Advanced Soil Mechanics
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Lecture-54
State Boundary Surface

Welcome back all of you, with last lecture we have already completed what are the basic requirements for critical state soil mechanics what I have actually planned for in this course. We have discussed about various 2 dimensional representations. The initial point where the soil starts, it is shearing, elastic behaviour, yielding and finally the failure. Now where are we heading towards that will be covered in today's lecture and that is defining the state boundary surface.

In fact we have already discussed this, we have already stated what are the bounds on a two dimensional representation. So, in today's lecture we will cover state boundary surface specifically. And we would represent the surface means actually the surface means it is three dimensional, we have been working with curves in a two dimensional representation. So, today we will integrate the two dimensional aspects into three dimensional and define what is known as the complete state boundary surface for the soil.

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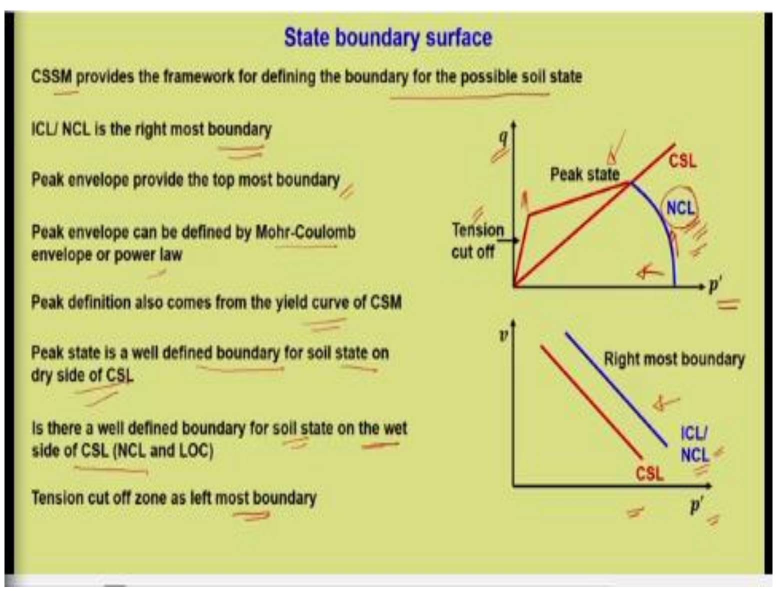

So, let us start today's lecture which is on state boundary surface. So, CSSM that is critical state soil mechanics, provides the framework for defining the boundary for the possible soil state. That means when the soil is loaded to be very specifically sheared from it is starting point, what is the ultimate state up to which the soil would exist? So, this can be defined by critical state soil mechanics, we have seen that and rather we can predict what is going to happen for a given initial state of the soil and by knowing the critical state parameters.

So, we worked with two dimensional representation where we have qp' plot and vp' plot. And we have already told ICL, NCL becomes the right most boundary and CSL is the point where it fails. So, CSL in qp' is given. ICL, NCL is the right most boundary, this we kept on telling, so right most boundary is already defined. But still there is something which we need to understand in v lnp'it is very easy to say that, that is the right most boundary.

But what is the bound when the soil gets sheared; I mean to say in qp' boundary. So, now since you have clearly understood qp' and v ln p', there is one additional point which I would like to stress here. If you see vp' representation, we are not talking about anything related to shearing; shearing is totally dependent on qp' plot, why? Because when if the soil is sheared we have the q that is a deviatoric stress that coming into picture.

And vp' or v lnp' plot is exclusively when we talk about ICL or normal consolidation or one dimensional consolidation where the shear stress has not yet developed. So, basically it is the initial state or maybe when the soil is getting consolidated, so that is what we define in the bottom most part. So, in that perspective ICL, NCL is the right most boundary is correct in terms of vp' but what happens when the shear stress comes into picture.

Now we also know peak envelope provide the top most boundary, that we have seen and peak is very specifically useful for over consolidated or dense state of the soil. So, we have already defined what is wet state and dry state and we know that it was defined with respect to critical over consolidation ratio line; rather you can also define it in terms of critical state line as the difference is not much.

In most of the textbooks you will find this wet and dry is defined with respect to critical state line as well. There is nothing wrong in that, it is with respect to which line you are defining wet and dry state. And probably one should understand that in the case of a normally consolidated sample, the initial state will have water content more than the critical state line. And as it gets compressed in the process of loading, it loses it is water content and it joins the critical state line, the stress path joins the critical state line where it will have water content less than it is initial state, so that is why it is called wet of critical state more specifically. And same is the case of dry state which is essentially for over consolidated sample, where the water content is less than the critical state. So, as the over consolidated sample is sheared, it undergoes dilation, so it has got a tendency to draw water into it, that we have already explained.

So, the final state will have the water content more than that of the initial state. So, that is why with respect to critical state line over consolidated point is on the dry side. So, whether you define the dry state or wet state it can be defined with respect to the critical state line or the final point or the failure point. So, peak envelope provide the top most boundary which we have already seen and this is very specifically for the over consolidated state of the sample.

