Foundation Design
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Lecture – 6A
Bearing Capacity of Shallow Foundation- Part 3

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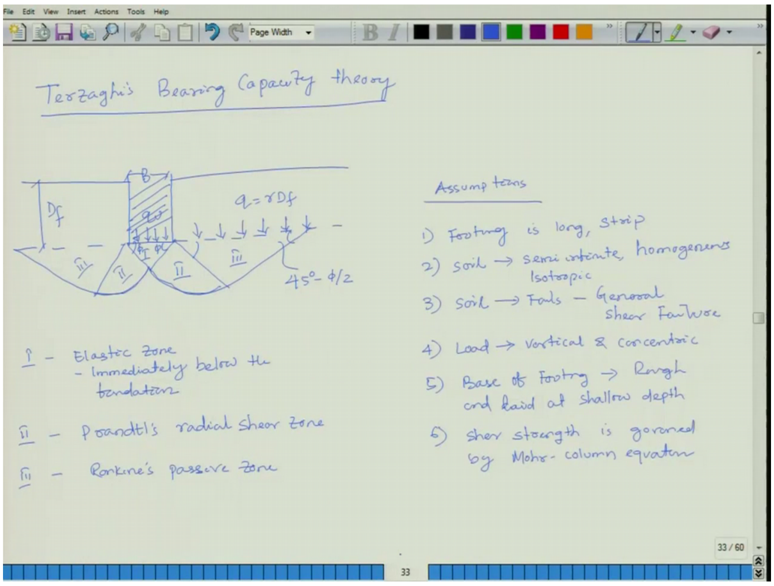

So last class I have finished Terzaghi’s bearing capacity theory and this bearing capacity theory there are assumptions and it is applicable for strip footing and the failure mode is assume to be general shear failure and the derivation has come for this bearing capacity theory and the ultimate bearing capacity is your C N c gamma D F, N q 0.5 gamma BN gamma. N c, N q and N gamma are bearing capacity factors it depends upon your phi then up to this I have finished. So, there are charts available for bearing capacity factors also tables available.

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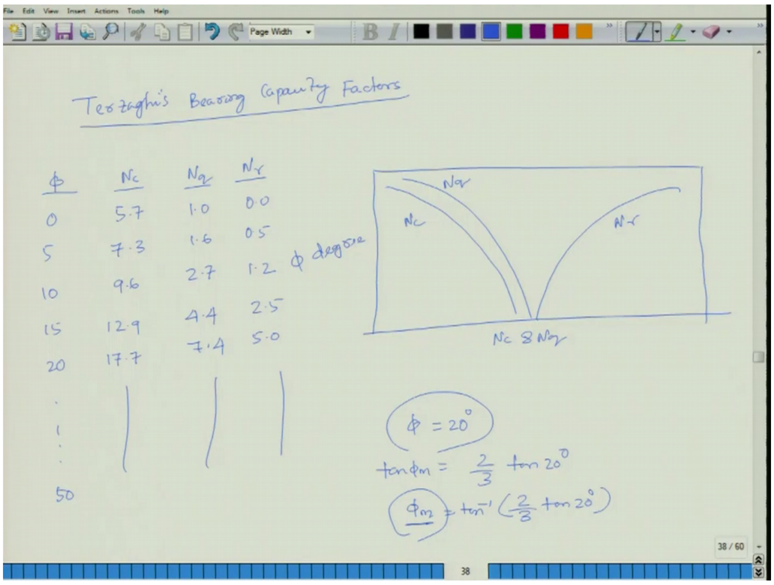

So, few parts I am writing it. Terzaghi's bearing capacity factors where different value of phi with a phi. So, then N c, N q, N gamma you can take this charts or this table. So, with you for examination point of view here it is 0 degree, 5, 10, 15, 20 and it will continue up to 50 because maximum value of the phi in the validities 50 degree, N c is 5.7, N q is 1.0 and gamma is 0.05 is equal to 0 degree, 5 degree it is 7.3, 1.6, then is your 0.5, then 9.6, 2.7, 1.2 or 15 degree 12.9, 4.4 and gamma is your 2.5 for 20 degree 17.7 then N q is your 7.4 and this is your 5.0 like this it will continue. And at the same time Terzaghi's, as also given in graphical forms this is your tabular form is a phi n degree phi n degree and this is your N c and N q, N q.

