Geotechnical Engineering II / Foundation Engineering
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Lecture - 48
Sheet pile wall (Contd.)

Let me continue again on Sheet pile wall and just in my previous lecture I have discussed about analysis of retaining wall, particularly for finding out the depth of embedment. And, I have shown different combination of combination of soil condition; that means, above dredge level below dredge level what is the soil sand cohesive and cohesive. But, we have discussed only sand sand combination and again as I have mentioned that in the sheet pile wall always there will be water table most of the time; that we have considered without water table and that is one thing.

And again that analysis two types that be: one is rigorous analysis another is simplified analysis and now I will take a problem by and try to solve by rigorous analysis and also by simplified method. So, and that is the application I will try to show immediately and then we will see the result.

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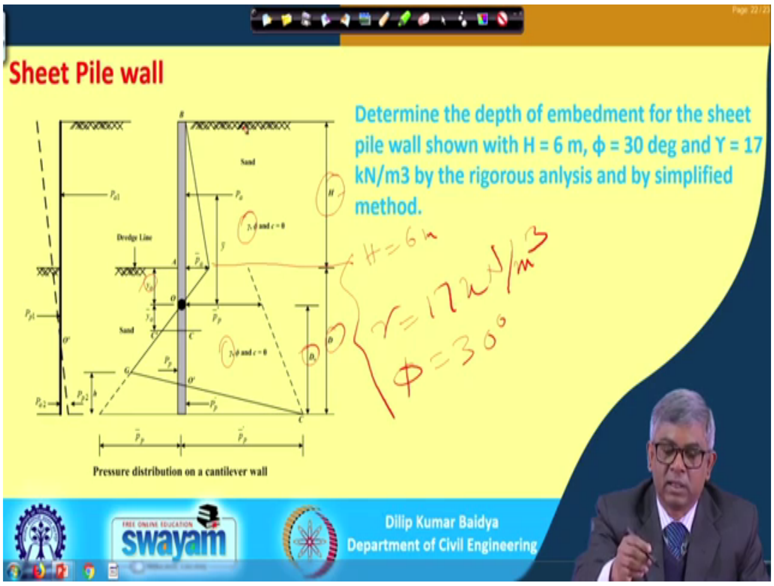

So, this is the problem actually, problem is like this determine the depth of embedment for the sheet pile wall shown with H equal to 6 metre phi equal to 30 degrees and gamma equal to 17 kilo Newton metre cube by the rigorous analysis and by simplified method.

There are two method actually we have to use and that is how this is the wall actually this dredge level. So, here actually H equal to 6 metre; so, H equal to 6 metre and your gamma hare gamma here.

So, that equal to 17 kilo Newton per metre cube and your phi here both are cohesive soil cohesion less soil phi equal to 30 degree. So, this is given and if this is the one this is the analysis also I have done so, this will be the corresponding pressure diagram. So, my unknown is y naught my unknown is D naught and finally D ok. So, this step by step if I follow then I can do it. So, for these um you can refer this figure and then I will all steps in calculation I will try to show and you can see here.

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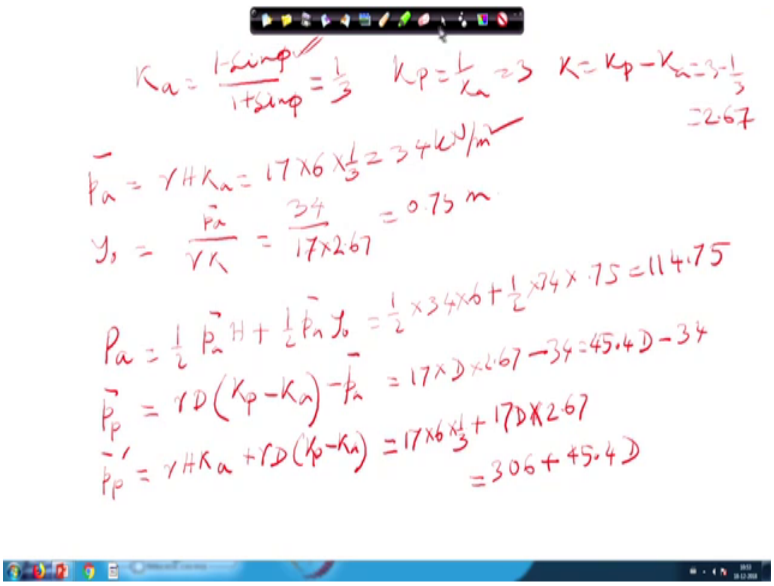

