Advanced Foundation Engineering
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Lecture - 15
Design of Raft Foundation

Class I have discussed about the design of isolated footing, now this class I will discuss about the combined footing and then I will discuss how to design the raft foundation. So, and then finally I will I will discuss about the to determine the allowable load carrying capacity of the foundation based on the SPT value or and then the and the and the proposed empirical correlations.

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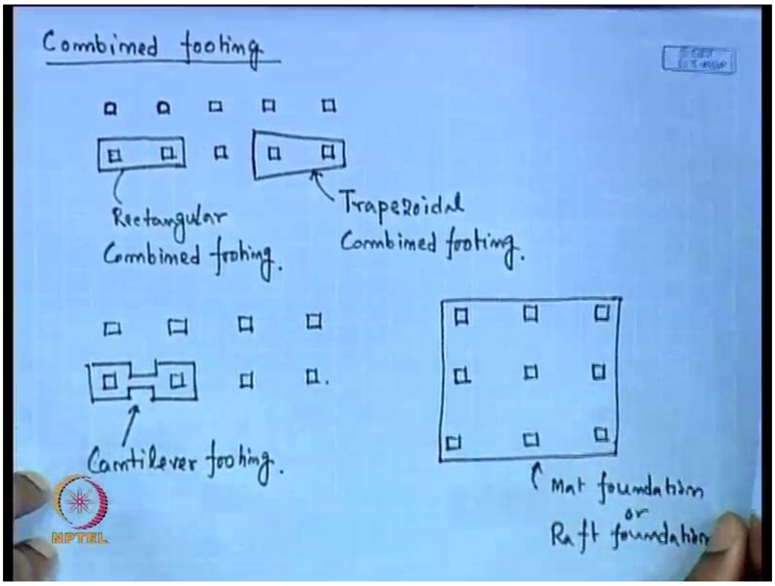

So, first I will discuss about the combine footings, now the combine footings, because last class I have discussed about the design of isolated footing. Now, here the combined footing may be suppose if these are the column arrangements, so these are the columns. Now, if we want to design the isolated footing, now if the spacing between these columns are very small, then it is obvious the influence zone of this each column, that will overlap.

So, there is a chance of that, there is the overstress zone, now in such situation then we can combine these two footings and this type of combination this is called the combined footing. Now, suppose this is the rectangular combined footing, so we can, so this is the column, one column, this another column. Now, instead of using isolated footing for one single column, we are combining these two columns, now this may be more than two also, so depending upon the situation in the field.

So, suppose this type of column, this type of footing is called the rectangular combined footing. Now, this type of footing can be also trapezoidal initial. So, depending upon the space available for this footing sometimes we have to use this type of combined footing also, where this shape is footing of the shape is trapezoidal.

So, this type of combine footing, here also, this is the two columns or two columns can be combined in a single footing, so this is called the trapezoidal combined footing. Now similarly, suppose these are the other columns arrangements, where sometimes we can use this type of footing also.

So, here also these two columns are combine in a single footing, now this type of footing this is called as cantilever footing. Now if this is the column arrangements of the building, then if we combine this entire area of the proposed building by one single footing, then this type of footing is called the mat foundation or raft foundation. So, these are the different types of combined footings.

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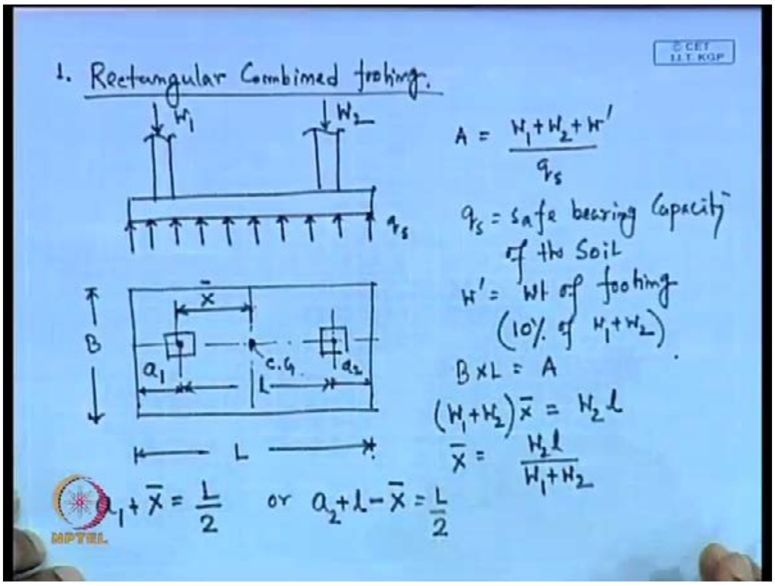

Now, first I will discuss about the rectangular combined footing how to basically discuss, I will discuss about the determine the dimension of this footing; that means, the width of the footing length of this combined footing then here these are the dimension of this trapezoidal shape, then I will discuss about the how to design this raft foundation or mat foundation.

Now, first if I go for this rectangular combined footing, so this is first I will go for this rectangular combine footing, suppose this is the sectional view of this rectangular combine footing there 2 columns are combined by a single footing. And these are the W 2 is the load that is acting on the first column and W 1 the load, that is acting in the second column; and this is the bearing pressure this is the upward reaction of the soil that is acting at the base of the footing. So, here we can say this is the q safe, safe bearing capacity of the soil or ultimate net bearing capacity of the soil.

