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Geotechnical Engineering Laboratory

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Lecture No – 11
Compaction and Permeability

Effect of compactive effort, now you know

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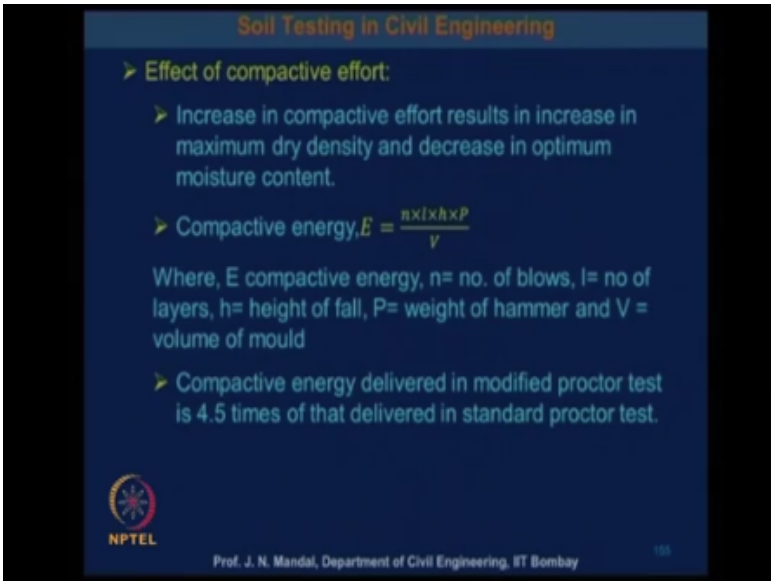

Increase in compactive effort results in increase in maximum dry density and decrease in optimum moisture content. Now this compactive energy we can write.
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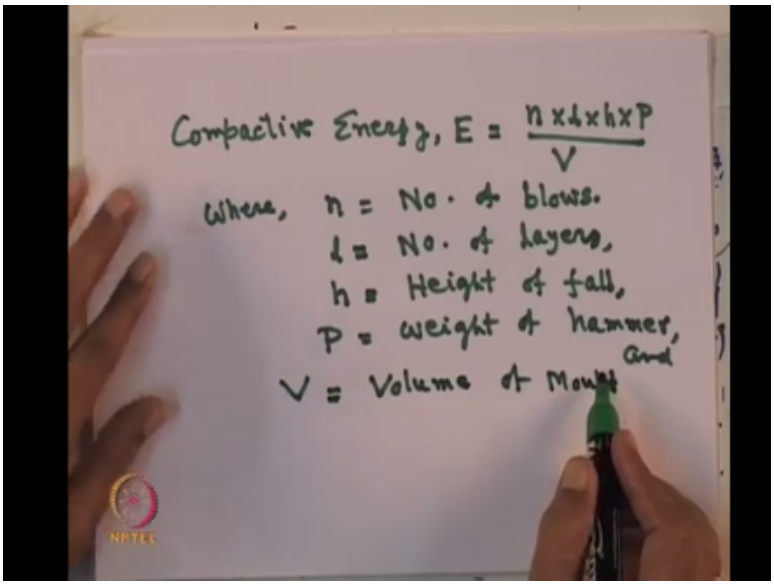

E can be define has n x l x h x P this divided by V, where n is no of blowing and this l is number of layers, and then h small h height of fall and P is the weight of hammer, and V = volume of mould. So this is the definition of the compactive energy and this compactive energy derived in the modified protractor is 5 times than the derived in the standard proctors. So you can compare what would be the compactive energy with standard proctors and the modified proctors.

So I will show you some calculation what will be the difference in the energy for the standard proctors and the modified proctors. For example that if you consider standard.

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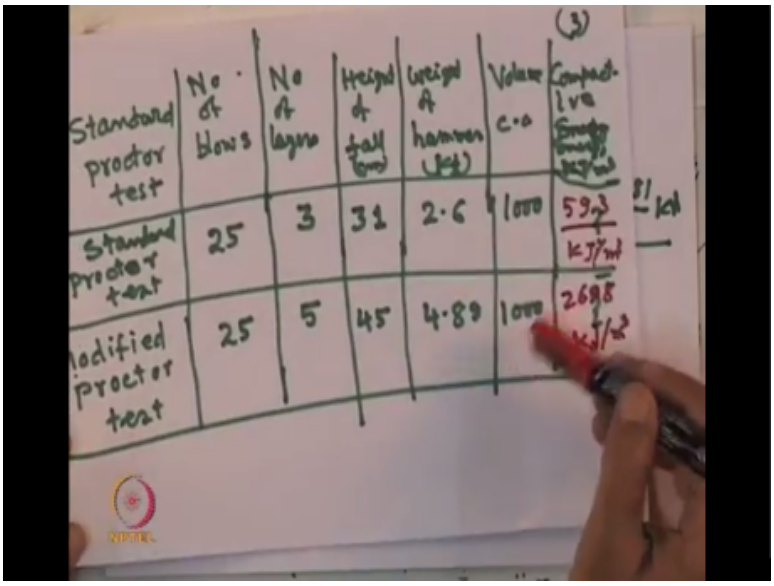