Ah First of all actually you can find out K a and K p, what is K a equal to 1 minus sin phi by 1 plus sin phi and that will be equal to 1. If I put phi equal to 30 degrees then it become 1 by 3 and K p become 1 by K a so, it will be 3 and K will be equal to K p minus K a. So, that become 3 minus 1 by 3 so, it become 2.67 and p a bar we can say first quantity p a bar will be gamma H K a.

So, gamma is actually how much? Gamma is here 17 H equal to 6 and K a equal to 1 by 3. So, that become your 34 kilo Newton per metre square. Then your y naught next step is y naught y naught become p a bar gamma K so; that means, it will become 34 divided by 17 multiplied by 2.67; so that become 0.75 metre.

And now, we can find out P a that is your P a that is that is actually if I go back to the diagram you can see P a is this one the area of this diagram. So, P a will be you can say half p a bar into H plus half p a bar into y naught. So, if I do that half multiplied by p a bar is how much 34 multiplied by 6 plus half multiplied by 34 multiplied by y naught is 0.75. So, this gives you 114.75 114.75 and now p p bar this will be equal to gamma D gamma D K p minus K a minus p a bar. So, this will be equal to 17 multiplied by D and this is 2.67 minus p a is 34.

So; that means, it will be 45.4 D 45.4 D minus 34 and p p bar dash that will be equal to gamma H K a plus gamma D K p minus K a. So, that gives you 17 multiplied by 6 multiplied by 1 by 3 plus gamma sorry ok. So, this will be this will be 17 D multiplied by multiplied by 2.67. So, this ultimately become 306 306 plus 45.4 D; so these are the things we have getting.

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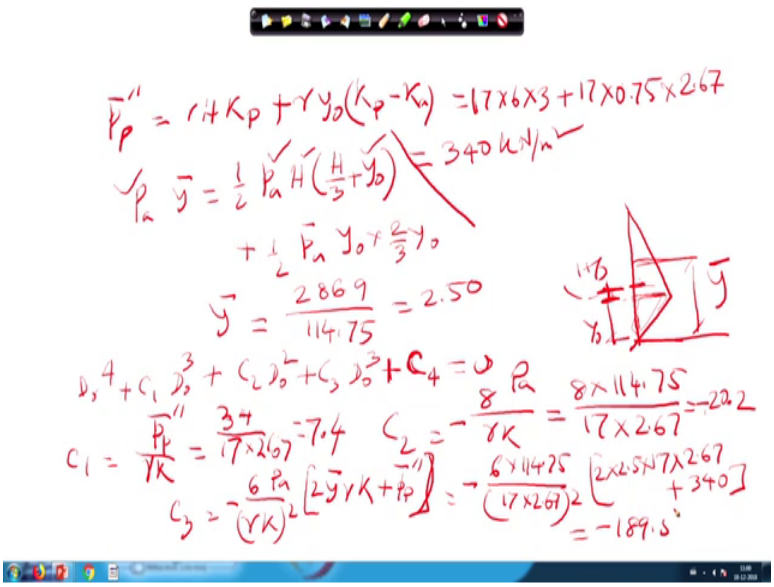

So, I will go to a next page. So, next page will be p p p p p bar double dash that would be equal to gamma H K p gamma H K p plus gamma y naught gamma y naught K p K p minus K a. So, if I put then we will be use 17 multiplied by 6 multiplied by 3 plus 17 multiplied by 0.75 and multiplied by 2.67. So, this gives you 340 kilo Newton per metre square and then to find out y bar I can do P a y bar equal to half P a into H half P a into H into H by 3 plus y naught.

