Soil Mechanics/Geotechnical Engineering I
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Lecture - 54
Earth Pressure (Contd.)

Let me take few more problems on this earth pressure.

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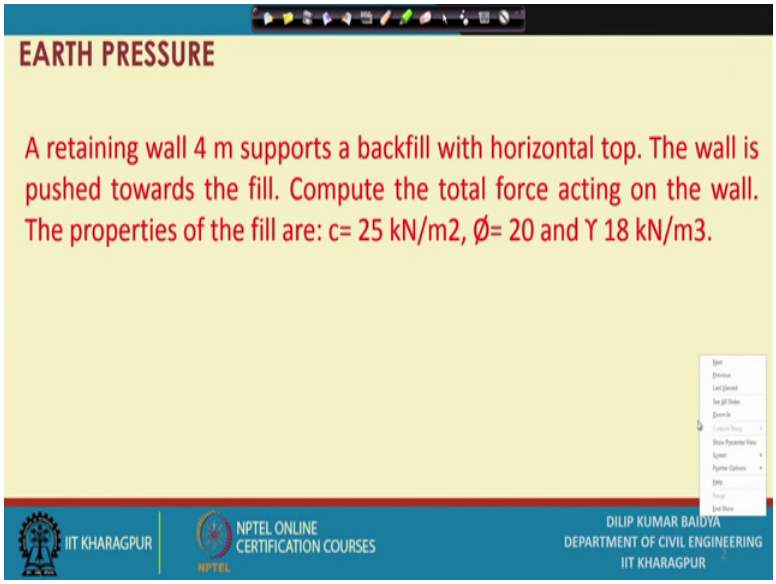

And I have done already 6 problems to show different variations active, passive address, sloping surface. The layering; layering only between cohesion less soil the cohesion less soil cohesive soil all those things are taken and few more I will take.

So, let me take the first one here the problem is like this a retaining wall 4 meter supports a backfill with horizontal top, the wall is pushed towards the fill. Compute the total force acting on the wall the properties of the fill are C equal to 25, phi equal to 20, gamma equal to 18 kilo Newton per meter cube.

So, here so far so many 6 problems I have taken, I have taken only one problem one address because address condition is most of the time is not essential while designing you do either active or passive. And I have rest of the 5 problems I have done active and again for different types coulomb, Rankin, and all we have done. But I have not taken so far any problem on passive.

And we have told that clearly that both active and passive and addressed three different types of pressure distribution is possible and when passive will be there when the wall is pushing towards the backfill. So, here the problem is given that the wall is pushed towards the field so; that means, this is a example of your passive case.

And this passive case we have taken and here actually surprisingly most of the time retaining wall will have granular fill, but here it is a partly granular partly cohesive you can see the soil is having both C and phi.

And when soil possesses both C and phi then the earth pressure will be different which already we have discussed I have taken one problem partly we have applied there. Here actually is a purely inter depth is cohesive soil C phi soil and then further and it is a passive case and for these what is the thrust will be on the wall that we determined. So, let us try to solve this one, a this is a off course quite simple one.

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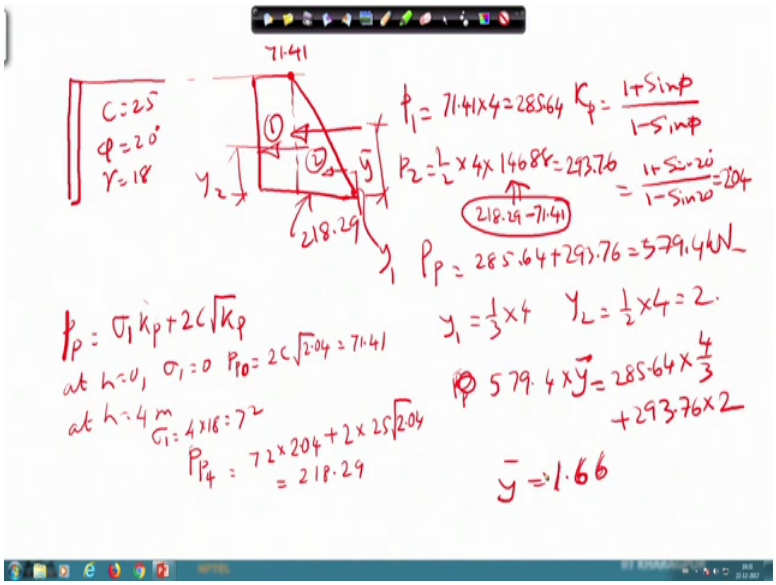