The peak envelope can be defined by Mohr-Coulomb envelope or power law. So, please refer to our earlier lecture on peak state. So, we have defined in both ways, so this particular state line what we have shown here comes from the Mohr-Coulomb failure model. But we have also stated that we can represent the peak state using power law. So, that it passes through the origin and the importance of it passing through the origin was also very well explained in that particular lecture, please refer back.

And we also stated that there is a limit up to which the peak state can go, so it cannot just go and join the q axis. The reason is because of the tension developed in the soil and we know that soil cannot tolerate the tension that gets developed. So, peak definition also comes from the yield curve, so peak definition it comes from the Mohr-Coulomb envelope which is a straight line it can come from the power law curve or it can also come from the yield curve which is the yield curve corresponding to failure.

So, why it can because we know that the effective stress path, it has to go and yield first before failing. So, in that perspective in critical state models such as Cam Clay and modified Cam Clay it defines it is boundary based on yield curve. So, yield curve also happens to be defining the peak state and in the previous lecture we have also quoted this particular point. Peak state is a well defined boundary for soil state on the dry side of critical state line, we have already discussed this.

Now the question is, is there a well defined boundary for soil state on the wet side of critical state line? That is normally consolidated and lightly over consolidated state. Now initial state wise we know that this is the right most boundary. But what about in qp’ plot? We are talking about such a line that whether this forms a boundary towards the right side when the soil is sheared, also this represents the normally consolidated line.

Now LOC will be less than this, so NCL forms the right most boundary. Now the question is whether such a curve or such a surface do exist as the right most boundary? So, this is the question and this is what we will be answering in today's lecture. Now we also know that the left most boundary is defined by tension cut off zone, all these aspects we have already discussed.

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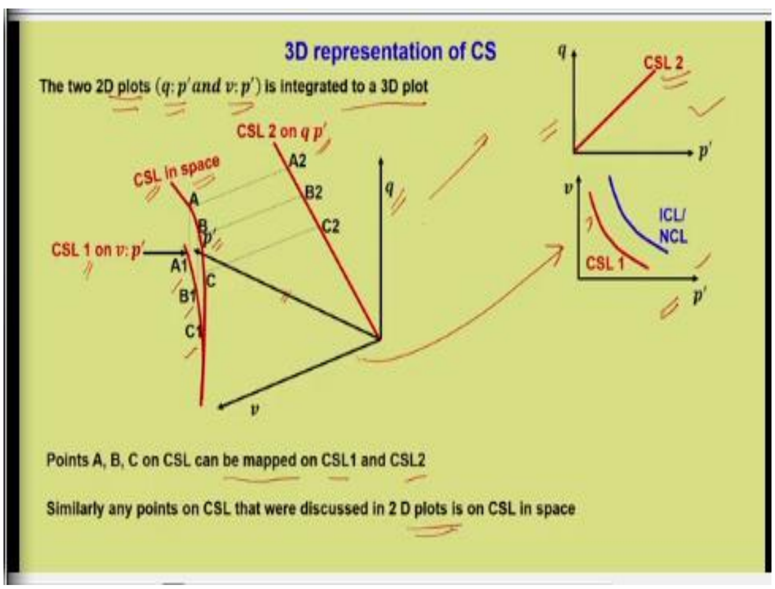

So, we are just summing it up. Now we have clearly understood the two dimensional representation, till last lecture we have consistently followed two dimensional representation of critical state soil mechanics. So, for the first time we will integrate whatever we have learned in two dimensional plane into a three dimensional surface. So, two 2D plots which we have learned which is qp’ and vp’ is integrated to a three dimensional plot.

So, this is qp’ we have seen, and vp’ we have seen rather we worked with v lnp’. So, for representation it is fine, we use vp’ as well**.** Now that we are now representing as a three dimensional plot where q is shown qp’, so this plane corresponds to qp’. And vp’ that is which is on the floor, this is floor or on the ground this is vp’ that corresponds to this.

So, this three dimensional plot is in fact broken into 2 different two dimensional plot. Ideally we should have started with a three dimensional representation and then breaking it up into two 2D plot. But if I explain the three dimensional plot in the beginning it is very difficult for you to understand. So, till now we have followed a two dimensional approach, now these 2 two dimensional approaches is now joined together where p’ axis is common.

Now if I represent critical state line in space, it will look like this. Now please remember this critical state line which is represented it is in three dimensional space. It is earlier we have discussed on two dimensional space. But now this is in imagine that this critical state line is in the space, so somehow somewhere in the space like this. Now if you take the projection of critical state line in space on vp’ we will get critical state line 1 which is lying on vp’ plot.