Standard proctor test and let us say the number of blows and then we can consider the number of layer and then what is height of fall in cm? And then the weight of the hammer, that is in kg, and then the volume, that is cc, and then we can calculate what the compactive energy that is kj/m3 is. So for the standard proctor test, let us say the number of blows is 25 and number of layer is 3 and height of fall is 31cm and weight of the hammer is 2.6 and the volume is 1000cc. So this is called standard proctor test. So you have to calculate what should be the compactive energy?

Similarly for modified proctors test, so the number of blows is same that is 25, and the number of layer will be 5 instead of 3 in case of modified proctors test and the height of the fall is about 45cm and weight of the hammer is 4.89kg and the volume is same that is 1000. So you have to determine what will be the compactive energy in standard proctor test and modified proctors test and see the difference. So how to calculate the energy for the standard proctor test, let us write this equation you know.

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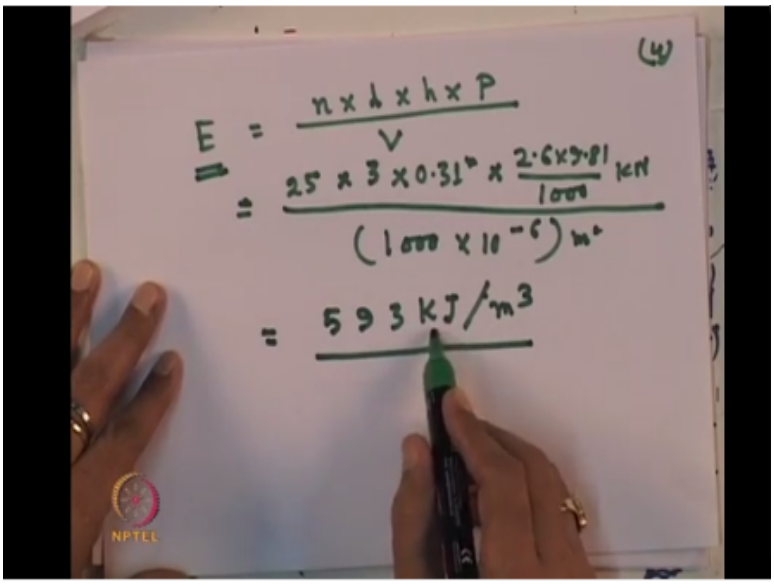

Energy equation E = n x l x h x P/V, so for the standard proctors you know that n = 25, that is here n = 25, number of layer is 3, you can write here 3 and the height is 31cm that is 0.31^{m} this x P, P is 2.6kg, so you can write 2.6 x 9.81/ 1000 this is in the kilogram. So this divided by the volume in meter that will be 1000 x 10^{-6} $m^{3.}$ So if you can calculate, so you can have 593kj/ $m^{3.}$ so for the standard proctors this V value will be 593kj/ m^3. So here we can write that 593 that is kj/ m^3 for the standard proctors.

Similarly we can calculate the compactive energy in case of modified proctors test, so modified proctors test you can write this equation.

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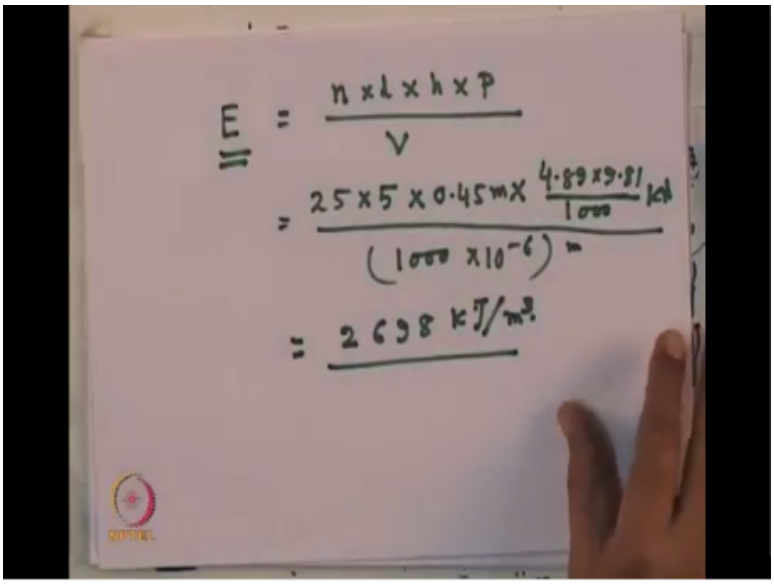

