0.434h + f$$

where P = service main pressure, psi;
p = pressure drop through piping and equipment, psi;
h = height from main to fixture, ft;
f = minimum permissible fixture pressure; psi.

In order to estimate friction drop, especially through a water meter, we must establish a tentative water service pipe size.

The probable rate of flow in the pipe is found as follows:

On each typical floor, the fixture unit load is

3 water closets, or 1 water closet and 2 urinals (flush valve)	30
2 lavatories	4
TOTAL	34 FU

And on the 24th and 25th floors, it is

3 water closets, or 1 water closet and 2 urinals (flush tank)	15
2 lavatories	4
TOTAL	19 FU

The load on the service pipe is
23(34) +2(19) = 820 FU

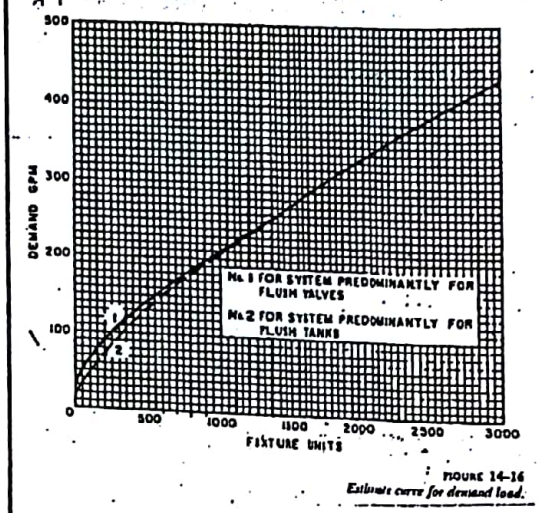


FIGURE 14-16
Estimate curve for demand load.

According to Fig. 14-16, the probable maximum demand is 184 gpm

Table 14-3. Demand weight of fixtures in fixture units.[a]

Fixture or Group[b]	Occupancy	Type of Supply Control	Weight in Fixture Units[c]
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 for closet	8
Bathroom group	Private	Flush tank for closet	6
Separate shower	Private	Mixing valve	2
Kitchen sink	Private	Faucet	2
Laundry trays (1–3)	Private	Faucet	3
Combination fixture	Private	Faucet	3

From NBS Report BMS79 *Water-Distributing Systems for Buildings.*

[a] For supply outlets likely to impose continuous demands, estimate continuous supply separately and add to total demand for fixtures.

[b] For fixtures not listed, weights may be assumed by comparing the fixture to a listed one using water in similar quantities and at similar rates.

[c] The given weights are for total demand. For fixtures with both hot and cold water supplies, the weights for maximum separate demands may be taken as ¾ the listed demand for the supply.

If we use iron pipe, Fig. 14-19 indicates a 3-inch main for a drop of 6 psi per 100 ft or a 4-inch main for a drop of 1.4 psi per 100 ft.

Let us tentatively select the 4-inch main to conserve pressure for the upfeed zone.

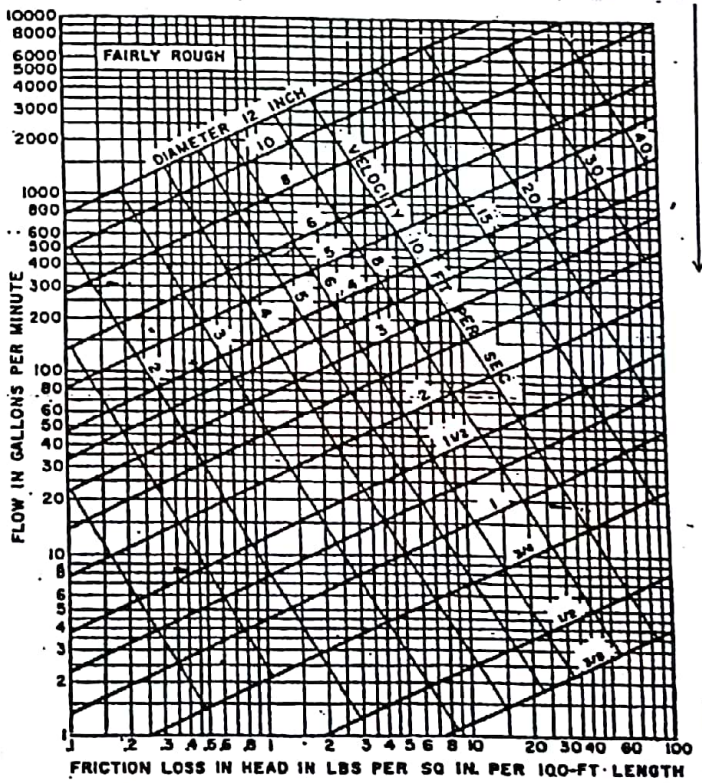
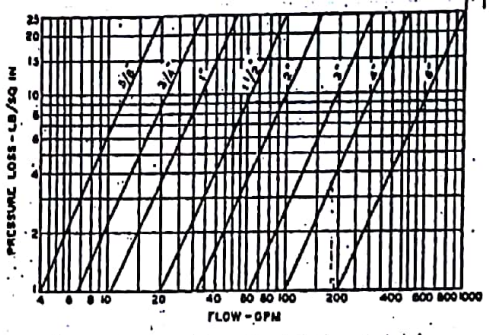


FIGURE 14-19
Friction losses in fairly rough iron pipe.

Figure 14-20 shows that about 3.5 psi drop occurs at a 4-inch meter when the flow is 184 gpm.



(See manufacturer's data for exact value for meter used)

FIGURE 14-20
Pressure losses in disk-type water meters.

In Eq. (14-1), let us allow 1 psi drop in branch from the riser and calculate the friction loss through the service pipe, riser and fittings. For fitting friction, 50% extra length is considered as initial approximation. Therefore, the height of the upfeed zone is found from the equation

$$50 = 3.5 + 1.5\,(70 + h)\,(1.4 / 100) + 0.434h + 15 + 1$$

$$h = 29.03 / 0.455 \approx 64 \text{ ft}$$

If the floor-to-floor height is 10 ft, 6 stories are indicated for the height of the upfeed zone.

We must remember that 64 ft is from main to top fixture. Therefore, a deep water main would limit us to 5 floors.

Table 14-2. Rate of flow and required pressure during flow for different fixtures.

