Geosythetics Testing Laboratory
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Lecture – 11
Triaxial Test and Pullout Test

As we are discussed earlier the Triaxial test and as well as the direct shear test, from the direct shear test from soil to soil you can determine what will be the cohesion and what will be the angle of internal friction. Similarly, we have also shown that how you can calculate the shear strength between the soil and the Geosynthetics material. So, from both the test we can determine what should be the efficiency.

So, you can write the equation and that what it called the efficiency. So, this is designated as E of c, E c is equal to C of a divided by c this into 100 and you can determine E of phi; that means, efficiency on friction.

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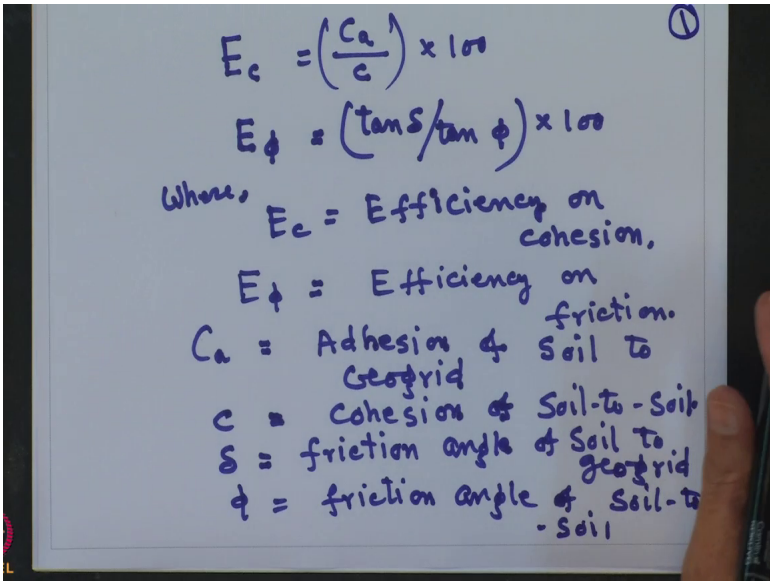

So, that we can write tan of delta divided by tan of phi this into 100, where E c is efficiency on cohesion, E c is efficiency on cohesion and E of phi is efficiency on friction. So, where C a, C a is adhesion of soil to geogrid material and this C is cohesion of soil to soil, soil to soil. And delta is the friction angle, friction angle of soil to geogrid and phi is the friction angle of soil to soil. So, from this test we can determine what will

be the efficiency on the cohesion and as well as what is efficiency of the friction; that means, E c and E phi can be determined.

Now, when you will perform the direct shear test and you have to remember that as a thumb rule the soil testing is done and device must be more than the 10 times of the size of the soil particle and generally when you will perform the geogrid material in a direct shear test machine. For example, that it is the direct shear test and this is the top and geogrid material is fixed with the top wooden block this is the geogrid material.

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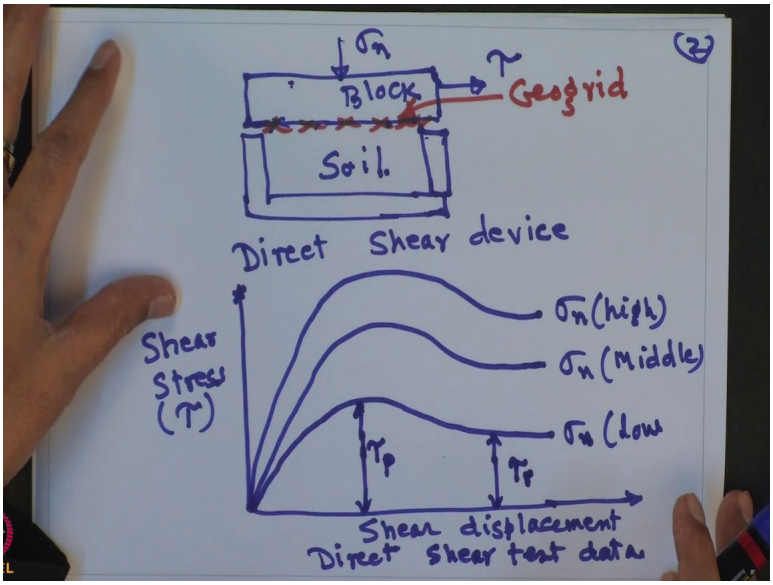

So, this geogrid attached to the block, this geogrid attached to this block then you are applying load and then you are giving the shear stress and bottom on is the soil. So, this is the direct shear device. So, any kind of the material we can determine what should be the friction angle between the soil and the geogrid or between the soil and the geomembrane or between the soil or any concrete woven geotextile and nonwoven geotextile material.

