Foundation Engineering
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Lecture - 32
Pile Foundation – VI

So, last class I have solve a problem on bearing capacity of or the load carrying capacity of pile in homogeneous sign and I have solve that problem by using 3 different methods and then considering I have solve the problem considering critical depth or critical length concept and without considering the critical length or critical depth concept, now this class I will solve a problem on layer soil.

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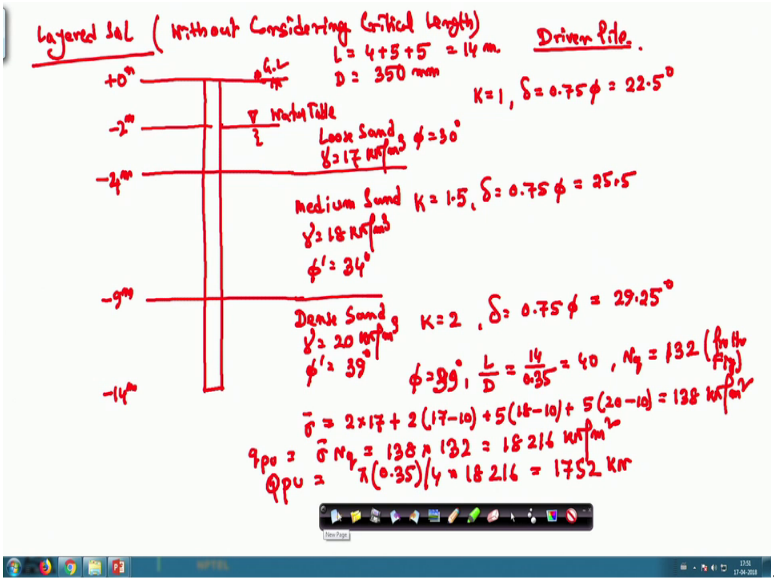

So, the problem is that we have a so this is the layer soil and soil layer this is down surface G L. This is the first layer of 4 meter this is 0 meter then the second layer is 5 meter; that means, up minus 9 meter and then the pile is inserted here.

So, total length of the pile is 14 meter ok. So, the pile base is at minus 14 meter. So, total length of the pile is so this is minus 14 so this is 4 meter plus 5 meter plus 5 meter is 14 meter and this diameter of the pile is taken as 350 millimeter and water table is at 2 meter below the ground layer.

So, this is this soil is loose sand and the gamma value is given 17 kilo Newton per meter cube the second layer is medium sand this is the medium sand and unit weight is taken as 18 kilo Newton per meter cube phi dash is 34 degree for the second layer and phi dash is 30 degree for the first layer and for the second layer third layer this is dense sand and unit weight is 20 kilo Newton per meter cube and phi dash is equal to 39 degree.

So, now, we have to solve this problem. So, now, from the table we have taken for the loose sand for the concrete pile and this is also driven pile this is also driven pile. So, k value is taken as 1 delta value for the concrete pile is 0.75 phi. So, that is equal to 22.5 degree for the second layer k is taken as it is medium sand because k value is 1 for loose sand and 2 for dense sand.

So, medium sand am taking it is 1.5 delta value is again 0.75 of phi. So, that is equal to 25.5 and dense sand k value I am taking 2 and delta value again 0.75 of phi and that is equal to 29.25 degree ok. So, now, the phi value is equal to 40 degree L by D is equal to this is the 14 divided by the 0.35 and that is equal to 40.

So, from the chart N Q value is equal to 132. So, 1 thing I want to mention that in few researchers they have suggested that you take the length of the last layer why it is penetrated and this last layer length; that means, 5 meter when you calculate the L by D part, but I would recommend to take the total length of the pile and the diameter 0.35 and take the phi value of the layer where the pile is rested ok. So, phi value I have taken of that layer where it is a just 39 degree sorry. So, it is 39 degree where it is rested. So, that 39 degree I am taken and the L by D value is taking the total length of the pile.

