What is Plumbing?

-The word Plumbing comes from the Latin word “Plumbum” which means lead as pipes were once made from lead

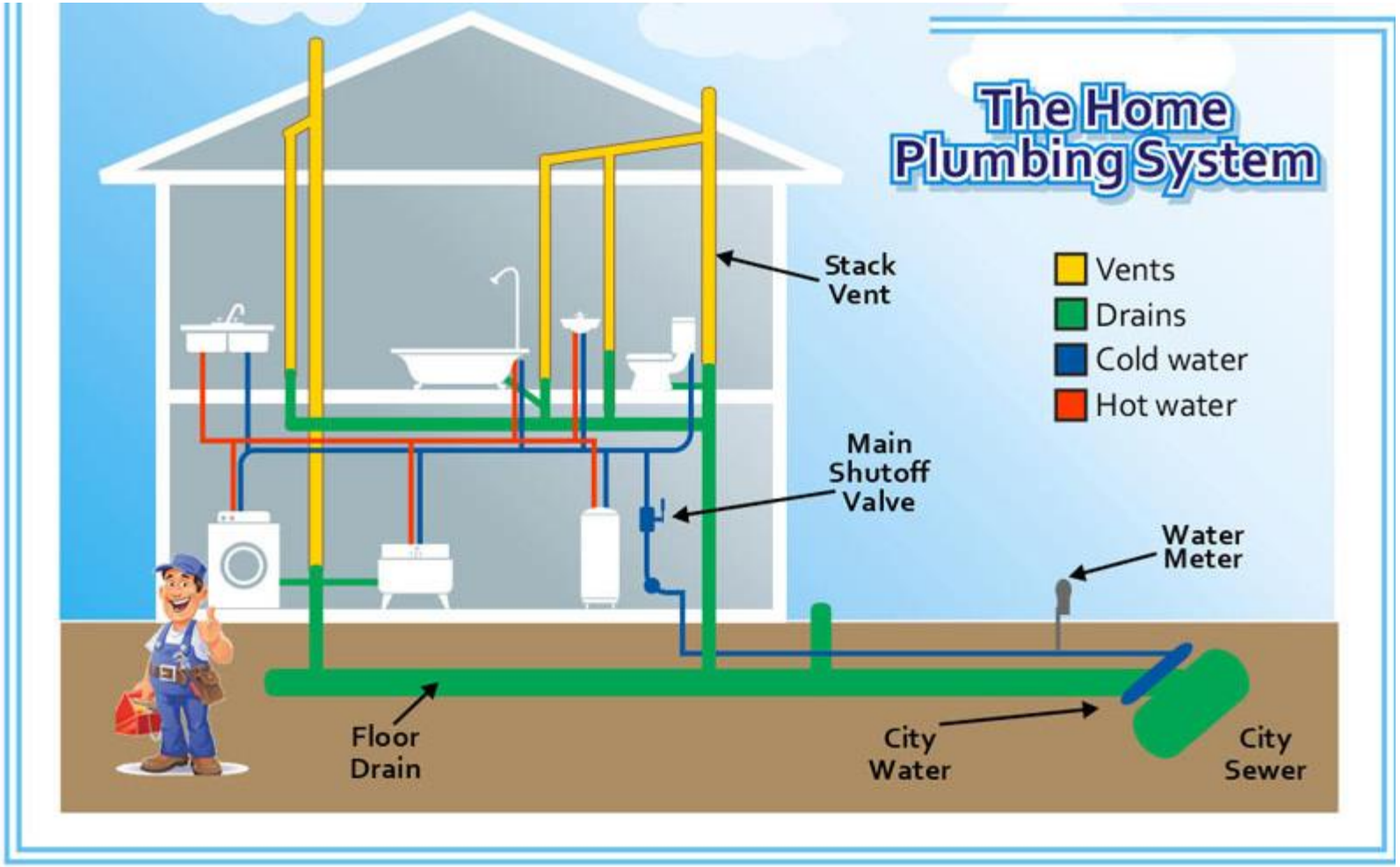
-Plumbing may be defined as the art, business or work involved in the design, installation and maintenance of pipes, fixtures, equipment and accessories that convey fluids like water, gas and water carried wastes within a building and around its premises



Plumbing System

- Refers to a system of pipes and fixtures installed in a building for the distribution of potable water and the removal of water borne wastes.

