4.4 PLUMBING SYSTEMS IN BUILDING (SEWAGE AND DRAINAGE)

Following are the four principle systems adopted in plumbing work in building

1. Two pipe system.
2. One pipe system.
3. Single stack system
4. Partially ventilated single stack system.

1) Two pipe system:

1. This is the best and most improved type of system of plumbing.

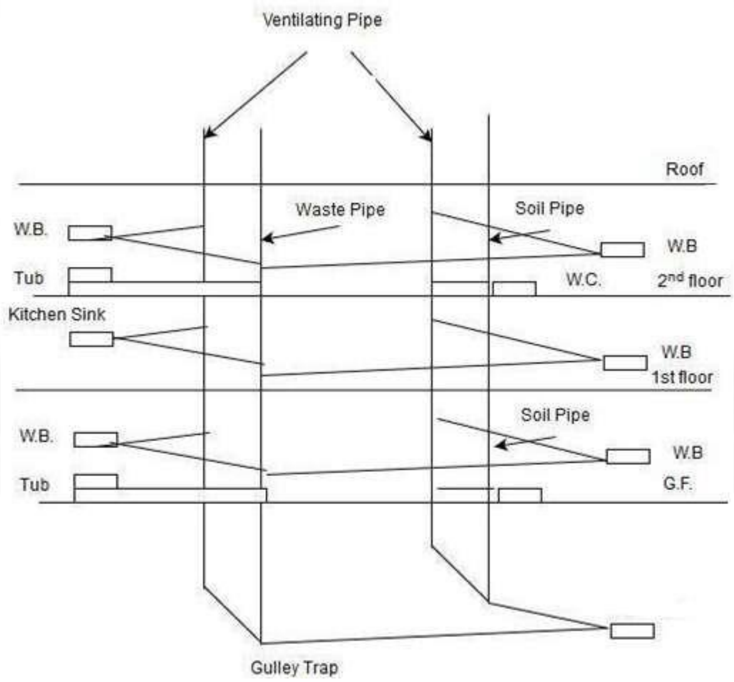
2. In this system, two sets of vertical pipes are laid, i.e. one for draining night soil and other for draining sullage.

3. The pipe of the first set carrying night soil are called soil pipes. and the pipes of the second set carrying sullage from baths etc are called sullage pipe or waste pipe

4. The soil fixtures, such as latrines and urinals are thus all connected through branch pipes to the vertical pipe.

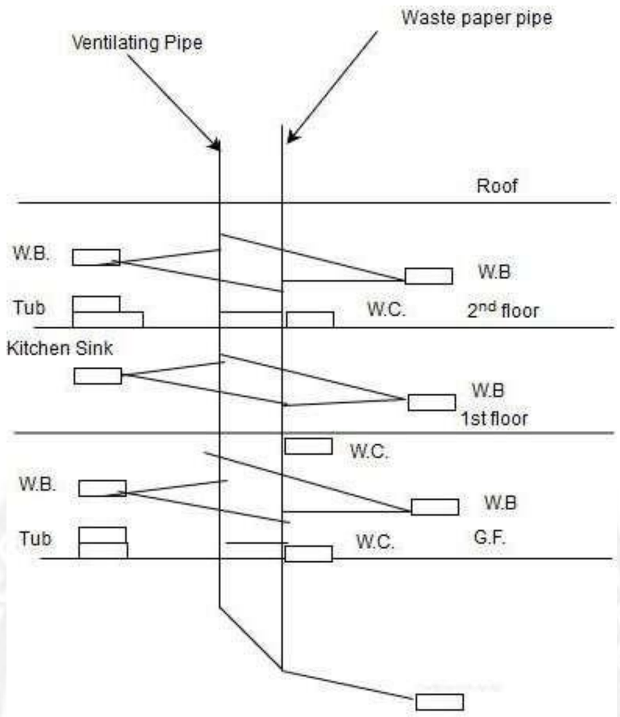
5. Where the sludge fixtures such as baths, sinks, wash-basins, etc are all connected through branch pipes to the vertical waste pipe.

