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The Evocative Study on Absolute Plumbing Method in a Structure: The Perspective of Dhaka City

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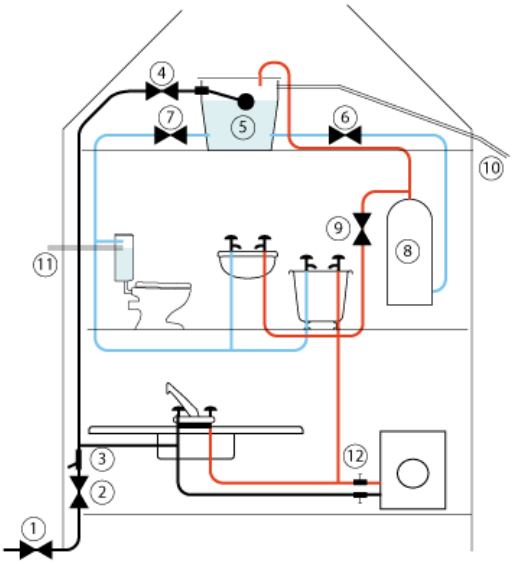
Abstract
Water is an integral part of human life. Without water, no living creature or plant on earth would exist. When a house or any building for that matter is built, water supply is always a major part of the design consideration. The plumbing layout is efficiently planned and laid out so that all spaces with water needs are connected to the water system. Aside from water supply, the layout also covers other important aspects like drainage and wastewater management systems. The components in the system would normally include pipes, fittings, valves, and other plumbing accessories. In this study, step by step procedure of supply of fresh water, drainage and wastewater management systems for a single multistory building of Dhaka city will be demonstrated. With an aim to provide more comprehensive information in a user-friendly manner to the practitioners, This study is designed to provide as a 'Formula' of plumbing system which can be applied in residential, commercial, industrial or other numerous varieties of buildings.
Keywords: Plumbing System, Fresh Water Supply, Drainage System, Fittings, Fixture and so on

1. Introduction

Dhaka is a densely populated city with an area of 1425 km^2 which is already labeled as a mega city. This significant population craves a larger amount of water for different purposes. On the other hand, where environmental concerns are ubiquitous, the management of wastewater is certainly a primordial consideration now in planning for the plumbing system. Used water either has to be disposed of properly without impacting the local ecosystem or be recycled for other uses like watering plants. The plumbing system broadly includes the entire system of fresh water supply and distribution, the entire system of sanitary drainage including solid and liquid waste and the entire system of storm water including collection and carrying of rain water to a public storm water drain or to a pond or river etc.

2. Fresh Water Supply and Distribution System

Fresh water supply and distribution system is a scheme in plumbing which provides and distributes water to the different parts of the building or structure. This provides the purposes such as drinking, cleaning, washing, culinary use, etc. It includes the water distributing pipes, control devices, equipment, and other appurtenances. Dhaka Water Supply and Sewerage Authority (DWASA) is the only authoritative organization available to deliver consumable water to Dhaka City dwellers. DWASA provides 75% of total demand of water in which about 87% is accumulated from groundwater sources, and the remaining 13% is collected from different treatment plants. There are two distinct systems of supply of water to a building from the mains; which are Direct & indirect systems. Direct system also known as upward distribution system, the supply of water is given to various floors in a building directly from the main which has sufficient pressure floors in a building directly from the mains which has sufficient pressure to feed the entire floor and water fittings at the highest part of the building. On the other hand indirect system also known as down take supply or downfall distribution system, the water supply from the mains may be drawn either by feeding water directly into the overhead storage tank provided at roof of the building from where the water is supplied to different floors by gravity or feeding the water into a underground water storage tank. The water from the underground tank is pumped to overhead storage tank from where; the water is supplied by gravity. In this study the indirect system and required devices, equipment for that will be more emphasized and discussed.

