Foundation Engineering
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Lecture - 52
Retaining Wall - V and Sheet Piles – I

So, this class I will discuss about few things those are related to a Retaining Wall design. So, in the last class I have discussed that how to check the bearing capacity of the retaining wall and how to check the no tension condition.

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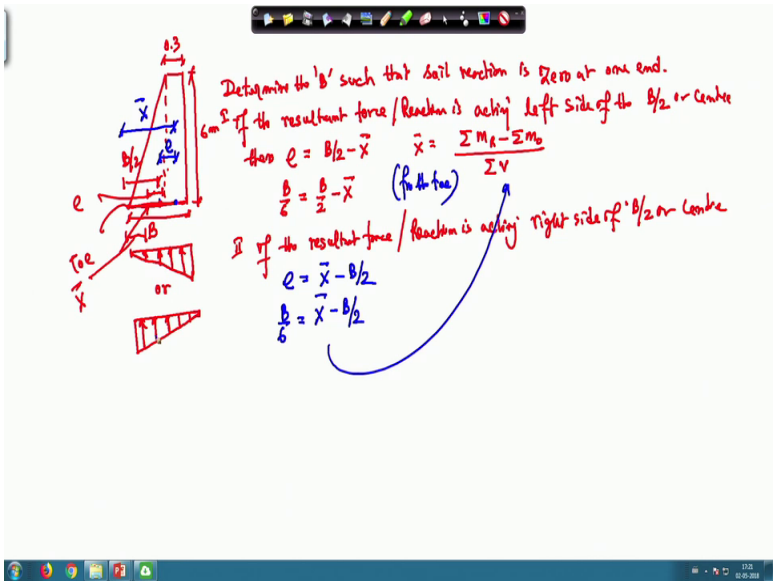

But, sometimes in your problems you will find that it may be ask that, suppose if this is your retaining wall. It may be ask that what would be the B value such that there will not be any tension in the retaining wall base or your stress in one end is exactly 0.

So that means you have to determine the B, such that soil reaction is exactly zero at one end ok. So that means, you have a soil reaction value is like this. So, what you have to do in that case that we know, but we do not know the B value. We know this value say 0.3, this h value is also known 6 meter. The unit weight of concrete, unit weight of soil all are known, but we do not know the B value. So, in that case so, there is a possibility that this weight can if this is the center line or this is the base.

And it can act this side of the center line or this side of this center line. That means, you are say resultant force or the all the resultant force. So, as I mentioned that your resultant force may act any side of this wall or depending upon that which side the resultant force will act your distribution may change. Your distribution will be either this one or it may like this also depending upon which side the load is acting ok.

So, now if your load is this is B, this is your toe you are taking the moment from the toe. If the resultant force or the reaction is acting left side of the B by 2 or center ok. So, this is your B by 2 if your x or resultant force is acting like this ok. So that means, this is your X bar, then your e will be this will be the e in that case ok. This will be the e, e will be B by 2 minus X bar.

And X bar how we will calculate? X bar will all the resisting moment minus the overturning moment divided by the all the vertical forces. And, as it is exactly 0 so, e value will be B by 6, this is B by 2 minus X bar. So, in this equation you put you calculate all the resisting moment; you calculate all the overturning moment all the vertical force, but only unknown will be the B in terms of B this part will be in terms of B. You put this in this expression then only unknown will be the B you to calculate the B value. So, that is one part.

Now, if the resultant force or the reaction is acting right side of the B by 2 or centered; that means, it is acting here ok. And X bar is from here to here you are calculating. So, in that case so, this will be your e because this is the center. So, this will be your e in that case. This red one is the case 1, blue one is the case 2. So, in that case your e value will be X bar minus B by 2. Because, this is X bar is from the toe; this is always from the toe and this is minus B by 2.

So, again the X bar e will be the B by c exactly 0 X bar minus B by 2, X bar we will get from here the same way. So, this may be the one type of problem because, I have discussed by knowing the I have discussed or solve the problems by knowing the B value you know the B value. But, if the B value is unknown then you can get the B value such that there should not be any tension at the base of the soil or the base of the retaining wall or it is exactly 0. Either this one or this one depending upon which direction your resultant forces or the reaction is acting.

