Geotechnical Measurements and Explorations

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Lecture No. # 09

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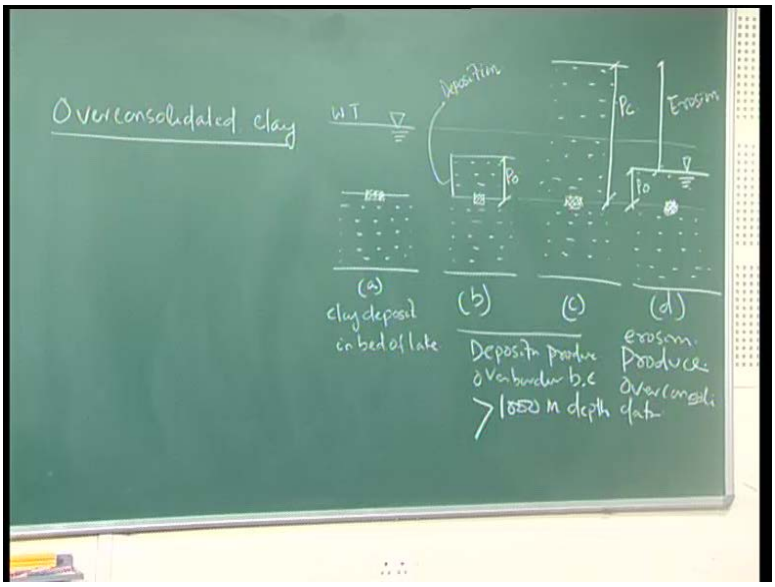

Last class we discussed CU test for normally consolidated clay. Now, come back to over consolidated. There are just cases how the over consolidation comes into picture - water table, clay deposit in bed of lake, then same if I extend it which is this clay deposit in the bed of lake. And this is P 0, then this is a deposition, and come back to here. (No audio from 01:58 to 02:18) This is your P c, then P 0.

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Now, over consolidation over consolidated clay, if I explain this over consolidated clay this has been drawn a, b, c, d - four parts. First, let us imagine this clay deposit bed - this clay deposit clay deposit in a bed of log bed of lake, where this water table is here, part a. Then, over the period of time in that bed of lake, over the period of time there is more deposition, the layer has been increased the deposition suppose this is the clay layer, and this is your deposition in a bed of lake. Then over the period of time this deposition has

been increased; to this is your P 0 is your over burden, then it has been increased to consolidation pressure P c up to this.

Then over the period of time again due to some other reason, there is an erosion - there is an erosion. So, what will happen this P c is still there, P c is still there before erosion that means this soil, particularly this soil exhibits. This clay soil this consolidation process starts means consolidation process starts, all of sudden what will happen? There is an erosion due to some other reason this part has gone.

So, due to this erosion this our consolidation, our consolidation process is there in the soil, because in the present state the past means pre-consolidation pressure in not there, but this over consolidation means, this consolidation has been over. So, this is a typical example, where this clay layer is there in deposit in bed of lake.

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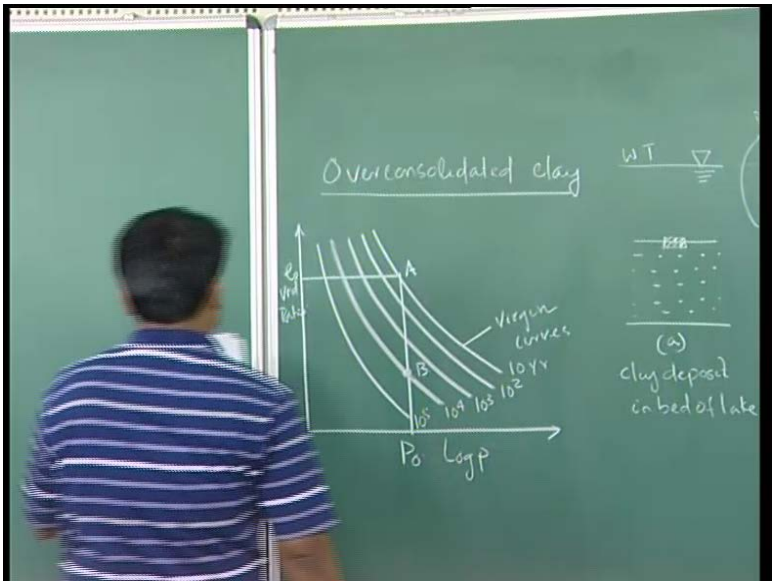

Now, if I understand with this graphically if I can draw a graph with this how this phenomenon of this over consolidation on this shear strength. Now let us say, these are the consolidation or virgin curve with this void ratio versus log P.

