Fundamentals of Environmental Pollution and Control
Prof. Jayanta Bhattacharya
Department of Mining Engineering
Indian Institute of Technology, Kharagpur
Lecture No. # 13
Ground Water and its Contamination (Continued)

Okay, we will start today's lecture with this you know the, with the continuation of what we begin in the last class, what we started in the last class. We are actually discussing about ground water contamination and there in fact you know I have discussed about the characteristic of ground water sources, the characteristics, characteristics of ground water sources or that we known as aquifer, that we know as aquifers.

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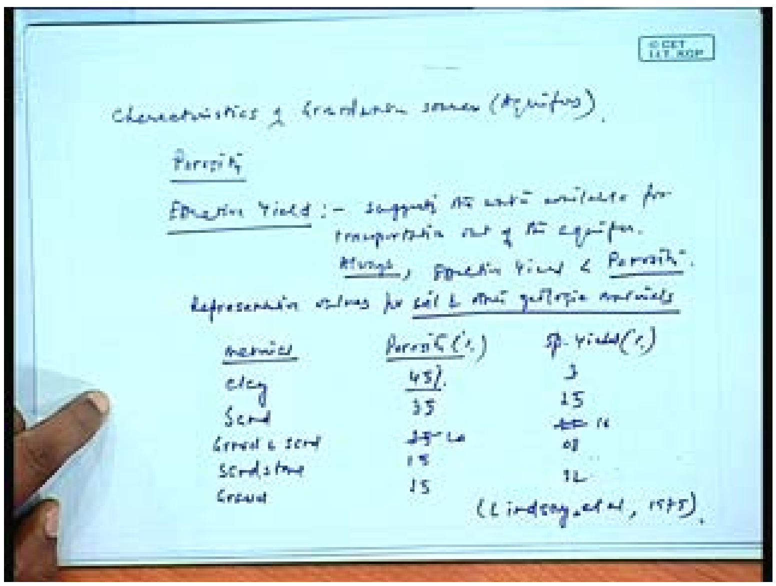

Having said that you know I have also discussed bout porosity, porosity and we have, I have explained you, you know that porosity would mean that the total say that the void volume divided by the total volume. Isn't it? So, this if we just try to understand little bit about this, you know there are another important thing is related to porosity is this effective, effective yield. The concept of effective yield is like this, I mean you know you see even if in many cases if you see you know it's like suppose you have a, you have wetted your clothes, you have wetted your clothes, how so well you rinse it? I mean you just turn it and all that, there would be certain quantity of water that would be essentially coming out, not all the water can come out. Isn't it? So, that you know when it cannot come out, so in it takes about the specific yield, even if the water content may be say 20% or 30% of the volume but you know only the available water that would be, that can be drained out would be above 20%, of 20% or so. So, you know you find a specific yield that is about a structure depending on a particular kind of structure, that is what is you know in a, in addition to porosity we will also have another parameter which is known as effective yield.

The effective yield suggests the water available for transportation, transportation out of, out of the aquifer, out of the aquifer, suggest the water available for transportation out of the aquifer. So, you know is not necessarily always is always as you can observe always effective yield, yield would be less than porosity, porosity. Effective yield would be less than porosity. The same example can also be given as the example that I have given for soil, for any other say geologic structures, any other kind of geological structures we can think of even if the water may be contained, water may be 30%, the whatever that is available for transportation may be only 20%, so 20% of the volume.

So, you know here in such cases, so you can see that the effective yield or the porosity would be always and the porosity would be always more than the effective yield or effective would be less than the porosity. So, you know in such cases like this let us just have a brief idea about the values representative values, values for soil and other geologic materials or other natural materials as you can write this, representative values of say the material is this. This is porosity and this is specific yield, specific yield percent. It is just say this clay as say you know, I will have high porosity but specific yield is very less, specific yield is very low, specific yield is very low, the soil, the water in the soil would not be available for transportation. So, here in such cases, here in such cases we can find out that you know in other cases like this sand is 35 %, 35 and 25.

This is gravel and sand, gravel and sand, 25 and 22 say sand stone, sand stone is 15 and 15 and 8. This one is just make a correction here gravel and sand would be, gravel and sand is 20, this one is not 22, it is 16 okay. So, it says gravel itself only would be, gravel itself would be is about 25 and 22. So, this is by you know Lindsay, Lindsay et al that is you know 1975. The significance of et al is there are few more in the group. So, you know that name if it is not necessarily, it will be mentioned we generally say et al, Lindsey et al in 1975. This is you know just to give you the specific yield of different water bearing formations particularly the aquifer. So, the aquifer you can see this see you know what is understandable here is, here it’s says that you know the clay can contain about half its volume, 45% as water whereas gravel, sand stone, sand itself can have about 35% of the, void volume would be, void volume would be 35% of the total volume that it signifies. So, the void that would contain water, void that would contain water would be about 35% of, 35% of 100% for a sand, for sand. So, it is the available water is 35 but only transportable water, the water that can be drained out is only about 25%, rest of the water would be locked into the structure itself okay either in the form of vapor or in the form of, or in the form of water, okay. So, this is what is means by this two terms, porosity and specific yield.