So, this kind of graphs it has given in terms of graphical forms your N gamma, then this is your N c and this is your N q. So, what will happen this is for your general shear failure if it is a local shear failures for example, phi is equal to say, phi is equal to say 20 degree, if it is less than 28 degree, it is local shear less than 26 degree it is local shear failure phi is greater than or equal to 36 degree it is your general shear failure. For phi is equal to 20 degree in that case then it has to be modified as per local shear failure tan phi n is equal to two-third of tan 20 degree from there you calculate phi m is equal to tan inverse two-third of tan 20 degree and this phi is a modified phi considering your local shear failure after you get the value original value is your 20 degree and corrections has applied for your local shear failure and from there then you can take it to here. Then you can to take it to here then find it out what are your modified value of your bearing capacity. Same table can be used for general shear failure as well as local shear failures.

Now come to next part, that is your next part is your as I said few problems also I will solve it. Next part is your effect of water table.

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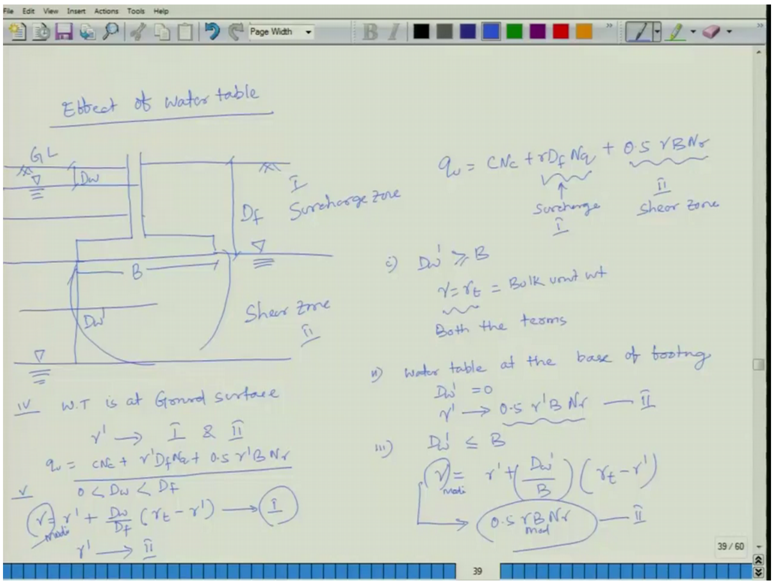

It is most important for your bearing capacity calculations particularly foundations. Let me draw a figure it will be motivate to you this a ground level and this part is your base and there is a water table here or may be water table here, this I put it 2 terms 1 is your D w and this your B width of the footing and this is your depth of footing and from here to here I put it D w prime. So, basically if you look at here there it has been said this is your surcharge zone, from here to here this part is your surcharge zone and this part will be your kind of not kind of this is your shear zone this is your surcharge zone and this is your shear zone. Let me write it out q u is equal to C N c plus gamma D f N q plus 0.5 gamma B m gamma.

If you look at here gamma D f N q this is your surcharge zone or zone 1 I can write it zone 1, this is a zone 1, this is a zone 2 here it is shear zone or I can write it zone 2 shear zone. Let us start with this from this; that means, one water table condition 1 one water table; that means, D w prime D w prime is greater than or equal to B when water table is at a distance below the foundation equal the your width of the foundation greater than equal to B in that case there is no water table corrections, there is no water table corrections then in that case gamma is equal to gamma t which is equal to bulk unit weight. So, it has to be used in both the terms, both the terms means both term 1 and term 2 there is no water table correction for case 1. When water table depth of the your water table is at a distance below the foundation equal to your width of the foundation in that case no water table correction is there.

Case 2 when water table is at the base of the footing, water table at the base of footing; that means, D w prime is equal to 0, it is 0 means water table is at the base of the footing. In that case gamma prime submerged unit weight to be used it should be used in the term 0.5 gamma prime B n gamma. That means, this shear zone is full up your water table; that means, what will happen if a tip stress will come in to picture then sum merge unit weight gamma prime will be 0.5 gamma prime B n gamma, but here in this term only gamma tr gamma has to be used remember the difference.