Compactive energy E = n x l x h x P/V, so in case of modified proctors test this is number of blow is 25, this is 25 and number of layer 5, so you can write number of layer is 5, this height of the fall is 45 cm, so you can write 0.45 this is meter, this is height and then you can write the P. Here P is 4.89 kg so you can write 4.89 x 9.81/ 1000 kn, so this divide by V and V is 1000 x 10^{-6}. So if you calculate you can have this value 2698 KJ/ $m^{3.}$ So this is the compactive energy for modified proctors' test, so you can write here modified proctors test about 2698 KJ/ m^3.
S you can see that effect of increase in the compactive energy on the compacted side.

So how the energy and also you can see the value and depending on the types of the mould, that is used as standard proctors mould or modified proctors mould. So in case of modified proctors mould the compactive energy above 4.5 times than that of the standard proctors mould. Now I will discuss the laboratory permeability test.

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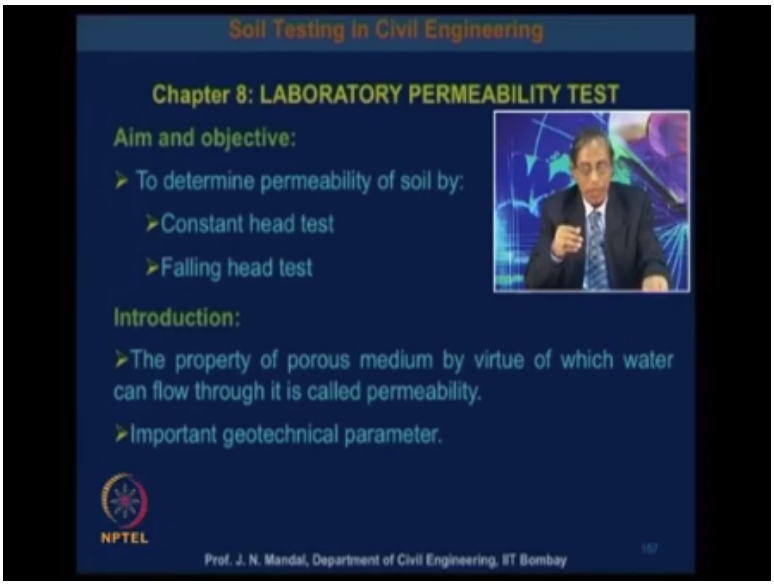

This permeability test is important in soil mechanics and how to perform the permeability of any soil, so the main objective of this permeability test is to determine the permeability of soil and there are methods, one is called the constant head method and this constant head method is particularly for the constant soil and other is called the falling head method and falling head method is particularly for the final gain soil.

So the property of the porous media by virtue of which water can flow through it is called permeability. So this permeability parameter is very important in geotechnical parameter and one should know what will be the type of the soil, whether it is clay, whether it is ravel or it is a sand or it is seal because may be it is a permeable it may be the impermeable, so this permeability value is very important for all different project. Now here we will see how to determine the coefficient of permeability of the soil.

So what is the use for the determination of permeability that we know that Darcy law, the Darcy they stated experimentally that for laminar blow condition, in a saturated soil the rate of blow or the discharged part unit time is proportional to the hydraulic gradient.