So, suppose this is the safe bearing capacity of the soil and now this is the dimension that we have to choose for this combine footing. So, first initially we consider, this is the width is B of this footing and L is the length of the footing. Now, these are the 2 columns position this is column 1 and this is column 2 and suppose this is the centerline of this is the centerline of each column, this is the centerline of this column 2 and this is the centerline of C G of, this is the C G of this foundation.

Now, this spacing between 2 columns this is small l this is known, now another option this is a 2 is the distance from this center of this first footing to the edge of the foundation. And a 1 is the distance from the center of the first column to the edge and a 2 is the distance from the center of the second column to the edge. Now, here now suppose this is x bar is the distance, this is the x bar this is the distance from the centroid of this total combine footing to the center of the first column.

Now, we have to design this or we have to choose the dimension of this a 1, a 2 then B and L, because small l is known that is the center to center distance between the columns. Now, we have to choose a 1, a 2, B, L such that the center of the resultant force; that means, the W 1 and W 2 these are the two forces acting in the column, this resultant force that should act at the C G of the combine footing. We can design in that fashion also that is the center resultant of these two forces, that will act at the C G of the foundation.

Now, if we can, so in this we can this is the required area of the total footing is W 1 plus W 2 plus W dash divided by q s. This q s is the safe bearing capacity of the soil (No audio from 09:01 to 09:11) of the soil, then W s is the weight of footing, which is generally taken 10 percent of W 1 plus W 2. That means the total load acting on this foundation and the footing foundation weight will be 10 percent of that total load.

So, we can write that required area is this and then B into L that will be equal to a, this is the area B into L. Now, if we take the moment at this first column center, then we can write that W 1 plus W 2, that is the total force that the resultant force into x bar, that is equal to W 2 into l. So, if I take the moment from the center of the first column, so this will be W 1 plus W 2 acting as the c g, so here, this is acting and this is the x bar.

So, x bar will be W into l divided by W 1 plus W 2, now here W 2 is known, W 1 is known, W 2 is known and small l that is also known. So, now, here we can further write that a 1 plus x bar, that is equal to capital L by 2 or a 2 plus l minus x bar; that means, a 2 plus l minus x bar that is also capital L by 2. So, first we will calculate the x bar by this expression, and then we can we will get this here this expression capital L 1 and a 1 capital L and a 1 both are unknown.

So, depending upon then if I assume one value a 1, then x bar is known, then we can calculate this l value similarly we can calculate this a 2 value also. So, by using this expression, we can determine the dimension of this total footing or a 1, a 2, B and L according to our design requirement, so next footing that I will discuss about the combined trapezoidal footing.

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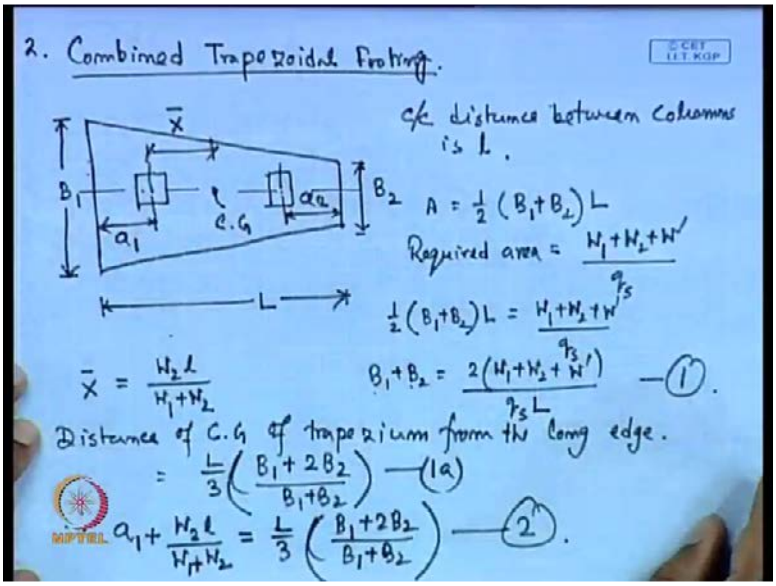

So, next one is the trapezoidal footing or combined (No audio from 12:11 to 12:31), suppose this is the dimension of this is the centerline and this is the position of one column, and this is the position of another column, and this is the center of this column and this is the dimension. So, suppose this is B 2 and this side dimension is B 1 total length is capital L and this is the C G of the trapezoidal footing and C G two first column distance is x bar. Similarly, we can write from this center this edge is a 1 and from this center this edge is a 2 and center to center distance of this center to center distance between columns is small l.

Again we can write this area here for this trapezoidal footing, this trapezium area is half B 1 plus B 2 into l this is the area, but the required area (No audio from 14:08 to 14:16), that is also again W 1 plus W 2 plus W dash divided by q s. Similarly, here q s is the safe load bearing capacity of the soil and W dash is the safe rate and W 1 is the load acting at the first column, W t is the load acting at the second column.