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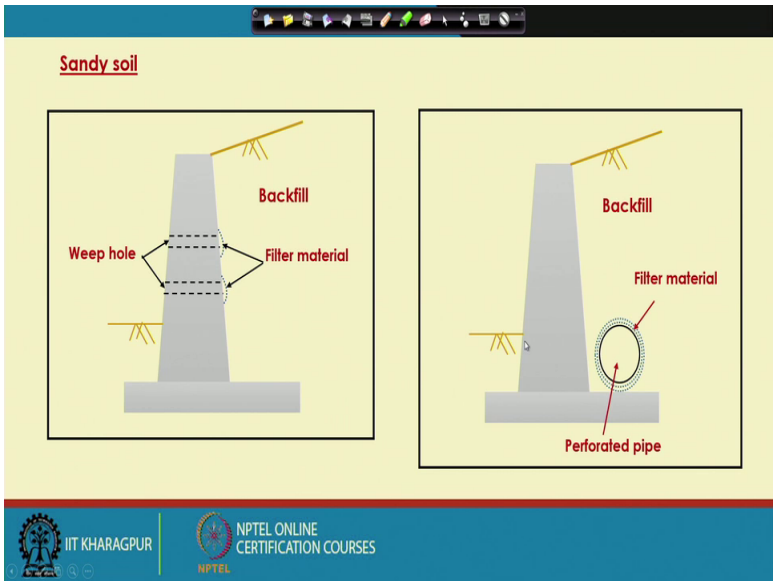

So, the next one discuss that what is the weep hole, let the how to minimize the water effect in the backfill. The suppose the problem is that if we have the water in the backfill then that water pressure will also act on the retaining wall. So, as you have noticed that during the earth pressure calculations water pressure is usual. And, we will not apply any artificial coefficient also in the water pressure water pressure calculation that value is 1.

So, that is why in the in case of soil if we have the water pressure then that your pressure of the force acting on the retaining wall will increase. So, you have to minimize the water table effect. So, preferably we use the sandy soil because, here the permeability is more. So, your water can easily pass from that place. And the general cohesion cohesive soil you do not recommend, but sometimes if it is not possible to avoid the cohesive soil also you need to provide some drainage path.

So, that this water can easily pass through that drainage path and can remove from that side so that your pressure acting on the retaining wall can be reduced. So, this way this is the weep hole by which we can provide the weep hole, we can remove the water ok. This is the hole which is provided in the retaining wall, it is backfill is sandy soil. So, that will give you the water will pass through this one.

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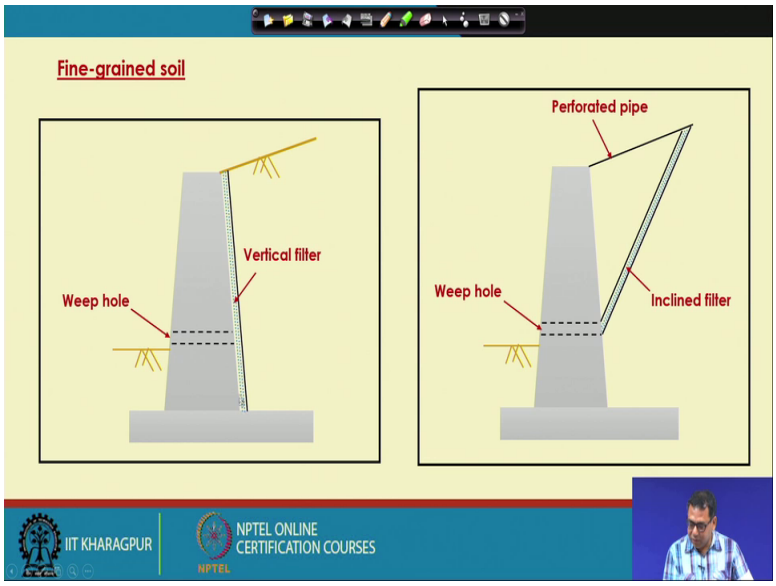

And here we can provide a filter material. Similarly, this is another kind of drainage path. This is a perforated pipe which is passing this perpendicular to this plane and it is passing throughout the retaining wall. So, the water can enter here and it can pass through this pipe. Then we can provide the vertical filter also on the wall and that if it is a fine grained soil.

These two are for the coarse grained soil, if it is fine grain soil you can provide the vertical filter and the as well as the weep hole. And, we can provide some additional inclined filter; so, that water can pass to this filter and can enter into weep hole and can pass from this side. So, these are the drainage procedures.

