**Advanced Foundation Engineering**
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Lecture - 14
Design of Shallow Foundation

Class, I have discussed about the settlement calculation of granular soil based on field test. Now, today I will discuss about the design of shallow foundation, because till now I have discussed about the bearing capacity calculation and the settlement calculation, because these two are the main criteria of the design of foundation.

Today, I will explain how to use this two criteria as as a same time that is bearing capacity as well as the settlement to design of a shallow foundation, that mean basically this lecture, I will I will try to design a isolated footing. Now, here design mean this that I will not be discussing about the reinforcement detailing and reinforcement part of the design, here I will basically discuss about the how to choose a dimension of the footing and the depth of the footing; based on the soil parameters considering, and the satisfying the settlement as well as the bearing capacity calculation.

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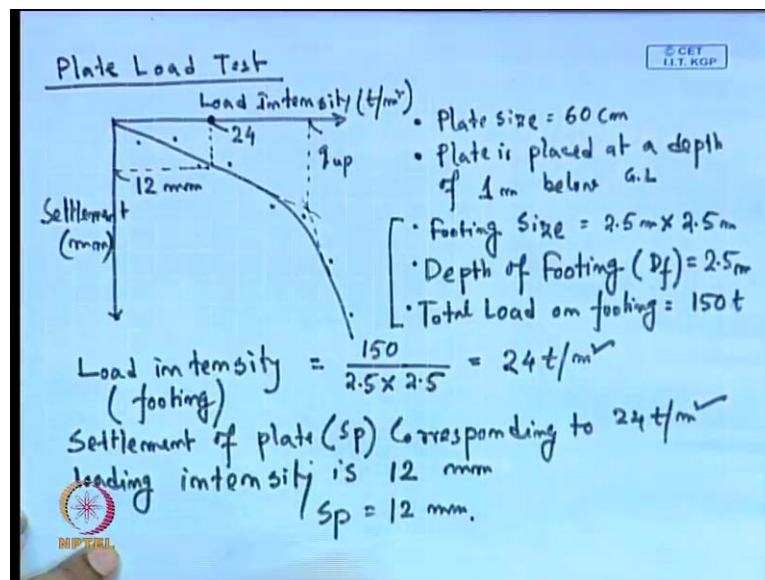
Now, before I start about the design part now, here is I will give you on example the how to apply the calculation or how to use the plate load test data, because last class I have

discussed about the plate load test, and how to get the settlement and bearing capacity from this plate load test.

Here, I will give one example, where we can see that from the plate load test data; this is the plate load test using this plate load test data how to determine the settlement of a real footing. Now, suppose after the plate load test, this is the load versus settlement graph, this is load, this is say ton per meter square or any other unit and this is the settlement, this is in millimeter.

Now, suppose we will get this type of graph from the plate load test, now as I have already explained for this type of graph, we can determine the ultimate load carrying capacity of this plate by using this double tangent method. So, the extend the state initial state portion, and extend the finality state portion, intersection upon the corresponding load intensity is the ultimate load carrying capacity of the plate.

Now, from these plate load test data, we have to determine the settlement of a real foundation, suppose the here the size of the plate or plate size was say 60 centimeter, and the plate is placed at the depth of 1 meter below G n, the plate is placed at a depth of 1 meter below ground level. That means, the condition is plate size is this one and depth of the plate is 1 meter which is plate is under the real footing, the footing size is say 2.5 meter cross 2.5 meter. So, real footing dimension is 2.5 meter cross 2.5 meter, and depth of footing that is D f is 2.5 meter this is also 2.5 meter, so D f also 2.5 meter, now total load on footing is a 150 ton.

So, in the real case the total load that is acting on a footing is 150 ton, size of the footing is 2.5 cross 2.5 as square footing, and depth of the footing is 2.5 meter, the footing depth is 2.5 meter where the plate is placed at the depth of one meter below G L, and size of the plate is 60 centimeter; this is also square plate. Now, the load intensity actual load intensity that we can, so this is on the footing that will be 150 is the total load divided it by the dimension is 2.5 and 2.5, so this is coming 24 ton per meter square.