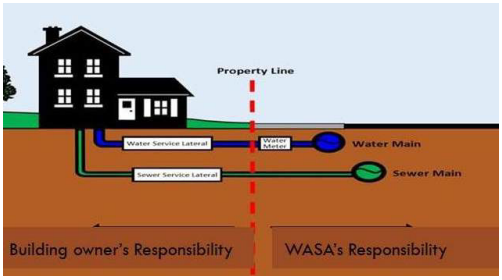


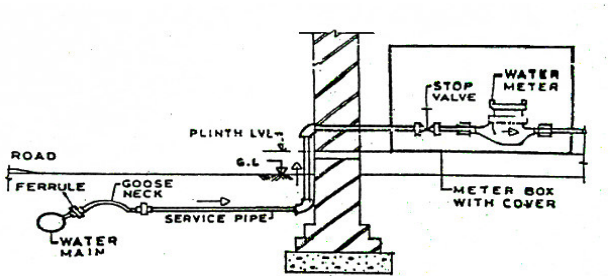
Different Parts of Indirect Water Supply System

1. Service connection
2. Householders stopcock
3. Draincock
4. Stopcock
5. Storage tank with a ballcock float valve to control the water stored.
6. Gate valve
7. Gate valve
8. Hot water cylinder.
9. Gate valve
10. Storage tank
11. WC overflow pipe
12. Inline valves

3. Service Connection

The water connection given from the city water distribution main [Dhaka Water Supply and Sewerage Authority (DWASA)] to the building owner is known as service connection. Water connection is provided with a water meter which is installed by the DWASA.A service connection includes; Ferrule, Gooseneck, Service pipe, Stop valve &Water meter.





Details of Service Connection and Different Parts of its

Each residence or family dwelling unit, each commercial or individual consumer and each public or private building not otherwise classified shall have a separate service connection to the public service as approved by the DWASA. A family dwelling unit is defined as a part of a multi dwelling unit having water use facilities equivalent in extent to a normal dwelling. Multiple-dwelling units with more than two units, such as rooming houses or boardinghouses or apartment houses, auto courts, hotels, rest homes, or trailer camps or condominiums which have community water use facilities may be served by a single service, subject to the provisions of the water rate schedule. As provided in the water rate schedule, a separate connection fee may be charged each dwelling unit regardless of whether or not a separate service is installed in each unit.

4. Brass or Bronze Ferrule

Ferrule is a special type of appliance made up of Brass or bronze. It has a vertical inlet for screwing on to the water main and a horizontal outlet to be connected to service pipe. The water main which is usually under pressure is drilled and tapped .the ferrule is screwed in without shutting down the mains. The normal size of the ferrule is to be used is usually half the size of the service pipe. It acts as a control stop which permits the water to be turned off should the building become unoccupied. However, since it is buried at the depth of the municipal main, a hole has to be dug before the corporation cock can be used.

Brass or Bronze Ferrule

Material: Brass/ copper

Provided by DWASA

Price: Tk. 25- 200/ pc

Gooseneck Material: Metal/ PVC Provided by DWASA
Size: ½ - 4 inch
Installed: Thread tape/ Solvent cement

5. Stop Valve

This is provided before water meter in a chamber with a cover to cut off the supply of water from the street main to the building for repairing the plumbing system within the building. It is a screw down pattern valve with horizontal inlet and outlet connections. It incorporates a loose jumper valve permitting flow in one direction only. It is used for isolating the supply of water in a high pressure pipeline. In case the supply main is shut off and drained down for any reason, the 'non-return' action of the loose valve plate will stop any backflow from the service pipe.

6. Water Meter

An appliance or device owned by the Government and maintained by the DWASA for the purpose of measuring water consumption. Metering is required to measure water consumed for billing purposes. Meter position shall be provided by the LP (employed by the applicant) for meter installation while water meters will be provided by the DWASA.

Water meters may be installed either by the DWASA or the licensed plumber. The size and location of the water meter will be determined by the DWASA. For domestic supply, a meter size of 15mm is usually recommended. For trade and industrial supply, the meter size is determined based on the actual water consumption.

