Ground Improvement
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Lecture 27
Dewatering

Hello, good morning to everyone. Let us continue to our Ground Improvement topic Drainage and Dewatering and this is a topic and that module and already I have taken one lecture on it about drainage and today I will try to discuss some of the aspect on dewatering and of course, every module I am trying to do in five, five lectures and initial four lectures will be general aspect, design requirements, et cetera and then there will be one lecture covering the application with the illustrative problem.

So, today, last lecture, I have tried to give you some information regarding the drainage. Today, I will try to give you some information and some importance, requirement, utilities, all those things about dewatering. And this dewatering already I have mentioned that many in the previous some of the ground improvement techniques, we have mentioned that some of the soil can be improved by some technique, but if the water table is close then it is difficult to do it.

And in that case actually if you want to use that type of application, then you need to do water or lower the groundwater table to facilitate that type of application of ground improvement technique. Here actually we are not going about for which purpose we are dewatering in general, how to do dewatering, what is the need and all those things about that we will try to discuss and let us see that first slide.

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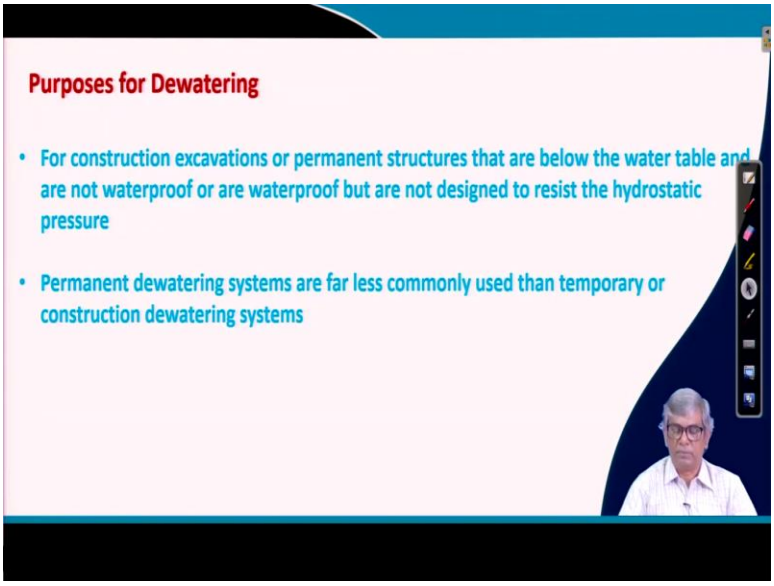

It is purpose for dewatering it is already I have mentioned that most of the for-construction excavation that means, when you want to build a building or anything else you need to have foundations particularly if the shallow foundation, then you need to excavate and if it is deep foundation, obviously, you generally a pile foundation can be done without excavation, but sometimes is required to excavate up to some depth.

That means construction excavation like foundation or some other thing. For excavation time if the water table is close to that or it is under water table then it is very difficult to do the work and also for sometimes some permanent structure also if we do not allow to water table be there are all the structure below under water table. Then in that case also you have to, you can do dewatering.

And of course, though there are two types of application as the construction excavation and the permanent structure lower are both in both purposes actually, we use dewatering but if you see in the practice that dewatering is required or used most of the cases in permanent not permanent cases permanent dewatering may be very rarely used otherwise it is mostly used for construction dewatering construction excavation type purposes.

You can see here that statement is given a second statement is given you can see that permanent dewatering system are far less commonly used than the temporary or construction dewatering

system. That what is the meaning of it? That means the permanent dewatering system is very rarely used until unless it is very essential and continuously running the pump and dewater remove the water from the groundwater, it is very, very expensive one and maintaining is very difficult.

Of course if somewhere, it is essential, it can be done otherwise, in most cases during construction if you face some water table or suppose some of the ground improvement application or some method you use and if it does not permit the water table to be close to the ground surface, that time also you dewater. These are the main purpose of dewatering.

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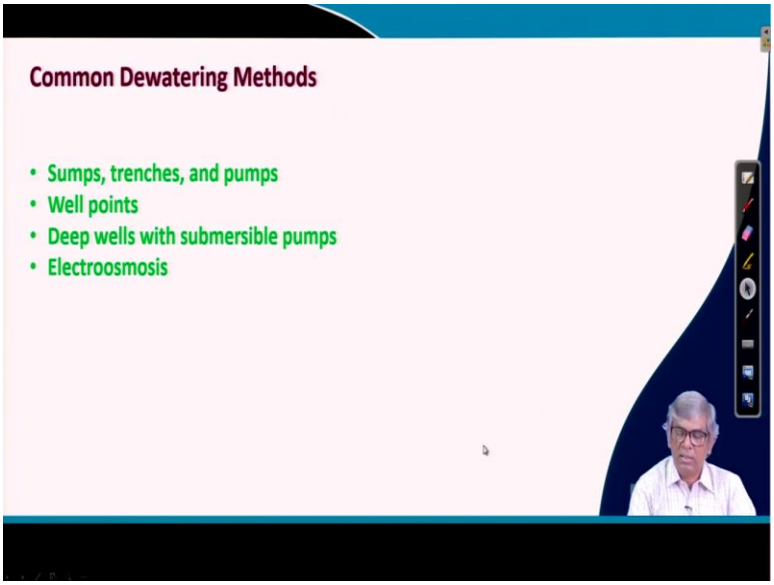