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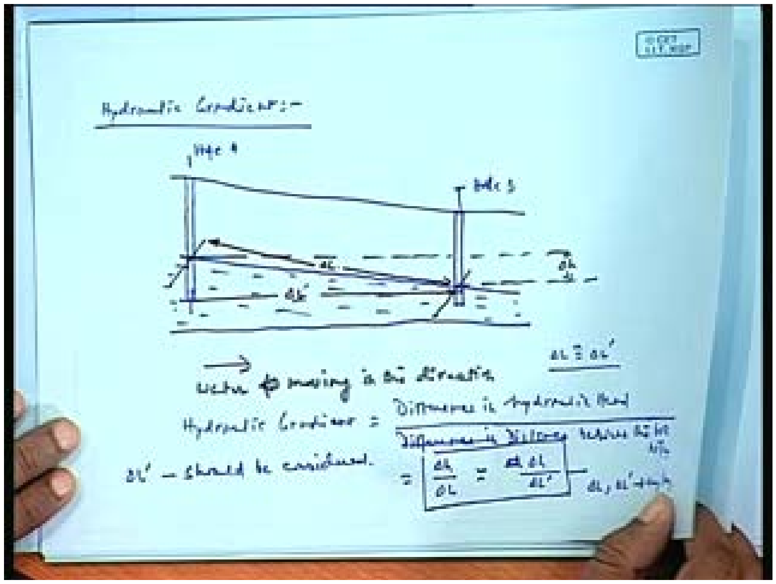

Another very important property you know particularly related to the, particularly related to this ground water is hydraulic gradient, hydraulic gradient. The word this you know hydraulic gradient you know hydraulic gradient is a very important aspect say you know in case if you just observe that there would be you know if you just can draw a scheme like this you know here it is a ground water and you can see this is, this is what is the, this is what is the ground water flow taking place from one area to another say from one area to another. We can see this is the piezometric level, this is the piezometric level of water we are obtaining this is in the structure. So, here you can see this is a piezometric level, here we get a piezometric level also here. So, this is say, this is where, this is where the water is, this is the water being flown through the rocks structure.

So, it is getting transported from the higher gradient side towards the lower gradient side okay. So, as you can see this as you can see here, so here as you observe, as we can observe in this diagram itself if you see this, if you just put this like this and if you just make a difference in this, this is what is del h, the difference of head okay. What I am trying to say is the water flowing in this direction, water moving we should not write flowing, water moving in the direction, water moving in the direction. So, here we can see this you know this is as we observe here, water moving in this direction and as you can see here this particularly there are two ways, one is you know in many cases say this one is, this one is known as, this one we generally call as del L, the del L in two ways you know generally in a case of a very long aquifer, this would also be sometime known as del L, okay.

When the aquifer we are considering, we are discussing is a long one, is a long one then we can think of the values this the del h, this del L and del L dashed or whatever you know in many cases will say consider del L is equal to del L dashed. So, this one would be almost same, almost would be considered same. Say, if it is a long very long aquifer we can consider that this del L by del h, this one is same. So, here in such cases the hydraulic gradient, hydraulic gradient, gradient is a difference in hydraulic head divided say you know between a say a hole A, hole A and hole

B, hole B, hole B difference in hydraulic head divided by the difference in, difference of the distance between them, the distance say distance. So, you can see this as del h by del L in many cases it can be del L sorry this is del h divided by del L dashed. We can in most cases when the, when the aquifer is very long, when the aquifer is a very long aquifer when we are these, the distance is this del L when del L and del L dashed or you know very long then we can consider this to be almost same. Isn't it? So, this is what you know for almost all practical purposes whenever if specify, if otherwise is not specified this would mean this distance remember this, if it is not otherwise mentioned this is the exactly the distance that is should be covered as del L dashed. So, you know we should consider in all practical purposes to make the correct judgment about the hydraulic gradient del h del L dashed should be considered should be considered, okay.

Now having said this just let me explain you how we can generally find out the hydraulic gradient. This is about a two hole case which is a straight case but you know in many cases it may not be so straight. Let me explain you like this. Say, this part is clear so far there is no problem in this, this is only an aquifer we are trying to observe the flow direction, we are trying to observe the flow direction and to observe flow direction what is done is two bore holes are driven at a distance. The bore holes, in the bore holes the piezometric water head is calculated, it's nothing but you know when you strike the, strike the water level here and the water level here. These two differences, the difference in these two should essentially give you del h. Isn't it? This should provide you del h. so, having found out the del h and if we know the distance between them you can find out the hydraulic gradient.

Now is essentially what is observed you know the basic principle is that water from a high head would travel towards the water at low head, right. This is just as simple as that but here else you know we would try to see how this can be, how this is computed. Suppose, you know say you know various areas, suppose in a mine area or any other agricultural field or any other places like you know for our practical purposes, we generally want to find out the hydraulic, hydraulic gradient.

