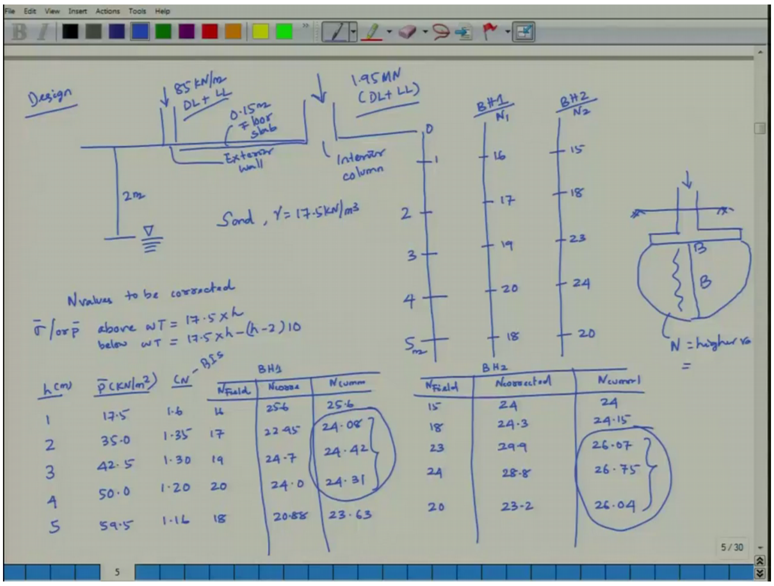
Foundation Design
Prof. Nihar Ranjan Patra
Department of Civil Engineering
Indian Institute of Technology, Kanpur

Lecture – 14A
Design of Foundation – Part 4

Last 2 lectures, I have solved 2 problems; just for a review foundations; shallow foundations in sand, shallow foundations in clay, first example was shallow foundation in sand.

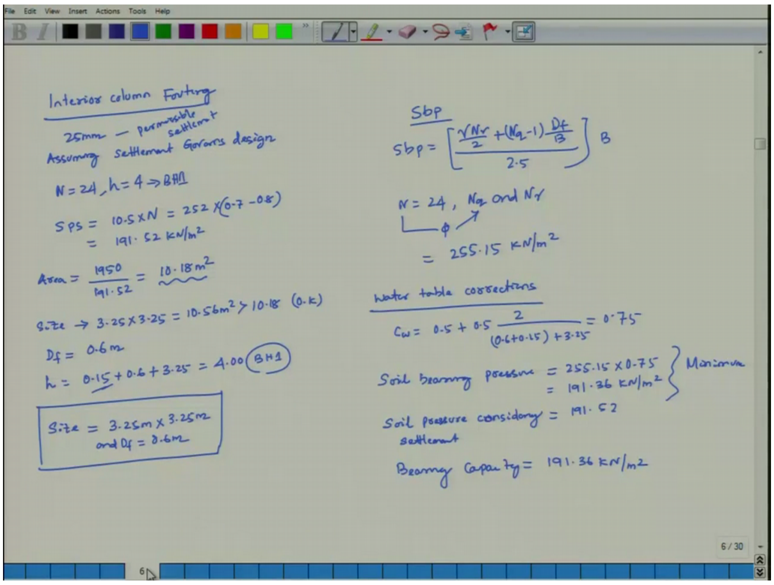
(Refer Slide Time: 00:41)



Here nothing has been assumed, rather in this case, if you look at here these has been based on the field data or the bore logs, first one what we have solved; there is a building, in the building, there is there are interior columns. This interior column have a load 1.95 or 1950 Kilo Newton del load plus live load as well as. There is one exterior wall and there are 2 bore holes; one is nearer interior column, the bore hole is here and exterior wall another bore hole is their water table and all properties as been given.

