Water Supply Engineering
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Lecture - 12
Surface Water Intakes

Welcome back friends. We will continue our discussion on water sources intake and conveyance what we started in the earlier lecture. So in previous lecture we discussed about what are the various available water sources and what are the major criteria for selecting a water source for the purpose of public water supply projects.

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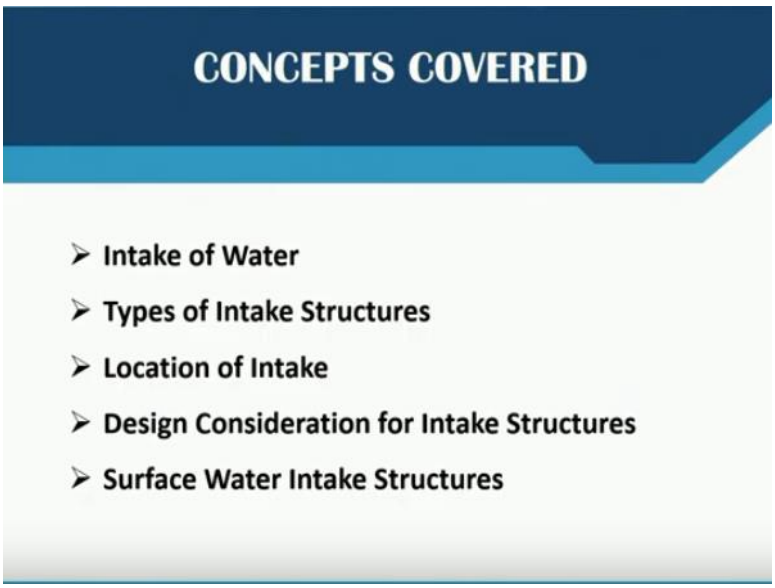

This class we are going to discuss about the abstraction of water, which is the intake of water. So what we are going to talk is the different types of intake structures. Then, what is the ideal location of intake or how we select a location of intake. Then the design consideration for general intake structures and we will be then starting discussion on the various structures which are used for the abstracting surface water, so practically the surface water intake structures.

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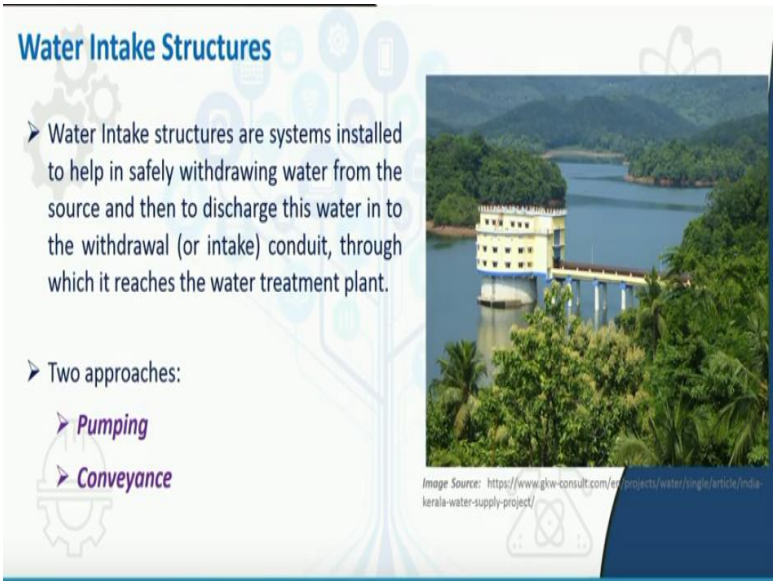

Now, the intake structures are typically the systems which are installed for withdrawing water, okay. We discussed about sources. So water is available at source but in order to make that water, convert that water to basically potable standards or purify or treat that water and then supply to the end consumer we have the first step is to withdraw water from the source.