Fixture	Flow pressure[1]	Flow rate
	Psi	Gpm
Ordinary basin faucet	8	3.0
Self-closing basin faucet	12	2.5
Sink faucet, ¾ inch	10	4.5
Sink faucet, ½ inch	8	4.5
Bathtub faucet	8	6.0
Laundry-tub cock, ½ inch	8	5.0
Shower	12	5.0
Ball cock for closet	18	3.0
Flush valve for closet	10 to 20	9 15 to 40
Flush valve for urinal	15	15.0
Garden hose, 50 feet and still cock	30	5.0

[1] Flow pressure is the pressure in the pipe at the entrance to the particular fixture considered.
[2] Wide range due to variation in design and type of flush-valve closets.

Now we should check the maximum height of a downfeed zone.

The maximum pressure on the lowest fixture occurs when all water flow is off and it is the static head obtained from the roof tank tank elevation.

Obviously, when water flows, frictional resistance lessens the pressure at the bottom of a riser. If the maximum pressure for a fixture is 50 psi, the maximum vertical distance from tank to fixture is 50/0.434= 115 ft.

Allowing a little extra height of the roof tank above the top-most flush tank fixture for overcoming friction loss through piping and fittings, about 20 to 25 ft of height between the top fixture and the roof tank is required, only 90 ft (= 150 – 25) is left to use for the floor-to-floor distances served by the riser. Hence, for 10-foot floor-to-floor heights, the maximum downfeed zone is 9 floors.

For our 25-story building, the use of two downfeed zones of 9 floors requires that the upfeed zone be (25 – 18) or 7 floors. But we found 5 floors as the maximum for the upfeed zone.

We have the choice between

(i) increasing the downfeed zones to three or

(ii) raising, slightly our maximum fixture pressure for a downfeed zone.

The latter alternative would take less equipment while the former would lessen the sizes of the units used.

If the maximum fixture pressure allowed is increased by 10 (0.434) or 4.34 psi.

Raising our 50 psi to 54.34 or, 55 psi is not objectionable.

Hence, we choose:

(i) Zone # 1
a 5-floor upfeed zone
(1st floor- 5th floor)

(ii) Zone # 2
a 10-floor downfeed zone
(15th floor – 6th floor)

(iii) Zone # 3
a 10-floor downfeed zone
(25th floor – 16th floor)

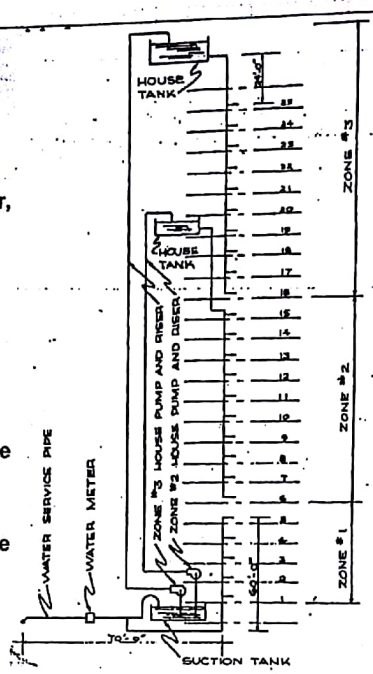


FIGURE 14–21
Water supply for a tall building.

Design of the Upfeed Zone

- First let us find the total pressure available for overcoming friction to flow in piping and fittings.
- It will be the main pressure less the sum of water meter pressure drop, static head loss, and minimum fixture pressure including pressure drop in branches from the riser for which allow 1 psi, or

$$p = 50 - [3.5 + 60\,(0.434) + 15 + 1] = 4.46 \text{ psi}$$

assuming that the top fixture is 60 ft above the main.

- The pressure of 4.46 psi can be utilized to overcome friction caused by flow through piping and fittings.
- We evaluate fitting friction by stating the length of straight pipe of the same size which will offer equal pressure drop at the same rate of flow.
- Table 14-4 lists equivalent pipe lengths for several fittings and valves of various sizes.

Table 14–4. Allowance in equivalent feet of pipe for friction loss in valves and threaded fittings.

Diameter of fitting (inches)	Equivalent length of pipe for various fittings						
	90° standard L	45° standard L	90° side T	Coupling or straight run of T	Gate valve	Globe valve	Angle valve
	Feet	Feet	Feet	Feet	Feet	Feet	Feet
⅜	1	0.6	1.5	0.3	0.2	8	4
½	2	1.2	3	.6	.4	15	8
¾	2.5	1.5	4	.8	.5	20	12
1	3	1.8	5	.9	.6	25	15
1¼	4	2.4	6	1.2	.8	35	18
1½	5	3	7	1.5	1.0	45	22
2	7	4	10	2	1.3	55	28
2½	8	5	12	2.5	1.6	65	34
3	10	6	15	3	2	80	40
3½	12	7	18	3.6	2.4	100	50
4	14	8	21	4	2.7	125	55
5	17	10	25	5	3.3	140	70
6	20	12	30	6	4	165	80

At the moment, we do not know pipe or fitting sizes, hence, an estimate of equivalent length must be made.

The riser is a straight vertical run, and a low increase in actual length to allow for fittings is reasonable. If the measured length of pipe from main to foot of riser is 70 ft and the riser is 60 ft, the total actual length is 130 ft.

Let us add 50% for fittings. The total equivalent length is 130(1.5)= 195 ft.

Therefore, the pressure loss per 100 ft is

$$p = \frac{(4.46)(100)}{195} = 2.3 \text{ psi per } 100 \text{ ft}$$

The tabulation of the information for sizing the upfeed zone is given in Table 14-5.

Table 14–5. Pipe sizes for upfeed zone of water supply system.

Floor	Fixture units	Accumulated fixture units	Demand flow (gpm)	Pipe size (in.)
Service pipe		820[a]	184	3½
1	34	170	85	3
2	34	136	77	2½
3	34	102	68	2½
4	34	68	58	2½
5	34	34	43	2

[a] Includes F.U. from zones 2 and 3.

- Each floor is listed.
- Then, the fixture unit load as previously determined is given to each floor. Calculate the accumulated fixture units corresponding to each floor.
- The rate of flow for each floor corresponding to the fixture unit demand load is determined from curve 1 of Fig. 14-17 for installations having flush-valve fixtures. From these rates of flow and a permissible drop of 2.3 psi per 100 ft, we can read the pipe sizes from Fig. 14-19.

