Building Services I

Lecture 2

Purpose of Distribution System

What is a purpose of a distribution system is it to deliver the water into the consumer with appropriate quality, quantity and pressure. So this distribution system is used to describe collectively all the facilities used to supply the water from the source to point of usage. When we consider distribution systems in a major layout when we talk about cities, small towns or any other communities it is generally laid below the roads. So below the roads and road payments so the layouts will be generally follow the road pattern only so even then we can classify that into four different types like grid iron system, ring system, radial system and dead end system.

Now when we take grid iron system this is suitable for cities with rectangular layout where it is already a planned city. So the roads will be at ninety degrees to each other so this how the grid pattern will look like. So when the roads are like rectangular and it is grid iron form we can follow this grid iron system so you see the center line main pipe and we have this B denotes the branch pipe. S is the sub mains and from sub mains we have the branch pipes these are dark coloured dots are the cut off valves so this grid iron system the only disadvantage we will face when this its like we cannot calculate the size of the pipes because there are too many branches have to be provided in all the branches that is the one disadvantage but when we see the advantages its again like good circulation will be there because its going all around you will have good circulation. You see here so it is the water lines are completely connected there is no cut anywhere so it is even when a part of the line is a problem only one that particular part will be disabled still the water will be flowing to the other areas so there is a advantage of grid iron system.

Now coming to the ring system here if you see it will be like the name ring comes from this the main line will go around the layout like a ring so the main pipe will go around the layout and you have sub main coming out from the circular main pipes so the cut off valves are there in the before the junctions of the sub mains and the mains. So when you see this it also follows the grid iron system but there is also pattern of dead end system because there goes ends in the end so the advantages if you see here water will be flowing in at least from two directions in any case if you see the thing so in any point of thing you take there will be two direction of water flow coming in so again when there is any repairs or anything we have to do the water will not be cutoff totally in that the parts also so in this system the main advantage is you can actually determine the size of the pipes that is very easy because of the flow pattern.

The next is the radial system. Radial system you will have the distribution that will be as split into zones and the distributor reservoir will be in the center of the zone so from there the branch pipes and the sub mains go radially so that is called radial system and advantage if you see it is it will give a quick service because the reservoirs are in the inside the zone itself and also calculation of pipes is easy in this particular system.

The next will be Dead end or tree system usually this is like you say as we told you it follows a pattern of the roads this is usually found in very old communities and very old cities where the development would not have been planned so the main road will take up the main line and wherever the roads go the sub mains will go along the roads and from there it will branch out to the zone areas. So the disadvantages here you have too many dead ends as the name says you have too many dead ends and the stagnation will occur in the pipes. Then advantage if you see there is the pressure will be easier because the number of valves will be less to show it very clearly see since main and there is like depending on the roads you will have very less number of the cutoff valves will be less so the pressure will be good in this type of systems and it is very relatively cheap to do this not much planning is needed in this system.so these are the four main water distribution systems for any major layout or cities, towns when we consider.

Distribution Layouts in Buildings

When we talk about buildings we have two types of line systems cold water line systems and hot water line systems. So when we take up cold water line systems we have four basic methods one will be the direct supply from the mains to the direct taps and the kitchen and WC's then you have a direct pumping system, then you have a hydro-pneumatic systems, then you have the overhead tanks distribution system.so we will see each one in detail.

This direct supply system we can use this particular system only when there is adequate pressure is there which is around the clock you shall have the pressure. So the pressure like till the top most floor you should have the pressure so because we don't have that enough pressure in most city mains we this is restricted to one or two floors only buildings which has only two or maximum of three floors only we can use the direct supply system and then when comes to direct pumping system. You have a pump here see the thing you have a pump here so from the underground tank you have a pump and the water is pumped directly with the help of the pump it is taken to the sink so the pressure will be maintained because of the pump so here we don't have an overhead tank for where it connects here it directly goes to the kitchen sinks and water closets directly so that is this system.

Then the start and stop operation for the pump you have pressure switches so when the pressure drops when you opena tap when the pressure drops your pump will automatically starts that is the system of this and the other thing is like since we have a pump you need to have a constant supply of power there so that is one thing we have to always have in mind and since is directly connected to the taps and closets you don't need any overhead tank for this system and this is particularly suitable where constantly where there going to be water usage not like your residential, commercial office buildings but in commercial buildings we can consider like when it is centrally air conditioned you need this because for the cooling towers and all those things the water will be running continuously so the pump has to be running continuously so there you can apply this direct pumping system

Then you have the Hydro –pneumatic system this is very similar to your previous pumps system but the only thing is you have air –tight pressure valve installed on the line to regulate the pump operation when you see here when you have this underground tank and the pump here you have

an air vessel here so air will be compressed in this so when the pressure drops the compressed air will operate the pump so this will be the operating that you don't have any operations which is your anything you have an air tank here pressure tank here which will operate the pump. The rest thing it is the same as the previous one and it is directly connected to the fixtures you don't need an overhead tank in this thing again so again here you also depend on reliable continuous supply of power again this will eliminate the need for overhead tanks there is one more advantage is there will be very high pressure in this particular system because we are using pressure tank so this is mostly used for multi storage buildings like when flows go beyond 7, 10 floors or 15 floors higher buildings use this hydro pneumatic system because a pressure will have very good pressure in all the floors.