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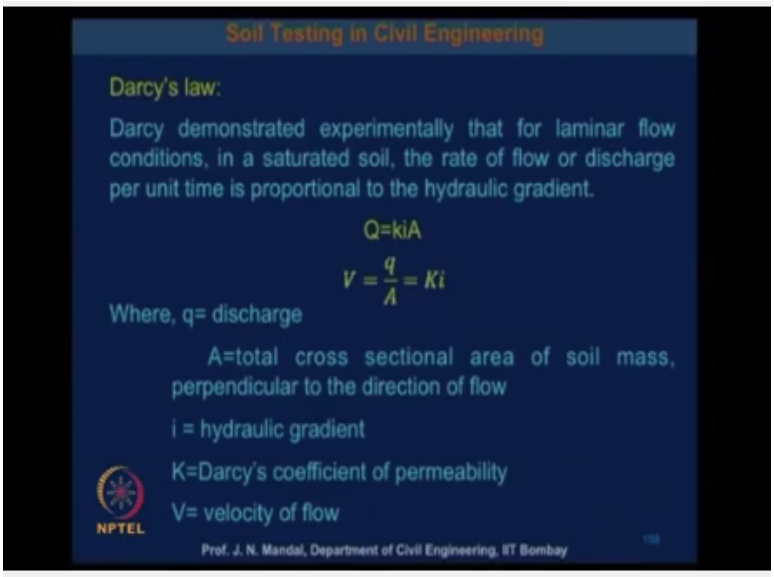

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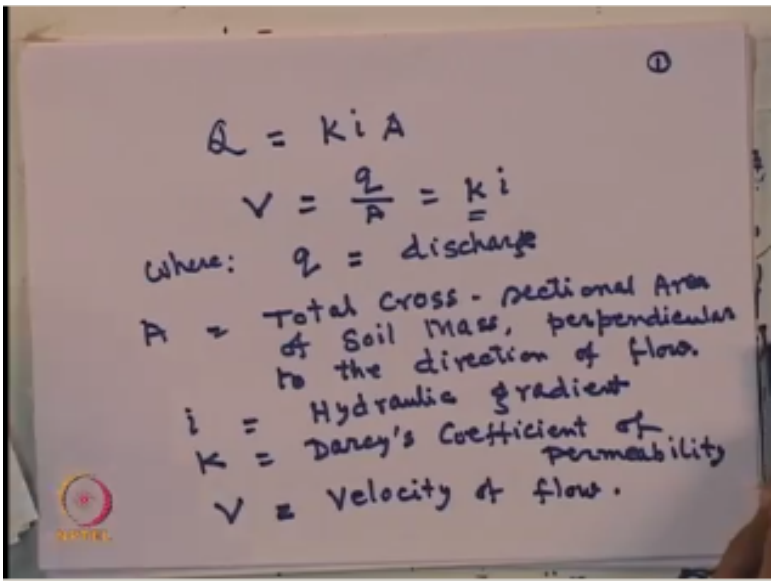

Write that Q = KiA again V = q/A that is ki, now here this small q is the discharge and A is total cross sectional area of soil mass and perpendicular to the direction of flow. And this i is hydraulic gradient and k is Darcy's coefficient of permeability and v is the velocity of flow. So we use that Darcy's law.

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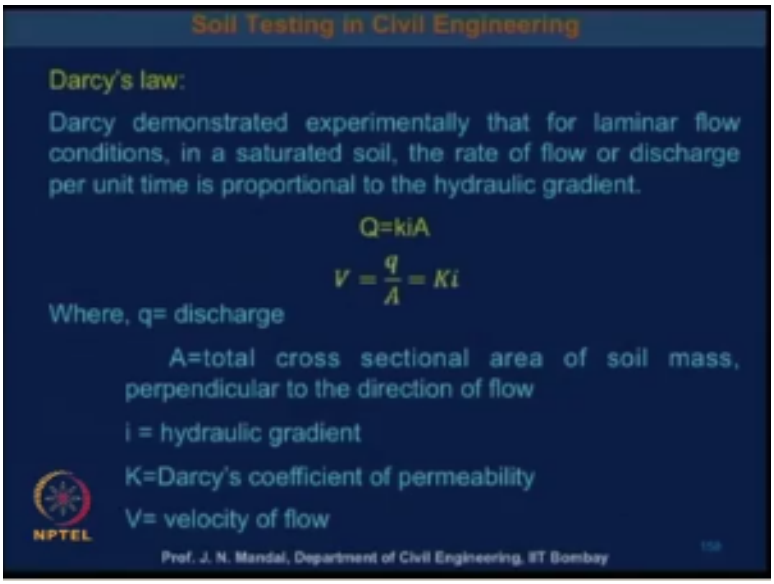

So this important this equation that v = q / a = ki you know what is i, hydraulic gradient and this is the k that is Darcy's coefficient of permeability and this is velocity of flow v.