Water Meter
Material: Metal
Provided by WASA
Price: Tk. 7000 - 15000
Size: ⅝ - 10 inch
Installed: Thread tape

7. Water Storage Tank

After service connection the supplied fresh water get stored in water storage tanks. Especially when the pressure in a water supply is irregular, uncertain, or intermittent, some method is necessary to obtain water in the plumbing system to store the water for regular supply. Two principal methods are used for this purpose; underground water reservoir and overhead water storage tank. Storage tanks may be made of Galvanized Iron sheet, pressed mild steel, fiber glass, reinforced concrete or other materials approved by the DWASA. Reinforced concrete is the most common material used. Prior approval by the DWASA must be sought when fiber glass tank is to be used. Fiberglass storage tank for potable water shall be of an approved type or certified to contain no toxic materials and suitable for storage of potable water.

Underground Water Reservoir
01 – Pipe of Supply Water
02 - Drain
03 – Motor
04 – Underground Water Reserve

A water storage tank shall be fitted with a ball valve and a full way gate valve at the inlet in the case of a gravity supply. In the case of a pumped supply to a single tank, the tank shall be fitted with an automatic control switch and without any stop valve. In the case of a pumped supply to twin tanks, each tank shall be fitted

with an automatic control switch and a stop valve for temporary isolation purpose. The ball valve or control switch shall shut off the supply when the water level is 25 mm below the invert of the overflow pipe or the warning pipe if there exists one. The invert of the inlet pipe or the face of the outlet nose of the ball valve shall be not less than 25 mm above the top of the overflow pipe. All overflow and warning pipes of potable water storage tanks shall be constructed of non-metallic pipe materials. The invert of an outlet pipe from a water storage tank with capacity less than 5,000 liters shall be at least 30 mm above the bottom of the tank; this distance shall be increased to 100 mm if the capacity is 5,000 liters or more.


Underground water reservoir
Material: Concrete
Capacity: 200 – 5000 liters
Uses: For storing fresh water
Cover Material: Mild Steel

The outlet pipe of every water storage tank shall be provided with full way gate valve. Provision shall be made for a drain-off pipe to enable the tank to be emptied. The drain-off pipe shall be properly plugged or adequate means shall be provided to prevent any unauthorized operation of the control valve at drain-off pipe. An overflow pipe shall be provided which shall discharge overflow water to a conspicuous position in a communal area easily visible and accessible by the occupants. The overflow pipe shall be at least one commercial size larger than the inlet pipe and shall in no case be less than 25 mm in diameter. No part of the overflow pipe shall be submerged inside the storage tank. A grating and a self-closing non-return flap shall be provided at the overflow pipe outside the storage tank. A warning pipe may be installed in addition to an overflow pipe. Except that a warning pipe can be of any size not less than 25 mm in diameter, it shall comply with all other requirements of an overflow pipe. The warning pipe shall be installed at a level below the overflow pipe and shall be extended to outside of the building periphery for roof tank or outside the pump room for sump tank.

Water Pump
To carry the water to the overhead storage tank
Material: aluminum or iron.
Price: Tk. 6000- 55000 / pc
Horsepower: 1- 8
Availability: Bangladesh, China
Capacity: 6.3 to 400 m3/hour
Voltage: 180- 220

Auto water pump controller
Used for automatically shutting of the pump after reaching the required water level

Double sealed covers with locking devices so constructed as to prevent the ingress of surface water shall be provided for all storage tanks other than tanks for flushing and fire-fighting purposes. Storage tanks shall be so positioned that they are free from obstruction and readily accessible via safe access for cleansing and to facilitate repairs. It shall be located so as to minimize the risk of contamination of the stored water. When the storage tank for potable water is to be placed adjoining to a storage tank for non-potable water, a physical break shall be provided between the two tanks, i.e. walls and slabs of the two tanks must be separated while tie beams linking the tanks for structural requirements are acceptable. The tie beams shall be constructed in such a manner that cross contamination of two tanks via the tie beams is not possible. All outlet pipes from the storage tank should, whenever possible, be positioned at the opposite side to the inlet supply pipe to prevent stagnation of water. Structural design of the tank and its supports should be subject to the requirements of the Building Authority.