Total length of the pile when you talking about the L by D and the phi value where the t p is rested, ok so that is the layer where t p is rest it or pile basis rested so that a phi dash is again 39 degree. So, now, this phi value is 132 or it can be around because I am taking from this chart. So, it will be around 130 to 132 so I have taken 132. So, now, the sigma bar so this is I am solving without considering critical length ok. So, the sigma bar I am taking the full effective over pressure. So, sigma bar will be 2 into 17 for the top part above the water table then again 2 into 17 minus 10 then plus 5 into 18 minus 10 then plus 5 into 20 minus 10.

So, that is equal to 138 kilo Newton per meter square. So, my q p u is equal to sigma bar into N q. So, N q is 133 from the figure so how, So, we are using the first method and all others problems I will use the first method and I will prefer to use that method. So, in the remaining problems I will use the first method and I will use that chart to calculate the N q.

So, this is the N q from the chart. So, and this value; that means, the chart I can show you the chart that are consider. So, I have use this chart basically.

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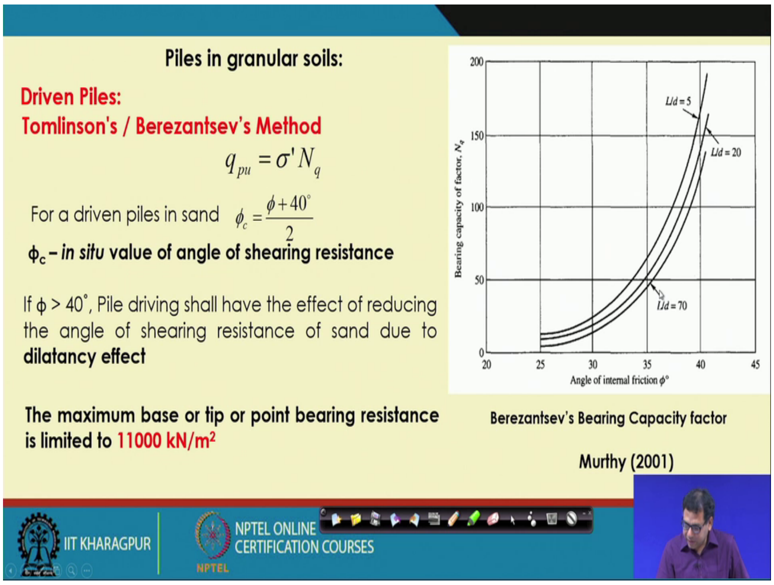

So, this is the chart it is 39 corresponding to L by d 40. So, this will be the value 132. So, now, this is the sigma bar N q, so, N q is 132. So, sigma bar 138 into 132, so, this will be equal to 18216 kilo Newton per meter square. So, I will take the full stress, so, that why I will not reduce this value. So; that means, Q p u is equal to pi these point pi d square by 4 into 18216 that is equal to 1752 kilo Newton ok. So, that is the Q p u. So, next part I will calculate the friction resistance that is the f s 1 so, that I will calculate from 0 to 2 meter.

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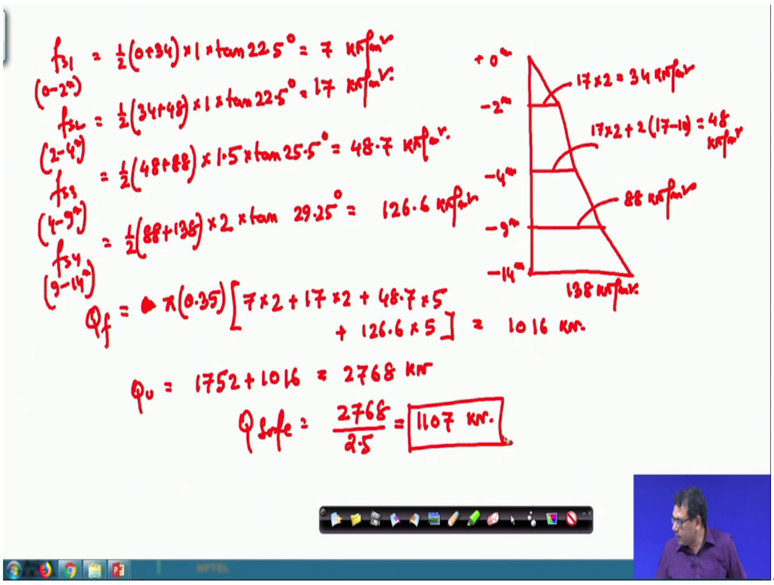