Now, here these are the points of the plate load test that we have conducting, so now from here the 24 ton per meter square, the loading intensity now from here, now here this is the load is 20 150 ton, now where we have to determine what would be the settlement of this real footing based on this plate load test. Because the, we will we will do the plate

load test whose dimension is 60 centimeter, depth is 1 meter and we will get this type of load versus settlement curve.

And in the real footing this is the real footing data, all this the real footing data this is size and here the total load is 150 ton, so that in the one the footing the loading intensity it 24 ton per meter square. Now, we have to determine what will be the settlement or the real footing under this 150 ton load, now this 24 ton per meter square loading intensity, now from this graph of this plate load test, this is the we have to determine what is the settlement of this plate corresponding to this 24 ton per meter square loading; suppose this is the 24 per tons per meter square value, so corresponding suppose this is 24 tons per meter square this point, this is the loading intensity.

Now, corresponding settlement that we have to determine from this plate, say suppose this settlement is 12 millimeter, so in the real footing this settlement corresponding to 24 ton per meter square is 12 millimeter. So, the we can say the settlement of plate that is S p corresponding to 24 ton per meter square loading intensity is 12 millimeter, now we have to determine so S p, so S p is 12 millimeter.

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Now, if I use this expression that S f is equal to S p into B f B p plus 30 B p B f plus 30 to the power square, so here S p is, so here the known value S p is 12 millimeter, B f with of the footing is 250 centimeter, and B p is 60 centimeter. Now, if we put this value will get this is 12 250 into 60 plus 30 divided by 60 250 plus 30 to the power square, so

this value is coming 21.5 millimeter; so corresponding to this 150 total load or 24 ton per meter square loading intensity, the footing settlement is 21.5 millimeter.

Now, here we have to apply the depth corrections, because depth corrections will be required because there is a difference of the depth of the plate and the depth of the footing, because if the plate was placed at depth of 3 meter from the G L, then this depth correction is not recovered. Now, as this depth is depth of the plate is 1 meter, so there is a difference of 2 meter from the 2 depth, so now we have to apply the depth corrections, suppose D root over L by B this value is because depth correction is depth difference of depth is 2.5 minus 1.

So, this is the difference of the depth into root over 2.5 into 2.5, because this depth correction we are doing that basically, because of the of the difference of the depth, because here the settlement we are calculating is we are considering that it is in the surface level (Refer Slide Time: 11:07). So, at that the but but the real footing is placed at depth certain depth D f, so that D f amount we have to apply some depth correction, because of this depth difference from the surface, and the real footing depth.

But, here the plate is placed at 1 meter depth below G L whereas, the real footing depth is 2.5 meter below G L, so there is a difference of 1.5 meter for from the plate and the footing; so that 1.5 meter due to that 1.5 meter, we have to apply this depth corrections. So, here D is 1.5 meter root over l, so this value is 0.6 and L by B here this is 1, so the correction factor factor is coming 0.83 this is from the chart, so this chart I have already explain or given (Refer Slide Time: 12:00).

So, on the corrected settlement at would be say 21.5 into 0.83 that is 17.85 millimeter, so the corrected settlement of the or actual settlement of the real foundation corresponding to other, the total load 150 ton is 17.85 millimeter is calculated based on the plate load test data. So, in this way we can determine the settlement of the real foundation based on the plate load test data.

The next part that I will discuss about the design of one isolated footing, so for this design purpose we should no some permissible value, so that is the first criteria is our bearing capacity criteria, and second one is the settlement criteria. So, we have to satisfy both this criteria, when we choose the dimension of a footing and depth of the, were we placed that depth of the foundation, so that we will discuss. So, now, for the first criteria

is the bearing capacity criteria, so there we have to apply one factor of safety ranging from 2.5 to 3.

