Application of Soil Mechanics
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Lecture – 18

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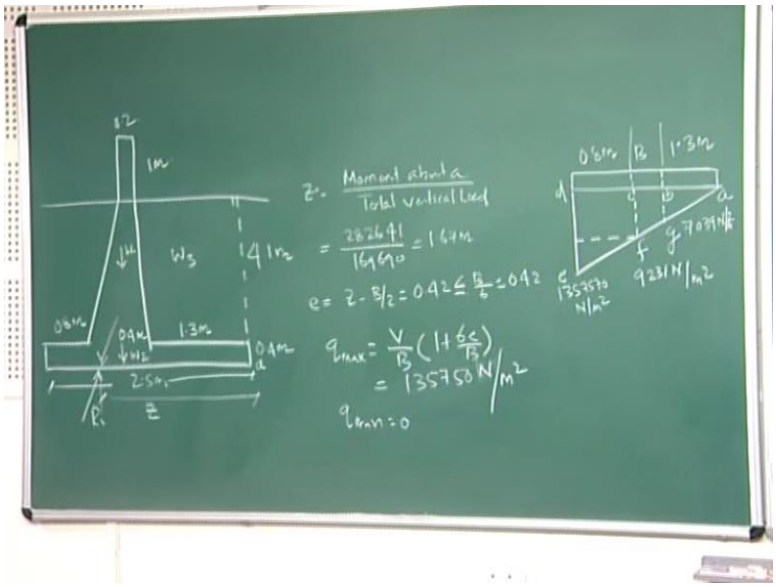

Last class a we have solve half of problem of example problem. We on go on through this calculations of different weights coming to this wall retaining wall. So, I have consider this this dimensions such the taking as per this tentative dimensions, and weight as been calculated, and this is your w 34.1 meter 2.5 meter, I have calculated movement about a this is also 0.4 meter this in 0.4 meter, and this is one point three meter all about this tentative of dimensions after satisfying this entity of dimensions, and after finding this tentative of dimensions than we have calculated the last class for stability analysis, what are the forces? What is the self weight? Because the w 1 w 2, and w 3, and movement about at point a, and as said earlier we can find about movement about this point as well as movement of this point.

So, the distance z from the point of application of a result of force are the base of the till end; that means, a this is the force coming r a, and this is the r a. So, distance z offer from a. So, distance z is e equal to this is a distance z. So, z is equal to total movement about a by total vertical load. So, movement about a by total vertical load total vertical load this comes out 2 v 2 8 2 6 4 1 as well calculated in the last class than 1 6 9 6 9 0,

which is coming about 1.67 meter, then is authenticity e is equal to z mains b by two is equal to 0.42, and which is equal to less than equal to equal to b by 6 b by 6 is equal to your 0.42; that means, tension crack satisfied, there is no tension crack. That means, both a this maximum, and minimum process below the base of the foundation they are positive now we can find it out what is the value of q maximum, and q minimum q maximum is equal to v by b 1 plus 6 e by b, which is coming about to be 1 3 5 7 5 0 kilo newton, and q minimum is coming about 0, because one minus 6 c by b 6 c by b is nothing, but c is equal to b c by b. So, 6 c into b this is one. So, 1 minus this is 0. So, q minimum is equal to 0 if I draw the special distribution below the base of the wall below the base of the wall. So, this of my base of the wall b. So, this is the b this is the b the special distribution is coming about to be this is zero, and this point this is your a, and this is your one three five seven five seven zero, it is Newton per meter square sorry this is not below Newton this is Newton newton per meter square.

And this part this part is your zero point eight meter, and this is your one point three meter, and if we name it a b c, and this is d, then if I take this like this, then this is about to coming e f, and this g by means of this, if it is zero this is this by means of simple trigonometry, and point f this value 9.31 Newton per meter square, and g is equal to seven zero three nine Newton per meter square this value is your q max this is your special intensity 1 3 5 7 5 0 Newton per meter square. If look at their I have calculated q max maximum presser below the rate of the one retaining wall by means of b one by b one plus 6 c by b.

So, it is coming about 1 3 5 7 5 0 Newton per meter square q minimum is coming about to be zero I have taken this base of this retaining wall with this dimensions has been given 0.81 second, this is your 0.4 this is 0.4, and this is 1.3 with these this presser is your maximum this is your q maximum 1 3 5 7 5 7 0. Newton per meter square minimum is equal to 0, if it is equal to 9 2 3 1 Newton per meter square g is equal to 7 0 3 9 Newton per meter square by means these… Now we are going to design for this, now there is a structural design part started other to overturning movement as also satisfiedother to like a check for your sliding against sliding, and bearing a check we do it lateran. If it is related to… Now let us start these structural design of the third point design of this stem design of this stem means this point is your stem.

