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Geotechnical Engineering Laboratory

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Lecture No – 13

Permeability and Shear Strength

Now I will show you I have to calculate the coefficient of permeability for variable head test method.

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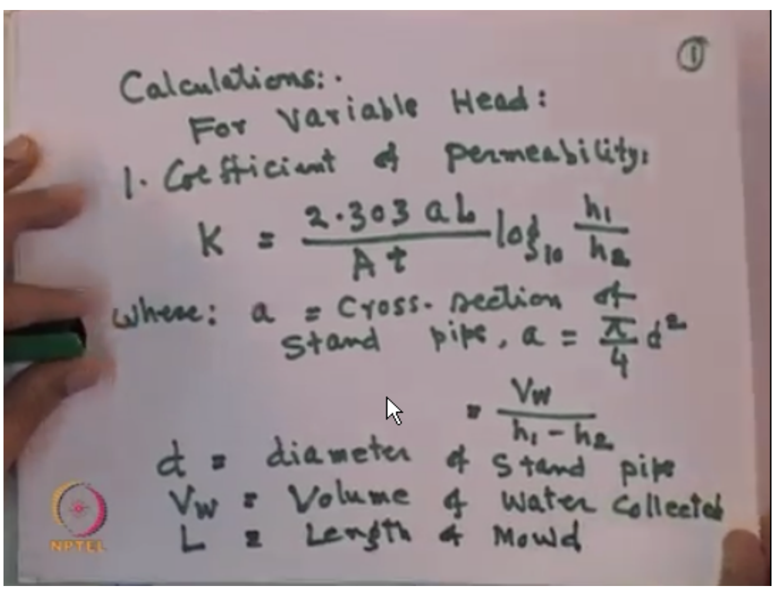

This is for calculation for coefficient of permeability for variable head one coefficient of permeability that equation for coefficient of permeability K=2.303al/ At*$\log_{10}$h1/h2 what small a is the cross-sectional of the standpipe I saw you earlier that what is stand pipe that a is cross section of standpipe that is $a=\rho/4*d^2$ and that will be equal to V_W/h_1-h_2 so what small d is the diameter of standpipe and V_W is the volume of water collected warm up water this is collected and L is the length of the mould length of the mould and A is the area of cross-section of soil sample.

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And t is time in seconds and h1and the h2 is the initial and final I showed you the earlier one escapes that you can you can calculate that what is called the center here, here this is a standpipe ok this cross-section of the standpipe is small a that is $\rho/4*d^2$ that means d is equal to diameter of this standpipe and then water fall from initial height is H_1 from here to here H_1 so initial height was here then water fall at a particular time then this position that is from here at a height of H_2 so that is why H_1 and H_2 at the initial height and the final height.

And here is a sample which length is equal to L that is L is equal to length of the mould and this mould also has a per section of this soil sample is capital A this is capital A this cross-section of the soil sample and at a particular time T then you collect the sample water and then you measure that what will be the quantity of water you have collected that is the volume of water that is BW volume of water is collected from here okay.

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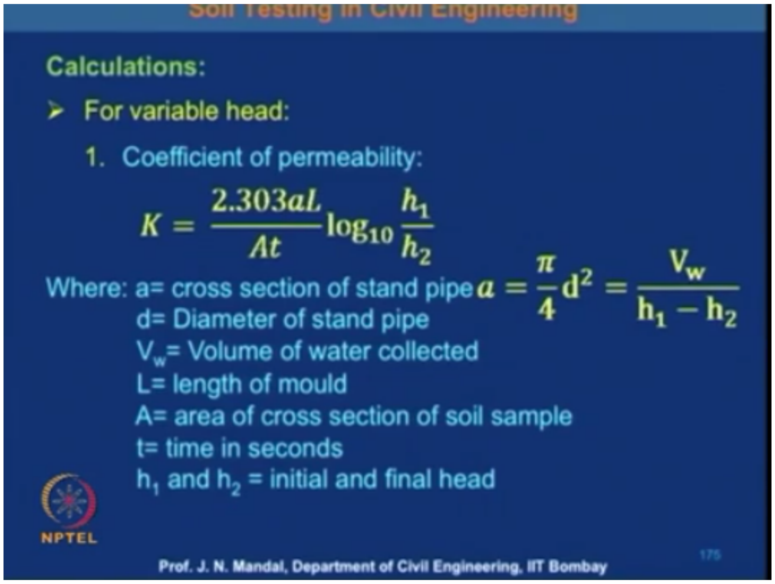

So then you can measure all these are some parameter that one is h_1 and what is h_2 also at a particular time t and what will be the quantity of water you have collected in terms of the volume and you know that what will be the area of the mould and what will be the area of the standpipe so then you can calculate that what will be the coefficient of permeability of the soil.