So for the purpose of withdrawing water from the source we use typically intake structures. So these intake structures are the systems which are intend to safely withdraw the water from the source and then to discharge this to the what we call as withdrawal conduit or intake conduit. The role of this is actually to take the water to the treatment plant, okay.

So like in previous lecture we were discussing that we have transmission stage of the water. So withdrawing water is through the intake structures and then putting the water into the conduit for transporting it to the next stage which is actually the water treatment plant. There are two major approaches, that one is the pumping and another is through conveyance.

The most cases the intake structures would have certain type of pump okay because water is usually aligned in the low areas. In some cases if say our source is at higher elevation and we want to take the water to the lower elevations, so then we may not need pumping, we can directly use conveyance systems, regulated pipe lines or regulated other floor regimes channel regimes for transporting water.

So it could be pumping, it could be conveyance or it is actually the combination of both in most of the cases. So water is pumped and then it is put through a conveyance system and then is brought to the next stage, okay.

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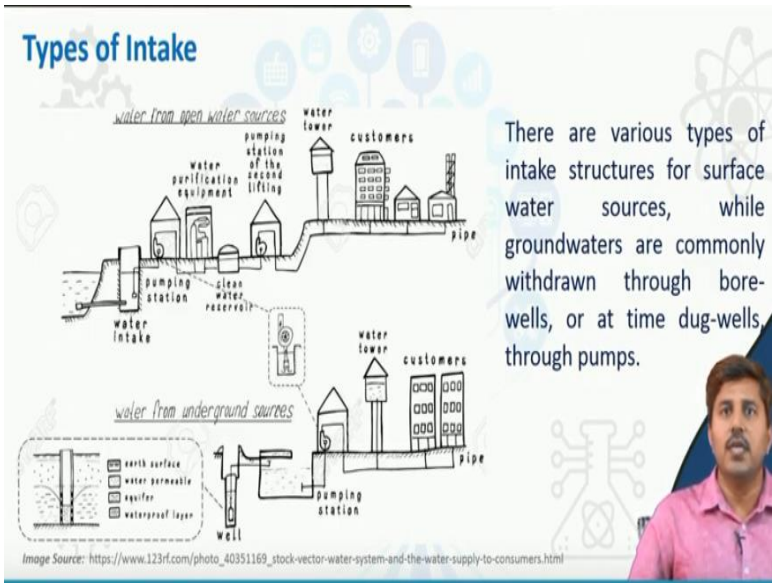

Now there are two major sources or places from where we abstract the water okay. One of them is surface water, another is groundwater. Even the other sources which we studied like sea water or what we call as rain water or atmospheric water. So all that will be pumped from primarily either from the surface or from the groundwater. If you have to abstract sea water it is similar to basically extracting water from a big lake or a river or a reservoir, okay.

Similarly, the water which actually seeps through the subsurface will be pumped as we are actually pumping groundwater. So there are various type of intake structures for surface water sources okay and ground waters will be commonly withdrawn through the help of bore-wells or at time dug-wells and then we pump that water. So there are two major approaches, withdrawal of surface water and withdrawal of the groundwater for the purpose of supply.

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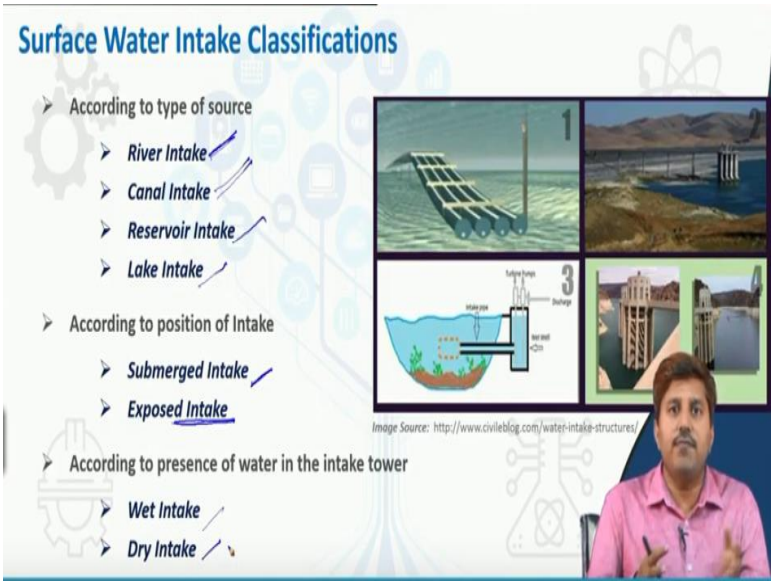