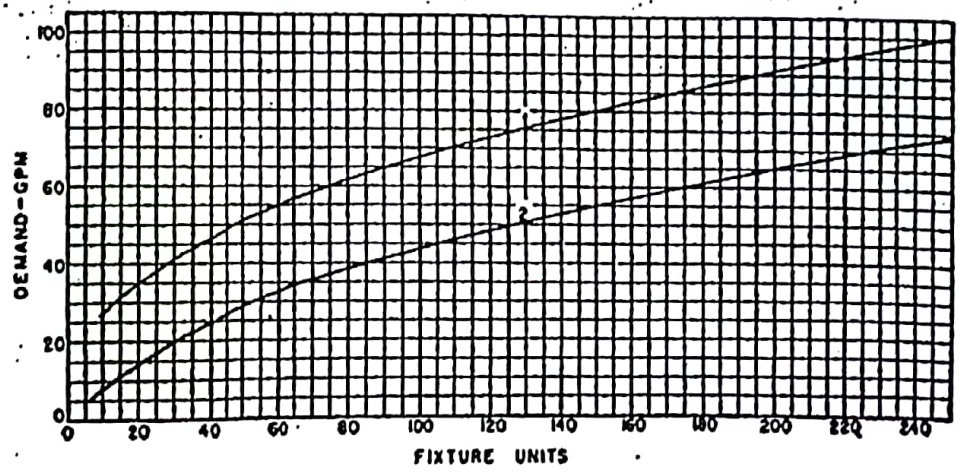


FIGURE 14–17
Enlarged scale of Figure 14–16.

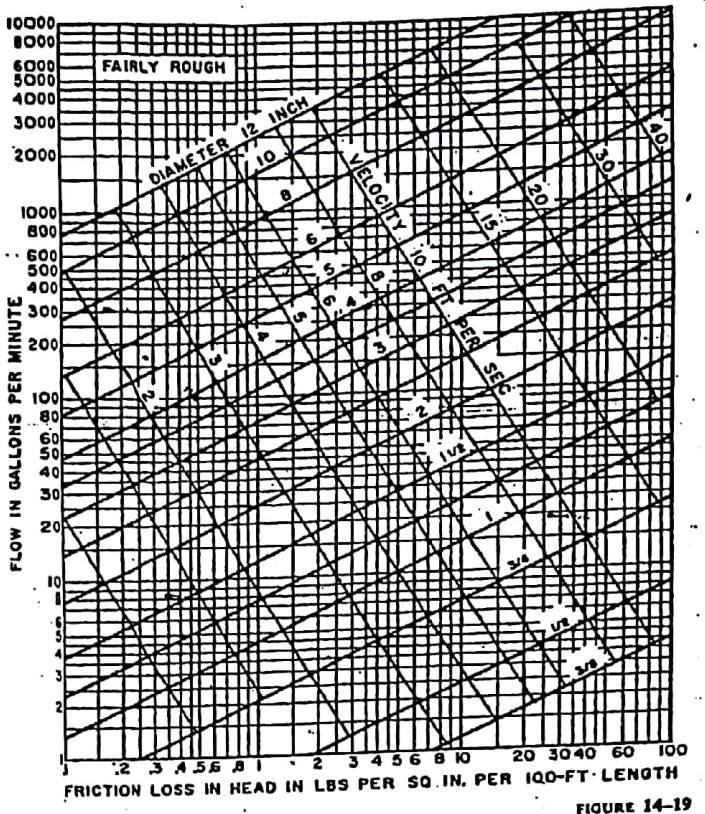


FIGURE 14–19
Friction losses in fairly rough iron pipe.

- In an actual layout, it is desirable to check on the assumed equivalent length for fittings after pipe sizes have been determined.
- Assume we had the following fittings in our upfeed zone. The equivalent lengths are from Table 14-4.

1 gate valve, $3^1/_2$ in.	2.4 ft
4 couplings, $3^1/_2$ in.	14.4
3 90° ells, $3^1/_2$ in.	36.0
2 90° ells, 3 in.	20.0
4 tees, straight run, $2^1/_2$ in.	10.0
TOTAL	82.8 ft

- Our assumed equivalent length was 65 ft or not quite enough.
- We could correct our drop by boosting the equivalent to, say, 85 ft.
- Then, we may calculate the drop as

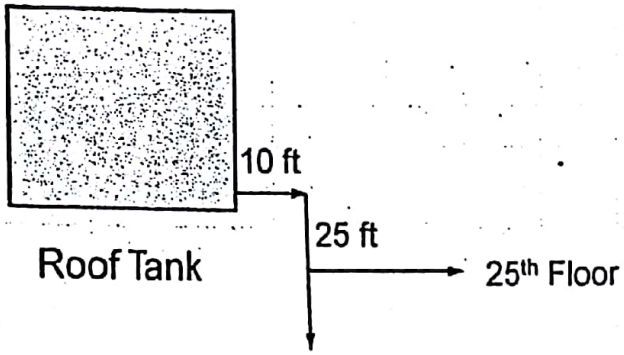
  p = 4.46(100)/(130 + 85) = 2.1 psi per 100 ft

  and check the pipe sizes in our table.

In this instance, little or no change would result. Our figures are based on a 4-inch water meter, and the use of a 4-mch service pipe will more than compensate for the error in equivalent length estimation.

Design of the Downfeed Zones

- Now, let us size downfeed zone 3.
- The problem is rather different from upfeed sizing. Two special conditions are to be satisfied
  (i) We must limit pressure loss at the top of the zone so that top fixtures will receive their minimum pressure.
  (ii) Lower down, we can size piping so that friction due to flow just balances the static gain.



- Let us set our tank at 24 ft vertically above the top fixture with 10 ft of horizontal pipe also required in the first section.
- Now, the permissible pressure drop in the pipe from the tank to the top floor is the static gain less the fixture pressure, 8 psi, and the fixture branch pressure, 1 psi.
- Therefore, $p = 24(0.434) - 8 - 1 = 1.4$ psi
- Assuming the fitting friction to be equal to a 50% increase in actual length, the drop per 100 ft is

$$\frac{1.4 \times 100}{34 + 17} = 2.80 \text{ psi}$$

- From Fig. 14-19, pipe size from tank to top floor is 3 in.
- We must remember that at the 23rd floor the minimum pressure for flush-valve fixture and branch is 15 + 1= 16 psi. Let us find the pressure drop from the 25th to the 23rd floor to obtain the 16 psi required at the 23rd floor.
- The static head gained is 10 + 10 = 20 ft or 20(0.434) = 8.68 psi. Therefore, 9 + 8.68 – 16 = 1.68 psi is available for overcoming friction.