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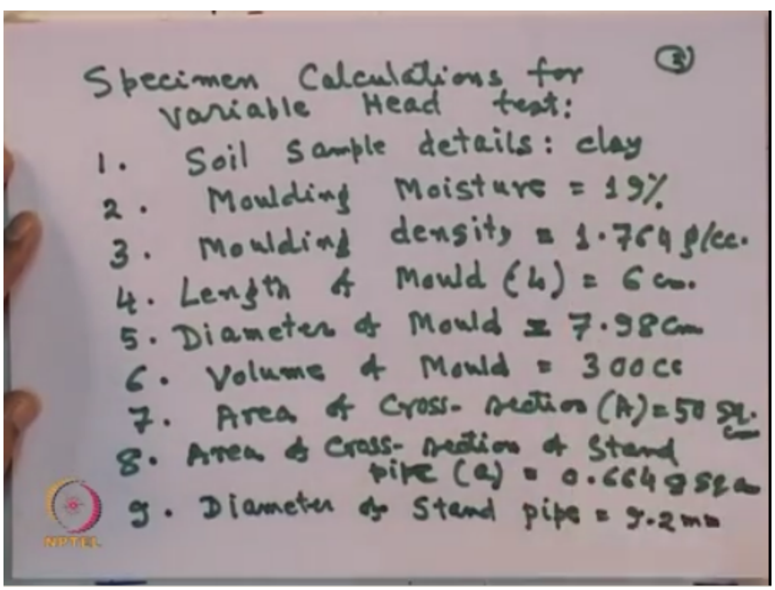

Next I will show specimen calculation, specimen calculation for variable head test so one is the soil sample detail and that is let us say clay then imager the moulding moisture let us say is 19% and then you calculate the moulding density this equal to 1.7764 gm/cc now you know what will be the length of the mould length of mould length of mould is designated at L is equal to 6cm and you know what should be the diameter of mould diameter of mould is equal to 7.98cm.

And six you know volume of mould, volume of mould is equal to 300cc and then you know that area of cross section or the sample area of cross section of the sample A is equal to 51cm now also should know what will be the area of cross section of standpipe that is designated as small a is equal to 0.6648sq/cm.

And then you should know that diameter of standpipe and that is 9.2mm so you know all this data you know about the soil then moulding moisture moulding density length of the mould will 6cm diameter of the mould 7.98cm volume of the mould 300cc area of cross-section capital A is 50sq/cm area of cross section of standpipe by small a this is .6649sq/cm and the diameter of the standpipe 9.2mm.

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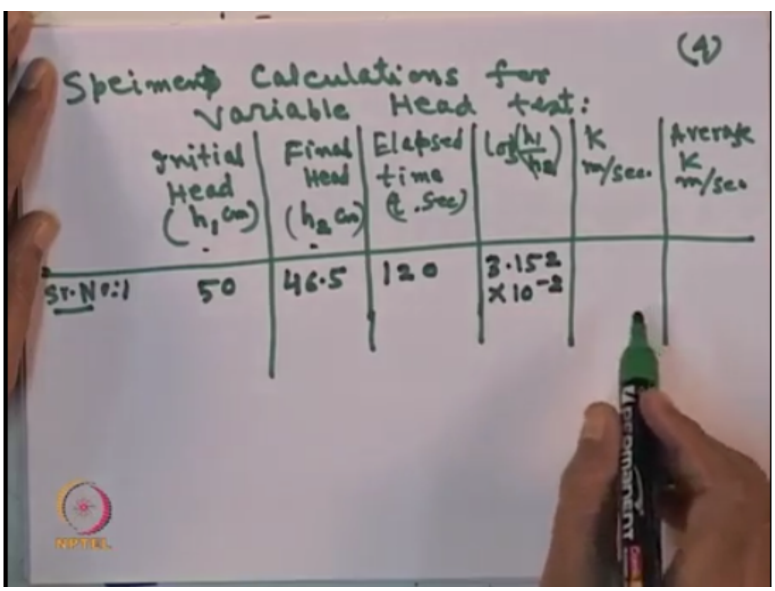

So knowing this all this data so you can calculate that what will be the coefficient of permeability of the soil I will show you about some specimen calculation what variable it for variable head test so you have to remember that equation what will be the specific for the equation for coefficient of permeability for the variability test method here let us say that for a particular serial number you have to determine what should be the initial, initial head and that is designated at h_1 centimeter.