So, what we have marked here this particular line is critical state line 1. So, we never quoted it to be 1 or 2, we discussed it as critical state line. So, now for your understanding what is this critical state line 1 is the projection of critical state line in space on vp’ plane. Similarly you can have the projection of critical state line on qp’ plot. So, that is critical state line 2 which lies on qp’ plot. So, this qp’, the critical state line is what you can see here.

So, you are taking the projection of critical state line in space and that will give you CSL 2. Now let us say that there are points A, B, C on critical state line which is located in the space. You can get the same points A, B, C on CSL 1 and CSL 2. So, points A, B, C on CSL can be mapped onto CSL 1 and CSL 2 rather that is what we were doing. We never mapped but we got the points on critical state line 1 and 2.

So, if I drop perpendicular you can get A1, B1, and C1 which are the projections of A, B, C on CSL 1. Similarly A2, B2 and C2 are the points on CSL 2 which is the projection of points A, B, C. Similarly we can get the points on the critical state line in space which corresponds to the points that we discussed in 2D plots when we discussed in our earlier lectures. So, all those points wherein the soil goes and fail and what we have discussed in 2D plots, in fact it lies on critical state line in space.

So, from wherever it is starting it goes and fails on the critical state line in the space. Projection of this on CSL 1 and CSL 2 is what we have discussed till our last lecture. So, when we understand this on the three dimensional representation we need to understand further how the effective stress path looks like in the three dimensional space. So, for facilitating the understanding better we define 2 different planes.

One is known as drained plane and the other one is known as undrained plane, now what does these planes correspond to? These are the planes which accommodates the effective stress path corresponding to a drained shearing or an undrained shearing. So, that is what we are going to see now.

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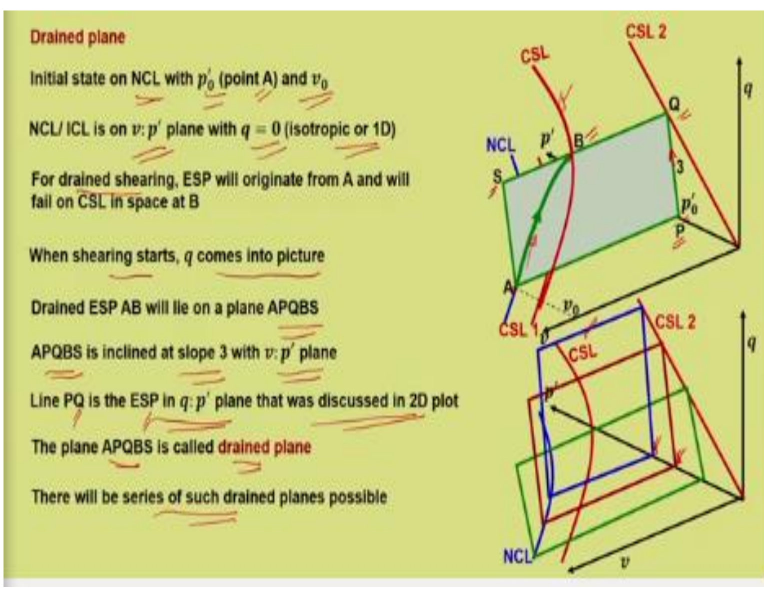

The first one is drained plane. Now let us consider initial state which is on normally consolidated line with p_o' as the initial point which is point A and the initial specific volume is v_o. So, let us consider the three dimensional representation $qp'v$. Now this NCL is on vp' please remember when we are talking about isotropic consolidation line or normally consolidation line, we are talking about vp' plane.

So, now the initial point is on the ground, let us say that if we consider vp' as the floor or the ground and q, the vertical direction upwards. Then what I mean to say is that CSL 1 and NCL or ICL is on the ground. So, NCL, ICL is on vp' plane which is on the ground with q = 0 isotropic or one dimensional. Please remember, there is no shearing which has happened, we have compressed the sample, we have consolidated the sample it is still it lies on ICL or NCL.

And when we say that there is no q, q = 0 for the initial conditions that means q that the point is on the ground itself or the point is on ICL or NCL. So, let this point be A, it has the initial point of v 0, that is the initial specific volume as v_o and the initial mean stress of p_o'. So, that is the starting point, A is the starting point now and now when it is sheared q starts developing.

So, without knowing much we can say that the effective stress path will start moving in the vertical direction, upwards. If it is for compression it will move downwards if it is for extension, so that is what we are going to see now. So, now we are talking about a drained shearing, so we are talking about drained plane, so we are referring to drained shearing. So, for drained shearing ESP will originate from A that means it will originate from this point A.

And it will fail on the critical state line, this particular critical state line in space at B. So, let us see how it happens? So, when shearing starts q comes into picture, that means the effective stress path has to move upwards for drained compression. So, this is how it looks like, now please remember this particular effective stress path AB is in space. So, it starts from the point on the ground and it goes and meets the critical state line in the space which is in upwards.