Let me see this. Then there are different ways that dewatering can be done. Dewatering means actually what the original ground level is somewhere and to facilitate the construction or, or other activity, you have to lower the groundwater table, how you can lower the groundwater table? You can pump water, and generally, water table means actually maintaining parallel through ground surface and will be horizontally maybe infinitely both sides will be extended.

But when you dewater or pump water for a particular location, then actually in that location water table will be lowered, it is not it will be the curb when I will show you all details, I will discuss later on that how the dewatering after dewatering so in originally, what are the groundwater? It is a horizontal one or parallel to groundwater ground surface.

And when you pump water, then how the groundwater table looks like that, we will see that and that means in a particular location, where you want to have the construction, you can dewater. This is the so that dewatering that means the lowering of groundwater level. The different ways this lowering of groundwater table can be done. And such there are four methods I will discuss here and maybe one method is I have not mentioned but it is attached to that.

There is a Sumps, Trenches and Pumps. That means you can make a sump and then trench and then by pumping in water will be collected there and that water can be pumped out that is actually the simplest way and when actually little amount of water or less amount of water and to be removed, then this technique can be done.

And that is a well point's the number of well can be installed and those wells should be connecting to the common pipe and then from their main pump can be operated through and to draw water from different wells and then collect in the main pipe and discharge some. That is well points and well points second can be of different single well point that means one level of well and by one level of well actually we can lower up to certain depth.

And then if we want to lower further then you can whatever level you have excavated lowered, after that you can excavate and then you can install another level of well point and then further dewater that area and then it will be further lowered at that zone and then again you excavate like that multiple well system also will be there. Well points here is mentioned, it can be of single well point, it can be multiple well points that I will again detail with photograph, figure I will show.

And deep wells with submersible pumps, they are actually again this is a larger quantity, water and water and you have to lower the water table quite deep then that the deep oil with submersible pumps are used and again sometime some soil if it is a permeability is high then with deep wells with submersible pumps maybe suitable, but sometimes if the permeability is low so that area sometime, we required to use in addition to that vacuum.

That is two types, deep wells with submersible pumps and deep wells and vacuum together with submersible pump that also can be there. I have not shown here separately, I will show the figure in the separately there and then there is electroosmosis, when the permeability is very low, then

by supplying electricity, we can collect water and you know one of the electrodes and then and from there actually, you can put install pump and collect water and that way actually dewatering, lowering of water table can be done.

This is actually there are four different methods by which we can lower the groundwater table. This is actually common method of dewatering that is sump, trench and pump, the well point's, deep wells with submersible pump and then electroosmosis. Let me go to one by one how they work.

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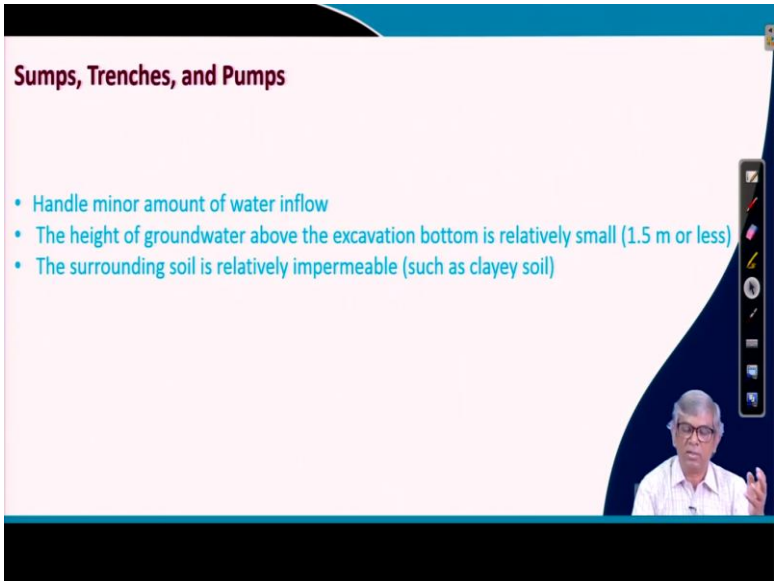

And you can see sump, trench and pumps. In this as I have already mentioned handle minor amount of water inflow. Not a large quantity of water because it is by gravity flow only. And the height of groundwater above the excavation bottom is relatively small. Height of groundwater above the excavation bottom is relatively small than that can be managed and it is actually maybe in the range of 1.5 meter.