So, from this direct shear test you can draw a correlation between the shear stress. So, this is shear stress that designated as tau and the shear displacement, shear displacement, ok. So, this is the direct shear test data. So, you can draw the curve like this, you can draw the curve like this, you can draw the curve like this.

So, you can determine the maximum shear stress or the peak residual test. So, this under sigma in middle this is sigma n this maybe the high and this is sigma n, it may be the middle or this is sigma n it maybe the low. So, you can determine that what should be the tau peak value you can determine what should be the tau r value; that means, peak residual value and peak tau value from direct shear test you can determine.

Apart from this that test setup procedure or interface between the soil and geosynthetic material you can determine also Mohr coulomb failure line. So, how can you determine the Mohr coulomb failure envelope? So, let us say be the normal stress that is sigma of n and this is shear strength and this is tau.

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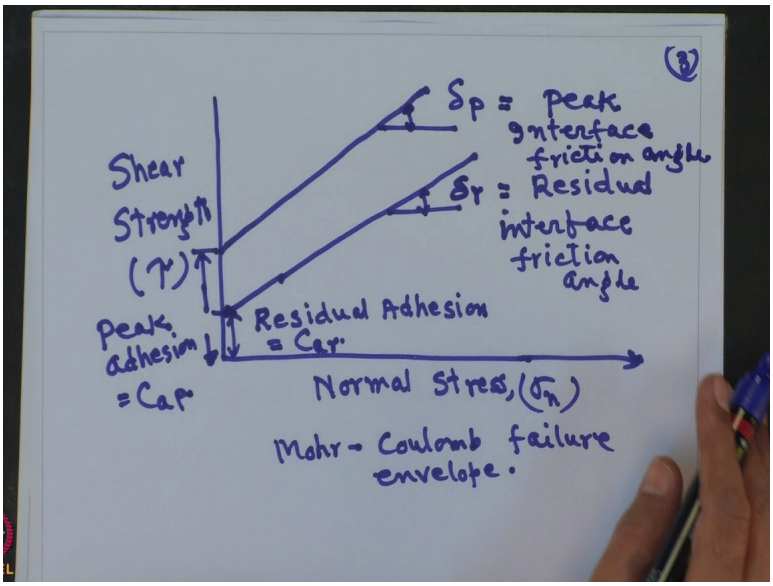

So, this you can draw the Mohr coulomb failure line like this and also like this. So, this part either this part is the residual, residual adhesion and this designated as C of a r and this part I can say that peak adhesion and that designated as C of a p. So, this is basically Mohr coulomb failure envelope. And from this curve we can determine what is delta of r; that means, residual interface friction angle, interface friction angle. And from this curve you can determine what is delta of P that is peak that is peak interface friction angle.

So, from this study you can determine the peak interface friction angle and the corresponding what is the peak adhesion and similarly you can determine what will be the residual interface friction angle and as well as the residual adhesion which is called C of a r. And most of the tests of geogrid soil interface direct shear test are to be performed

in a larger scale direct shear test and with dimension will be about 300 millimeter into 300 millimeter in size.

So, I can show you also some of the different material and how we can determine the friction angle and also the efficiency. So, for example, that test condition is soil to soil and you can determine number of the test 1, test 2, test 3 like that.

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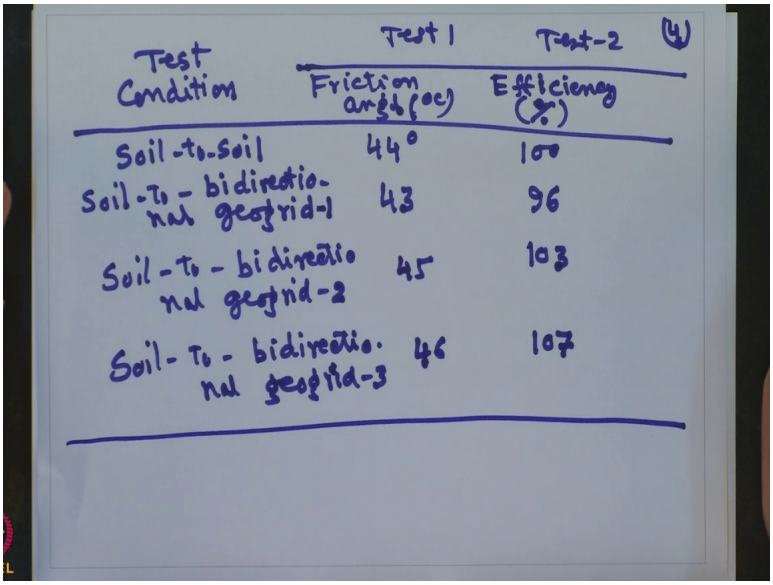

