Foundation Engineering
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Lecture – 55
Sheet Piles – IV

This class, in will discuss mainly the Sheet Pile in cohesive soil and then I will discuss about the cantilever sheet pile in cohesive as well as cohesion less soil. So, before I start that sheet pile in cohesive soil, so I have solved one example in the last class that sheet pile in a granular soil or phi soil.

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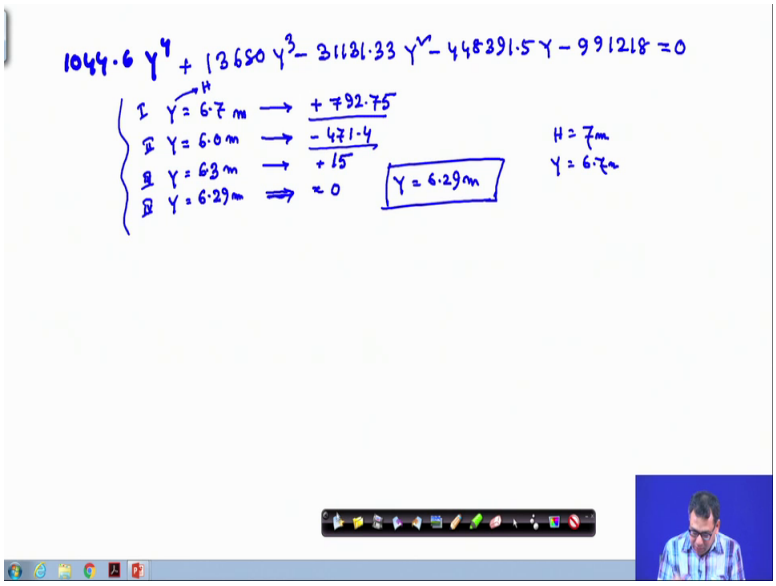

And ultimately I got that expression that final expression was 1044.6 y 4, then plus 13680 y cube minus 31131.33 y square minus 448391.5 y and minus 991218. So, it is a y to the power 4 equation, so ultimately I solve it through trial and error method. So, initially that I assume 6.7, so if I put y is equal to 6.7 in this expression, then ultimately this side should be equal to 0 ok. So, but if I put y equal to 6.7 meter then I am getting a value say plus 792.75, but which is greater than 0 and it is plus. So, what I did I reduce the y value in the second trial take 6 meter ok. This is the trial 1, this is trial 2 and I got a value in the left hand side is minus 471.4.

So, again it is minus we have to again increase the y value. So, in the third trial, I put y equal to 6.3 meter, and I got a value which is plus 15 which is a very close to 0. So,

ultimately in the fourth trial, but it is plus 15. So, we have to reduce it. So, fourth trial I take 6.29 meter, so which is giving me very close to 0, ok. So, that is why I put y equal to 6.29 meter. So, this is the value that I got through the trial and error method.

So, you also use a trial and error method if you have the y to the power 4 expression and if you have the square y to the power square expression, then you can solve it through the calculator. So, that is the way you can determine the y value from this equation ok. And one guideline that what should be the first value you have to choose for the trial and error method. So, my guideline you first choose for the first trial you choose y value is close to H because in our case the problem H value was 7 meter, ok.

So, that is why I put the y value first trial is 6.7 meter. So, for the first trial, you choose a y value which is close to H ok. Then, according to the values that is coming either plus or minus you have to either reduce it or increase it. So, next point that I want to discuss is that I have done the analysis considering that your sheet pile is rotating about the base of the about the about a point below the dredge level ok.

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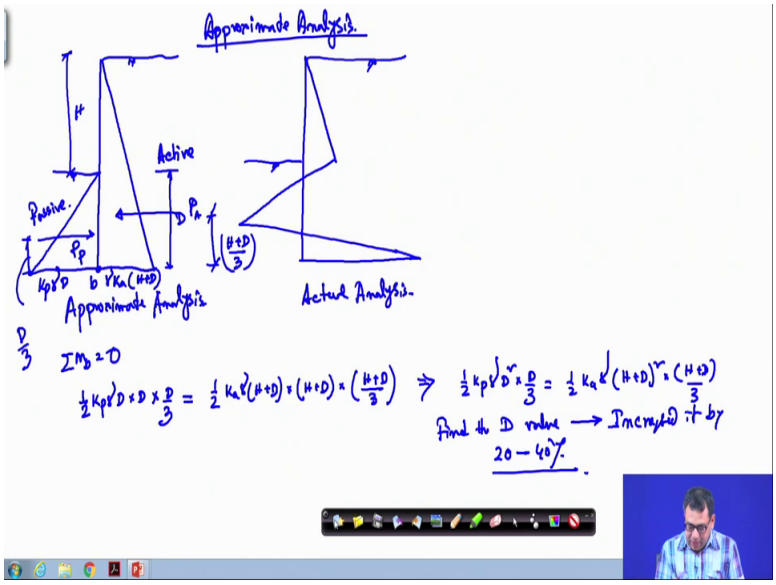