And surrounding soil is relatively impermeable where you are making the trench and there actually if it is highly permeable, and then that again water will be drained and it will pass through the through the surrounding soil. That trench area should be relatively impermeable, so, the water will be collected there and then that water finally pumped out. This is the main

working principle of the sump, trench and pump and you have I can show you the figure corresponding to these.

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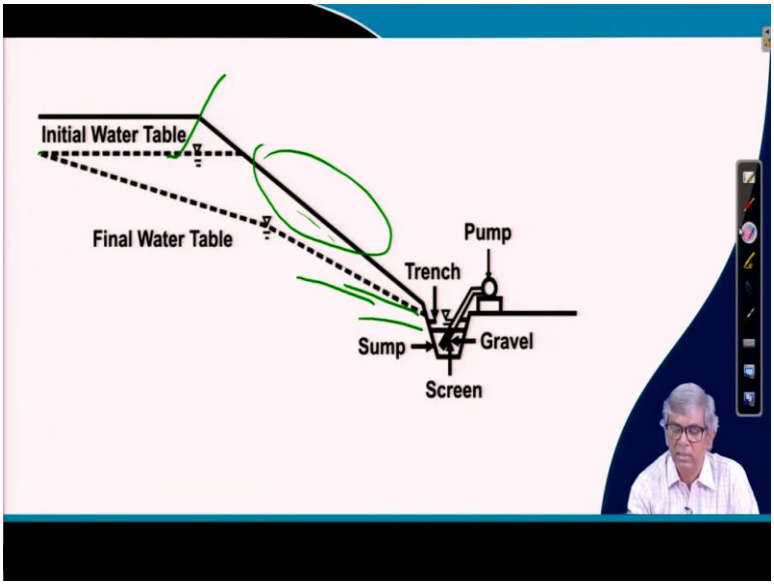

You can see here so this is the original water table you can see that original water table is here and this is supposing a slope and this slope if the water table is here then flow will take place along these and then this type of flow when take place and then there will be this slope will be maybe an endangered, so generally we try to keep water a little lower than that.

To lower this water table what you can do, we can make a trench here you can see and then this in the trench actually there will be, this is a sump actually and then through these actually this water will be entering and they are actually you can, this water when it will be in a particular level, always it will maintain this maximum of this groundwater level and the only pump will be kept here and when it will be in a particular level, then you can pump it out so that it should not overflow and again it comes by flood this area.

This is the way actually then it is continuously when water naturally it will be grabbed under gravity flow, since it is some opening escape and water will be entering to this and then if I pump it out, then again it will be water will be flowing in it and like that, if you continuously do it, then ultimately this water table may come like this finally, this will be what shape of the water table finally.

So, this is even if you do further it may lower further and when is with time actually suppose this water table effect is up to here and if you do for a longer time, and continuously the water table may extend further. This is the way this water table loading can be done. And of course, this method applicable to lower only maximum of 1.5 meter or that is what already you have mentioned.

This is a simplest method and easy and construction wise also and of course here actually when you are pumping, they are actually some screens has to be there otherwise, this one when water coming through these there will be some fine particles and those with the form of mud can enter and choke the pump. To prevent that, there will be a screen with gravel and all we used. So, let me come to next one method.

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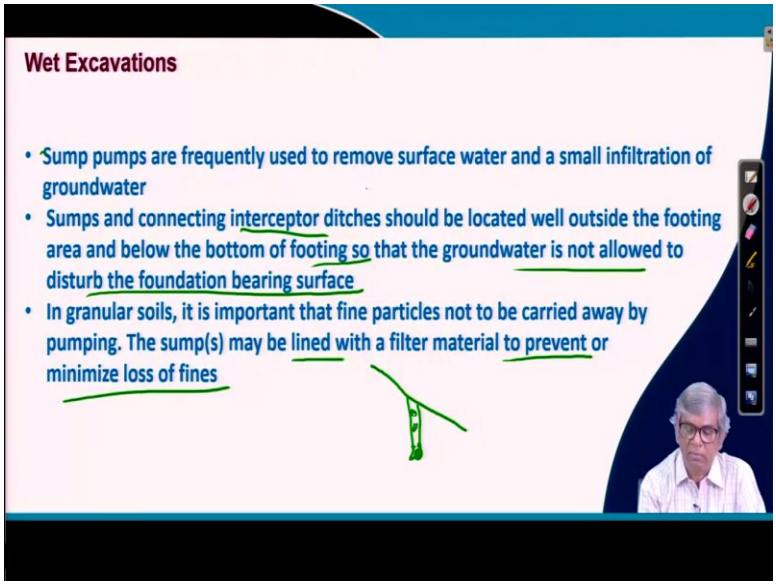

That this is actually about the precautions actually when you do by these some pump frequently used to remove surface water and small infiltration of groundwater. What there will be rain actually to infiltration and that infiltration of joining to ground or before that it can be collected to trench and through that it can be pumped out and then, then that is the that water table should not go goes up that can be maintained.