And you can see the wall height was how much I think 4 meter height. So, wall was of 4 meter height. So, this is 4 meter, and it has level and C equal to 25, phi equal to 20 and gamma equal to 18, so it will have since we are going to we are going to apply as the passive case. So, I have to find out now K p K p equal to what 1 plus sin phi by 1 minus sin phi.

So, it will be 1 plus sin 20 divided by one minus sin 20, so this will be the value will be 2.04 2.04, K p is 0.24 and as per the C phi soil earth pressure diagram or P p expression will be will be sigma 1 K p plus 2 C root K p, this is the formula perhaps you have done. And so at h equal to h equal to 0, sigma 1 equal to 0 then P p 1 will be equal to P p 0; suppose will be so this portion become 0, so it will be 2 i C multiplied by root K p as a 2.04 so that value is 71.40.

And at h equal to 4 meter, so sigma 1 will be equal to 4 into 18 equal to 72 so P p at 4 meter will be equal to 72 multiplied by 2.04 plus 2 into 25 multiplied by under root 2.04. So, this is giving you value 218.29, 218. 29. So, the value the if I draw the pressure diagram from the wall, so this is the one suppose wall the initially you had a pressure equal to 71.41, and at the base we have got a pressure equal to 218.

So, this is actually 218.29, so this diagram area if I find out then it will be thrust will be acting somewhere here. So, it is a trapezoidal area, one can if I know the centroid of trapezoid etcetera and other thing then we can find out correctly. Otherwise for simplicity I can divide into two part that will be 1, and this will be 2.

So, I can find out p 1 will be equal to 71.41 into 4 that will be equal to 285.64, 285.64; and p 2 will be equal to half multiplied by 4 multiplied by 146.88; 146.88. So, how to find out this 140? This is actually 218.29 minus 71.41.

So, from here I am getting this one, so this if I p 2 if I get then it will it giving you 293 293.76; and then your P p will be equal to this together 285.64 plus 293.76. So, this gives you 579.4 kilo Newton, and now to find out y bar this is suppose y bar I can find out y 1, so y 1 is for this ok, so this is y 1 and this is y 2.

So, this height is y 2 middle of the, so y 1 will be y 1 will be one-third of 4 meter, this entire triangle I am considering and y 2 equal to half of entire so 2 meter. So P p into or I can say directly 579.4 multiplied by y bar equal to 285.64 multiplied by 4 by 3 plus 293.76 multiplied by 2 and if I simplify this we will get the y bar equal to 1.66.

So, this is the problem for passive one passive of pressure application you can just you can see here and so then how to do the passive pressure diagram and how to find out the thrust? And how to find the point of application this is shown. So, let me go to one more problem.