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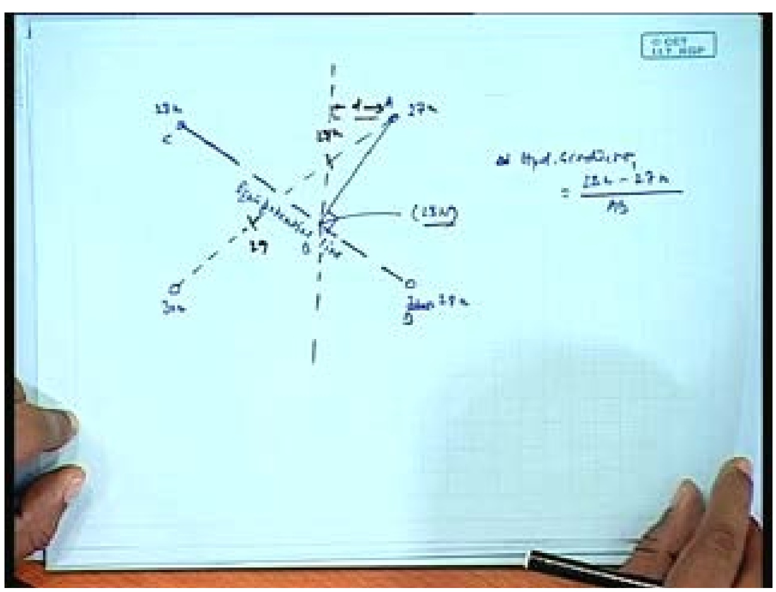

What is say you know the bore holes are like this, the bore holes are like this, the bore holes have been say made like this you know is about this and say we have made the bore holes quite regularly say you know so you can see in a, if it is essentially it has to be in the form of a grid, essentially it has to be in the form of a grid always, it is always has to be in the form of a grid. So, let us compute this one as like this okay. What we see is the water level here say is a water head here is say 30 meter, okay. We find that you know this water here is about 32 meter sorry, sorry, this one is 30 meter, this one is 28 meter, 28 meter, this one is you know also having a 28 meter, 28 meter we have computed and this one is you know at a further distance from this, we just gone it as 27 meter. What is this? This is the water head, this is the water head remember this, this is the water head.

How to compute the hydraulic gradient? How to compute the hydraulic gradient? Say in a most case one very simple thing here is you know from this you know one value of hydraulic gradient is like this. If you just observe this one, this is called an equipotential line, equipotential line. This known as the equipotential line which is having an equal potential, the water head is same, okay. So, if it is in equipotential line what we generally try to do is from here we draw in the plot, in the table we generally plot a, write a perpendicular on that. So, here it becomes you know also all as you can see, we can conceptualize that this value is about 28 meter also here this is because of the equipotential line, okay.

This equipotential line from this we would find out say this is what is the, here the hydraulic gradient is, hydraulic gradient is hydraulic gradient one value of hydraulic gradient this is say hydraulic gradient one, let us keep that hydraulic gradient one as this. So, we would say this is hydraulic gradient one and this one is so we can find out the value like say 28 minus 27 meter divided by this distance say if it is we just put it like ABCD. So, we find out this has the distance this is, this distance is, if this distance measured we can find out the hydraulic gradient. Isn't it? This is one value of hydraulic gradient that we are going to obtain. Any confusion? No confusion, so it's okay.

Now, here suppose we have to incorporate this one also, we have to incorporate this one also. There are two ways to do this, this incorporation here. One is, one is you know you just find out here, just see this one way of incorporating this with 30 meter here is this. What we do? Try to follow this, this is what we try to do is we generally draw a line, connect this, just merely connecting this, okay. I think you know somewhat not straight line, anyway. So, what we try to do is between 30 meter and 27 meter say among this, around this distances, around this distances say you know we find 27 to 30 meter. So, if you are, this is a 3 meter gap say 3 meter difference in the head, if we just distribute this 3 meter head, 3 meter head into along this line here, so you can find say this is where we are getting the 29 28 30 30 29, sorry 29 say this one is no, no 30 to 27, right. So, 20 30 29 okay, 29 is here and then 28 here okay. In such cases what we observe is here again we have to make an equipotential line from here, we can find this equipotential line like this. You connect, this one is the new equipotential line, this is the new equipotential line, this is 30, this is 30 29 28 here you know apart from this. So, you find that this is a new equipotential line from this there, so we will find out there the distance 28, 28 minus 27, 1 divided by this distance here, this d would provide you the new hydraulic gradient. So, the objective here is, objective here is to let me explain you further on this. Here, if you just observe you know due to you know this can result, this can result due to different aspects you know due to different reasons. If this can result in due to different reasons, the different reasons would be say the different reasons may be you know in case of like a certain particularly least resistance area working in this area.

So, you know we can have a, you can have a widely distributed. Here, you can 28 meter we have found out here but this 28 meter has to be further modified has to be further modified. In such cases this one would be, we are going to find in another equipotential line and that has to be explained like this and has to be found out this distance equipotential line, the equipotential line considering the three points and there the distance from the equipotential line perpendicular distance from that point to the equipotential line and divided by the distance, okay. So, let me, let me take you another example in this case, generally what we generally try to do is like this.