And sumps and connecting interconnected interceptor ditches should be located well outside the footing area and below the bottom of footing so that groundwater is not allowed to disturb the

foundation. What is the meaning of it? Suppose whatever trench we have shown, in addition to that, there will be some time like that intercept this is called interceptor here actually some water will be taken and then through the pipe it will be taken out.

This type of arrangement also should be far away from the bottom of the footing and the groundwater is not allowed to disturb the foundation bearing surface. If it is close to this arrangement, if you do close to the foundation, then somehow whatever arrangement would take still water table will be close, close to the bottom of the footing and which result in the lowering of bearing capacity so that should not be should that is what it is some sort of warning or precautions are mentioned here.

And, and in granular soil it is important fine particle not to be carried away. So that is what whatever I have shown previous slide that some screen has to be there and he has to make an arrangement show that fine particle should not be carried away by while flowing water, that some arrangement has to be taken. And so, to prevent to do that, to achieve that sump may be lined with a filter material to prevent or minimize loss of fines.

That is the additional things has to be considered. This is the by and large about the sump and pump method. And in that case, what are the precautions where to make the, the sound where you have to make the interceptor and then what are the other important precautions that while since water is coming through gravity flow while flowing actually it can may carry some fine particles and to prevent that fine particle you have to maybe some lining to be designed. This is by and large about the trench and pomp and sump method.

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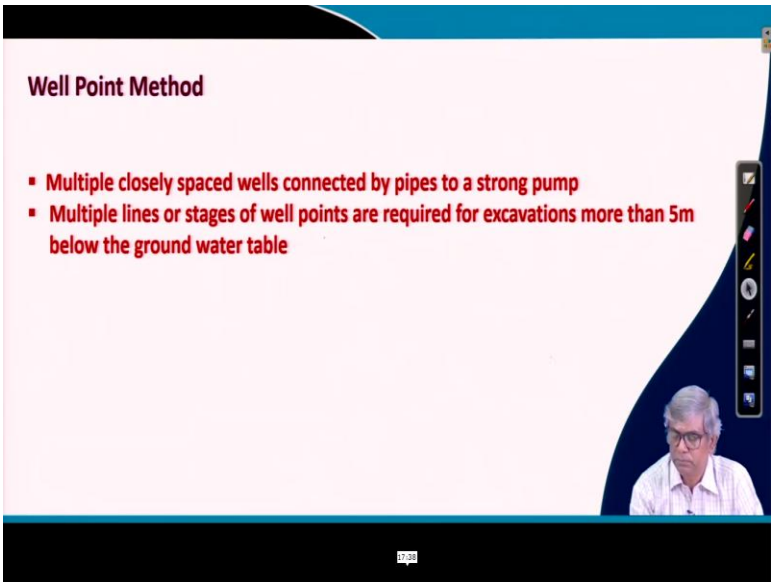

Next one will be about well point actually, this well point method and you can see that I will show the figure I have already mentioned that multiple closely spaced wells connected by pipes to strong to a strong pump. Suppose one well here like that, suppose, you have to dewater this surface and then you have to make number of wells in a line and then finally, those are those will be connected to a pipe and to a and that pipe will be connected to a very strong pump so that by operating one pump that water can be drawn from the number of wells.

That is one and then again if you want to lower for a larger area, then multiple lines can be used. you one line actually to influence some distance, then if you want to extend the influence then you can another line you can extend further your one more line like that, the depending upon your area over which the lowering of water table is required, you can design the that well point system.

The line number of lines you can do and then again another aspect is suppose by one line of well point system, you can lower maybe some 4 or 5 meter, but you are lowering is required suppose even more than actually by lowering the first level of well point, you load first and then at that level, you can do, up to that level you can do excavation, and then you put next level of well point and then again the pump water and then the lower for that well point that line of well point.

And then again that by that well point system, again will be lowering may be 4 meter or 3 or 4 or 5 meters, then again, you proceed excavation up to that depth again, if you do require further lowering, then one more that is multiple stage of well points system can be done. Like that, if you want to the extent of the extent of the lowering of groundwater, if you increase laterally, the number of lines can be increased.