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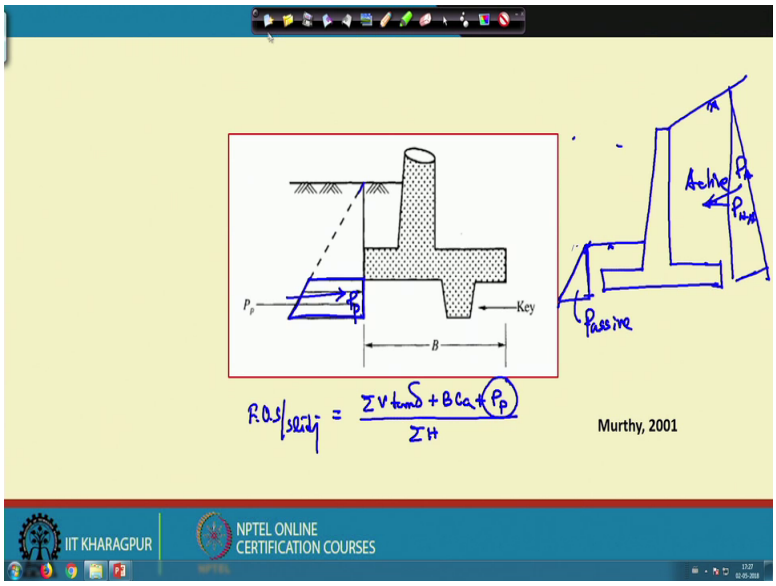

And, the next one that I want to discuss that as I mentioned during our design of a retaining wall we are not considering the passive part. Because, our retaining wall if you see that a retaining wall part that this is the retaining wall. So, this may be the backfill, this is the below foundation. So, this part is passive zone this portion, here it is active pressure ok. This active pressure is acting fine, but here the passive pressure is acting in it. So, this is the passive pressure is acting, if it is a retaining our sandy soil then this is the passive pressure that will act.

So, this is the passive pressure. This pressure is the passive because, your wall is move in this direction so, this is the active side. So, this is the passive side, but we are not considering this passive pressure, but sometimes if your design is unsafe against sliding. So, what we will provide some shear key ok, this is called key. So, in such case we provide this passive resistance also because, these shear key this is the passive resistance. So, we provide to calculate this portion of the force and then we add these things with the with your passive resistance part.

So, with the sliding bearing capacity calculation; so if this is your passive force P p. So, then the factor of safety against sliding will be summation of all vertical forces into tan delta plus this B into C a if the cohesion is there plus P p. This P p is the passive resistance divided by summation of all horizontal force or generally the act of P active force ok.

This active force which is acting ok, the horizontal component of this P active force P H A. So, in that case this passive resistance we introduced during our design of the key and we design the out determine the factor of safety ok. But, again when you design these passive or calculate this passive force we reduce the phi value and if it is c phi value then both phi and c values are reduced, because, it is doubtful that the full passive condition will be developed under this situation.

So, as it is doubtful so, it is recommended you reduce the c and phi value during that design. But, this is the design procedure for with the key ok. So, next one that I will start is the sheet pile ok.

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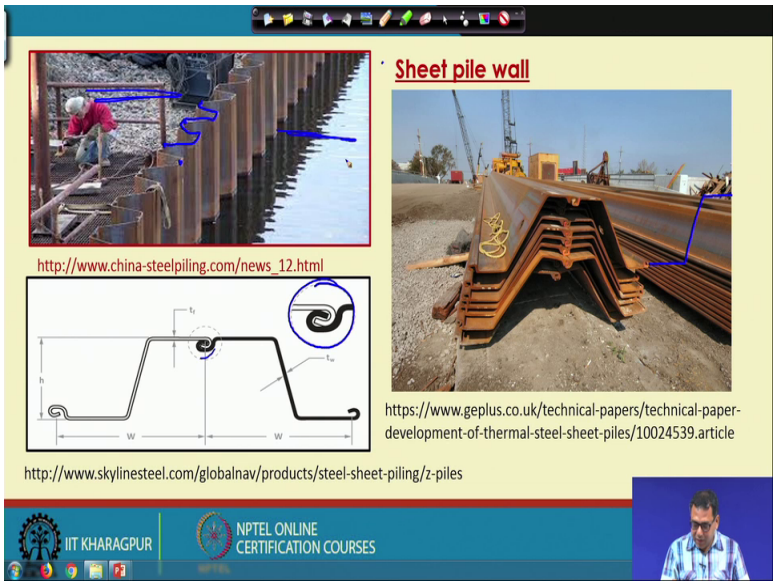

So, sheet pile is another type of flex retaining structure. So, what is the basic difference between the sheet pile and the retaining wall? So, in the retaining wall that we have designed till now, these are a rigid type of retaining wall. So, the wall weight or the wall rigidity will resist the force that we got acting on the on the retaining wall. But, sheet pile is a flexible type of retaining structure and it is generally temporary kinds of kind of retaining structure. So, what is sheet pile?