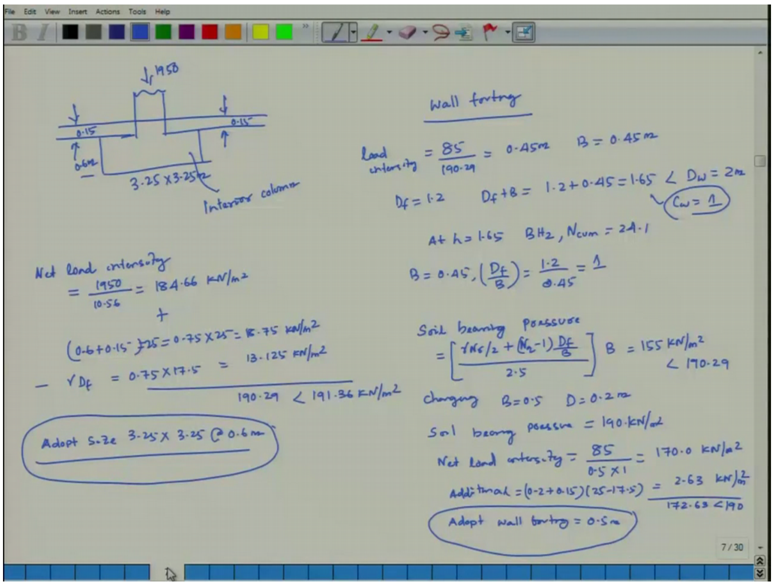
So, the calculation has been made for bore hole one and bore hole 2 based on your ASTN and N cumulative as been calculated and looking at the profile where you; we are getting a consistent value of N value. So, that within that region, this pressure wall should cover once you know the zone of influence of the pressure wall automatically your dimension will come into picture automatically your depth of the foundation will come into picture.

(Refer Slide Time: 01:52)

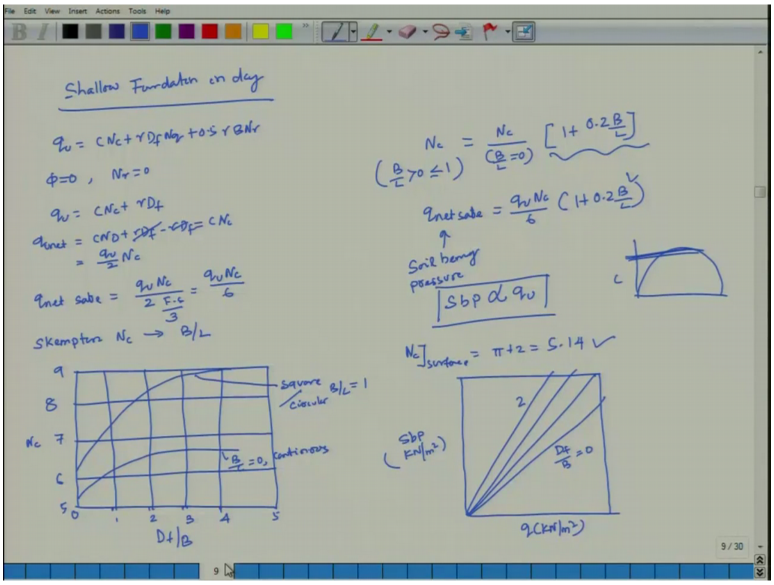


So, based on that your size of the footing is 3.25 by 3.25 and at the same time I have also checked whether this bearing capacity has been satisfied. Also you can check whether the settlement permissible settlement 25 mm has been satisfied or not then one more problems I have solved.

(Refer Slide Time: 02:15)