So, now if I draw the stress distribution, so, up to 2 meter this is the value it will further reduce then it will further increased then this is the stress distribution. So, I am giving you the value. So, this is plus 2 meter this is minus 2 meter this is minus 4 meter this is minus 9 meter this is minus 14 meter ok. So, 14 meter I have already calculated that is 138 kilo Newton per meter square, for 2 meter it is 17 into 2 that is equal to 34 kilo Newton per meter square and the 4 meter that will be that 17 into 2 plus 2 into 17 minus 10. So, that is equal to 48 kilo Newton per meter square.

So, similarly here it is 88 kilo Newton per meter square. So, if I calculate the first part then this will be the average value 0 plus 34, k is taken 1 and tan it is 22.5 degree. So, that is coming out to be 7 kilo Newton per meter square; f s 2 from 2 meter to 4 meter this value is the average of 34 plus 48 then k value is 1 and tan 22.5 degree. So, that is equal to 17 kilo Newton per meter square then f s 3 from 4 meter to 9 meter. So, this is also have 48 plus 88 average k value is here is 1.5 because this is the second layer, 4 to 9 is a second layer the k value is 1.5 and 0 to 2 and 2 to 4 is the first layer where k value is 1.

So 1.5 and here the delta value is 25.5. So, you will take into tan 25.5 degree. So, the value is 48.7 kilo Newton per meter square, then f s 4 which is 9 meter to 14 meter and this is half into 88 plus 138 into 2; here the k value is 2 delta value is 29.25 into 2 into tan 29.25 and that is equal to 126.6 kilo Newton per meter square.

So, my f Q, Q f is equal to pi d pi d is 0.35 then we have to consider this length. The first one is 7 and the length is 2 meter then second one is 17 length is 2 meter 4 minus 2 that is 2 meter third one is 48.7 length is 9 minus 4; that means, 5 meter then the last one is 126.6 and the length is 14 minus 9 again 5 meter. So, this is equal to 1016 kilo Newton ok. So, the value is 161016 kilo Newton and ultimate value will be equal to which is 1752 1752 plus 1016; so, that is equal to 2768 kilo Newton. So, the Q safe is equal to 2768 divided by 2.5 that is equal to 1107 kilo Newton.

So, this is the safe load without considering the critical length concept ok. So, now, I will consider the critical length concept for the same problem and then we will see how much difference will be there, the same problem if I consider the critical length. So, the same this is the ground level, so, now considering ok.

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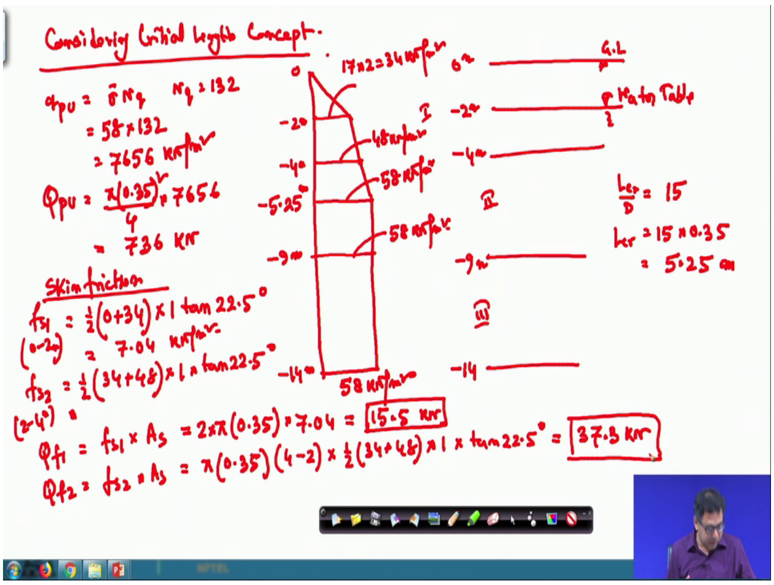