So, sheet pile is this is the one particular this steel sheet pile section. So, these are attached in this form and ultimately it is installed in this fashion ok. So, it is this one there is a junction ok, it is a junction here also there is a junction, here also. So, this is

one panel then there is junction, another panel there is a junction. So, this is the same way, this is one panel you can see this is one panel, this is another panel.

So, it is this is the junction point between the two panel. So, this is one panel and then similarly another panel will come here ok. So, this is the sheet pile and it is installed here. So, you can see this side of the sheet pile is the backfill and this side is either water body or it is void. So, this is the retaining kind of retaining wall.

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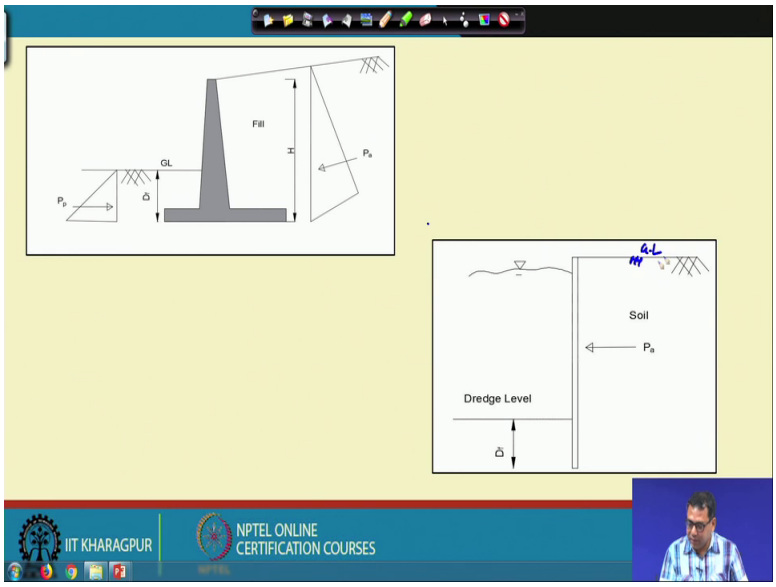

And then what is the basic difference of the sheet pile and the retaining wall. As I mentioned in the sheet pile generally we do not consider the P p. If you consider the P p, then this P p will give you the additional resistance and you can add it during your stability check as I have discussed during the key design.

So, but the retaining wall here passive resistance we do not consider. So, the active force is taken by the wall itself. So, this wall is rigid. So, that wall will take this active force and as I have designed these things during our two cases: one is gravity retaining wall design and one is cantilever retaining wall design. So, I have shown that how we will design this retaining wall, but the sheet pile is a flexible kind of retaining structure.

So, here this wall we will not consider this we will consider it is weightless during the design. We will not consider the weight of the retaining wall. So, now who will take give you the resistance? So, in the case of sheet pile the resistance will be given by the soil.

So, here we have to consider the passive part also, otherwise we will not get any resistance from anywhere. Because, here in the in the normal renewal design we are taking the weight of the soil.

Or we are taking the weight of the wall during the stability checks ok, during stability checks, overturning over the sliding. But, here we are not considering the weight of the wall because, these are very thin you can see this thickness are very small. So, that is why we will not consider the weight of this steel section. So, but the resistance the passive resistance that we are getting from the soil based on that we have to design this sheet pile.

So, the depth of the sheet pile here D f will be much higher as compared to the depth of the retaining wall. So, this depth of the sheet pile is much higher as compared to the depth of the retaining wall, because, this soil below the dredge level or the sheet pile base will give you the resistance. Now, what is dredge level? And, what is this; this is your ground level. Dredge level means, if from this picture you can see this picture. So, here you can see this side is backfill and this side, if it is wide then the base of this portion is called the dredge level ok.