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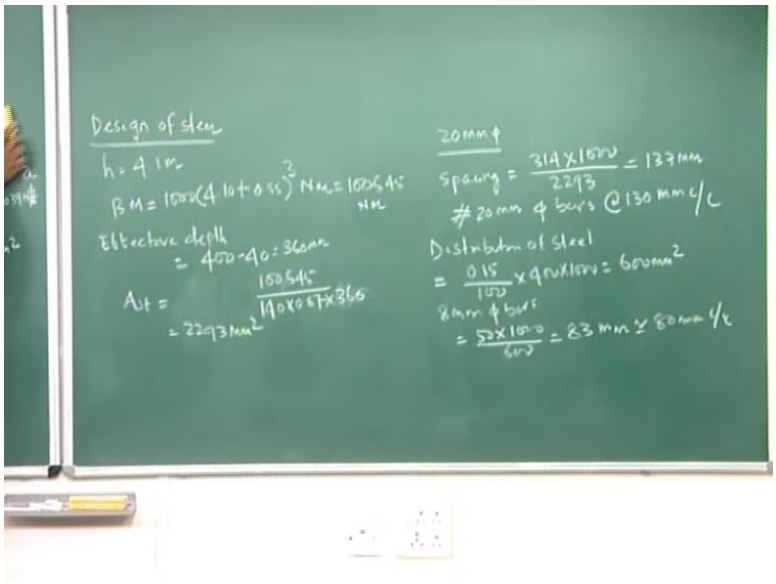

So, structural design of your stem. So, actual height of stem how much it is four point one meter height of stem h is equal to. So, actual bending movement. So, movement is equal to one thousands into 4.10 plus 0.55 whole cube Newton meter this is the bending movement. If we look at here this is your four point one meter, and this side is your 4.55 meter. So, actual bending movement is equal to 1004.1 plus 0.55 cube Newton per meter effective depth consider effective depth effective depth at the base which is equal to 400 minus 40 which is equal to 360 mm.

Now area of steps required a s t is equal to movement of resistance or bending movement movement of resistance by b d b d into t t is equal to movement resistance is equal to your movement of resistance this it comes out to be 100545 Newton meter. So, 100545 Newton meters divided by 140 ,140 is about hundred forty, because this is your mile steal. So, b is equal to q b d square q b d square into q b d into 0.87 0.87 into 140, sorry into 360 360 is your effective depth. So, if I write it area of steal in terms of area of steal from these steal area of steal coming about to be 229 322 93 m m square.

Now, let us consider provide a reinforcement bar of 20 m m pi 20 m m pi bars let us provide with these spacing is equal to spacing coming about to be 314 into 1000 divided by 2293, which is about 137 m m now provide it now provide 20 mm 5 bars at the rate 130 m m center to center how I have to written these this is your main enforcement bar in the stem, because this is structural design this is comes out to be 20 mm 5 bar. If I am

take into 25 or 80 pending upon the availability in the local market at the rate hundred thirty mm center to center; that means, basic is hundred thirty center to center this main than reinforcement as to be provided now distribution of steel distribution of steel, it is about 0.15 percent of main reinforcement as per your as per your Is code.

So, this is Indian standers code this is 0.15 by 100 into 400 400 is your total debts the 400 in to 1000 for meter which is com coming about to be 600 m m square. So, let us say distribution steel let us say 8 m m 5 bars which is is equal to 50 in to 1000 divided in to your 600. So, 6000 is your distribution of your steel total various 650 is in your area of this in to one thousand, it is coming about 83 m m say 80 m m canter to canter. So, this your enforcement main than enforcement your providing 20 mm 5 bears at a facing 130 m m center to center, and your enforcement is coming about 80 m m, we are providing at the center 80 m m center to center 8 m m 5 bears.

Now I just say is just see from here design of this steels particular this stem if a look at here if a look at here this diagram this banding movement. If you consider you have consider this banding movement at the base this is my stem, but this they bending movement is raring at any interfile from the top. So, bending movement you will be less here bending movement will be more, and bending movement will be more at the base; that means, this bars are not going to provide throughout you will formally rather you need to half of bare for your bather design or may be your as per as economic point of view cattlemen of bare is required.