So, now we can write that half B 1 plus B 2 into l, that is equal to W 1 plus W 2 plus W dash divided by q s or we can write that B 1 plus B 2, that is equal to 2, W 1 plus W 2 plus W dash divided by q s into l, so this is one expression. Similarly we can calculate x bar by previous fashion, that is W 2 into small l divided by W 1 plus W 2. So, now the distance of C G of trapezium (No audio from 15:38 to 15:48) from the long edge and distance of C G from of the trapezium from this long edge; that we can write this is this is by expression L by 3 into B 1 plus 2 B 2 divided by B 1 plus B 2, this is the expression on the long C G.

So, now we can write that for this expression that from this figure a 1 plus x bar that is W 2 into l divided by W 1 plus W 2. So, W 1 plus this x bar that is equal to this distance l L by 3 (B 1 plus 2 B 2 divided by B 1 plus B 2). So, this is another expression this is say expression number 2, because here the distance from this C G from long edge by given by this expression or we can write this is expression number 1 a. So, this expression number 1 a given by this value. So, from this figure we can say this a 1 plus x bar x is W 2 l divided by W 1 plus W 2, this x bar that is equal to this distance form of the C G of the foundation from the long edge.

So, now in this expression the unknowns are we can say B 1. B 2, L then small a 1. So, now, we have to use first assume a suitable values for few unknowns, then we can choose our dimension of the footing. So, here first if we want to find this a 1 value, then we have to choose say B 1, B 2 or L for because we have only two expressions, but unknowns are here number of unknowns are this expression is 2 number of unknowns are 1, 2, 3 and one is here that is 4. So, that means we have to we have to assume 2 values to determine two other unknowns.

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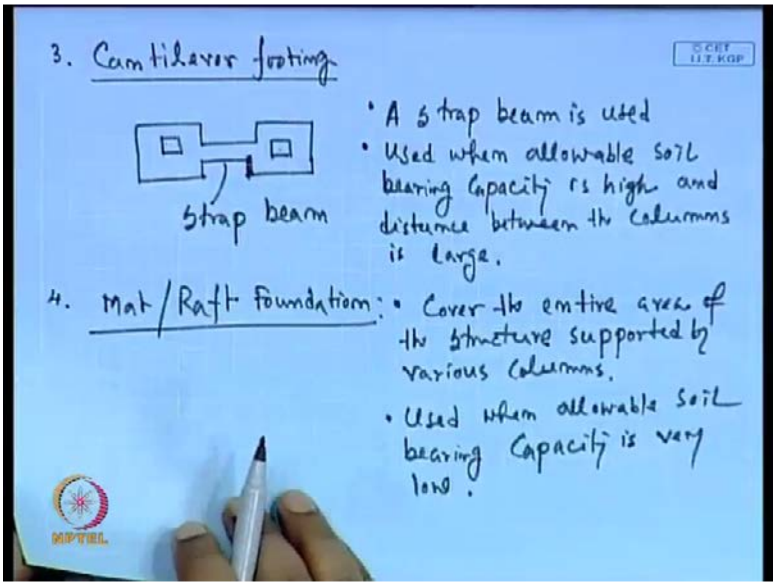

So, in this wave we have to determine the dimension of this trapezoidal footing, here also the resultant force is acting at the C G of this trapezoidal. So, in this way we have to determine the dimension of the footing. So, next one is the cantilever footing that we will discuss this how to determine this cantilever what is the cantilever footing.

So, third one is the cantilever footing (No audio from 18:46 to 18:56), so this is the cantilever footing that I have already mentioned, this is the footing looks like this and this is the 2 columns, which are attach. That means, these are the column which is attached by one this strip beam this strap beam that we will use to attach this two columns. So, one condition this one strap beam is used (No audio from 19:30 to 19:39) to connect this columns and second one is it is used, when allowable soil bearing capacity is high and distance between the columns is large.

So, that means, it is used when this strap beam is connected between two columns this is used when the allowable bearing capacity of the soil is high and distance between two columns is large. Then the fourth one is the mat foundation or the raft foundation (No audio from 20:42 to 20:52), so this is used this is cover the entire area of the structure supported by various columns; and it is used when allowable soil bearing capacity is very low.

So, this covers entire area of the structure and it is used when the allowable soil bearing capacity is very low. So, these are the different types of combined footings, first is rectangular combined footing, then trapezoidal combined footing, then cantilever footing then the raft and mat foundation.

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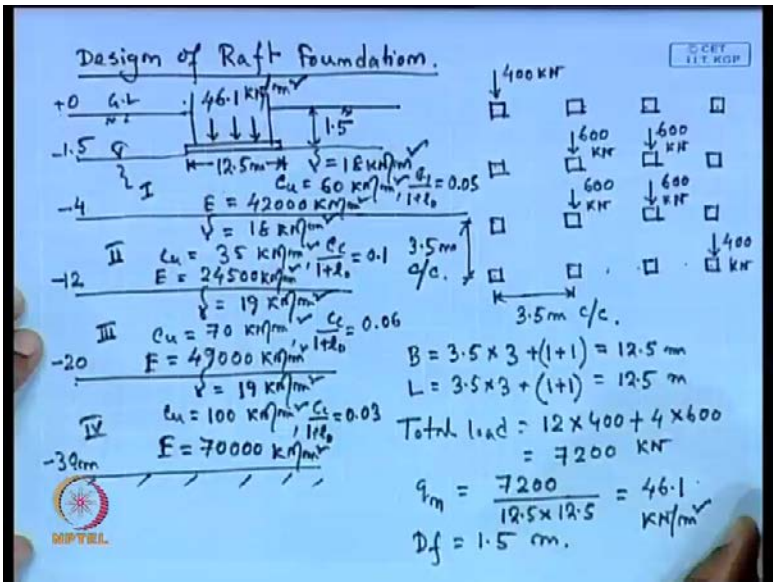