Then case 3, case 3 if D w if water table is less than equal to B 1 is water table is at a distance below the foundation at a distance B in that case there would not be any corrections, water table corrections is not there. One is water table at the base of your footing, 1 third part is your water table in between it will be in between here. So, in that case in that case generally gamma will be taken, modified gamma will be taken gamma submerged plus D w prime by B into gamma bulk unit weight into gamma submerged and this has to be used, this modified value of the gamma is to be used in 0.5 gamma B N gamma.

So, if water table is in between below the foundations and at a distance which is equal to D w is equal to B in between water table is there; that means, in the shear zone in between an entire gamma which is going to be used particularly in shear zone it has to be modified gamma submerged plus D w by B into gamma t minus gamma prime and this gamma has to be use in zone 2. Zone 1 is unchanged.

Now case four case 4, if water table this part is over shear zone part is over. Now let us go to your surcharge zone. If water table is at the ground surface water table is at ground surface then what will happen? Here water table is raising it is at the ground surface look at here this soil is submerged, this soil is submerged. So, in that case gamma prime; that means, submerged weight unit weight has to be used both zone 1 and zone 2, both zone 1 and zone 2 in that case what will happen? qu is equal to C N c plus gamma prime D f N q plus 0.5 gamma prime B N gamma then last case, case 5 plus case similarly water table is in between; between your depth of the foundations between this in between not at the ground surface not at the base of the footing, in between water table is there.

So, in that case 0 less than D w less than D f in that case gamma is equal to gamma prime plus D w by D f into gamma t minus gamma prime it has to be used in zone 1. Like here the gamma has to modified, because the water table is lying in between. So, this gamma has to be modify gamma prime plus D f by D w gamma bulk unit weight minus gamma prime that is your submerged unit weight in zone 1. In zone 2 what will happen? In zone 2 this is completely submerged in zone 2 gamma prime or submerged unit weight to be used in zone 2.

So, there are 5 cases you just try to understand and very frequently it will be used in foundation design, sometimes in a sub soil surface you sometimes you may encounter water table at the shallow depth sometimes you may encounter water table at the greater depth. So, let me revise it. So, bearing capacity is your C N c gamma D f N q plus 0.5 gamma B N gamma. So, this part your gamma D f is your surcharge this has been called surcharge zone gamma B N gamma is your base below the base it is called shear zone.

Case 1 if water table is at a distance d at a distance D w which is equal to width of the footing below the foundations, so in that case there will not be change in any corrections any correction in gamma. So, gamma is equal to gamma t bulk unit weight has to be used in both the terms zone 1 as well as zone 2. When water table is at the base of the footing look at here suppose water table at the base of the footing; that means, entire soil in zone 2 is submerged, so in that case submerged unit weight has to be used in zone 2; however, in this part bulk unit weight. So, if water table is in between from here to here in between water table is there then entire gamma has to be modified to be used this modified gamma you can write it this is your modified gamma to be used in zone 2. It is your gamma prime plus D w prime by B into gamma t minus gamma prime.

Point number 4, if water table at the ground surface, what will happen if water table is at the ground surface. Once water table is at the ground surface; that means, entire soil, soil in surcharge zone, soil in shear zone is completely submerged in that case both submerged unit weight gamma prime has to be used in both zone 1 as well as zone 2 this is what I have written. Then water table is in between the D f depth of the foundations.

So, what happen? The gamma has to be modified you can see that this is your modified and this modified gamma has to be used in zone 1, in zone 2 what happened if water table is here entire soil will be submerged; that means, in zone 2 gamma I mean submerged unit weight has to be used. This is what is your effect of water table; that means, because of water table some corrections are required and this correction has been has to be applied and made while calculating bearing capacity of your foundations.