Overhead storage tank
Material: PVC/ Steel
Capacity: 200 – 10000 liters
Availability: Bangladesh, China, India
Price: Tk. 7.20- 9/ liters
Inlet Size: ¾ - 2 inch
Outlet size: ¾ - 2 inch

8. Use of Different types of Pipes for Fresh Water Supply and Distribution System

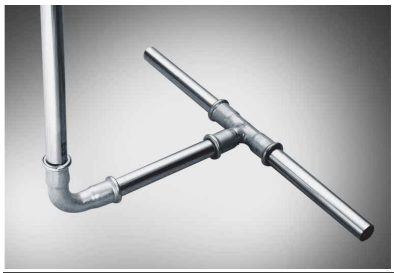
A water pipe is a pipe or tube, frequently made of plastic or metal, that carries pressurized and treated fresh water to a building (as part of a municipal water system), as well as inside the building. In plumbing system various types of pipe is used. Each pipe is used for different purpose depending on its material and thickness. Following types of pipes are commonly used in water supply system.

9. Cast Iron Pipes

Cast iron (C.I) pipes are extensively used in water distribution mains because they are comparatively cheaper in cost. C.I. pipes are highly resistant to corrosion and have very long life. These types of pipes are cast in length varying from 3m to 6m. C.I. pipes are very heavy and need special care to prevent damage during transportation and making connections.

Cast Iron Pipes
Size: **1**'-**10**'
Price: **200** tk – **2500** tk / Rft.
Installation: Concrete or Welding

Copper pipe Size: 1.25" to 6"
Price: 14 tk – 112 tk / Rft
Installation: Thread Tape or Welding



Steel pipes Size: ½" to 3"
Price: 34 tk – 180 tk / Rft
Installation: Welding System

10. Copper Pipe

This type of pipe is mostly used for hot and cold water distribution as well as being regularly used in HVAC systems for refrigerant lines. They have high tensile strength and can therefore have thin walls and they can be bent easily. To enhance their appearance copper pipes are sometimes chromium plated to match with the chromium plated water supply fittings. Copper pipes come in three different sizes – type M, L, and K. Type M has very thin walls, while type L is of medium thickness, and type K is the thickest of the three.

11. Steel Pipe

Steel pipes are recommended for use in water mains in situations where the pipe is subjected to very high pressure ('.e. above 7kg/cm2) and the diameter of pipe required in large. Steel pipes are stronger and lighter in weight as compared with C.I. pipes. They, however, require adequate preventive treatment to sustain adverse atmospheric conditions. Stainless steel pipe is less commonly used than other metal pipes, as it is more expensive and harder to find. It is primarily used in marine environments because it can withstand salt water, which would erode most other metal pipes.

12. Galvanized Iron Pipes

Galvanized Iron (G.I.) pipes are wrought steel pipes provided with zinc coating. G.I. pipes are most commonly used for water supply work inside the buildings. They are also invariably used in service connections. Mostly screw and socket joints are used for G.I. pipe connections.

13. Polythene Pipes

Polythene and P.V.C. pipes are being used increasingly these days for supply of cold water in external and internal plumbing work. They are light in weight, noncorrosive, lower in cost and do not required any threading for connections.

14. Reinforced Cement Concrete (R.C.C.) Pipe

R.C.C is the most durable and longest-lasting pipe available for underground usage. The service life for concrete culverts, storm sewers and sanitary sewer pipe can exceed more than 100 years. Precast reinforced concrete pipe meets all requirements and can be manufactured to custom specifications. Sanitary liner systems are also available.. It is leak proof, easily repairable and is non-reactive to sewerage toxins.

Use of different types of pipes for fresh water supply and distribution system in a building

There is a vertical (no. 1) pipe connected with the lower part of the overhead storage tank. This pipe is called ventilation pipe. This pipe helps to continue the uninterrupted water supply in the building. The (no. 2) green pipe carries fresh water from Overhead Storage Tank to the building. Whereas (no. 3) pipe line is for hot water supply and Galvanized Iron is used here to serve that purpose& no. 4 green pipe is a PVC pipe used for cold water supply.

The total washroom pipe line connection is described by main tap line (no. 5), shower tap line (no. 6), flushing cistern line (no. 7), hand shower line (no.8) & a wash basin line (no.9). For kitchen purpose, (no.10) is for sink and (no. 11) for down was.

