Ground Improvement
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Lecture 28
Dewatering (Contd.)

Hello, everyone, let me let us continue with our, Ground Improvement topic, Drainage and Dewatering which is in module six we are running and we have discussed some of the aspect we have discussed drainage, we have discussed dewatering. Further, I am continuing with the continuing with dewatering general aspect still I will be continuing now, and maybe later on maybe next to this lecture, we will discuss about design aspect and design example.

We have discussed in the previous lecture about different dewatering methods and now I will try to summarize what is what and where it is applicable etc. And then we will go further some more aspect of this, let me see the first slide.

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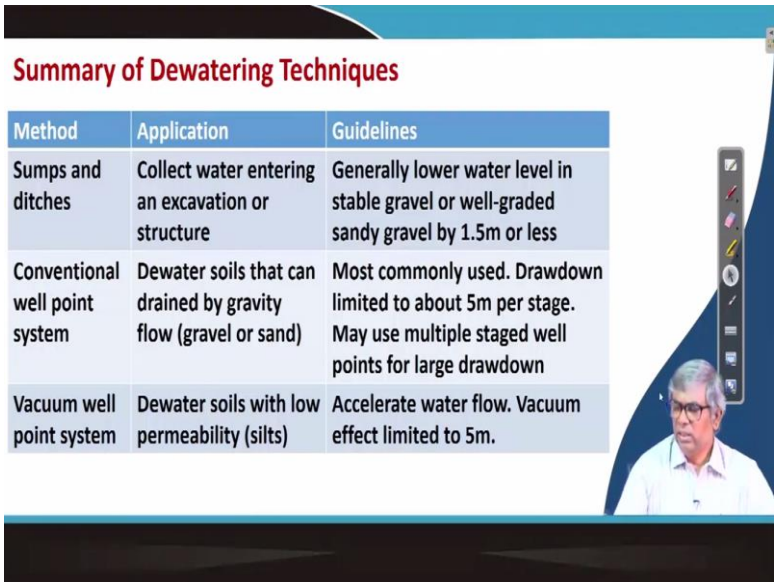

And you can see that summary of dewatering we have mentioned here and we have listed here you can see that there is a method is mentioned and then corresponding the method where it is the applicant what is the application and then how to apply there is guidelines. These three ways actually it is summarized and you can see sumps and ditches it is a simple one we have mentioned already in the last lecture and say collect water entering an excavation or structure.

When water is entering to an excavation area or in a structural area, then before that you can make a sumps or ditch and from where actually the water can be collected and the pumped out that your excavation area will be free from water and what is the guideline generally lower water level in stable ground gravel or well-graded sandy gravel by 1.5 meter or less. That is what it will be applicable only in the state of gravel and well graded the sandy gravel.

Other than that, if it is there, then this method is not that applicable. This is the one actually limitation also what is the other limitation it can only lower maximum of about 1.5 meter or less what is that when there is a requirement of 1.5 meter or less this method again can apply again further you have to verify that whether the what type of soil, soil if it is a gravel or sandy gravel then only this method can be adopted.

Similarly, conventional well point system and here actually what is the application dewater soils that can drain by gravity flow. They are actually and it will be gravel and sand again they are actually in sumps and ditches it is a gravel and sandy gravel, but well point system it has to be gravel or sand and then only the conventional well point system can work and it is most common well point system is very widely used in the industry and drawdown of course, limited to 5 meter per stage.

Because of that, if you want to lower the power of groundwater level more than that, then actually you can use multiple stage. And suppose if you want to lower more 10 meter or 12 meter or 15meter, then 3 or 4 stages of well point system can be designed and so that is all when large drawdown is there.

You can use multiple well point system and vacuum well point system again that as you have mentioned that whether it is well point system or it is a deep well submersible system that when the soil is not sand or gravel in that case that water flow will be limited and this well point, well point system may not be that effective and to make it effective then this can be additionally there can be a vacuum can be installed and that way actually that entire method can be method can be made useful.

And of course, this method, normally it is well point system, all the vacuum is used to accelerate the water flow and vacuum effect limited to 5meter. So, how much 5meter vacuum we can apply

may not more than that. Of course, you can want to do this further than multiple stage of course is their option. Then, let me go to next slide.

