Application of Soil Mechanics
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Lecture – 20

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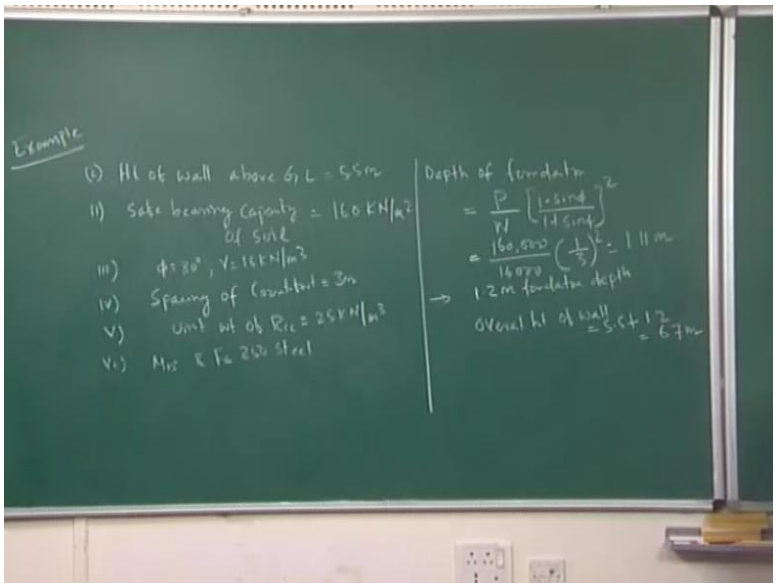

Now, we will solve a example problems about this design of counterfort retaining wall. Now look at this example, it is given design of counterfort retaining wall for this following even by particulars first one is given height of wall above ground level which is equal to five point five meter, then safe bearing capacity of soil safe bearing capacity of soil is given hundred sixteen kilo newton per meter square phi value is given phi is equal to thirty degree, and unit weight of soiled is given sixteen kilo newton per meter q spacing of counterfort spacing of counterfort counterfort about three meter three meter, and r c c unit weight unit weight of r c c or unit weight of r c c, which is equal to twenty five kilo newton for meter q, and huge m fifteen grade concrete, and f e two fifty still. As I said earlier, now this is typical example problem will have to designing counter for detaining all no dimension as to given dimension has to be taken derived, then you are stability analysis, then you are it is given height of wall about ground level is five point five meter; that means, ground label to above is five point five meter.

And the soil below the ground label it is bearing capacity is given 160 kilometer per square phi, and gamma of the retaining soil retaining soil is given, and spacing of

counterfort wall is about three meter, and unit weight of r c c reinforce concrete twenty five kilo newton per meter q, and it has been the plant to use m fifteen grade of concrete, and two fifty steel mile steel two fifty or designing this counterfort retaining wall.

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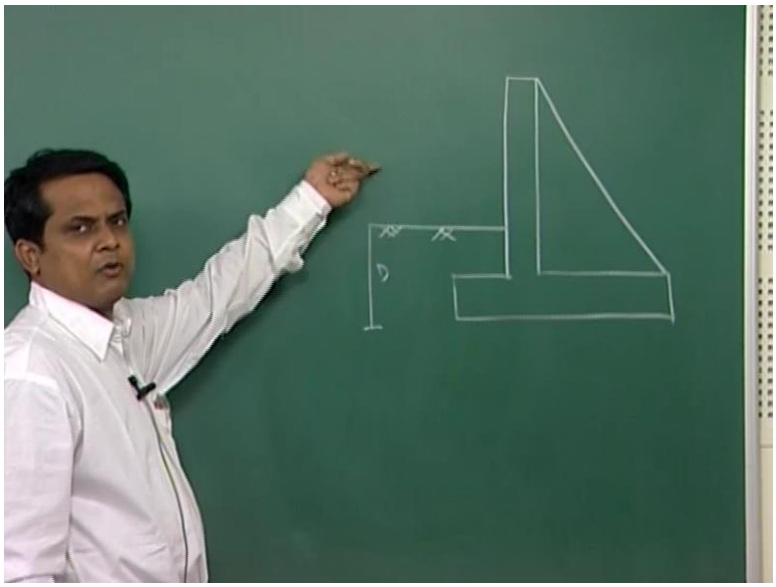

Now, first step is wall has to be if I take this retaining wall like this, if I go for this counterfort wall like this what will happen you will have to consider some depth as a depth of the foundation as a depth foundation these depth of the foundation generally provided about one to two meter either you can assume or you can this depth foundation you can find it out from these depth of foundation you can get it p by w in to one minus sin phi by one plus sin phi whole square where is you are p is your safe bearing capacity of soil soil pressure in these case, and it is coming about one sixty thousand divided by over w g over unit to weight of soil waste on that.