Now based on the as we said that for groundwater abstraction, we will have to have a well, either a dug-well or bore-well and then we pump that water through that well. But for surface water, again there are various types of intake structures available and it can be classified based on the different criterias okay. So if our criteria is the type of source then we are going to have, if we are withdrawing water from a river, we will say that a river intake okay.

If we are withdrawing water from a canal it becomes canal intake. If you are withdrawing water from a reservoir or dam it becomes reservoir intake and similarly withdrawing water from a lake or pond it will be actually lake intake okay. Now that is one criteria depending on the nature of the source. Then the intakes can also be classified based on the position of intake.

Position of intake means either these intakes would be submerged in water or they would be exposed in the atmosphere. So if they intakes are submerged in the water they are known as submerged intake and if they are exposed in the atmosphere or they are actually exposed to the open, so these type of intakes are called exposed intake. So we can classify the intakes as submerged intake are exposed intake as well.

There is another way or under criteria to classify the intake and that is basically the presence of water within the intake structure okay. So within the intake we can have wet intake or dry intake, means if the water is not there inside the intake, inside the

intake well or tower whatever we call that, we call that dry intake systems or dry intake towers, dry intake structures.

And if the water is there within the intake itself we call that wet intake. So we will discuss all these in the like coming slides, okay.

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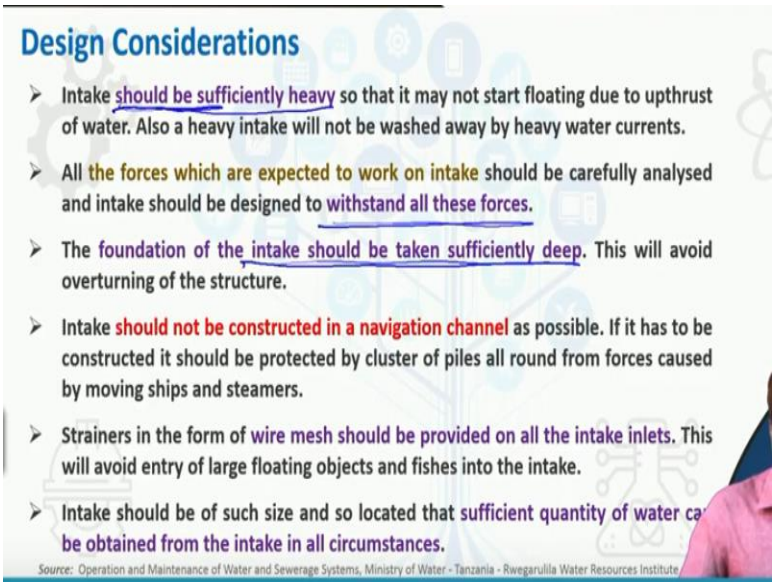

Now there are certain things that we need to very cautiously see when we plan to design intake structures or in fact choose intake structures what kind of intake we want to provide, okay. There are certain design consideration that we need to follow okay and these are important in the point that these are related to the to the idea that how a intake should function, okay.

So first and foremost thing it should be sufficiently heavy, okay. The intake structure that we are planning particularly the like surface water intakes because the groundwater intakes are as we discussed there are simply dug-well or bore-well. But the surface water intakes which is to withdraw water from surface should be sufficiently heavy.