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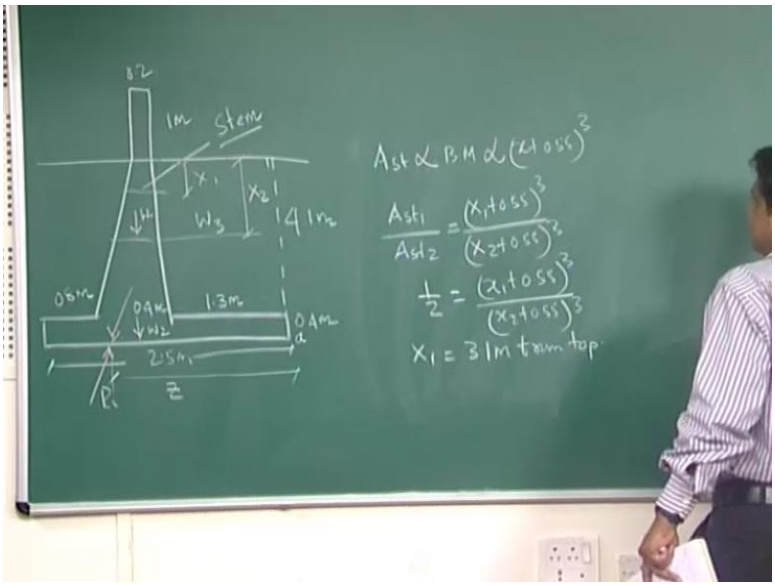

Now, bending movement we can say at any debt x, let us say at any debt x what is are your bending movement or area of steel area of steel is direct proportionality for here bending movement which is directly proportionality your x plus zero point five five pole q. Now if I take two section, Let us this is x one, and let us say this is x 2 now I can write it area of steel at section one divided by area of steel at section two which is is equal to 2 x 1 plus 0.55 hole q by x 2 plus 0.55 hole q. So, this is coming about to be if I if I want to cutlet at every alternate if distance let us say alternates bars to be cutle alternates bars means 1 bare after that another bare to be cutle; that means, equal distance, if I take it x 1, and x 2 is your 2 x 1. So, area steel a s t 1, and a s t 2 which is coming about we half, and which is your x 1 plus 0.55 hole q by x 2 plus 0.55 hole q.

So, now you decide your x 2 x 2 we can take it depending upon this your value we can take it is. So, x 1 is coming about to be x 1 is coming about to be three point one meter from top. Now what does it mean at a distance from top three point one meter the bars main the enforcement bars are not. Suppose to be going to provide throughout let it; that means, 20 m m 5 bares at the rate of 130 m m center to center rather you will cutle every alternate bare. So, it will become 20 m m 5 bares every alternative bars facing we be double, because your cutting it will be 160 m m interval are the alternative bars now this is about your design of your steam.

Similarly, we are go for design of your tau slab this tau slab one part design of this stem

for reinforcement is over; that means, of your structure pat is over. Now structure design of a stable, if I go for the structure design for stem, if a look at here.

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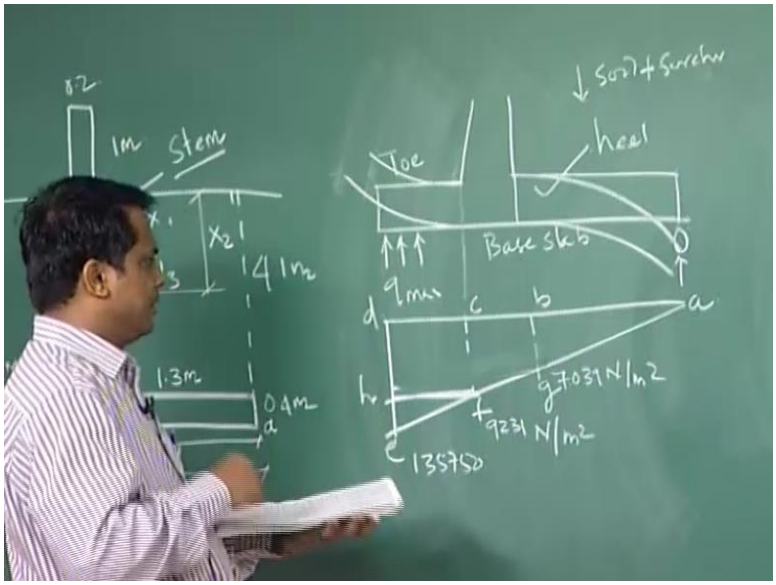

Look at this diagram this is my base slab whatever the process going come here in this case at the base slab from here to here; that means, at tau one is at tau other is at heel at tau what are the process of are to come the forces is coming to be this is your q max q maximum force is coming, and here are the top may be the fillings I will come. So, what kind of movement we will come in to picture this bare will band like this; that means, compression this side intention of sorry tension this side, and compression on this side if he look at here in this case there is a self weight of a soil plus weight a search as, and this presser are this base, and this point it will be 0. Now what kind of how the bare how the base slab of the heel resin how it behave it will be like this, because weight to will be more, and at the top.