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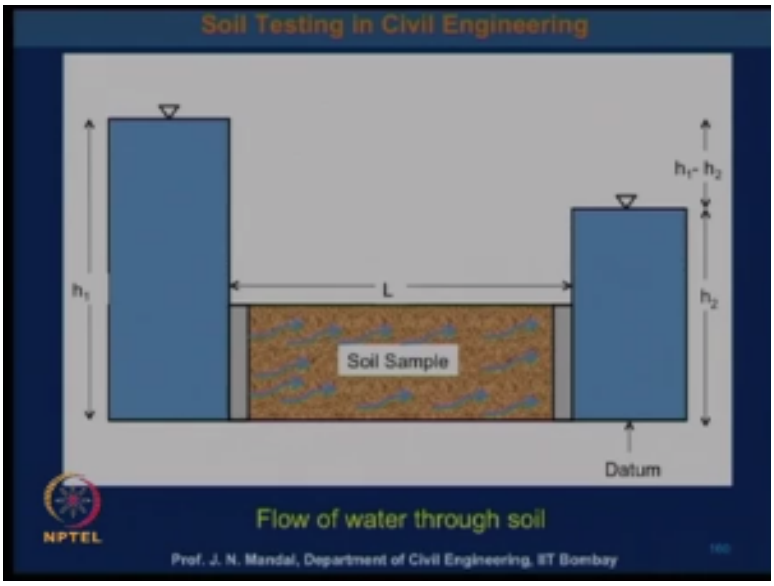

Let us say that this is the soil sample of length is L, and this is h1 here head water is here is h1 and this is water head here is h2 so water can pass from this upper and through the soil sample to this, this is the datum. So there is a difference here is h1 – h2 so if a soil sample of length is l and the sample also has a cross sectional area support a I am just representation here that is the sample length.

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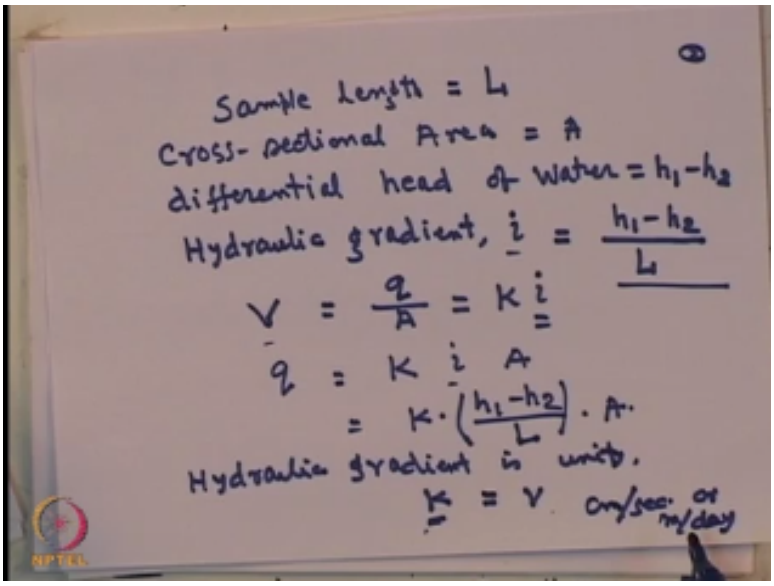

Sample length is equal to L and cross sectional area is equal to a and it selected in the different it that means there will be a differential in head so differential head of water = h1 = h2 so this is a h1 – h2 this is the differentiation water here. So then we can calculate that what will be hydraulic gradient so hydraulic gradient i it can be express as h1 – h2 / length of the sample L, so this hydraulic gradient is can be defined as h1 – h2 and this is the length of the sample.

So you can perform the test under different hydraulic gradient, but that is also certain specification we have to maintain that specification what under hydraulic gradient we should perform the test. So you know how to express the hydraulic gradient, so hydraulic gradient i is h1 – h2 / l. Now we earlier mention that v that means velocity of flow is equal to that is q / a = k x i so this i is the hydraulic gradient that means h1 – h2 / l.

So we can write substitute I = h1 / h2 / l so that v = q/ a = k so q = this is k and i and a q = kia or k x i = h1 – h2 /l so we can write h1 – h2 / l x a. now look here that in the hydraulic gradient that means h1- h2 / l is unity that means that if the hydraulic gradient is the unity so you can write that q = k a that means you can write that it is the velocity that means q = v. so when the hydraulic gradient is unit that means k = v. that means it should be the velocity because hydraulic gradient = 1. So v will be equal to the k or k will be equal to the v.