So, virgin curves show this suppose say 10 years, then it is your 10 to the power square, 10 to the power cube, 10 to the power fourth, 10 to the power five means suppose this deposition virgin curve, this deposition of this clay over this clay means there is a clay deposit in the bed of lake over this clay. There is a deposition, suppose it happens with

10 years, then may be after ten may be after 10 square years, what is there deposition? So, deposition it increases - it increases, so that means this over burden pressure it increases P 0 to pre-consolidation pressure, so that consolidation process starts.

Now, suppose say this is my e 0, initial void ratio of this clay. So, it starts with A, suppose within this ten years it is A, where with correspondence to P 0 over burden. Now, so due to cliff or may be due to erosion, so what will happen? It will drop down somewhere else here say this is my B.

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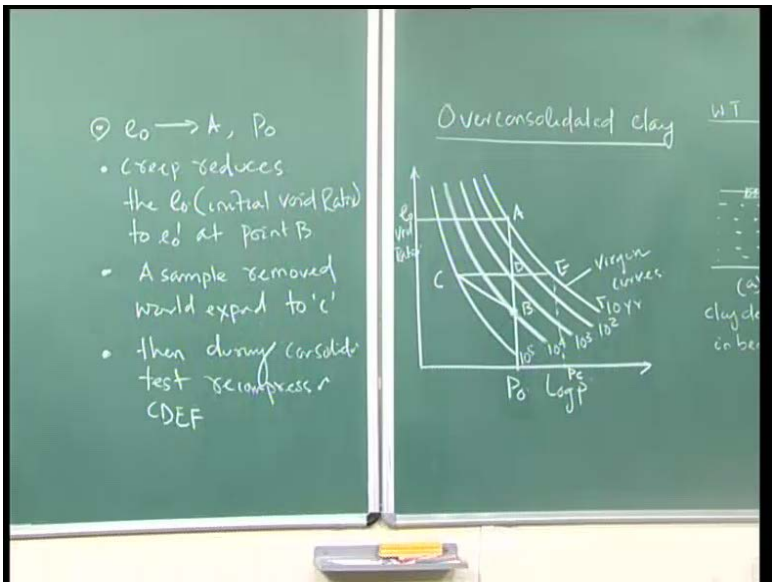

Now, if I write it point one, so e 0 which is at A of P 0, then second part is your creep reduces, the e 0 or initial void ratio to e 0 prime at point B. Then, third point is your a sample removed removed would expand to C, it would expand to say C. Now, then during consolidation test, so recompression occur CDEF, that means C, D it will go E, and F. So, this will be your P c at e. Now, if I compare with this figure in terms of void ratio e versus log P what will happen suppose this is my initial state, suppose this is a clay deposit in the bed of lake.

So, initially what will happen after certain time there is deposition, So, let us say this deposition is up to this ten years, then once there is a deposition, because of over burden the clay deposit undergo consolidation. This is my first consolidation graph or virgin graph, then again another 100 years may be 10 10 square 10 to the power two years or another 100 years there is again deposition. So, because of that deposition again this

consolidation curve - virgin curve looks like this, again another 100 years, so it will continue this because of this consolidation process continue. So, it sits towards your e versus log P towards the left.

Now, suppose let us say let us say this is my initial void ratio e 0, this is the initial void ratio e 0 of clay sample. So, soil is here, so with this with this clay sample with this over burden pressure P 0 is over burden pressure, so it it intersect at point say e, one of this virgin curve that is called 10 10 years time. Now, what will happen? Now what will happen with this, so it will due to creep due to creep suppose the void ratio will change from e 0 to e 0 prime.

How it will change e 0 to e 0 prime? Over the period of time, there is the there are means depositions on the clay deposits, so due to some other region. Suppose, this is the initial layer again deposits in 10 years, another 10 100 years deposition is there, another 100 years deposition is there.

So, it will achieve up to a pre-consolidation pressure P c, P c; then what will happen due to some other reason, the movement the soil sample will achieve a pre-consolidation pressure P c. So, consolidation process starts or over burden pressure P 0 consolidation process starts, once the consolidation process starts, then what will happen due to sudden erosion. That means soil will be taken out or may be water table may be this sea layer, this is the deposition in the sea bed of lake what will happen? This water table goes down, it falls down; that means this over burden has lost certain part of the over burden has lost.