And if we want to lower much deeper or greater depth then what you have to do by one line you must lower and then do proceed excavation then reached up to the level where it is groundwater already reached. And then again install another level of well point system then again lower the water table like that you can proceed. This one actually explained quite well in the next figure I can show you.

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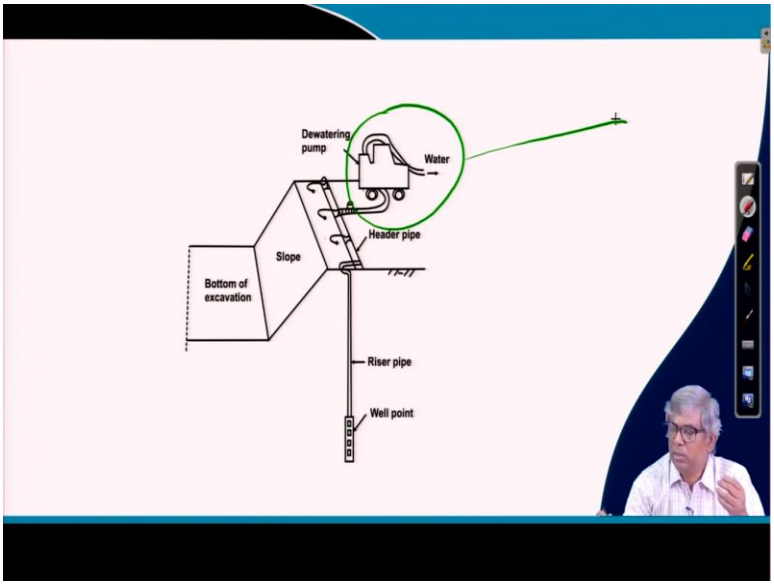

You can see here this is the actually the well actually the well point I can see only one because it is these are all well points system these are all number of them and this is the common pipe. This is a common pipe like that perpendicular to the board, there are a number of them and there will be a big pump is attached to this and when it will be operated then from all wells actually water will be entering to this pump this pipe and through this pipe it will be discharged away from the construction site.

This is the way dewatering can be done up to some depth and if you want to go deeper than what you have to do, we can see that multiple stage well point system let me go to the next slide.

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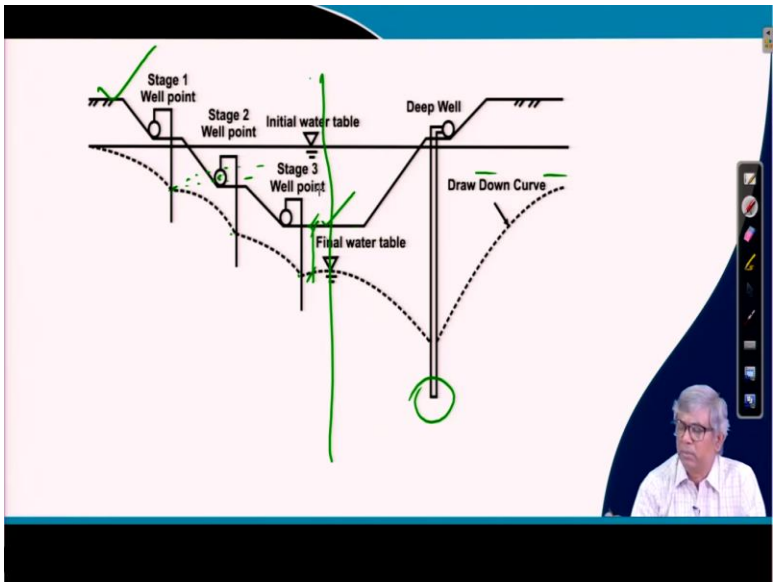

And you can see here suppose actually original groundwater level was here and then what we have done I have excavated up to this and you cannot go excavation generally up to the groundwater level little gap you have to above actually you have to stop and there actually otherwise you will not be able to this construction activity like installation of well etc it will be muddy. you will not be able to you have to keep to three feet at least above groundwater table and up to that actually you have to excavate and then install the well point system here.

And then the water table actually lowered here up to this so it might have gone like this, what like this and then or something like this, and then what do you do, you can excavate up to some distance and then you low you again install this level, another set of well point system perpendicular to the board actually, there will be a number of them and this is connecting pipe and these are our well point system.

Then by doing this again is water will be lowered further you can see from here to here, it will become this and then you can again further excavate and then reach to this level and then again install this well point system like that, you can lower the water further up to these and then you can reach up to this. So, this is supposing your groundwater or excavation level and this is

actually an always you have to keep some distance between the groundwater and the bottom of the excavation, so, maybe 4 feet or 5 feet or even 1 meter by 1.5 meter or 1 meter.