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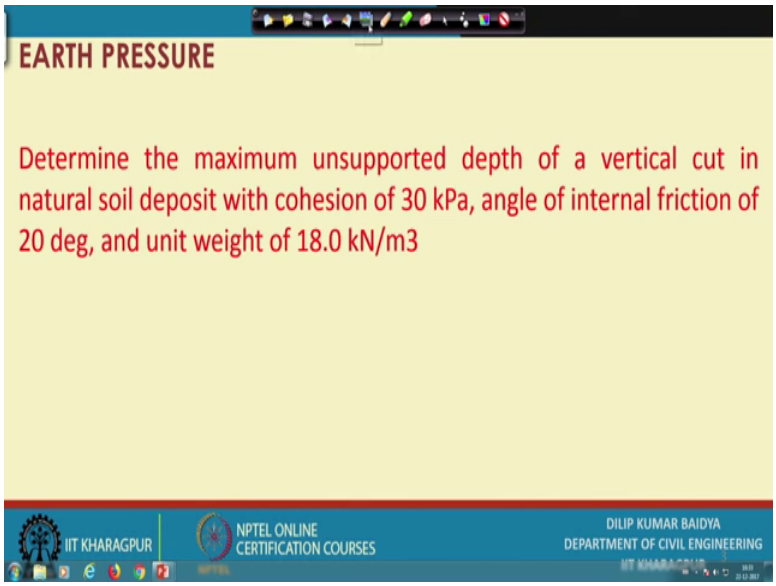

This is suppose determine the maximum unsupported depth of a vertical cut in natural soil deposit with cohesion of 30 kPa, angle of internal friction of 20 degrees, and unit weight of 18 kilo Newton.

So, this is the problem we have discussed the theory that when it is a active case your P a expression for P a equal to sigma 1 K a minus 2 C root K a, where sigma one equal to 0 when sigma 1 equal to 0, which is at the surface at the surface we have negative pressure.

So, negative pressure means it will have a tension; that means, because of these lateral pressure there we there is suppression will take place and when separate if you will not separate then will collapse. So, during excavation that actually happens.

So, if you if you exchange certain depth of excavation because of this spectra mechanism the soil will fell automatically. So, your pressure diagram generally comes like this which I have discussed during a theory part this one, and you can see this much is negative and that some depth it will become negative 0 pressure there is no pressure. But up to these depth definitely you can without support you can, but additionally theoretically you can go without this support up to this.

Because this negative pressure and this negative positive pressure ultimately resultant thrust on the wall become 0 so; that means, theoretically at this up to this much depth

you can find out we can go without support excavation without support this, I have discussed during the your discussion theory. So, let me do the steps or calculation here.

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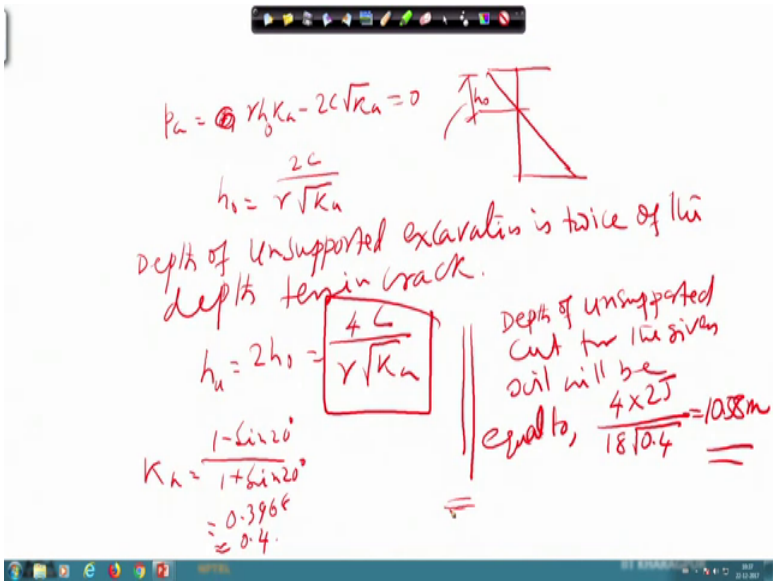

Here actually you can see that you can P a P a will be equal to 2 sigma 1, or I can say gamma h K a minus 2 C root K a, and where it will be 0 so; that means, you get the pressure diagram something like this. So, I find out depth at which this depth suppose called h naught, suppose this is h naught where pressure is 0. So, like if I said 0, then h naught will be coming 2 C by gamma root K a, but here depth of unsupported cut depth of unsupported cut excavation suppose is twice of the depth of tension crack.