So, from initial void ratio to it will come back to the void ratio will change, void ratio is here, volume of voids by volume of solids, so it will come back. So, this is your e 0 prime, because of your erosion; that is that that produce your over consolidation. Now, the moment you take the soil sample, the moment you take the soil sample, and take the soil sample from here to the laboratory to start your consolidation test. What will happen? At this positions, then once you put it in consolidation. So, what will happen? It will be a recompression it will start, it will expand from here to here, because the moment you take out the soil sample this over burden has lost, whatever this over burden is there, it has lost. This is because of erosion, so that is why the curve comes down from

e 0 to e 0 prime, then once you have taken soil sample. So, what will happen? This over burden P 0 will loss, it means it will completely go away, because of loss in over burden.

So this will be expand, so then once you put it in consolidation what will happen? This will become again recompression, it will continue up to e; so that corresponding to your pre-consolidation pressure, so now it will go CDEF. This is what? Exactly this phenomenon over consolidated clay comparison with this example means a typical case, clay deposited in a bed of lake, how this deposition has increased over the period of time. All of sudden water table comes down, and erosion has lost. So, the soil already here clay deposit it has acted, there means already this clay deposit is there, this consolidation process already previously started, that means over consolidation over consolidation condition is there. So, once you have taken this clay sample how it falls?

Now, these things has to be relocated relocated, you have to relocate effect of over consolidation on shear strength.

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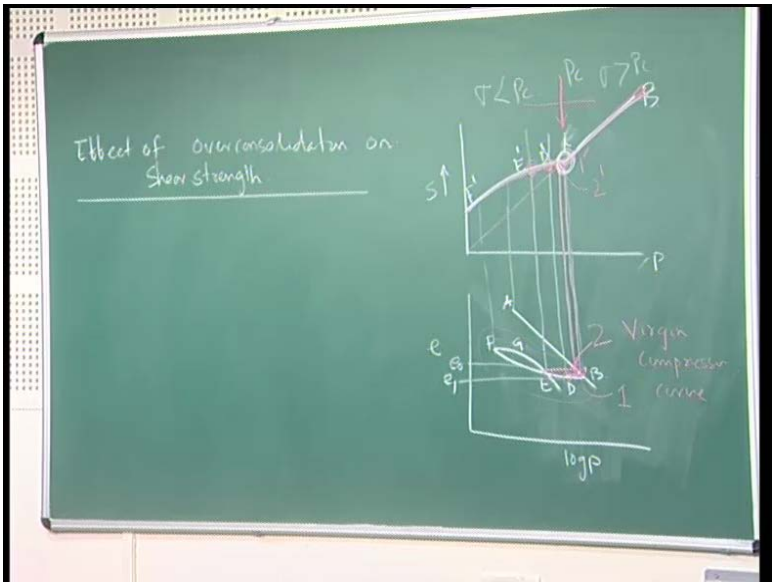

Now, from consolidation curve, you can show these effect of over consolidated on shear strength graph. So, let us draw these e versus log P diagram, let us draw the e versus log P diagram. Then, here it will be say e 0, then at point D, it will be e 1. So, I draw this e versus log P, this is my virgin compression curve, and this is the expansion curve, and

this is your recompression curve. What is this effect of over consolidation particularly in case of shear strength, in case of shear strength.

How this how this looks like in in case of shear strength what is the defect? Now, choose two point - one is D, other is your E; you can choose D, E means points in these you can mark it. Just for example, I have taken for better understanding D and E with D and E draw lines - horizontal lines: first one is from D, I draw the horizontal line where it intercept this virgin curve. This is A, B intercept virgin curve, that is your point one, that is your point one. Now, from E draw horizontal line, where it intercept virgin curve, that is your point two basically this is point one, and this is point two.

Now, with D and E extend this extend this, so to this shear strength, because this has been shear strength, and P with this e versus log P it has been plotted in the same scale. So, you extend it, now where it intercept one and two points at A and B of your virgin curve, it has been extended. Now, where it intercept in shear strength versus log P, this point - this is the intercept point, this is your one; point one, so it intercept say one dash. Now similarly, point two so it intercept with this say two prime, with this one prime, and two prime draw horizontal lines parallel to your log P. So, this horizontal line whatever you whatever you from E and D, vertical lines extended it will intercept at point this point is your D dash, and this point is your E dash. Like this all the points from from swelling to recompression that you have to locate, that means your over consolidation points to be located in shear strength.

