Foundation Engineering
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Lecture – 54
Sheet Piles – III

So this class, I will solve one example problem on cantilever Sheet Pile in granular soil, ok.

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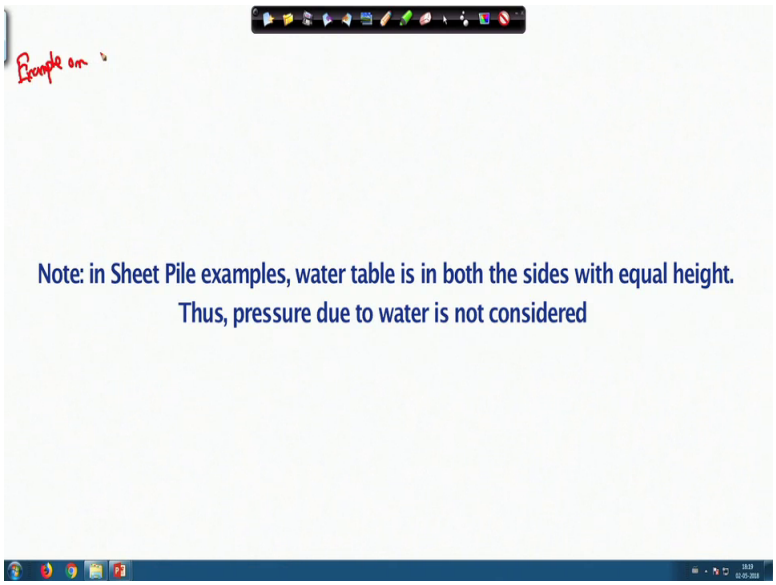

So, the example problem I am taking is that this is on phi soil is cantilever sheet pile.

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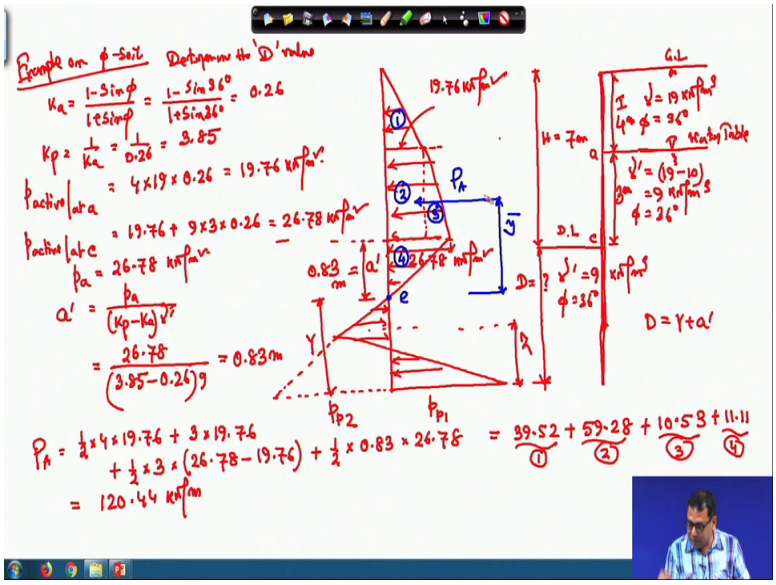

And, the problem that I am taking so this is the sheet pile. So, this is the dredge level this is the ground level this is G L this is the dredge level or D L ok.

Now, there are layer soil is given. So, this is the layer one layer soil. So, this is layer I and unit weight is given 19 kilo Newton per meter cube or phi value is given 36 and this is the water table. So, water table is this way and basically it is a single layer, but the water table position is here. So, we can treated as a two layer system because here the unit weight will change this is the unit weight is effective unit weight or submerge. So, this will be 19 minus 10. So, we are taking this is 9 kilo Newton per meter cube phi value will remain same 36 degree and here also below the dredge level also this is 9 kilo Newton per meter cube and phi value is 36 degree.

So, height of the retaining wall is known. So, that height is given of total 7 meter. So, out of that 7 meter, this is the 4 meter and this one is 3 meter. So, the water table is 4 meter below the ground level and then the dredge level is 7 meter below the ground level. So, the H value is 7 meter and. So, we have to determine the D value what is the depth of the a retaining or sheet pile required, ok.