So thus this coefficient of the permeability is define as a average velocity of flow that will occur through the total perceptional area of the soil under a unit hydraulic gradient. So this hydraulic gradient coefficient of permeability and is dimension is express as cm/second or you can be

express also m/day. So the unit of this coefficient of permeability is cm/second because k = v almost velocity so this can be express like cm/ second or m / day.

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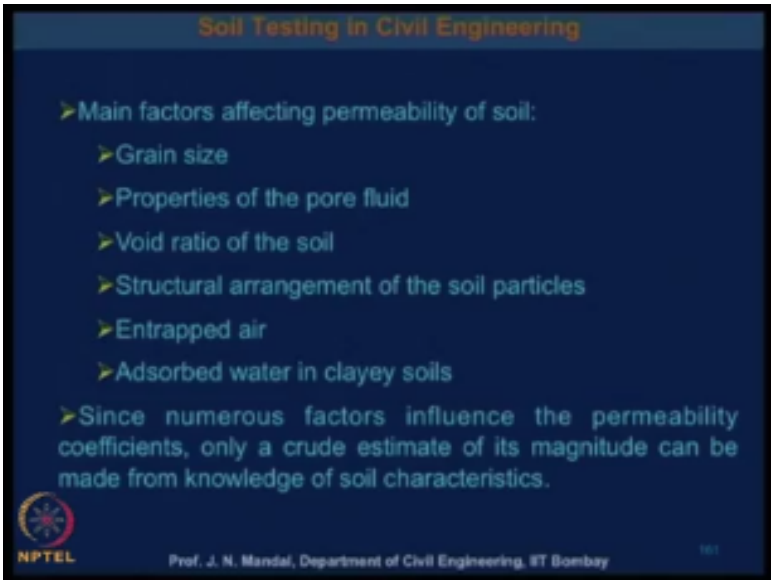

So there are many factors which affecting this coefficient of permeability of the soil and it depend on what will be the grain size of the soil what should be the properties of the pore fluid what will be the void ratio of the soil and structural arrangement of the soil particle then entrapped air then absorb water in clayey soil. Since numerous factors influence this permeability coefficient only crude estimate of its magnitude can be made from the knowledge of the soil characteristics. Now for the determination of the coefficient of permeability there are various methods

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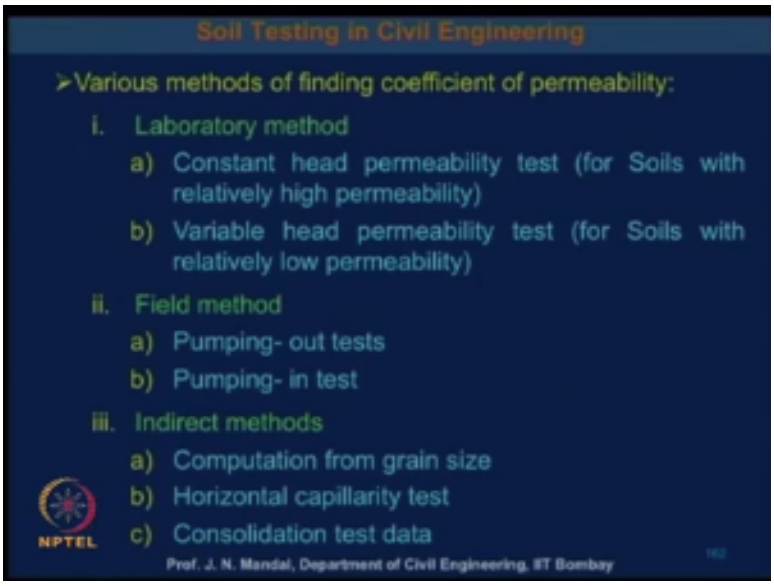

And there are some laboratory methods that what will call the constant head permeability test and this is particularly the soil for relatively high permeability and there are also variable head permeability test methods for soil with relatively low permeability and there are also the field test that is pumping out test and pumping in test so you can directly determine from the field what will be the coefficient of permeability of the soil apart from this laboratory method and the field method you can also obtain the coefficient of permeability by indirect method that is computational from the grain size then horizontal capillarity test and the consolidation test data.

So there are various types of the method for the determination of the coefficient of permeability and as I say this is the very important parameter for soil mechanics or geo technical engineering and the as I describe you how you magnetically how you determine the coefficient of permeability. Next we will focus that how you will perform the test of the coefficient of permeability with the different method with the constant head method or the variable head method for the different type of the soil it maybe the course mean particle or the final grain soil particle. Thank you.

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