Now, you will get if I draw it, you will get a curve like this, then it will go. So, this is the point, this is the boundary line, this is the point particularly it shows over consolidation. That means in over consolidated clay, you will get a shear strength graph of like this, if I come back to earlier so this is my P c. So, this is sigma is less than P c, and this is sigma is greater than P c; that means, you will get a discontinuity at the point of pre-consolidation or over consolidation, you will get a discontinuity in shear strength curves.

So, this is all about this effect of over consolidation on shear strength. Now, in cCU we have we have already discussed two things: One is your UU, and CU consolidated undrained case, where it has been used particularly the test we will discuss in the next class.

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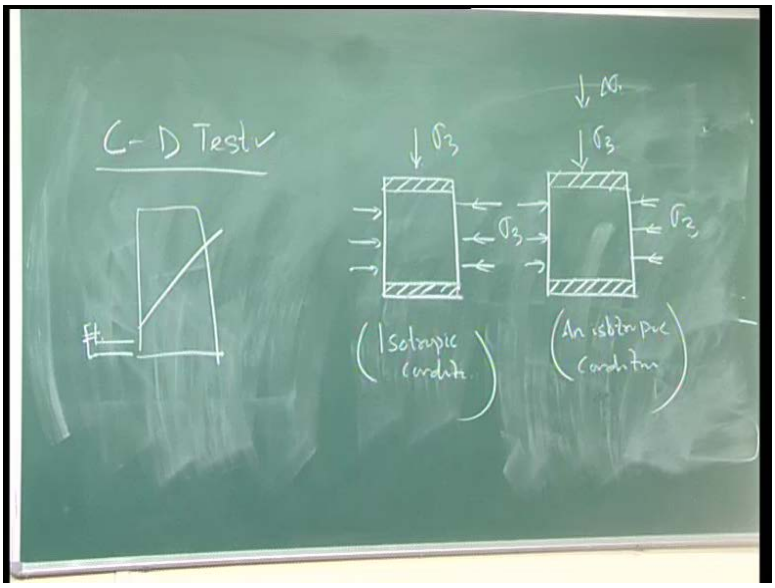

Now, last part is your CD - CD test is your consolidated drain test; consolidated drain test means as I said earlier for CU test, there are two types of consolidation; you can say that isotropic condition, where all around pressure is constant, that is your sigma three with all around pressure this consolidation going to happen, but other case is your anisotropic.

This is sigma three all-round pressure, with these sigma three all-round pressure additional stress delta sigma one is applied, so that stress in sigma three, stress in y or stress in x is not going to be same. So, this is a case of anisotropic. So, in consolidation consolidated drain test, the consolidation you have to do either the two conditions, so truly it will reflect, particularly anisotropic conditions it is recommended go for consolidation. So that, it will reflect your condition of your field condition, then once this consolidation is over, while sharing while sharing drainage valve drainage valve was opened. That means during sharing, there is a volume change during consolidation also there is a volume change. So, these are the this is this is CD test means, where we are going to apply in field what for we are doing this, UU, and CU, and CD.

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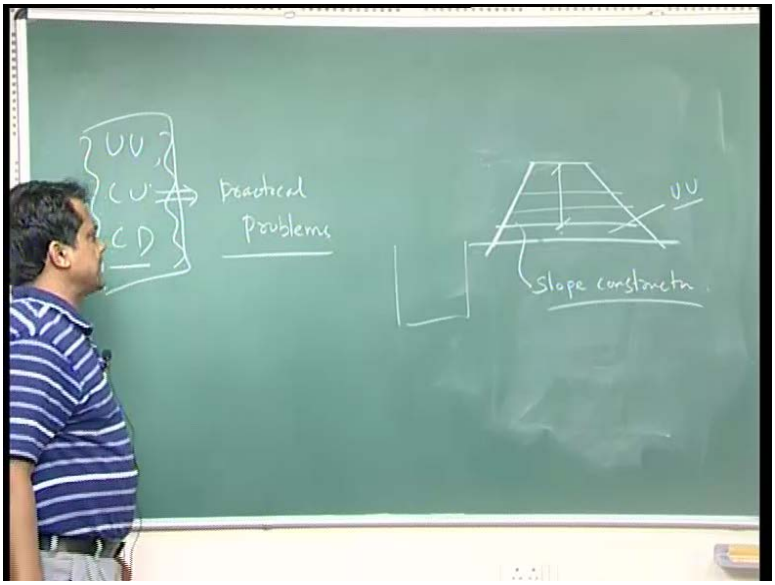

How UU, CU, and CD. What for we are doing this test, and how far it is related to our practical problems. This I am going to discuss over the (( )) means, may be next class how this UU, just in brief what is the condition of UU. I will discuss many practical problems unconsolidated undrained, unconsolidated undrained the moment to say unconsolidated undrained suppose take an example of slope stability, slope construction.