Then is an overhead distribution systems this is the very common system that will see everywhere so we have the pump here when we switch on the pump water goes to the overhead tank here first and from the overhead tank it is distributed by gravity it is distributed to all the fixtures kitchen bath and WC. This pipes are located on terrace those pipes distribute to the various parts the down takes is the gravity so the gravity will take the thing into various fixtures

Now coming on to hot water line systems for domestic purposes we generally use storage heaters but when it comes to hotels, or apartments where there are too many number of apartments, or service apartments we go for centralized storage and distribution system so we go for a design of a hot water supply the temperature is very important in that when you see here there is a tabular column for various thing first scalding 65 degree Celsius beyond which we cannot use the water will be very hot for sink is 60, for hot bath it is 43 degree Celsius for a warm bath it is 37 degree Celsius and for a tepid bath it is 29.5 degree Celsius. So we have to maintain these temperatures even if it going to be a centralized storage or we are going to use heaters these temperature has to be maintained.

So when you see water line systems such they are one particular thing is like you cannot directly connect the mains to the hot water line so you need to have a storage tank to supply cold water for the heaters so that is what is told here the storage tanks are for supply of cold water to hot water heater should to be separate that is very important you cannot have it directly. So in case of multi storage buildings when we see multi storage buildings means you will have a common overhead tank in case they are using the overhead tank distribution system you will have a common distribution tank so for water heaters you have to have additional tanks one or more tanks like you see in this picture will have this the storage tank is here so in this particular thing they have taking one per floor they have one heater storage heater so the tank will be connected to this and from there only the supply is taking off so generally for multi storage buildings above the shaft we have a tank and this is the additional tank for giving the hot water supply and the other tall multi storage buildings when the we are talking about very high buildings like it goes beyond 15 floors, 30 floors and all those buildings so there static pressure will be more that will increase in height so what happens is if you put only one on top of the floor, terrace that will not sufficient so what we do here is we give additional tank in the intermediate floors see this is one on the terrace and in between you have another and then you have another terrace tank here from this tank will be supplied from the main overhead tank that will be only one for water heaters

alone you have intermediate tanks where because you have to maintain the pressure . So here from here it comes to all these tanks and from the tanks it is given to each floor and each unit.

So this is another hot water line systems. Another alternative to all these systems is individual storage tank can be provided for each unit itself like one apartment you can have one separate tank so that is one alternative that is what is shown here so there is a water tank for each floor consider this as a one unit so this will be one water tank for each floor so this is the best alternative when consider all the other things but depending on the design and the provisions that we can make this is how we do the hot water line systems.so this is what about the distribution network about water, water supply for large communities and individual buildings

Water Consumption Calculations

So now coming to water consumption calculations. First we look into what are the daily water requirements so pipe water supply is for any communities when we give which will be adequate for following things so when we take up domestic needs that is your residential needs you needed for drinking, cooking, bathing, washing, flushing of toilets, gardening and individual air conditioning and when it comes to institutional you have drinking, washing, everything except for your cooking and bathing and you have flushing of toilets, gardening and individual air conditioning and when comes to public purposes we have to consider street washing or street watering because we will have landscape and flushing of sewers and watering of public parks.

Industrial and commercial uses and then you need water for firefighting purposes if you have livestock you need water for that and you also consider any other wastage that will happens so you will have a percentage of wastage that has to be calculated so these are the things you should consider when you consider the daily water requirements so the ministry of health in their manual on water supply they have recommended per capita per day needs they have already done their own calculations and they given a standards kind of thing

So for communities with population up to 10,000 you have 70-100 litres is a requirement for one day for a person so then same way for communities from 10,000 to 50,000 it will be 100-125 litres and above 50,000 it is 125-200 litres. Now when we take up the national building code of India the 1983 part they recommended a minimum of 135 litres per capita per day for residences alone so the break up for that will be like for bathing you will need 55 litres this is for one person, toilet flushing for 30, washing of clothes you need 20 litres, washing the house you need 10 litres, washing utensils 10 litres then cooking 5 litres then drinking 5 litres so this is the breakup for this 135 litres that has been given in the national building code of India.

So for other buildings also they given it like this so if you see for factories where bathrooms are provides 45 when they are not provided it is 30 so like that we have a whole list of our daily requirement that is there for each and every types of hostels, hotels, offices, residents for everything they have given a consumption in per day in litres for one person so with this we can calculate the water consumption for any buildings.

So for one person we have to calculate and from that we can use the total people who are there in the building and then we can do so the calculation will be only like this the quantity of water

required will be equal to per capita demand * population. So per capita demand is the water consumption rate and then the population is the population to be serve so how do we calculate this so water consumption rate as we seen earlier we take it from the 1998 NBC which is 135 litres if it is residences, for other buildings we take this list as the norms for calculating the water consumption rate and then for the population to be served.