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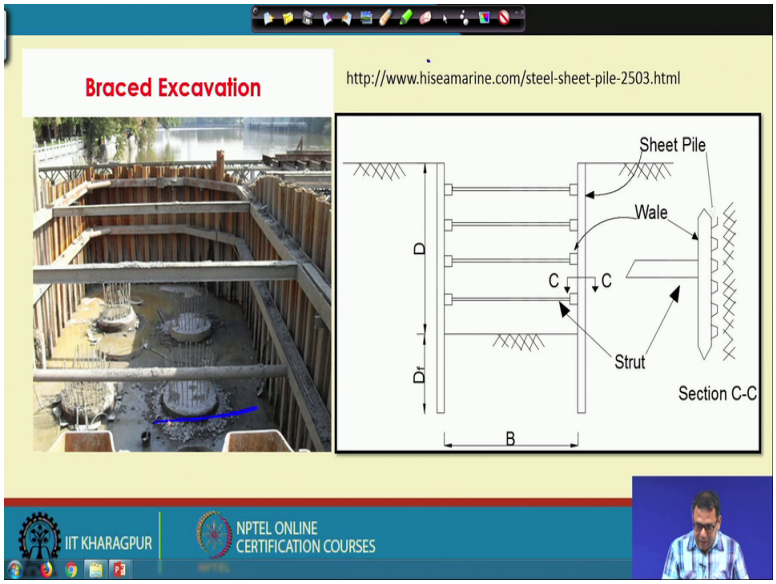

This is the base of this wide portion. So, that is called the dredge level. So, this is the similar another kind of retaining structure I will discuss later on, but here if this is the

sheet pile these are the sheet pile, this is the dredge level. This base portion is called this is the dredge level; so I if I draw this part.

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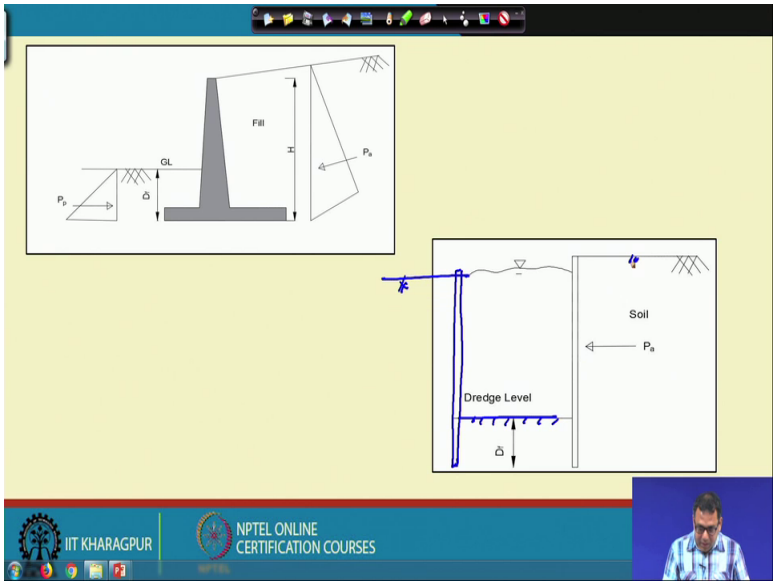

So, this is the wall, this is the dredge level. Now, if we have another wall in this side and then this is another soil. So, this portion is because this portion is wide either it is water is bodies there or this portion of soil is been excavated. So, this is called the dredge level and this is the ground level. Now, this sheet piles can be two types ok.

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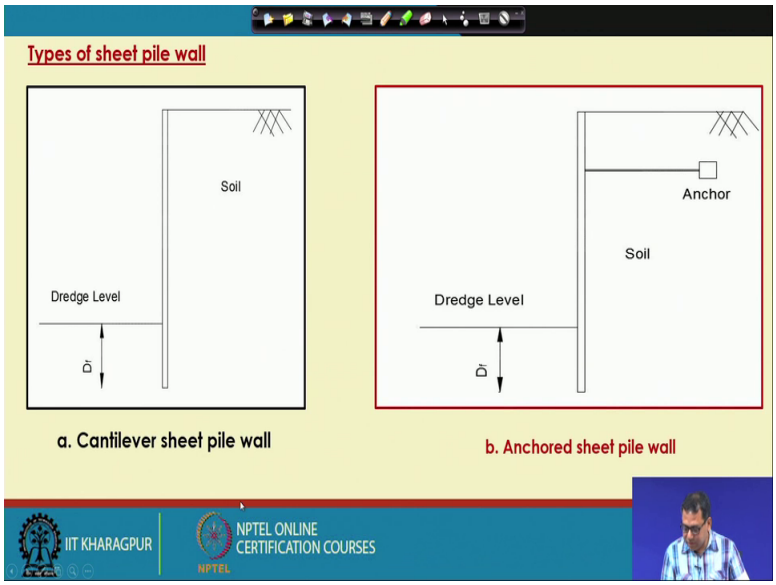

