Building Services I

Lecture 3

Piping System

Now when we take a piping system there are some basic principles that we have to follow so the first the few basic principles we will cover in the first few slides. The first and the foremost thing is to we have to avoid contamination because when we say water supply and sanitation they are going to be one inflow and outflow so there should be no cross connection between the pipe and the fittings of the wholesome water that is the supply portable water and the impure water and then provision of reflex or non-return valve can be used a substitute when there is a possibility where you cannot you have to give a cross connection then you have to give a non-return valve then the next important thing is there should no backflow towards the source of supply whatever is incoming should not return so particularly from cisterns and appliances which is contributing for the impure water so there again you can use the reflex and non-return valve to prevent the backflow.

The next thing will be like the supply which is delivered it should be only when it comes to or when it is the pure water or the portable water supplied as an alternative or stand by for impure water in case of flushing of toilets so it has to be delivered only into the cistern not directly then all pipe work should be water tight so there should not be any wastage of water and also there should not be any damage to the property because when there is a water leakage and there is going to be floods in the building then it is going to be a damage to the property and also to reduce the risk of contamination then no piping should be in a close proximity to any sewer or like sewer fixtures or anything of that nature not through any material whose nature will be like undue deterioration of the pipe should not happen because it is passing through that material.

So the piping when we lay the pipe we should make sure that it is not passing through the materials which will detoriate thepipe. Then adequate precautions should be taken when pipes have to be laid along with or in close proximity electric cables or in corrosive soils there will be the soil types it is corrosive you cannot do anything about that or when it is going very close to the electric cables you should take proper precautions how you can do it is the properly protected by exterior tubes even additional tube exterior tube which will come in contact with the corrosive soils and to reduce the frictional loss the pipe should be as smooth as possible the inside of the pipe should be as smooth as possible.

The problem will come when you join the pipes for that the jointing methods applied you should avoid the method so that you don't have internal roughness or any projections in the joints so it should be very smooth the inside of the pipe should be very smooth also to avoid undue loss of head there should be change in the diameter and change in direction when you do that it should be very gradual otherwise there will be a loss in the head.

Now underground piping when you laying at depth or it isit should be a sufficient depth so that the pipes are going to be laid where traffic is going to be there it not be the major roads but still within the complexes you will be having dry ways and all those things those places only we do underground piping so there it should not be damaged by the traffic rules or because of the traffic there will be vibration on it so these thing should not damage the underground pipes so you take sufficient precautions or the pipe should be taken sufficient depth then boiler or such machinery when you supply things water from these to these machinery it should be from a cistern it should not go directly from the supply pipe.

So overall due attention should be paid when you design a piping system maximum rate of discharge should be there or required economy should be there whatever the labours or materials you are using, protection should be there against any damage or corrosion and protection from frost depending on the place we are laying the pipe if there is going to be snow fall and there is going to be a chance of frost it should protected from frost that is why it is given if required, avoidance of airlocks there should not be any airlock because there will not be any continuous supply of water then noise transmission the water which is going to travel up flow or down flow there should not be any noise transmitted from the pipes and unsightly arrangements when you are fixing the pipes above ground it should be so that there is unsightly arrangements so for that what they do is they try to put the pipes along the projections like balconies or cupboards or something like that or you provide shafts for the pipes so that it is not have any unsightly arrangements so doesn't disturb the aesthetic of the building.

So these piping system when we take majorly or commonly for a building you will have these following thing single stack system, single stack partially vented, one pipe system, one pipe system partially vented, and two pipe system.

So when you take single stack system this is a one pipe system, one pipe system means there will be a only one pipe for the whole building like only one pipe will be distributing water to all the water closets, sinks, wash basins and all those things and here will be no trap ventilation in a single stack system there will be no trap ventilation. Trap ventilation is all the fixtures will be connected to traps this is where the foul smell or any bad smell should not come inside the building so for that use trap and that traps has to be ventilated but when you go for a single stack system there will be no trap ventilation if it is going to be a single trap partially vented or it is called one pipe partially vented in this thing one pipe system it will have a relief vent at the top here you will have the relief vent.

Let us see one pipe system in detail here so this is going to be your main pipe which will be taken down so your S is for sink WS is for wash basins this will be connected to the floor traps and this is your floor level FL is your floor level and then you have your water closets so this is how it will be connected and then all the things will come and join in one particular pipe so this is one pipe system and when these traps are ventilated it is one pipe single stack partially vented or one pipe partially vented system.