So, determine the D value or depth of the sheet pile, ok. So, first we will do the will draw the earth pressure distribution diagram of this sheet pile, ok. So, this is the dredge level and this is the below the dredge level ok. So, we have this is the 4 meter depth. So, this is 4 meter depth. So, 4 meter depth first we will calculate that at 4 meter what will be the P

a first we will calculate K a K if I use the Rankine's earth pressures theory. So, this is 1 minus sin phi 1 plus sin phi. So, this is equal to 1 minus sin 36 degree 1 plus sin 36 degree. So, this is equal to 0.26. So, the K p is 1 by K a. So, this will be 1 by 0.26 this is 3.85 ok, the passive part.

So, now the p active at a; so if this is a point this is c point say. So, active at a point will be what? So, this will be height is 4 meter, 4 into unit weight is 19 into K a is 0.26. So, the value is 19.76 kilo Newton per meter square. So, this value is 19.76 kilo Newton per meter square. Then there is a water table. So, this will continue here as the phi value is not changing and then this is another part, ok. So, this is the active force.

So, the p active at c point this point c point will be the total will be that 19.76 plus the additional stress due to this portion this 3 meter portion. So, this will be the unit weight is 9 height is 3 into K a that is 0.26 ok. So, this total will be 26.78 kilo Newton per meter square. So, this total one is 26.78 kilo Newton per meter square. 19 plus this 9 into 3 into 0.26 additional part due to this 3 meter soil below the water table. So, this is 26.78.

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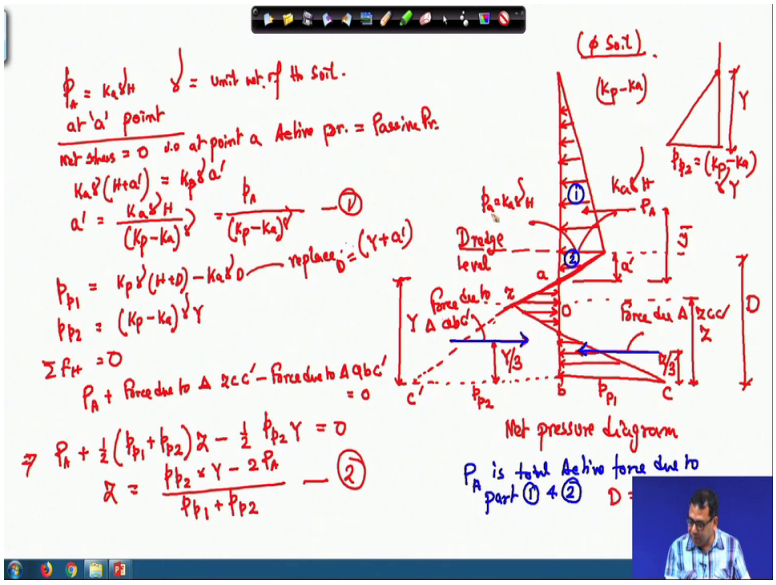

So, this is basically in the previous problem so, this value is basically the P A ok. So, this value is P A now at the dredge level. So, I can write that my P A value is here is equal to 26.78 kilo Newton per meter square. So, the a dash equation number 1 so, this is equation number 1. So, a dash is P a divided by K p minus k into gamma. So, I can write that a dash will be p a into K p minus K a into gamma. Here gamma will be gamma dash

because the I want to calculate the a dash. So, an a dash is below water table so, I will consider the gamma dash another thing from here. So, my earth pressure distribution will be need earth pressure distribution will be like this these things I have already explain, ok.

So, this portion is a dash total and this maximum one this maximum one is capital Z from here to here this is capital y and total one is D. So, D is capital Y plus a dash. So, a dash I will get from here. So, I can draw this diagram, and I have to extend this to determine the p p 1 and pp 2 ok. So, this is p p 1 this is p p 2. So, a dash is p a divided by K p into K p minus k into gamma dash. So, p a is 26.78 divided K p is 3.85 minus K a is 0.26 and gamma dash is 9 ok. So, this is equal to 0.83 meter. So, this value a dash is equal to 0.83 meter.

So, now I have to calculate the P A P capital A. So, this P capital A will here. So, this is P capital A and that will act at a height of y bar from this is a point sorry because a point I have already written. So, that the point was mention here it is a. So, you can give any different name say this is I am writing this is e point ok. So, because your capital your y bar is from this point to the P A. So, this point is here e and this is the capital this is the y bar and capital P is the force due to this total portion ok, H plus a dash portion.