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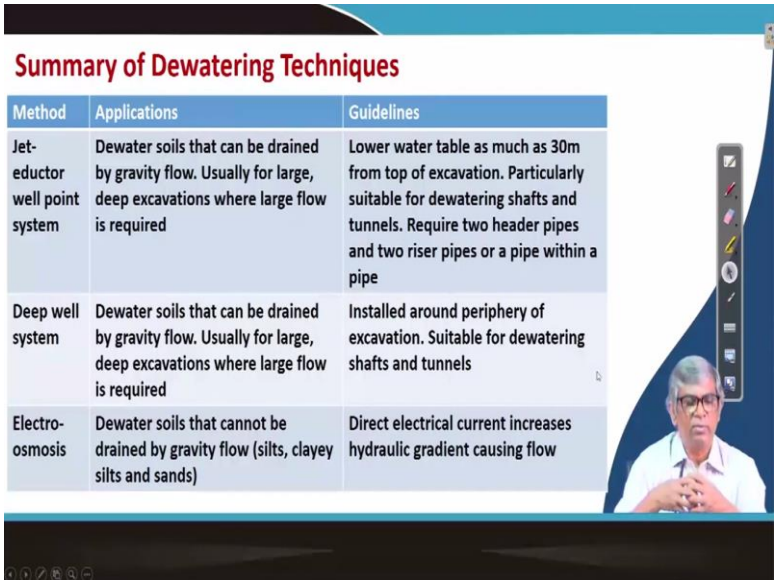

Again for a few more, we have mentioned a number of them. So, then Jet eductor well point system here actually dewater soil that can be drained by gravity flow usually for large deep excavation where large flow is required, this method is applicable and there are a number of guidelines given here and if it is applicable for lowering water table as much as 30meter from top of escalation.

That is what is application and particularly suitable for dewatering shafts and tunnels and require two header pipes and two riser pipes or a pipe within a pipe. This is the requirement of this method and deep well system this is obviously, we have mentioned that it is also lowering a large depth of water table and here also it can be dewatered soil that can be drained by gravity flow generally and usually for large deep excavation where large flow is required, then only we use this method and installed around.

Generally this deep well system, will generally if there is an excavation area we generally install around the excavation area and we will design and then that overall by the pumping of water from different well entire area will be lowered significantly.

That is what they generally there is suitable design sometimes if it is an area is quite large in that or moderate to large actually then along the periphery then at the middle may be one or two by that also it can be done. That design I will show in the latter stage. And then there is an electroosmosis method this is of course, we have discussed and when the water is not sand or gravel, where gravity flow is not based on gravity flow this dewatering is not possible.

In that case we have to put anode cathode and you had to gradient to be created between the soil within the soil and then water will be flow towards the cathode and from there a cathode will be treated as a well point system and from there water can be pumped out to take away the lower the groundwater. This is actually how we work actually direct electrical current increases hydraulic gradient and causing flow. This is the summary of all the dewatering method whatever we have discussed in the previous one. Let me go to next slide.

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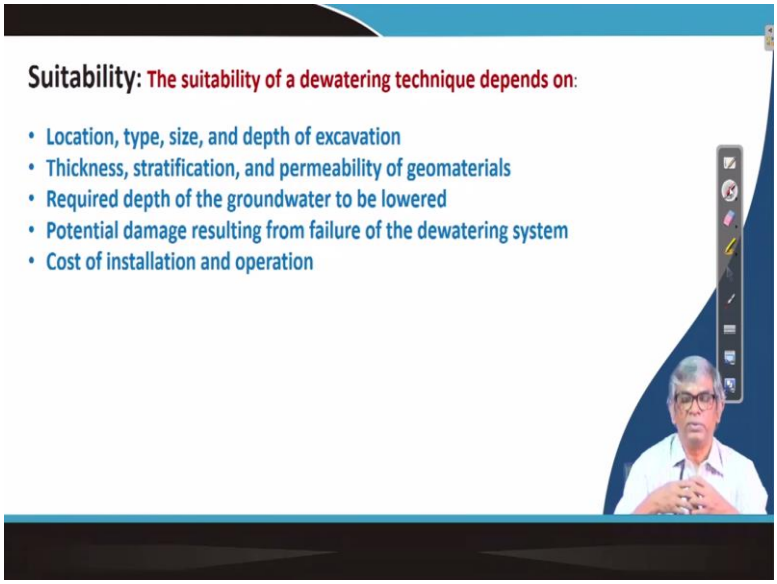

And suitability where actually we can use this the suitability of dewatering technique depends on actually, we have we have there are a number of methods and how we will be adopting a particular dewatering method. That actually depends on several factors, the most important factor is actually the location where actually you need to do then you need to what is the type of is required and then what is the size and depth of excavation. If there is a 2 meter of depth of excavation, then the method of dewatering system and if it is a 10meter depth or 5 meter of depth of excavation, the method of dewatering will be different.

That is what is, that is why it is mentioned location is important, type is local mentioned, size also what size actually area what how big is the area to be lowered, and how what will be the depth of lowering that is also influencing parameter and then thickness also and stratification, stratification and permeability of geomaterials. Again, as we have mentioned that, that different methods will be applicable for different types of soil.