So; that means, h will be equal to that is unsupported excavation it will be 2 h naught equal to 4 C by gamma root k a. So, this is the formula we have to find use to find out the depth of excavation without support. Now since K a is there. So, K a can be calculated from here K a is a 20 degrees, so 1 minus sin 20 degrees by 1 plus sin 20 degrees.

So, that gives you value 0.39; 0.3968 approximately equal to 0.4 ok, so that means, you get depth of unsupported cut for the given soil will be equal to will be equal to 4625 divided by gamma is 18 under root 0.4 so that gives you a value equal to 10.58 meter.

So, you can see otherwise you excavate on the sand then because of the lack of cohesion, with the absence of cohesion or you cut a vertical cut then sand will try to flow and make

a particular slope it never be vertical. But if the soil has some amount of phi then you can see this is actually vertical cut you can do up to almost nearly 11 meter.

So this is the duty in the strength property of the soil. So, this happens also in the field or you can apply frequently this type of things in the application, so this is the second problem. So, let us go to last application which is the very again simple.

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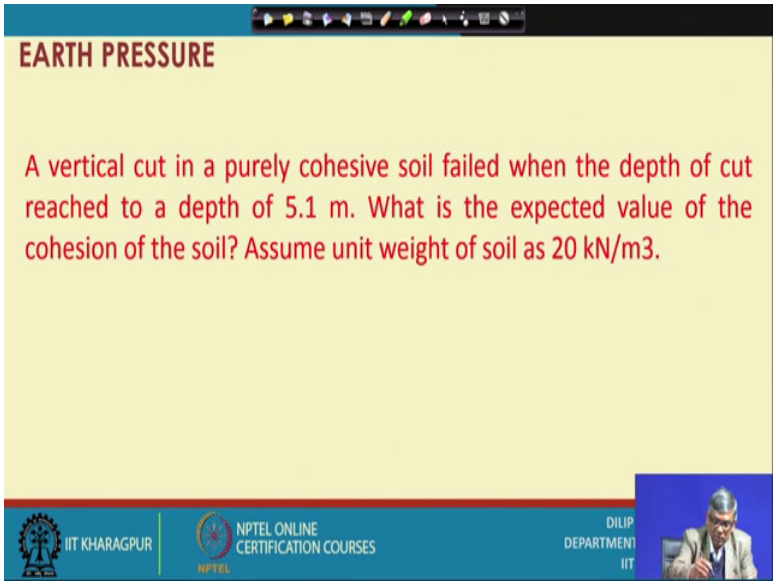

You can see a vertical cut in a purely cohesive soil failed when the depth of cut reached to a depth of 5 meter, 5.1 meter. What is the expected value of the cohesion of the soil? So a pure cohesion cohesive soil is mentioned and excavation is going on and suddenly when reduced to 5.1 meter it failed.

So, from here you have to guess based on whatever knowledge we have using that you have to estimate the probable value of cohesion of the soil. So, it is pure cohesion is mentioned phi is absent so that is what you have to do here. So, let me see this problem.

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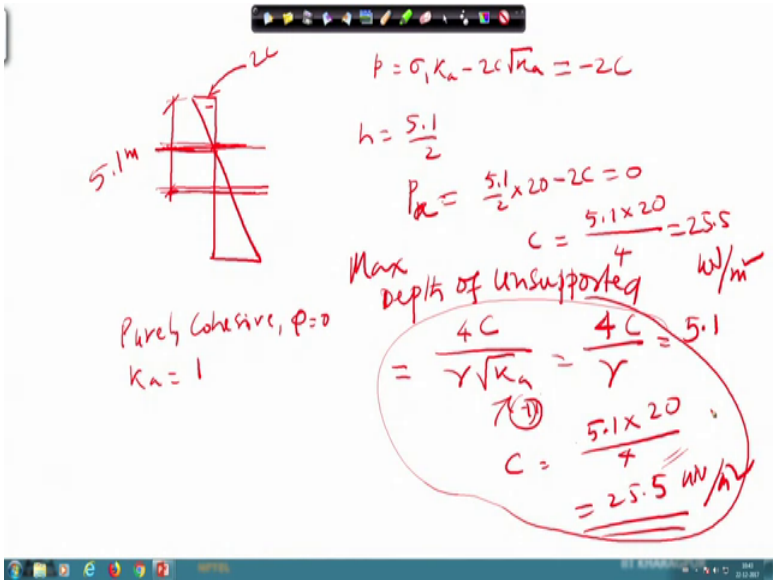