So, now P A I will calculate. So, one in P A I will calculate. So, I am taking different again different segment. So, this one I am taking first segment this rectangular I am taking third second takes segment this triangle I am taking third segment, again this triangle below the dredge level I am taking fourth segment, ok. So, this four segment I have taken for the P A calculation. Now, will calculate P A first is the first triangle first triangle height is 4 meter base is 19.67. So, this will be half into 4 into 19.76, ok. So, this will be half 4 plus into 19.76.

Now, for the second part this rectangle this is 19.76, height is 3 meter. So, this will be 3 into 19.76 ok, then plus the third portion the half height is 3 meter; and this is total is 26.78 this is 19.76. So, this portion will be 26.78 minus 19.76 this triangular portion the third portion plus this fourth portion. Fourth portion this base is 26.78 height is a dash a dash is 0.83. So, I can write this is half into 0.8 or 83 into 26.78. So, this is equal to if I calculate separately for the first part it is 39.52 plus 59.28 plus 100 10.53 plus 11.11. So,

that is equal to 120.44 kilo Newton per meter. So, this is due to first segment this is second one, this is third one and this is fourth one.

So, now I will calculate the y bar part. So, and the capital Y bar is form the a e point to the P A.

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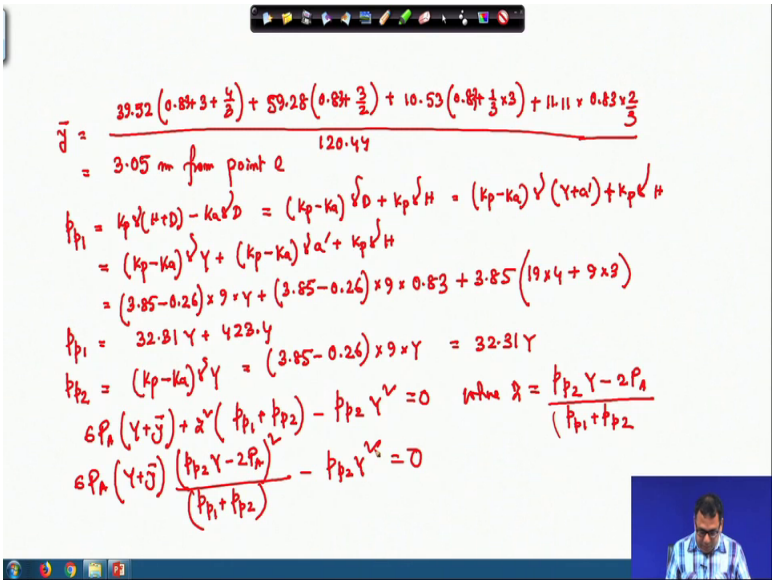

So, the capital y small y bar just our first part the first triangle let us see for the first triangle. So, first triangle this is the force is acting here. So, the y bar will be 0.83 plus 3 meter plus 4 by 3, ok. So, I can write that first one is this force is 39.52. So, I can write this is 39.52 then lever arm 0.8 plus 3 meter plus 4 by 3 this is for the first part second part will be point 0.8 meter. So, I have calculate is taking 0.8 meter. So, you can take also 0.8 meter ok. So, I have done the calculation with point 8 meter. So, you can take 0.83 also for their, I have taken 0.8, ok.

So, and then this is point and for the second part it will be 0.8 plus 3 by 2 because this is a rectangle. So, it will be the force is 59.28. So, force is 59.28 into lever arm is 0.8 plus 3 by 2. Third one is a triangle it will be 0.8 plus 3 by 3 and force is 10.53. So, this will be 10.53 0.8 or 0.83 plus 3 by 3, this will be 0.83 or 8 this will be 83 plus the fourth one it is 11.11; 11.11 and this will this will form here. So, it will be 2 by 0.83 this will be from this side this is one third of 0.83 this side will be two third of 0.83. So, I can write this is 11.11 into 0.83 into 2 by 3, and the total force is 120.44. So, this will be 120.44. So, this

lever arm is 3.05 this y bar meter form point e ok, this is point e. So, this part is done pa calculation and the lever arm calculation or y bar calculation, I have done.