It is coming about sixteen thousand into one third whole square which is coming about one point one one meter. So, let us take let us take about foundation on depth is equal to one point two meter foundation depth than once you are taking this foundation depth is equal to one point five meter, then overall height below the above the ground surface overall height of wall overall height of wall overall height of the wall is equal to five point five plus one point two which is equal to six point seven meter. If you look at here is given height of wall a for ground level the ground level is here. Because retaining wall cannot stand above the ground level you have to makes you are that there is the some

foundation depth retaining wall has is put it below the ground level. So, these height is given about point five. So, these depth of the foundation is we have take care one point two. So, overall height of wall is coming about six point seven meter, now base of the wall

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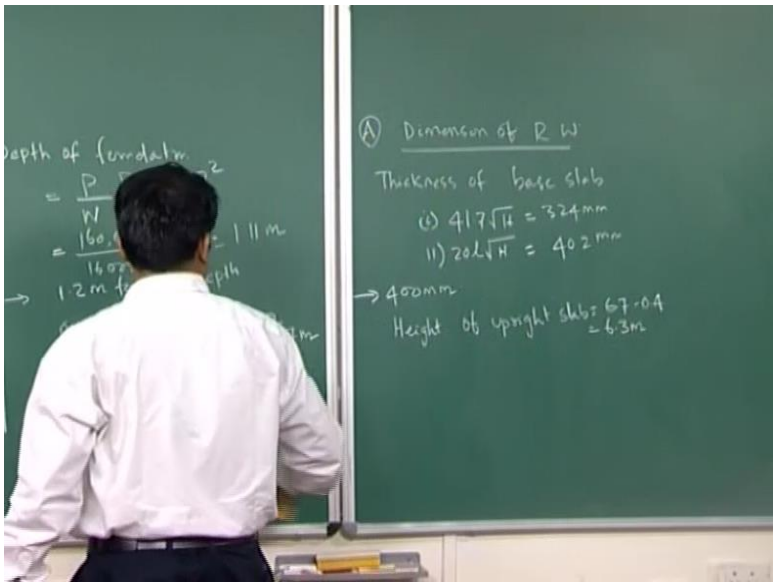

Now, the dimension this overall height is depth of the foundation is over, but one is you are dimension of retaining wall dimension of the retaining wall in this dimension of retaining wall first find it out you are thickness of base slab. I have said earlier for counterfort involve forty one point seven rot for up h it soon not be that, and twenty l rot for up h, and it is coming about to three twenty four m m, and this coming about to be four zero two m m. So, this thickness of base slab not lower, then this. So, now, you can take higher value of let us provide thickness of base slab say four hundred m m four hundred m m. So, now, we actual height of operate slab up right slab this is your operate slab thickness of base slab. So, we have four hundred mm; that means, zero point four meter now this up right slab for up right slap actual height. Height up right slab height of upright slab is equal to six point seven minus zero point four which is equal to six point three meter three meter. So, this height is above coming six point three meter now depth is coming about depth of the foundation it is coming about is equal to one two meter now will have to find it out particularly for your upright slabs in case of upright slab what is you are intensity in up right slab per up right.

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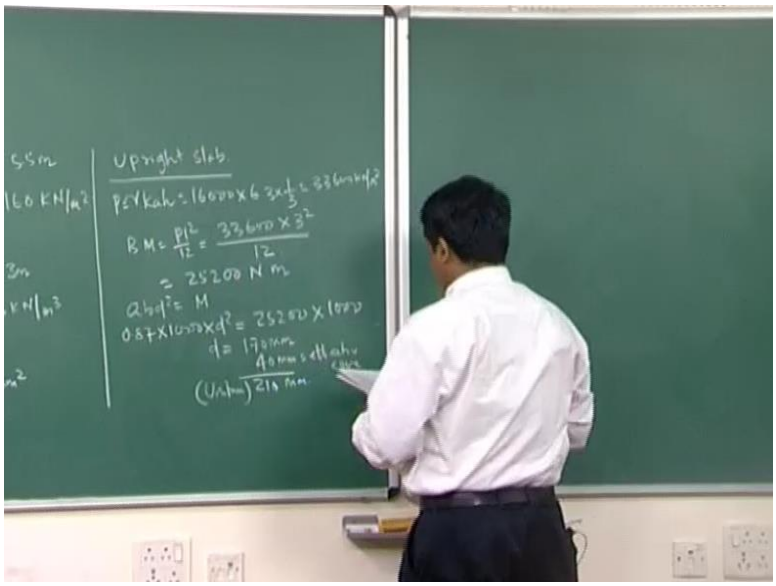