What will happen in slope construction? The soil from nearby pit has been taken, and it has been compacted in stages. Once, you start compacted in stages, because the consolidation process takes time; that means during construction there is no consolidation. And also during construction, there is no drainage, this case will simulate to your UU, unconsolidated undrained.

Now, the moment I say consolidated undrained means CU, after the construction you allow some times, allow some times this slope. Once the construction is there, may be 2 years, 3 years, 5 years or 10 years, what will happen? The consolidation process starts, here this layer particularly bottom the consolidation process starts, because of your over burden.

May be for certain time means consolidation is there, you want to that for a quick time means not a longer period, what is the parameters? So, this will be your CU, if I look at for a longer period then you can go for a C D. So, these are we are going to discuss one by one case by case problem, suppose in case of footing.

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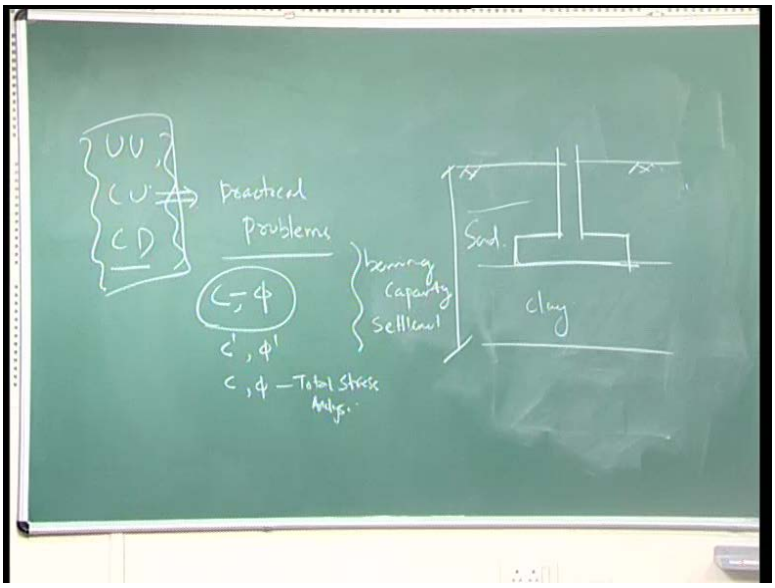

just this is the this is I am discussing in brief I will discuss next class in details. A footing is there, it is lying over sand as well as clay, so the moment the construction of footing will occur, what will happen? Immediate effect is there, that means immediate settlement is going to happen. So, during construction what test you are going to do? Is it U U, CU or CD. Then after consolidation for a over means after construction, after construction for a over period of time say 5 year, 10 years, what parameter you need to have, so that this design can be done.

So, these are all criticals things, because this once you identify the problem, and the parameters required to calculate your bearing capacity and settlement, then you need you need parameters C, and phi; it may be C prime, phi prime effective stress analysis or it may be C and phi total stress analysis. Depending upon the requirement, so these things will be discussed later on.

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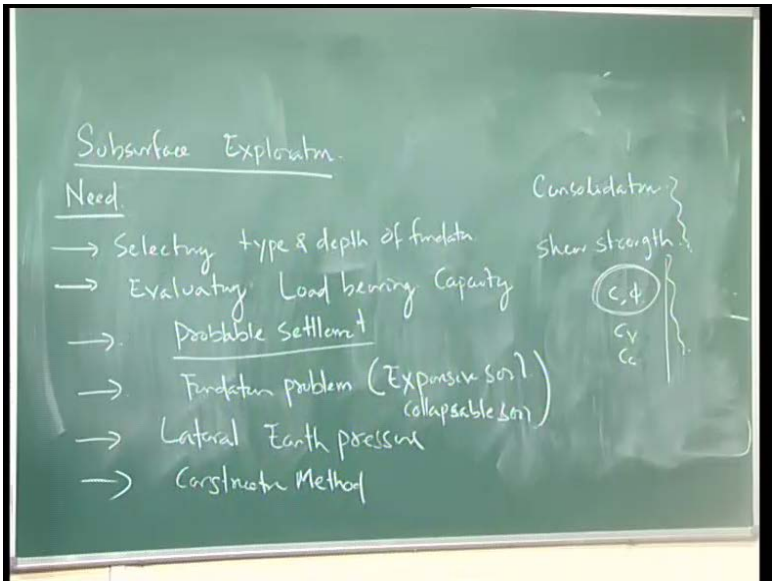

Now, we will start with a new one what are the field test or may be site sub soil exploration or site investigation, whatever we discuss these are the two topic we discuss, because these are required in terms of a particularly in this course, one is your consolidation, another is your shear strength.