So that means, this is your compression at this particularly if look at here compression will be at this side compression will be this side; that means, in this case main enforcement to will be provided here in this case main enforcement to will be provided here. Now we I go for tau slab banding movement calculations now off word soil presser up word soil presser how much it is coming, if I draw it once again, if I draw it what I have what I have drawn it earlier let me draw it this is the part I have drawn earlier, if I of drawn in earlier this is the part. So, I am naming it a b c, and this is my d, and this will

be e e.

And what I have drawn earlier. So, this will be f, and this is g e f, and g, and this will be here h, and this value is coming about 135750, and this is 9231 Newton per meter per square, and this value is coming from 7039 Newton per meter square this values is are coming from single this total base is given, and from they are single. We can find it out this value known other value we can find it out from this from this figure I can say that up word soil presser c d f h c d f h up word soil presser.

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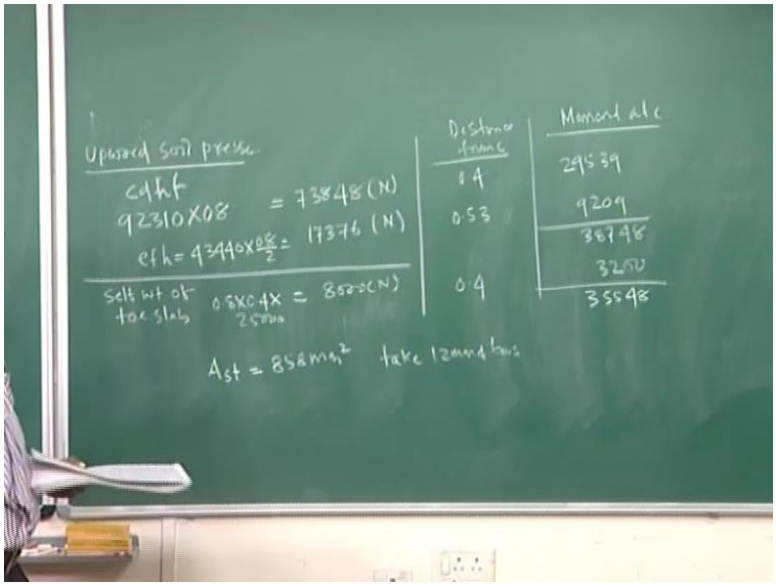

That is your value of c d f h f c d f h, because this part we are only tau part. So, I will consider only this part only for this banding movement calculation or design of your tau slab. So, I have consider in to two parts base slab one is a tau slab anther is will heel slab sofa tau slab, I am taking in to consideration of this part, and making in to two parts one is your c d h f how much in to pressure intensity this is coming about this is coming about to be 92310 in to 0.8. So, this presser are this point will be 9230 into 0.8 this thickness your this, this with your 0.8. So, this comes out to be this comes out to be 73848. Similarly e f h e f h part is coming about to be 43440 in to 0.8 by 2 it is coming about to be 17376 if a look at here this is a triangular distribution this is a triangular distribution total presser are this point is 135750 presser are this point is your 92310. So, this mains this is the presser coming here. So, this will be half this is your 0.8 it to the presser. So, this is your presser 0.8 divided by in 2 half this is your load coming in to

picture am a coming in to this total load coming in to this. So, this is your newton. Now we this off word we have to deduct is self weight, because this has been made by means of way concrete r c c concrete we have deduct by means of is self weight; that means, self weight of tau slab tau slab it comes out to be 0.8 in to 0.4 in to 24000, which is equal to here eight thousand Newton 0.8 is your this is your 0.8 this is your zero four into, we unit to weight of concrete that is your 25000 Newton per meter square. So, it is coming about 8000 Newton.

Now, distance from c distance from c how much your distance from c, because you are going to find it out movement what we designing were going to find it out movement at this point of out a see. So, distance from the c is about 0.4, and this part is your 0.53, and this part is your 0.4 now we can calculate movement movement at c, and this is to be coming about 29539, and 9209, and this comes about to be total coming about to be 38748, and 3200, if can check by yourself weather this calculate are correct or not.