Drained ESP AB will lie on a plane APQBS, what it means is that? This particular effective stress path can be accommodated on a plane which is represented by APQBS, how does it look like? So, it looks like this APQBS, so this is the plane which accommodates this effective stress path AB you can very clearly see that this particular plane is with an inclination, without thinking much you should be in a position to now answer what will be the slope of this particular drained plane.

Because that is what we were working with for the last few lectures, we did not understand this in terms of plane. But definitely we have understood this in terms of the slope of drained effective stress path. And we know that the effective stress path is at an inclination of 3 in qp' plot, so that is exactly what we are doing now also. So, APQBS that plane is inclined at slope 3 with vp' plane, so with vp' plane is the bottom plane.

So, this plane APQBS is inclined at 3 with the vp' plane. So, line p q, this line p q, this one is the effective stress path in qp' plane. So, please remember that is what we were working with, that was discussed in 2D plot. So, every time we were referring to p q as the effective stress path in qp' plane and that is with an inclination of 3, remember. So, in qp' plot with CSL 2, so this line is p q with an inclination of 3, this is what we have discussed.

So, it is one at the same, so it is just the projection of one of the side of the drained plane on qp' plot. So, the plane APQBS is called drained plane, so that is what we need to understand. So, drained plane is what? Drained plane is the plane which accommodates the effective stress path corresponding to drained shearing or to be very specifically compression or extension. So, there will be series of such drained planes possible, depending upon various initial state.

Now p 0 dash becomes p 1 dash, so you will have another drain plane because the effective stress path then changes. Similarly a series of drained planes are possible in the case of drained shearing. So, let us say that what it means when I say that there is a series of effective stress path or the drain planes which are possible, so this is the plane what I have already explained with an inclination of 3.

Now parallel to this plane you will have another plane with the same inclination of 3 but with a different initial point. Similarly you can see that how it progressed, so this is with maybe another initial state. So, whatever B the pattern is same, inclination is 3, so this is what is meant by drained plane. So, now it is very easy for you to understand what is an undrained plane, because if the drain plane is the plane which accommodates the effective stress path corresponding to drained ESP.

Then we know that undrained plane has to be the plane which accommodates the undrained ESP for a given state. So, that is what we will see next.

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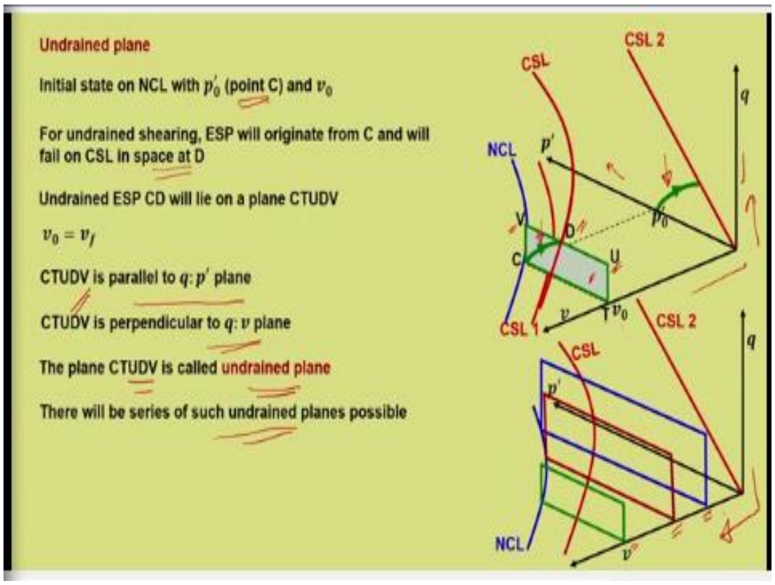

So, we will see undrained plane so same initial state p'_o and v_o, let that point be point C. So, NCL, the starting point is on the NCL, so point C with specific volume v_o and p'_o is the initial mean stress. For undrained shearing ESP will originate from C and will fail on CSL in space at D, that we know. Now how it will fail? So, it will fail like this, we know that for an undrained test, the initial specific volume and the final specific volume is same.

So, what does that mean? The final point which lies on the CSL which is point D should have the same specific volume as that of v_o. So, that means $v_f = v_o$, now what does that mean? It gives another hint that it should lay on a plane which is parallel to qp' or which is perpendicular to q v plane. So, then only this condition is satisfied, so whatever is the kind of effective stress path that we have in plane the same projection we will get on the qp' plane as well.

And this is the effective stress path which we discussed earlier in all our previous lectures. So, undrained ESP CD will lie on a plane CTUDV. So, it looks like this CTUDV, so this is the plane and this particular effective stress path CD is on the plane CTUDV. Now how does this plane looks like? So, $v_f = v_o$ so we know that CTUDV has to be parallel to qp' plane, that means this plane is parallel to qp' plane then only the condition $= v_f$ will be satisfied.