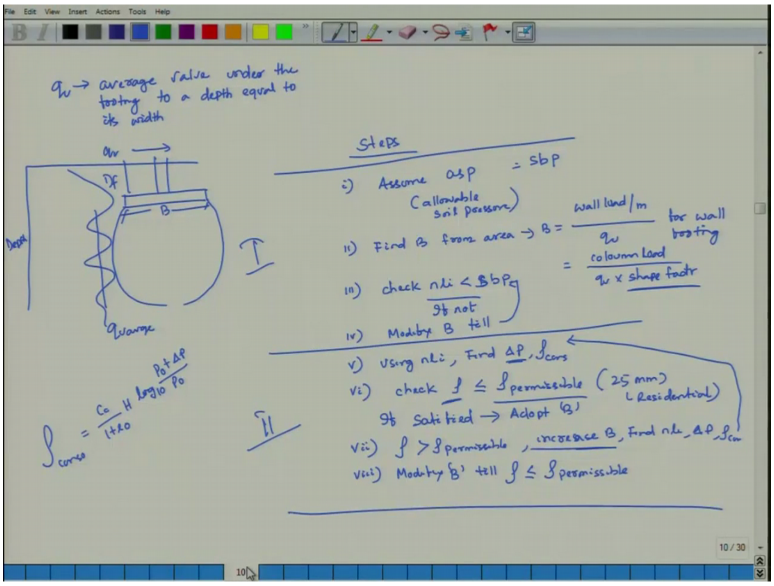


(Refer Slide Time : 02:21)



For the case of shallow foundations in clay, I have explained for purely cohesive soils 5 is equal to 0 and N gamma is equal to 0 and it is nothing, but if I write it bearing soil; bearing pressure is directly proportional to your q u there are charts of l label N c verses D f by B and I have also explained there are 2 steps.

(Refer Slide Time: 02:44)

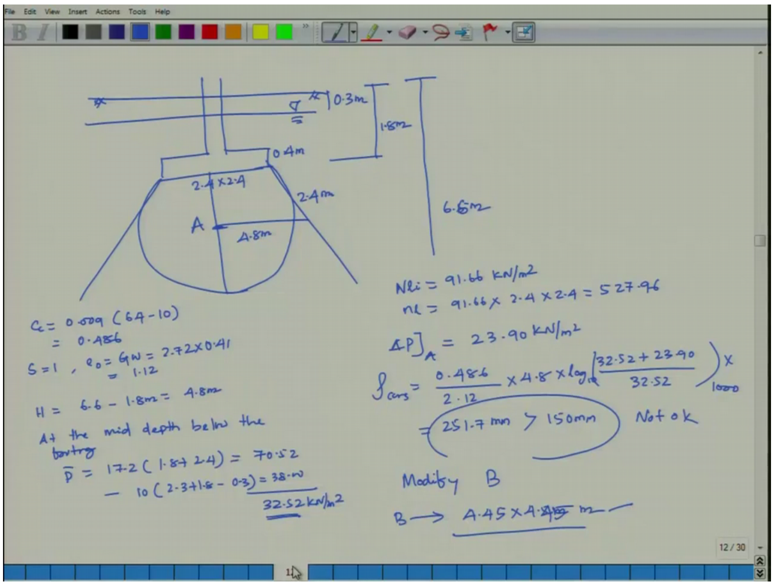


Step one is your assuming allowable soil pressure is equal to soil bearing pressure, find it out, what is the dimensions? Once you get your dimensions then with these dimensions check your permissible consolidation settlement at any stage suppose at any stage if it is not satisfied, then you modified the value of the B. So, this case one example I have solved last class; there is a case and there is a column interior column load is 510 Kilo

Newton and all other properties has been given there is a CPT value and q u is given and average q u value has been given.

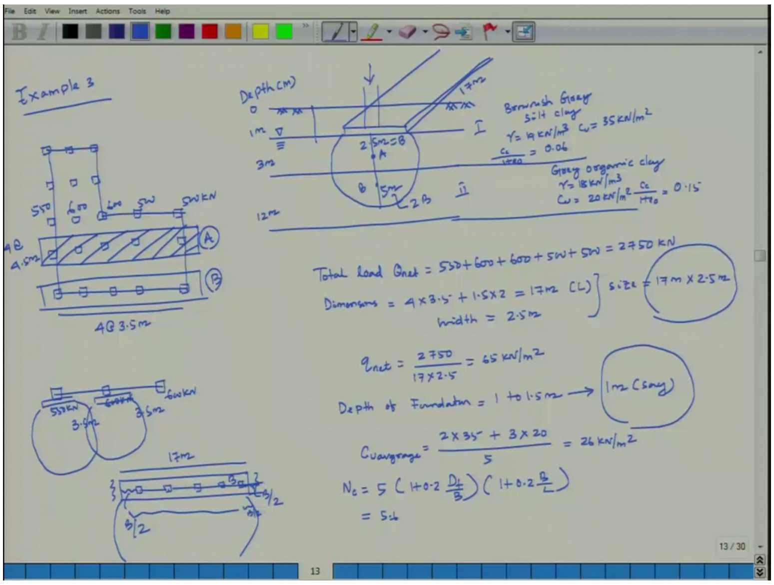
So, based on that so, for step one, we have calculated the dimensions size of this foundation is your 2.4 meter by 2.4 meter; remember anything has not been assumed based on the sub soil profile the design has been made then while going to your settlement check going to settlement check, it has been observed that the settlement is not coming within the permissible limit; that means, it has been given maximum settlement should be 150 mm.