Some of the methods will be using the gravity flow of water, but some methods actually by gravity flow is not enough. Because of that thickness, stratification and permeability of geomaterials it is also important to select a particular method and then require depth of groundwater to be lowered. Suppose somewhere you need to lower the 2 meters, somewhere, you need to lower 4 meters somewhere you need to lower 6meter.

That is the best on if you maybe again whatever depth of lowering is required, there may be a number of methods again may be applicable again based on type of soil and permeability again out of the number of methods, we can select a particular one which is the best suitable for the particular situation. Then, then there will be another important point actually that potential damage resulting from failure of the dewatering system from.

If I continuously dewater then there will be instability also may cause because of several reasons, we will show you some cases like if there is a nearby structure already and if you continuously lower the water and then because of that, that the effective stress will be increased and that increased of effective stress sometime may cause of settlement of the foundation which may cause the instability of the overall system. That also to be seen.

If it there is a nearby structure, there is some limitation will be there or some arrangement to be made. That we will see in the subsequent slides and then cost of installation and operation also important to select a particular method. These are the points based on which actually we have to adopt a particular method of dewatering.

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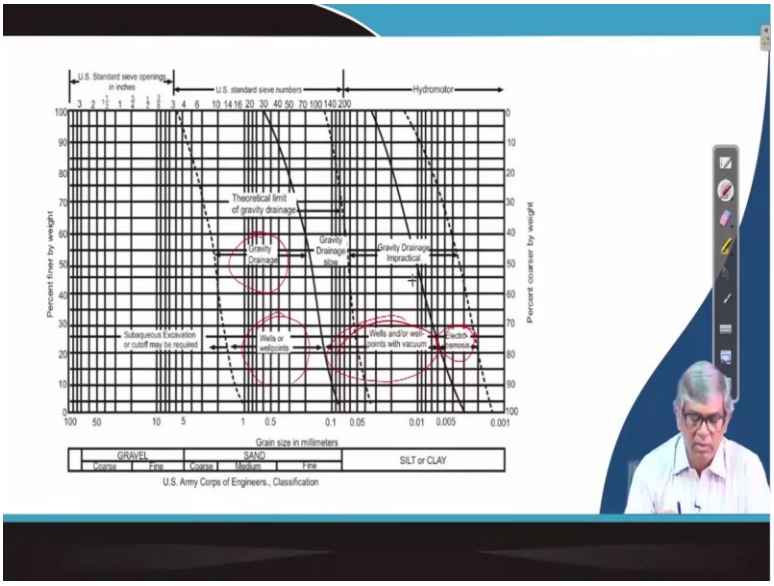

And you can see here the as the soil type is one of the important parameters and you can see here this if we see this chart from this chart actually, some of the methods are actually you can see wells or well points actually will be applicable in these zones. Similarly, and here actually gravity drain is also useful and this is the theoretical limit of gravity damage. This is the soil in a particular site, where you want to dewater there actually if you do grain size distribution and if it falls under between these, then you can adopt these methods.

Similarly, if the soil falls between these and these and these and these actually from here to here, and gravity drainage is impractical. This is not possible and because of that, you can see again the here actually you can do from here to here, these zone you can do electroosmosis and again from well wells are well points with vacuum actually from here to here, these zone actually it will be well points can be there or will point with vacuum can be used.

So, these are actually that means, this is the guidelines actually of the suitability of different methods. If a particular site, if you want to dewater, then you can collect the sample you can drew the grain size, grain size distribution from the grain size distribution, you will be able to judge the permeability or level of gravity flow possible and based on that, you can decide what method is suitable for the particular that site. These are all different you can see here actually gravity data is impractical, you well point or multiple well point whatever maybe you cannot apply that, so, water will not flow.

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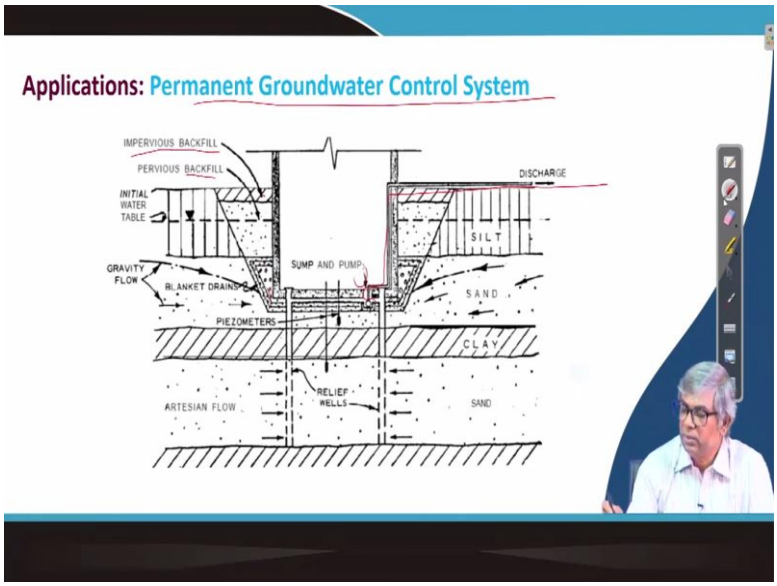