Plumbing System



Plumbing System

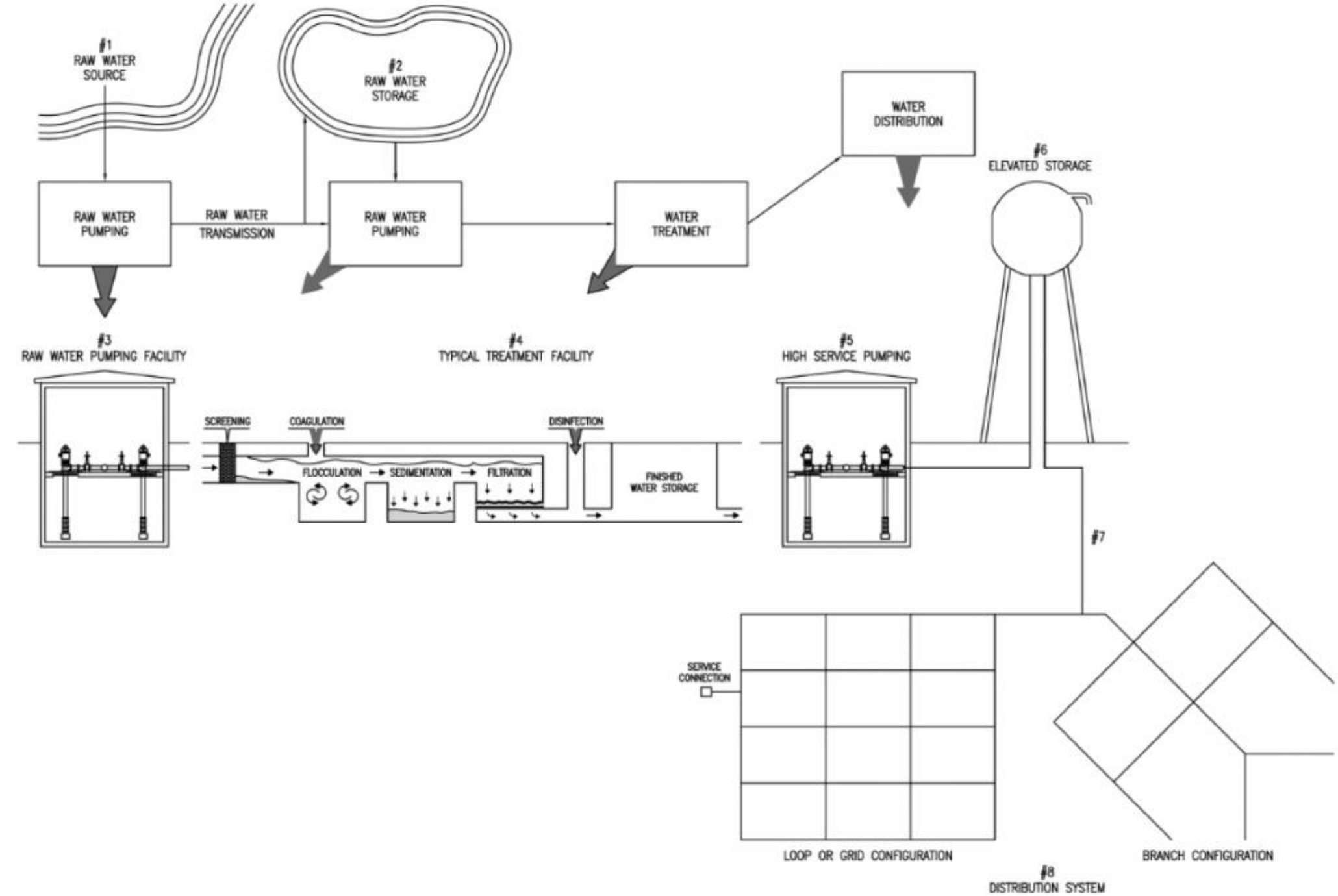


Objective of Plumbing

- Quick supply of wholesome, sufficient water
- Disposes the waste quickly and sanitarily

- Plumbing system shall be safe
- Does not impair the strength of building structures
- Easily approachable for easy operation and subsequent maintenance

- Water Supply System
  - Source
  - Collection System
    - Intake
    - Intake Main
    - Transmission Main
    - Pumping Station
  - Treatment plant
  - Distribution System
    - Pumping Station
    - Distribution Reservoirs
    - Distribution Pipes


#1
RAW WATER
SOURCE
#2
RAW WATER
STORAGE
WATER
DISTRIBUTION
#6
ELEVATED STORAGE
RAW WATER
PUMPING
RAW WATER
TRANSMISSION
RAW WATER
PUMPING
WATER
TREATMENT
#3
RAW WATER PUMPING FACILITY
#4
TYPICAL TREATMENT FACILITY
#5
HIGH SERVICE PUMPING
SCREENING
COAGULATION
DISINFECTION
FLOCCULATION
SEDIMENTATION
FILTRATION
FINISHED
WATER STORAGE
#7
SERVICE
CONNECTION
LOOP OR GRID CONFIGURATION
BRANCH CONFIGURATION
#8
DISTRIBUTION SYSTEM

- Distribution System
  - Gravity System
    - When source of supply is at a sufficient elevation
  - System with Direct Pumping
    - Least desirable
    - Failure in the power supply means breakdown of the system
    - Varying pressure
  - System with Pumping and Storage
    - Uniform rate of pumping
    - Stored water serves as a reserve to take care of fire demands and pump breakdown

- Pressure Requirements in Distribution Pipes

  - For general domestic purpose: 50-60psi
  - Minimum 20psi, Maximum 120 psi
  - For fire fighting: 80-100psi

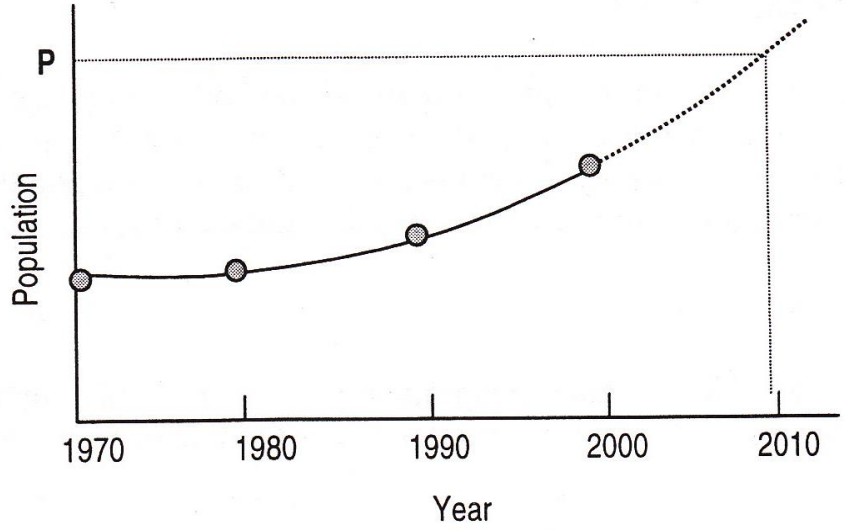
- Estimation of water requirements :

-The estimation of the water requirement of a community is important for the design of a water supply system. Usually a water supply system is designed for a future population. The total quantity of water required by the community is computed by:

$$Q=P \times q$$

Where Q is the quantity of water requirement per day, P is the projected population estimated at the end of the design period and q is the rate of water consumption per capita per day.

- Population Projection:
  - Graphical extension or curvilinear method



  - Graphical comparison method:
    - This method involves the extension of the population-time curve of the community under study into the future, based on a comparison of population-time curves of similar communities instead of projection by eye estimation. This method is also called the modified curvilinear method.
  - Geometric progression method:

$$P_f = P_p(1 + r)^n$$

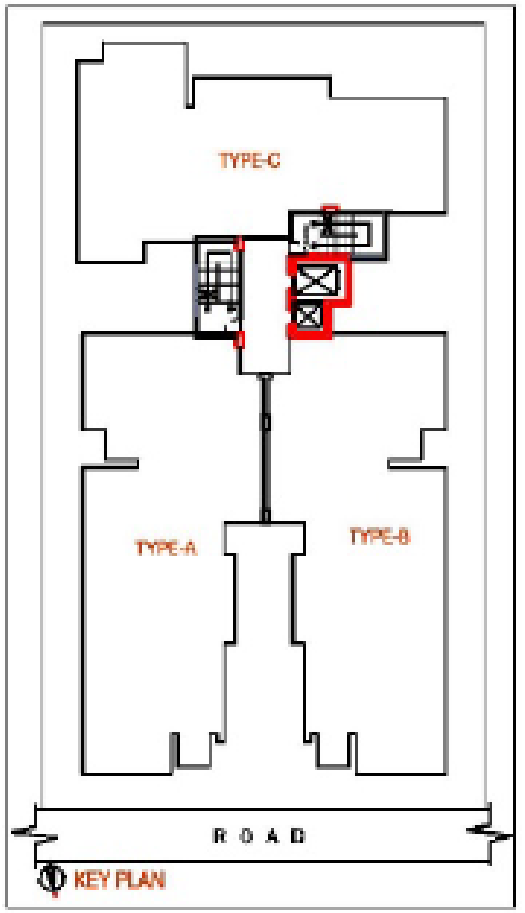
    - Where Pf = future population; Pp = present population; r = rate of yearly population growth and n = number of years to be considered
  - Least square parabola method:

$$Y = a + bX + cX^2$$

    - *X* and *Y* denote the years and the population

Calculation of Water Demand of a Building

- Occupancy Type: Residential
- Socio-economic Status: Middle Income Group
- Location: Mirpur 10
- Restricted Facility
- Number of Floors: 9
- Size: 1837 Sft



- Population Estimation

Info:

Residential Building

Exact number of occupants is unknown

Decision: Family size: 5

Design Criteria:

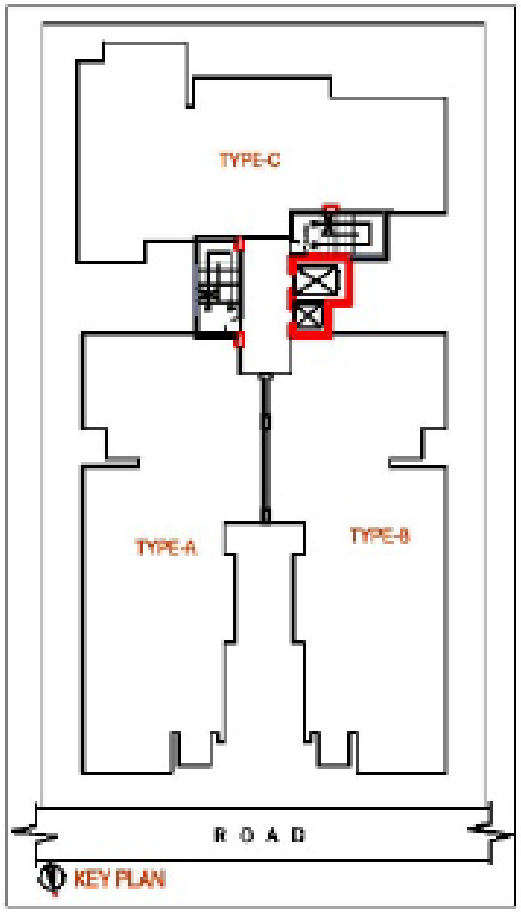
- Population size depends upon the type of usage and facilities provided in the building.
- For residential buildings, the requirements of water shall be based on the actual number of occupants; where this information is not available, the number of occupants for each residential unit may be based on a family size around 5 (five).
- To estimate office building occupancy, allow 7.4-9.3 sqm (80-100 sq ft) of floor space per person, depending on the type of office building, exclusive of elevator and stair space, corridors, or service areas.

- Calculation of Dwelling Unit

Number of Floors: 9

Units per Floor: 3

- Total Dwelling Units: 8 X 3=24



- Population Estimation

Family size: 5

Total Dwelling Units: 24

Total population: 24*5= 120

- Water requirements

- Info:
  - Occupancy Type: Residential

Building Occupancy Classification

– According to BNBC 2012, Building Occupancy is classified as follows:

Occupancy A	Residential
Occupancy B	Educational
Occupancy C	Institution for care
Occupancy D	Health Care
Occupancy E	Business
Occupancy F	Mercantile
Occupancy G	Industrial
Occupancy H	Storage
Occupancy I	Assembly
Occupancy J	Hazardous
Occupancy K	Garages
Occupancy L	Utilities
Occupancy M	Miscellaneous

- Water requirements

- Info:
  - Occupancy Type: Residential
  - Location: Mirpur 10
  - Socio-economic Status:
    - Middle Income Group
  - Size: 1837 Sft
  - Restricted Facility

Decision:
Water Consumption per person per day: 135L

Table- 8.5.1(a): Water Consumption for Domestic Purposes (Cities/Big District Towns [In Residential Buildings]

Cat	Socio-economic group, Type of Building & Other Facilities	Water Consumption	
A	*Big Cities / City Corporation Area / Big District Towns (Population > 0.5 million)*	Full Facility (lpcd)	Restricted Facility (lpcd)
a	High income group:		
a1	Single Family Dwelling with Garden & Car washing	260	200
a2	Big Multi Family Apartment /Flat (> 2500 sft)	200	150
b	Middle income group:		
b1	Officer's Qrt./Colony & moderate Apartment (< 2000 sft)	180	135
b2	Small building/Staff Qrt. & small Apartment (< 1500 sft)	---	120
c	Low income group:		

Table- 8.5.1(b): Water Requirement for Domestic Purposes (District Towns/Upazilas/Urban growth Centres) Vol. 3

[In Residential Buildings]

Cat	Socio-economic group, Type of Building & Other Facilities	Water Consumption	
B	*Small District Towns/ Upajilas & Urban Growth Centre (Population > 0.1 million)*	Full Facility (lpcd)	Restricted Facility (lpcd)
a	Middle income group:		
a1	Single Family Dwelling with Garden	---	150
a2	Officer's Qrt./Colony & moderate Apartment (< 2000 sft)	---	135
a3	Small building/Staff Qrt. & small Apartment (< 1500 sft)	---	120
b	Low income group:		
b1	Junior staff Qrt. /flat (< 1000 sft) & temporary shade	---	80
b2	Private Stand post connection in the fringe area	---	65
b3	Common yard (stand post) connection in the fringe area	---	50
b4	Slum dwellers collection from road side public stand post	---	40

Water Demand:

Estimated Population x Water Requirement

Water consumption in each apartment: 5*135 LPCD = 675 Liter per Day

Total water consumption: 120*135 LPCD = 16200 Liter per Day

- Water Reservoir:

  (a) To provide for uninterrupted water supply if the public water supply mains are shut off for any reason

  (b) To meet the peak demand within a building when it cannot be met by city mains

  (c) To provide water for fire fighting

  (d)When the public supplies are not continuous

- Underground Water Reservoir:

For dependable water supply mains- the capacity of an underground reservoir should be the net difference between the peak demand and the flow during hours of supplies.

