Application of soil mechanics
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Lecture – 22

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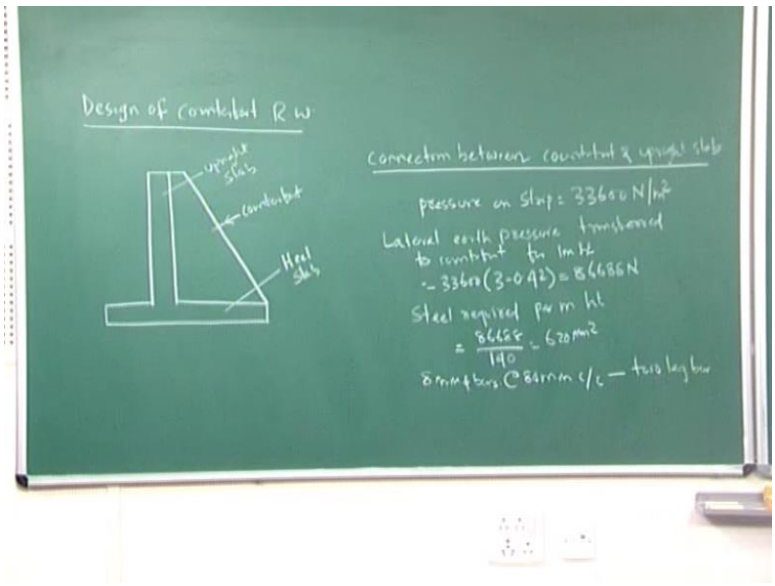

Now last class we have purist, last two class design of this counter fort retaining walls, where continuing with this, design of counter fort retaining wall. In this part, we have finish this for a particular counter fort retaining wall, the height was given; we have finished this first step one is your dimension; step two stability analysis; step three structural design part of your ((Refer Time: 00:53)) as well as counter fort wall. Now we are going to do this connection between this counter fort and (refer time: 01:00) the upright slabs.

If this is my counter fort wall, this is your retaining wall, and in this retaining wall counter fort, these are the counter fort, counter fort has been connected between your upright slab. If this called upright slab, between upright slab and counter fort and heel slab and counter fort. Now how this connection has to be made, that design part we left it and as well as your drawings. So now connection between counter fort and upright slab, so consider the bottom of one meter deep strip of upright slab, we consider the bottom the one meter deep of these strips, so the pressure on the strip, we have calculated earlier 33600 Newton per meter square. Lateral earth pressure

transferred to the counter fort for one meter height lateral earth pressure transferred to counter fort for one meter height, which is equal to 33600 into three minus 0.42, it comes out to be 866 88 Newton. So steel required per meter height, is about 866 88 by stress in steel is your 140, it comes about 620 mm square. So you can take eight mm phi bars at a spacing you can take it as a eighty mm center to centre.

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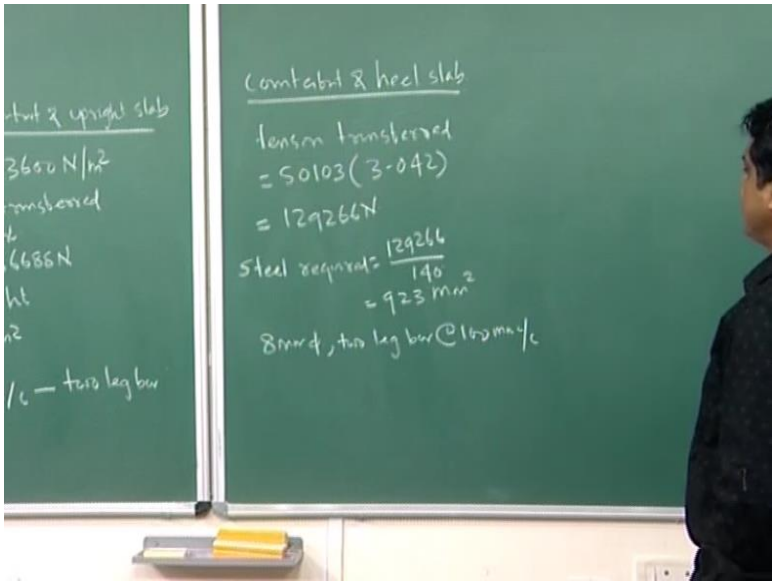

Now similarly connection between counter fort and slab, counter fort and heel slab. So tension transferred in 1 meter width of the counter fort near the heel slab end, how much tension transferred ah in one meter width of counter fort near the heel slab, it comes about to be 501033 minus 0.42, which is equal to 129266 Newton. So steel required which is equal to 129266 by 140; this about 923 mm square. We can consider 8 mm phi 2 legged, it is a two leg bar. In this case also 8 mm phi, 2 leg bar at a spacing of hundred mm centre to centre.