(Refer Slide Time: 03:54)



So, it is coming out to be 251.7 mm. So, it is not. So, based on that B value has been modified and the B value comes out to be 4.45, by 4.45 meter taking into this dimensions you can check yourself, this is for you kind of a home assignment; home assignment, you can check whether with this dimensions, whether this foundations is going to satisfy the bearing capacity criteria as well as settlement criteria this is what I have gone through.

(Refer Slide Time : 05:07)



Let us come to one more problem; interesting problem, I will solve one by one few examples go to the examples 3.

So, in example 3, rows of column in a building as been given, let me put it in this 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 then here also in between I put it. Now this is the dimension as been given. So, if we look at the dimension of individual column has been given its kind of 550 in this row. This is your 600, this is again 600, this is your 500, this is your 500 Kilo Newton and this dimensions is given 4 meter at the rate of 3.5 meter, here 4 at the rate of 4.5 meter.

So, what does it mean? 4 at the rate of 3.5 meter; that means, distance from here to here is 3.5, 3.5, 3.5, 3.5, equally. So, this is total 4; 1, 2, 3, 4 where even drawing is slightly wrong. So, it will be 3.5 meter each here 4 at the rate of 4.5; 1, 2, 3, 4.

Now, there are rows of the columns. Now what else it is given? It is also given sub soil profile. Let me draw the sub soil profile. This is your depth in meter, this is 0, this is your 1 meter and suppose to be a from putting it, do not put it; what kind of foundation it is supposed to be, then here it is 3 meter, here it is 12 meter and there are 2 zones, if I can write it water table located at below 1 meter; this is your ground surface, let me put it and this is zone 1 and this is zone 2; in zone one, it is brownish grey silt clay, here gamma is given 19 Kilo Newton per meter cube C u is equal to 35 Kilo Newton per meter square C c by 1 plus e 0 which is equal to 0.06; let me extend it also, this one here; it is grey organic clay gamma is equal to 18 Kilo Newton per meter cube C u under cohesion is equal to 20 Kilo Newton per meter square C c by 1 plus e 0 is equal to 0.15; this is what the sub soil profile as been given and this is what your column expected column loads suppose to come rows of columns are there and there is a building of L shape, if you look at here, this is a kind of L shape building has to be constructed.

You can solve this problem many ways; you can solve the problem many ways; how considering each column load you can consider as one of your isolated footing isolated; footing means suppose here one column is here; suppose for example, here it is there, I am taking this row this column is your 550 Kilo Newton load here, it is 600 Kilo Newton, here it is also 600 Kilo Newton; the distance is 3.5 meter; the distance is 3.5 meter.

We can do it and individually also you can find it out first considering this with your sub soil profile, this is a very long problem considering these with this sub soil profile; you can find it out the width of the foundations, it may be any size because no assumptions. So, once you get the width of the foundations then you apply for your pressure intensity because load of the column is given this is your pressure wall.

Consider second one as if it is an one of the individual isolated footing take the sub soil profile and find it out the dimensions again plot your pressure wall and look at here whether the 2 isolated footings is there any overlap of pressure bulb or not if there is any overlap of the pressure bulb, then it is not go even not into recommend for an isolated footings then what else let once isolated footings as gone go for a combined footings.