And then there are a number of applications again you can see here the application first one is the Permanent Groundwater Control System, which is actually I in the beginning I have mentioned that generally the dewatering is useful or required in the construction activities in the construction site if the water table is close to the ground, then it is very difficult to perform the operation.

Because of that most cases will do a dewater or lower the groundwater table also you can permanent dewatering also can be lowering the groundwater also sometimes we do but that is a rare use, but here this is the application is found first. And you can see this is the suppose, the particular area sump and pump is kept here and this is the area suppose permanently you have to lower the water, water table is here, then you can design this one with particular you can see the pre pervious backfill and pervious backfill here impervious backfill at the top, the pervious backfill here and this water table.

If it comes then there are some design escapes and you can see here relief wells are kept here and you can see here that these are actually sump and pump actually this is the one from here water can we drawn and it can be discharged and this is the way actually this area continuously can be kept the water table at a particular level. So, by gravity, this is one application actually sometimes we use for by dewatering. Next application let me go to,

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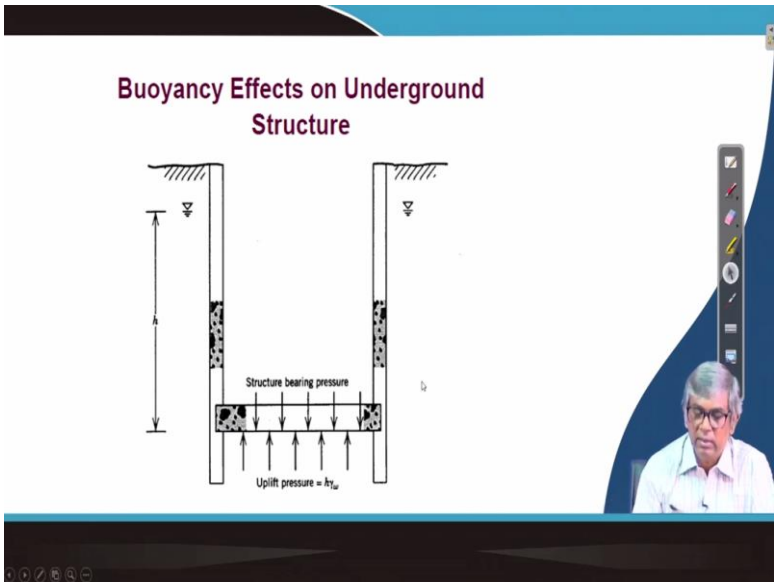

You can see here Buoyancy Effects on Underground Structure actually see if you have because, if the water table is there and then this because of this there will be uplift pressure. Because of that you can lower the water table so, that is another application and maybe we can go to next.

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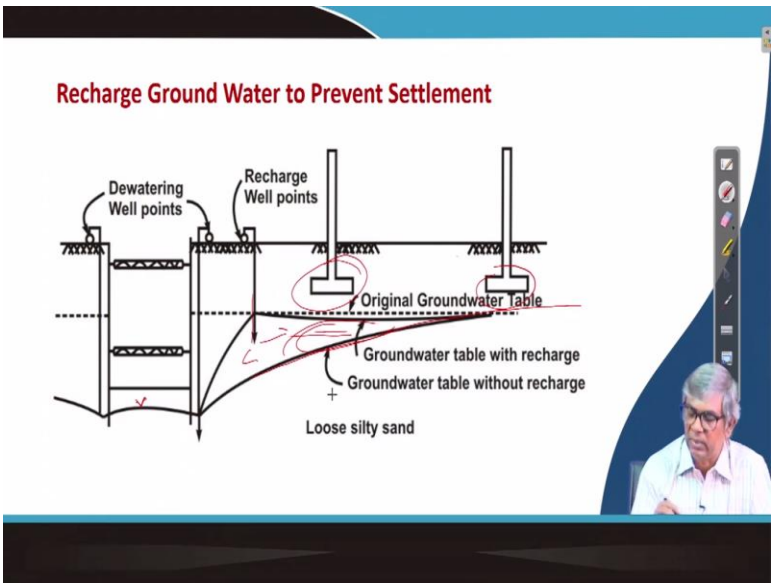

This is actually seen Recharge Ground Water to Prevent Settlement as I have told you the before that because of the lowering of groundwater table, the nearby structure may be affected you can

see here this is the dewatering system and there is some this excavation will be done for some purpose and you need to dewater and lower the groundwater table from here to here.