That you have to this is that actually to be maintained to maintain that we can do the multiple well point system here and alternatively, you can also do deep well, so that I will discuss later on you suppose this is the one you can do by single one actually directly you can draw water from here, then water table were directly it will come down here, this way that will explain that separately only you can see one side that multiple well point system how we are reaching from here to here and know where water table will be it will not face any problem because of the presence of groundwater table. So, this is the, the multiple well point system. Next one,

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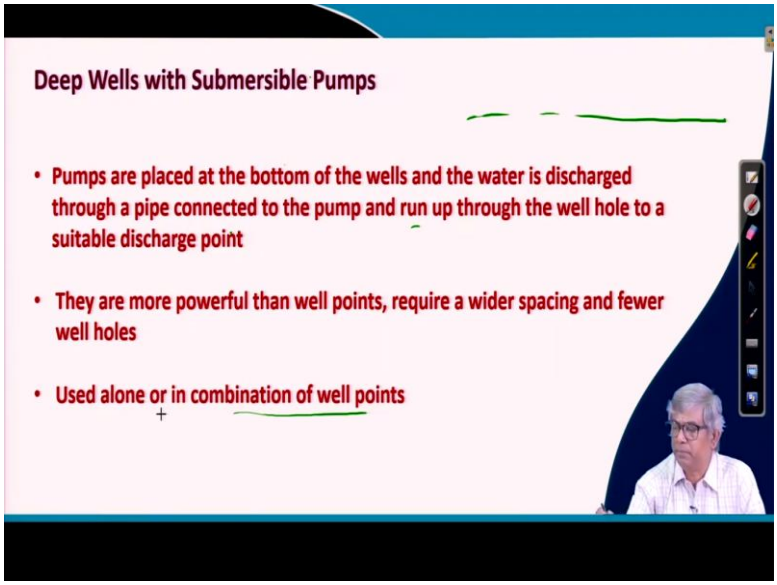

Let me come Deep wells with submersible pumps. here actually, as I have mentioned that, when you want to have water lowering of groundwater quite deep, then those methods most of the time will not be suitable, but deep well pumps if you use then you can quite deep you can do quantity of water can be discharged quite high and it can be run continuously and all those things are there.

Pumps are placed at the bottom of the wells and the water is discharged through a pipe connected to the pump and run up through the well hole to a suitable discharge point. Suppose this is the location of operation and then the pipe will finally discharge somewhere it should not be closed,

if you discharge close to the construction area a lowering area, then again it will water may again infiltrate and join groundwater table.

It has to be discharged away from the construction area. Actually, this is the arrangement that is what it is mentioned pumps are placed at the bottom we make a hole and then this pump will be at the bottom and then collecting water there will be there will be screen through which water will be entering when will be operating with the pump that I will come to the next slide and bottom of the wells.

And the water is discharged through a pipe connected to the pump that pipe will be connected and then it will come to up to the surface not only up to the surface run up then may be bottom to up and then through the well hole to a suitable discharge point. This pipe will be connected quite far actually. So that water will not join again what are discharging what it should not join again in the water table then continuously recycling will happen and never water table will be lowered.

They are more powerful than well points require wider spacing and fewer well holes. If we use well point system quite frequently act closely to place it and, and if we want to go deeper again, you have to do multiple stage, but here actually is more powerful required wider spacing. That will show how to find out capacity of well points, the deep wells etc. we will discuss some equations or some analysis will be there.

For the time being require wider spacing that means distance between the two deep wells will be quite far and still you can lower quite deep and fewer well holes will be required and then used alone or in combination of well points. This is actually whatever figure I have shown in the previously one side multiple well point and then there is a multiple well point and there is a deep well both up there. Similar to that in both way combining both can we use some time.

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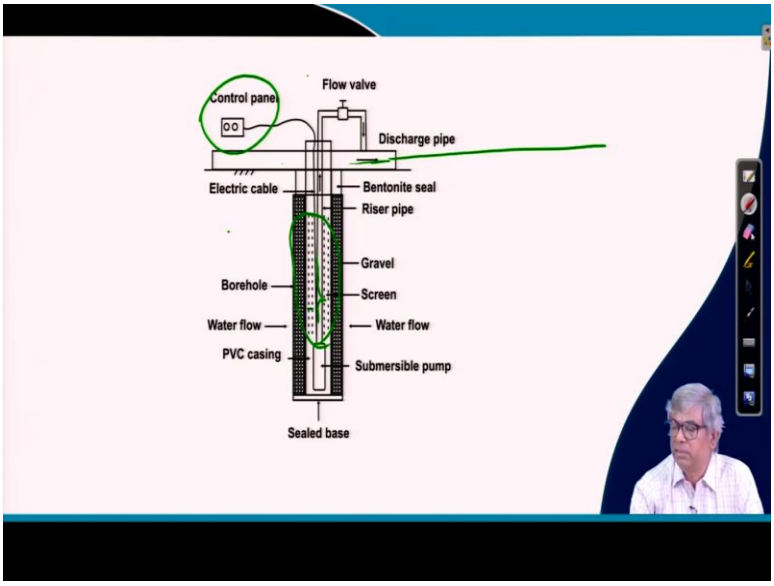

Let me come to the next point and this is the, this is the figure for corresponding to this method and you can see here this is the pump as I have told that you have to make the hole and it will bottom will be sealed with particular way, that water should be entered only collected from this level only, and this is the one actually this is the pump and this is with PVC casing and here will be screen this is the screen material.