So, factor of safety means, the load carrying capacity of this soil under this footing or loading are footing condition, and the load intensity that is applied on this footing. So, that means the load carrying capacity of the footing is 2.5 to 3 times that should be 2.5 to 3 times higher than the load that is coming on this soil; that means, we have to apply on fact of safety it is 2.5 to 3.

Next in the settlement correction the calculation, so I S code recommends that, so for the different types of foundation whether it is a isolated footing or it is a raft footing, and the different types of soil, whether it is a sandy soil or steep clay or it is a soft clay a plastic clay, so the I S code recommends view permissible settlement. So, that means, we have to go for the permissible settlement that mean, when we do the design have to keep in mind that the settlement of the foundation that should not be beyond this permissible settlement.

So, the settlement of the this foundation should be within thus permissible settlement, so I will consider in this design the I S code recommendation for this permissible settlement, so that means, that element should not be within should be below this permissible settlement, as well as the bearing capacity that here there fact of safety minimum 2.5 we have to satisfy.

Now, here so there are different how different types of settlement are here we have to mention, so that one is our total settlement, the another one is the differential settlement, then the next one is the tilt or the angular distortion. So, then I will first discuss about the different types of settlement, and what are the recommendation of I S code on that regarding the permissible value of of of this different types of settlement, then I will start the design.
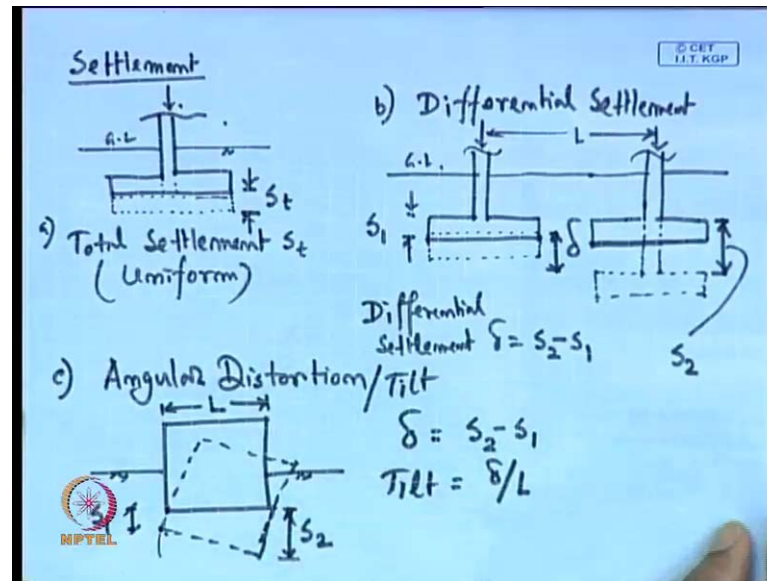
So, first if I go for this different types of settlement, so now for the settlement part, now suppose this is the footing (No audio from 16:00 to 16:21), so one is first one is total settlement or S S t means total. If it is uniform that means, this is the ground level a load is applied, so there is a uniform settlement of this footing; so that mean total footing we will come down here, so this is the new position of the footing after the load is applied.

So, these amount is the total settlement S t if it is uniform, so that means, first one is the total settlement if there is a uniform settlement of the footing that is the total settlement. The next one is the differential settlement, (No audio from 17:28 to 17:47) now suppose this is the two footing for column, this is footing one, this is the ground surface, and this is another footing (No audio from 18:03 to 18:21) (Refer Slide Time: 17:58), so load are applied here this two, and this is the distance between the column is L, so this is also G L.

So, suppose there is a deformation of the footing, suppose this is the deflected safe or deflected position of the footing for the first footing, so this is the amount of the settlement for the first footing, so thus is S 1 is a total settlement of the first footing this is (Refer Slide Time: 18:39). And suppose there is a further deformation of this footing, so this is the amount of deflection, (No audio from 19:11 to 19:18) so this is S 2 or total settlement of the footing of the second footing, so there is a difference between the after the deformation there is a deflection difference, so that amount is this one.