In consolidation, we discuss details how to get it C P, and time factor in shear strength we discuss also UU, CU, CD in drag shell, as well as direct shed test, as well as your unconfined compression stress; these are all these are the two particularly test - consolidation and shear strength. These are required with simulate your field conditions means once these soil sample will you will bring it from field. How how and how far, and how you are going to simulate in the lab, so that you will get required design parameters.

Now, next part is your subsurface exploration (No audio from 34:08 to 34:28) selecting mean, why you need sub surface exploration, what is the need? What is the need that you want to do exploration below the ground, what is the need selecting type and depth of foundation. Second is your evaluating load bearing capacity, third is your probable settlement, fourth is your foundation problem like expansive soil, then collapsible soil, then your lateral earth pressure, then what are the construction method.

Sub soil exploration is required to take soil sample below the ground, so that exactly you will you can test in the laboratory considering your considering this site condition or field condition, so that you can get design parameter. So, what is that need? This need for

sub soil exploration that you need to have, you can get from sub soil exploration soil sample from there you will get C, phi - this is shear strength parameter, and coefficient of consolidation C b, and C c. As I said C b is your time required to consolidate, and C c is your how much? Means and C, and phi is your C, and phi is your shear strength parameters, how these parameters are going to useful; these parameters are going to useful particularly selecting type, and depth of foundation.

What type of foundation you are supposed to choose, and what is that depth number one; number two how much load is going to take by this foundation with the help of sub soil exploration, you can find it out these parameters, with these parameters you can you can get particularly how much load this footing can take. Then, what is the probable settlement or you can say expected settlement over a period say may be 5 year, 10 year, 20 year over this design period, then is there any foundation problem, let us say is there any foundation problem. That means is there any expansible expansive soil or collapsible soil.

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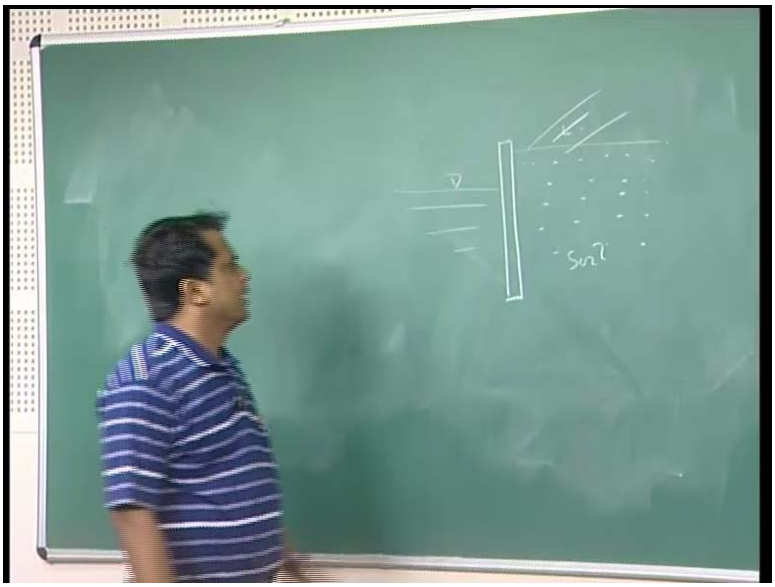

Then what is the lateral earth pressure; lateral earth pressure is generally it is useful particularly retaining structures retaining structures, where where one end is like water or other end is to retain soil mass to retain soil mass. So that, above this soil mass you can construct road rail, retaining wall means to retain the soil mass. What will happen in retaining wall, it will apply lateral pressure. So, to find it out, what is that lateral pressure

acted that also required for your sub soil exploration from this consolidation, and shear strength parameters. Then, how do you construction, particularly once you get shear strength parameters.

What is the construction methodology, you are going to do that also you want to do it. So, these are the need, because of this these are our requirement, because of this we go for sub surface exploration from there the soil sample has been taken. And the soil sample has been simulated to the field conditions, these are the test has been conducted. So from this test, you will get C phi, C b, and C c.