Why should be heavy because it is trying to withdraw water from a water body okay. In most cases in general cases let us say if it is river or those kind of thing, so there is possibility of a thrust working on the intake structure, okay. Anyway when we are putting intake in the water or whatever part of the intake in the water so there is bound to be an up thrust okay.

So a heavy intake will be able to sustain that up thrust, okay. It will not be washed away when there is a say heavy water currents particularly in the river, okay or in the lake also like the it can easily negate the effect of the buoyancy forces. So that is why a heavy intake structure is considered better okay. Now another point is because we are installing a structure in the water or part of structure in the water okay, the intake may be exposed also.

So then it is not in the water but then also there is some part of the intake will be in the water. So if we are installing that kind of structure in the water, we have to see what are the various forces acting on the structure, okay. There will be various forces acting on the structure and we have to have a good understanding of all the forces that are going to act upon.

And we have to design the system so that it can withstand all these forces, whatever forces are acting on the intake it has to be sufficiently robust system, so that it can withstand all the forces which are acting on this. There will be buoyancy force, there will be water current forces, there would be the dead load of the intake, the kind of what kind of soil is there.

So all everything has to be analyzed properly and see what are the drag forces, lift forces, so all the forces has to be kind of understood properly and must be incorporated into the calculations when we tend to design a intake. For the same reason, the foundation of intake also should be sufficiently deep. Remember we are working in a structure which is in the water.

So again because the nature of the water and the buoyamcy forces and these thing and then up thrust that water will put on the structure, we have to have a very deep and strengthful foundation so that our structure is not overturned and particularly in the case of rivers, because we know that in the lakes it is still a calm water and the levels, pool levels are also more or less static.

There is variations but little, but in river we have a huge variation in the pool levels, okay. The depending on whether it is a monsoon season or dry weather season we can

have very low flow, we can have very high flow. So the kind of thrust that will be put on the structure might actually overturn it. So we will have to have an idea of how like what kind of foundation should be provided so that it is strengthful enough to retain the structure as opposed to these heavy loads as well.

Another point is it should not be constructed in a navigation channel if possible, okay. So if let us say your river is having, is providing a pathway for navigation system, board, steamers and those kind of things, so that should not be obstructed. So it has to be kind of seen that it is properly not disturbing the ecology of the water body itself okay and does not hampering the navigation and those things if it is being used for that purpose.

So this is only valid if navigation is taking place in the system or if it is applicable, okay. So if it has to be constructed, again there has to be proper protection with cluster of piles all around this so that it remains protected and safe. There should be wire mesh based strainers installed on all intake inlets because water enters through the inlet in the intake, okay.

Whatever structure we provide either let us say we are providing a well for abstracting groundwater. So there is a point from where water enters into the well, okay. So if we do not provide any protection, all the sediments debris or other things may enter the well and then when you pump that water it will actually spoil your pump. The quality of water that you are going to pump is also going to be very poor.

Similarly from surface water, I am sure all of you have seen the kind of status our rivers are in. You go just cross by any river you will see lot of floating materials and like flowers, tree leaves, then there are plastics, wrappers, polythenes all these means several things are there in the river and when you try to abstract that water, you have to have a system to prevent these entering into your inlet.

Because from there you are going to pump water. So there has to be a strainer provided, which is usually a wire mesh, which can stop all these floating materials entering into the intake, okay. So this will generally avoid entry of the large objects,

fishes and those kind of animals also will not enter into that. So that kind of protection is also to be provided in a intake structure.

And intake should be of such size, that sufficient quantity of water can be obtained in all circumstances. So as we discussed one of the, in the last week, last class also that one of the important aspect of withdrawing water or one of the most criteria is that it should meet the water demand in all conditions and so our intake has to have sufficient capacity that it can withdraw the sufficient quantity of water in all circumstances okay.