And when you do this then water table if I pump water from here, then water table will be this is the water table location finally, and, and what if the water table level is lowered from there to here and then what will happen because of these, this foundation this foundation may get a little affected because of this lowering of water because this foundation was originally designed considering the water table here and if the water table is lower than the effect will be at that condition is changing and that may cause some problem and if particularly if there is a consolidating soil is there it will be consolidated.

Because of that to maintain the stability, we can design another rechargeable point here and you can recharge water here this water actually will maintain water table here and but still by pumping this one you will be getting water level lowered up to this level. This is actually another application sometime that recharge well will also can be by stability by improving the stability of the nearby structure.

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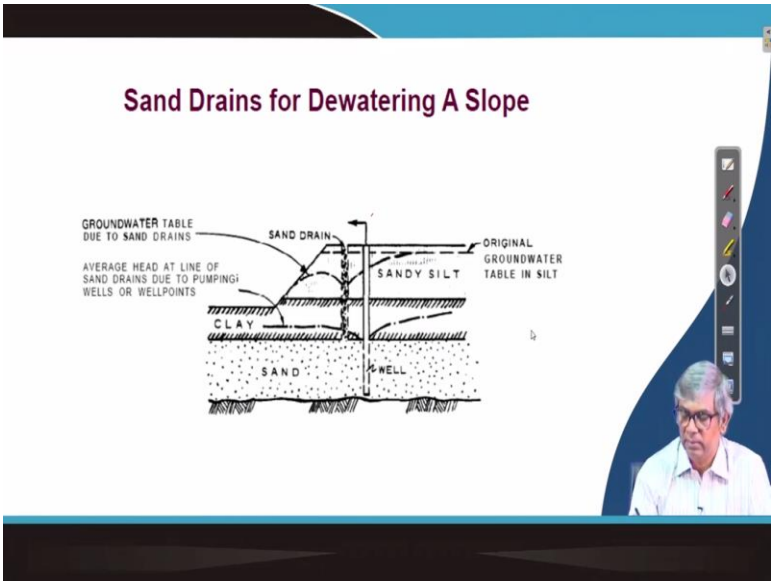

Next one and Sand drains for Dewatering a Slope, you can see here we can see this is the slope and if the water table is there, this may be harmful. Because of that you can see here the sand drains are created here and this will be connected to this sand layers. And then finally, if we put

well here and then it will be ultimately water level will be lowered like this. Though this is water table is here and this is impervious layer.

Through this drain, it can be pump and connect to these and then if I pump water from here, then ultimately these water table finally can be will be lowered like this. And so, ultimately this, the slope will be, will be having prevented from some problem whatever, because of these water table may cause. So, this is another application and you can see here groundwater table due to sand drains.

Because of the sand and this is the water table and average head at line of sand drains due to pumping wells for well points. So, when you add additionally if you do this by draining this well actually water table may low become these, but when you do this water table further it will be like this. This way actually can be designed. Let me see the next slide.

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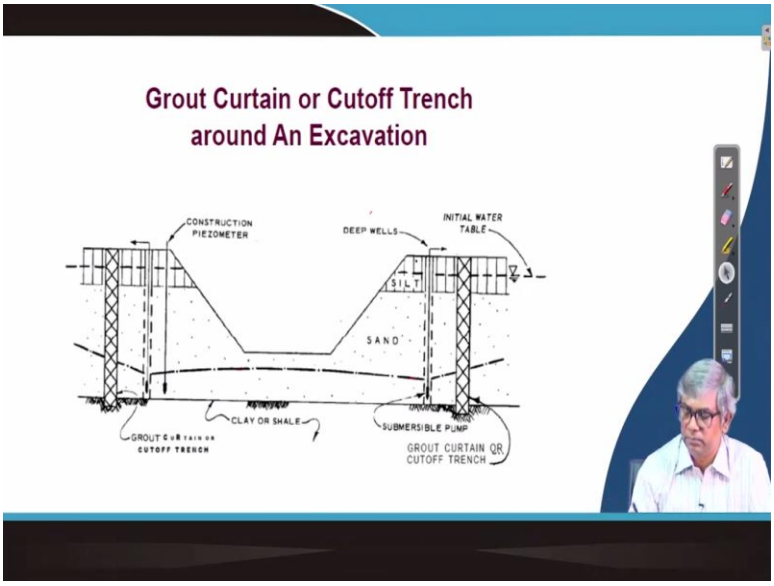

You can see here; this is Grout Curtain or Cutoff Trench around an Excavation. And here you can see that you can see here this is the deep wells and water table was somewhere here. Suppose somewhere here and then this can be having grout curtain and so, that water cannot directly go there and if I take water from here and then it will be water table sometimes it will be lowered like this and this is supposed, impervious layer. This is another application of dewatering.