You know that pressure diagram is something like this ok. So, purely cohesive phi equal to 0 so; that means, your K a become 1, that is one thing. And at this point what will be the value actually this is actually you have p equal to sigma 1 K a minus 2 C root K a, so this is the one.

So, this of course 0 so it will be 2 C root K a, so ultimately it will be minus 2 C only at this point, this is 2 C minus and at this point will be some value depth is not known. So, you do not know, but you can see it failed means up to this you will never fail as according to our understanding if you reach at this level it will fail so; that means, this depth is 5.1 meter, and this half of this distance.

So, if I do suppose at this depth 5.1 by 2 at that distance your pressure is 0. So, at h equal to 5.1 by 2 your P p will be sorry P a will be equal to 5.1 by 2 into gamma is gamma is 20 and minus 2 C root K a means 2 C. And we know that at this depth is failure occur. So, middle of this is actually pressure is 0.

So, this pressure must be equal to 0 if you said this is equal to 0 then from here you can get the C equal to C equal to 5.1 into 20 divide by 2 into 4, so this gives you value equal to 25.5 kilo Newton per meter square, so this is the problem through proper understanding I have drawn the pressure diagram and I have shown that it failed at this depth.

So, at the middle of this the pressure is 0, by using this concept otherwise also direct formula that is depth of unsupported cut depth of unsupported or it is a maximum depth actually maximum depth of unsupported cut the formula will be equal to 4 C by gamma root K a this formula is there so K a is here 1, so it is 1. So, if I use that will be 4 C by it is 4 C by gamma so; that means, what it is 4 C by gamma and this is actually we have got 5.1 ok.

Then C will become C will become 5.1 into gamma is 20 divided by 4 equal to 205.4, 205.5 kilo Newton per meter square. So, this is another way this is directly formula we have used and whereas, here we have just applied the fundamental so; that means, we have drawn the pressure diagram.

And then based on that pressure diagram where you fail you know it failed at actually double the depth of 0 pressure depth, and from there we have taken that is fundamentally we have done that one and this one. Also if you want to use formula for depth of unsupported cut there, K a will be 1 and that can be used and then you will get this value. So, this is another way this can be solved.

So, these are all earth pressure related whatever different kinds of problems are possible actually all I have covered now I will just summarize that what are the important things we have done here basically you have to you have to know the difference between active passive and address condition.

What are what are these how they are different from each other that you have to understand first that wall movement wall when moves towards the away from the backfill that is active when addressed that is that is k naught pressure or address pressure and when moves towards backfill is passive and this is definitely we can visualize when the wall moves away from the backfill pressure will be less.

So, because of that the least pressure will be active and maximum pressure will be passive. So, these are the qualitative information sometime in memorized type of problem memory type of problem the question; that means, from the memory you have to answer.

So, that type of question if that that can be asked which one is the maximum which is minimum or sometime we will discuss describe wall moves towards this then what it is

active passive addressed or none of them, so that also sometime can be asked. So, you have to get that from this so these are the qualitative some information initially you have to know and then once you get that next part was your how to find out this active pressure.

So, different ways you have discussed Rankine's theory and we have also describe coulombs theory. What are the basic what are the basic difference between these two the Rankine's theory is simplified there is no friction in the wall and wall surface is vertical. And also level backfill of course later on it is extended for slopping backfill, but the important formula actually you have to remember that your for K a equal to 1 minus sin phi by 1 plus sin phi or in the tan form also tan square that formula also there that also you can use.