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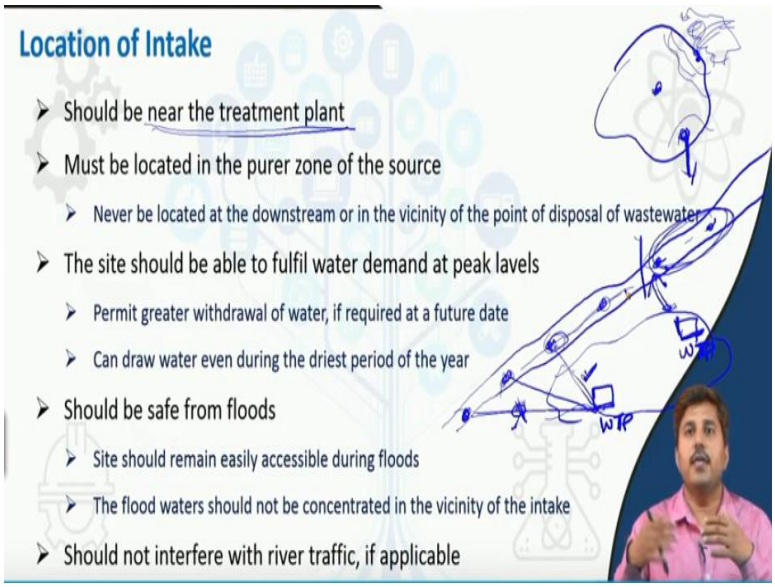

So that is some of the design considerations which are important for conceptualizing or putting intake systems. Now for selecting location of intake, again there are certain criterias which should be followed for selecting location of intake. This also is mostly applicable for surface water because groundwater intakes ground waters are available everywhere. So we can select a suitable location and pump water from there.

But surface waters are available at select places. You cannot have a river just flowing beside any point of your choice okay. If a river is there in the city wherever it is located it is located. You cannot move on like shift that river. Similarly, the location of ponds, lakes, in most cases reservoirs are all fixed, okay. So in such cases how do we select an appropriate location of intake, okay.

Let us say for say this is my town or city and I am actually having a river flowing like this okay. So for purpose of selecting intake I may have a intake, I may select intake here, I may select intake here, I may select here, I may select here, I may select here, I may select, there are various options. Now which one to choose or how to select or if you are say having a lake okay.

If say this is your lake, so whether to withdraw water from this point or withdraw water from this point or withdraw water from this point. So then there are various options available in same way. Now how we select appropriate location of intake, first thing the intake should be near the treatment plant. That is one preferential criteria but is not mandatory.

Preferential why for one simple reason because after withdrawing water from the source through intake, the next stage is to basically transmit this water to the water treatment plant. Now if the intake location, let us say here is my water treatment plant for this city, okay. This is my WTP. Now if I select a location here, I have to basically arrange transport to this distance.

If I select a intake here I have to arrange transport to this distance and if I select a intake here I have to transport to this distance. So obviously, transporting water for long distance require more amount of energy and more amount of costs. So I would not prefer this. If there is no other criteria, okay we will talk about other criterias also, but if there is no other criteria, I would certainly not prefer this okay.

I would, this is intermediate stage, I would not prefer this also over this. So probably this is giving us the least cost and least energy requirement for transporting water from river to the point of treatment. So this location is better as opposed to these two locations. So that is one criteria that as close to the treatment plant the intake is it is actually better in terms of saving the cost for transmission of the water.

Then another criteria is must be located in the purer zone of the source. So because from let us say particularly in the case of river or just I was giving an example of lake. So let us say you are having more like population living here. So this part of lake will

obviously be more dirty and this part of the lake might be more might have actually better water in terms of sediment or some other criteria.

So why not select water, withdraw water from here as opposed to here okay, which might actually be require more degree of treatment okay. Or particularly in the rivers, okay. So rivers again if you are having say a industry here, which is disposing effluent here. So of course this zone of water is going to be having lot of lot more pollution as opposed to this zone of water, okay.