I will show you the one test one result. So, what should be for the test one what should be the friction angle? What should be the friction angle in degree centigrade? And for the test angle one what should be the efficiency and that is in terms of the percentage.

So, if you soil to soil let us say friction angle 40 degree, so efficiency is 100 percentage. So, there are different types of the geogrid material. So, let us say soil to bidirectional geogrid material. So, the friction angle is 43 and efficiency is 96. So, there are different types of the bidirectional geogrid material it maybe let us say this is geogrid 1 and let us say that soil to bidirectional geogrid 2 and friction angle is 45 and efficiency is 103.

So, let us say soil to bidirectional geogrid 3 the friction angle is 46 and efficiency is 107. So, there are different types of the material under the different test condition in maybe soil to soil it maybe soil to geogrid it may be soil to any geosynthetics material. So, from this test you can determine that what should be the friction angle and as well as the what should be the efficiency.

So, from this triaxial test and as well as the from the direct shear test. So, you know how to determine the cohesion and angle of the friction, how to determine the adhesion and the angle of friction and how to determine the efficiency due to cohesion and as well as efficiency due to the angle of internal friction. And I recommended that when you will perform the direct shear test always the size of the direct shear test will be 300 millimeter by 300 millimeter in size. So, this will give very good result because when you will perform the geogrid material there will be a good interaction or bonding or interlocking between the soil or aggregate and the geogrid materials.

So, next I will talk about the pullout test and you know that pullout test is very important parameter and you should know how to determine the pullout test of the geogrid material. And it will be very helpful for the design of the mechanically stabilized reinforced soil wall and also it will be very helpful for the design of the steep slope reinforced soil steep slope. So, for this pullout test we will adopt the ASTM D 67069.

Now, main aim and objective of the pullout test to determine the anchorage resistance of the geosynthetics material. So, in interaction it is very important to compute the pullout capacity of the reinforcement to ensure stability of any reinforced structure as I told you reinforced soil retaining wall reinforced soil slope etcetera.

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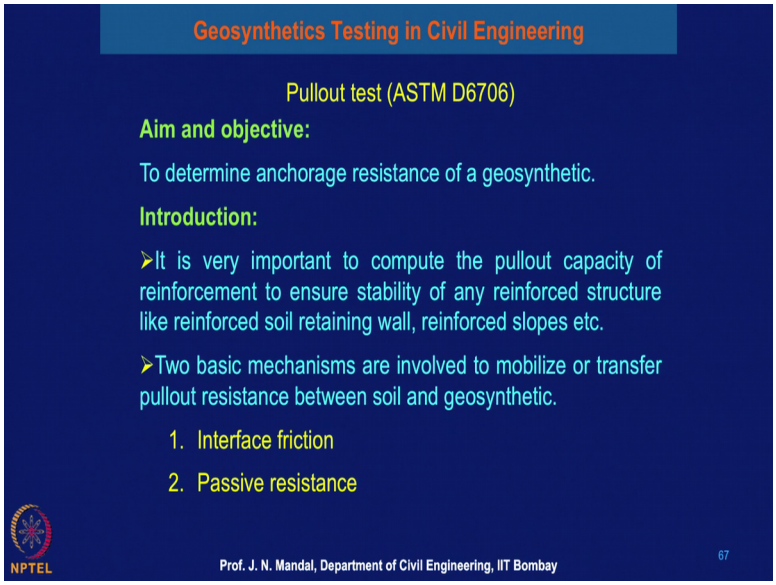

So, two basic mechanisms are involved to mobilize or transfer the pullout resistance between the soil and geosynthetics you want be the, what is the interface friction and what should be the passive resistance.