Then one pipe system so in this you will see it in detail so when you see here see his is the floor level you have your sink you have your bath floor trap your wash basins and your water closet so you see you can see that everything is taken in one pipe so everything is connected in one single pipe and it is taken down so this is your main vertical from there you get your connection and this is how you taken down so the thing that is going out that will be in one pipe so this goes directly to the building drain so this is what one pipe system is. So waste from sink, bath, and wash basins and the soil pipe branches are all connected to one main pipe so the gully traps and waste pipes are not used in this but all traps are completely ventilated when you see here so you will understand this better in the next thing where you see the two pipe system.

So in this if you see you can see that wash basins, bath and sink is put in one connected to one pipe and the water closets are connected to one pipe so this is what we call as two pipe systems. The inlet for sink also it is separate for this and the water closet so this is what is two pipe system so where soil and waste pipes are distinct and separate so the soil pipes if you see it is connected to the drains and the waste will be connected to the gully trap so if you see there this is directly connected to the drain but this will be connected to a gully trap here and from then it will be connected to your building drain so all traps here will be ventilated so this pipe is here you can see the ventilation at the top so this is your ventilation so all the traps will be ventilated in a two pipe systems so these are the major piping system you have in a building.

When coming to the piping materials any material you use for the pipe it should conform to the code of Indian standard we have a building national building code there you have all the rules and regulations that should conform all to that code. Generally the various materials of the pipes are cast, steel, reinforced concrete, pre-stressed concrete, mild steel tubes, copper, brass, wrought iron, asbestos cement, lead, polyethylene, and unplasticized PVC pipes.

Now when you see lead pipe, lead piping that will not be used for domestic water supply because there is always a possibility for lead poisoning the water so what we do is if we have to use lead pipes it can be used for flushing and overflow pipes you can use lead pipe. Where the water coming out of it will not be used again so this is also liable to corrosion so when it comes to contact with your fresh cement and concrete so it should be protected suitably and it is not mostly used nowadays. Coming to copper piping this is used for mainly hot water installations it has good corrosion resistance except in acidic condition so PH levels to be maintained when you are using copper piping.

Then you have steel and iron piping for most of the building industry traditionally these are the piping materials that are used so this is like this pipes iron pipes or steel pipes you had a possibility of having internal and external corrosion was possible so this is used only for outdoor use and for internal plumping we don’t use steel or iron pipes then came the polyethylene pipes and PVC pipes so these pipes they are high resistance for corrosion when compared to your steel and iron pipe but the problem is you cannot lay it in close proximity to hot surfaces or hot water pipes you cannot bring it together so it is corrosion resistance, lighter in weight,

but it susceptible to physical damage when you expose it above ground when sunlight falls on it the ultraviolet rays from the sun it will make the pipe brittle and it can easily get damaged.

So the latest thing we use nowadays is the CPVC piping which is the chlorinated polyvinylchloride so it is used in water and sanitary systems for hot as well as cold water distribution so this is the thing currently being in use it has a better corrosion resistance and high tolerance to acids also it is also light weight and it is nontoxic and odourless so it has many advantages over all the other pipes all other pipe materials so we prefer CPVC piping nowadays. Now coming to plumbing fixtures.

A plumbing fixture is nothing but an exchangeable device so it is connected to an plumbing system so it delivers water and certain fixtures will drain the water so the common fixtures we have seen in our everyday life they are bathtubs, bidets, channel drains, drinking water, hose bib, kitchen sinks, showers, water tap or faucets, valves, urinals and water closets this we are familiar with bathtubs, showers, and all those things. Bidets, bidets are used for hygienic purposes in European countries was mostly used for washing purposes and hose bib, hose bib is like thing pipe that connects from your washbasins to the outlet.

So there is a selection criteria for all these things we have to follow the codes usually but before that all pipes, valves, taps and other fittings that is used for supply of drinking water purposes or for removal of waste water. They should not contain harmful substances that is the first requirement and they should be capable of handling nominated water pressure so water any water whether it is pressure or non-pressure it has its own pressure so the pipe should be capable of handling the pressure pipes fixtures and everything. Then it should be able to withstand external pressure so if it is going to be buried underground when the pipes are going to go underground the external pressure as I told you the traffic will be there people will be walking about, machinery will be there so it should be able to withstand the external pressures also the vibration the pressure that comes from the vibrations then it should withstand the impact of environmental factors like heat, cold, expansion, contraction that will happen because of the climate change and corrosion, PH, bacteria levels though you monitor PH and bacteria levels that will fluctuate so even when there is going to be a fluctuation the pipe should be able to withstand all these factors.