So whether to withdraw water from this point even if say your water treatment plant is here, okay, say your water treatment plant is here. But if you should still not withdraw water from this point because this is not a zone where the water quality is good. Rather you should target to withdraw water from here or here or anywhere upstream to this zone where water quality is likely in a much better condition.

So the point is that one should select a zone which is actually relatively having better quality of water, okay. The general convention is that the disposal of wastewater is usually done to the downstream of city and the withdrawal of water for supply is usually preferred from the upstream side of the city.

So as we were just giving example, if this is my river, if this is my city or town, I withdraw water from here, treat it in my WTP, then supply it in the city, collect the sewage, treat it and then if I have to dispose off the sewage I dispose in the downstream. Because at the point of disposal you expect the water quality to be not as good.

And you do not want that zone spoiler zone to be there somewhere in the city because here people will be using for different purposes and as water is getting some contamination some channel and these things will be entering. So for purpose of water supply, it is best to withdraw water from the upstream. So the point is that the withdrawal point should never be located in the downstream or vicinity of the disposal point.

So if let us say here is my another community living and they have their wastewater disposal point here, so then it is totally not advisable to have basically withdrawal point just downstream the disposal point, okay. So then we will probably have to choose some other point or maybe even if it is far we will select a point from here point here to withdraw water and bring to this place okay. So that is another criteria.

Then the site should be able to fulfill water demands at peak levels. So as we discussed whenever the requirement is highest, the intake location that you are selecting should have because in rivers you know that some places might not have adequate depth, some places do have good depth. So you have to select a place where sufficient water depth is there.

That even in the lean patch, even in the driest period, there is sufficient water which you can basically withdraw for the meeting the peak demand of the water, okay. So the site should permit greater withdrawal of water if required at any future date and it can draw even during the driest period of the year. The structurally wherever we are choosing a location of intake it should be safe from the floods okay.

So generally, we choose a site which is not that affected by the flood, it is not that flood is coming and then all our like entire intake system is submerged in the flood and we are not able to access it. So the site should be easily accessible during the floods because this is the time when people gets into the crises and they do need water supplies. So the site should be accessible during the floods as well.

And the flood water should not concentrate in the vicinity of the intake, that also should be seen, okay. Further it should not interfere with the river traffic if any, so as we were just discussing if there is navigation and those kind of thing, so the system should not, basically the system that we are installing should not interfere with the traffic, river traffic, okay.

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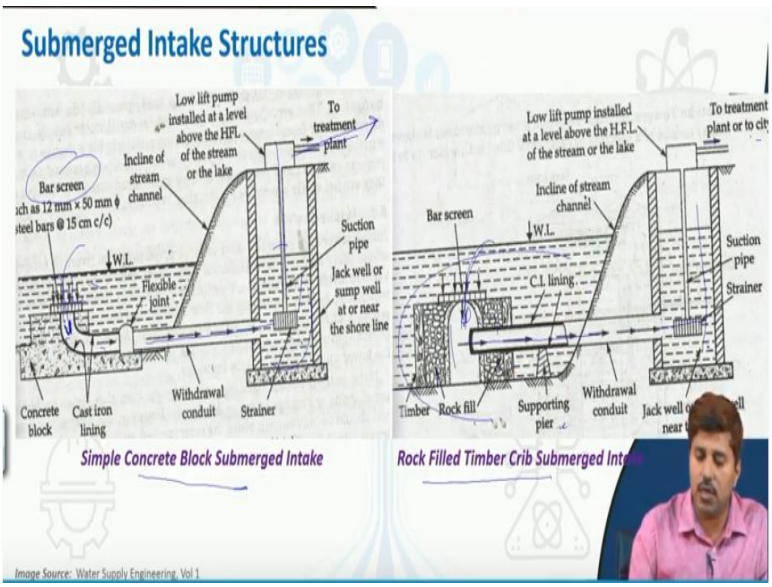

So as we were just discussing there are different type of surface water intake, okay. So we discussed that there would be submerged and exposed intake structure and then based on the sources there are river, lake, reservoir or canal intake structures. Then wet or dry intake structure. So we will be discussing all that but to begin with the submerged intake structures or exposed intake structures are distinguished based on how they are conceptualized.

