

Design of Plumbing System for a 10 Storey Residential Apartment

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ABSTRACT : Multistoreyed buildings are inevitable in today's modern living. Other than structural stability there are lot of services being emphasized like water supply, sanitary, fire fighting, etc., These require specialized engineering knowledge along with inter-disciplinary fields like electrical, mechanical, etc., A civil engineer's scope under duty are not only to design and construct the structure, but also to provide the best services and maintenance. So we decide to take a case study of a proposed tilt plus 10 storey residential apartment, for that we decide to design a perfect engineering plumbing system.

KEYWORDS: Design, Service and Maintenance, pipe loses

I. INTRODUCTION

1.1 TYPES OF PIPES

- PVC – Poly Vinyl Chloride
- UPVC – Unplastisized Polyvinyl Chloride
- CPVC – Chlorinated Polyvinyl Chloride

1.1.1 PVC PIPES

- These pipes are low cost pipes.
- PVC pipes are corrosion resistance and also temperature resistance.
- They are used mainly for plumbing works.
- And also used as a substitute for metals.
- They can withstand high impact of loads.
- And are less ductile.

1.1.2 UPVC PIPES

- UPVC pipes are very low cost pipes.
- And they are used as a substitute for wood.

1.1.3 CPVC PIPES

- CPVC pipes are highly resistance to temperature and corrosion.
- They can resist up to a temperature of 40° - 80°C.
- And are more ductile.
- These pipes are mostly used in water heaters.

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1.2 BOB CORPORATION: The BOB Corporation is an Indian Private Sector company, with its main headquarters in New York.

The following are the products manufactured here,

- Low, medium and high pressure pipes.
- Heating and plumbing systems.
- PVC doors and windows.
- Drip and sprinkler irrigation systems.
- Float valves with NPT (National Pipe Thread) inlet and outlet connections.
- High efficiency heaters.

The following are their 3 basic categories of pipes,

- **Supply pipes** joints made of iron, copper and PVC.
- **Waste pipes** such as unpressurized pipes, vent pipes and gravity pipes.
- **Fixtures**

1.3 FINOLEX PIPES

- The average length of Finolex pipes ranges between 3 – 6 meters.
- It's both ends are plain and threaded.
- The fittings are made of GI (Galvanized Iron) fittings.
- The sizes range between 1/2" – 4".

The following are the sizes of Finolex pipes available in market,

- 1/2", 3/4", 1", 1 1/4", 1 1/2", 2", 2 1/2", 3", 4"

1.3.1 FINOLEX PIPE FITTINGS

COUPLER– used to join pipes

ELBOW– used for 90° turn

END CAP– used at the end of pipeline

FEMALE THREADED ADAPTOR (FTA) – used to join PVC and GI pipes

MALE THREADED ADAPTOR (MTA) – used to join PVC and GI pipes

TEE JOINT– used to take a bypass or a service line pipe

REDUCER– used to join service line to main line pipe after Tee joint

TAIL PIECE – used for special spigot and socket joint

- The wall thickness of the fittings is 1/8".
- The schedules available are 40, 80 and 160 fittings.

1.4 AVONPLAST PIPES

- Avonplast pipes are the largest unit of rigid PVC pipes.
- In this most modern techniques are used.
- They are most famous for quality control.
- They use ISI marked rigid PVC pipes.
- Domestic and industrial wirings are also manufactured here.

1.5 CENTRIFUGAL PUMP

Centrifugal pumps are a sub-class of dynamic axisymmetric work-absorbing turbomachinery. Centrifugal pumps are used to transport fluids by the conversion of rotational kinetic energy to the hydrodynamic energy of the fluid flow. The rotational energy typically comes from an engine or electric motor.

1.6 RECIPROCATION PUMP

Reciprocating pump is a class of positive displacement pumps which includes the piston pump, plunger pump and diaphragm pump. It is often used where a relatively small quantity of liquid is to be handled and where

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delivery pressure is quite large. In reciprocating pumps, the chamber in which the liquid is trapped, is a stationary cylinder that contains the piston or plunger.