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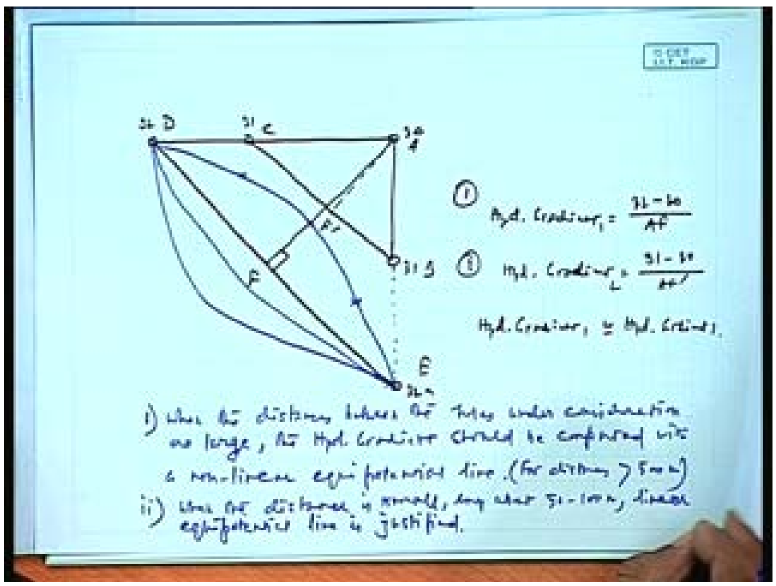

Say there are, there is an example like this, you know we have a plot. In cases when the plots are you know quite in a perpendicular fashion it is much more easier, it is much more easier to find out the equipotential line, mostly in a generally done in a Greek pattern. So, you know the, you can always find out the values like this say here for the same case say you know for here this one is say 32, this one is 31, this one is 31, this one is 31 and this one is 30, okay. There are two ways to do, the procedure one, one is you know you can extrapolate this, you can extrapolate this to so almost the same distance at the 30th. So, this is 32 and then you can connect this to, this has becomes the equipotential line here and then from here you can find out the perpendicular and can find out the hydraulic gradient. Isn't it?

So, you can find out here say ABCDE it is F, so you can find out is hydraulic gradient is, hydraulic gradient is 32, 30 minus 32 minus 30 divided by F. This is one way. Another very straight way is you know another very straight way is this, you just can, you can calculate this 31 meter here and can find this perpendicular, you can find the perpendicular say you know it can be somewhat changed or say similar in that case F dashed.

This F dashed, this is another way is 31 minus 30 divided by AF dashed. This would be, both of them would be provide same. There would be a, if you say this is 1, this is 2, we generally find that hydraulic gradient 1 would be similar to hydraulic gradient 2. Now question is having said this, having said this, is there always an equipotential line I mean or is there an equipotential line is necessary there has to be straight line. No sir, it is not, it is not but you know in such cases, in such cases also the approximation id even if in an, if say you know even if it is equipotential line may be like this or it can be like this you know or it can be like this as well. Yeah, they lead to somewhat closer, so you know you can see this equipotential line not necessarily has to be a straight line.

It is not necessarily a straight line so here in such cases, here in such cases we can find out the equipotential line at different points, equipotential line we can find out at different points say here there is one, this is one hydraulic gradient that you can see here. There is you can find another hydraulic gradient here, we can find another hydraulic gradient there, so average of that would be the hydraulic gradient of the field. This is called the, called the hydraulic gradient of the field. This is how we can compute the hydraulic gradient but in necessary cases you know generally we for say, if say for 100, 200 meters when the number one, when the distance between the holes under consideration, distance between the holes under consideration. A large, the hydraulic gradient should be computed, should be computed with a non-linear equipotential line, the non-linear equipotential line, all right. When it is said that with a non-linear equipotential line in such cases you know non-linear equipotential line, so your distance say you know say for distance is, for distance is more than 500 meter, from each bore holes, from each bore holes if the distance is, distance is for more than 500 meters.

So, you can find out that you know that this non-linear equipotential line, we have to find out the hydraulic gradient at all points and from there we have to compute. We have to compute the average hydraulic gradient and that would be used for the total field, total ground water body or otherwise when the distance is small, when the distance is small, when the distance is small, when the distance is small say about 50 to 100 meter small say about 50 to 100 meter say linear potential line, linear equipotential line is justified. So, essentially it becomes an engineering decision, it becomes an engineering decision as to how to compute but the method of computation remains the same. That is the change in the, change in the water head divided by the distance. Most in all case it is the perpendicular distance that is under consideration that has to be a perpendicular distance. So, this is you know this is one way is a hydraulic gradient has to be found out and is hydraulic gradient is an very important property that is required to be found out in almost all cases you know is particularly when we are working with this ground water contamination.

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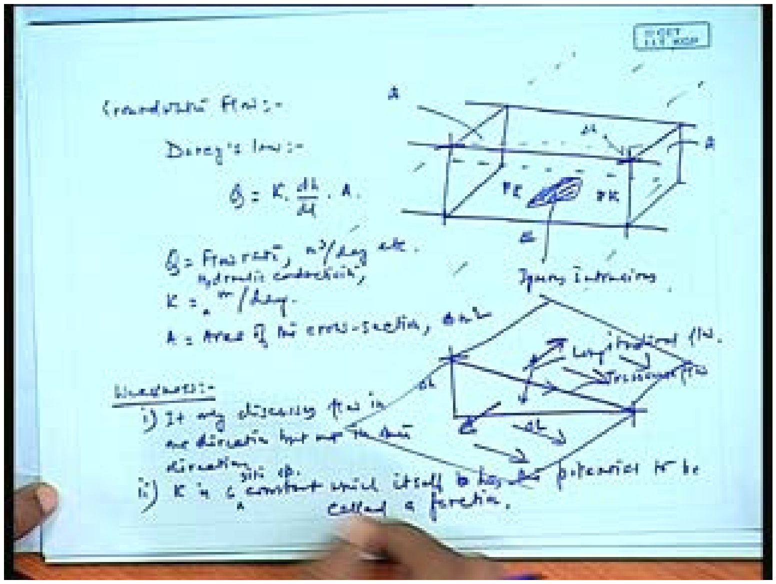