So, this is the delta or the deflect differential settlement of this system, this is took also; that means, this is the settlement because as we know that for the different types of footing the loading condition may be different, and when your calculating this footing that the soil beneath this footing one, and footing one there may not be same. So, if this is different type of soil, and the loading condition is the soil condition is not same between the two footings, if the loading condition is not same on this loading that is coming on the footing.

Then there is chance that is that the amount of settlement for this two footings may not same, so that means there is a differential settlement between these two footing, so that is call the differential settlement, so that we have to also calculate now, if one to make this two settlement same. Then you have to design of foundation such that, under the soil condition beneath the two different types of footing or do different footing, because the soil condition may not same.

So, that means, we have to design or footings such that, the under the two different soil condition the and the two different loading condition also the settlement would be same, so in that case there will be now differential settlement. So, if we want to avoid the differential settlement, then we have to consider or design that two system such that, there we know such differential settlement.

So, that mean the total settlement of one column, and total settlement of the other column that should be same or within the permissible limit, so that means, here the differential settlement (No audio from 21:24 to 21:34) (Refer Slide Time: 21:24) is delta is S 2 minus S 1, and if that is a tilt or the if this total system deform uniformly then this points settlement. And the last one is another one is the angular distortion that also we can, suppose the total 16, suppose this is the initial position of one system or one billing.

Now, due to the difference about the here, suppose there is a this is the deformation or the settlement of this billing or the deformation safe of this billing after the deflection, so this is the deformation say, so that means, we can say suppose this is a settlement of the first or the this corner is S 1, and this is the settlement of this corner is S 2. So, again here also there is a differential settlement, now the difference of this differential settlement because here the total system is tilted or this is angular distortion or you can say this is the tilt, so because of this tilt this billing it is angel that we will get.

So, here also that delta is we will get S 2 minus S 1, so the angular distortion all the tilt that we will get delta by r, if the total length of this two corners are this is L. So, that means, there is a three different types of settlement, one is our total settlement this uniformly settlement is S t, on this is the difference of settlement where the two columns, this is a two differential settlement the difference of these two column settlement will give you the differential settlement (Refer Slide Time: 23:18). And the angular distortion of the T the total system T's any direction, so I am that is because of this settlement difference the two different corners.

So, this air the first corner difference is S 1, and the second corner is S 2, so tilt will be delta by L were delta is S 2 minus S 1 del L is the del L between two corner. So, that mean when you design, this all the permissible value for the all the total settlement differential settlement and angular distortion of the tilt we have to satisfied.

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Now, in the next thing is I will give the total permissible limit of this different settlement, so first through the IS code recommendation this is for the IS code 1904 to 1978. So, according to this IS code if I draw this table, so this is the footing (No audio from 25:06 to 25:18), and this is the type of sand, we can say this sand, and hard clay, and another one we can say this is the plastic clay.

So, we are also we will give for the maximum settlement of the total settlement, then will go for the differential settlement, then we will go for the angular distortion, here also will

go for the total, differential, and angular (No audio from 26:27 to 26:36), so these are the different permissible value that will give, for this is the footing. So, first if it is isolated footing, so this is isolated footing the if this is resting on, if it is a resting sand or hard clay, in the permissible total settlement is 50 mm differential settlement is 0.0033 L, and angular distortion is 1 by 300; where L is the length where L is the length of deflected part of wall or raft or center to center distance between column (No audio from 28:11 to 28:18).

So, either L is the total length of deflected part of the wall or raft or center to center is the distance between the columns, so this is for the isolated footing. Now, if it is resting on the plastic plate this isolated footing, then the maximum settlement is permissible value is 50 mm, differential settlement again 0.0033 L and angular is 1 by 300, now here this is for the isolated, it is isolated steel structure (Refer Slide Time: 28:59).

Now, these conditions are for the isolated steel structure, for next one is this is isolated RCC structure, I mean this is steel and this is concrete, reinforced cement concrete RCC structure (Refer Slide Time: 29:29). And again this permissible value for the maximum settlement for the total settlement for the sand or hard clay, this 550 mm and then this is 0.0015 L is the differential settlement, and angular distortion is permissible 1 by 666. And for the plastic clay or the clay, which is 75 millimeter and this is 0.0015 L, and this is 1 by 666 for the angular distortion, so this is for the angular distortion.