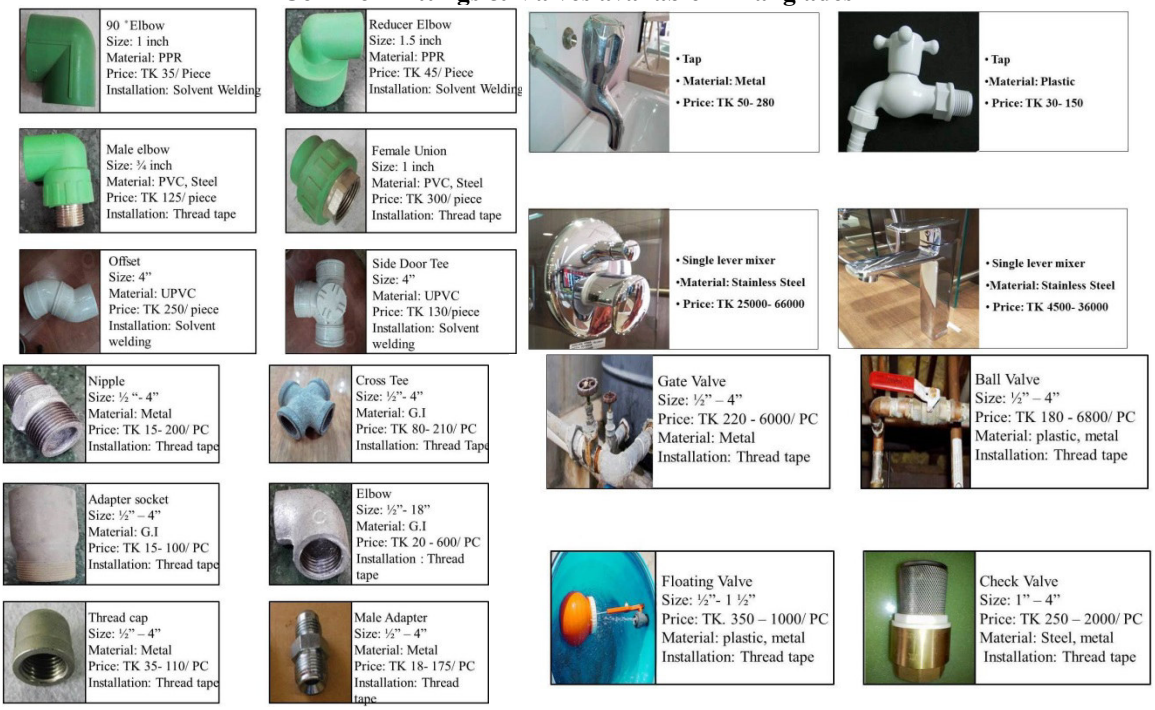
14. Fittings

Fittings are used in pipe and plumbing systems to connect straight pipe or tubing sections, to adapt different sizes or shapes, and to regulate fluid flow. Fittings, especially non common types, can be expensive, and require time, materials, and tools to install, so they are a non-trivial part of piping and plumbing systems. The basic purposes of any pipe fitting are ;connecting the bores of two or more pipes or tubes, connecting pipe sections, connecting a pipe to a different apparatus, changing the direction of fluid/liquid flow, Maintaining or regulating the flow, closing and sealing a pipe.

15. Common fittings for both piping and plumbing

While there are hundreds of specialized fittings manufactured, some fittings are used widely in piping and plumbing systems. Elbow is pipe fitting installed between two lengths of pipe or tube allowing a change of direction, usually 90° or 45°. The ends may be machined for butt welding, threaded (usually female), etc. When the two ends differ in size, it is called a reducing or reducer elbow tee is used to either combine or split a fluid flow. Most common are tees with the same inlet and outlet sizes, but 'reducing' tees are available as well. The fitting is one of the three main components of a T-Line, alongside an end-cap or fill port and a length of tubing. They are plumbed into the system, with the perpendicular barb (and its attached stretch of tubing leading to a fill port or a cap). A cap has a similar function to a plug. In plumbing systems that use threads the cap has female threads. A plug closes off the end of a pipe. It is similar to a cap but it fits inside the fitting it is mated to. In a threaded iron pipe plumbing system, plugs have male threads barb is used to connect flexible hoses to pipes. One end had a stub with ridges that is inserted into the flexible hose to secure it.