If you look at diagram then you will be find out. So, the one diagram is there something like this. So, this is this is the one so, you have to find out y bar from here actually y bar a suppose this is acting here. So, y bar is this one so, y bar so this area multiplied by the distance from here to here actually corresponding to this area this is somewhere here suppose, then this will be this will be H by 3 plus y naught this is y naught this is y naught and this is H by 3 suppose. So, that is what this is done so, sorry this is different and plus half p a bar y naught. So, this area actually this area you have to find out the this area and this is easy from here actually two-third y naught.

And, if I put all values then ultimately y bar will become I know this I know this I know this everything is known and I know this also. So, y bar will ultimately will become 286.9 286.9 divided by 114.75 114.75; so, that gives you 2.50 ok. So, and your final equation your final equation will be D naught to the power 4 plus C 1 D naught cube plus C 2 D naught square plus C 3 D naught cube plus plus C 4 equal to 0. Now, one by one I have to find out C 1 C 1 equal to actually p p bar double dot divided by gamma K.

So, which will be equal to 34 by 17 multiplied by 2.67 that gives you 7.4 and C 2 equal to minus 8 P a divided by gamma K. So, that gives you 8 multiplied by 114.75 divided by 17 multiplied by 2.67. So, that is actually minus 20.2 minus 20.2. Then your C 3 becomes minus 6 P a divided by gamma K whole square multiplied by 2 y bar gamma K plus p p bar double dot this one. So, this way if you are calculate so, it will become minus 6 multiplied by 114.75 divided by 17 multiplied by 2.67 whole square 2 multiplied by y bar is how much you have got, 2.5 multiplied by gamma 17 multiplied by K 2.67 plus p p bar double dot actually how much 34 and a p p bar double dot is 340.

It will be a 340 it is 340 so, this one if you calculate then it comes actually this comes minus 189.5. So, this is become C 3 now I get C 4.

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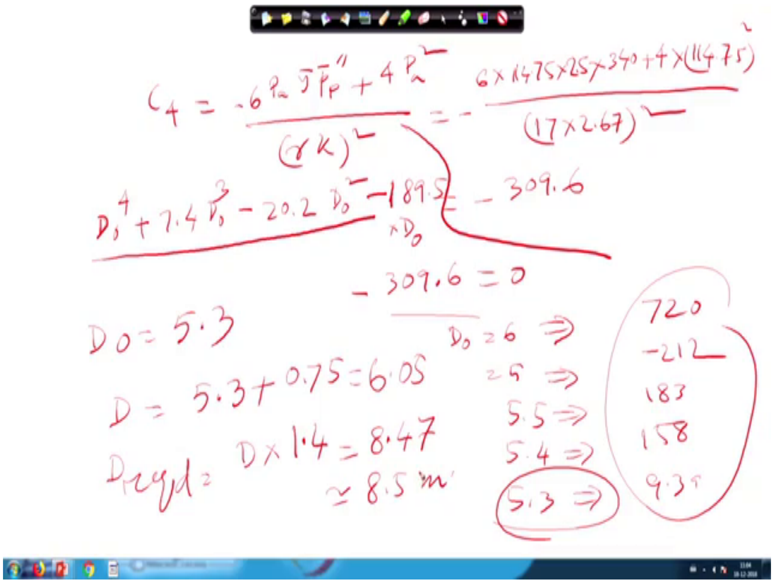

C 4 will be equal to C 4 will be minus 6 P a y bar p p double dot plus 4 p a square divided by gamma K whole square. So, if I put this it will become minus 6 multiplied by P a is 114.75 multiplied by 2.5 multiplied by 340 plus 4 multiplied by 114.75 square divided by 17 multiplied by 2.67 whole square. And then we will get minus minus 309.6 so, we are getting this. So, all coefficient I have got now I if I express then I am getting D naught to the power 4 minus plus 7.4 D naught cube minus 20.2 minus 20.2 D naught square minus 189.5 sorry..