So when selecting materials for water supply pipes these are the main points that has to be kept in mind water pressure, water temperature, compatibility to water supply, durability, support, ease of installation, cost. Ease of installation is a very another important thing because jointing is because we cannot have so the height of the building is more than that the length of the pipes so jointing is has to be very water tight and that installation has to be that is what we call it as ease of installation should be considered when you are selecting the pipe for the water supply pipes and cost is the another factor when coming to plumbing fixtures the plumbing fixtures we select should be free of sharp projections or sharp corners and adequate clearance should be there in water outlet and overflow level when it's going to be a tap kind of thing so the outlet and overflow there should have adequate clearance otherwise there will be a

backflow when you take sanitary fixtures it has to be durable, smooth, and impermeable to water because we have to have very hygienic fixtures these things are very important, no hidden surface that can become fouled or polluted so the sanitary fixtures should not have any hidden surfaces or any crevasses or anything so the water will stagnate there or it will any pollution can happen because of that both internal and exposed outside surface accessible for cleaning the sanitary fixtures are internal and the whatever exposed surface is there it should be easily accessible for cleaning and then the other thing should be the fixtures we saw as these fixtures.

These fixtures will be having additional thing like fixture trap we should be able to fix trap to the fixtures otherwise we cannot use that particular plumbing fixture so these trap will prevent the sewer gases entering the area we saw that earlier itself we need traps and traps have to be ventilated so these traps will prevent the thing coming into the area where we are using the fixture then we have to design it so that the incoming water is through an air gap there should be no backflow so for that we need an air gap so the fixture should be able to have an air gap in that if the air gap is not there. So The next for that appropriate backflow prevention device we have backflow prevention device we have valves for that so these valves we should be able to fix the valves to the plumbing fixtures so the where air gap cannot be provided like we saw this hose bib where portable or flexible hose being used the tubes have been used there we should have the backflow prevention device.

Domestic Hot Water System

Now coming on to domestic hot water system the accepted method for domestic is we have to use only storage heaters but when it is going to be like large area there going to be many number of units where you are going to supply hot water system then you can go for a centralized system. When you use storage system means what happens is the water is steadily heated up. There the water will be heating up will be very study and temperature can be set predetermined so predetermined temperature will be there and the water will be stored then you can use it so that is the main usage of storage heaters and we have to use it for domestic purposes storage heaters are highly recommended.

The storage temperature we saw we have a predetermined storage temperature it has to be 60 degree Celsius that is the recommended thing because why we have to maintain this is this will minimize the danger of scalding, precipitation of scale from hard water if the water is going to be hard the precipitation will be there the scale of precipitation will be there and then standing heat losses when it is kept for a time the heat will be lost so that standing heat losses and risk if steam formation so if it is overly heated there will be steam formed and the possibility of explosion is there and possibility of damage to porcelain or other fixtures will happen so the storage temperature should be 60 degree Celsius when the storage capacity is limited then you can go for 65 degree Celsius can be adopted but there should be soft water should be used you cannot use hard water for that.

Now coming to storage capacity, now it is governed by the maximum short time demand that is needed for the domestic purposes so when you see at 60 degree Celsius if you have a storage water heater it should be of 50 -75 it should be able to supply ok 50-75 litres for a bath tub and it is going to be for showers where you use bucket for supply it should be 25 litres will be enough so when you calculate the storage capacity it should not be less than 20% in excess of required if you require 100 you can have 120 litres capacity so that is the storage capacity we look into so for domestic purposes the small heaters are 15-25 litres is an ideal for a dwelling for any residential unit so this is a norms given in the NBC where you have the volume of hot water required when you mixed to usually mixed with cold water before using it so that the storage temperature is given here 75, 60, 55 all those things how much hot water is required how much required for 115 litres for bath how much required everything is given here so based on this you can also you can calculate the capacity.

Then coming to storage design tank design so the shape should be oblong or cylindrical so that when you install it the longer side should be vertical why we do this is because when the water is heated it will heat up in layers so for that the longer vertical side longer side should be vertical when you install the storage tank the materials used for this tank it should be resistance to chemical action of water which is being supplied and then the installation should be restricted to one type if metal one type of metal only like the cold water that is been fed to the storage tank and the hot water that is being taken from the tank to the taps so all the pipe materials and the storage tank material everything should be of one metal only you cannot mix metal in that because the temperature expansion coefficient will differ for metals when you use different metals so the recommended thing is the copper or all galvanized steel is the material recommended for hot water system.