That the only through the screen only water will enter not the fine particles would be prevented and before that there will be gravels and all would be there and bore holes actually this is the borehole and water will be flowed in this direction this direction and then we will be entering through these zone only will be entering through these zone and then it will be this is the this is the control panel and where is this motor actually it is submersible, but power will be actual control from here.

You can stop we can operate run actually based on control panel here. This is separate connection and this once again water is connected from here and this is through pipe actually will be there and then from these actually this, this is the pipe and then discharge actually far away from the construction site. So, this is the well point, deep well actually summer with deeper submersible pump.

This is the design generally will be there in the field about the design we will discuss later on. So, this is by a large the deep well with submersible pump. Let me see the next slide.

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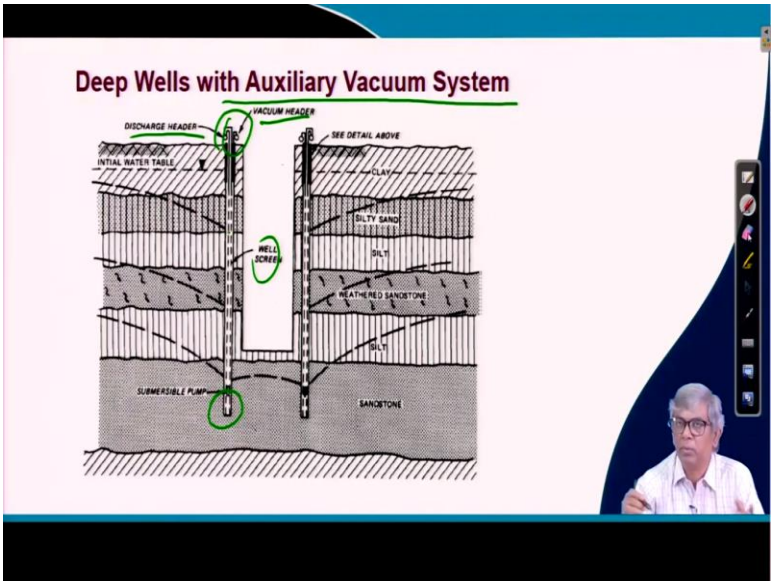

And this is actually which I have not told actually Deep wells with Auxiliary Vacuum System when the soil is sand and gravel, then by gravity actually what if you pump them by gravity actually water easily can come and quantity of water can be discharge, but if there is a soil is fine compatibly sealed or mixed with sandy silt, silty sand, then water movement will be quite slow to accelerate the movement of water we can additionally you can see vacuum header actually can be I think you can see, this is the one the well's screen here this is probably where water is entering and this is the submersible pump and this is the pump and this is the vacuum is there.

And then in addition to that, there will be pump and all additionally will be there to discharge water. This is the discharge header and this is a vacuum header and these two together can be accelerate the lowering of groundwater table particularly for fine soil, it is a gravel or sand it may not be required, but when it is a fine grain soil is there then this technique may be useful, but of course, this is expensive.

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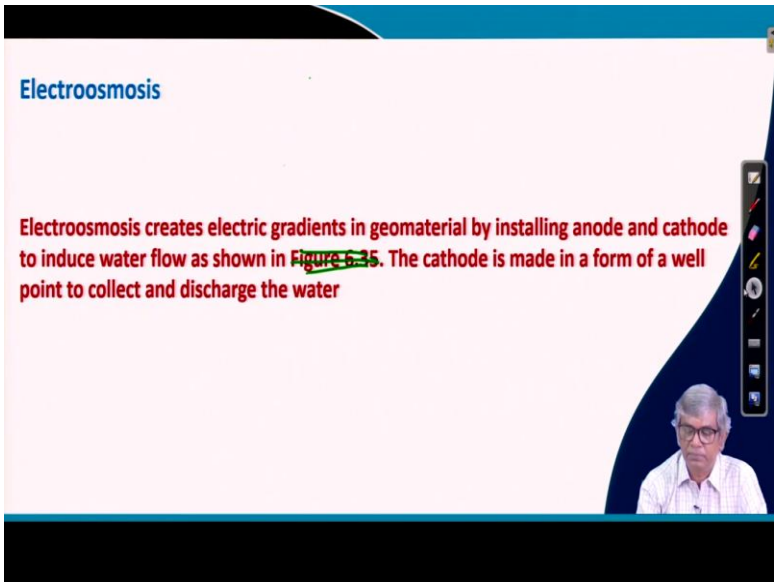

Next one, for example, Electroosmosis. As I have told you, so far, the soil should be permeability should be high. So that if you discharge water and lower in a particular zone, then from the water from the side will be moved to that zone and again it will be pumped out. Ultimately influence area will be so if I pump from here the influence it will be in initially at this point, but surely, if you continuously pump water then slowly the influence area will be increased.