Now, the next section I will design one raft foundation, then how to determine the settlement and the bearing capacity of this raft foundation, that I will discuss. (No audio from 22:28 to 22:39) Here again like isolated footing, here design means I will just give the idea, how to determine the dimension of the footing and the depth of the footing. That mean width and the length of the footing and depth of the footing by this method, I will not discuss about the structural design that part I will discuss in the last module; and there I will give the idea how to design this footing in structural point of view.

So, now here suppose we have one grid pattern is this, so this is the footing grid say (No audio from 23:20 to 23:40). So, here center to center between the columns for this here it is 3.5 meter, this is the center to center from this direction and this direction also this is 3.5 meter center to center, so the load that is acting in the central the here all the outside column. So, there is 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 outside columns, and 4 inside columns.

So, load that is acting for each outside column is 400 kilo Newton and in the inside columns for each inside columns, the load that is acting is 600 kilo Newton each. So, in the outside column it is 400 kilo Newton and inside column this is 600 kilo Newton for each inside columns. So, this, so that means, the total in 12 column, which is subjected by 400 kilo Newton load and each and 4 in inside columns or internal column there subjected to 600 kilo Newton load in the each column; and the center to center distance for the columns 3.5 meter from both y and x directions.

Now, we will as we will design, we will use the raft foundation for it is it is observed by it is observed that the raft foundation in the suitable foundation as the bearing capacity of the soil is very low. So, that means, we will consider the raft foundation, so that will consider for the total area of this structure. So, now the first we will choose the dimension of the each footing that from this x direction the dimension from this this this side; that means, the dimension that we are choosing that this is 3.5 into 3, because this is 3, 1, 2, 3 and then we choose initially 1 meter in each side.

So, initial trial we will choose the dimension say this is the B width of the footing, so 3.5 into 3 this is 1, 2, 3 that is into 3.5. And then this side from the center of the column we choose, we take one additional meter and that is this side also in the both the sides we will take one additional meter. So, that means, the total dimension on the total width of the raft that we are taking is 12.5 meter. Similarly, in the length will be also 3.5 into 3 for the first trail, we are taking one additional this side and one additional that side, that is also 12.5 meter. So, this is the square raft we designing that can be rectangular raft also.

Now, the total load that is acting on this raft foundation the total amount of load that is coming is total load that mean 12 column, it is subjected by 400 kilo Newton load, and the internal column this four columns which is taking 600 kilo Newton total load. So, that means, the total load is 7200 kilo Newton and the dimension of this raft we are taking 12.5 into 12.5 meter. So, the net load that is acting on this raft is 7200 divided by area, which is 12.5 into 12.5. So, that means, it is coming 46.1 kilo Newton per meter square. So, this is the net load acting.

Now, the soil condition suppose this is the 0 line this is plus 0 or ground line. So, these are the raft dimension that we are taking this is the raft, this is the total area, so this raft dimension we are taking 12.5 meter, so width is 12.5 and length is also 12.5 meter. And the footing load that is the net load that is acting at the base of the raft that is 46.1 kilo Newton per meter square and here the water table location is 1.5 meter this is the water table location that is minus 1.5.

So, this is the 1.5 meter, so we take the D f Depth of Foundation D f is also 1.5 meter. So, that means, the depth of foundation is at the water table level, so that is at 1.5 meter below the ground level. So, next we will get this is the fluid layers one layer is up to 4 meter. So, this is up to 4 meter this is our layer 1, 0 to 4 then another layer, which is up to 12 meter this is another layer this is layer 2. Then up to 20 meter this is another layer 12 to 20, this is third layer, then 20 to 30 meter this is layer 4 and then this is the hard strata.

So, this is the soil condition, this is the loading condition and these are dimension for the first trail, we have chosen this dimension and this is the total load acting and this is the foundation grid pattern. Now, we need the soil properties that gamma for the first layer is giving 18 kilo Newton per meter square, gamma for the second layer is given also 18 kilo Newton per meter square. Gamma for the third layer is given 19 kilo Newton per meter square, gamma is given 19 kilo Newton per meter square. So, these are the all saturated unit weight saturated unit weight of the soil that we are using.

So, now this c u value this is the all are the clay soil, this c u value for the layer 1 is given 60 kilo Newton per meter square c u value for second layer is 35 kilo Newton per meter square. C u value for the third layer is 70 kilo Newton per meter square, c u value for the fourth layer is 100 kilo Newton per meter square; these are the soil data which is observed after the testing.

Now, cc this c c 1 plus e 0 for the first layer, which is giving 0.05, similarly this c c 1 plus e 0 for the second layer which is giving 0.1. Now c c 1 plus e 0 for the third layer is giving 0.06 and c c 1 plus e 0 for the fourth layer is 0.03. Similarly e value for the first layer is given 42,000 kilo Newton for meter square E value for third second value is 24500 kilo Newton for meter square that is 24500 kilo Newton for meter square.