Now the question was, once this structural design part is over, how this counter fort has been connected to your upright slab as well as how this counter fort has been connected to your heel slab. The connection, the steel required for the connection that means your phi bar, about eight mm phi bar in case of counter fort and upright slab, 80 mm center to center to it is a two leg. Similarly, for 80 mm phi bar ah for counter fort and heel slab spacing hundred mm centre to centre, it is again a two-leg bar.

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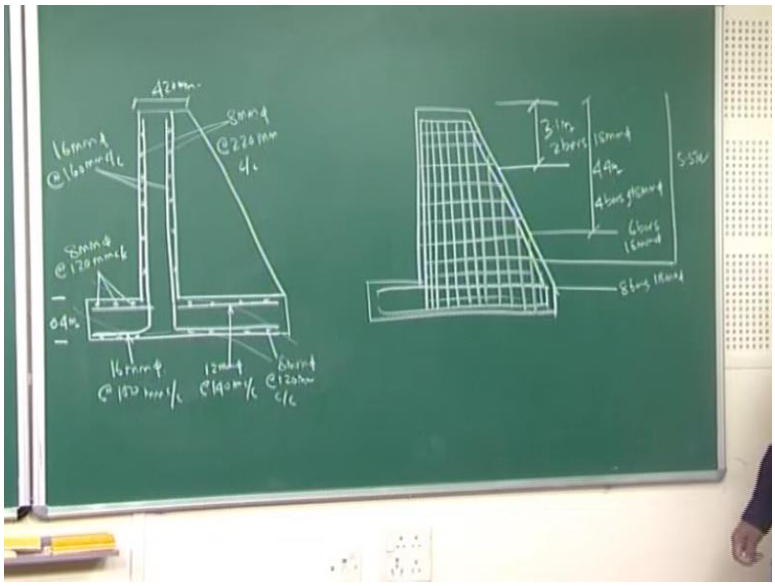

If I draw simple, now if draw the how this drawing looks like if we look at this bars to be connected, now these way this drawing has to be provided. So this comes out to be, this dimension is your this dimension is your like the same dimension. This is your the centre dimension for this, this is your 420 mm. And this about your 0.4 meter, so now if I am writing it, you have to show this which is main bar, which is shear reinforcement bar, this is your 16 mm phi, at the rate 100 mm centre to centre. And this part is your 12 mm phi at the rate 140 mm centre to centre, and this your eight mm phi at the rate 120 mm centre to centre.

And this also all the bars, in which is your main, which is your shear reinforcement, you have to show it very clearly, 8 mm phi bar at the rate 120 mm centre to centre. And these two are main reinforcement that means this is your sixteen mm phi at the rate 116 mm centre to centre. And these also these are all your shear reinforcement, 8 mm phi at the rate 220 mm centre to centre. This is your cross sectional elevation midway between the counter fort.

If this will continue, this retaining wall will continue in this way, if it will continue in this way, like this, it is every you can say that every three meter interval, your counter fort is there. This cross sectional has been taken, where this counter fort wall is there, and this reinforcement bar has been shown. If you look at here, in this case, these two are is your main reinforcement, this is your sixteen mm phi bar at the rate of 16 mm centre to centre. These are all your shear

distribution, this is your 80 mm phi bar at the rate of 220 mm centre to centre, they have also calculate. In this case, this one is your reinforcement, because if the plate like this, the pressure will be more at this and pressure will be less. In this case, the pressure in the vertical will be more, and it will be deflected in this way that is why this is the main reinforcement in this case.