Another important thing that is you know say the particularly the one that is the flow for flow this. So, this is ground water flow, when you are discussing ground water flow essentially what you start with, we start with a basic very simple presumption that very simple presumption that you know the flow behaves in a fashion that can be represented by an equation known as Darcy's law, a flow can be Darcy's law. So, this is the force, the Darcy's law. A flow can be characterized by an equation known as Darcy's law. The Darcy's law says is very simply it is states that a quantity that is you know meter cube per hour meter cube per minute flow, this is Q is the flow multiplied by K, this is you know this is you know as the hydraulic conductivity then dh by dL is the hydraulic conductivity, this is conductivity coefficient K and this one is A into, their into A area of the, area of cross section.

Let me explain you this here, if and if you know if is pictorially if we just try to observe this, if we just pictorially try to observe it suppose this is, this is a ground water, this is a ground water block that can be represented like this. This is a ground water block that can be represented like this, so here in such cases this is, this is the ground water, this is the total cross section, one cross section of the ground water looking like this and you can see here this is where it is finally heading to, this is where it is finally heading to, okay. See, this is, this is the area A, this is the area A, this is the area A cross sectional area we are just considering a particular block, a particular cutout in the ground water flow regime, this can, this the flow can extend this area also, this can also extend this area all these places it is extended like this but we are just considering a particular cross sectional area. This is what is this is, at this point is this is what is would give you that this is, this provides you the change in the, this is the L, this is the, this is the L, this is the L del L. This is, this would be this point and this point you find out, this would give you, this should give you the hydraulic, this would give you the del h.

This would provide you the del h difference between the, difference of the water level in the aquifer, difference in the water level in the aquifer and del L is known, area is known and the quantity of flow, this is the flow quantity. This is Q, Q is the flow rate, Q is the flow rate which is known as this say meter cube per day or meter cube say this is meter cube per day etc. So, this is K is, K is known as meter per day, K is this hydraulic conductivity, hydraulic conductivity in meter cube meter per day and say del h by del L is without coefficient, without I mean without units and A is the area, this is cross sectional area, area of the cross section, this given in terms of meter square, given in terms of meter square. So, we can find out the Q as is equal to meter cube per day or meter cube per year that is how the condition is meter cube per year, meter cube per day on the time conglomerate coefficient because in many cases the speed is very slow in aquifer. So, we generally need not have to represent in terms of minute or in terms of second things like that. Mostly if you are representing in terms of day is fair enough because the velocity is very low, velocity is very low.

So, you know you can see here this is, this is the, this is known as the Darcy's law but this Darcy's law's provides to be you know somewhat quite simplistic in the sense that there are few things you know it generally understands here, there is no, there are… If you are just observing this flow, if you are just observing this flow right here you can see this, if this is the direction you just see if this is, if you can see you know in terms of a, if change in the hydraulic head, if you just consider this change in the hydraulic head here and the change here, the change here you see this, this one is del h, this one is del L. Isn't it? So, this is the two points in the aquifer, this is the two points in the aquifer, this is del h, this is del L. Okay, is it clear?

So, having said this is, this is this particularly is one flow direction is not necessary that you know the flow would be only in this direction, there would be, there would be a flow in the normal to this direction of flow as well normal, the spread of dispersion would be in the case of normal to, normal to the direction of this flow. So, here you can see this is, these are known as, this is known as a transverse flow, this is known as the longitudinal flow, this is known as the longitudinal flow. We know it should be essentially depending on several other purposes but everything set and done everything set and done you know this Darcy's law has proven the test of time and is very much used, is still very much used in almost all kind of, almost all kind of ground water regime calculations because it provides a very good quick estimate, it provides a very good quick estimate, this is Darcy's law's.

So, the weakness if we can see weakness of Darcy's law, one is you know it only discusses, it only discusses flow in one direction but not in, but not in other directions. Two is hydraulic conductivity K as identified, K is a constant, a site specific constant, site specific constant, K is a site specific constant which itself has the potential to be called, to be called function, as a K is which is itself as say can be called as a functions. So, we can see is what it says is the K here, K, K at, if we just try to observe K at this point K here and the K here are same but if you just think of an aquifer there would always as you know in most of the geologic materials, in the most of the natural materials the anisotropy is quite common, disqualities are quite common.

So, we do we can very well see that this K would not remain constant in all cases. The K would not remain or constant in all cases. Suppose, you know in such cases you know in cases like where there is a certain you know a block of igneous formations or igneous intrusions coming in, the K is likely to change, this is igneous, igneous intrusions coming in, the K is likely to change. So, you know K itself cannot be a constant, this to understand K as a constant over a, over a length of aquifer say about 2 kilo meters, 3 meters, 4 kilometer is too simplistic, K itself cannot be a constant. So, K can be a function by itself, is the function, the nature of the functions can change depending on the construction of the materials in the aquifer. Isn't it? So, but then again you know weaknesses are this, you know whatever we say that you know this but this is quite popularly used as I have said there is a, there thing is…

So, another the important change is in another important area of weakness as I have discussed is that it only discusses about the flow in a particular direction but it does not discuss about the dispersion that is how it is taking place you know dispersion taking place all around the aquifer but then again as you can just observe you know just observe in a aquifer flow like this, we can also compute the Darcy's, the Darcy's coefficient across the plane of transport, across the plane of transport. This is, if this is how, this is what is the plane where the transport is taking place across this is the plane where it is transport is taking place, on all these cases the water is moving like this, we can also compute the value or across the plane can be computed. This is what we generally try to do in the dispersion model but the dispersion model will just briefly discover about the, discuss about dispersion model but here again this is what is the weakness of this Darcy's law.