This is if would this is 1 189.5 D naught minus 309.6 equal to 0. So, this is equation; that means, D naught to the power 4 this is the equation minus 189.5 D naught multiplied by D naught minus 3 this. So, this is the equation and so, I have to put I have to solve for D naught I have to solve for D naught. So, if I want to solve for D naught then what I will do, I will assume here particular value of D and find out the value of this function. So, as I have told you that guideline what I can do, the D naught can be taken as same as your depth of embedment. So, if I take D naught equal to 6 D naught equal to 6 this function gives a value such 720.

And, if I take then I if I take D naught equal to 5 this gives you a value equal to minus 212. If I take 5.5 this gives you 183 something and if I take 5.4 if I take 5.4 this gives you 158 and if I take 5.3 this gives you 9.3 and it is quite close to 0 I can say. So, I can assume that solution for this equation is D naught equal to 5.3. So, your D become 5.3

plus y naught actually is 0.75 so, that become 6.05. So, actual D required will be equal to D multiplied by suppose 40 percent increase if I do, there are 1.4 if I multiply then it become your it become 8.47. And which is nothing, but 8.5 metre so; that means, the if I go back to the problem if I go back to the problem.

So, for this problem for the for this problem when the depth is 6 metre and your your [file/phi] phi is 30 degrees, gamma is 17 then your depth of embedment required your depth of embedment required for shape design retaining; so, it is 8.5 metre ok. So, so these are the if I go back from here; so, this is the one step 1 then this is the page 2; that means, different coefficients I have calculated; that this is page 3 that equation I have got. And then finally, solving this we have got equation 7.5 so, all those things now. So, that is this is the solution I have obtained by rigorous analysis ok; let me see now so, let me see now by simplified method.

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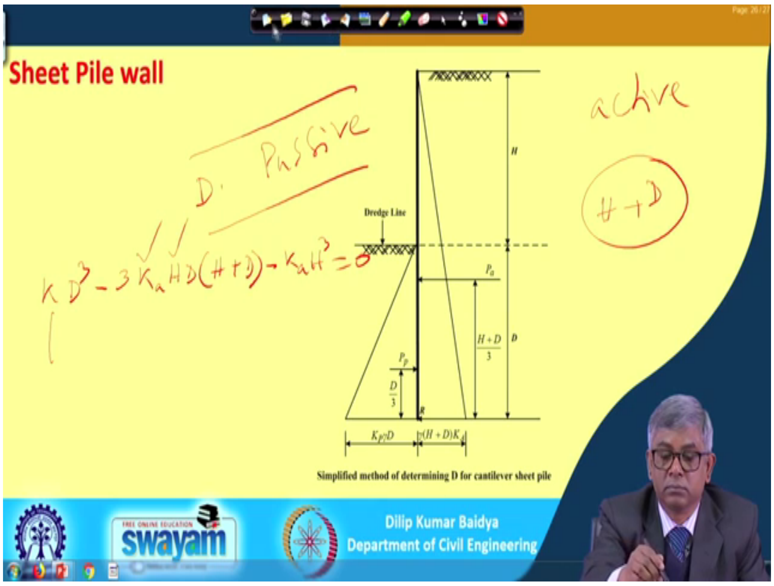

If I do by simplified method this is the diagram and I have shown the corresponding equation that I have to assume that this is the wall now, wall height assumed to be H plus D and for that I calculate active pressure. And wall height actually is D and for that I will calculate passive pressure. And, for equilibrium this pressure and this pressure must be equal and if I do that then as I have shown that I have got an equation which equation was simplified equation was actually you are a K D cube K D cube minus 3 K a H D into H plus D minus K a H cube equal to 0 this was the equation.

So, this is the equation and everything is known H is 6 K equal to 1 by 3, K is 2.67 and if I put all those things. Suppose, if I put all those thing then I will get a equation 2 point 2.67 D cube minus 3 no 3 multiplied by 1 by 3 multiplied by 6 multiplied by D multiplied by 6 plus D minus 1 by 3 into 6 cube equal to 0.