Also for convenience we can say that CTUDV is perpendicular to v q plane as well. So, CTUDV is perpendicular to q v plane, this plane CTUDV is called undrained plane similar to what we discussed for drained. So, there will be a series of such undrained planes possible. This is the first plane what we have discussed corresponding to v_o Now for v_1, there will be another plane which is again parallel to qp' and another plane which is parallel to qp' depending upon different initial conditions. And all these planes will be parallel to qp' and perpendicular to q v, so this how it looks like.

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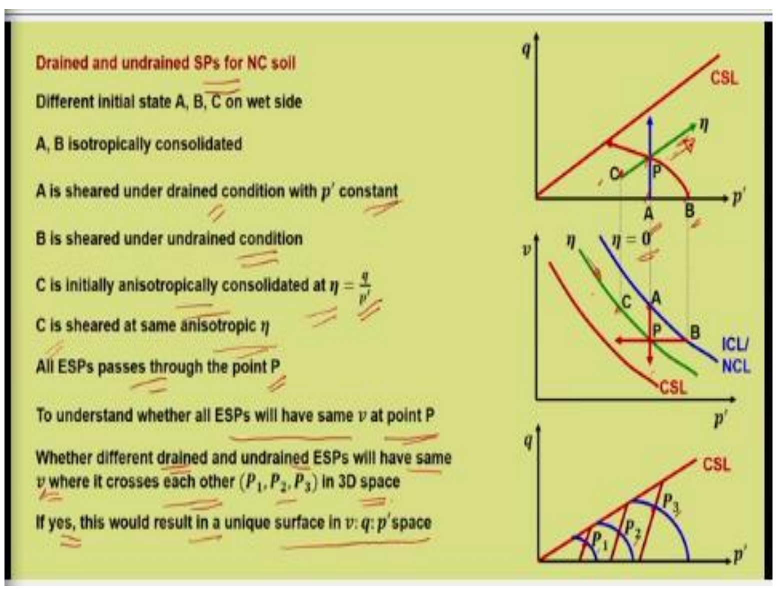

So, now we have discussed about drained and undrained planes and how the effective stress path lies on it. Now the question still remains, that can we define a right most boundary in terms of a normal consolidated curve which is there on the qp' representation. So, let us try to first find out because this is relevant for NC soil, so drained and undrained SPs for NC soil. Let us say different initial state A, B, C which is on the wet state.

So, we are discussing whether we are trying to find out whether there will be a unique boundary on the right side. So, we have 3 different initial states A, B and C which is on the wet side**.** So, A, B is isotropically consolidated, this A and B we know that it is on the p' axis, so it will be isotropically consolidated. A is sheared under drained condition with p' constant, we can do the way we want, we can regulate it.

So, A represents shearing under drained condition, no A is not representing, A is the initial point, from A the soil is sheared under drained condition holding p' to be constant. So, it is very easy to represent, so this is the way in which the effective stress path will be. B is shared under undrained condition; we know that for undrained shearing it will move towards left, that is how it moves the effective stress path.

And C is initially and isotropically consolidated at $\eta = \frac{q}{p'}$, remember, so we have already stated this, this is a K_o consolidation not isotropic consolidation. So, $K_o$consolidation will lie above the p' axis. So, that means there is a ratio $\frac{q}{p'}$ at which it happens, on the isotropic consolidation line q is 0, so η = 0. Here the initial consolidation is under an isotropic condition where $\eta = \frac{q}{p'}$.

So, $\frac{q}{p'}$ at this point C = η. Further the soil sample is sheared at the same anisotropic η. So, now the shearing is also done in such a manner that η is maintained or q by p' ratio is maintained, which means the effective stress path should move at an inclination of η, so that is what it means. So, this is the line where $\eta = \frac{q}{p'}$ is maintained and the shearing is happening.

So, q is also increasing, p' is also increasing and q by p' is always kept constant at η, so that is how the effective stress path moves. So, all ESPs passes through the same point P, now whether this point P is unique or not, so this is the question. We have different effective stress path moving in space depending upon the starting points A, B and C. The question is these effective stress path crisscrosses each other at point P.

If so, whether the specific volume at that point P is same for all the effective stress paths. Now if it is so, then it means that there is a unique surface, that means you are making something like a net. There is some thread going in this direction, there is a thread going in this direction and another thread going in this direction corresponding to A, B, C. Now the point is whether the effective stress path going in this direction and going in this direction whether it is touching or whether it is above.

So, when it is crisscrossing at a point P, if it is touching, this means that this has got a unique point or unique specific volume. So, that is what we need to understand, so that is why this whole discussion is. So, all the ESPs passes through the point P, so this is η = 0 on the vp' plane. So, you have the initial points A and B on NCL or ICL, so A is mapped and A and B is on the ICL line because η = 0, why η = 0? It is isotropic consolidation.