Slab what is you are pressure intensity pressure intensity is equal to gamma k a h, which is coming about sixteen thousand in to six point three in to one third this is coming about thirty three thousand six hundred kilo newton per meter square. Now maximum bending movement coming about to be maximum bending movement, which is equal to w l square by two l or p l square by two l p g or pressure intensity p is equal to pressure intensity maximum bending movement is equal to pl square by two l form they are we can find it out p is equal to three three six thousand into three square by two l, and these comes out to be two five two zero zero newton meter.

So, once you get maximum bending movement, then what you are what you can suppose to get it you can find it out you are area of steel these might steel for m fifteen grade concrete the permissible stress concrete c is equal to I just said earlier it is equal to five newton for m m square per per per m fifteen grade concrete, then might steel apple to two fifty steel permits stress in steel t is equal to hundred forty newton per m m per square best on these if I equate maximum bending movement two area of steel this would become out to be.

If can either equate maximum bending movement area of steel or maximum bending movement you are q b a q b square, because you have to find it out. This thickness also we got it thickness now you have to find it out thickness of upright slap had be best. So, from this q b d square which is equal to maximum bending movement q for m fifteen,

and two fifty steel it is zero point eight seven b into one thousand into d square which is equal to two fifty two hundred into one thousand. So, d is equal to hundred seventy m m now if I am using effect it cover of forty m m this is you are effect if cover.

Then it comes out to be two hundred ten m m. Now let us say thickness of upright slab two hundred ten m m two hundred ten m m, you can keep this thickness of this upright slab either you can these wave or you can keep it continuous throughout from top to bottom this thickness will be same there is no baring in thickness. So, in this case you have considering the thickness uniformly throughout; that means, uniform throughout this thickness we are considering the this this about two hundred ten m m, then then after getting the these thickness means up your upright slap of the base it comes out the two hundred m m. Then thickness of you are base slab zero point four m meter or four hundred m m now best with these has to be comma out to end these two have to become out, then will you go for your stability analysis.

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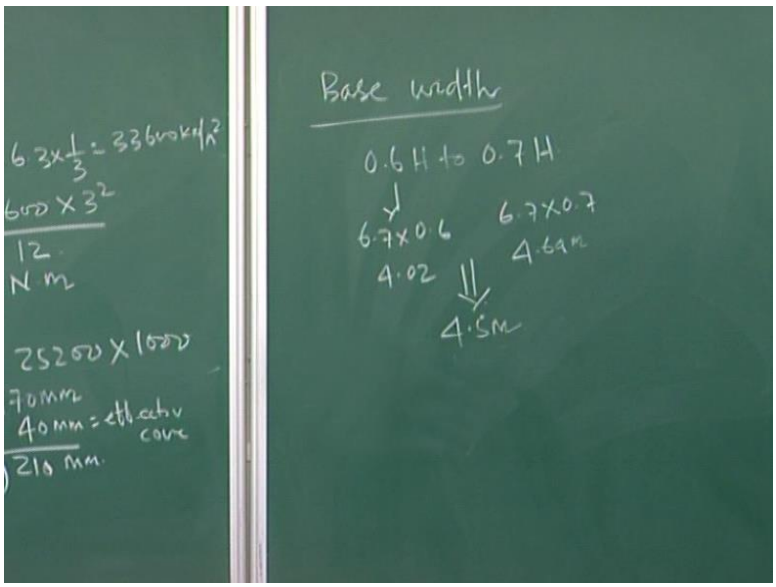