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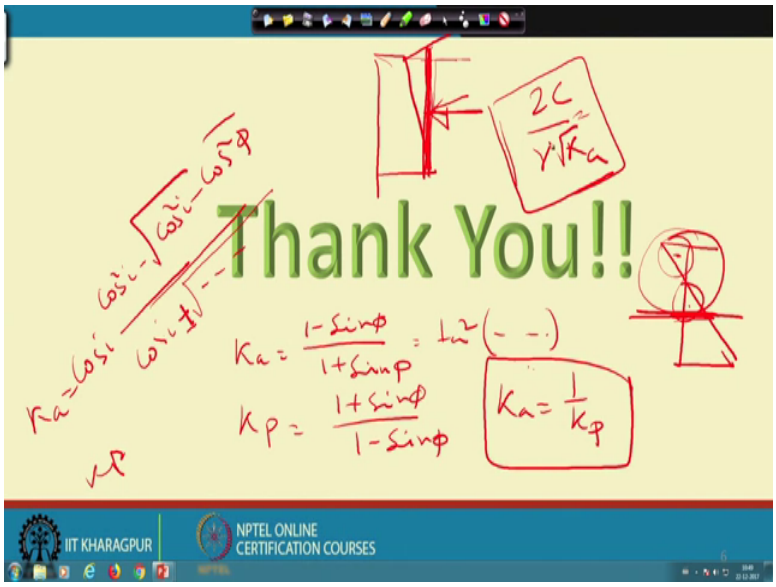

And K a also will be equal to 1 plus sin phi by 1 minus sin phi. So, from there we can see that K a equal to 1 by K p. So, this is also another point to be remembered and when there is slopping surface then the K a little modified K a equal to cos i, and then you have you have cos i minus under root cos square i minus cos square phi divided by cos cos i minus under root this is plus.

So, this is corresponding K p also will be here will be minus and this will be plus this you applied remembered and coulombs theory no need to remember actually it is

generally difficult to expect that problem to remember only thing. When you do homework there can be some problem you can refer the equation and do it.

Otherwise important thing is what is the difference between Rankine's and coulomb this 2 part can be studied or remembered and then second thing was that if the wall face retaining side actually if it is inclined then how to use Rankine's theory. So, that you have also discussed that is if it is a slope something like this.

And wall from then what you do we can of course if it is a level backfill it will no change I have shown one problem if you your wall meter considered this one and this one your wall to be considered as this one and but if it is a slopping backfill then wall will be considered as this one.

So, this difference accordingly everything will be same only wall height will be change and because of that your magnitude of earth pressure will change so that is also I have shown one problem. So, that is another aspect and then third aspect was C phi soil possessing some amount of cohesion. Then what is P a expression? What is P p expression? And then and then you know the active earth pressure when at when there is no at a surface active pressure become negative and because of the negative pressure there can be a tension crack and that tension crack depth you can find out the cohesion cab be asked 2 ways.

Find out the depth of tension crack and then it will be 2 C by gamma root K a depth of tension crack do not get confused this is sometime it is only asked depth of tension crack. Because the crack will extend up to this beyond that pressure is 0, just point pressure is 0. So, because of that when pressure becomes 0, the beyond that will be positive so tension crack will not be there. So, if the depth of tension crack asked then this is the answer and if it is asked depth of the unsupported maximum depth of unsupported excavation then actually root twice of that.

So, how it is we have visualized we have visualized the your pressure diagram is like this and then this is negative pressure. So, up to this because of total of this negative and total of this positive, so become 0 so; that means, up to this depth on the wall late effective pressure is 0, so because of that up to this much depth you can cut without any support. So, this is another so there actually you have to do multiply by 2 to get the actual depth.

So, this is the way actually you have done all I hope this is enough and it will be useful for you.

Thank you.