6. The soil pipe as well as the waste pipe are separately ventilated by providing separate vent pipe as shown in figure



2) One pipe system:

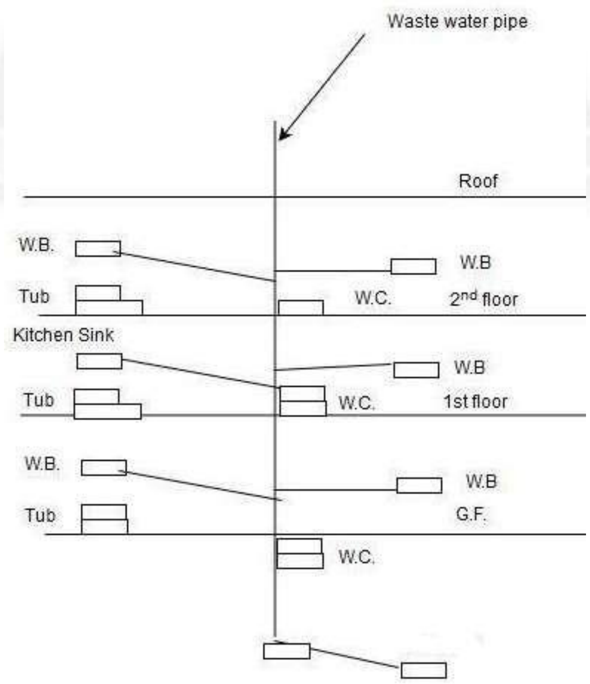
In this system, instead of using two separate pipes (for carrying sullage and night soil, as it done in the above described two pipe system), only main vertical pipe is provided which collects the night soil as well as the sullage water from their respective fixtures through the branch pipes. This main pipe is ventilated in itself by providing cowl at its top and in addition to this, a separate vent pipe is also provided, as shown in the figure.



3) Single Stack System:

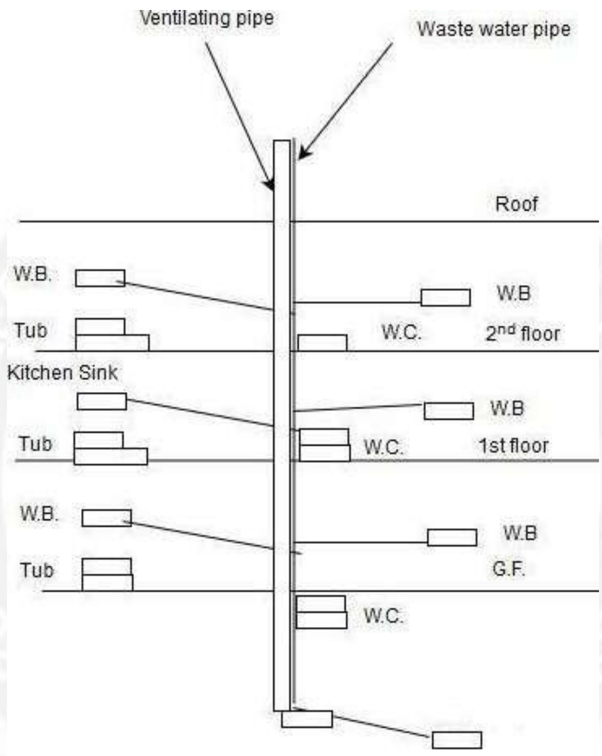
This system is a single pipe system without providing any separate ventilation pipe.

It uses only one pipe which carries the sewage as well as sullage, and is not provided with any separate vent pipe, except that it itself is extended up to about 2m higher than the roof level and provided with a cowl for removal of foul gases as shown in fig.



4) Partially ventilated single stack:

This is an improved form of single stack system in the sense that in this system, the traps of water closets are separately ventilated by a separate vent pipe called relief vent pipe. This system uses two pipes as in single pipe system but the cost of branches is considerably reduced compared to single pipe system.



4.4.1 STORM WATER

The determination of sanitary sewage is necessary because of the following factors which depend on this:

1. To design the sewerage schemes as well as to dispose a treated sewage efficiently.
2. The size, shape and depth of sewers depend on quantity of sewage.
3. The size of pumping unit depends on the quantity of sewage.

Estimate of Sanitary Sewage:

Sanitary sewage is mostly the spent water of the community into sewer system with some groundwater and a fraction of the storm runoff from the area, draining into it. Before designing the sewerage system, it is essential to know the quantity of sewage that will flow through the sewer.

The sewage may be classified under two heads:

1. The sanitary sewage, and
2. Storm water

Sanitary sewage is also called as the Dry Weather Flow (D.W.F), which includes the domestic sewage obtained from residential and residential and industrials etc., and the industrial sewage or trade waste coming from manufacturing units and other concerns.

Quantity of Sewage:

It is usual to assume that the rate of sewage flow, including a moderate allowance for infiltration equals to average rate of water consumption which is 135 litre/ head /day according to Indian Standards. It varies widely depending on size of the town etc. this quantity is known as Dry Weather Flow (D.W.F). It is the quantity of water that flows through sewer in dry weather when no storm water is in the sewer.

Rate of flow varies throughout 24 hours and is usually the greatest in the fore-noon and very small from midnight to early morning. For determining the size of sewer, the maximum flow should be taken as three times the D.W.F.