In this case, this part is your main reinforcement. At it can be extended, it can be extended at the both the ends, so these main reinforcement for those slab, it is about 16 mm phi at the rate hundred mm centre to centre. For heel slab, this is about 12 mm phi bar at the rate hundred forty mm centre to centre; rest is your, these are all is your shear reinforcement, these are all your shear reinforcement. Then this bars alternative bars has been extended here, it can be put it, as I additional bars, both the sides, so that (( )) or may be additional instead of providing additional sd bar, these bar may be extended here and here, so that it can be adjusted.

Now if I take cross sectional elevation, how it looks, I just put it this bar then I can show this, how this curtailment has been made, curtailment can be made. If you look at here, as I have calculated, as I said earlier, how this curtailment has been made. I can say that up to 3.1 meter, 3.1 meter, so it will be 2 bars 18 mm phi, this is for counter fort. Then up to 4.4 meter, this will be four bars at the 4 bars of eighteen mm phi diameter. Then up to your 6 point you can say that 5.5 meter, this will be 6 bars, 18 mm phi. So at this case, this will be your eight bars, eighteen mm phi.

If you look at these 2 parts, one is your cross-sectional view of cross sectional elevation view of this where this counter fort is passing. Then you make it this counter fort, so from there, we say that this is my main reinforcement, this is my shear reinforcement for toe slab, this is my main reinforcement, this is the shear reinforcement. Similarly, this is the main reinforcement, this is the shear reinforcement. Now if I come back to counter fort, there are total eight bars required. In this case, if you look at here, every section there is a curtailments of bar. So here we have already calculated in 3.1 meter, there are only two bars at the top. Then at 4.4 meter, there are around only four bars of 18 mm phi. At 5.5 meter, there are only 6 bars of eighteen mm phi. At the bottom, that means 6.1, there are 8 bars of 18 mm phi.

So once you show this two diagrams, after the design, this field engineer, they can understand that that means whatever bar they are going to provide, how they are going to curtail and how

many number of bars, they are supposed to cut, it will be clearly failed out. So this completes your design of your counter fort retaining wall as well as cantilever retaining wall, so we have followed this design into three steps. Just for a quick review, we have followed into a three steps.

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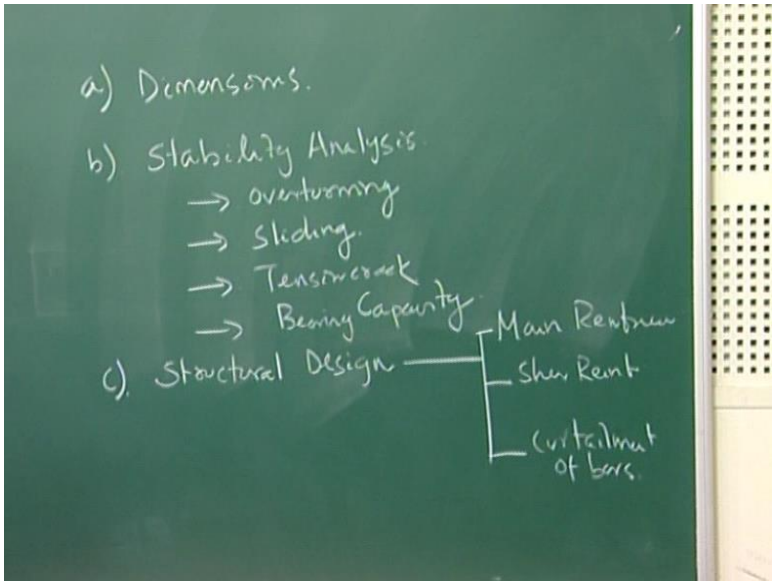

First one is your dimensions, tentative dimensions you start with this tentative dimensions. Then with this tentative dimensions, check this stability analysis. Stability analysis there are four, one is your overturning, second is your sliding, third is your tension crack, bearing capacity. Then third part is your structural design. So there are three parts, three steps we followed generally in design of cantilever as well counter fort retaining wall. First one is your tentative dimensions. So there are set of dimensions, with tentative dimensions, then you check this stability analysis, stability analysis there are four parts of stability analysis. One is your over turning moment, second is your sliding, tension crack and bearing capacity; each stability analysis is that means if it is stubble, this stubble with respect to your assumed value of tentative dimensions. That means there is no change in tentative dimensions. If this stability value is not coming, then maybe you can your tentative dimensions or maybe try to put shear keep sliding value is less than 1.5. Step one and step two has been satisfied then we go for a structural design, basic structural design.