- The permissible pressure drop per 100 ft is

$$\frac{1.68 \times 100}{1.5 \times 20} = 5.60 \text{ psi}$$

- This pressure drop can be used to size the riser for the 23rd and 24th floors.
- From this point on, all piping can be sized to use up the entire static head gain. In other words, once we have 16 psi available, any additional gain from static head can be used to overcome friction.
- Permissible pressure loss, $p = 16 + 10 \times 0.434 - 16 = 4.34$ psi
- Thus, at each floor the gain is $10(0.434) = 4.34$ psi, and the loss per 100 ft is

$$\frac{4.34 \times 100}{1.5 \times 10} = 28.9 \text{ psi}$$

- Table 14-6 illustrates a convenient tabular form for the riser pipe sizing. We find the fixture unit loads present at each floor and the accumulated load on the riser at each floor using Table 14-3 as we did for the upfeed zone. From the fixture unit loads, we find the corresponding probable flow rates from Figs. 14-16 and 14-17.

- We can read the pipe sizes from Fig. 14-19 corresponding to the flow rates and the permissible pressure drop per 100 ft length of pipe.

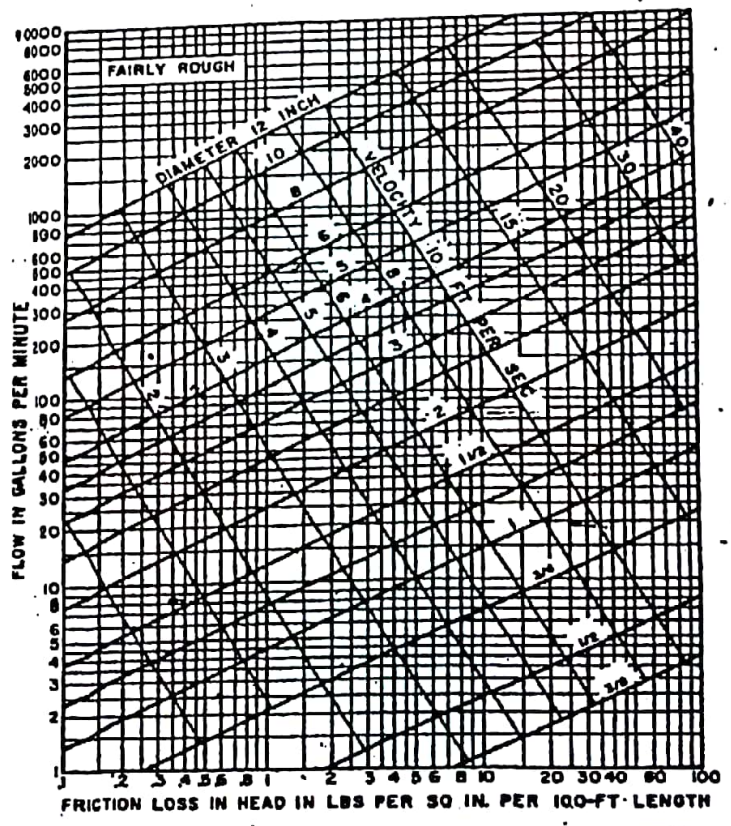


FIGURE 14-19
Friction losses in fairly rough iron pipe.

Table 14-6: Pipe sizes for downfeed zone 3 of water-supply system.

Floor	Fixture units	Accumulated fixture units	Demand flow (gpm)	Actual pipe length (ft)	Equivalent length due to fittings (ft)	Total equivalent length (ft)	Pressure drop (psi/100 ft)	Pipe size (in.)
25	19	310	110	34	17	51	2.80	3
24	19	291	107	10	5	15	5.60	2½
23	34	272	103	10	5	15	5.60	2½
22	34	238	98	10	5	15	28.90	2
21	34	204	92	10	5	15	28.90	2
20	34	170	85	10	5	15	28.90	2
19	34	136	77	10	5	15	28.90	2
18	34	102	68	10	5	15	28.90	1½
17	34	68	58	10	5	15	28.90	1½
16	34	34	43	10	5	15	28.90	1¼

- It is again desirable to check the assumption regarding equivalent length due to fittings after pipes have been sized.

Sanitary Drainage Systems

INTRODUCTION

- There are basically two types of drainage systems - *sanitary drainage system and storm water drainage system.*
- The system that drains waste water from sinks, tubs, showers, lavatories, and soil matter from toilets is known as the *sanitary drainage system,* and the other system that collects storm water from roofs, yards, and areaways is known as the *storm water drainage system.*
- These systems may be used separately, each draining into a public sewer, a private cesspool, or septic tank. When both systems are combined, they are known as a *combined drainage system.*

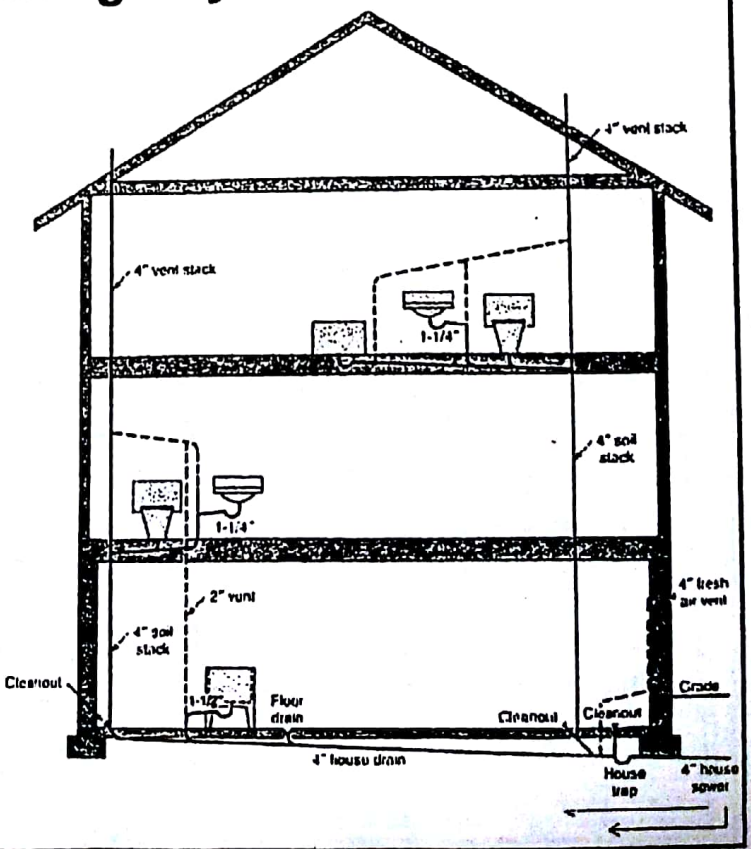
Wastewater Removal

1. Wastewater is carried to the sanitary sewer or septic tank through the building drainage system consisting of horizontal and vertical pipes.
2. These pipes are isolated from the water supply system and must be sized for sufficient capacity, have the proper slope and venting, and have provisions for cleanouts.
3. Typically it is practical to drain as many of the fixtures as possible into a single main drain.
4. The drainage system is not under pressure and depends on gravity to carry the wastewater to the sewer.