Then you take what will be the final head and that is designated as h_2 centimeter so you know that initial head you know that what is the final head then you know that elapsed time that is let us say T second T in second and then from the equation you can calculate what is log of h_1/h_2 and then we can calculate the K coefficient of permeability in meter per second and then you can calculate what will be the average K m/sec that is meter per second.

So this is for a serial number one test okay let us say that initial head that is h_1 initial head that is h1 here this initial at each one let us say this head for the serial number one this head is 50cm and the final head this is h_2 so this h_2 it let us say 46.5cm and when the water from falling from the h_1 to h_2 so it takes time let us say time is equal to 120seconds then if you can calculate log h_1/h_2 because h_1 is known h_2 is known that will log of 50/46.5.

So this you can we can calculate this will give $3.152*10^{-2}$ so you know that this log h_1 h_2 you know the time and then you can calculate that what will be the coefficient of permeability of the soil using this equation that is $k=2.303al/At*\log_{10}h_1/h_2$ do you know from here what is log h_1/ h_2 so this value is known you know that time the last time, time is required this time you know the final and initial and final head so you know this and this is constant cross section area of the standpipe.

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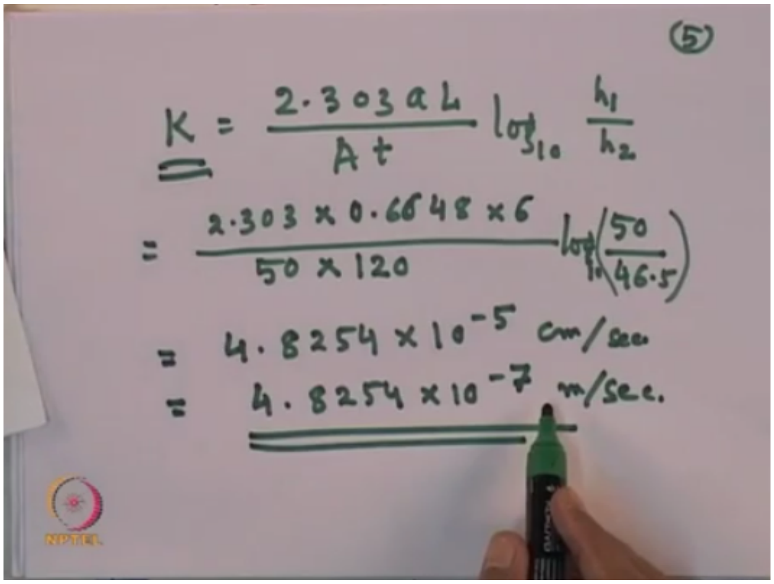

This equation is at the standpipe is known L length of the sample is known a cross section area of the mould sample also it is known so knowing this you can calculate that what will be the coefficient of permeability let us say that coefficient of permeability of the soil for the serial number one okay for the serial number one I am showing you one that is $k=2.303al/At*log_{10}h_1/h_2$ so this is 2.303 into that is small a that is cross sectional area of the standpipe.

That means these values cross section area of the standpipe a that is .6648meter so you can write small a=0.6648 this into the L, L is the length of the mould that sample is 6centimeter so L will be equal to the six this divided by a this is a that means this is the cross sectional area of the sample and this cross sectional area of the sample also is given this is cross section area of the sample a is 50 okay.

This is 50square meter so this will be the cross section area 50 and I say from this that time required is 120 so this is 120second so this into log you know h_1/h_2 that means log of that initial height h_1 is a 50/46.5 so you can calculate this and you can determine the coefficient of permeability let us say 4.854 you calculate it with 10^{-5} this is centimeter per second and that means you can write down for $.8254*10^{-7}$meter per second.

So you can calculate the coefficient of permeability or the sample for the variable 8 this method and this coefficient of permeability value you can say for $.8254*10^{-7}$ because it is a tray type of the soil you can see earlier that coefficient of permeability is 10^{-5} maybe the sand shield but in clay this coefficient of permeability about 10^{-7}meter per second so you can now calculate that coefficient of permeability for the variable head method.