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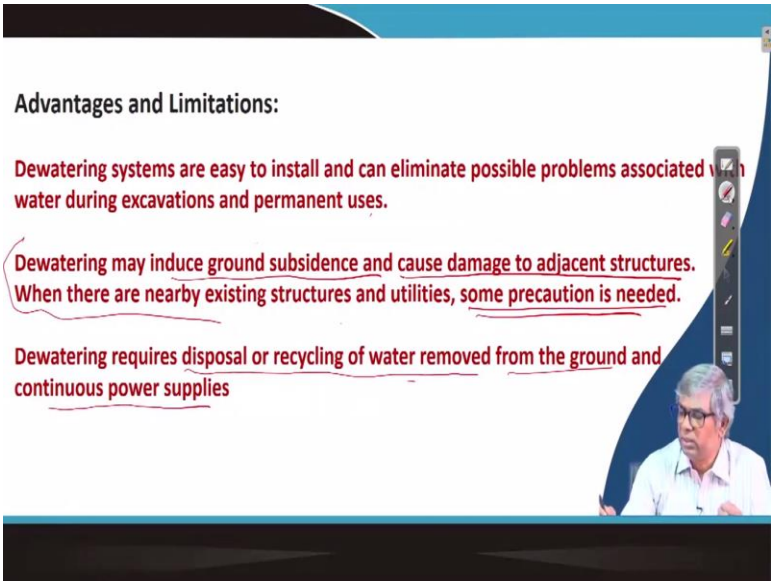

And then let us see those advantages and limitations. Here dewatering systems are easy to install and can eliminate possible problem associated with water during excavation and permanent uses. So, that means, you're as we have mentioned from beginning that dewatering, we use because only to the make easier the excavation activities that is a may or sometime the permanent, permanent lowering of water table also will do for some below the structure and this is not difficult to install and to facilitate the excavation and lowering.

This is the one advantages and, and but there are some limitations actually dewatering may induce ground subsidence and cause damage to adjacent structure. That I have shown some figure that in the previous few slides that when you draw water and a particular from the pump well and then surrounding area will be water table will be lowered and if there is a structure nearby and that lowering the water table below the structure actually may cause some damage or make a create some potential damage and that is the disadvantage actually sometime.

When there is some such situation arises or exist, then some precautions are required and not only precautions and there may be additionally you may use some recharge well point through which you can pump water and recharge in the groundwater to maintain the water level below the adjacent structure or nearby structure.

That is the disadvantage sometime suppose, you are required to lower particular water table, the particular area you are doing that and successful in it, but this effect will be extending to up to

some distance and that area there will be a permanent structure which may get affected to prevent those actually sometimes you have to do some activities that is recharging or some other like cutoff wall or some other type of things can be done.

This is some of the disadvantages. And next one is and dewatering required disposal or recycling of water removed from the ground. So, as we have whatever the water, we are getting that water has to be discharged. So, you have to get some area where to be discharged and continuous power supply this is also another important thing without that it cannot be done.

These are all of course, not disadvantages these are the requirements, but this is also associated problem of dewatering but that can be solved also. These are all issues whatever required just so, next let me, let me go to the next slide.

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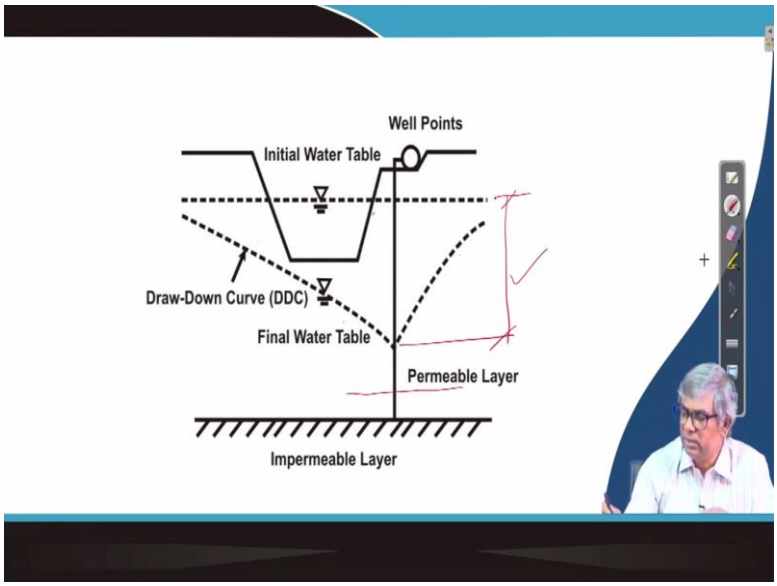

And here actually, as already we have discussed that different aspects through almost two lecture, I have given different aspects of dewatering about different methods suitability, how to select a particular methods and now we have to go for a design and design, design, there are design requirements, design requirements, one of the design requirements actually depth of lowering actually this is the this is the groundwater table and you have to lower up to these then what is the depth of lowering.