For non-dependable water supply mains-the capacity of an underground reservoir is taken at 24-48 hours of the average daily water demand in the building

BNBC 2012: Capacity of Under Ground Reservoir = 1 x Total daily demand of water (m3) + 1 hr. reserve (m3) for firefighting (for tall building). For emergency requirement 2-3 days daily demand of water is sometimes stored.

See BNBC 2020, Part IV: Sec 4.5 (Page 340), Table 4.4.2 (Page 329); and Part VIII: Sec 5.9.1.2 (Page 2244)

- Rooftop Water Reservoir:

  Capacity of Roof Tank = ½ x Total daily demand of water (m3) + 1 hr. reserve (m3) for firefighting requirement (for tall building). Therefore, two times filling of roof tank will meet the daily requirement.

Water Distribution System

Introduction

- The layout of water distribution piping is basically a combination of horizontal or vertical piping arrangements designed to supply water from a source to points of use at different locations.
- Depending upon the location of supply in respect to the source of water, the distribution system is termed as up feed or down feed system.

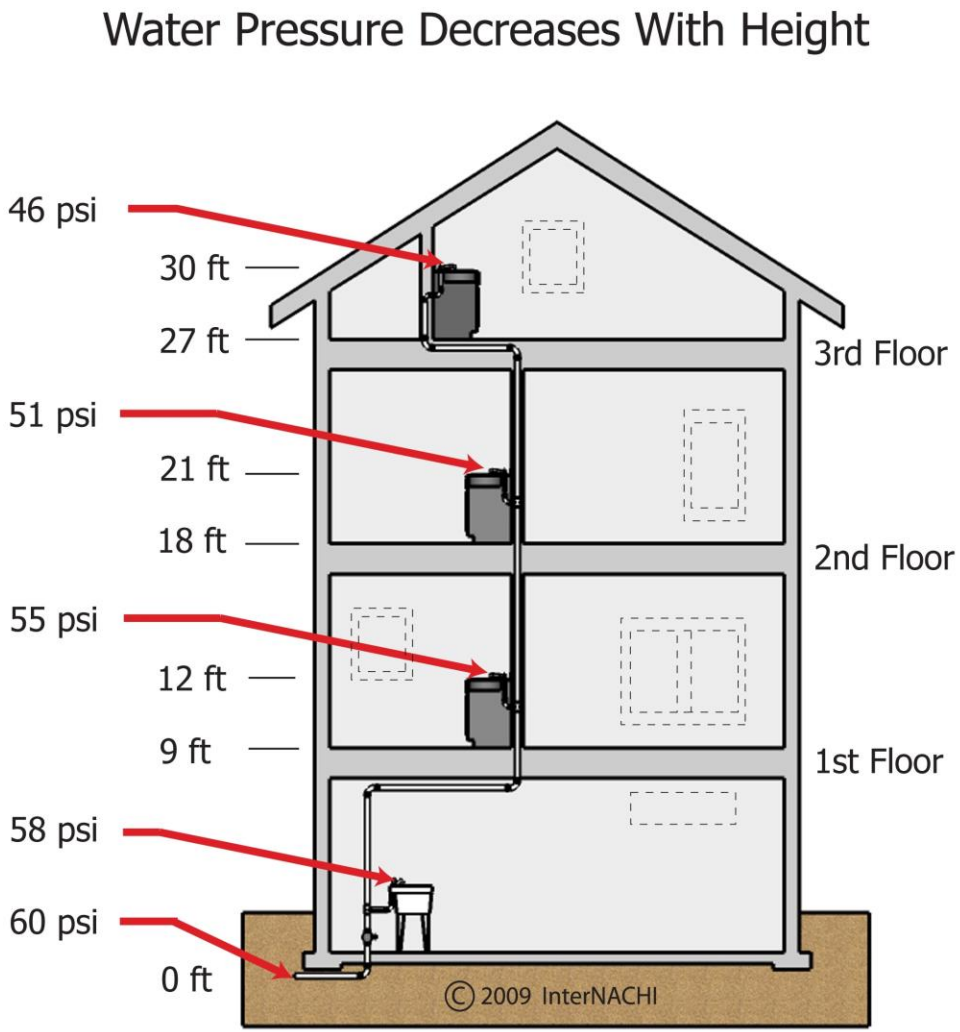
Types of Distribution System

- Up feed system
- Down feed system

Up Feed System

System with piping above the main or pressure tank is called up feed system.

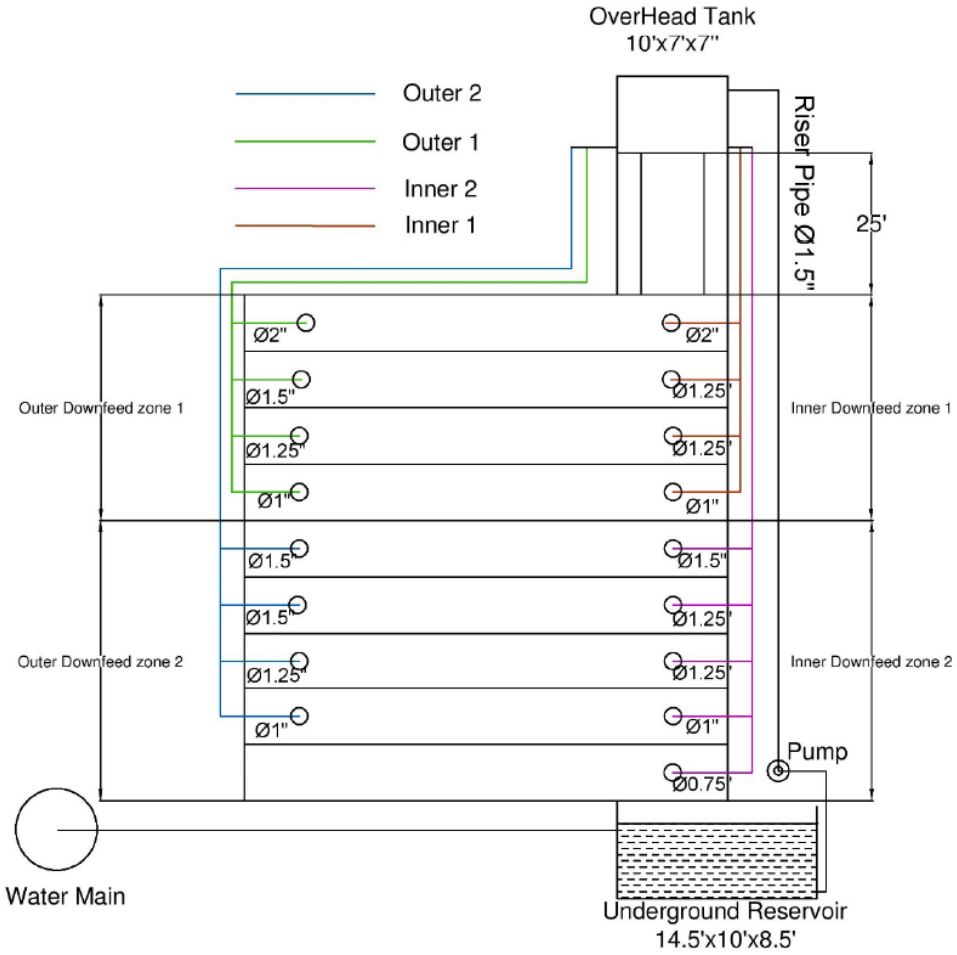
- In this system, as water is forced to rise from the main or reservoir, pressure is lost in overcoming the static head and friction offered to water flow.
- At the uppermost and furthest outlet, enough pressure must be ensured to operate the faucet.