Wastewater Drainage System

A. The typical public sewer pipe runs in the center of the street below the frost line.
B. The house sewer taps into the public sewer pipe.
C. In order to understand a typical sanitary drainage system it is necessary to know the function of each pipe and fitting within the system.
D. The piping that makes up a sanitary system is generally as follows:

1. House sewer
2. House drain
3. Soil, waste, vent stacks
4. Fixture branches
5. Fixture traps
6. Fixtures
7. Fixture vents

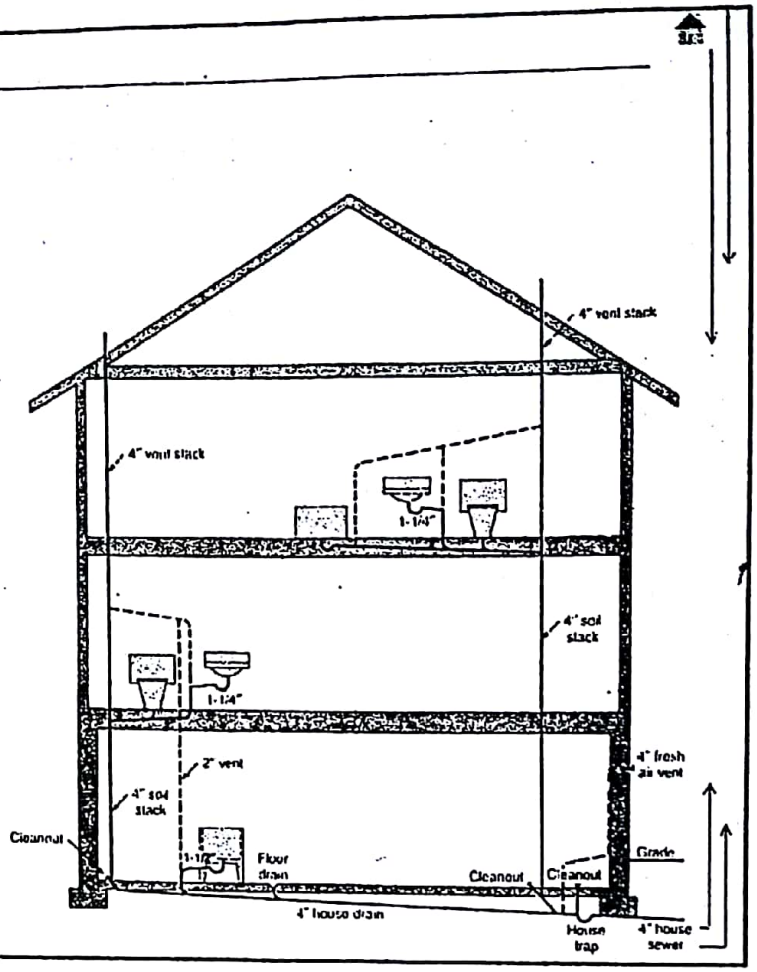


HOUSE SEWER :

1. The house sewer is that portion of pipe that extends from the public sewer pipe in the street to about 3 to 5 ft from the house.
2. The minimum pipe diameter for the house sewer is 3 in. Larger sizes are of course required when serving a greater number of fixtures.

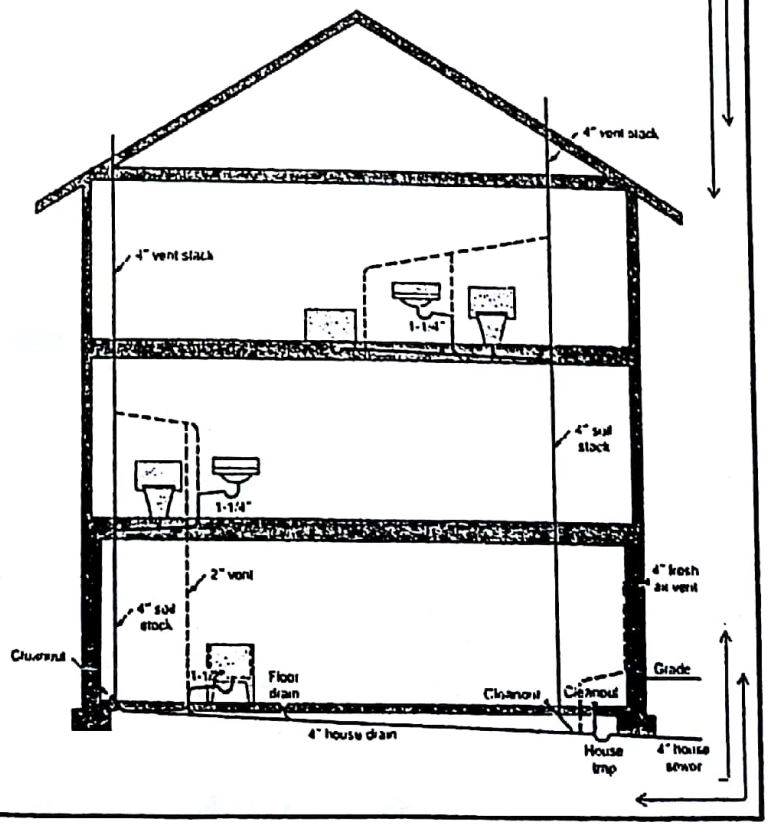
HOUSE DRAIN :

The house drain is the horizontal pipe inside the house into which the vertical soil and waste stacks discharge.