Next one what I will do that I will calculate the p p 1. So, p p 1 what is the expression of p p 1? P p 1 is K p gamma H plus D minus K a gamma D. So, p p 1 I can write that K p gamma H plus D minus K a gamma D, ok. So, now, if I simplify that; so this will be K p minus K a into gamma D plus K p gamma H. So, D I can replace with K p minus K a gamma D is capital Y plus a dash plus K p gamma H ok. So, I can further write this term is equal to if I simplify these things further. So, I can write K p minus K a into gamma into capital Y plus K p minus K a into gamma into a dash plus K p gamma H, ok.

So, now the K p value is 3.85 K a value is 0.26 and gamma into capital Y. So, this capital Y part is below water table. So, instead of gamma I will take gamma dash. So, gamma dash is 9 into the capital Y plus again K p is 3.85 minus 0.26 again a dash is below the below the dredge level water table and the dredge level both. So, I can write this is also gamma dash 9 into a dash value is 0.83. So, this is 0.83 then plus K p 3.85. So, I am taking it as 0.83 ok, it is not 0.8.

So, point this is 3.85 then this H, H is some part is above water table and some part is below water table. So, this part I will write this gamma into H I will be write 19 into 4 above water table plus 9 into 3 below water table. So, remember that it is Y which is below water table that is why I have taken gamma is 9 a dash this below water table I have taken gamma is 9, but H some part is about water table some part is below water table. So, I have taken two different gamma and above water table 19 into 4 below water table 9 into 3, ok; below water table is submerged. So, this is p p 1 is equal to 32.31 into capital Y plus 423.4 because only unknown is capital Y in this equation.

Similarly, I can write p p 2 which is equal to, p p 2 expression you can see that my p p 2 expression is K p minus K y into gamma into Y. So, I can write this is K p minus K a into gamma into capital Y ok. So, K p is 3.85 K a is 0.26 again it is capital Y the below the water table. So, this will be 9 into capital Y. So, this is equal to 32.31 into capital Y, ok. So, this is p p 1 and p p 2.

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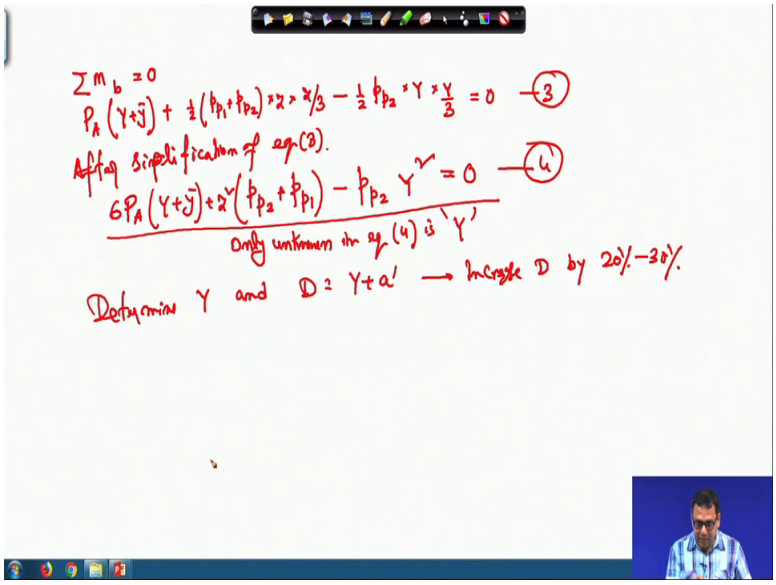

So, as I mention that after simplifying this expression this is the final expression ok. So, now, I will use this final expression and if you forget this expression you can you can derive it by taking the summation of all the forces is 0 from there you will get the z expression and from here summation of all the moment about the base is 0, you will get the final expression.

So, I am using the final expression. So, the final expression is 6 P A into capital Y plus y bar plus z square p p 1 plus p p 2 minus p p 2 capital Y square is equal to 0. So, this is p p 2 capital Y square is equal to 0. So, here that where z is equal to p p 2. So, this expression z is p p 2 into capital Y minus 2P A divided by p p 1 plus p p 2. So, I will use this expression this is p p 2 into capital Y minus 2P A divided by p p 1 plus p p 2.

So, now I will put this expression this z value in this z square part. So, now, if I put these values I can write 6 P A capital Y plus y bar and this z expression I am writing here. So, this z expression this is z square, ok. So, I can write p p 2 into capital Y minus 2P A square and then this is also square, but there is another term p p 1, p p 2. So, one and one will cancel out. So, I can write this is p p 1 plus p p 2 because this will be square, but that is this term. So, it will cancel out. So, it will only p p 1 plus p p 2. So, this is minus p p 2 capital Y square is equal to 0. So, this is another simplified form.