Similarly, the next one the raft foundation or max foundation in steel, for steel structure raft foundation, the permissible total settlement on the sand it 75 mm, (()) differential settlement limit is 0.0033 L, angular distortion 1 by 300, and for up clay this is 100 mm this is 0.0033 L, and this is also 1 by 300 (Refer Slide Time: 30:59). Similarly, for the raft foundation or mat foundation RCC structure is permissible value for the total settlement on sand is 75 mm, differential settlement is 0.002 L, angular 1 by 500, on the clay plastic clay this is 100 millimeter, this is 0.002 L the differential settlement, and angular is 1 by 500.

So, these are the table for the permissible settlement, for the footing isolated steel on the sand and clay, isolated RCC on sand and clay, raft steel on sand and clay, and raft RCC on sand and clay. So, total settlement difference for the isolated steel is 50 mm, and RCC also 50 mm and sand, raft for steel and RCC both on sand is 75 mm, and isolated steel on

plastic this 50 mm, RCC 75 mm, and raft or both steel and RCC on the plastic clay for maximum settlement limit is 100 mm.

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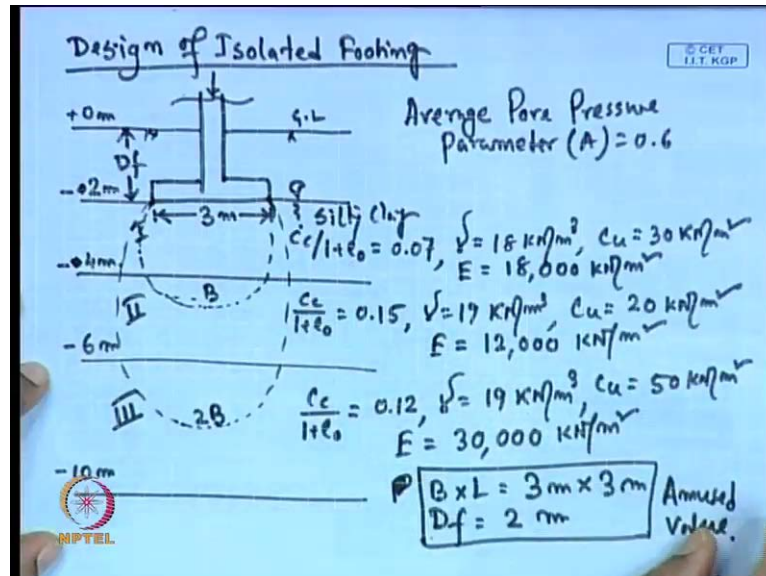
So, now we will design this isolated footing, considering this total design consideration, so suppose we will design this footing (No audio from 32:55 to 32:12), this is the isolated footing will design a particular particular footing. So, is this is the footing, so here we will design or choose the dimension of the of a single footing or a isolated footing, and we will consider only the here for maximum settlement consideration.

Because, we are not considering the other footing, and then if we are continuing two or three footing or column, then you have to go for the differential settlement or the angular distortion. But here we will consider I will design the only one particular column footing, so there so we will consider the permissible settlement of maximum settlement only, and as as well as the bearing capacity calculation.

So, this is the footing which is the, this is the ground level or plus 0 meter, this is ground level; now suppose the depth of the footing we assume is 2 meter, and the position of the water table is also at 2 meter (Refer Slide Time: 34:07). Now, this is the first layer is thickness is from the ground level is 4 meter, and this is the second layer (( )) thickness of this is, this will be minus, this is down word direction, so thickness is 6 meter and this is the third layer (( )) thickness is that mean 10 meter (( )) 4 meters, this thickness is 2

meter and this is the 4 meter, so total 10 meter soil strata we have, this is the layer 1, this is layer 2, this is layer 3.