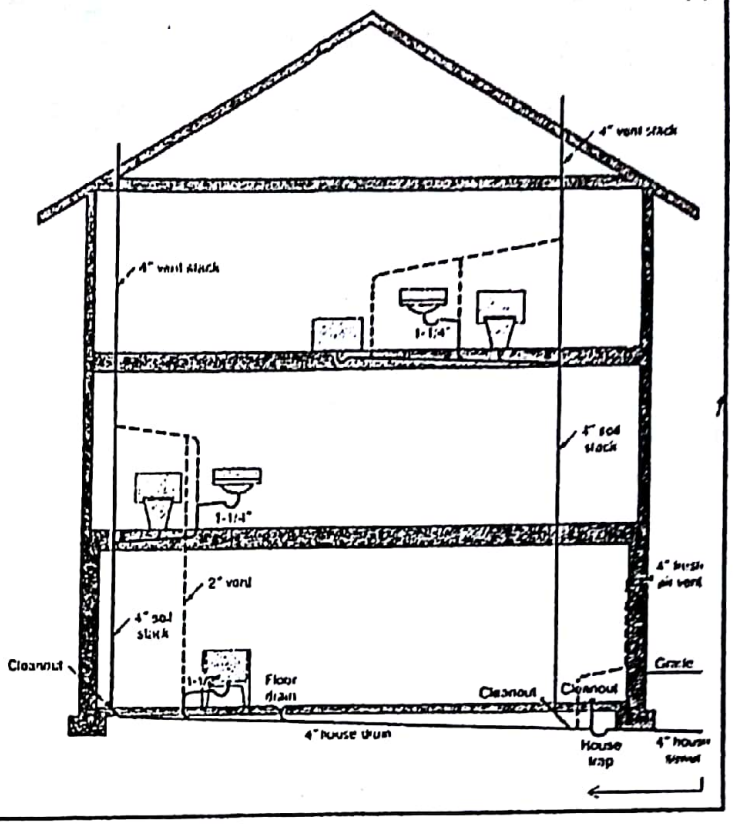
SOIL, WASTE, AND VENT STACKS :

1. Soil, waste, and vent stacks are the vertical pipes of the drainage system.
2. The soil stack receives the soil matter from the water closets and urinals.
3. The waste stack receives wastewater from all types of fixtures except water closets and urinals.
4. If a stack receives both soil matter and sullage, it is termed as a soil stack.
5. Vent stacks are used only to allow movement of air through the system.



FIXTURE BRANCHES AND BRANCH VENTS :

1. The fixture branch is the horizontal pipe running from the fixture trap to the vertical soil or waste stacks.
2. The fixture branch vents are the horizontal piping that run from near the fixture trap, then overhead of the fixture to the vent stack. Branch vents are arranged so that waste matter flowing through the fixture branch cannot clog and foul the vents.
3. Branch vents should never be taken from fixture branches below the hydraulic grade.
4. *Hydraulic grade* is a line from the high water level of a fixture to the branch connection at the soil stack.



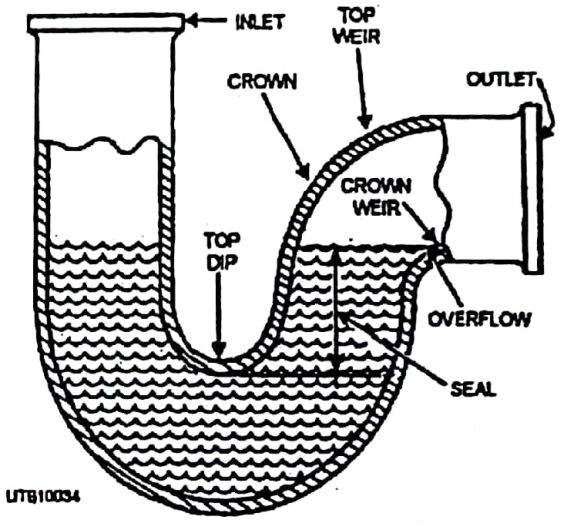
FIXTURE TRAPS :

A fixture trap is a device fitted to a fixture which is so designed and constructed as to provide a water seal which prevents the entry of foul air or gases into the interior of houses or building from drains, waste and soil pipes without materially affecting the flow of wastewater through it.

The trap most commonly used with plumbing fixtures is the P-trap. The P-trap gets its name because of its general shape-that of the letter P.

Strength of a Trap:

The strength of a trap is the ability of its water seal to resist the passage of air or gas through it and in determined by the vertical height to which water in the trap can rise above the dip to resist this passage.



Classification of Traps

Traps may be classified in two ways:

(1) According to their shape, as

- → P-trap,
- → Q-trap, and
- → S-trap, depending upon their shapes with reference to the letters, *P*, *Q* and *S* respectively

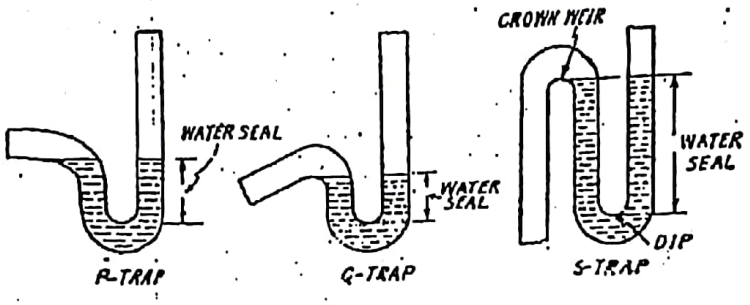
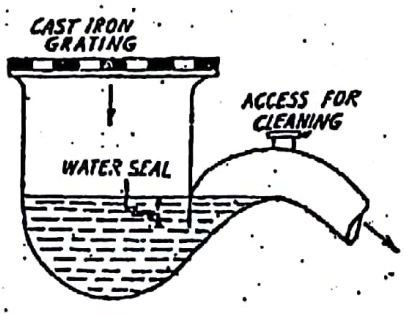


Fig. 1·6. Traps according to shapes.

(2) According to their particular use as

- **Floor Trap**
- **Gully traps**
- **Intercepting trap**

Floor Traps : These are used primarily for admitting surface wash or Wastewater from floors of baths and kitchens. These are invariably provided with cast iron grating at top to exclude coarse solid matter, so as to prevent it from passing into the drain along with the wastewater and thereby cause blockade.



Fig· 1·7. Floor trap.