This has been made by myself. So, this is coming about 3554 835548. So, this is the maximum bending movement of the tau slab after at point c, and it will be in this directions, because soil presser will be more from this, and we have calculate earlier from this we can find it out we can find out what is the area of steel area of steel is come about to be 858 m m square. So, let us take let us take 12 m m 5 bars 12 m m 5 bars local available market 8 10 12 14 this are the availability in the local available market bars bars means steel 12 mm 5 bars.

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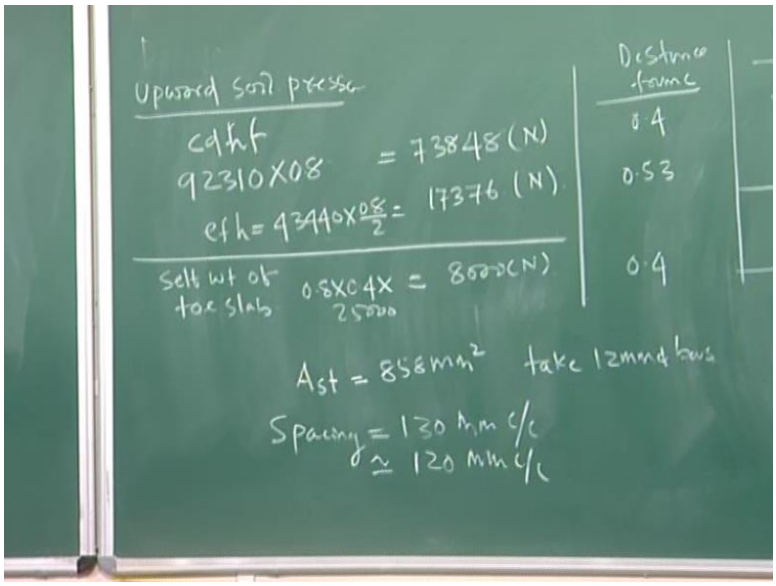

So, facing coming about to be facing coming about to be hundred thirty mm center to center we can say we can take at about one twenty mm center to center this calculation I have made it first structural design this is are approximate, because we can go in detail as per your Indian standard code this is the overall how this design as made taking in to contradiction of structural part. Similarly we can calculate this is for this is for tau slab

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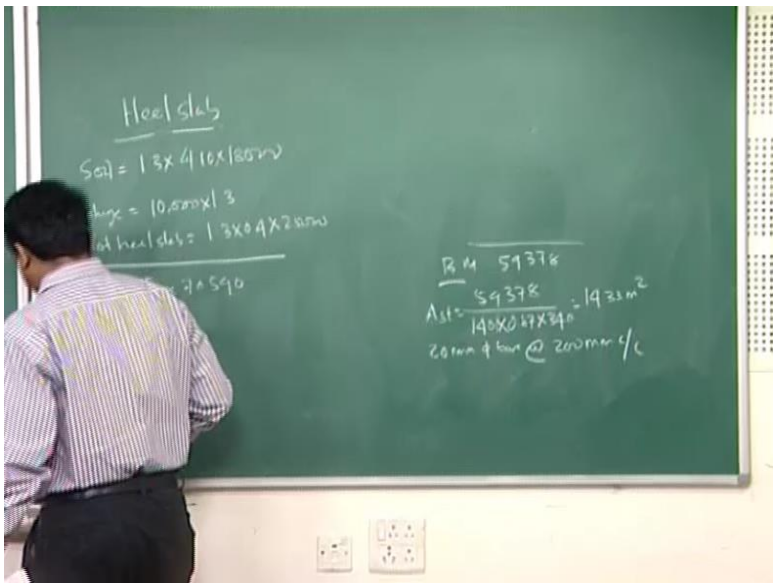

We can also go for a heel slab we can find out the heel slab in case of heel slab in case of heel slab in case of heel slab weather the thinks, they are; one is your one is your soil one

in your soil, this is coming about one point three in to 4.10 in to 18000 if at look at this heel slab this distance is 1.3, and soils feeling up to height of four point one, and unit weight of soil is your 18000 kilo meter than traffic load surcharge as surcharge also given surcharge is equal to ten thousand in to one point three than we can say that weight of weight of also heel slab heel slab this comes out to be 1.3 in to 0.4 into 20000, and from they are we can deduct the presser distribution of two heel slab b a g here it is 0 here it is 7039 Newton per meter square how much presser is coming to the heel slab that as to be deducted. So, that is coming about 1.3 by 2 in to 70590 this is your this, and the best one that we can find it out what is neat bending movement we can find it out distant from here from point b what are the pressers what is the distance, and movement about point b we can calculate. So, neat bending movement is coming about to be left this for reference we can do the calculation one calculation I have done for you ears you can do it.