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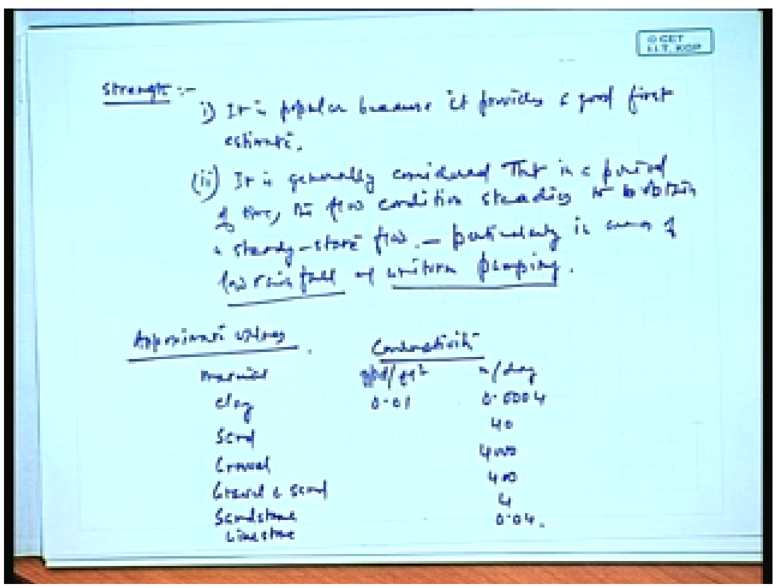

But the simply very important thing is in the strength is if you just, why Darcy's law is so popularly used is popular, it is popular, it provides a good, is popular because it provides a good first estimate, good first estimate. Suppose, in case you do not have data I mean or you don't have anything to bank on, in such cases the first value is important value. Say, suppose in a test, if in a, if you are doing a titration test or anything like that if you just know that okay this is be the value, this is the one value on which I can say the ultimately value, the correct, the most correct acceptable value, the most acceptable value would be close to, the most acceptable value would be very close to this value. It gives a good first estimate. In any engineering design or any engineering decision making you know the good first estimate is a very important thing which most have to have a good first estimate that when you are designing anything on any installation we are discussing about say what is the life of the installation.

We generally have an estimate is not necessarily that installation would live up to that years or it might, the time may be reduced, time may be increased but the first estimate is an important thing and this Darcy's law provides a good first estimate. There is, there is a number is another important thing about Darcy's law is it is generally considered, it is generally considered that in a period of time, period of time this flow condition steadies to obtain a steady state, steady state flow, to obtain a steady state flow particularly in areas of low rainfall and uniform pumping, particularly in areas of low rainfall and uniform pumping where is a pumping ground water is being pumped uniformly and there is a low rainfall in such cases we can consider that this Darcy's law works well. This is a strength you know it works wherein such situation okay. Another this thing in, another important thing is a, there are some approximate values that will discuss about, approximate values of this hydraulic conductivity, material is, material clay, a conductivity, conductivity is, this one is not so important but this one is important. Ground part day per feet square say gallon per day per feet square, so meter per day it has this is 0.01, I think you know this one is more important value, 0.004, clay is like this, sand.

We can find a value of sand to be like this sand, gravel would be, gravel and sand, gravel and sand is 400 and sand stone and sand stone is about 4, lime stone you can put lime stone also, lime stone is about, lime stone is about 0.04, lime stone is about 0.04 okay. These are the values so you know these are the values for approximate values of you know conductivity that. So, we can find out, we have found out porosity we have found out this specific yield, we have found out conductivity. Next in the next class you know I will discuss about this, the other aspects of ground water flow all right. 5 minutes break. Okay sir.

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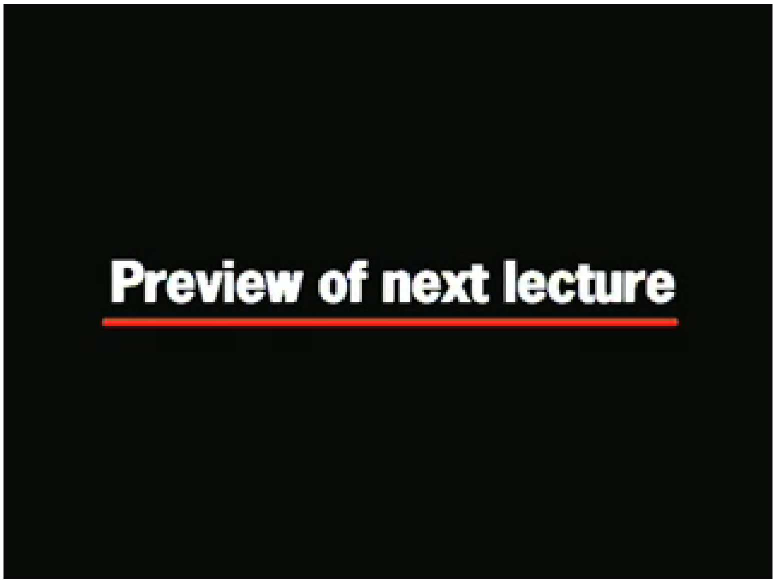

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Well, we begin the discussion again I mean this we are starting with this, we have discussing the ground water flow.