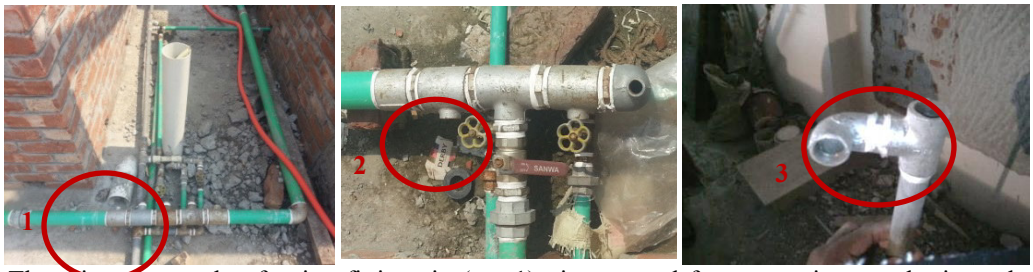
Common Fittings & Valves available in Bangladesh



16. Use of Valves in Fresh Water Supply and Distribution System

Valve is a fitting commonly used to control the flow of water along a pipeline. With the introduction of valves it is a possible to isolate any sections of a pipeline for the purposes of inspection, repair of a leak or addition/alteration to the already functioning water supply system. Valves are commonly used in domestic water supply system are Globe Valve,Gate Valve,Float ValveTaps and Stop Cock.The gate valve is used in systems where astraight flow with the least amount of restriction isneeded. These valves are used in steam lines,waterlines, fuel oil lines, and fire-main cutouts. The valve is operated by a float which allows the valve to be fully open when it is in lower position. As the water level rises, the float also rises which gradually closes the valve and shuts off the supply of water as soon as the water reaches the full supply level mark. Taps are used at the end of a pipeline for draw off purposes. Taps are also called Bib cock or Bib tap. A stop cock is a valve used in pipeline for controlling or completely stopping the flow of water to a fixture. Taps and stop cocks are two most extensively used type of fittings in domestic water supply system. They are normally of screw down type and open in anti-clockwise direction

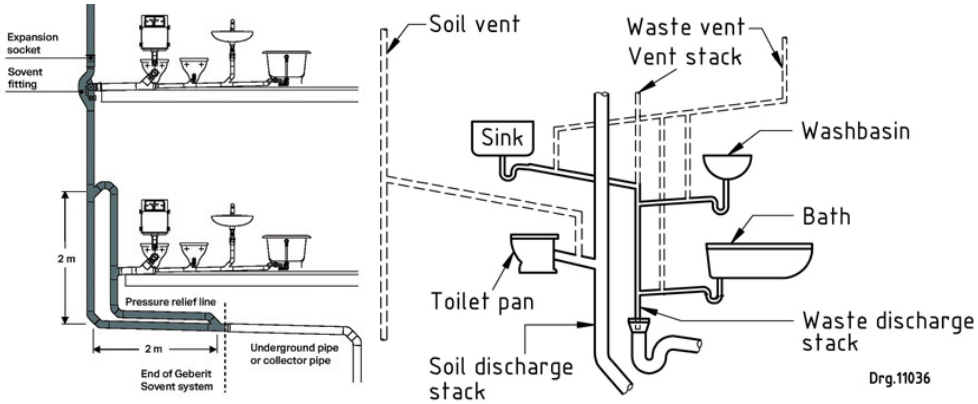
Use of different types of fittings & valves for fresh water supply and distribution system in a building



There is an example of union fittings in (no. 1) picture used for connecting two horizontal pipes for maintaining the water flow. The (no. 2) picture is a gate valve used for controlling the flow of water or completely shut the water flow for maintenance purpose. Whereas(no. 3) picture is the example of reducer elbow with tee pipe which is used for changing the size of the pipes according to the requirements.(no. 4) is the example of ball valve in the supply of fresh water line.no 5 & 6 is the use of male elbow, coupling and end cap fittings use in fresh water supply system.