Design Discharge of Sanitary Sewage

The total quantity of sewage generated per day is estimated as product of forecasted population at the end of design period considering per capita sewage generation and appropriate peak factor. The per capita sewage generation can be considered as 75 to 80% of the per capita water supplied per day. The increase in population also result in increase in per capita water demand and hence, per capita production of sewage. This increase in water demand occurs due to increase in living standards, betterment in economic condition, changes in habit of people, and enhanced demand for public utilities.

Factors affecting the quantity of sewage flow: -

The quantity of sanitary sewage is mainly affected by the following factors:

1. Population
2. Type of area
3. Rate of water supply
4. Infiltration and exfiltration

In addition to above, it may also be affected by habits of people, number of industries and water pressure etc.

The quantity of sanitary sewage directly depends on the population. As the population increases the quantity of sanitary sewage also increases. The quantity of water supply is equal to the rate of water supply multiplied by the population. There are several methods used for forecasting the population of a community.

The quantity of sanitary sewage also depends on the type of area as residential, industrial or commercial. The quantity of sewage developed from residential areas depend on the rate of water supply to that area, which is expressed a litres/ capita/ day and this quantity is obtained by multiplying the population with this factor.

The quantity of sewage produced by various industries depends on their various industrial processes, which is different for each industry.

Similarly, the quantity of sewage obtained from commercial and public places can be determined by studying the development of other such places.

Rate of water

Truly speaking the quantity of used water discharged into a sewer system should be a little less than the amount of water originally supplied to the community. This is because of the fact that all the water supplied does not reach sewers owing to such losses as leakage in pipes or such deductions as lawn sprinkling, manufacturing processes etc.

However, these losses may be largely be made up by such additions as surface drainage, groundwater infiltration, water supply from private wells etc. On an average, therefore, the quantity of sewage maybe considered to be nearly equal to the quantity of water supplied. Ground water infiltration and exfiltration.

The quantity of sanitary sewage is also affected by groundwater infiltration through joints. The quantity will depend on, the nature of soil, materials of sewers, type of joints in sewer line, workmanship in laying sewers and position of underground water table.

Infiltration causes increase to the ―legitimate‖ flows in urban sewerage systems. Infiltration represents a slow response process resulting in increased flows mainly due to seasonally-elevated groundwater entering the drainage system, and primarily occurring through defects in the pipe network.

Exfiltration represents losses from the sewer pipe, resulting in reduced conveyance flow rate is due to leaks from defects in the sewer pipe walls as well as overflow discharge into manholes, chambers and connecting surface water pipes. The physical defects are due to a combination of factors including poor construction and pipe joint fittings, root penetration, illicit connections, biochemical corrosion, soil conditions and traffic loadings as well as aggressive groundwater.

It is clear that Infiltration and Exfiltration involve flows passing through physical defects in the sewer fabric and they will often occur concurrently during fluctuations in groundwater levels, and particularly in association with wet weather events; both of which can generate locally high hydraulic gradients. Exfiltration losses are much less obvious and modest than infiltration gains, and are therefore much more difficult to identify and quantify. However, being dispersed in terms of their spatial distribution in the sewer pipe, exfiltration losses can have potentially significant risks for groundwater quality.

Quantity of storm water:

When rain falls over the ground surface, a part of it percolates into the ground, a part is evaporated in the atmosphere and the remaining part overflows as storm water. This quantity of storm water is very large as compared with sanitary sewage.

Factors affecting storm water:

The following are factors which affect the quantity of storm water:

1. Rainfall intensity and duration.
2. Area of the catchment.
3. Slope and shape of the catchment area.
4. Nature of the soil and the degree of porosity.
5. Initial state of the catchment.

If rainfall intensity and duration is more, large will be the quantity of storm water available. If the rainfall takes place very slowly even though it continues for the whole day, the quantity of storm water available will be less.

Harder surface yield more runoff than soft, rough surfaces. Greater the catchment area greater will be the amount of storm water. Fan shaped and steep areas contribute more quantity of storm water. In addition to the above it also depends on the temperature, humidity,wind etc.

Estimate of quantity of storm water: -

Generally, there are two methods by which the quantity of storm water is calculated:

1. Rational method
2. Empirical formulae method

In both the above methods, the quantity of storm water is a function of the area, the intensity of rainfall and the co-efficient of runoff.

Rational method:

Runoff from an area can be determined by the Rational Method.The method gives a reasonable estimate up to a maximum area of 50 ha (0.5 Km2).

The minimum duration to be used for computation of rainfall intensity is 10 minutes. If the time of concentration computed for the drainage area is less than 10 minutes, then 10 minutes should be adopted for rainfall intensity computations.

This method is mostly used in determining the quantity of storm water. The storm water quantity is determined by the rational formula:

$$Q = \frac{C.i.A}{360}$$