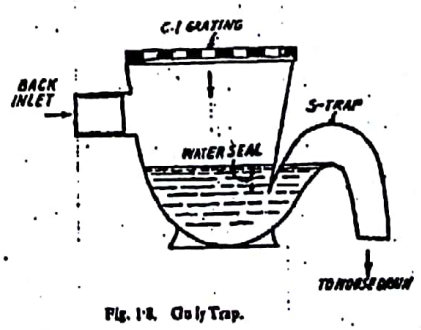
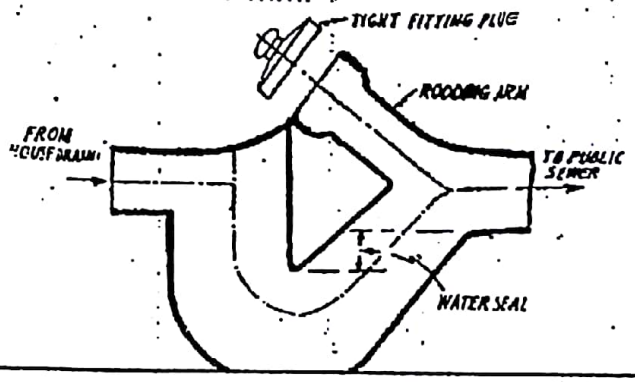


Fig. 1·8. Gully Trap.

Gully Traps: These are used for the reception of sullage from baths, sinks and wash-basins as well as rain or surface water from house-tops or back-yards. The upper section of the trap is covered by a *C.I.* grating to exclude coarse. solid matter.

Intercepting traps : These are used at the junction of the house drain and the home sewer with the primary object ive of preventing the foul gases in the public sewer from entering the house drainage system,

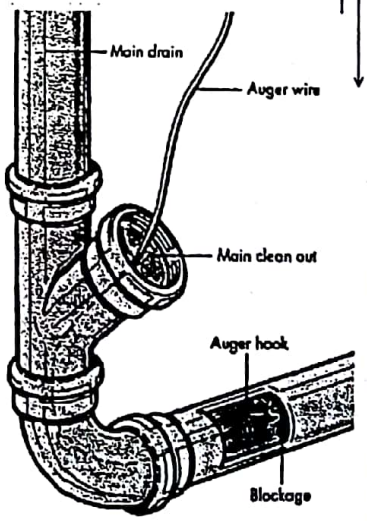
The trap has an opening at the top called the 'cleaning eye' or 'rodding arm' arid has a tight-fitting plug. This enables the trap to be periodically cleaned of any obstruction present inside. The water seal is sufficiently deep, as much as 75 mm.

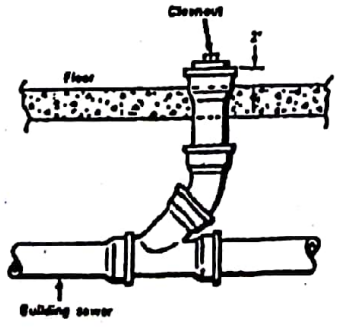


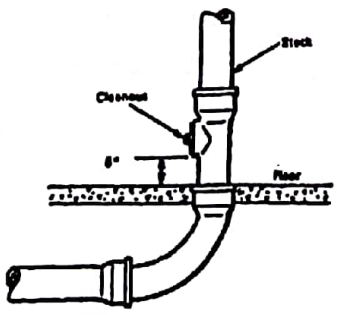
Cleanouts

A plumbing cleanout is a cleanout fitting with a removable plug that is found in a building drainage system. It is designed to help keep clear any type of debris that could cause any type of stoppage in the water drain lines.

Cleanouts are usually placed at the connection point between the sewer lines and the drain lines where the base is located of a vertical stack and at all places were the pipe direction changes at 90 degrees.







One-pipe System :

In this system, a separate vent pipe is added. This has a caged dome at the top which projects 90 cm or so above the roof top, thus providing a natural outlet to the foul gases.

All the traps of water closets, basins, baths etc., are kept completely ventilated to preserve the water seal, by connecting them to the vent pipe.

This system is costlier than the single-stack system and the arrangement of pipe work is difficult.

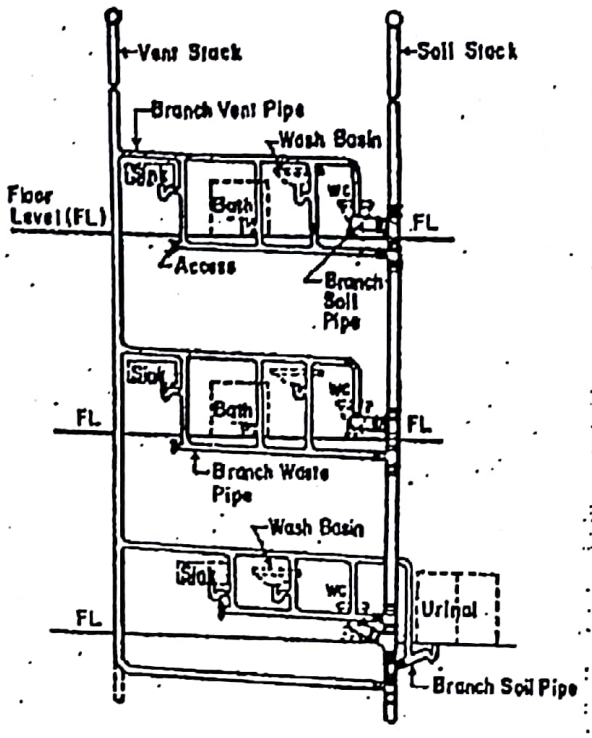


Fig. 8·7·2 Diagram of One-Pipe System

Two-pipe System :

In this system all soil appliance *i.e.*, water closets and urinals are connected to a vertical soil pipe whereas all waste appliances *i.e.*, baths, wash-basins, sinks., etc., are connected to a separate waste pipe.

There are, therefore, two sets of vertical pipes - the soil pipe and the waste pipe each having a separate vent pipe. As such, we have four stacks in a two-pipe system.

A modification of the two-pipe System with only one vent pipe for both the soil pipe and waste pipe is favoured now a days.