So, it is coming about to be neat bending movement is coming about five nine three seven eight base on the bending movement coming that we can find it out what is your area of steel area of steels come out to be required area steels come out to be five nine three seven eight divided by one fourteen it is a tress in to steel in to zero point eight seven in to 340 it is in to be 1433 mm square. So, we can take it available ether 12 mm 5 bar or twenty mm 5 bar what is they are let us say 20 mm 5 bars. So, facing coming to be 200 200 mm center to center would this area of steel availability with the availability of here bars in the local market to I have taking 20 mm 5 bars this center to center provided center to center provided 200 mm center to center; that means, 200 center to center means after 200 mm you provided anther 20 mm 5 bars this is about your tau slab, and heel slab.

Now, will go for another most important part of the checking that is your sliding that is your sliding factor of again sliding as I say I have done it, and not done it earlier. So, I just combine in part of structural design, because this factors at again sliding is not coming within this permissive limit.

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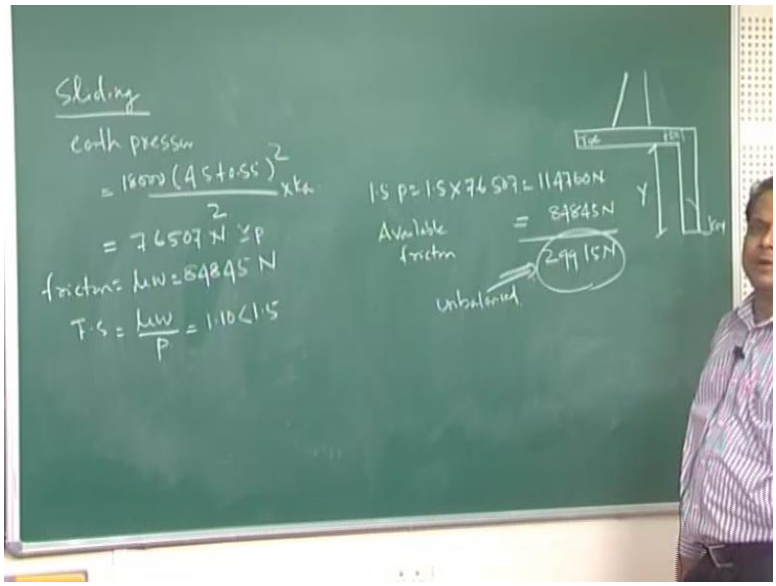

So, total horizontal earth presser earth presser, now this is for check for sliding earth presser is coming about to be eighteen thousand in to 4.5 plus zero 0.554 0.5 how it is coming this distance is your 4.1 plus zero point four this is your 4.5 plus this site is your 0.55. So, this hole square by two in to k a, and this value is coming about to be 76507 Newton. So, maximum fiction how much fiction your getting the fiction is coming about to be me w, and this is equal to 84845 Newton.

So, factor site is equal to me w by p, and this comes out to view 1.10 which is less than equal to 1.5. If you l u look at the sliding factor again sliding is about coming 1.0 which is less than is in your minimum requirement of factors step what does it mean this retaining wale will slid at the base of the foundation soil base of the foundation soil; that means, to satisfy this we have to provide is c r key c r key we have to provide c r key either heel or either the tau were he can provide it I am taking at the providing c r key at the heel. If I consider this is my weal this is tau, and this is heel. So, this is a c r key. So, now, what is the intense provide the c r key; that means, it would not allow it would not allow this c r key, it would not allow to further preside means it would not to allow to slid it will not allow to slid this about this retaining in wall about your base are the base.

Now, let us provide 1.5 times of 1.5 times of say total apprises say it is a p now 1.5 times of p how much 1.5 times of p how much it is your 1.5 times in to 76507, which is equal to 114760 Newton, and available friction available friction which is equal to 8488 4845

Newton, and this comes out to be 299 on 5 Newton this is your unbalanced.