So, same ground level is 0 meter, this is minus 2 meter where it is the water table this is the ground level that is the water table and here this is 4 meter the first layer this is minus 9 meter the second layer and minus 14 meter third layer up to 14 meter this pile is rested.

So, the distribution will be now if I draw the state distribution, so now, the question is which critical length will consider because this first layer is the loose sand second layer is the medium sand third layer is the dense sand and the. So, I would prefer to take the critical length as a critical length divided by D is 15 because that is the range from lows to medium and for the dense sand it is 20, but the soil the top portion is lows to medium.

So, I will take that critical length divided by D is 15 because that is the top portion where this is the loose sand this is the medium sand.

So, if I take this is 15. So, your critical length is 15 into 0.35. So, that is equal to 5.25. So, that is the critical length. So, again if I draw the distribution, so up to 2 meter this is the value. So, up to 2 meter it will be 17 into 2 so, that is 34 kilo Newton per meter square then 4 meter. Again this value is 48 kilo Newton per meter square because in the 4 meter we have calculated that is 48 kilo Newton per meter square. Then the critical depth is up to 5.25.

So, it will further increase up to 5.25. So, this is minus 2, this is minus 4 this is minus 5.25. So, these value is 5.25, so, these value is 58 kilo Newton per meter square then after that it will remain constant because you are considering the critical depth concept. So, this is minus 14 meter and in between that here it is minus 9 meter. So, this is 58 kilo Newton per meter square this is also 58 kilo Newton per meter square ok. So, now, first will calculate the q u p q p u, so q p u that N q will be mentioned. So, sigma v into N q and N q value is 132 we are use in the last problem; that means, sigma bar is 58 and N q is 132.

So this is 7656 kilo Newton per meter square. So, now, Q p u is equal to pi 0.35 pi d square by 4 into 7656 that is equal to 736 kilo Newton ok. So, now, I calculate the friction part so, first the skin friction, so first f s 1 that I am calculating from 0 to 2 meter; 0 to 2 meter which is again half into 0 plus 34 k, k value is for this portion that will not change. So, k value is 1 delta is 22.5 here k value is 1.5 delta is 25.5 here k value is 2 and delta is 29.25.

So, your k value is 1 and this is tan 22.5 degree. So, these value is coming out to be 7.04 kilo Newton per meter square ok. So, similarly the f s 2 will be the average of this 2 that is 34 plus 48 and here it is 1, k value is 1 and tan is 22.5 degree. So, that value is that is f s 2 is 2 meter to 4 meter. So, that value is coming out to be for, so, this is your 22 and so, the final value I have the final value so this is the calculation. So, similarly from here I can calculate f s 1 is equal to f s 1 into A s this is the Q f 1 a s. So, A s is pi into 0.35 and f s 1 is 7.04 so, this is equal to 15.5 kilo Newton.

Similarly Q f 2 is f s 2 into sorry pi D and they will be L also this is 2 L is 2 because this is the pi pi D and L, L is 2 meter because this is 0 to 2 meter into the f s is 7.04 and f s 2 into A s that is pi into 0.35 pi D and L, L is 4 minus 2 and then into f s; f s is equal to this value is f s value is half 34 plus 48, k value is equal to 1 into tan 22.5 degree. So, that is equal to 37.3 kilo Newton so here I am just directly calculating the Q. In the previous problem at the end of the all calculation of f s I determine the Q f, here I am separately calculating the Q f.