So, the condition that is given this is for the silty clay, so here Cc by 1 plus e 0 value is given 0.07, for this layer gamma unit weight is given 18 kilo Newton per meter cube, Cu value is given 30 kilo Newton per meter square, and e value we have calculated here all the clayey soil (Refer Slide Time: 35:35). Because this is the all are the clay is start a we will calculate e considering 600 Cu, if I consider that thing, that means e value is given 18000 kilo Newton per meter square.

So, similarly for the third strata the Cc 1 plus e 0 value is given 0.15, so these are the soil parameter after the testing these values are given, for the and we will use this value for the design purpose. So, 0.15 then gamma is 19 kilo Newton per meter cube, Cu is 20 kilo Newton per meter square, and E for this second layer is 12000 kilo Newton meter square, Cu also in meter square. For the third strata this is Cc for the third layer, e 0 value is 0.12, gamma is also 19 kilo Newton per meter cube, Cu value is 50 kilo Newton per meter square, and E for the third layer is given 30000 kilo Newton per meter square (Refer Slide Time: 36:58).

Now, the pore water pressure coefficient for the, all the average pore water pressure parameter a, so (( )) we can write the average pore water pressure (Refer Slide Time: 37:37 to 37:49) parameter A is given 0.6. Now, we have to choose a proper dimension of the footing and depth of the footing, so here for the first trial we choose that or dimension is 3 meter by 3 meter are square footing, so that means, the dimension that we will choose, so that is B cross L is equal to 3 meter cross 3 meter.

And D f as I have already mentioned, the D f value we have taken that at the 2 meter, so depth of the footing is 2 meter, so now considering the first trail will consider this value, we assume this is our assumed value, assumed value for the first trial. Now, we will design this thing, and we will say whether this assumption or these dimensions is satisfying the bearing, as well as settlement calculation or not that is our task.

So, now for this thing, this is the dimension of the footing, so that means the for the bearing calculation zone will be up to D, and for the settlement calculation zone will be up to twice B, so twice B means up to 6 meters, the influence zone for the settlement calculation up to 6 meter. So, this is the influence zone up to 6 meters, and for the

bearing capacity this is the influence zone up to 3 meter (Refer Slide Time: 39:26), so I have mentioned for the bearing calculation, we will consider the influence zone up to B, so this is for up to B, this is for B, and this is for twice B, this will use for the settlement and this is for the bearing. Now, bearing up to B means 3 meter, and 2 B is means 6 meter, so now, for the our as I have mention this is the assume dimension.

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So, now, the net load that is acting and another thing the total load that is acting here, the total load is 600 kilo Newton, so total load that is acting on this footing or this column is 600 kilo Newton. So, that mean the net footing pressure is 600, and our assume dimension is 3 by 3, so this will be 66.7 kilo Newton per meter square, this is the assume, this is the total loading intensity is coming on the footing base.

So, first and we have taking the D f is also 2 meter, so first we will calculate the Bearing Capacity, so here we will use the Skempton bearing capacity expression, that is bar in net ultimate this Cu Nc. This is for the bearing net ultimate load using the Skempton expressions, where Nc is given 5 1 plus 0.2 B by L into 1 plus 0.2 D f by B, for as it is a square footing, so B by L is equal to 1, so directly we can write this is 61 plus 0.2 D f by B.

So, here D f we can write, so this is 6 1 plus 0.2 into D f is 2 meter, B is 3 meter, so this is coming 6.8 it is less than 9; it is ok. Now for the when we calculate the C value, this is for the Skempton expression skempton expression that we have used. Now, for the Cu

part we have taking the weighted Cu value, because from this figure we can see for the bearing capacity calculations this is the influence zone; so to this total 3 meter, 2 meter is in the first layer, and 1 meter is in the second layer.

So, we have taking the weighted c value instead of taking this the first layer value, because all the most of the influence zone is within first layer. But we have taking the weighted average value c u value C u value that is for the two layer for the first layer 2 meter and one meter for the second layer. So, first layer C u is 30 and single layer C u is 20. So, weighted C u value will be 30 into 2 plus 20 into 1 divided by 3, because or v is 3 meter.