So we provide shear reinforcement, main reinforcement, also we can say that in these structural design we show that main reinforcement then shear reinforcement as well as your curtailment of

bars, so main reinforcement, shear reinforcement and curtailment of bars. So once this structural design over this complete design of cantilever as well as counter fort retaining walls, so once this design is over, will have to show this sectional view, how this steels are going. Where is your main reinforcement, where is your shear reinforcement as well as I said in the earlier also previous diagram, you can show that curtailment of bar at what distance from the top, and what are the number of bars to be curtail. It may be alternative bar, it may be quarterly bar, what are the bars to be curtails. Then this finish your complete design of your cantilever as well as counter fort retaining walls.

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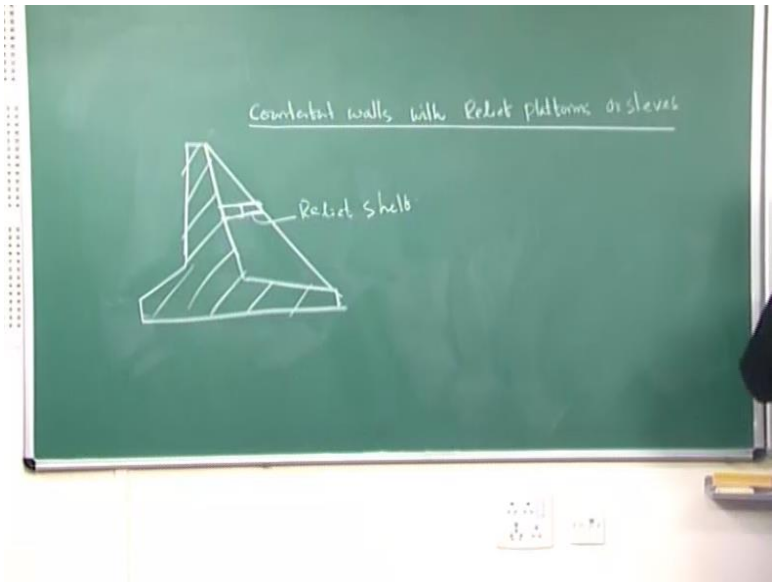

Now start with one more thing, most important part in this cantilever and counter fort, that is a new thing. So sometimes this counter fort wall we provide counter fort walls with relief platforms or it call sleeves, counter fort walls with relief platforms. So sometimes what happen in this counter fort retaining wall, the stability analysis may not satisfied; even if within this permissible value of your tentative dimensions. So the moment you provide your relief platforms or sleeves, it becomes more stable. It becomes more stable.

If I draw it, how it looks the cross sectional part of this, how this counter fort retaining wall with relief sleeves, how it looks. With this, this is my you can say this is the I can make it, this is the typical counter fort retaining wall. With these counter fort retaining wall, generally every cross

section, every in the sectional view at regular intervals we provide relief valves, relief slabs, or relief shelf. We provide this relief shelf. What is the use of this relief shelf. This relief platforms are sleeves once you provide, it says that it will be more stable. How far it is going to change your earth pressure distribution diagram, we will see it.

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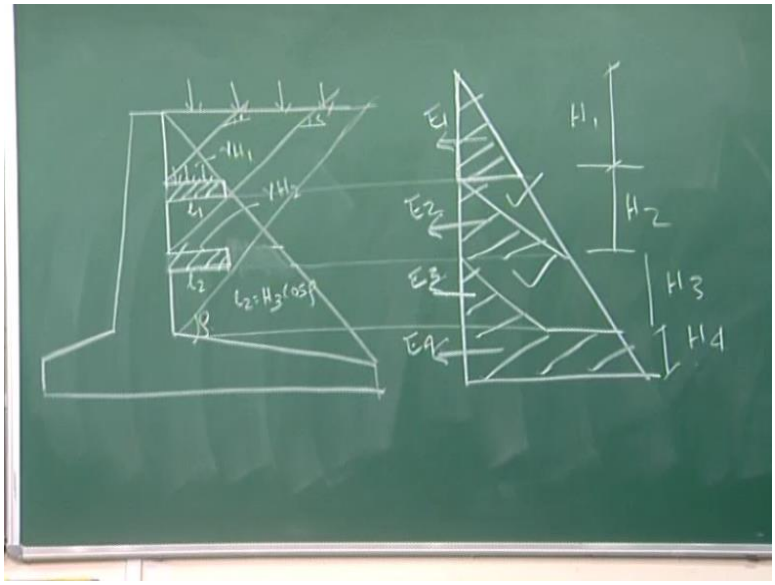