Down Feed System

When the source is located at an elevated position than the points of use then the supply system is called a down feed system

- In this system static head is available for overcoming friction to flow through piping and for obtaining adequate delivery pressure at faucets.
- Water distribution from overhead tanks to faucets in the lower floors is the down feed system



Down Feed System

Pressure at any point is determined by distance from outlet of tank

- Height of zone served is determined by max allowable pressure on the fixtures at the bottom
    - Max pressure approx. 45 – 60psi
    - Max height of zone (60psi / .434psi per ft) or about 138ft
    - Beyond max height, pressure-reducing valve needed

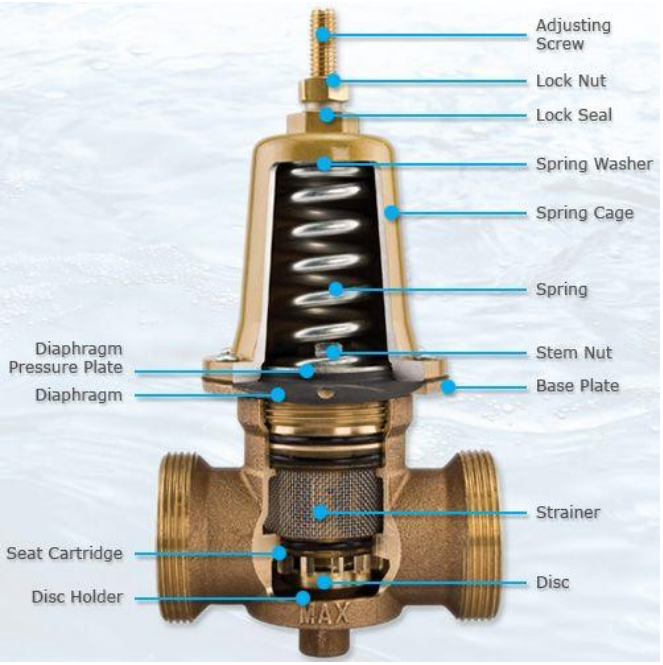
- Fixtures at top of zone must have min pressure to work properly
    - Example: flush toilet needs 15psi then water tank must be min of 15/.434 or 35’ above the fixture
    - Actual distance slightly greater to overcome friction

Excessive Water Pressure

If water pressure is excessive in a water distribution system, then it will cause damage to the components of the system. The damages that may occur are as follows-

- Bursting of pipe
- Failure of joints and for supports
- Fracture of valve and equipment
- Producing noise in pipe
- Splashing of water from faucet

Water distribution pipe in a building shall be maintained at a pressure so that none of their fittings shall are subject to a water head greater than 35 m (approximately 50 psi).



General Features of Distribution System Design according to BNBC

- The water supply system shall be designed to supply minimum but requisite quantity of water to all fixtures, devices and appurtenances in every section of the building with adequate pressure. The design requirements of a water supply system are presented in Table 8.5.6.
- For a down feed water distribution system (roof tank supply), static pressure due to gravity increases with increasing floor height (4.32 psi or 0.3 Bar per floor of 10 ft. height at non flow condition). Therefore, water distribution pipe in a building shall be maintained at a pressure so that none of their fittings shall are subject to a water head greater than 35 m (approximately 50 psi).
- The distribution system shall be maintained at a pressure not less than those specified in Table 8.5.6 during peak demand period.
- The minimum size of supply pipe for different fixtures shall be in accordance with Table 8.5.6. The fixture supply shall not terminate more than 0.76 m (2.5 ft) from the point of connection to the fixture. A reduced size flexible water connection pipe shall be used.
- The water flow velocity in the distribution system shall be controlled to minimize the possibility of water hammer.
- The design of water distribution system shall conform to approved engineering practices.

Plumbing Fixtures and Appliances

Introduction

A receptacle or device which is either permanently or temporarily connected to the water distribution system of the premises, and demands a supply of water there from, or discharges used water, waste materials or sewage either directly or indirectly to the drainage system of the premises, or requires both a water supply connection and a discharge to the drainage system of the premises.

The fixtures most commonly included in toilet and kitchen are as follows

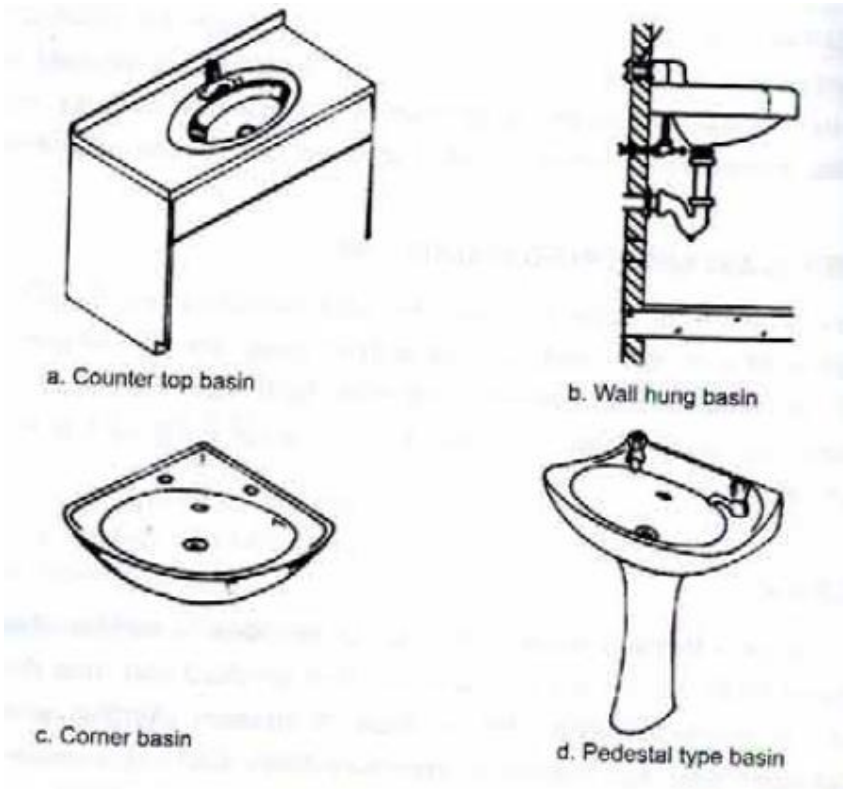
- Lavatory
- Sink
- Water Closet, Urinals
- Bathtub
- Flash Tank
- Faucets
- Floor Drains