Initially what if this is the bottom of the well, then you are well then you are that you are splitting line or surface groundwater level will be something curved something like that. After some distance influence will be there. Close to the well point influence is maximum but if you go away from the well point the influence will be reduced.

That means in the gravity flow it happens and but when the soil is particularly fine grain soil sealed and clay, then this type particularly clay, then this technique will not work for that actually we will need to do another method called electroosmosis.

Electroosmosis actually creates electric gradients in geo material by installing anode and cathode to inter induce water flow as shown in the figure I will show this is not irrelevant actually this figure number is not relevant here. The cathode is made in a form of well, I will show you the figure that well point to collect and discharge the water.

So, anode and cathode will be there and water will be because of the electric gradient change that water will be collected in the cathode and that cathode will be used as a well point system, where actually and pump etc will be there and then water will be, water what we collected then that will be discharged out. That I can show you in the next figure.

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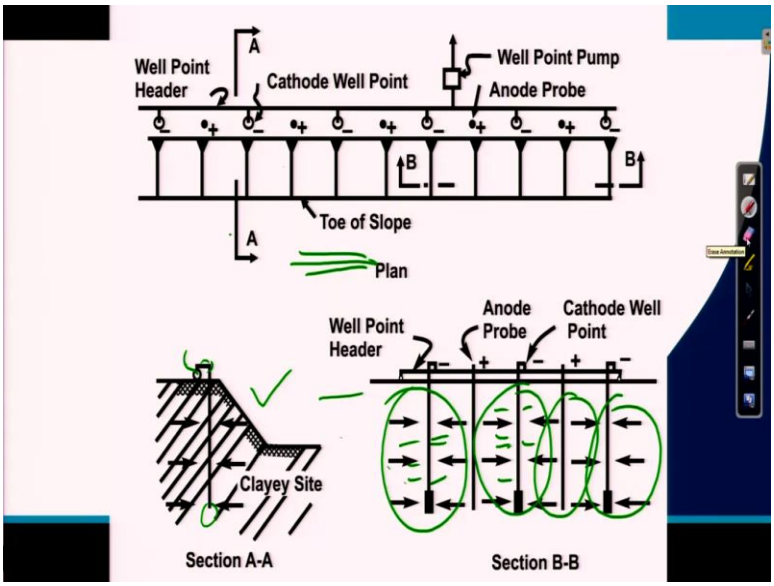

You can see here this is the typical electroosmosis, this is suppose the plan view and you can see anode and cathode this is anode, cathode anode cathode like this and if I take a section here and you can elevation if you see, you can see this is the elevation you can see here, this is the cathode point and then water will be moving towards this one and this will be treated as well point system and through the pump water pump water can be taken away and then slowly water level will be lowered.

And similarly, if I see it is a plan, plan way you can see here are BB along these if you take and then you can see here anode, anode and cathode then anode cathode I like that one by one it is there and you can see these and water when there will be electricity will be supplied then because of this difference ingredient in the soil, the water will try to flow towards cathode and you can see direction this is anode will be it will intact, but water will be moving towards this again water will be moving towards this.

That means, this area from this area this well point this area, this area or this area, the water will be collected. If I continuously draw water from these zones ultimately water table whatever was there suppose in this one and then slowly water table will be lowered with if you continuously operate this one over the time. This is by a large electroosmosis method and this is applicable for fine grain soil and will be these are all about general aspect of different dewatering methods.

We will be discussing also further few aspects of dewatering system and then simultaneously at the end will be whatever methods you have discussed how to design them. As I have mentioned that well point system if you do then you need to put frequently or spacing will be quite closer, but if you use deep well with submersible pump, then your spacing will be wider.

That is how to design that what size of the pump is required, what is the borehole diameter, what is the capacity and all though how is the spacing required depending upon your requirement that means water table was at 2meter from the ground but you have to lower suppose 10 meter that means 8 meter lowering what method is suitable.

All those things we will be discussing in the few subsequent lecture. With this, I stop this one. I will take a few more aspects, maybe in the next two lectures for completing this dewatering and drainage module. Thank you.