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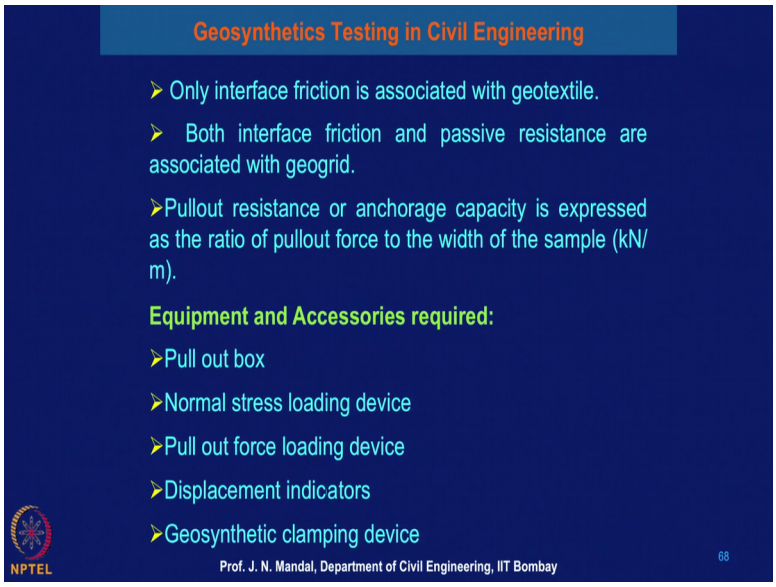

So, only the interface friction is associated with the geotextile material because geotextile material may be the woven geotextile material or maybe nonwoven geotextile material. So, there will be the interface friction between the soil and the geotextile material.

On the other hand the both the interface friction and the passive resistance are associated with the geogrid materials because geogrid is a kind of the open mesh. So, there will be the interface friction between the soil and the geogrid and also because for the opening of the geogrid material there will be a passive resistance which will be acting between the geogrid and the soil. So, pullout resistance of or anchorage capacity is expressed as the ratio of the pullout force to the width of the sample and it is designated as kilonewton per metre.

So, to perform the pullout test and we require certain equipment and accessory. So, these are you required the pull out box, you required what if the normal stress loading device and pull out force loading device and the displacement indicator in which we can measure what will be the displacement and also you require the geosynthetic clamping device. So, here I am showing you some pictorial view of the pullout test.

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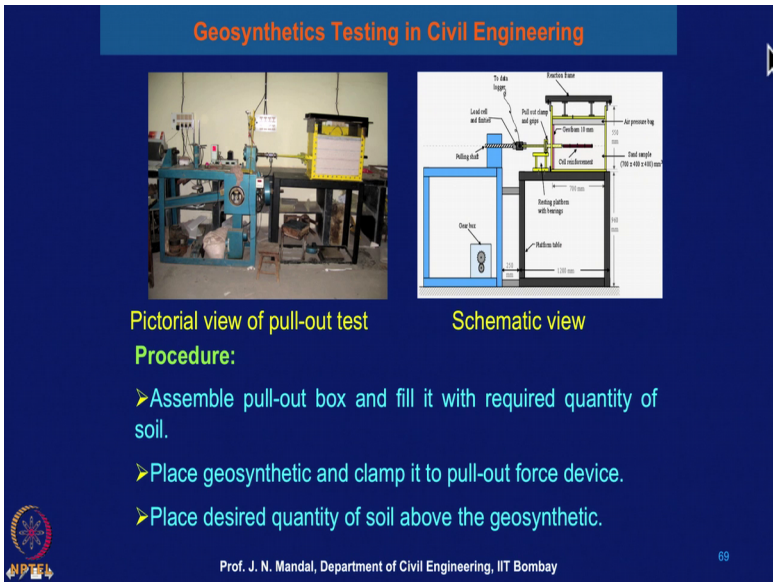

So, this is the pullout test equipment and this you are pulling, of this shear you can see some schematic diagram. And here I am showing you here is that here is the box, pull out box and is rest on a platform with the bearing and you are to provide with some kind of the airbag also top of this.

The airbag are to be placed on the on the sample and this is the geogrid material which is to be pulled it out and this is the load is applying on this on the top of the sample here to put air pressure bag, because air pressure bag is very important because the load will be distributed symmetrically. So, that is very important here to provide the air bag here then you have to pull it out.