So, but you have seen that this analysis is very complicated ok. So, that is why a approximate analysis is also can be done, a analysis can be done that is what we are assuming that this totals this side is under active and this side is under passive condition. So, this is your cantilever sheet pile and for that a approximate analysis. This is can also be done. So, what is the assumption that here it is assumed that this side is active, this

total side is active and this side is passive. This is the approximate analysis actual analysis, the a net pressure diagram is something like this. So, this is our actual analysis.

So, to simplify this analysis, one approximate analysis is also suggested ok. So, this is the actual analysis and we have solved this earth pressure diagram, we got the equation and from there. We know how to calculate the y value, but here in this approximate analysis if this is the H and the total D is the depth of sheet pile, the instead of this active passive and a active passive part it is considered that this total side is active, this total side is passive.

Now, remember that this is an approximate analysis ok. So, and it is assumed that for this part you know this is the passive. So, it is K p gamma D and this side is gamma K a H plus D. So now, if it is a point say b, now for the summation of M b at a point b is 0. So, I can say that half into K p gamma D into D into this is this side is active force and this side is the passive force, P p active. So, I am just this total triangle is half into this base is K p gamma D and into the height which is D and then the lever arm from this point is D by 3. So, that will be equal to because both are acting in opposite direction. Again this is half into K a gamma H plus D into H plus D into H plus D divided by 3.

So, because this is acting the height of H plus D divided by 3 and this is D divided by 3 ok. So, finally, if I simplify this equation, this will be half K p gamma D square into D by 3 is equal to half K a gamma H plus D square into H plus D divided by 3. So, from he this equation only unknown is D ok, H is known. So, you get the D value from here, so find the D value then increase it by 20 to 40 percent, it by 20 to 40 or 30 percent ok.

So, this is the approximate analysis, but I would recommend to do the actual analysis that I have solved in the previous class ok. So, next thing that we will start is the Cantilever Sheet Pile in Cohesive Soil.

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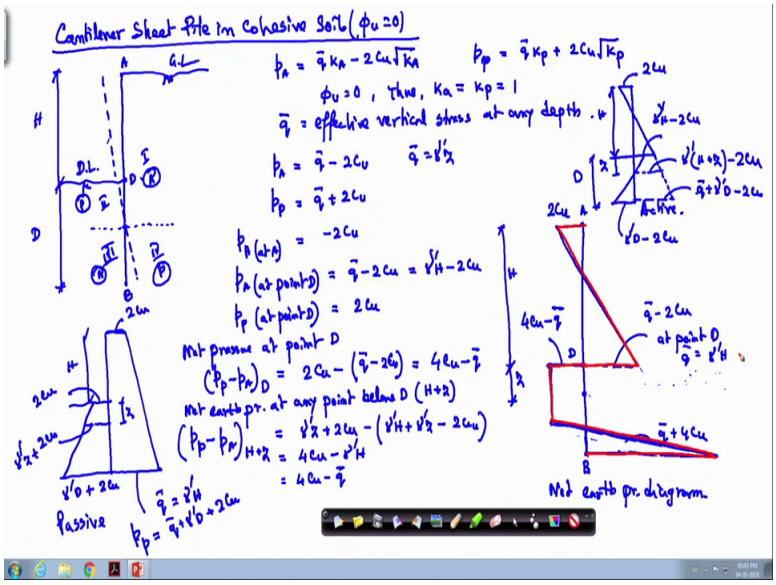

That is phi u is equal to 0. So, in the Cantilever Sheet Pile in Cohesive Soil; again it is assume that this is the gl, and this is the dredge level that your point of rotation will be any point below the dredge level and above the base of the wall.

So, again it has two I mean four parts ok. So that means, this is first region second region third region and this is third region and this is the fourth region. So, there will be active passive and this is active, this is passive again, this is active, this is passive ok. So, the same as the cantilever sheet pile in cohesion less soil, but the distribution is slightly different ok.

So, let us start for the C phi soil you know that p A expression is q bar K A minus 2 c u root K A ok. So, this is the general expression for the c phi soil now here that c u is equal to 0. Thus your ka is equal to K P is equal to 1 because your phi value is equal to 0. So, K P, K A is equal to 1 and the q bar is equal to effective vertical stress at any depth ok. So, if I have say this is A point, this point is D point and this point is the base B and this height of the sheet pile is H and depth of the sheet pile is D ok.