So, influence zone will be up to 3 meter for the bearing, so this value is coming 26.67 kilo Newton per meter square. So, q net ultimate will be C u value is 26.67, N c is 6.8, so this is 180 1.33 kilo Newton per meter square. Now, the factor of safety, that we will calculate our net ultimate is 181.33, then divided the total load intensity that is coming is 66.7.

So, the value is 2.7 is the factor of safety that is coming which is greater than 2.5, so you can say this is set against bearing. So, the load carrying capacity in net ultimate load is 181 ultimate state is 181.33 kilo Newton per meter square, where that the, so that end the load that is coming is 66.7 kilo Newton per meter square. So, fact of safety will be 181 divided by 33.3 181.3 0.3 divided by 66.7, so 2.7 which is greater than 2.5, so it is safe against bearing.

So, next we will go for the settlement calculation or the settlement calculation (No audio from 44:57 to 45:08) and we will consider the same dimension of the footing, first we will calculate this is the B is the settlement calculation, I will first we will calculate the immediate settlement (No audio from 45:18 to 45:32). So, now here q n u is sorry q net intensity is 66.7 kilo Newton per meter square; that means, this is the load intensity coming on the footing.

And B we have assumed 3 meter mu for the clay soil of taken 5.5 that is we have taken in I f is 1.12 at we have for the I f at the center that is from the table. So, this is from the table for the influence factor table that I have given, so from their we will give the I f values is 1.12. So, here also that we've when you calculate the E, because thus immediate settlement expression is q n into B divided by E (1 by mu) square into I f.

So, we know q n is 66.7 kilo Newton per meter square, B is 3 meter mu is 0.5, I f is 1.12, so we have to calculate the E value. When we calculate the E value here also we have taken the weighted average E value, because for the bearing capacity, we have taking the influence zone is for the bearing capacity of taking influence zone is up to B, the settlement calculation of taken influence zone is up to twice B.

So, here first 2 meter for the first layer, second 2 meter for the second layer and third 2 meter is for the in the third layer. See, for the calculation of E we have taking the weighted value, so this is E will be 18000 into 2 plus second layer E value is 12,000 that is also 2, third layer E value is 30,000 that is into 2 divided by total thickness 6. So, the E value is coming 20,000 kilo Newton per meter square. So, our S i immediate settlement that is 66.7 into 3 divided by 20,000 into 1 by 0.5 (1 minus 0.5) square into 1.12.

So, this value is coming is 8.4 millimeter. So, in the immediate settlement we have to apply the corrections, now these corrections are so here isolated footing. So, rigidity correction is not require, so only correction for immediate settlement is the depth

corrections when we calculate the consolidation part then we have to apply the depth correction as well as the consolidation correction. For the immediate settlement this correction is the depth correction now for the depth corrections, so our d by root L by L B. So, this D is 2 meter L is 3 B into 3, so this is going 0.67 and L by B is 1.

So, correction factor that is equal to from the chart, because this correction factor chart that I have already given, that from the chart corresponding to D by root L B 0.67 and L by B equal to 1 the correction factor is coming 0.8 point. So, this immediate settlement corrected that will be 8.4 into 0.81, so this is coming 6.8 millimeter. So, immediate settlement total immediate settlement is 6.8 millimeter.

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So, next we will calculate the consolidation settlement or the second part is the consolidation settlement. So, when you calculate this is for the consolidation settlement our expression is cc 1 plus E 0 the summation H thickness of each layer in to log p 0 bar plus del p into p 0 bar. So, for the consolidation corrections, we have taking the three points (Refer Slide Time: 50:29) one point to the center of the first layer that is the 2 meter that is a, second point a center of the second layer it is B. And the third point is center of the influence zone within the third layer.