II. FORMULAE

- Discharge = Area * velocity
- Velocity in main pipe = Discharge / Area
- Entrance loss = $0.5 * v^2 / (2 * g)$
- Bending loss = $k * v^2 / (2 * g)$
- K – Bending factor (taken from D_2 / D_1 ratio)
- Velocity in sub main pipe = Discharge / Area
- Contraction loss = $0.5 * v^2 / (2 * g)$
- Friction loss = $f * l * v^2 / (2 * g * d)$

III. DESIGN OF SUMP TANK AND OVER HEAD WATER TANK

Per capita demand for high income persons = 200 lpcd (liters per capita per day)

Average daily demand = $860.2 * 200$
= 172040 liters

For fire demand increasing 20% of average daily demand,
= $172040 + (0.2 * 172040)$
= 206448 liters

Sump capacity = 2 times of fire demand
= $2 * 206448$
= 412896 liters

Tank capacity = half of the fire demand
= $0.5 * 206448$
= 103224 liters

We are designing four numbers of overhead tank and four number of sump tank for the total building.

Hence capacity of each tank = $103224 / 4$
= 25806 liters

As per plan size of the tank are as follows,

Length = 5.64 m

Breadth = 2.9 m

Depth = 1.52 m

Volume of tank = $5.64 * 2.9 * 1.52$
= 24.86 m^3

Capacity of each tank = $24.86 * 1000$
= 24861.12 liters

On comparing as per plan capacity and as per design capacity taking higher value = 25806 liters

Volume of each sump = 415.36 m^3

Now to find the dimensions of the sump tank,

Assuming length $L = 1.5 * B$

Depth $D = 2 \text{ m}$

Hence length $L = 17.6 \text{ m}$

Breadth $B = 11.8 \text{ m}$

Depth $D = 2 \text{ m}$

Volume of sump tank = $17.6 * 11.8 * 2$

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$$\begin{aligned} &= 415.36 \text{ m}^3 \\ \text{Each sump tank volume} &= 415.36/4 \\ &= 103.84 \text{ m}^3 \\ \text{Capacity of each sump tank} &= 103.84 * 1000 \\ &= 103840 \text{ liters} \end{aligned}$$

IV. DISCHARGE FOR ALL FLOOR

Table 10 – Discharge table for 1st floor

1 st Floor Discharge for each network	Tank 1	Tank 2	Tank 3	Tank 4
Kitchen Network 1	58.74	59.25	59.39	59.27
Toilet Network 1	33.06	33.33	33.31	33.41
Toilet Network 2	33.37	33.28	33.26	33.28
Toilet Network 3	33.19	33.26	33.06	33.26
Toilet Network 4	32.59	NIL	33.02	33.13
Kitchen Network 2	59.04	59.03	59.23	59.05
Toilet Network 5	33.32	NIL	33.15	NIL
Kitchen Network 3	59.10	NIL	58.47	NIL
Toilet Network 6	33.22	33.48	33.03	NIL
Kitchen Network 4	58.76	NIL	NIL	NIL
Toilet Network 7	33.15	33.26	32.46	NIL
Toilet Network 8	33.39	NIL	32.77	NIL
Toilet Network 9	33.31	NIL	32.65	NIL

- Discharge values are in liters per minute

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FOR GROUND / STILT FLOOR

Table 11 – Discharge table for ground floor

Ground floor discharge for each network	Tank 2
Toilet network 1	34.93
Toilet network 2	34.89
Toilet network 3	34.87

- Discharge values are in liters per minute
- The discharge values beyond the requirements are reduced using the discharge reducers.

V. CONCLUSION

Plumbing and drainage system for a multistorey building is highly emphasized in engineering design, because its day to day service related issue is empirical approach may not result in favorable and apt service. Plumbing design is a fluid mechanics problem –Flow through pipes. This involves precision pressure head and friction loss, calculation and accuracy in implementation of various pipes, joints, motor etc., Only through proper engineering approach and design such service is possible. Drainage system is a hydraulic problem – Open channel flow. This involves challenges in life achieving self – cleansing velocity and proper gravitational flow leads to sewage treatment plant and other filter units. The integrated plumbing and drainage system design results economical and efficient service. Rainwater harvesting system in a multistory building shall solve water scarcity. In multistoried buildings fire fighting is a great challenge which is interconnected with plumbing and water supply system. Proper design methodology result efficient fire height and fire safety in such buildings.

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