That is one important and then another aspect is that permeability of the soil. So, that means or when you are doing when you will when you are a project in a particular site first of all what you have to do, you have to find out collect the sample and you have to see it study the type of material what type of material is available, how is the level of permeability, and based on that you have to select, you have to select a particular method as we have already discussed number of times.

Then in addition to that depth of lowering also important and now, here actually, suppose depth of lowering is still further more and in that case, how we will be using whether it will be well point system or whether is a submersible pump and will deep well and submersible pump. That is the way you have to do and this is actually suppose if I use well point like this, then actually if you have to run longer time to lower the water table from this site or below the excavation level, but instead of doing these if you do the next one, let me see the show you instead of doing these if I do this way like

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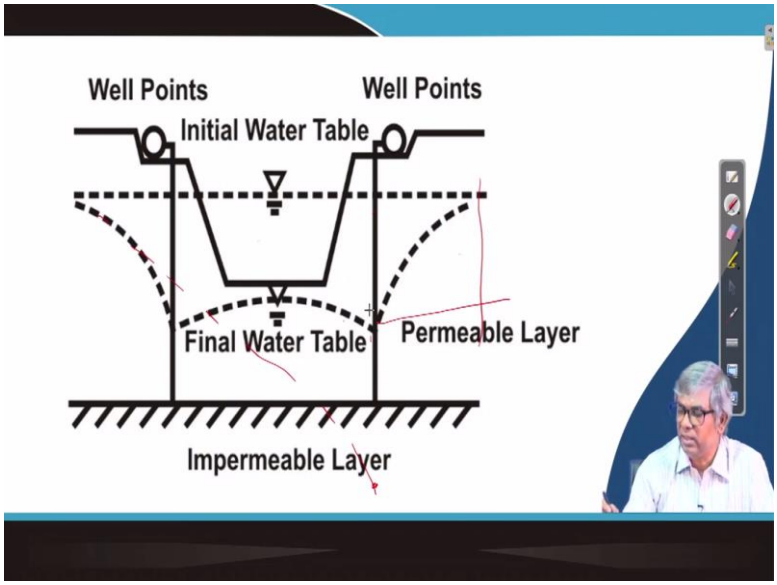

Compared to the previous one if I do this way, you can see that one pump here another here and then automatically that efficiently I can lower the both side of the water table otherwise, by if I do one side at this point you have to go much deeper. If I want to come the water lower water table from here to here, that this side has to go suppose or see by one side of the well points if I

do then if I want to lower below this excavation level, then I have to lower this one upto this then only this water table will be coming like.

Whole zone was shown in the previous one instead of that we can plan this way then more efficiently the water table can be lowered below the excavation level. Another important point to be noted here, that when I do the pumping of water from the ground, groundwater, then how the groundwater are level it, it will be a parabolic actually you can see here and close to the, pumping area close to the close to the pumping area, it will water table will be lowered maximum and where it will go away from the well then lowering will be less and it will be you will find some area where there will no effect.

These actually the area of influence this is called area influence up to his that when you are pumping water up to the influence is extending that is called area of influence. That again, how much the area it can influence particular well that can be designed actually you can find out and suppose and accordingly you can design what is the spacing et cetera, maybe within one or two lecture maybe a subsequent lecture I will can discuss.

And then there are certain design how we will design etc. there are different methods are available analytical methods. So, let me show you only picture figure only

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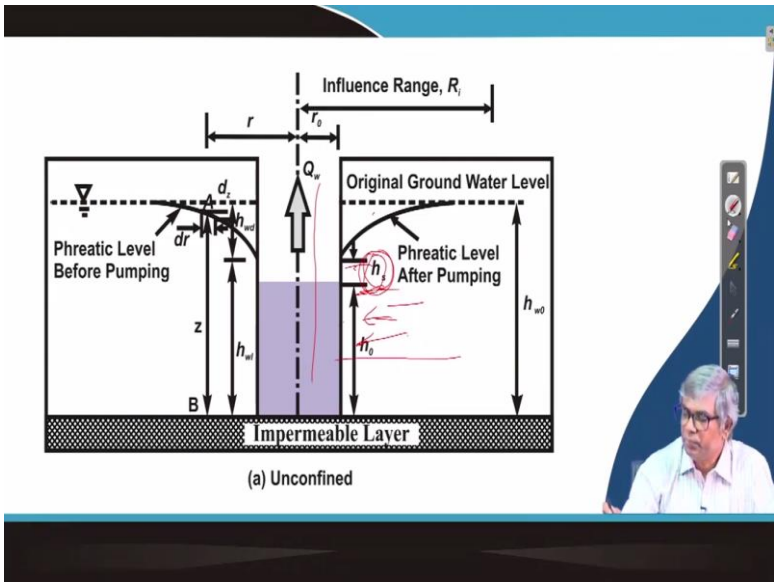