17. The entire System of Sanitary Drainage System in a Building

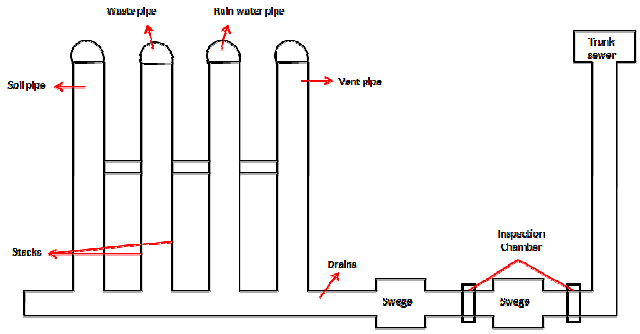
The sanitary drainage system in a building includes a drain-waste-vent (or DWV) which is a part of a system that removes sewage and grey water from a building, and regulates air pressure in the waste-system pipes to aid free flow. Waste is produced at fixtures such as toilets, sinks, and showers, and exits the fixtures through a trap, a dipped section of pipe that always contains water. The sanitary drainage and vent piping system are installed by the plumber to remove wastewater and water borne waste from the plumbing fixtures and appliances and to provide circulation of air within the drainage piping.Types of Sanitary Drainage Systems are; One Pipe system in which instead of using two separate pipes for excreta and sullage, only one vertical main pipe is provided, that collects both night soil and sullage water. The main pipe is ventilated at the top, in addition, a separate vent pipe is also provided. On the other hand twopipe system, two sets of vertical pipes, one for excreta (solid waste) as soil pipe and another for sullage as waste pipe. The soil pipes as well as waste pipes are separately ventilated, by providing, separate vent pipe or anti-siphon age pipe. Two pipe system is commonly used as it is the improved & better option.



One Pipe System **Two Pipes System**

18. Technical Terms used in Sanitary Drainage System

Soil appliance includes water closets, urinals, bedpan soil pipe etc. Soil pipe carries discharge from any kind of soil appliances. Waste appliance includes wash basin, sinks, bath tubs etc. and waste pipe that carries discharge from any kind of waste appliances. Vent pipe is used for ensuring the circulation of air in a plumbing system and for relieving the negative pressure exerted on trap seals. The ventilation is usually achieved by providing a fresh air inlet connected to the lower-most manhole or inspection chamber. Fresh air from the atmosphere will enter through this inlet into the manhole, and finally goes out at top through the vent pipe. The air along with foul gases will finally escape out from the cowl provided at the top. A flap valve is provided at the inlet of fresh air into the inspection chamber, to avoid the escape of foul gases in the street or courtyard.



A house drain is a system of underground horizontal pipes used for drainage of discharge from soil and

waste pipe of a single property.Since the drain is laid within the private boundary, the responsibility of its maintenance rests with the owner of the property.Sewage is a combination of discharge from soil pipe, waste pipe, with or without rain water.And sewer is a system of underground pipe belongings to local municipality authority which collects discharges from drains and house drains from outside the private boundary of more than one property. Trunk sewer is a main sewer which receives discharges from all the smaller sewers and conveys it to a sewage treatment plant or to the final point of disposal. An inspection chamber or manhole is a small masonry chamber provided for inspection, cleaning and repairing purpose.

19. Fixtures commonly used in plumbing system (Soil appliance & waste appliances)

Plumbing is the practice, materials and fixtures used in the installation or maintenance of all pipes in connection with both water supply and sanitary systems within or adjacent to any building. The entire system of piping, fittings and the appurtenances are known as plumbing system. Sanitary plumbing system includes the pipes, fittings are the appliances used in a house plumbing system, to receive the human excreta and sullage wastes of the house. Soil appliance & waste appliances includes; Water closets (WC), Urinals, Flushing cistern for water closets Bath tubs, Washing basins, Kitchen sinks. The waste water is generated through the sanitary fittings. The provision of an efficient sanitary plumbing system for collection and movement of the waste water to the nearest municipal sewer is an important aspect of the building construction.