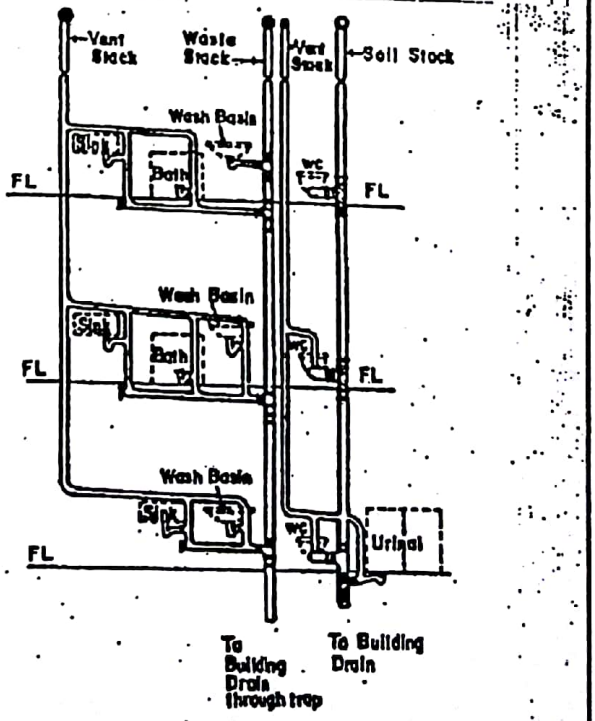


Fig. 8.7.3 Diagram of Two-Pipe System

General requirements about installation of drainage pipes:

1. Provision of adequate supports for drainage pipes during construction of building.
2. Pipe lay-out should be direct and simple. Pipes should be laid in straight lines.
3. Any abrupt changes in the direction of flow should be avoided. The contained angle between intersecting pipes should not exceed 45 degree.
4. Installation be not done so as to impair the structural safety of a building .
5. The drainage pies should be sufficiently strong and durable. They should also be air-tight and gas tight.
6. The pipe-joints should be strong and leak proof .
7. The entire network of pipes should have ample means for cleaning and removing obstruction.
8. Traps are required for every fixture .
9. Any possibility of air-locks, siphonage, undue deposits and obstruction should be thoroughly looked into and avoided.
10. Pipes when not embedded should run clear of the wall with a minimum clearance of 5 cm.
11. Each. stack should be suitably covered on top above roof by copper or galvanized iron wire dome.

Choice of the Systems:

The choice of a particular system depends on the height of the bulding and outside sewerage system. If the building height is low, the length of the fixture branch does not exceed 3 m, and combined sewerage system is available in the area, single stack system will be the most suitable for the building. But if the building height is medium or high, one-pipe system will be the most desirable. However, if separate sewerage systems exist in the area, two-pipe system will be the choice. In case of combined sewerage system, there is no reason to adapt two-pipe system for a building. If only the storm sewerage system is available, two-pipe system should be used with the sullage except the kitchen wastewater should be discharged directly in the sewerage system and the black water and kitchen wastewater should be disposed into a septic tank system. If the soil condition is not favourable for construction of a soak pit, the effluent can be discharged into the storm water sewerage system.

Design of Plumbing Drainage

1. The sizing of drainage piping is obviously a function of the load from all the fixtures that might operate at any one time. The drainage load is rated in fixture units. Fixture units represent the rate of discharge from a fixture. A lavatory can drain 7.5 gal per minute, or one fixture unit.
2. Assign FU value to each starting fixture branch and calculate the cumulative FUs for the drainage system.
3. Once we know the loads (FUs) on all parts of a drainage system, it is a simple matter to size the individual fixture branches, building drains and sewers from prepared table.
4. Note that soil and waste stacks are the same size throughout their length and do not diminish toward the top.

TABLE 2-3

Fixture Units

Fixture	Fixture Unit
Lavatory or wash basin	1
Bathtub	2
Laundry tray	2
Sink (except slop sink)	2
Combination fixture	3
Urinal	3
Shower bath	2
Floor drain	2
Slop sink	3
Water closet	6
Slop sink with flushing rim	6
Drinking fountain	½
Dental cuspidor	½
Bathroom unit containing one water closet, one lavatory, one bathtub, with or without shower, or one shower stall	6

Design Example:

Fig. 2-17 Sizing pipe by fixture units.

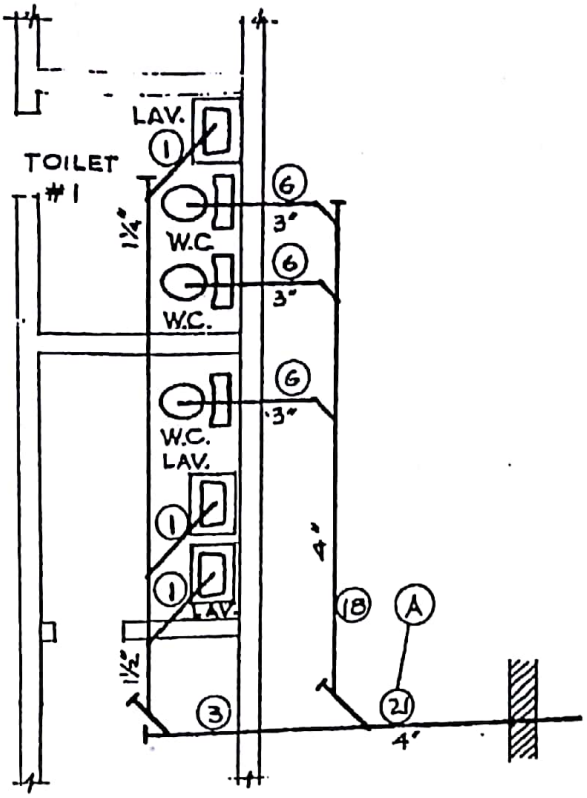


TABLE 2-4

Maximum Permissible Loads for Sanitary Drainage Piping
(in terms of fixture units)

Pipe Diameter (in.)	Any Horizontal Fixture Branch	One Stack of 3 Stories or Less in Height	Stacks more than 3 Stories in Height		Building Drain, and Building Drain Branches from Stacks			
			Total for Stacks	Total at One Story	Slope (in. per ft)			
					1/16	1/8	1/4	1/2
1¼[a]	1	2	2	1	—	—	—	—
1½[a]	3	4	8	2	—	—	—	—
2[a]	6	10	24	6	—	—	21	26
2½[a]	12	20	42	9	—	—	24	31
3	20[b]	30[c]	60[c]	16[b]	—	20[b]	27[b]	36
4	160	240	500	90	—	180	216	250
5	360	540	1100	200	—	390	480	575
6	—	960	1900	350	—	700	840	1000

[a]No water closet permitted
[b]Not over two water closets permitted
[c]Not over six water closets permitted