What I have done I am taking the factor of is equal to 1.5 1.5 intend of taking 1.10 I have taking the factors of is equal to 1.5; that means, p in to 1.5 times; that means, p is your total little are presser p in to 1 point times this is the think, and the available friction is me, and w, and unbalance force is your 29915 Newton this unbalance force as to be taking by your c r key this will be taking by will your c r key. Now sub bearing capacity with this design with this design let us take for a lateral load, but per particularly sub bearing capacity of vertical load is given 200 200 kilo tone per meter square for lateral loads sub bearing capacity.

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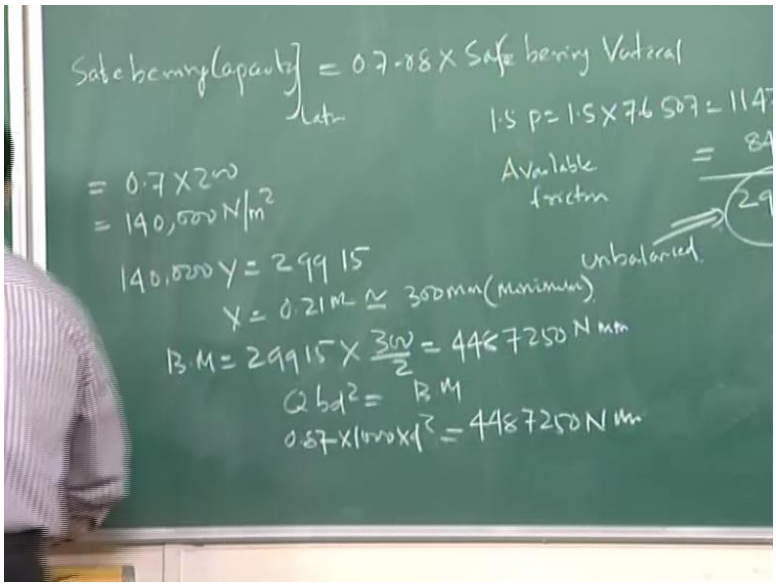

Safe bearing capacity for lateral its takes out to be 0.7 to 0.8 in to sub bearing in vertical how much it is coming it is coming about. Let us say 0.7 in to 200 kilo tone per meter square its coming about to be 140000 Newton per meter square, let us provide height of the key is equal to height of the key bellow the ground surface city is equal to y y. So, what will happen? This 140000 in to y y which is is equal to which is equal to unbalance force how much it is unbalance force is equal to 29915. Sub bearing capacity in lateral direction which is is equal to 0.7 to 0.8 time of sub bearing capacity in vertical direction sub bearing capacity in vertical directions it is giving when vertical it is given 200 kilo tone per meter square, because of this soil. So, self bearing capacity in lateral it is coming about 140000Newton per meter square.

So, I have taking this 1400000 Newton per meter per square, he will acted upon the height of the y in the key. So, this in to y is equal to total unbalance for 2991 Newton from they are y is about to be coming 0.21 meter 0.21 meter, but as per Indian standers minimum value we have to take 300 mm this is your minimum. So, then Maximum bending movement how much you maximum bending movement is coming about to be 29915 in to 300 by 2 it is your maximum bending movement is coming about to be unbalance force in to w l by two this will be acted like this. So, maximum bending movement will be coming about to be w l by 2. So, which is your which is your 4487150 Newton mm Newton mm Newton mm based on that based on that we can find it out we can find it out q b d square is equal to maximum bending movement bending movement.

So, q is equal to for m 50 n mail still its is equal to 0.87 into b is equal to later say 1000 in to this square which is equal to 4487250. Newton mm, and this comes out to be this comes out to be d is equal to 73 m m. Now minimum thickness minimum thickness as per the Indian standers it should be provided is equal to 200 mm 200 mm this is your minimum minimum know, if this is my this. So, d defectively defectively your total mains clear cover of your concrete. So, 200 mains clear cover of concrete I have taking 60 mm. So, which is coming about 140 mm. Now the area of steel require is equal to area of steel require from this bending movement is it coming about 263 mm square which is very less very minimum.