C will lie on η that is q by p' = η, now P is this particular point, now the effective stress path moves through P. So, from A it moves downwards and it will fail at the critical state line, so for B it moves in the left ward direction through the point P. And we know that this particular line it is still moving through the point P, this η. So, that is how it is whether it follows this particular condition or not, so that is what we need to understand.

So, here you can see one interesting fact that if you are loading with such an η, you can say that the soil is not going to fail, it is very much similar to the ICL or NCL. But still the shear stress is there in the soil, but that shear stress is not going to fail the soil. If we are able to and this particular aspect we have already discussed with respect to the slope M. If the ESP is at a slope less than M, it is not going to fail, so this η is such a similar condition.

To understand whether all the ESPs will have the same v at point P. Now this is very well explained before in terms of normalization. So, when we normalize it, it all boils down to the same point, so we have already explained this, in fact there is a unique point or a unique specific volume that is possible. So, I am putting it again this particular question whether different drained and undrained ESPs will have same specific volume where it crosses each other.

That is P_1, P_2, P_3 in three dimensional space, what I mean to say is this. These are the series of undrained tests and these are the series of drained test. Let us say that the point where it crosses each other is P_1, P_2, P_3 so this $P_1, P_2, and\ P_3$. Now the point is whether the specific volume at

$P_1, P_2, and\ P_3$ will be same for undrained and drained stress path? If yes, then there is a unique surface, if not, then it is not, so it is very difficult for us to understand and tell this it has to be based on experimental evidence.

And lot of studies have been done in the past by very prominent scientist and they have come up with a clear understanding on this, and that is what we are going to discuss now. If the point is unique, that means wherever it is crossing each other if the specific volume v is same then this would result in a unique surface in vqp' space. Otherwise every thread is lying up and down, then there is no unique surface, every thread is lying at the same if it is crisscrossing like this at the same point for corresponding to the given state, then only a unique surface is possible.

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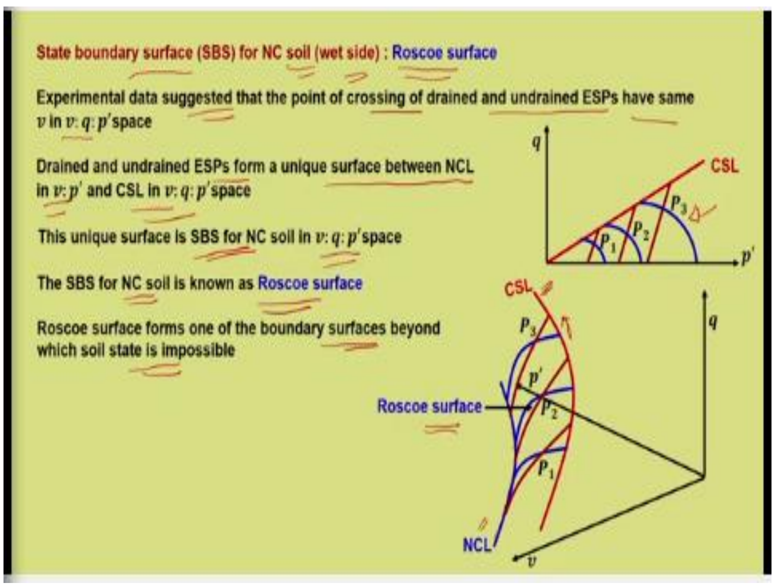

So, that is where we will discuss the state boundary surface for normally consolidated soil which is the wet side of critical state line, and that particular surface is called Roscoe surface. So, you probably understand that the answer is yes, there is a unique surface which is possible in vqp' space. In fact this answer comes from the normalization which we have already studied in our previous lecture.

We have shown normally consolidated line as a point on the p' axis, we have shown critical state line as a point, so that is how we have normalized the peak line. So, please refer back, so if it normalize and it exist at a particular point the critical state line exist at a particular point then it in fact shows the uniqueness. So, experimental data which is published and which has been investigated in detail, suggested that the point of crossing of drained and undrained ESPs have same specific volume vpq’ space.

Which means that P_1, P_2, P_3 in fact have the same specific volume. So, drained and undrained ESPs form a unique surface between normally consolidated line in v:p’ and critical state line in v:q:p’ space. So, this is the starting point, so all the starting point of ICL, NCL lies on the ground that is on a v:p’ plane. And the final failure will be on this critical state line in the space, so what it means is that?

All the drained and undrained ESPs from different starting points, it forms a unique surface between normally consolidated line and critical state lines. So, between NCL and CSL there is a unique surface. So, this is how it looks in the space, like you have these undrained stress paths and then followed by drained stress paths. So, you can see that if you have multiple such initial points it will look like a net, so it is a well net surface.

So, P_1, P_2, P_3 is shown here the same two dimensional representation is shown in the space. This forms a unique surface is the state boundary surface for normally consolidated soil in v:q:p’ space. So, the SBS for normally consolidated soil is state boundary surface for normally consolidated soil is known as Roscoe surface. So, this particular unique surface is what is represented by Roscoe surface and that Roscoe surface is the state boundary surface for normally consolidated soil.