E value that means elastic modulus of the soil for the third layer is 49000 kilo Newton for meter square and E value for the fourth layer is 70000 kilo Newton for meter square so these are the soil data and dimension. Now we have to design for the first (( )) whether these dimension of that I have chosen I have chosen that is correct or not. Now first calculation that will do for the bearing capacity calculation, then we will go for the settlement calculation. So, first calculation that is the bearing capacity calculation (No audio from 33:33 to 33:43).

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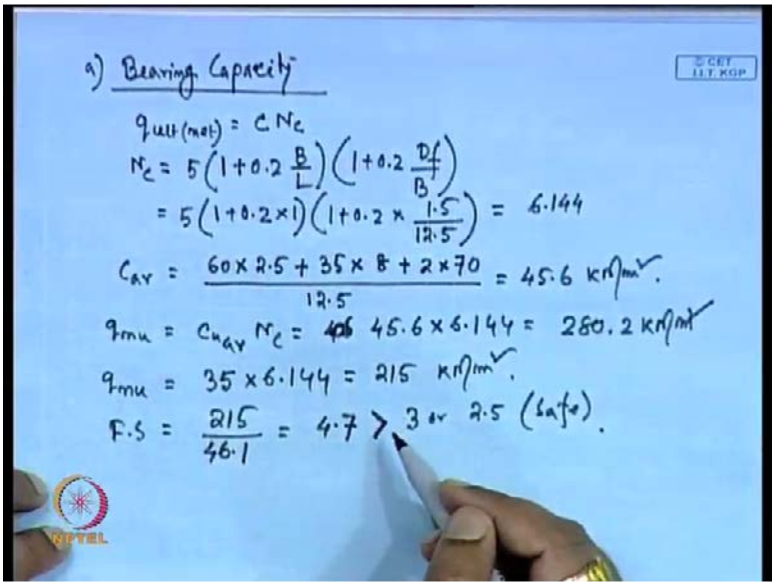

Now, here as it is all other clay, all the layers are the clay soils, so we will use the skempton bearing capacity expression, so that q ultimate net is C N c. So, here N c value that we will get 5 into 1 plus 0.2 B by L into 1 plus 0.2 D f by B, here this B by L is 1 D f is 1.5, B is 12.5. So, we will get N c value is 1 plus 0.2 this is 1, this is square footing plus 0.2 into 1.5 divided by 12.5. So, N c value that value is coming 6.144.

Next we will get the C c c c value or the cohesion of the soil, so here we can see that for the for the this width of the raft, that we have chosen this 12.5 meter. So, that means, the bearing capacity calculation the influence zone that we will take is up to B and for the settlement calculation we will take up to twice B. So, that means, up to B is 12.5 meter up to twice B is 25 meters. So, this depth of the soil layer below this footing is around 28.5 meter.

So, this influence zone is up to fourth layer. So, for the bearing capacity calculation up to the B zone, we take the weighted c e value or weighted C u value or we can take the minimum one for this calculation here the minimum one is 35. The first layer is 60 kilo Newton per meter square C u, second layer is 35 kilo Newton per meter square, third layer is 70 kilo Newton per meter square and fourth layer is 100. And this influence zone zone is definitely up to third layer. So, from this three layer the minimum 35 kilo Newton per meter square or we can take the minimum one or the weighted average.

So, first we will calculate the weighted average Cu that means, c average value for the influence zone for the first layer is 60 is the Cu and influence zone is 2.5 meter, then the second layer is this 35. And the thickness of the layer is 8 and up to B for the third layer is this third layer 2 meter we will consider, this 2 meter into 70 and total weight is 12.5. So, that is coming 45.6 kilo Newton per meter square, so q net ultimate is C u average into N c, so 46, 40 45.6 into 6.144, so this is 280.2 kilo Newton per meter square.

In second method we are taking only the minimum Cu, so in that case this will be 35 because minimum Cu is 35 into 6.144. So, this is 215 kilo Newton per meter square. So, factor safety that we are getting, this is we are taking the minimum one that is we are we are choosing this one 215. And the loading intensity is 46.1, so this is 4.7 which is greater than 3 or 2.5, so this is safe, but it is over safe.

Now, we will check first settlement calculation, now if that settlement is also over safe then we have to redesign the dimension. So, that we can redo, we can design this properly may do not design this foundation as a over safe design. Next when we calculate the settlement calculation.

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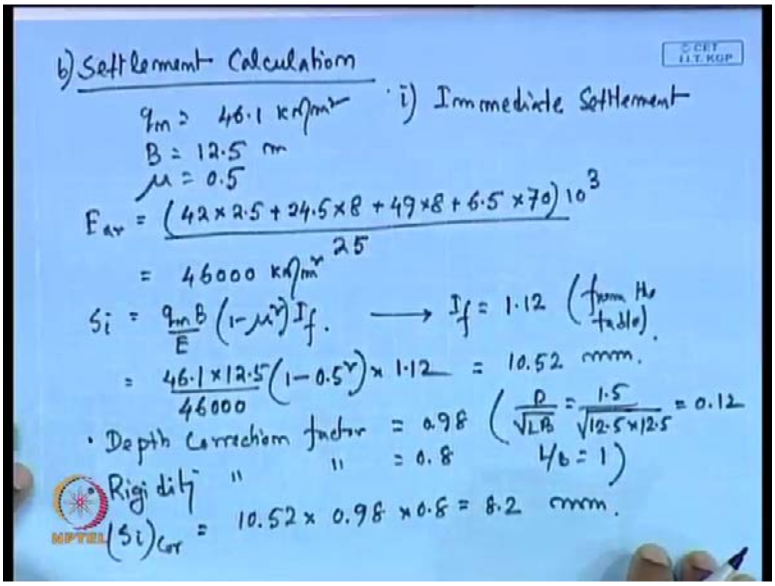