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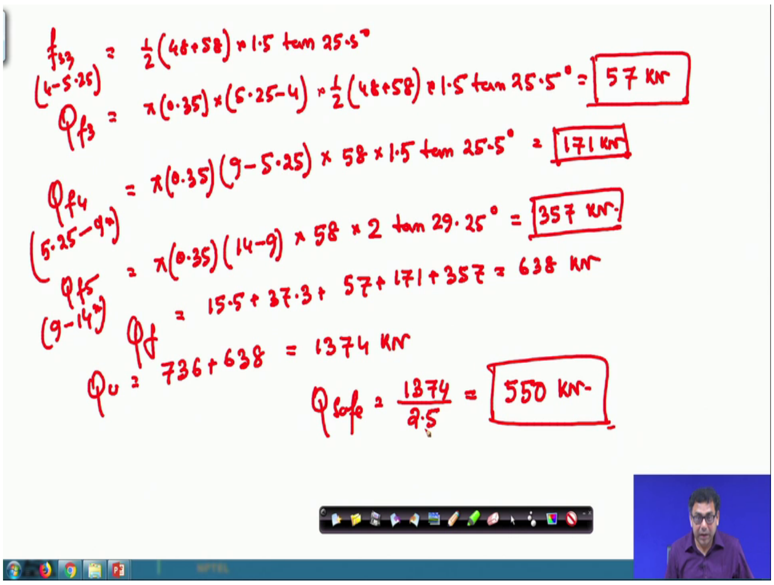

So, similarly the f s 3 that is from 4 meter to 5.25 meter. So, that is equal to 4 meter to 5.25 meter and here this value is 48 and 58. So, 48 plus 58 and here this k value is taken as 1.5 and tan value is taken as 25.5. So, now, if I calculate f a Q f 3, so, that is pi D L is here 5.25 minus 4 into this value so, into half 48 plus 58 into 1.5 into tan 25.5 degree. So, that is 57 kilo Newton ok.

Similarly I can write the Q f 4 that is from 5.25 to because the 5.25 to 9 because otherwise the stress is uniform, but up to 9 it is a one layer and beyond line there is another layer. So, we have to consider up to 9 so this is up to 9 meter. So, the value is pi D 0.35 L is 9 minus 5.25, then the this is value is uniform value because 58 is throughout this uniform. So, that stress is 58 and then k value is taken as 1 point k value is taken as 1.5 so that is 58 and k value is here k value is 1.5 and delta is 25.5.

So, k value is 1.5 and delta value is tan 25.5 degree. So, this is 171 kilo Newton ok. So, next one Q f 5 which is from 9 meter to 14 meter that is equal to again pi D L is 14 minus 9 into again uniform 58, but k value is 2 here, k value is 2 here and delta is 29.25

and delta is tan 29.25. So, that is equal to these value is coming out to be 357 kilo Newton ok. So, now, the final Q f is equal to 15.5, 37.3, 57, 171 and 357.

So, I can add these 15.5 plus 37.3 plus 57 plus 171 plus 357 that is equal to this value is equal to 3638 kilo Newton ok. So, now, Q u will be equal to 736 because this is 736, 736 plus 638. So, that is equal to 1374 kilo Newton and Q safe is 1374 divided by 2.5 that is equal to 550 kilo Newton. So, this is the load that pile can take if I consider the unit critical depth and this is the load pile can take if I consider if I do not consider the critical depth concept.

So, in the next part that I will start is I have solve the problem of pile in the mainly in the granular soil. So, and I have solve this problem for homogeneous sand as well as layer soil. So, in the next part I will start the load carrying capacity of pile in clay soil if the pile is in clay then what would be the load carrying capacity. So, this things I have discuss I finished that so, now pile is in clay.