So, H is known D we have to determine and this soil parameters are also known. So, now, I can write that as K A is K P is equal to 1. So, p A at any point will be q bar minus 2 cu because your K A is 1. Similarly, I can write that p P is equal to. So, p P expression is equal to q bar K P plus 2 cu root K P ok. Now, K P is also 1. So, I can write q bar plus 2 c u ok. So, if I draw the net earth pressure diagram for this problem, so this is the

dredge level or D point ok, this is A point and this one is the B point ok. So, at A point, so up to this portion; that means, this portion is totally active above the dredge level.

So, I can draw this diagram is like this ok. So, at this is a active this side. So, p A at A point is equal to minus 2 cu because your q value is 0 ok. So, q bar is gamma bar into H ok. So, or Z, I should write this is z at any point. So, this is z. So, at point a z value is equal to 0. So, this will be minus 2 cu. So, this will be 2 cu ok. So, I can write a p A at point D at this point will be will be q bar minus 2 cu and q bar will be gamma dash H minus 2 cu. Gamma bar or gamma dash is consider if water table is present.

If water table is not there, so you can take gamma bar is equal to gamma and q prime can be written as q. So, this at point D. So, I can write that at point D this is the active pressure which is q bar minus 2 cu ok; q bar is written as gamma dash into H ok. Now, I can write that p P at point D; so p P at point D. So, p P is this portion is second portion is passive so, but initially if it is a cohesion less soil, then p P at point D would be 0, but here it would not be would not be 0 because here the cohesion is there.

So, at point D, the p P will be equal to because your q is 0 because here this is a no soil zone this is the soil. So, here it will start from this point. So, your q value is equal to 0. So, at point D, your passive stress will be 2 cu ok. So, this will be the 2 cu. So, I can write that this is active and the net pressure at point D that is p P minus p A at point D will be equal to p P is 2 cu, this will be 2 c u minus q bar minus 2 c u ok.

So, this will be ultimately 4 cu minus q bar. So, this is the net earth pressure and you can see that this is the net earth pressure. So, and it will shift from this side. So, this will shift from right side to left side at D point itself, because D point itself your passive earth pressure is greater than the active earth pressure, it may be depending on the your soil properties. So, I can draw the earth pressure net earth pressure at this is the value because this is the net earth pressure I am drawing, net earth pressure diagram.

So, I am drawing this value is 4 cu minus q bar ok. So, 4 cu minus q bar. Now, what I am doing? So, this is the net earth pressure at point D. Now, any point below D the net earth pressure, that net earth pressure at any point below D. So, under this condition say suppose that point is your H plus z ok. So, at any point, I want to determine what would be the earth pressure net earth pressure diagram. So, at any point p P minus p A, so, a

point say H plus z ok. So, what would be the value? So, if I take this is z, so for the passive this will be q bar in that case will be gamma dash into z plus 2 cu.

Then, minus q bar minus 2 cu, in that case the q bar will be gamma dash into H plus the additional gamma dash into H minus 2 cu because now I am calculating this portion the at point D, at point D, your q bar is equal to gamma dash into H ok, at point D because this is the value of H. Now, if I want to determine at any depth that this is the point here I want to determine what would be the earth pressure net earth pressure. So, this point is same H plus z. So, at this point if I extend this diagram or this value, this will be the value. So, this value again will be gamma dash H, then plus gamma dash z minus 2 cu ok.

And in this portion the net earth pressure will be gamma dash plus 2 cu. Now, if I draw, let me draw it for the in different portion ok. So, if I draw it in different diagram active passive in separate way. Suppose, if I drawing the active one here, this is active. So, this is say H. So, your diagram will be this is 2 cu and this one gamma dash H minus 2 cu ok. So, at a point z, this will be the diagram gamma dash H plus z minus 2 cu. So, this is a point say z. This is the active ok. Similarly, the passive will be. So, passive will start from the dredge level ok. So, this is H. So, passive will start from here like this and this value is 2 cu. So, this portion at a I at depth of z from the dredge level, this will be gamma dash z plus 2 cu.

So, the net earth pressure will be gamma dash z plus 2 cu minus gamma z H plus gamma z z minus 2 cu. So, finally, this gamma dash z will cancel out and this will be again 4 cu minus gamma dash H ok. So, that we are writing at 4 cu minus q bar. You remember that that your q bar here is gamma dash into H ok. So, at point D, this is 4 cu minus q bar at a point D plus or H plus z or at a point z distance below the D is also 4 cu minus q bar. So, that means, your earth pressure distribution is same in this region and it will remain same up to a certain distance.