Now coming to the storage tank when you location of the storage it should be placed that the pipe will run with the most frequently used outlet not a very rarely used outlet most frequently used outlet should be connected and it should be as short as possible so these water heater should be fed from a cold water storage tank it should not be from the water main it should be a separate tank and from the tank only you can connect the water heater not directly this cold water tank which is going to supply to the heater it should be at least twice the hot water capacity and it can be reduced to 1.5 times if it is going to be connected to more than 10 numbers then you can reduce the capacity to 1.5 but it has to be at least twice the capacity of your storage heater

Solar Water Heating System

Now when you heating system nowadays solar water heating systems which is becoming very common nowadays so what solar thermal do is they harness solar energy by utilizing the radiations and they generate heat so that heat is used to heat your water or air or by steam so you will hot water or hot air or steam will generated from this and that will be used in turn to heat your water or the thing so when you take solar water heating it can be deployed for many applications not only for water heating like in power generation or large scale they use solar for

space heating is space heating if you are want to heat the room like air conditioning so space heating and space cooling and community cooking in large areas like hotels or your communal spaces there you can use this for cooking purpose and process heating this picture shows a typical solar water heater.

Now this water heater it has a collector so this picture will show the details of how a solar water energy system is so you have your PV panel on top of the roof it has always to be placed on the sloping side facing the sun so from there it goes to a solar storage tank we have a tank here so here it is connected to this tank there you have the then you have the boiler here and you have a solar station which is where it controls the temperature and then it goes to the these are the pipes where the consumer will use the water so it has a collector to trap the this the PV panel collector which will trap the heat energy and then the heat is transferred to the pipes and tubes so the tubes will get heated and the heat in the tubes will get transferred to the water in the tank the total system with solar collector, storage this whole system is called the solar water heating system the collector, storage and the pipe lines everything together we call it as solar water heating system.

Using this solar we can raise up to 80 degree Celsius so and by recirculating the same water whatever heating know it keep on recirculating it you can get up to 80 degree Celsius when you come to solar water heating system we have many developed so much that we have many types in that we have active and passive they are the major types this active type it will have machinery like circulating pumps and control will be there in passive nothing will be there everything will be natural.

So when you take Active solar water heating systems there is direct circulation system and indirect circulation systems so in passive we have integral collector storage and thermo-syphon systems we see bit about this in the next slide ok. When comes to active solar water heating systems the direct circulation system what happens here is the pump circulate you have a pump here it will circulate the water in the pipes so the cold water will go in it gets heated and then it comes out so the energy from here it pass through the pipes and the pipes will heat the water so these warm water will come here and will get heated up and goes out as a water outlet. The water cold water inlet is here so pumps circulate household water through the collectors and it goes into the home so this is the best use the direct circulation system is for climates where there will be no freezing of water will happening so in areas where the water is going to be freeze there you have indirect circulation system here what happens is instead of the water here you have an anti-freeze solution so these anti-freeze solution will get heated up and then it will come this is the heater exchanger coil so this will be heated up and that will in turn heat the water in the tank.

So the pumps circulate a non-freezing, heat-transfer fluid through the collectors and the heat exchanger so will heat the water this is very much used in a climate where you have freezing temperature or the water might freeze then integral collector storage passive systems this is the passive system where you can see here there will be no pumps and nothing will be here this

thing so here you will have a large volume of water will be stored here so here it will get heated up and it will come down to the thing so this is best in where again you don't have any freezing and when you have more day time those areas we can use this particular passive system then you have thermo-syphon system here this will have the tank in the above and the collector at the bottom so what happens is as the water heats it goes up so there is no mechanical process here at all it is a natural convention so the water comes down and gets heated up it goes up and then it goes and get collected in these tank so that is why this is called a passive system so water flows through the system when warm water rises as cooler water will sink so the collector will be installed below and the storage will be above so this is the passive thermo-syphon system for solar passive solar water heating system. These are very reliable because it can be attached to the roof design this is the picture we saw in the first slide so it is more expensive than any other the previous one the integral collector-storage passive systems.

Now the application when comes to solar water heating systems when you look at the applications it is not only for simply heating water you can also have combi-systems which will be used for room heating and also cooling also we can use process heating system the first two things we used like heating water and heating the space room heating and room cooling are the things we use in a residential buildings.