Next part which your base width generally baring from zero point six eight to zero point seven h. So, if I take total height h is equal to five point five height it is this height operative slab is you are height is there. So, if I am taking in to this is coming about to be six point seven in to zero point six six point seven in to zero point six, and this is your six point seven in to zero point seven it comes out to be four point zero two, and four point six nine meter. Let us provide let us provide these base width is four point five meter. So,

base width is comes out to be four point five meter if you look at here this base width base width generally zero point six zero point seven times of total height of this retaining wall. So, total height, if I am taking it is point seven five point five plus one point two this is a coming about to be six point seven six point seven in to zero point six six point seven in to zero point seven this base width you can take it return four point zero two two four point six nine meter either it. You can take four point zero three four point three four point five four point six just I put it any value written this four point five meter base width now next part your toe projection toe projection means how much it will provide projected this is my retaining wall, and this is you are toe, and and these is heel, and this part will call heel slab, and this is you are up right this is you are upright slab this part you are this part enter part moving toward this this is upright slab now how much you are toe has to projected beyond this retaining of soil mass. So, these toe project comes out to be. It says that one fourth one fourth of b one fourth of b, and this values here b. So, this comes out to be one point one meter. So, you can provide either one point one or you can provided now one meter let us provide this toe projection of one meter toe projection of one meter now if I provide this toe projection of one meter; that means, these dimension is almost over dimension is almost over. Let us make a how the dimension it look completely retaining wall.

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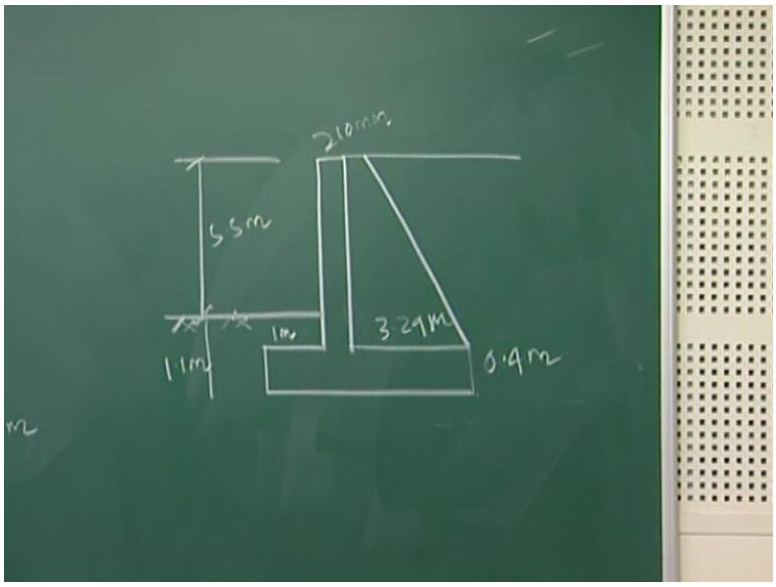

So, in a stage of you are dimension analysis one point one meter, and this is about to be this is about one meter, and this is your two hundred ten m m, and this is you are zero

point four meter, and this is you are three point two nine meter. So, with this with this this is your dimension, and now with these dimension will check ability analysis if this stability analysis satisfied four factor safety one is your factor safety other you are factor safety again sliding, and is would you are authenticity should is less, then equal to b y six, and bearing capacity; that means, the dimension are if this stability analysis is e pt c not satisfied either you modify the dimension or if can go for some remedy.

So, we can check this now this stability analysis calculation of this forces we can check how it is how it is coming about means total resisting force, and driving forces all as to be calculated, then once you calculated, then you can go for here movement, and pressure of the base all this things. Now if I name it this is w two this is w one w one w two if can name it w three also this part is your six point three this part your w three now start what one by one w one is your what is your w one w one is your weight of this operate slab from here to here. So, that means unit weight what is the width zero point two one into six point three six point three six point three this to this height is six point three in to unit weight of concrete is twenty five thousand which comes out to be which coma's out to be three three zero seven five kilo newton. So, this is a vertical force, because this is verticals down what by self weight this is vertical down what similarly you can find it out w two w two is your weight of base slab w two is your weight of base slab which is about to this is this weight is you are four point five meter this.

So, w two is equal to four point five into zero point four in to twenty five thousand which is coming about to be forty five thousand, and this is we can vertical. If I am putting is this symbols, and this symbol this means acting literal in that direction, then third part is w three w three is equal to three point two nine in to six point three into sixteen thousand if you look at here three point two nine is the this width, and this height is you are six point three with this counterfort soil has to retain. So, soil is again this is verticals sixteen thousand, and which is coming about to be thee three one six three two again this is verticals. Then fourth are that is k a gamma by two which is equal to one third sixteen thousand in to six point seven whole square by two then. So, they are, then movement you can find it out from this movement this is your pressure, then movement you can find it out k a gamma h q by six which is equal to one third in to sixteen thousand into six point seven whole q by six. So, now, this is the verticals force.