Combined footings again many types either you can combine with a strip foundations or you can go for a raft foundations or you can go for a kind of a rectangular loaded foundations, considering here bigger; this space here minute be available this space here minute be available this space here minute be available. So, let us try with this a row of the foundation first one strip foundations or a row of the foundations; if I take the row of the foundations. So, let me put it in such a way that I am covering 1, 2, 3, 4, 5; 5 columns in a row this is called your strip.

So, then based on that what will happen? I am taking a strip here foundations over the foundations; all your columns loads are here; that means, it had a one size and once you take it, suppose this is a one row, similarly you can take a this is a another row here, if there are 2 rows then you check also pressure bulbs this pressure bulb will go like this, here you can take pressure bulb; here you can take the pressure bulb whether this pressure bulb super impose or not that also we can check if it is super impose like this then this strip foundations also are combined in a strip is not going to be recommended then what else left first you have tried for isolated foundations then you have tried for strip then there is no alternative rather then you can go for raft foundations.

Let us start with this strip. So, total load I can put it q net for this strip; let us put this strip is A and this is A because any way it is same A, B, C; if I am putting another strip here; these are the same load intensity coming 550, 600, 600 plus 500 plus 500 which is equal to 2750 Kilo Newton.

Now, with this 205 Kilo Newton, how do you find it out your dimensions; how do I take the dimensions you have to identify the dimensions look at the dimensions; how I am taking 4 into 3.5 here; 4 at the rate of 3.5 because this spacing this spacing this spacing this spacing completely included 4 into 3.5 plus here, if it is a 3.5 then distance is 3.5 here generally I have to if this is my B, here it will be generally taken by B by 2 here we generally we take it by B by 2.

So, then it will be 3.5 divided by 2; it will be 1.75. So, rather I put it 1.5 into 2; these are my dimensions calculations; how it has come 4 into 3.5 centre to centre distance is your 3.5; here to here distance is your 3.5 here, here, here, 1, 2, 3, 4. So, that is why 4 into 3.5 plus 1.5 into 2 which is equal to 17 meter.

Now, what should a width length; I got it, this length is 17 meter. So, width will be generally if I take it here, this will be kind of you can put it in this way also B by 2; here to here also B by 2 or here to here also half; we can take it B by 2; B by 2; it will be B approximately it will be B. So, B is your 3.5 we can consider width it is your length you can consider width is equal to say 2.5 meter.

So, size is equal to 17 meter into 2.5 meter. Now total load intensity is known; now find it out q net; q net is equal to 2750 divided by 17 into 2.5 which is equal to 65 Kilo Newton per meter square. In this case depth of the foundation because this is a shallow foundation depth of the foundation initially you start with an assumptions water table is located at what one meter.

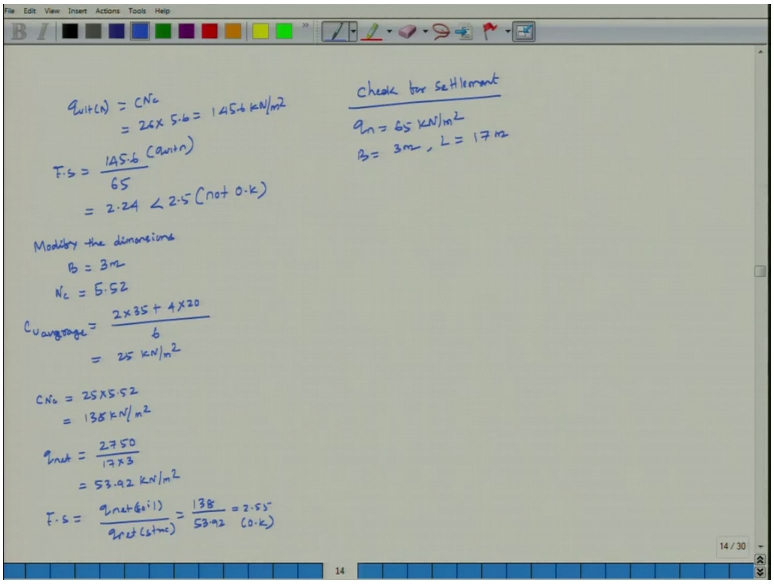
So, generally what depth of the foundation people generally assume or taken generally depth of the foundations which is equal to either 1.5 meter because water table is located at 1 meter I assume or I take it depth of the foundation say 1 meter; say do not want to put below the water table because what will happen why it has been taken one meter what will happen beyond one meter because you have to Exabyte because water table at one meter you have to Exabyte. So, that you are concreting steel or caging it has to be prepared here then you have to go for concreting then refill it.