20. Principles of Sanitary Plumbing System

The sanitary plumbing system should be designed keeping into consideration the following general principles: For better maintenance, the sanitary pipes should be preferably laid into the ground by the side of the building rather than in walls or underground. Vertical pipes in buildings should be kept outside and accommodated in shafts, to avoid their bad appearance. Horizontal pipes should be laid straight and at grade between inspection chambers. All sharp bends and junctions should be avoided and made through inspection chambers. The entire plumbing system should be ventilated. The house sewer should be connected to the street sewer, keeping the outfall level of the house sewer sufficiently higher than the water level of the public sewer to avoid backflow.

21. Use of Traps in Plumbing Drainage System

A trap is a device which is used to prevent sewer gases from entering the buildings. The traps are located below or within a plumbing fixture and retains small amount of water. The retaining water creates a water seal which stops foul gases going back to the building from drain pipes. Therefore all plumbing fixtures such as sinks, washbasins, bathtubs and toilets etc. are equipped with traps. commonly used Traps in domestic drainage r supply system are;Gully traps, constructed outside the building to carry waste water discharge from washbasin, sinks, bathroom etc. and are connected to the nearest building drain/sewer so that foul gases from sewer do not come to the house. The only difference between P trap and S trap is that P. trap is used for outlet through the wall whereas S. trap is used for outlet through the floor. Floor Trap is provided in the floor to collect waste water from washbasin, shower, sink and bathroom etc. Grease trap is a device to collect the grease contents of waste and can be cleaned from the surface. This is generally used in food processing unit. Bottle trap is used below washbasin and sinks to prevent entry of foul gases.

Example of Sanitary Drainage System in a Building

No. 1 type pipe is waste pipe & carries the waste water from waste appliances (except the waste of WC). No. 2 type pipe is soil pipe & carries human discharge from water closet. No. 3 pipe is vent pipe. This pipe doesn't carry any kind of waste, just used for uninterrupted west supply. No. 4 pipe carries rain water from roof & balcony. All vertical pipes are called Stacks example;(No. 8) & horizontal pipes are called Drain pipe example;(No. 5). All stacks & drain pipes are connected with some different traps like "Q" trap (No. 6), "P" trap (No. 7) etc.

All those pipes are connected with the septic tank which shows in picture (No.8).(No.9) is the picture of septic tank, used for containing discharge from soil and waste pipe of a single property.(No.10) is the sewer line that which collects discharges from drains and house drains from outside the private boundary of more than one property to Trunk sewer.(No.11) is the picture of inspection chamber or manhole provided for inspection, cleaning and repairing purpose along the way of sewer line till trunk sewer.

22. Septic Tank & Sewerage System

A septic system is a small scale wastewater and sewage treatment system common in rural areas where connection to city sewer lines is minimal or non-existent. An anaerobic bacterial environment, that is, one existing without the presence of oxygen, causes decomposition of the waste discharged into the system. The septic system is designed to remove, and treat, then slowly release wastewater over an area of land to be absorbed by the soil.

23. Conclusion

The survival of man depends on many factors, and one of the most important among them is, without a doubt, water. When constructing multi-story building, the factor needs to be assured that the systems installed in it will efficiently make use in supply of fresh water and properly dispose of waste water.There are several benefits to designing a building with an efficient plumbing system in mind. Aside from the obvious ones, like lower construction costs and the ability to achieve greater and more improved building efficiency, a thoughtfully-designed plumbing system can have a direct impact on savings among other disciplines involved, helping the design team deliver a successful building design without exceeding the project budget.

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I.Ar. Farhana Choudhury is a illustrious Philanthropist and correlated named as a contemporary Interior Designer. She accomplished MA and BA (Honors) in Interior Design from Shanto-Mariam University of Creative Technology, Bangladesh. She consummated some of the professional experiences in several arenas of education learning-teaching institutions. Furthermore she attained BA (Honors) in English as a second Major to accelerate her career in anticipations. At present she is functioning as a Senior Lecturer and Students' Adviser in the Department of Interior Architecture at Shanto-Mariam University of Creative Technology. Her vicinity of concentration is historical and chronological understanding and analysis based on Interior Design, English Literature, and Contemporary Design Adjustment and so on. Se is one of the esteemed members of nationally reputed professional clubs in Bangladesh and awarded as a Faculty Excellence in her professional fingerprints.