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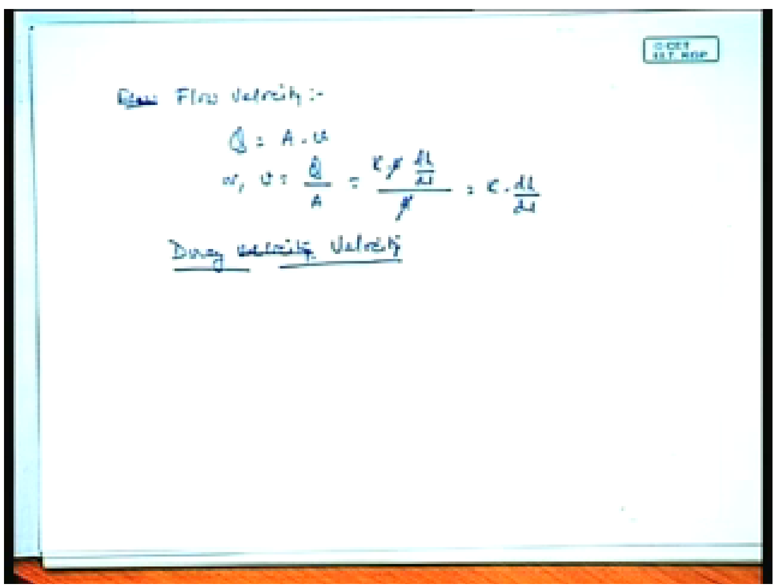

Then this is the flow velocity is the thing that you know that we will discuss now. Flow velocity, flow velocity having to see in the flow velocity part you know let me explain few things about here. What is generally if we can see that generally a very popular notion that you know Q is equal to A into v that you know A is the area of cross section, v is the velocity that you know, so or so v is equal to Q divided by A. Here in this Darcy's case you know if you Q divided by A is as we have done for this, for this KA dh by dl that we have done for Q. If we this, this KA cancels out, K dh by dl that is you know this very simply can be written like this, velocity as this. So, this velocity is known as the Darcy velocity, Darcy velocity. If this requires a certain explanation here Darcy velocity, velocity, this Darcy velocity if this can be, this is known as the Darcy velocity.

Now let me explain this Darcy velocity. Here suppose you know in this case yeah. So, here say you know in case of a Darcy velocity, what is generally understood is this. This is, if this is the, this is the cross section of the, cross section of the aquifer under consideration, cross section of the aquifer under consideration. It talks about then you know the cross section there would be some impervious zones, some pervious zones like this say here. It's not coming in there… No sir. Now, it's coming okay.

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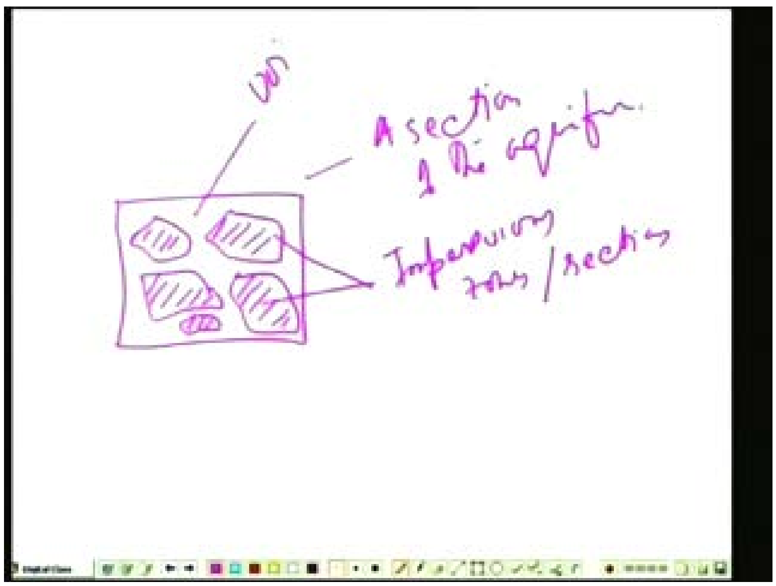

So, here we can see this, the impervious section. If we just make a section in the aquifer, this is a, this is a section, a section of the aquifer this is, these are the impervious, impervious zones, impervious sections or impervious zones you can write a sections. Now, here this is, this is the area you know the white portion is the void, this is the void, this is the void. People generally do not use them see even if so that is the beauty of this Darcy's law and things like that is you know you can have a very quick first estimate, 5 years, it would take 5 years.