If water table is there; then if you go beyond water table then you have to take out the water by pump out then do it. So, now, size I got it depth of the water table I got it let us start with this design. Now one size is 2.5 meter by 17 meter say B is equal to 2.5 meter and here it is going in these directions. It is your 17 meter, now as it is 2.5 meter; 2.5 meter, try to understand 2.5 meter. So, if I go up to 2 times B 2.5 into 2 is your 5 meter.

Let me draw the pressure bulb. So, total will be 5 meter considering it is your 2 times B and this is my B. So, once it is 5 meter; that means, first 2 meter one soil layer the next 3 meter another soil layer, fine, here it is a here it is B at the middle almost 50 percent 50 percent of the soil 50 percent of the soil is coming one of the sub soil profile another 50 percent is coming another sub soil profile. So, in that case better to consider average value. So, C u average 2 into 35 here it is 35 is given plus 3 into 23 into 20 divided by 5 which is equal to 26 Kilo Newton per meter square; that means, I have considered only one C u value and considering this one C u value you can go for both way this side as well as other side also you can go it you can find it out.

But instead of doing that considering only one C u value that would be better way of designing you can go then let us go for your N C; N C is nothing, but what we have a formula because at this surface is your 5, it is 1 plus 0.2 D f by B into 1 plus 0.52 B by L and it comes out to be 5.6 depth of the foundation D f; this is my depth of the foundation B 2.5 B is equal to 2.5l is equal to 17 meter this distance you can put it as l come to the next step; find it out q ultimate N.

(Refer Slide Time: 23:11)



Net ultimate or net safe ultimate C N C by factor of safety because sub soil profile is your purely cohesive soil, there is no 5, it is purely cohesive soil, there is no 5. So, then it comes out to be 145.6 divided by 2.5 whatever is your divide 145.6; I am not putting it a factor of safety q net; I am taking it C N C not safe q ultimate net I am taking C N C which is equal to 26 into 5.6 which is equal to 145.6 Kilo Newton per meter square.

Now, factor of safety 145.6 divided by 65; this is your q ultimate net soil and where is your 65; look at your q net; load intensity is your 65, then the factor of safety is comes out to be 2.24 which is less than 2.5 then not then what is the next step next step as to be you have to increase the size at least B, B means you have to increase this B this size as to be increased.

Let us start with this, we modified the dimensions modified the dimensions. So, let us say B is equal to 3 meter then N C comes out to be N C; N C from here is your N C, using the same equation, N C comes out to be 5.52, right, then C u average has to be changed because once it is a 3 meter then it will become a 6 meter to 4 then is your C u average 2 into 35 plus 4 into 20 divided by 6 which is equal to 25 Kilo Newton per meter square.

Now, C N C is equal to 25 into 5.52 which is equal to 138 Kilo Newton per meter square. Now q net 2750 divided by 17 into 3 q net has to be changed. If you look at q net 2750, total q load and dimension is changing q net also changed. So, it will be 17 into 3 length is 17 width is your 3 and with this 17 into 3 this comes out to be 53.92 Kilo Newton per meter square.

Now, look at your factor of safety; factor of safety is your q net soil by q net structure which is equal to 138 divided by 53.92 which is equal to 2.55. It is now this part is; so, let us go to the other part; what are the things to be done bearing capacity part is now we will go for settlement part. For settlement part check for settlement; that means, what are the things has been given q N is your 65 Kilo Newton per meter square B is equal to 3 meter L is equal to 17 meter and all other value will take it from sub soil profile settlement calculations I will discuss in the next class.

Thank you.