Now let me draw, a bigger picture of your counter fort retaining wall. So if I see this, that means relief platforms are sleeves has to be provided at regular interval. These are all your relief sleeves or relief platforms has been provided. So what exactly going to happen, so this suppose this length is l one and this is l 2, so if I draw here, this will retain the soil mass of gamma one, gamma H one, and this will retain the soil mass of gamma H two. And let us say above this there are also surcharge, acting on this surcharge. If I make the extension of this, let it be rho, so l 2 comes out to be H 3 cos rho, then you can find it out l one, l two all the value you can find it out. These also comes out to be rho, these also comes out to be rho.

Now if I draw the pressure distribution diagram, earth pressure distribution diagram, without providing relief shelf for cantilever retaining walls, a counter fort retaining walls, this is my earth pressure distribution diagram. The moment you provide your relief walls, what will happen, this is the value of E 1, this is the value of E 2, this is the value of E 3, and this is the value of E 4.

And let us say this part is your H 1 and this to be H 2 this to be H 3, this to be H four – height H 4.

So if you look at this complete picture, this figure without any relief platforms or sleeves, how without in relief platforms, this is my relief platforms or sleeves at alternate means at regular interval we provide it. If there is no relief platform or sleeves, what will happen, what is your pressure distribution diagram. The pressure distribution diagram will be complete triangular, so it will come there. The moment you apply relief platforms or sleeves, the pressure distribution diagram, it will be like this. You see, this is how much pressure has been reduced, earth pressure coming to this retaining wall has been reduced.

Without relief platforms or sleeves, the pressure distribution diagram is your triangular. The moment you are provide your sleeves or relief platforms that means up to this height say H one, this height is H 1 and this height is your H 2, and this is your H 3 and this is your H four. For H 1, entire soil mass whatever the weight coming, it will be taken by your relief sleeves or relief platforms. So that means your earth pressure for case is your E 1. Below this relief platform from here to here, these part of soil will take, so earth pressure instead of starting from here, it will start from this l 1 and it will go there. This is your reduction of earth pressure distribution diagram; in this case, because of your relief platforms or sleeves.

So then what will happen, for there you take individual cases, like height H one, what is your earth pressure; height is 2, what is your earth pressure; height is 3, what is your earth pressure; height is 4, what is your earth pressure. For all together, for four heights, you find it out your earth pressure, so these part of the earth pressure will be it will used in this case, so the height you can increase, by providing relief platforms or sleeves. The height of this counter fort retaining wall can be increased, so you can also go for whatever height for counter fort retaining wall without relief sleeves, it will be 1.5 times more than providing your relief sleeves or relief platforms or sleeves.

So this is a new development. Generally earlier days, try for cantilever walls; if it is not stable, then go for counter fort wall; if it is not stable, then go for counter fort retaining wall with relief platforms. And this design is same. This relief platform only provided to reduce your earth pressure, at rest design is same. And check this stability analysis, by taking your tentative

dimensions then once the dimensions has to be satisfied, stability analysis has to be satisfied that means the dimension is. Then after the dimension is ok, then you go for your structural design. While doing the structural design, you consider for a modified value, even if your over turning moment, modified value of your earth pressure. Earlier this pressure is complete triangular, in this case, earth pressure will be reduced. So modified value of earth pressure will have to consider for subsequent design point of view.

Other part of this stability analysis about your tentative dimensions, structural design is same. This relief sleeves or shelf or the relief platforms, it is only to provide to reduce your earth pressure, nothing else. It will only to reduce the earth pressure, so that you can increase this height of the wall or maybe the counter fort retaining walls are more stable. I will stop it here, I can start my next lecture in a new topic there.

Thanks a lot.