Basic Requirements for Fixture

- Fixtures should be made of smooth non adsorbent material.
- These should be designed accurately so that it becomes free from any fouling space and should not have any sharp edges.
- Fixtures should be so constructed and installed that they are convenient to use.
- Special provisions shall be made available along with fixtures, required for the disables .
- Every fixture must have non-corroding drainage fittings and a trap positively connected to drainage system.
- Fixtures requiring retention of water, should be provided with a plugging and overflow arrangement.

Lavatories

The lavatory is a bowl or a basin used for washing of the hands, face etc. The bowl is usually oval in shape. The bowl has a capacity of about 4.5 liter (1 gal) up to the overflow line. The bowl has wastewater and over flow outlet. Lavatories are available in various styles, colors and sizes.





Lavatory Trim

Lavatory trim consists of faucet which controls the supply of hot and cold water to the lavatory and lavatory drain fitting through which the wastewater drains from the lavatory.



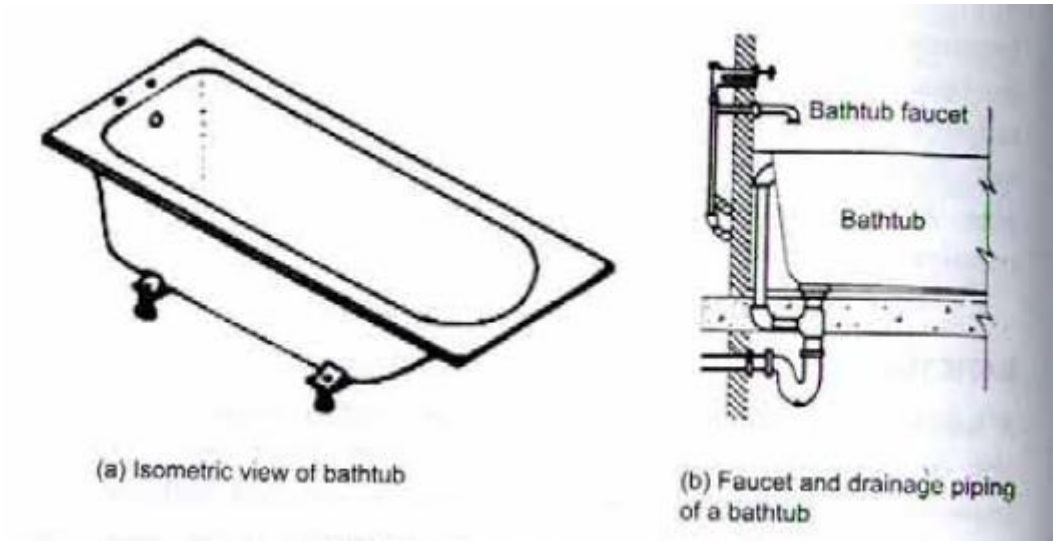


Faucets

Faucet is a fixture for drawing or regulating the flow of liquid especially from a pipe.

Bath Tub

A bathtub is a receptacle for holding water and is shaped for allowing one or two human body to soak in for taking bath. Water holding capacity of a bathtub depends on its size. A standard bathtub holds about 150 to 180 liters of water for soaking. Pressure in the faucet shall be such that bathtub is filled in 3 minutes.



(a) Isometric view of bathtub

(b) Faucet and drainage piping of a bathtub

Bath Tub Trim

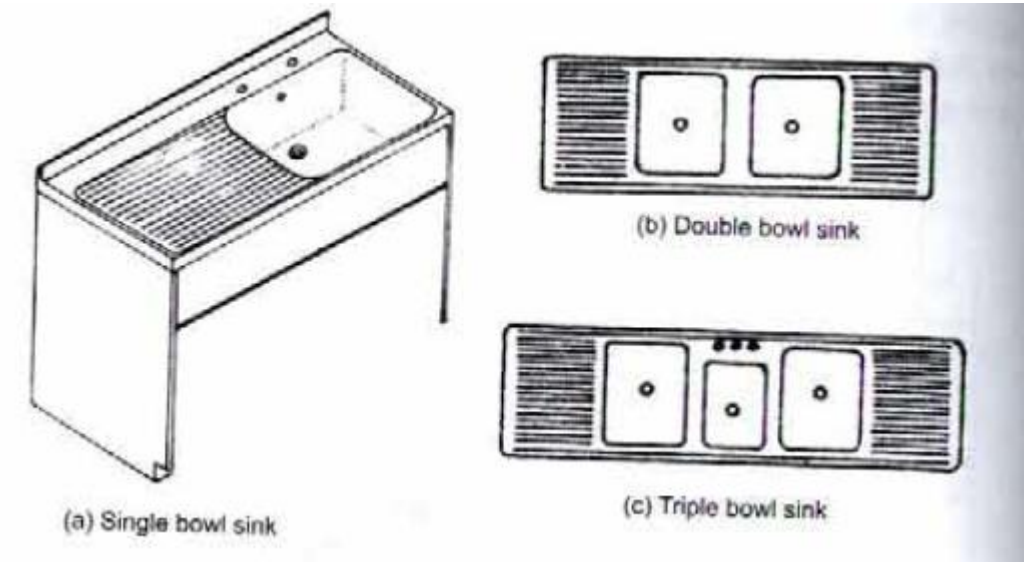
Generally for supplying hot and cold water in the bath tub a bathtub mixture faucet is mounted on the wall at the end of the bathtub. Bathtub may be used both as a bathtub and as a shower bath . Bathtub maybe used both a bathtub and as a shower bath. So, sometimes combination of bath and shower fitting is also installed.