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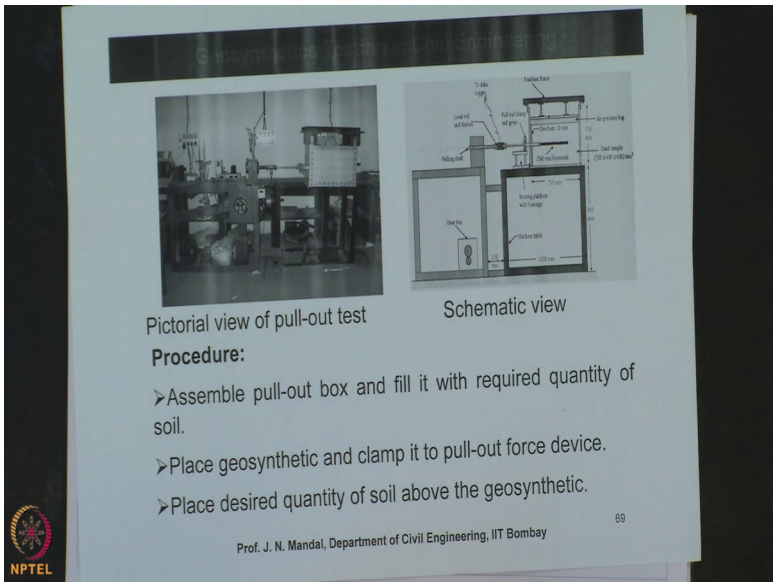

So, from this here to assemble the pull out box and filled it with the required quantity of the soil here and then place the geosynthetics and clamped it to pull out the force to the device, to place desired quantity of the soil this above this geosynthetics material. So, then you can apply this normal compressive stress ensure complete connection by applying the seating load and note the gauge reading apply the pull out force at a constant rate of displacement and continue loading until the geosynthetics fail. So, repeat the procedure for different normal load.

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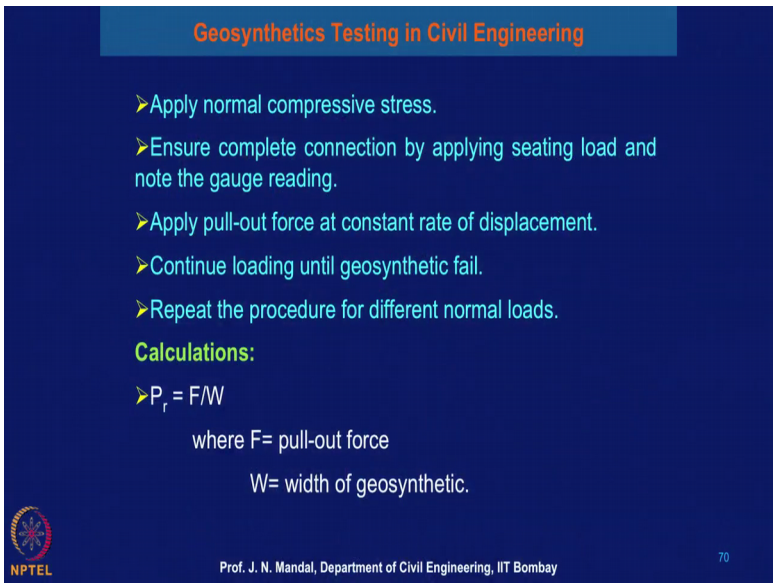

So, from this test you can calculate that what should be the pull out force that is P of r. So, that will be the what will be the pull out force that is F and what will be the width of the geosynthetic material. So, you can calculate that P r will be equal to, so P of r you can calculate that P of r will be equal to F divided this W, where F is equal to pull out force, F is equal to pull out force and W is equal to width of geosynthetics, width of geosynthetics material.

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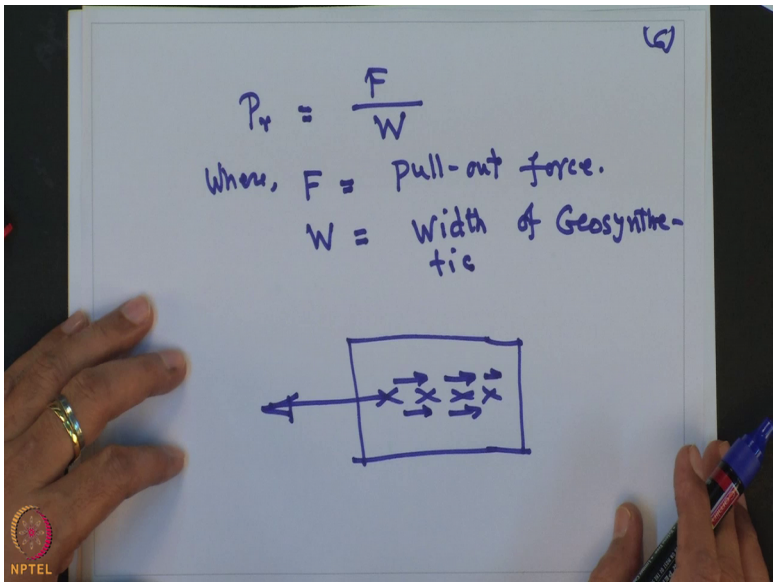