And that constant head method and this parameter is very, very important to us because this parameter we can use for any drainage and the any kind of the filtration problem and the gradation of the soil and coefficient of permeability of the soil and you should obey the duchies law you know T is equal to K into I into a whether it is in a laminar flow condition or it is in a terminal condition and accordingly we are to calculate the coefficient of permeability of the soil.

So depend types of the soil it will be the gravel sealed quiet and so these coefficient of permeability also vary from soil to soil so one has to be select proper kind of the coefficient of permeability whether it is for the daily for the permeable purpose always a three the impermeable purpose for example if you use for the landfill where they we use certain compacted clay liner.

So it is a impermeable so you need the more impermeable so that value it may be helpful here that $4.825*10^{-7}$ meter per second will be the most important value for the compacted clay liner what you can use for the construction of the landfill or apart form that we have to go for the landfill let us say about 400 to 2500 or 3,000 millimeter the thinness of the compacted clay liner.

But now it is some alternative geo-membrane has come with thicknesses maybe already that one or 1.5 or two millimeter thickness alternative to the 200 500 or 3,000 millimeter of compacted clay liner and that also as an impermeable material so here we are restricted for the clear for the ready will what this variable head method how you can calculate the coefficient of permeability of the clip and the constant head permeability how you can calculate the coefficient of permeability.

Let us say like a sand okay what you require for the proper kind of the drainage system that's why we use for the sand in that you know that that then it can be very faster and it depends upon the value of coefficient of permeability what the excess of poor water pressure can develop and the water can be permeable very faster of course there are some alternative system like the sandal that alternative station like PVD prefabricated vertical drain which will give much, much higher coefficient of permeability than the sand.

And you know that that you can consolidated the soil very faster than acceleration is very fast you are not to wait for the long time to consolidate it so within a short period of span we can complete the conservation with some alternative system so that was the reason that it is very, very important to understand that coefficient of permeability for different types of the soil that it is a constant head method or it is a very valid method.

Now we will discuss the shear strain test this is another very important parameter shear strength of the soil and you should know how to perform their shear strength of the soil they are also defined types of the soil it may be like clay it may be the sand it may be the gravel may be the silt and how to calculate the shear state is a very important parameter in the geotechnical engineering and the shear strength of the soil or system parameters is very, very important.

So our here is the main objective is to determine the shear strength of the soil sample there are different method in which we can calculate the shear strength of the soil one is the direct shear test method and this also smaller-scale directives or the larger scale directives a can perform and sometimes nowadays you require for the larger scale direct shear test method because if we wanted to determine the shear strength parameter of the gobble okay which he may not be accommodate in a small-scale direct circus he require larger scale direct shear test value.

Even then we have some 1 meter by 1meter directly very, very large a scale direct shear test in it you can calculate that what will be the shear strength and shear strength parameter of the soil apart from the direct shear test also you can calculate this shear strength and the shear strength parameter of the soil by the tri-axial test and for the time unconfined compression same test so what is the shear link strength the shearing strain is the property which enables the soil.

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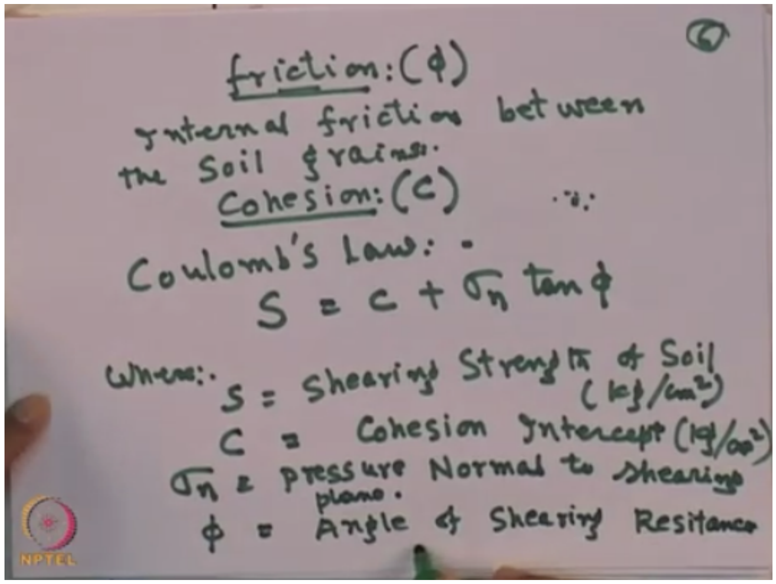

To maintain equilibrium on a sliding surface so shear strength of the soil consists basically of the two component so one component is the friction one component is the friction okay which is dependent on the internal friction between the soil grain so it is important that what will be the internal friction, internal friction between the soil grain so one parameter is very important that is what is called the friction this is important and second parameter is called the cohesion.