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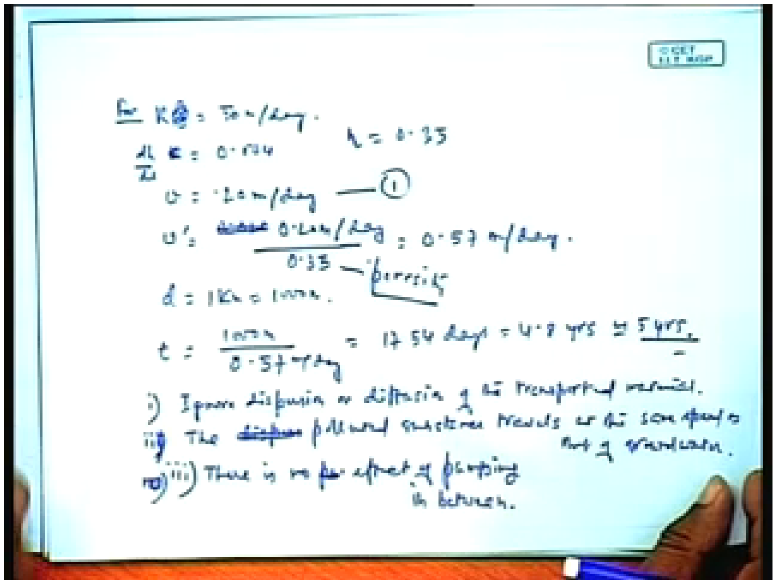

So, whatever things you want to do, you have to think about the changes within that time, within that time. So, you know here but well I mean having said that this is one is you know one is a 5 years and things like that. So, here again as we have said it has mostly discussed about the flow but this Darcy's law does not discuss about the dispersion. Let me briefly put light on you know what will be the dispersion and things like that. So, this has a two, there are three assumptions to make here, you know any case in a sorry 1 2 and 3, 3 assumptions here is that, ignore dispersion. I'll just take it out, it's going to diffusion. Sir, if this personal dispersion is not so good then after also 10 to 12 are equilibrium. Yes, yes it would, it would suddenly is going to affect suddenly you know dispersion or diffusion of the transported material, let me explain this. This is ignore the dispersion, ignore dispersion or diffusion. This Darcy's law generally do not take care of this.

Another is the dispersed, sorry the polluted substance travels at the same speed that of ground water ,that of ground water. This also is perfectly, perfectly mixed when you consider is perfectly mixed then you can consider that this polluted substance travels at the same speed that of as that of as that of the ground water and the third is that there is no pumping effect of pumping, pumping in between, there is no effect of pumping in between. So, in between the two holes under consideration in between the two points that we are discussing. So, this is, this is the Darcy's laws you know the typical assumptions of Darcy's laws in this ingrained with the inefficiency by which Darcy's law cannot estimate several other things but let me just briefly discuss about what is, what is the important difference here is that you know along the head, along the decreasing head. So, it is essentially discussing about the mostly the transverse flow but transverse flow sometimes this longitudinal flow and transverse flow, the longitudinal flow, longitudinal flow sometimes is more than transverse flow, transverse flow.

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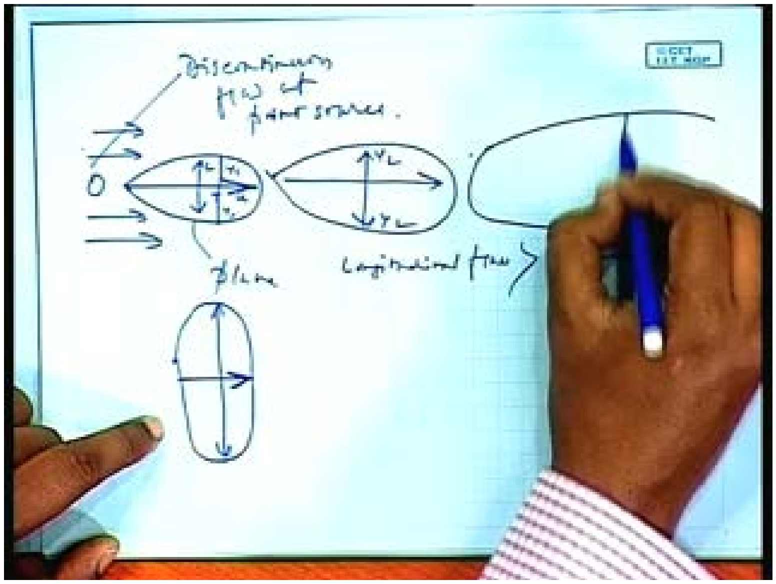

So, what is observed here is instead of, instead of the plume might look like this. The transverse movement has been much more than the, say the longitudinal movement has become much more than the transverse flow is quiet possible you know in most cases it is quite possible that this kind of situation can take place. So, in such cases that it is you can see that in that cases it is not very, is not quite possible to explain the flow, total flow by means of Darcy’s law.

We have to find out another parametric coefficient, parametric functions to deal with this kind of situation. So, instead of movement in the x direction, we will have to consider the movement in around y direction. So, this kind of thing, this is only is possible with a, with a differential equations that will not deal with but you know I’ll just tell that you know there is a scope of use of those kind of methods to deal with situations like this. So, any way none the less this is what is generally it is, it would look like, it is how it would look, it will consider this case it will be like this. So, but one thing interesting here is to you must observe here as that this particular, this one if you just say this one is, this one is x, x the direction x, the y 1 or y, y 1 here or both sides this y 2 y 2 here.