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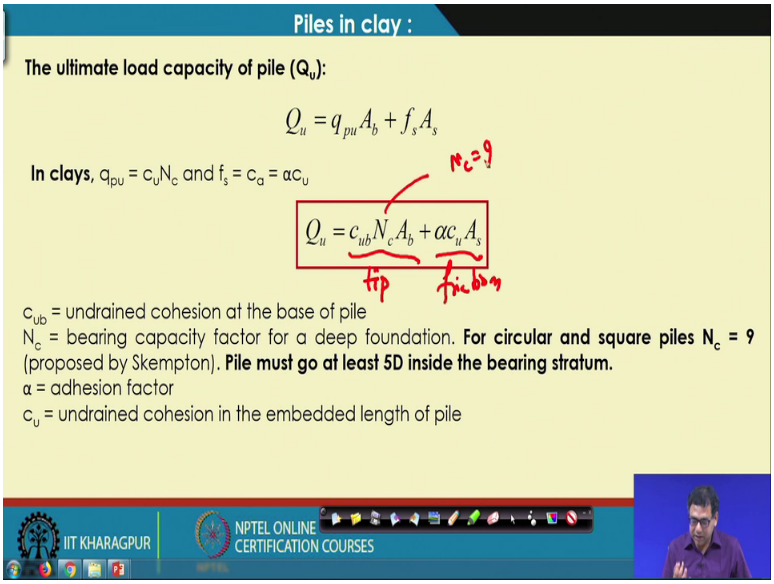

So, the same thing here also pile will get the resistance from the tip as well as the friction, but here the equation is slightly different that here so, the as the phi value is 0, so, the N gamma value will be 0, N q value will be 1.

So, that part we have neglected here. So, we have consider only Q N c, c u N c and the friction part. So that means, here this here it is the tip resistance and this is the friction ok. So, friction is alpha is the addition factor. So, nearly this N c value is taken as 9, c u value is the undrained cohesion, A b is the area of the base and alpha is the addition factor. So, how will I look and c u is the cohesion, A is the area of surface area of the pile.

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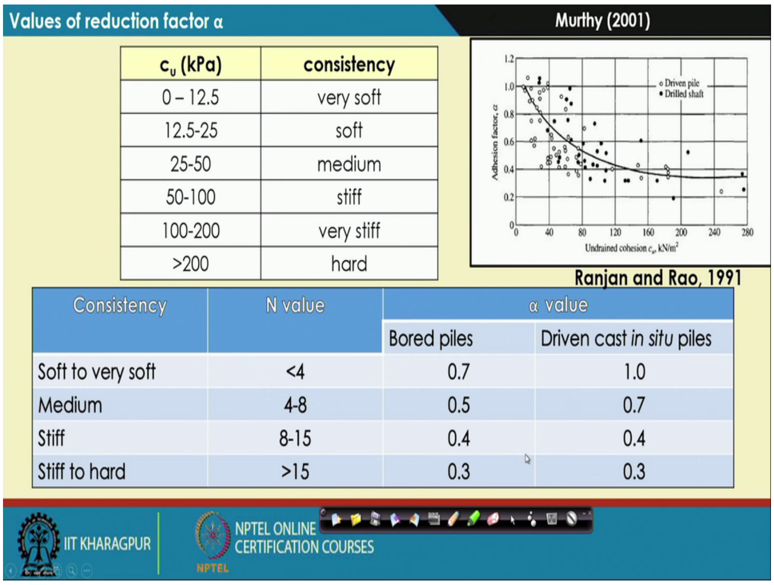

Now, how I will look calculate the addition factor? So, I will get the addition factor form these table that if the soil is up to very soft then the driven pile it is 1 medium it is 0.7, stiff it is 0.4 stiff to hard it is 0.3 and which based on the c u value also we can identify which soil soft, very soft medium stiff very stiff and hard and you have a graph also from here also will get the value of the addition factor if I know the cohesion value. So, in the next class I will solve the problem on pile in clay and then I will also discuss the IS code recommendation was IS code as mentioned how to calculate the load carrying capacity of the pile in clay.

Thank you.