Kitchen Sink

A kitchen sink is a shallow, flat-bottomed plumbing appliance that is used in cleaning dishes and utensils. There is a corrugated table or drain board in one or both sides of the sink.







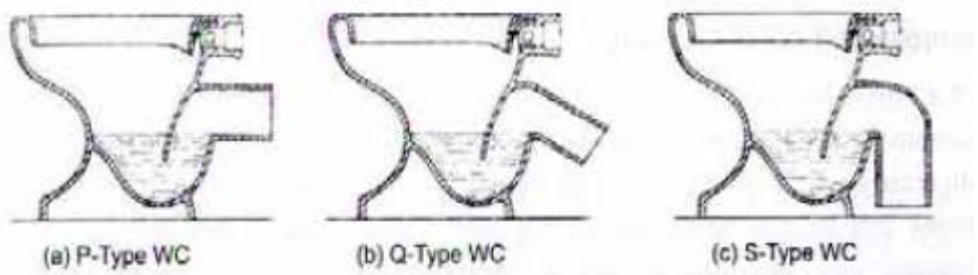
Water Closet

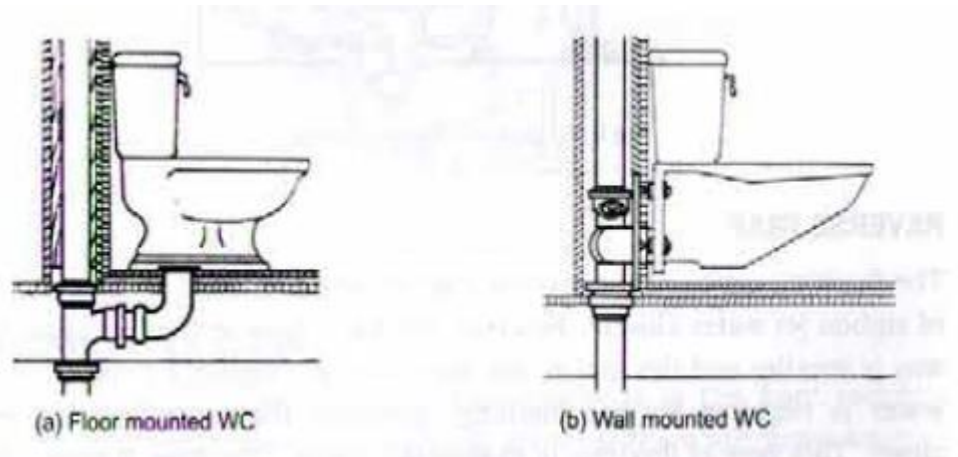
Water closets are water flushed plumbing fixtures that receive human excrement and finally dispose off into drainage system using water as a conveyance medium.

Three Types of Water Closet

- European type
- Indian type/ Squat type
- Universal Type

European type





European Type Water Closet

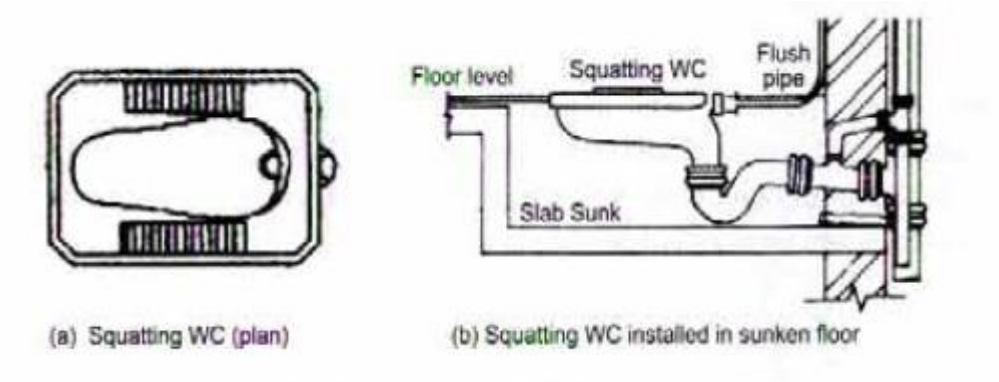


Wall mounted



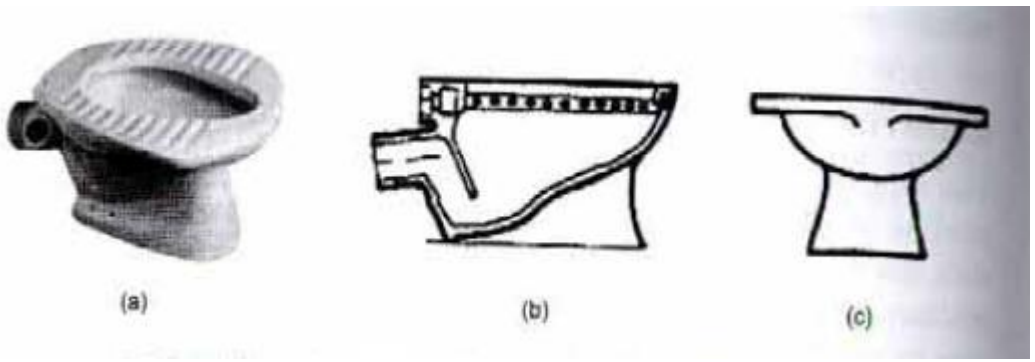
Floor mounted

Indian Type Water Closet





Universal Type Water Closet

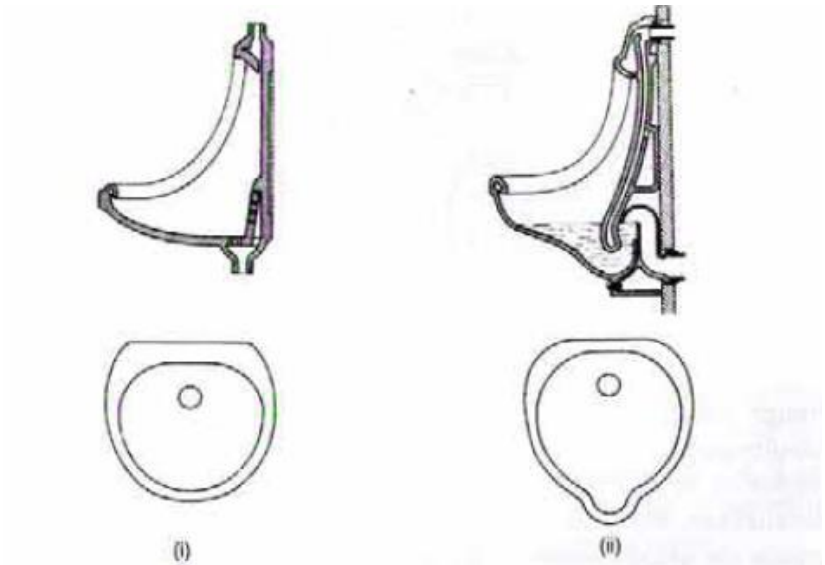






Urinal

A urinal is a plumbing fixture designed to receive urine directly.