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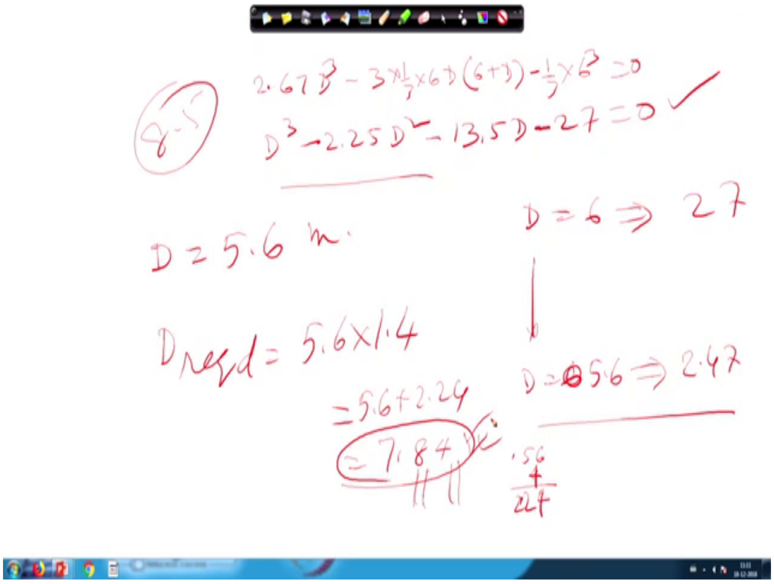

And, if you simplify this then I will get a equation equal to D cube minus 2.25 D square minus 13.5 D minus 27 equal to 0. So, I will get a rigorous analysis based on [regular/rigorous] rigorous analysis I will get this equation. And, if I get this equation you can see this is a cubic equation so, I can assume a D value equal to equal to 6 then the function value comes actually 27.

And, then by reducing the D value at value D equal to 6 value D equal to not 6 actually 5.6 this function gives a value equal to 2.47 2.47. So that means, I can assume that solution of this equation solution of this equation D equal to 5. 6 5.6 metre. And, since it is a simplified method so, D required as I have done 5.6 multiplied by 1.4 if I do then this become actually 5.6.

So, it would be so, 2.24 it would be added so, 5.6 plus 2.24. So, that become 7.84 it is coming around 7.84 whereas, we have got previous analysis around 8.5 ok. So, this is the only difference actually we are getting little lesser depth here by a simplified analysis. So, it may not be so, you may have to use more factor of safety bigger factor of safety. So, otherwise for approximate analysis actually to get an so, if you have enough time and scope and so, then in that case you can do a rigorous analysis. But, by simplified analysis what will be the depth required we can get a just initial estimate ok.

So, so we can see that if you want to do rigorous analysis you have to refer the all those things calculations you have to see and based on that based on that you have to arrive at the solution. But, you are if you would do the simplified analysis there is nothing one side you consider wall height equal to H plus D and then find out active pressure. And, other side you can say wall height equal to D and find out passive pressure equate; get the equation, solve the equation then you will get the analysis answer and so, that may not be correct accurate.

So, you have to get the correct value what you have to do you have to a rigorous analysis. So, to get a preliminary estimate one can do this and otherwise it is rigorous analysis is preferred. And finally, as I have mentioned that in the examination such a lengthy problem is difficult to do and particularly for you this simplified method will be important for your; so, you can practice this one. And, other whatever things are available actually when you need to do the design in the practice you can refer book and do the follow the steps and get the solution that is not a problem. But, for exam purpose perhaps we will try to avoid this complicated rigorous analysis ok.

So, with this I will stop here thank you and next class and next lecture I will try to take the anchored sheet pile wall how to analyse and how to find out finally, depth of embedment. And, actually in the anchored sheet pile wall there are two things here actually one important thing that is depth of embedment and their thickness if thickness will come from bending moment and all which I have not shown, but I will I may discuss later on. And, anchored sheet pile wall actually two things will come not only depth of embedment one one part and in addition to the depth of embedment you have to find out anchor force because the anchor has to a design.

Anchor I have to prevent too much of settlement I am putting anchor, if the anchor cannot support that much load if it may tear or it may slide so, many things can happen. So, to design a a proper anchoring system we need to find out the anchor force. So, those two things I will do in the next class.

Thank you.