One is the cantilever sheet pile, another one is the anchored sheet pile. Now, what is cantilever sheet pile? This cantilever sheet pile where is inserted into the soil. But, in the anchored sheet pile this portion or the top portion of the sheet pile is anchored into the soil.

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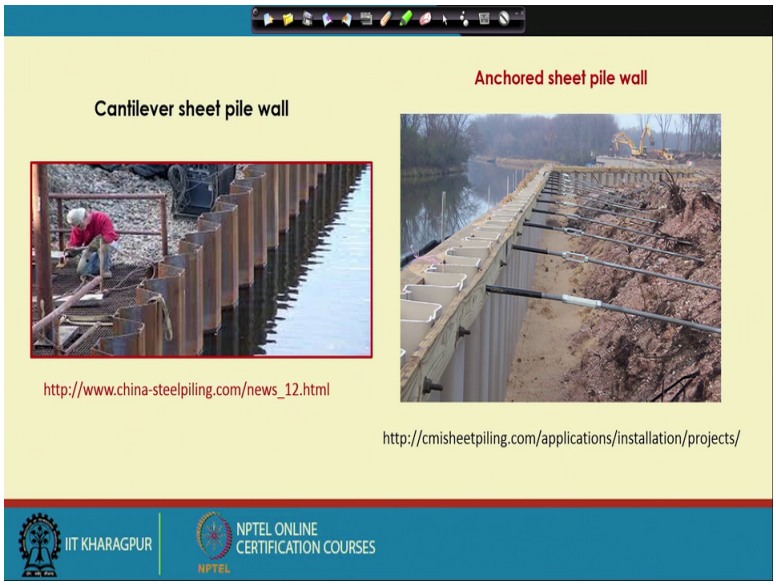

So, you can see this is the cantilever sheet pile, example of the cantilever sheet pile. This is the example of the can anchored sheet pile. You can see this top portion of this sheet pile is anchored into the soil. So, what is the advantage of that because, within the normal sheet pile as I have mentioned that most of the resistance is coming from the passive resistance that the soil is given below the dredge level. So, you if cantilever sheet pile the height of the sheet pile or the depth of the sheet pile below the dredge level is very high.

So, to reduce that we can anchored this one such that we can provide tension force already in this direction or the anchored force in direction, so that this depth will be reduced. So, now if this height of this sheet pile or this wide portion is very high then also we can provide this anchorage. So, first I will discuss about the cantilever sheet pile and then I will discuss about the anchored sheet pile.

I will discuss this cantilever sheet pile both for sea soil as well as the phi soil and the anchored sheet pile for the sea soil as well as the phi soil. So, this is the cantilever sheet

pile and the anchored sheet pile. So, first I will discuss about the cantilever sheet pile in granular soil or the phi soil, granular soil or phi soil where c is equal to 0.

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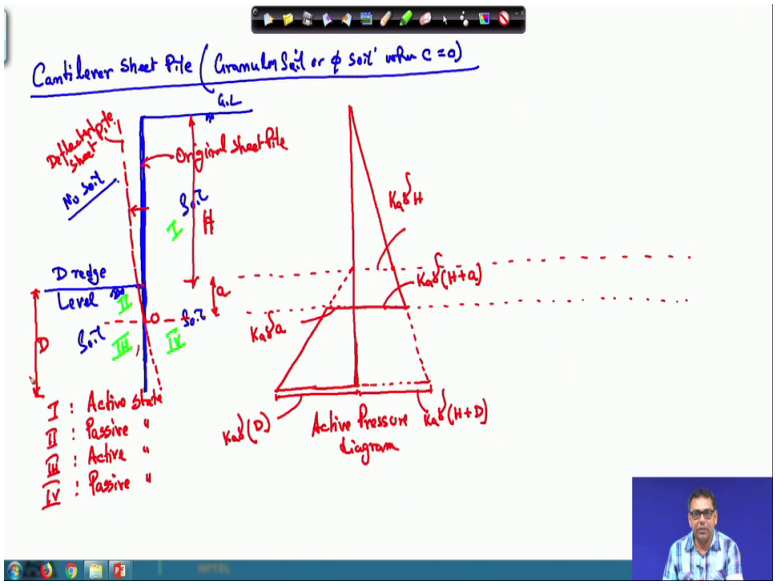