So, it is a very small quantity. So, what will happen from this heels slab alternative bars should be bend in side, because of the area of steel required is 263 mm square from the heel slab alternative bars are may be, sorry from the tau slab the bares alternative bars should be put in to inside. So, that it will acts in to a enforcement in case of key in case of key now this completes or design now if I draw the how the enforcement bare I will have to. So, in the diagram how the enforcement bars means the enforcement bars we have to show in the diagram as well as show at clear diagram, we have to show we have also keep this how it looks to…

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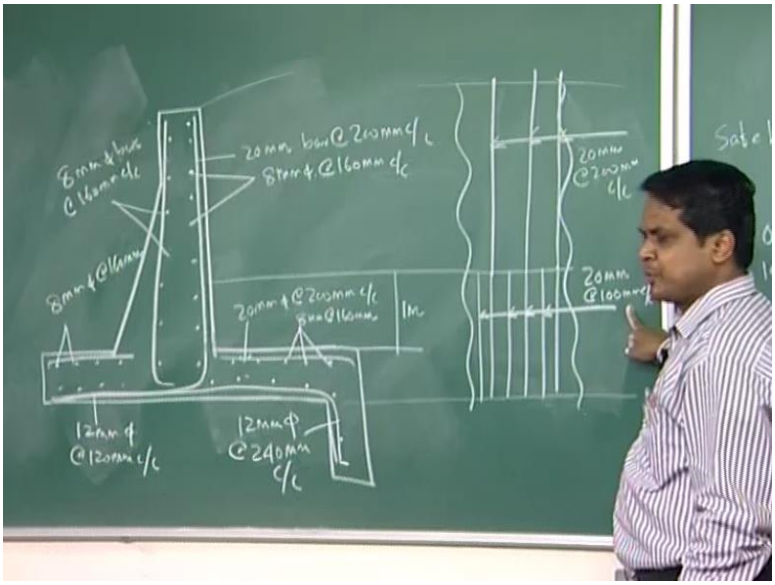

If I take it this my wall this is a writing wall this is the c r key what will happen I have taken this bars like this, then I provide this way, and this bar has been taken like this now other bar is coming about to be like this. So, this are also bar this dot points are also bars in this directions this bars are in this direction, and this bars are in this direction this are vertical. But in this bar is are in this directions in look at here this my main enforcement of stem, because this main enforcement is 20 mm 5 bars at the rate 200 mm center to center, and this are my all c r enforcement in this case, then what will happen?

So, this will this will how it will y y this is a compression, because this side he will go in this way. So, that mains this part will be compression compression completely, and this will be tension. So, in this top party if it is a compression part. So, this part will be even this here to 20 mm 5 bars in 200 mm, this is main enforcement, and this is my enforcement, and this dote will be your c r enforcement here, it is a it is a again this a earlier 8 mm 5 per, and than 60 mm center to center this is your than main enforcement, because this will be bend like this as I said earlier this should bend like this.

So, main enforcement he will come at the base in this case main enforcement he will come at the here at this side main the enforcement he will be this side it has been a extended it has been a extended. So, that here are every alternative bare. If you look at here 12 mm 5 bars at the rate of 120 mm center to center this bare as been a extended date as c r key, this is your 12 mm 5 bars at the rate of 240 mm center to center 240 mm means alternative bars as been extended to your c r key, if I take a cross section of this part as I said bending movement is where every sections from x 1 x 2 at the base bending

movement to will be more.

So, at the base it is your 20 mm 5 bars at the rate of the 100 m m center to center main than enforcement bars, but above one meter inter well it is your 20 mm 5 bare at the rate of 200 mm center to center, this means once we gives this diagram this means the field engineer he will understand every alternative bars. If at look at this every alter this is your main bar alternative bars has been cutteled has been cutteled, and this alternative bar are cutteled, because of your economy design economy design. So, this complete your structural design.

If I divide I to three parts first one is your once again I am repeating for this retaining invalid design first one is your tentative dimensions second one of this design parties your that is your stability analyses than thread, one is your structural design in this particular in this problem did after this tentative dimensions this a stability analyses they are four part it is satisfying one is your robotic movement it is coming I have do I have not calculated it will come within the permissible limit, then e is less than equal to b by 6; that means, that should not be any tension crack that also satisfied, and foundation bearing capacity also as to be satisfied that also satisfied I am not domain the calculation. Only stability analyses which is not satisfy that is your about sliding; that means, sliding is coming less than equal to 1.5 it is coming about 1.2; that means, you have to provides c r key at the heel or at the tau depending upon that.

So, I have provided this c r key at the heel, then what is your avail, and balance force has been distribution in the c r key, and the distance as been coming about to be three hundred mm this distance as been taken in to consideration after is all design is over, this kind of diagram structural part completely showing where is your c r enforcement where is your main enforcement as to be shown. So, that filed engineer as well as design engineer they can understand how the cuttlement of the bar, where is your main enforcement where is your c r enforcement has been provided it as to be tern this completes your design of reinforce retaining in one will start next class design of your count of word retaining words.

Thanks a lot.