Flushing Devices

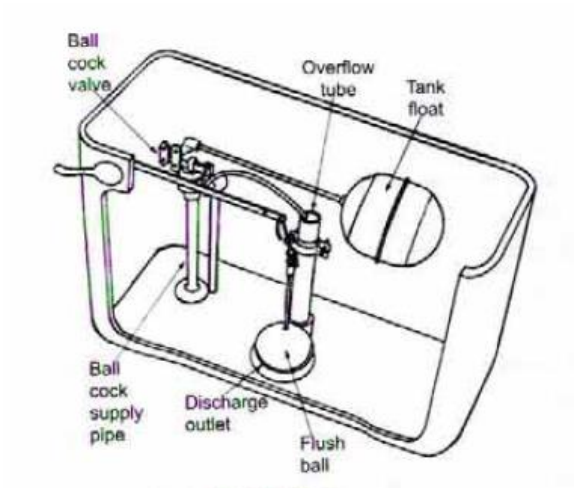
Every water closet and urinal must have a flushing device designed and installed so as to supply water at an adequate rate and volume for satisfying flushing the waste in the bowl. For this purpose, water is supplied from a flush tank or by a flushometer or simply flush valve.

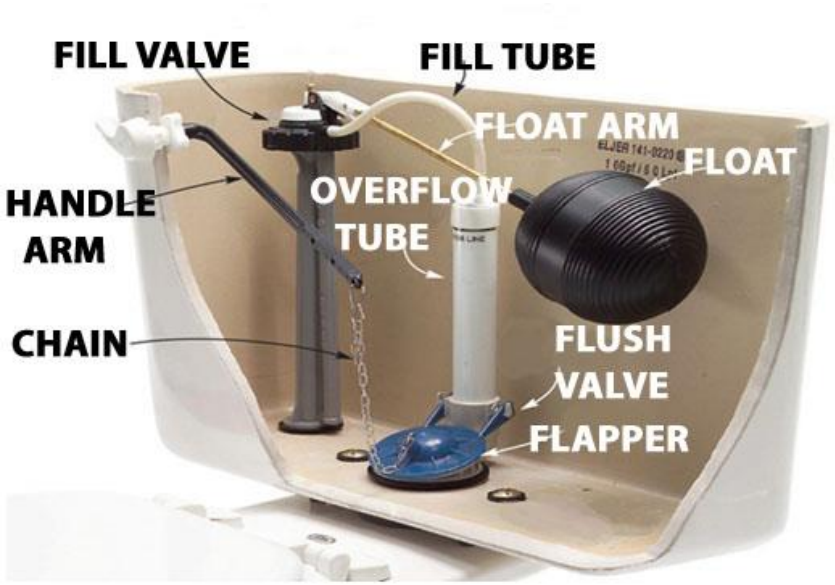
- Flush Tank
- Flush valve or Flushometer

Flush Tank

A flush tank is a tank that holds water to be supplied for the flushing water closet or urinal. The typical flush tank consists of the following major parts.

- Float valve or ball cock assembly connected to the water inlet pipe.
- Flush valve assembly includes an overflow tube, valve seat and a rubber tank ball attached to the trip lever with a lift wire.

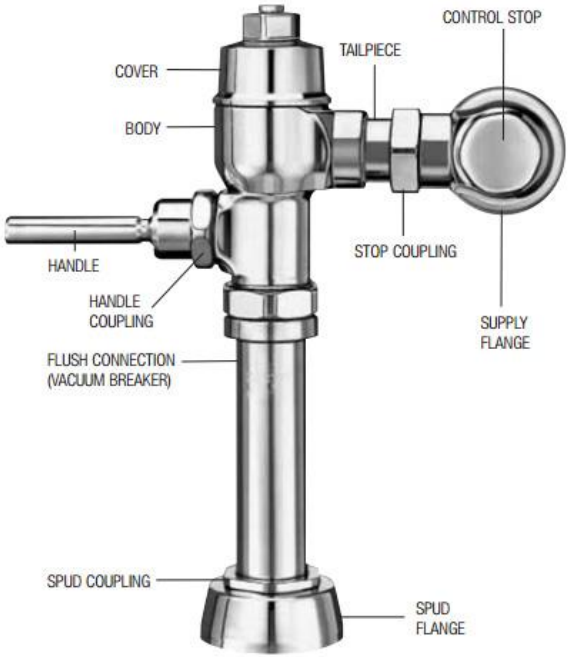




Flushometer valve

A flush valve also called a flushometer is a valve designed to supply fixed quantity of water in a fixed time for flushing.





Building Drainage System

- A drainage system is a system of piping that conveys **sewage and storm** water or other liquid wastes to an adequate and approved means of disposal.
  - The objective of installing sanitary drainage system in a building is to provide efficient sanitary disposal of human excreta, ablutionary wastewater, laundry and kitchen wastewater etc. from the fixtures to the public sewer.

Terms and definition

- ***Stack*** is the vertical main of a system of soil, waste or vent piping.
- ***Soil stack/pipe*** is any pipe which conveys the discharge of water closets or fixtures having similar functions with or without the discharge from other fixtures to the building drain or building sewer.
- ***Waste stack/pipe*** is a pipe which carries liquid wastes free from fecal matter.
- ***Vent stack/pipe*** is a pipe or system installed to provide air flow to or from a drainage system or to provide a circulation of air within such system to protect trap seals from siphonage and back pressure
- ***Relief vent*** is a vent the primary function of which is to provide circulation of air between drainage and vent system

Assignment Questions:

1. Illustrate the concept of plumbing in your own words with appropriate explanations. Also, describe the fundamental principles that must be maintained for the plumbing system of a building.

2. Given the following building details:

   Occupancy Type: Residential

   Socio-economic Status: Middle-income

   Location: Mohammadpur

   Number of Floors: 12

   Units per Floor: 2

   Family Size: 4 persons per unit

   Water Consumption Rate: 12 LPCD (liters per capita per day)

   Calculate the total water demand of the building. Also, calculate the required capacity of the underground and rooftop water reservoirs must be determined.