So, distance of this a point from the base of the footing is one meter distance of B point from the top of the first layer is 1 meter distance of c point from the top of the third layer also this is 1 meter, this is also 1 meter (Refer Slide Time: 51:07) and this one is also 1

meter. Because this is the center of this (( )) this layered first layer thickness below the base of the foundation is 2 meter. So, this 1 meter is a point is 1 meter below the base of the foundation. Now, this B point is the center of the second point the second second layer, second layer thickness is 2 meter.

So, this is also 1 meter from the top of the second layer, now the influence zone within the third layer is 2 meter. So, the point is 1 meter from the this starting of the third layer. So, when we get this 3 point, so we will calculate at a this p 0 bar we will calculate this is 2 is the 18, because the first 2 meter the water table as the 2 meter (Refer Slide Time: 52:02) from the ground label.

So, this will be 2 into 18, 18 is the density we consider this as saturated density, we consider this saturated and the bulk also use the this 18. So, 2 into 18 plus 1 meter below thus bottle level. So, this will be 18 minus 10, so this value is 44 kilo Newton per meter square. Similarly del p if you consider two is to one distribution this will be 67 into 9 into 3 divided by 3 plus 1 and 3 plus 1. So, this is 37.52 kilo Newton per meter square consider two is to one distribution.

Similarly, at B the p 0 bar that will be two into 18 plus first layer 2 into 8 plus the second layer 1 meter 1 into 19 is the density unit weights. So, 19 minus 10 this is 9, so this is 61 kilo Newton per meter square. Similarly, del p considering this against is to one distribution 3 into 3 this is the density of 3 and this thickness is from the base is 2 meter for the first layer plus 1 meter from the second layer this is 3 meter. So, this is plus also 3 meters square footing, so this is 16.7 kilo Newton per meter square.

So, at c p 0 bar that calculation is 2 into 18 plus 2 into 8 plus 2 into 9 in the second layer plus 1 into 9; in the third layer in the third layer also unit weight is 19. So, this is in the below water level, so it will be 9, so 79 kilo Newton per meter square. Similarly we can calculate del p is 66.7 into 3 into 3 divided by 3, because total distance of this c point from the base of the footing is 2 meter from the first layer 2 meter from the second layer plus 1 meter in the third layer, so this will be 5.

So, this is also 3 plus 5, so this is 9.4 kilo Newton per meter square. So, once we get this value then finally, if we put this value in this consolidation settlement calculation.

So, then we will get this is for c c for the first layer is 0.07 thickness is 2 meter, this is log 10 (44 plus 37.52 divided by 44), then plus c c for the first second layer is c c by 1 plus E 0 is 0.15 thickness is 2 meter, this is log 10 del p 0 is (61 plus 16.7 divided by 61) plus c c divided 1 plus E 0. For the third layer is 0.12 thickness is 2 meter; thickness 2 meter is means only the influence zone thickness in the third layer not the total thickness of the third layer. This is by considering only influence zones of the third layer log 10 (79 plus 9.4 divided by 79), so the total settlement we will get 80.75 millimeter.

Now, the depth correction factor is here 0.81 as it is for the immediate settlement, and the pore water pressure correction pressure correction that we will get from the chart is 0.7, because A is taken 0.6 and H c by B influence zone; that is 2. So, the chart I have given for the to calculate the pore water pressure correction correction factor from that is chart corresponding to A and H c by 2 we will get 0.7.

So, S c corrected is 80.75 into 0.81 into 0.7, so this is 45.78 millimeter, so the total settlement will be the immediate settlement corrected plus the consolidation settlement. So, this is 52.58 millimeter which is less than 75 millimeter that is permissible, so this is safe. So, because in the clay and this is RCC structure. So, permissible value is 75. So, that is safe for the RCC structure. So, in this fashion we have designed the isolated footing and we have calculated the first we have chosen the dimension and the depth of

the footing, and based on that web design and the all that things are within the permissible limits, so our design is safe.

If it is not safe then we have to go for the next trail, and then we have to choose the new dimension in the depth and this fashion we have to determine the dimension and the depth of the footing to design this isolated footing. So, next class I will design the raft foundation and other techniques also I will discuss to design any foundation system.