So, Roscoe surface forms one of the boundary surfaces beyond which soil state is impossible. So, there is no soil state which is possible beyond this particular surface.

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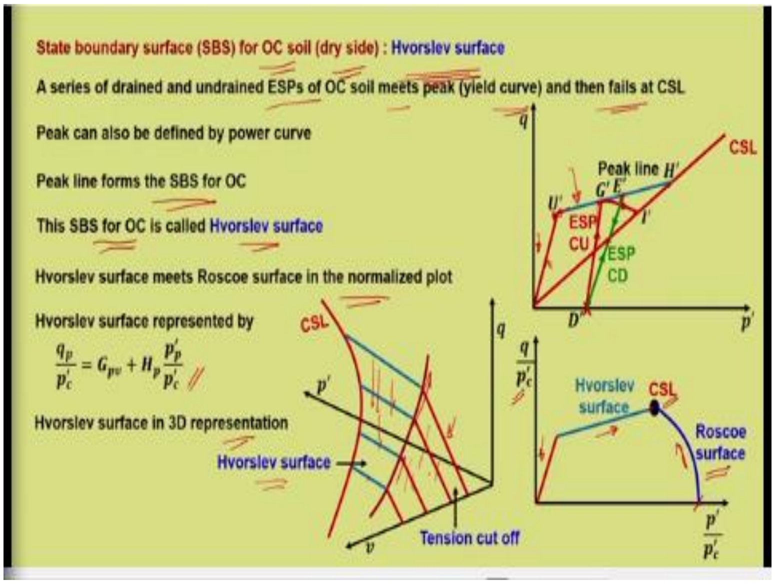

So, similarly we will also discuss state boundary surface for OC. We know that it is a peak line, and this surface in three dimensional plane is called Hvorslev surface and this is for OC soil which corresponds to dry side of critical state line, and the surface is known as Hvorslev surface. A series of drained and undrained ESPs of OC soil meets peak or yield curve and then fails at critical state line, we know this.

This is exactly what I am telling and we have already discussed this. So, CU fails so U yields and then fails similarly the consolidated drained ESP goes and yields and then fails at this particular point. Peak can also be defined by power curve, so this peak line can also be defined by power curve. Peak line forms the state boundary surface for over consolidated state, this state boundary surface for OC is called Hvorslev surface.

Now Hvorslev surface meets Roscoe surface in the normalized plot, so this if you normalize by $\frac{q}{p_C'}$ $\frac{p'}{p_C'}$ it will meet at this particular point, so that is how it looks like $\frac{q}{p_C'}\frac{p'}{p_C'}$. We have already seen this, only thing is we have learned Roscoe surface as normally consolidated state. So, this corresponds to normally consolidated point, this point corresponds to critical state line, so this is Hvorslev surface, this is Roscoe surface projection on the normalized plot. Hvorslev surface is represented by

$$\frac{q_p}{p_c'} = G_{pv} + H_p \frac{p'_p}{p_{C'}},$$

this comes from the peak line that particular lecture. Please refer back this is the equation for Hvorslev line. Hvorslev surface in 3D representation, so how does it look like? So, this is CSL, this is the line which gets terminated, so this is the tension cut off zone, we know that the peak line terminates at this point, so this line is the termination of peak line.

So, this is the peak line corresponding to various initial states, so this, this, this is the same line which is shown here. So, the peak line in space forms a surface and this is the tension cut off which is shown here in three dimensional representation. So, this top surface, so this surface is what is known as Hvorslev surface, and this surface is the tension cutoff zone.

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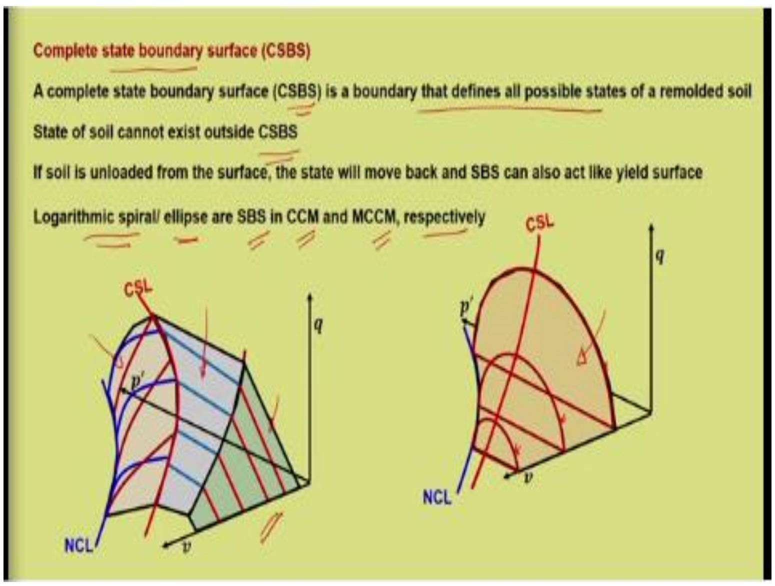

So, we have defined the right most boundary, the top boundary and left side boundary, and bottom is the ground, what is that ground? Ground is vp' plane, so all the sites it is bounded. So, soil state starts from the ground and it goes and meets at the state boundary surface. State boundary surface is basically defined by the critical state parameters what we have already learned, and that is how the three dimensional representation takes place.