So, so it is it is like that if I can draw a small sketch like this, if this is the pull out box and if this is the geogrid material and you are pulling. So, what will be the mobilization of friction between the soil and geosynthetics material? It is like this or it may fail any point. So, you are determining that what will be the pull out force. So, if you know that then you can determine P r value which is F by W.

From this test you can determine what is interaction coefficient of the geotextile material, interaction coefficient of the geotextile material, how you can calculate the interaction coefficient of the geosynthetics material.

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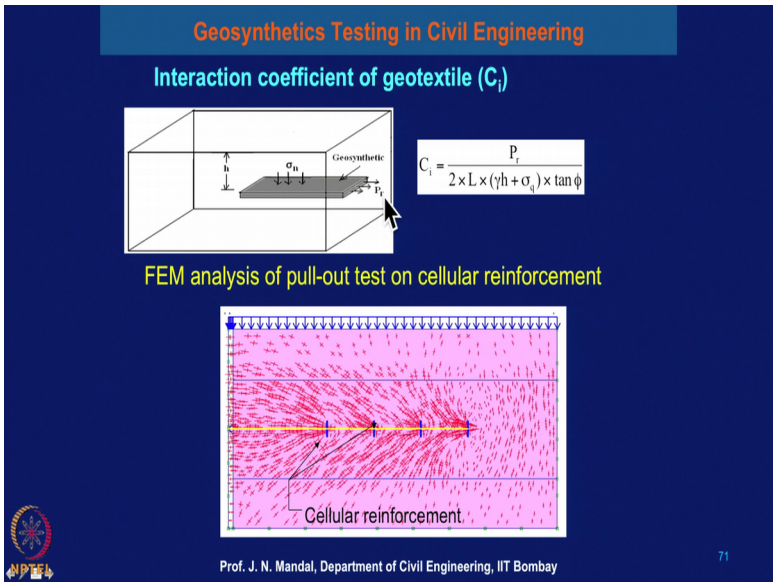

I am showing you that interaction coefficient it is the pullout this is P r this is geosynthetics material and this is the normal phase sigma n and this geosynthetics material is located at a depth of h here and this is P r. So, from this you can calculate what will be the interaction coefficient of the geosynthetics material that is C of i; that means, you know that C i will be equal to the P r divided by if this length is equal to L when you are putting the bond length is equal to L, so 2 into L, and this is the load is equal to gamma of sigma n is equal to gamma into h. If there is any surcharge that is sigma of q and that, into tan of phi that will be the friction, developed.

So, you can determine that what will be the interaction coefficient you know P r because you know F you know w you can determine P r. So, this P r will be equal to that is interaction coefficient C i into this. So, from this pull out test you can determine interaction coefficient of the geosynthetics material. So, you know what will be the length of the geogrid material, you know where it is located if there is a surcharge you can add you know what will be the phi value.

So, these also we had done something with the cellular reinforcement and then pull out test has been performed and you can see that this is the cellular this is reinforcement. That means, it is a kind of geo cell material or geo web material and the pull out test has been performed and this is the finite element analysis you can see how the traces are distributed along this geocell material.

So, from this test we can determine that what should be the interaction coefficient of the material. So, you should know that: what is interaction coefficient. This is very important and that interaction coefficient vary to geosynthetics to geosynthetics material, some geosynthetics material interaction coefficient maybe 0.6 or 0.7 or 0.9, it vary. So, 0.6 to 0.9 even then sometimes 1 interaction coefficient.

And this is very important parameter the interaction coefficient. So, this is very very important parameter and this interaction coefficient will help you to design for the mechanically stabilized reinforced soil well and as well as the any reinforced steep slope design. So, in many cases even then if you use geogrid material any woven or nonwoven geotextile material even then if you can use that geocell or geoweb material this interaction coefficient is very sensitive and this is very important and this parameter you must consider into the design, but proper laboratory testing of that particular material. You cannot assume that any value of interaction coefficient for the design of geosynthetics reinforced soil structure.

Thank you.