So submerged intake structures are the generally which remain submerged in the water as the name itself suggest. So they will be mostly built in the water. From top will not be able to see much of it. Whereas exposed intake structure, a large portion of the intake tower or intake chamber is actually exposed and can easily be seen. So submerged intake structure, this actually couple of examples of submerged intake structures as you see.

So this one is simple concrete block submerged intake. So what you see here that let us say this is a river or lake generally lakes for lake submerged intake structures are more used. So let us say if this is a lake, and we are we can have a pipeline over here, then this is the water level in the lake. We can have a screen here. Through screen water enter in this pipe, which is actually a withdrawal conduit.

We can have some flexible joint over here and then water reaches to this well from where we can actually pump water to the treatment plant. So this is a simple concrete block. These are basically concrete block which supports the point, the pipe and we

lay the pipe over this. We can actually have some machinery work over here and then there is a strainer, which is actually the bar screen to prevent the debris and other things entering into the pipe.

And this brings water here, which is typically a jack well or sump well and then from here water can be pumped. Similarly, we can have a Rock filled timber crib submerged structures. So this is again a simple similar design in fact. The pipe will come here and then we will have lining of the pipe. We can have certain supporting pier and instead of direct water entering into the pipe, we have a timber block to prevent this thing and then a rock filled.

And then we can provide a lining, concrete lining also. So we create a chamber and through screen water first enters in this chamber and from this chamber water is taken to the our jack well or sump well and then it can again be pumped to the treatment plant. So that way the like we can have structures and these are all since these are all submerged in the water so we call them as a submerged structures.

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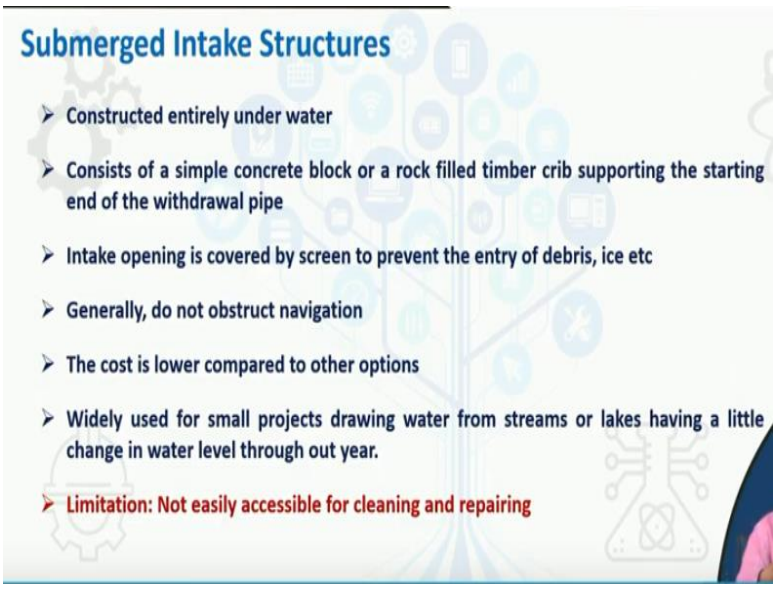

Now the submerged structures are constructed entirely under water as we were just discussing. They do consist a simple concrete block or a kind of rock filled timber crib which supports the starting end of the withdrawal pipe as just we were discussing. The intake opening is covered by screen to prevent the entry of debris, ice these kinds of materials. They generally do not obstruct navigation.