So, now we will define complete state boundary surface, we have discussed everything in piecewise. Like we have started off with 2D, we have defined the bounds, now we have represented 3D for Roscoe and Hvorslev surface. Now we will put all these things together and that will give us the complete state boundary surface. A complete state boundary surface CSBS is a boundary that defines all possible states of a remolded soil.

So, that is how v it will look like, so this is the Roscoe surface, this is the Hvorslev surface, so this one is Roscoe this is Hvorslev and finally this is the tension cut off. So, this forms the complete state boundary and whatever soil state is there on vp' plane that is the ground finally it comes and joins at any of these points on the state boundary surface. State of soil cannot exist outside critical this complete state boundary surface.

If soil is unloaded from the surface, the state will move back and SBS can also act like yield surface. So, this is one sort of representation we also know that at yield point if it is not failed, it can trace back. So, it can go further down, so it can go down the state boundary surface, so state boundary surface can also become a yield surface. For example in the case of Cam Clay model or modified Cam Clay model we have a kind of yield surface.

So, if it is ellipse like this then it becomes the modified Cam Clay. So, this type of plane also forms the state boundary surface because it touches at the critical state line in the space. So, then this is the kind of surface, so this surface is also complete state boundary surface but when it is considered in terms of modified Cam Clay. So, logarithmic spiral or ellipse are the state boundary surface in Cam Clay model and modified Cam Clay model respectively.

So, it can be an yield curve that is developed into a yield surface or it can come from this kind of representation as well. So, whatever be the complete state boundary surface is defined in critical state framework.

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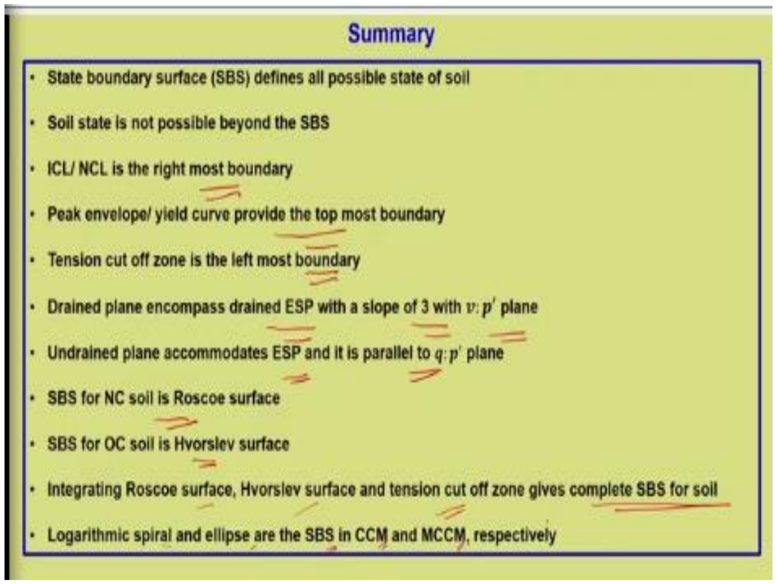

So, let us summarize what we have learned today. The state boundary surface SBS defines all possible state of soil. Soil state is not possible beyond the state boundary surface. ICL, NCL is the rightmost boundary without any doubt. Peak envelope or yield curve provide the top most boundary. Tension cut off zone is the left most boundary, drained plane encompass drained ESP with a slope of 3 with v:p' plane.

Undrained plane accommodates ESP and it is parallel to q:p' plane rather it is perpendicular to v q plane. SBS for NC soil is Roscoe surface, SBS for over consolidated soil is Hvorslev surface. Integrating Roscoe surface Hvorslev surface and tension cut off zone gives the complete state boundary surface for soil. Logarithmic spiral and ellipse are the state boundary surface in Cam Clay model and modified Cam Clay model respectively.

So, all of you, so now we have completed all the relevant lectures which are needed for module 4. And probably all the lectures which are needed for this particular course advanced soil mechanics. Now we are left with lecture on using the problems or rather working out the problems with respect to the critical state concepts which we have learned. Then we will summarize module 4, and further will be the closure of advanced soil mechanics.

So, we will work out some problems in the next lecture, you may please go through all the lectures what we have done for module 4 till now once again. So, that you will understand the problem and it is solution in a better manner. So, that we will see in the next lecture, so that is all for now, thank you.