Maybe analysis I will do later on there can be situation unconfined aquifer actually suppose water table is here and you have to lower the water table somewhere here, then if I pump water, how it will be how much quantity what is the relationship lowering and all how much is the area of extent all those things can be analytically or mathematically can be expressed.

And maybe I will show you here that when you I am doing a with a pumping from this particularly to make a well and I will be installed the pump here and then discharge water from here and then the surrounding water will be entering to the well. When it will go water is drawn here, then water will be entering this way like this and this will then this actual groundwater or phreatic surface, how it will be it will be not joining exactly joining to the surface it will be a little above.

That is what that is called h_s we will discuss later on when we will be explaining the derivation. And then like other aspects actually designation is given actually at a particular depth. If I consider it water is this is well is circular and from cylindrical that means circular all direction water is entering. We can inward in a cylindrical surface through which water is entering using that some derivation will be done which will be done in the next class or next lecture.

And some more things I wanted to show this is another aspect, how much it will be it depends on many things which will be an empirical equation out there that I will also discuss and finally,

quantity of flow with permeability and many other things can be relate and by which actually that pump size and all those things to be done the spacing of the wells, all those two we can be designed. That actually design part it will be done in the in the in the subsequent lectures. Similarly, this is when it is an unconfined layer these are the different parameters will involve in the in the analysis. Similarly, if you have an unconfined or confined aquifer like this

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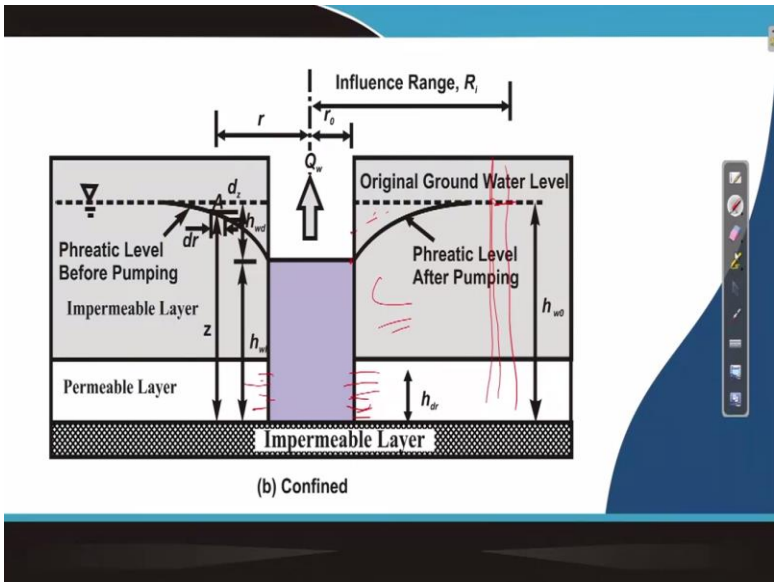

That means, this is an impermeable layer ground close to the ground surface it is impermeable layer and this is a permeable layer actually where water is there. If you want to and because of these, these layers actually holding water and if you punch if you make an if you make a borehole and then it may show water level here that this is actual groundwater level is this.

If I want to this groundwater level if I want to lower then you have to make the borehole penetrating throughout the impermeable layer and reach up to this permeable layer and up to the next impermeable layer and then you have to pump water from here and if you do this, then actually the how will be the poetic surface under these it will be like this, but the water is entering through these only unlike the previous one that phreatic surface from here, but here actually phreatic surface will be immediately after this one.

Because water is only entering through these with this area water is not there, water is entering through this area and then when you are pumping out from here and with this quantity, quantity

of flow and there are many other head draw down et cetera that can be relate through mathematically and that will be useful finally, to find out the capacity of the pump, frequency of the pump or spacing of the pump.

This part actually will be we will take up in our next lecture and that then later on, we will show the application of this in the design. These are the various aspects of dewatering. I wanted to discuss. And with this, I will be closed here. And in the subsequent lecture, I will try to try to derive. This expression for quantity of flow in terms of permeability and many other aspects and which will be useful for the design of the dewatering system. With this, let me close here. Thank you.