So, this is my sheet pile and we are representing the sheet pile it a with a single line ok; as we are not considering the weight of the sheet pile. This is the ground level and this is the dredge level. So, this portion is void and this portion is the soil. So, soil is here, soil is here and definitely soil is here also. So, these are the different so, this portion is the void, either water is there or there is no soil there is no soil.

Now, when this soil will apply the pressure on this wall? So, this will try to rotate. So, we are assuming that this is rotating like this ok. So, it will rotate about a point say O below the dredge level. So, it will rotate about a point O, but I do not know the position of this O that I will determine. So, now you this is rotating about a point O below the dredge level. So, this is the deflected sheet pile and this is the original sheet pile. So, now as I mentioned this total portion is soil and this is also soil. So, I can divide this portion in four parts ok.

So, what is those four parts? So, this is the part I, this is part II, this is part III and this is part IV. So, I have divided this portion of soil these four parts because, all are soil the same soil are divided four parts. So, I can write that my part I this will be either active or passive. Now, what is that part? So, it here you can see if you remove this lower portion

of the O, then if the upper portion is all soil here the wall is deflected in this direction ok. So that means it is away from the backfill.

So, from this portion it is away from the backfill. So, my part I is in active state all active condition. Now, the part II or the region II; so region II is this portion of the wall it will deflect towards the soil. So, it is towards the backfill. So, part II will be the passive state or passive condition ok, then the part III. So, part III again this is the soil. So, it is moving away from the backfill ok. So, in the part III it is moving away from the backfill from this side to this side.

So, from if I consider only this part III soil then this retaining wall in this part III region is moving away from the backfill. So, this will be the active state. Now, if I consider the fourth region. So, in this region only the fourth region this retaining wall is moving towards the soil. So, this will be the passive state ok. So, we have four state of a retaining wall cantilever retaining wall or four region for a cantilever retaining sheet pile if it is in phi soil.

So, we have assume the rotation is about a point O below the dredge level. So, we have four parts or four region. So, region I is active condition, region II is the passive condition, region III is again the active condition and region IV is again the passive condition. Now, what I will do? I will draw the active pressure diagram, passive pressure diagram and the net pressure diagram separately. So, this is the dredge level. This is the point about which the wall rotates ok.

So, I am just taking this portion. So, I am increasing this part also fine. So, my up to this point it is because, this soil up to the dredge level the soil the up to the dredge level soil is only one side this side right hand side, left hand side there is no soil. So, the right hand side will be the active condition ok. So, this is the active condition in the right hand side and as I mentioned up to this stage I or the state I or the region I it is active condition.

So, up to here it is active condition then the active state will start from this portion is also active condition ok. So, this is the active pressure diagram. So, this is the active pressure diagram fine because, this is the region I. So, this is the region I which is total active and region III this is also active. So, region III is active condition and region I is active condition. And, region I is the stress diagram will start from the top. And, region II or the

III the stress diagram will start from that dredge level because, this is no soil. So, I will start from this portion only. So, this is the stress diagram.

So, I can write this portion you see if this is K a is the coefficient of active earth pressure K a gamma H, if this is the H ok. And, if you this portion is a and this is the depth of the sheet pile is D. So, I can write this portion diagram this value is K a into gamma H plus a because, this is the a part, this is the H part. So, up to here this value is K a gamma H and this portion this value is K a gamma H plus a because, this is this point.

Similarly, here I can write that this value is gamma K a into H plus D and here this is the active part. So, this portion also I can write this is K a gamma into a because, this is here this starts from 0. So, this will be K a gamma into a and this one will be K a gamma into D the total one is D. So, I can write this is the active pressure diagram ok.

So, in the next class what I will do that I will draw the passive pressure diagram and then I will draw the net pressure diagram, then I will do the analysis.

Thank you.