It will not change, you can see this again also 4 cu minus q bar. But now, if I take now at point b net earth pressure, so it will again if I extend this one at point D you can see that at point D this value will be q bar plus gamma dash into D minus 2 cu. This is a active pressure diagram and passive pressure diagram, this value will be gamma dash into D

plus 2 cu ok. So, this is the passive pressure diagram, this is passive pressure diagram, this is the active pressure diagram.

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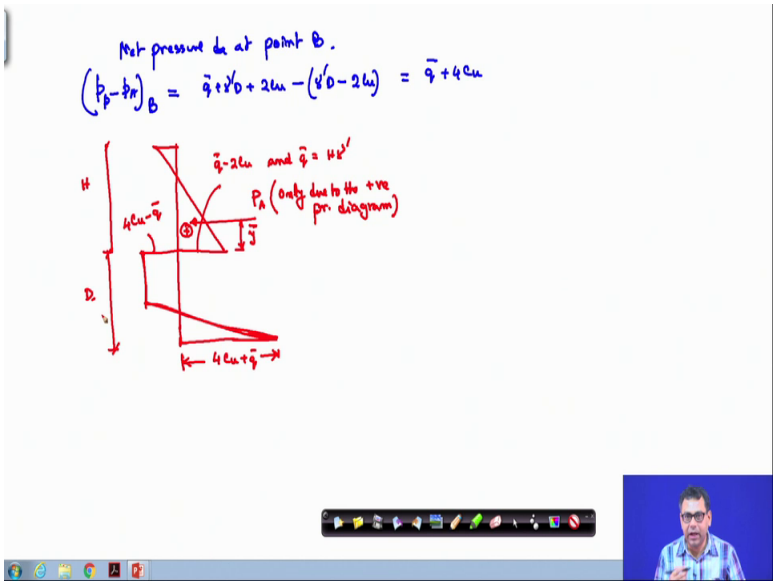

So now, at point B, if I draw the net pressure diagram, that net pressure the net pressure at point B; so what will be the net pressure, p P minus p A at point B that will be equal to the passive pressure value ok. So, this is the active pressure value and this is the passive pressure value. But here, at this point this is the zone 4 where this is the passive pressure ok. So, if I draw the passive pressure diagram here, so this is the passive pressure diagram for this side. So, this will be something like this is the passive pressure diagram.

And here also active pressure diagram will be something because this is a negative part. So, this is the active, this is passive. So, this side this will be 2 cu and this side, the passive p P will be q bar plus gamma dash D plus 2 cu ok. So, you can see in the B point your, it is passive; right side is passive, left side is active. So, instead of using the active in the left side, now it will change. So, this will be the passive. So, I can write that here the passive value is q bar plus gamma dash D plus 2 cu minus the active at this point B, point it is active and a active value will be gamma D.

Now, if I draw the active here, so the active value will be here. So, this will be the gamma dash D minus 2 cu ok. So, this is the passive diagram this is the active diagram. So, our case this base which is the fourth zone this base. So, this is this right side is passive and left side is active. So, the active at this point, the B point the active is gamma

D gamma a dash D minus 2 cu and the passive is q bar gamma dash D plus 2 cu. So, I can write this is also gamma dash D minus 2 cu ok. So, the net earth pressure will be q bar gamma dash D will cancel out plus 4 cu ok.

So, the final so that means, here it will continue up to certain distance, then this is the value which is because this side now passive. So, this is passive pressure will be more compared to the active. So, this value is gamma bar plus 4 cu. So, here to here it will change the direction ok. Actually, this will be something like this ok. This is the diagram. So, the final diagram will be that the net diagram is this is the active part then this is the net. So, this will be the diagram for this case ok. So, continue a sheet pile in cohesive soil, this is the diagram where q bar remember that gamma dash into H ok.

And depending upon your water table position, this gamma dash value can change ok. Sometime, above the water table it will be gamma below the water table it will be gamma dash gamma dash is this effective unit weight of the soil or in terms of you can say below the water table it will be the gamma sum ok. So, finally, we will get a distribution is this is the final distribution ok. So, this is the D value that we have to determine, this is the H value which is known ok.

And so, we are taking the p A, this is the active earth pressure and remember that as I have mention, we will not consider this negative part. So, we will consider only the positive part during the calculation of p A. So, calculation of p A only due to the positive pressure diagram ok. So, p A will consider only this positive triangle not the negative one and then you will find that this value say y bar and y bar will be the this height and this value is your this value is coming out to be this is gamma bar minus 2 cu ok. So, this will be our q bar minus 2 cu and q bar is H gamma dash and this value is 4 cu minus q bar and this one is 4 cu plus q bar and q bar is H into gamma dash. So, 4 cu plus q bar, this is 4 cu minus q bar.

So, this is the total pressure diagram. And in the next class, I will solve that from this diagram how I can get this D value, so that, I will show in the next class.

Thank you.