This is your lateral obtained by these direction. So, this are about your force, now if you

can find it out lever are lever are means this force acted how far from two or how far from you are heel. So, in these case from this toe this w n is coming about to be one point one zero five. So,, because it is one meter, and zero point two one by to. So, this is coming about one point one zero five, and w two is your it is state it it is half it is coming about your two point two five, and w three is coming about two point eight five five eight, and at a distance six point seven by three. So, then after that you find it out you are clock wise movement, and anti clockwise movement you find it out you are two movements clockwise movement, and anti clockwise movement about you are toe.

If you look at this how this clockwise movement all verticals forces this will give a clockwise movement laterals this will anti clockwise movement; that means, if you write is clockwise movement anti clockwise movement, and from this you can find it out this clockwise movement all the top on w one it is coming about three six Five four seven point eight, and this is coming about one zero one two five zero point zero, and w three is coming about nine four six eight zero nine point three six. So, and anti clock movement is becoming two six seven three four five. So, this comes out to be one zero eight four six zero seven point two. So, now, net movement you can find it out net movement is equal to clockwise movement minus anti clockwise movement which is coming about to be eight one seven two six two point two four newton meter.

Now, we can check you can find it out you can find it out this is the force r obtain. So, how far from you are c g how far from you are c g you can find out e. So, first find it x bar distance of your x bar from the toe, which is equal to m by v total movement resisting as well as clockwise as well as anti clockwise, and total vertical forces it is coming about to be eight one seven two six two point two four by four zero nine seven zero seven which is equal to one point nine nine, and e is equal to e is equal to b by two minus x bar which is equal to zero point two six.

So, b by six is equal to zero point seven five; that means, e is equal to less than b by six it means there is no tension crack one stability criteria has been satisfied, we find it out what is would be less, then b by six; that means, there is no tension crack; that means, there is no tension crack below the base of slab that is what you mean by tension crack one there is a tension crack there is a gap between soil, and the wall. So, there is no gap between soil, and wall. So, similarly again sliding you can check from these factor safety again slide it is coming about four point zero, which is I just live it for you than sorry

factor safety again slide it is coming about one point seven one one. If can assume is equal to between concrete, and soil is equal to zero point five you can assume this concrete, and soil is equal to zero point five. So, one point seven seven one now which is which is greater, then greater, then you are one point five. So, and and you are factor safety against capacity also it is it satisfied. Now you can find it out what is the value of p maximum are the base, and p minimum, it will comes it will be calculated with b by b one plus six e by b, and it will be calculated v by b total verticals force v by b one minus six e by b, and this come out to be one two one three nine four newton per m m square, and this comes out to be six zero six nine seven newton per m m square. So, now, if I draw it this is my impress distribution is coming. So, this distribution this part is coming about one two one three nine four, then six zero six nine seven, this is you are impress distribution around this below the base of this slab what I did after the dimension has be fixed based on the calculation or based on the assumes an value.

Then you can do it systematically by taking in to our forces which your vertical forces lateral forces, then clockwise movement, and anti clockwise movement. So, I have made it in to very small small part. So, that there would not be any mistake I make it operate slab w one base slab is w two soil retaining in the counterfort part is here w three, then is your how much earth pressure coming all I have taking we can in to small small part it I am total movement is calculated once you calculated calculate your total movement, and total vertical forces also you can calculate from here from this these, these, these, what is your total vertical forces. So, x bar you can find it out from you can find it out, and you check it whether e is less, then b y six or if not e is less, then b y six; that means, there is no tension crack one factor safety satisfied second factor safety sliding as been check I live it for the student to calculated, it is about one point seven one one, which is greater than one point five mu has been assumed as zero point five. And also factor of safety against overturning as well as factor safety against bearing capacity has also been checked it is within this limit, then once this stability analysis has been done, then what will happen this dimensions whatever we have taken that is now that is now.

So, step one dimension is step two stability analysis has been done step three is your design structural design of your r c c counterfort retaining walls. So, from this stability analysis we calculated p maximum maximum pressure below the base of the wall minimum pressure bis below the base of the wall. And now in the next class we will go

for a structural design of your counterfort retaining wall.

Thanks a lot.