So these are the two parameter is important to ask and which you have to determine that what will be the CNE resistance of the soil of friction of the soil and friction of the soil is sometimes designated by ρ and that question is designated at C so you have to calculate what will be the shear strain and the shear strength parameter of the soil so C is the cohesion and C and the ρ and C is the cohesion and equation which is influenced by the grain size and the state of packing of the soil particle and the water content.

So this two parameter that is Coulomb's law we call the Coulomb's law, Coulomb's law so this is the $S=C+\sigma_n$ tan ρ so once develop this law that means shear strength of the soil is equal to the cohesion that is C plus the angle of internal friction that is why for a particular normal load σ in where S is shearing strain of soil and it expressed as kg per centimeter Square and C is equal to cohesion intercept and that also expressed as kg per centimeter Square.

And σ_n is the pressure normal to shearing plane and ρ is equal to angle of shearing resistance angle of shearing resistance and that any resistance of soil and that also can be expressed as at degree, degree so this shear strength parameter also sometimes that depend on what type of the soil if it is a cohesive soil if it is a cohesion less soil or if it is a both cohesion soil and the cohesive soil and then how you can calculate that what will be the shear strength parameter of the soil.

So if it is a we have to determine what will be the normal stress and the shear stress and then you can draw from the Mohr circle diagram what should be that shear strength of the soil so you know that what is the normal stress you know that what will be the shear stress then you can calculate that what will be the angle of friction ρ or what will be the equation value so that you can only calculate it based on this Mohr Coulomb criteria and from that equation.

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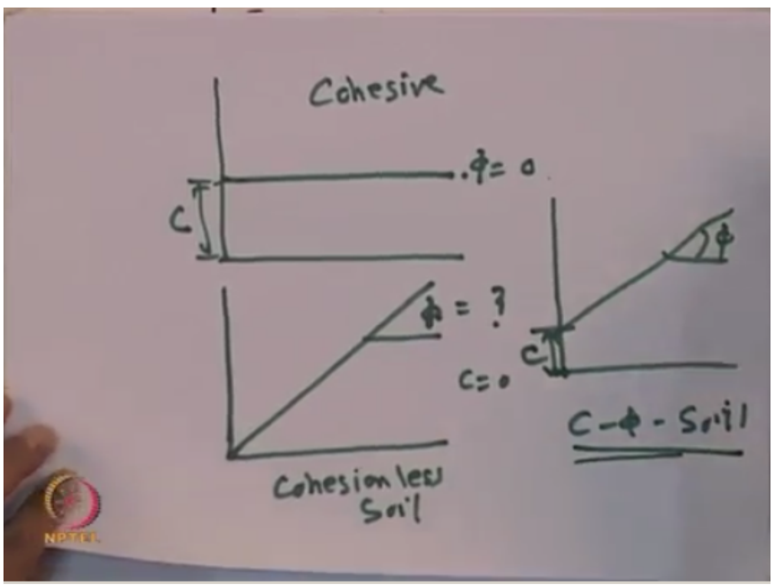

It can be you can calculate so, so if it is a let us say that if it is absolutely that cohesive soil then line will be like this what there is a ρ=0 okay this is absolutely you the classic type of the soil or if it is the let us say there is a sand then it will be give only that ρ value okay there is no C value no C value only you can have some ρ value 30 degree 35 degree whatever it may be if it is the cohesion less soil or sand.

If it is a cohesive soil if it is a cohesive soil so you can have what will be the cohesive value here see so y is 0 when if it is a cohesive soil, soil so you are having the ρ but C is 0 or if it is a both the friction and question so you can have this ρ value and you can have the C value and this also called C and ρ soil so from this also you can calculate that what will be the coefficient value and what will be the angle of the any resistance of the soil this is called the C Point soil because there is a cohesive angle of internal friction.

So this is what we will study in detail by the shear strength parameter how you can determine as I told for different types of the diagram you can drop for the different types of the soil if it is a cohesive soil if it is equation soil or it is a both the cohesive soil then you can see how we can draw the Mohr Coulomb failure envelope and how we can determine that ρ value angle of generations of the soil and cohesion of the soil these other two parameter is very, very important in for the soil mechanics or the geotechnical engineering so you should know how to perform that test next time we can go detail about this and thank you.

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