So, for the settlement calculation, so q n is 46.1 kilo Newton per meter square, first we will calculate the immediate settlement. So, this is immediate settlement, then B is 12.5 meter mu we have taken for the clay soil is 0.5. And we can choose the if E average value here that is 42,000 we are taking 10 to the power 3 outside and influence zone is 2.5 here influence zone is up to 25 meter.

So, you can see that here from this figure we will consider for the settlement calculation this width is up to twice B or 25 meter. So, we will choose 4 points one is here at the center, suppose here at the center this is a point, another center of this layer this is B point another center of this layer, this is c point another say influence zones is up to here say. So, we will take in this layer center is D point.

And this we can take the weighted c e value to calculate the immediate settlement, so up to 25 meter. So, weighted d 2.5 plus 24.5 into 8 plus 49 into 8 plus 6 because last layer influence zone is only up to 6.5 last layer thickness not the total thickness 10 meter. So, up to 6.5 into 70 into 10 to the power 3 divided by 25 meter.

So, E value that we are getting is 46,000 kilo Newton per meter square, here we are taking the weighted average because the total influence zone is because we can see in the previous case the influence, we are taking the minimum value 35. Because the influence zone is 12.5 meter and among this 12.5 meter this 35, Cu value 35 kilo Newton per meter square thickness is almost 8 meter.

So, most of the thickness is most of the influence zone is within this layer. So, that is why we are taking the minimum value, but here this up to 25 meter. So, all the thickness this is two all the other thickness are also influence this when we calculate the settlement that is why we are taking the weighted average value, so this is 46000 kilo Newton. So, immediate settlement S i is this is q n into B divided by e 1 by mu square into I f this is the influence factor.

Now, for this from the table influence factor for this square footing, we are taking 1.12 this is from the table. So, we can put this is 46.1 B is 12.5 is 46,000 1 minus 0.5 square influence factor 1.12. So, value that will come is 10.52 millimeter now here this is the raft foundation. So, this is the rigid foundation, so here we have to apply the two corrections one is rigidity correction, another is depth correction. So, first we will apply depth correction factor that is we are getting 0.98, because our D by root L B value is 1.5 into 12.5 into 12.5. So, this value is 0.12 and L by B is equal to 1.

So, from the chart corresponding depth correction factor is 0.98 corresponding to this values L by B is 1 and D root over L by B L B is 0.1. Similarly the rigidity correction factor, factor for this as I have mentioned that will be 0.8. So, S i corrected that will be 10.52 into 0.98 into 0.8, so this value is 8.2 millimeter. So, this is the immediate settlement corrected, so next we will calculate the consolidation settlement.

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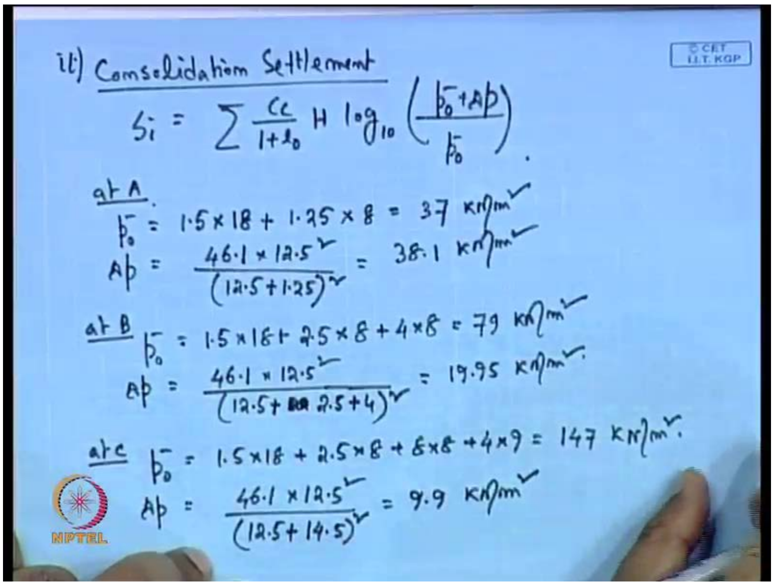

So, we will calculate the consolidation settlement (No audio from 44:07 to 44:22), so consolidation settlement S i is the summation of c c 1 plus e 0 thickness of each layer soil log 10 into p 0 bar plus del p divided by p 0 bar. Now, for at a as we are taking the middle point of the each layer, so at A p 0 bar will be 1.5 into 18, because this is above the water table zone that is why 18 plus below the water table we will consider this zone is 1.25, this is the center of this layer.