So, now what I will do I will take this final form. So, this form I can write. So, I am writing this expression again.

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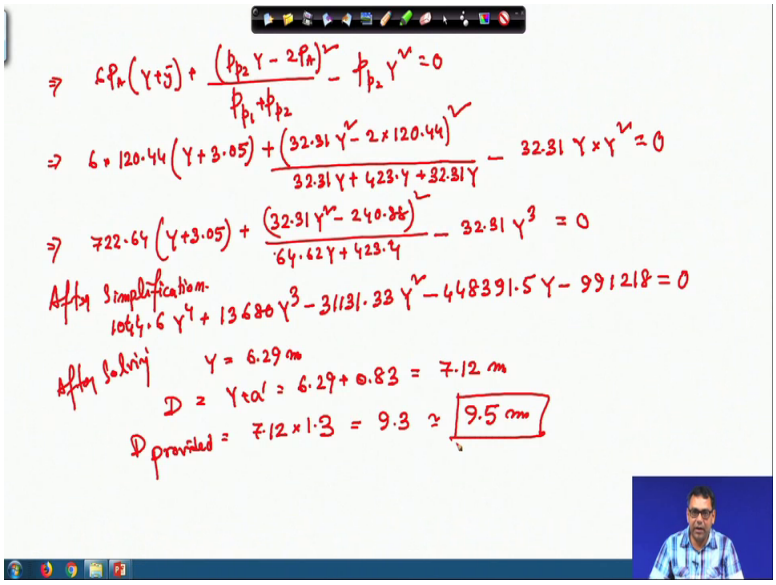

6 P A capital Y plus y bar plus p p 2 into capital Y minus 2 P A whole square divided by p p 1 plus p p 2 minus p p 2 capital Y square equal to 0. So, 6 P A value is 120.44 capital Y plus y bar is 3.05. So, you can see the y bar is 3.05 and P A is 120.44. So, I can write this is 3.05 plus p p 2. p p 2 is this is the p p 2 which is 32.31 Y and p p 1 32.3 31 Y plus 423.4.

So, I can write this is 32.31 this is capital Y minus 2, this is p p 1 is capital Y and there is already one capital Y. So, it will be capital Y square. So, minus 2 into p p P A is 120.44 this is square divided by p p 1 is 32.31 capital Y plus 423.4 plus 32.31 capital Y p p 2 minus 32.31 Y into Y square that is equal to 0 because p p 2 is Y there is a Y term.

So, if I simplify this expression here you can see the only unknown is capital Y, in this expression. So, this will be 722.64 capital Y plus 3.05 plus 32.31 capital Y square minus 240.88 whole square divided by 64 because we will add that 64.62 capital Y plus 423.4 minus 32.31 this is Y square and Y this will be capital Y cube ok. So, this is equal to 0.

So, after simplification so, if I simplify the; I can write 1044; 1044 6 y to the power 4 plus 13680 Y cube minus 31131.33 capital Y square minus 448391.5 capital Y minus 991218 equal to 0. So, if you solve that then after solving that we will get capital Y. So, after solving will get capital Y is 6.29 meter ok. So, you can solve it by trial and error method or you can solve the issue of in a calculator you can solve the cubic equation you

can use that or you can solve it by trial and error method, ok. So, 6.29 is the solution of capital Y.

So, D value will be Y plus a dash, so 6.29 plus 0.83. So, this is equal to 7.12 meter. So, I will increase it by 30 percent. So, D provided will be 7.12 into 1.3. So, that will be equal to 9.3. So, I will provide 9.5 meter is the depth of the sheet pile. So, you can see that for a height of H is 7 meter, the depth is required depth is 9.5 meter which is very high. So, so to reduce this depth or if you have a very high value then we will provide the anchored sheet pile.

So, next class what I will do I will first discuss the cantilever sheet pile on sea soil, because till now I have discussed the cantilever sheet pile on phi soil or the granular soil. So, next class first I will discuss the cantilever sheet pile on cohesive soil, in cohesive soil and then I will discuss the anchored sheet pile in both granular soil as well as in cohesive soil.

Thank you.