So when you take community is your any city or town or thing when you are doing for a large number you take the expected future population as the basics of population to be served so for that what we do is there various methods to calculate that it is like they go for the demographic method of population projection or arithmetic progression method, geometrical progression method, methods of varying increment or incremental increase, logistic method, graphical projection or comparison method we are going to the detail just to have an idea how they calculate the population to be served.

So when you take buildings especially you go for the occupancy load that is easy to calculate even for that we have in national building code from fire and safety we can see that for residential, for educational so occupant load for floor area based on the floor area for a person they have given so if it is going to be residential which is A category will be 12.5 person for a floor area for one floor area in meter square area so for one meter square it will be 12.5 for institutional it is 15 like that it is meant for all the different types so with this with the floor area we can calculate what will be the occupancy load and you multiply with the daily requirements that is also there in the NBC. So with that we can calculate the water consumption pattern.

Water Tank Capacity

Once we have this total water requirement then we can decide on the storage of water that is needed.So when we look at the storage of water needed you should see the following reasons why we need how much it should be sufficient it should provide during repairs to mains when there is a repair that is going to have happen to the mains we are dependent only on the stored water and to reduce the maximum demand on the mains, so when we store the water the mains will be we need not keep on drawing water from the mains so demand from the mains will be less and to tied to the period of intermittent supply in case there is a drought or there is some kind of situation where you cannot have a supply of water that time you can this storage of water is going to help you then for firefighting requirements of the building this is a very important point for storing water for in a buildings so when you look at the storage we will have two types where it is overhead tanks or underground tanks. Overhead tanks is your OHT we call it as and underground tanks we call it as UGT. So the general guidelines for calculating the capacity after you calculate the total required value.

You cannot give the whole thing in one particular tank either the underground or overhead tank so if you depending on the system where there is only OHT is provided then there is no underground tank you provide 33.3 to 50 percent of the day's requirement so if the day's requirement is going to be 100 litres you provide from 33.3 to 50 litres only for the tanks capacity it won't give the 100 litres tank, if this going to be underground tank you are provided to 50 to 150 percent of one day's requirement and when it is going to be a combined storage you

are going to have both the underground and the overhead tank then you split up like 66.6 percent of the required will be in your underground and 33,4 percent will be your OHT for one day's requirement so this is how you calculate and you determine the capacity and you design for a storage tank.

Now coming to water meters now we are calculated everything now we know what is the required but all people going to use this we everybody waste water so to have a limit or to have a control over the usage of water the authorities water supplying authorities they install water meters in each and every building so what are the water meters they are devices use to measure the volume of water used by residential commercial buildings which is supplied by a public water supply system any other place we need not have the meters but nowadays even in apartments we have because everybody is know contributing for the water separately.

so even there we have water meters so this is to regulate the usage of water or actually to calculate who is using how much so that we can charged accordingly so that is the basic thing so it measures the volume of water used so there are different types of water meters that can be used based on they have different methods based on the if you have to measure the water volume you use the displacement water meter, if you use the flow control to measure then you use a velocity water meter and any other measurement devise you use in the water meter itself you use electromagnetic or ultrasonic waves in the water to calculate the volume of the water that is being used we will see each of the meters in detail.

Now the displacement of water meters so I given a picture here so this is how a displacement water meter looks like so the pipes will be outlet and connected here when you see the cross section so I told you this displacement water meter is going to based on the volume it is going to give you the volume this is the device which is going to move the water when it flows through it will move up distance this is called a piston or sometimes it will be like disk so the water with the speed that comes here this will move this piston and the speed of the piston will be recorded in the meter so the piston or disk that moves a magnet it operates the water volume register this is very accurate for very low to moderate flows only for very high flows we cannot use this water meter.

Then we have the velocity water meters here what happens is for a specific volume the speed of the flow will be taken into account and then it is convert to units of volume so you see here. Here again you will have a impeller will be there so this impeller the water will propels this impeller and the speed with which this impellers rotate will be recorded and then it will be converted to units so the water flow turns an impeller which rotates at a known speed so that will be compared to the water speed and then you will measure the water. So there are different types in this single and multi-jet water meter and turbine water meter then you have the ultrasonic water meters this is a very advanced meter here you see this the thing so this is how it looks like outside so sound waves will be sent through the water so water will be flowing and sound waves will be sent through it so that will be measured and the speed of the sound waves will be measured and that will be converted to the water volume this is very accurate and a smaller point 0.05 litres can be calculated using this there is a cross section for this you see this you will understand so this is what the upstream and downstream is there so you will have a you know you have reflectors here

so the ultrasonic waves will come here reflect here and then the go back so with this they will calculate.

So upstream and downstream transducers and receivers they reflect the signals and they in the flow tube this is the flow tube which we saw previously here this is the flow tube. So the time difference used to calculate for the waves to go and come will be taken into account and from that they will calculate the thing so this is your water.