So, that means, for the a point is (Refer Slide Time: 45:06) the center of the first layer the first layer is below the base of the foundation is 4 minus 1.5. So, that means, 2.5 is the thickness of the first layer below the foundation. So, that means, the middle point is the middle point of this thickness, so we are taking this is 1.25 meter. So, as we can if we chose more points, then we will get a further accurate value, but if for this center point this is also good enough to calculate the settlement.

So, we are considering the center point of the each layer here, also the layer thickness is 8 meter. So, this point is 4 meter from this say from this layer starting of this layer. So, similarly we can calculate this is 1.25 and below the water table, water table has 1.5 meter below the ground level, so this will be 8 because 18 minus 10, so this will be 8. So, this value is 37 kilo Newton per meter square.

Similarly, del p we are considering 2 is to 1 is to 2 distribution, so 46.1 into 12.5 whole square divided by 12.5 plus 1.25, for this thickness 1.25 whole square; because is just square footing. So, this is 38.1 kilo Newton per meter square. Similarly, at B p 0 bar is 1.5 into 18 plus 2.5 into 8 plus 4 into 8, so this is 79 kilo Newton per meter square. Similarly del p will be 46.1 into 12.5, whole square divided by 12.5 plus 1.2 that distance is, so this is the 4 meter plus 2.5 meter.

So, 2.5 is the thickness of first layer plus 4 meter is the thickness that is square. So, this value is 19.95 kilo Newton per meter square. Similarly, at c point p 0 bar is 1.5 into 18 plus 2.5 into 8 plus 8 into 8 plus 4 into 9, that is 147 kilo Newton per meter square. So, similarly del p that value will be 46.1 into 12.5 square divided by 12.5 plus the thickness of this layer this point and the depth of this point below the foundation level is 14.5 meter, so that is square. So, this value is 9.9 kilo Newton per meter square.

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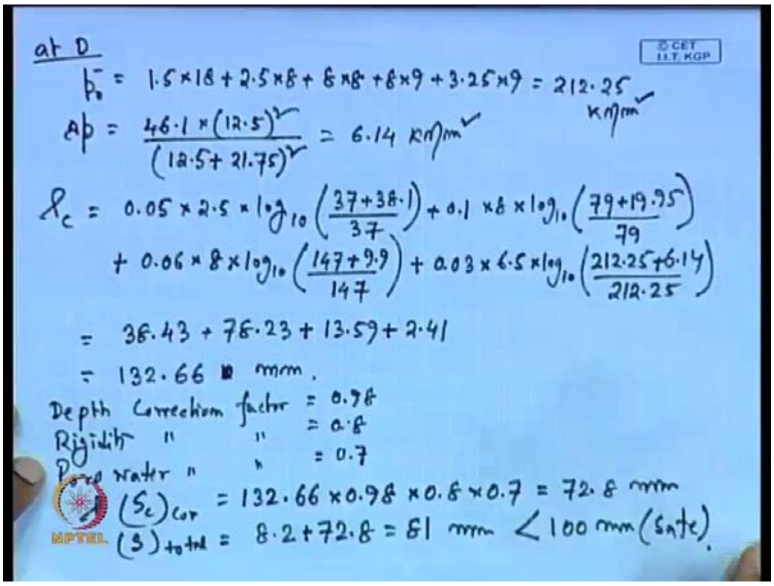

So, similarly we can calculate in similar fashion we can calculate the at point D this p 0 bar we can calculate in similar fashion that is 1.5 into 18 plus 2.5 into 18 plus 8 into 18 plus 8 into 9 plus 3.25 into 9. Because the D point is 3.25 distance from the third layer, so this is 212.25 kilo Newton per meter square. Similarly, del p value is 46.1 into 12.5 whole square divided by (12.5 plus 21.75); that means, the this D point is 27.5 meter 21.75 meter below the base of the foundation, the D point is 21.75 meter below the base of foundation.

So, this value is 6.14 kilo Newton per meter square. So, the consolidation settlement that we will get say 0.05 this c into thickness is 2.5 for this first layer into log 10 (37 plus 38.1 divided by 37) plus 0.1 into 8 into log 10 this is (79 plus 19.95 divided by 79) for the third layer is 0.06 is Cc plus 1 by e 0 1 plus e 0 into 8. If the thickness of the layer log 10 (147 plus 9.9 147) for the fourth layer this 0.03. And fourth layer influence zone thickness is 6.5 not the total thickness, so this is log 10, so (212.25 plus 6.14 divided by 212.25).

So, the individual settlement for the each layer is 38.43 plus 78.23 plus 13.59 plus 2.41. So, we can see the last layer this thickness is very negligible, so the total one is 132.66 millimeter. Now, the correction factor here also the depth correction factor, factor is 0.98 this rigidity correction factor is 0.8 and then pore water correction factor the properties that given a value for this clay soil that is from this chart it is coming 0.7. So, based on the properties of these clay type of soil, this pore water correction factor is this coming 0.7.

So, the corrected consolidation settlement this is the corrected is 132.66 into 0.98 into 0.8 into 0.7, so that is 72.8 millimeter. So, total settlement that will be the total settlement value that is 8.2 plus 72.8 that is 81 millimeter. So, permissible for these raft on the RCC raft on the clay soil is 100 millimeter. So, it is safe, but it is here also it is slightly over safe, so we can redesign this or we can again choose a new dimensions, so that we can make it more economical section.