Because they will be just inside of a lake okay not in far off and even the sufficient height for navigation is left and from out on site it is not visible also. There is like the cost is low as when we compare it to the other or exposed options, these are very simple to lay down. They are widely used for small projects drawing water from lakes particularly but in some cases streams and rivers also.

However this protection in case of streams has to be provided properly because it is in the in stream and then when the higher thrust of water comes, it should not be actually kind of eroded or those kind of protections has to be insured. So that is very important and for that reason it is more preferred in the lakes. But in streams also and rivers also particularly for small projects, these can be installed, okay.

And it has to be seen that the it has to be installed at a level so that it gets the water throughout the year, particularly if it is being installed in the streams. Because streams as we discussed water level fluctuates, so it has to be installed at the low water level so that even in the leanest patch or driest period of the flow also we get sufficient amount of water to withdraw from.

The major limitation is that it is not easily accessible for cleaning and repair because it is submerged in the water. So the maintenance part is a bit tricky. We will have to kind of see that how to maintain such a system and then because it is in the submerged condition so maintenance part also has to be done under the water or you basically if you are planning to take out and maintain this thing.

In fact the construction is also under water itself. So all the maintenance part is has to be done under water and that is why that is the tricky part and that is what prevents the major installations of such systems.

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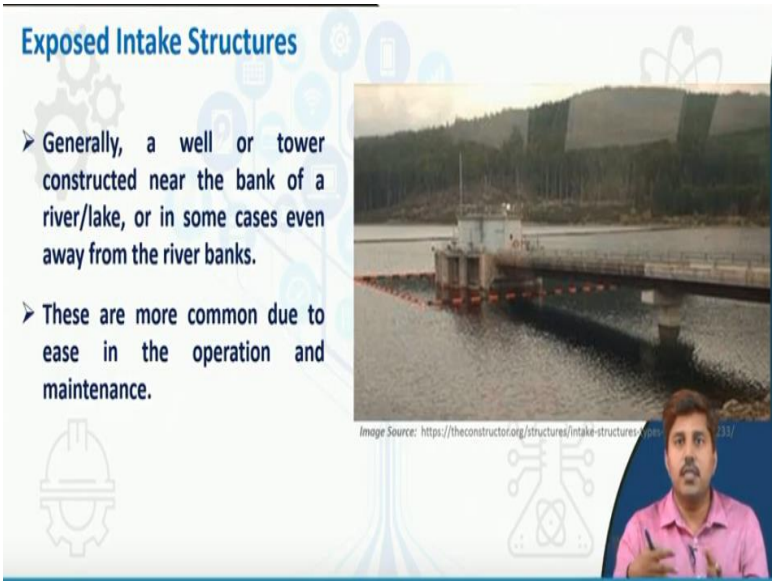

And particularly for large setups or large systems these are generally avoided okay. For small scale setups, the submerged intakes might be used. Then the exposed intake structures are generally a well or tower which is constructed near the bank of a river or lake, okay. In some cases, it can be constructed away from the riverbank also. And these are more common due to the ease in operation and maintenance.

So because they are exposed system it is they are easily approachable. So any maintenance work or any like, daily operation control works is far more easier as opposed to the in the case of wet intake towers, okay in the submerged structures. So the exposed structures have these distinct advantages and that is why they are more commonly preferred.

And particularly for the large systems when we want to install such systems in a reservoir or in rivers, they are more commonly used. For lakes submerged systems are more common, but lakes also might have exposed intake structure. The bigger lakes particularly might have exposed intake structure for withdrawal of water from the lake. So with this, we end this discussion for this particular lecture here.

In the next class, we will be talking about various other, in fact as we say that the intake structures can be classified on various grounds. So wet and exposed is one ground but as we discussed that based on the source so we have different intake systems. We may have different intake systems for river, reservoirs, ponds, lakes or

canals. And so we will discuss these different intake setups in the next class. So thank you for joining and see you in the next class.