So, then we have to choose the second trail and second new dimension and make the design more economical, the process is same, because it is slightly over safe. So, that is we have to choose a second second we have to go for the second trial or new dimension, so that we can make the foundation more economical. Now, next one and the last thing that I will discuss about the how to calculate the ultimate bearing factor in case of allowable bearing pressure, so based on the n value.

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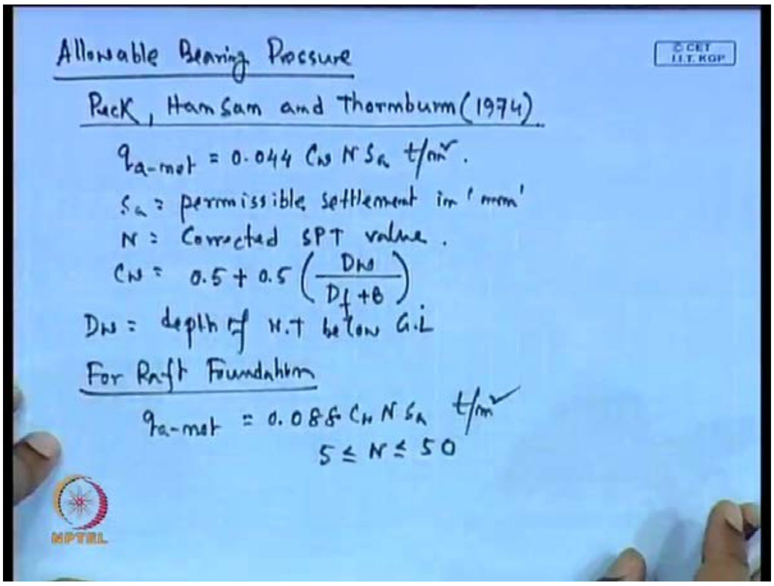

So, this is the allowable bearing pressure, so there is a few empirical correlations are given, so here I will discuss only the one value one correlation that is given by Peck Hanson and Thornburn in 1974. They proposed that for the net allowable net we can determine by using this correlation this is C w N S ton per meter square this is considering the settlement consideration. S a is the permissible settlement in millimeter and N is the corrected SPT value and C W is the water pressure corrections that will consider 0.5 plus 0.5 D w by D f into B.

So, here D w is the depth of water table below G L and D f is the depth of foundation, B is the width of foundation this is for isolated footing. Similarly, for the raft foundation, this q a net that is 0.088 C w N S that is also ton per meter square. So, this is 5 less than equal to less than equal to that is within value this is applicable within 5 to 50 N value. So, now we by using this consideration we can directly calculate the net allowable, so there is the others correlations also available correlation given by Tin, correlation given by Meyerhof, correlation given by bowels. But I will discussing only this is very popular correlation that we can use that is Peck, Hanson and Thornburn.

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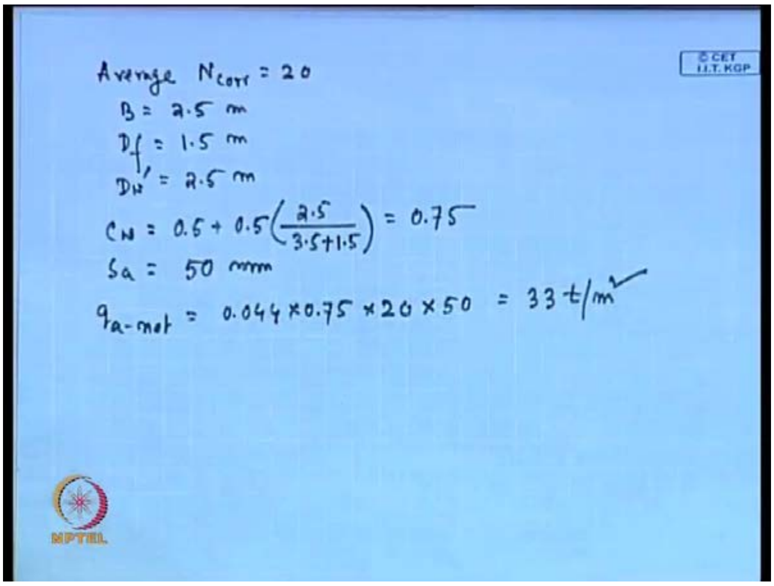

So, now for this case suppose if the average N value, N corrected is 20 say and width of the foundation is say 2.5 meter and depth of the foundation is say 1.5 meter and D w dash is 2.5 meter from the ground level; depth of water table from the ground level. So, we can calculate C w is 0.5 plus 0.5 (2.5 divided by 3.5 plus 1.5). So, this is 0.75 and S a value permissible settlement say 50 millimeter.

So, now what would be the net allowable bearing capacity of the soil. So, by this expression net allowable bearing capacity of the soil 0.044 into 0.75 into 20 is the average N value corrected into 50 is the permissible settlement. So, this is 33 ton per meter square. So, if we know the permissible settlement and this other dimension water table position N value; that means, the SPT value then we can calculate the net allowable bearing capacity of the soil by using this type of expressions.

So, now this we have I have finish the shallow foundation part, so next class I will discuss I will start for the deep foundation part. And then the structural design of this foundation system that I will discuss about the last module of this course.