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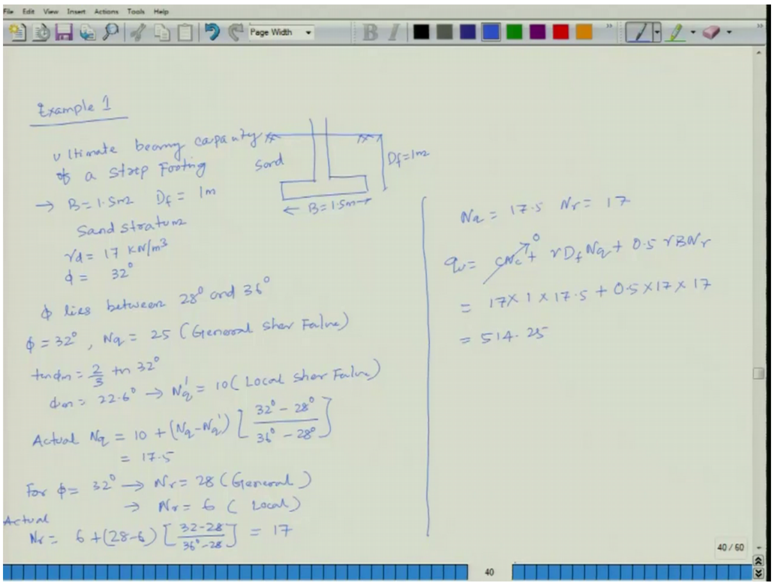

Now, we will solve at least 2 problems. So, example 1 determine the ultimate bearing capacity of a strip footing, strip footing of 1.5 meter wide B is equal to 1.5 meter, with a base at a depth of depth of the foundation is given 1 meter and resting on sand stratum or sand soil it is given gamma d is equal to dry unit weight 17 kilonewton per meter cube phi is equal to 32 degree. Find it out ultimate bearing capacity of a strip footing, if I draw it ultimate bearing capacity of strip footing and this is your depth of the foundation which is equal to 1 meter and B is equal to 1.5 meter and it rest the soil is entire profile is your sand phi is given, gamma is given.

Now, look at the here phi is your 32 degree it is neither general shear failure nor local shear failure rather you have it is a mix shear failure, you have to calculate find it out for this value of phi N c, N q and N gamma. So, particularly phi lies, phi lies between 28 degree and 36 degree. How you are going to do it? For phi is equal to phi is equal to 32 degree, taking into this table taking into this table N q is equal to 25 considering it is a general shear failure. A local shear failure assuming phi is equal to 32 degree local shear failure tan phi m is equal to two-third tan 32 degree and phi m is equal to 22.6 degree. So, local shear failure then from there N q prime is equal to 10 degree, 10, N q prime is equal to 10 considering local shear failure right.

Now what would be the actual N q value? So, from there you can find it out actual, actual N q is equal to 10 plus N q minus N q prime then 32 degree minus 28 degree divided by 36 degree minus 28 degree. It has been interpolated, it has been interpolated between your local as well as general shear failure and actual N q you have to calculate considering phi is equal to 32 degree take the same chart, find it out N q is equal to 25 considering it is general shear failure. Then modified the phi value considering it is a local shear failure then modified phi m is coming 22.6 degree considering this N q prime is equal to 10. So, it has been done interpolations. From there N q is coming out to be 17.5.

Similarly for phi is equal to 32 degree then gamma is equal to 28 considering general shear failure, then N gamma is equal to 6 considering local shear failure right. Then actual value of N gamma, N gamma you can find it out 6 plus 28 minus 6 into 32 minus 28 by 36 degree in 28 which is about to be 17. Now you got it by interpolations you got it now actual N q is equal to sorry N q is equal to 17.5, N gamma is equal to, N gamma is equal to 17. Then you find it out ultimate bearing capacity q u is equal to C N c plus gamma D f N q plus 0.5 gamma B N gamma and because it is a purely (Refer Time: 23:01) soils sand soils is in our component is not there. It is 0 then put the value gamma D f gamma is equal to 17 into depth of the foundation how much, depth of the foundation is a 1 meter into N q is equal to 17.5 plus 0.5 gamma is equal to 17 into N gamma is equal to 17 which is equal to 514.25.

So, this is a typical example because if it is phi is greater than 36 degree very easily you can use that table, phi is less than 28 degree very easily you can use that table considering local shear failure, if it is in between between 28 degree to 36 degree then interpolation has to be done considering it is a local shear failure, considering it is a general shear failure find it out actual N q as well as actual N gamma. So, I thought to solve it later on why we will be designing this part will come again and again, phi value is generally 30 degree, 32 degree, 33 degree then you have to do this interpolation find it out what is the actual value of N c and N q and N gamma.

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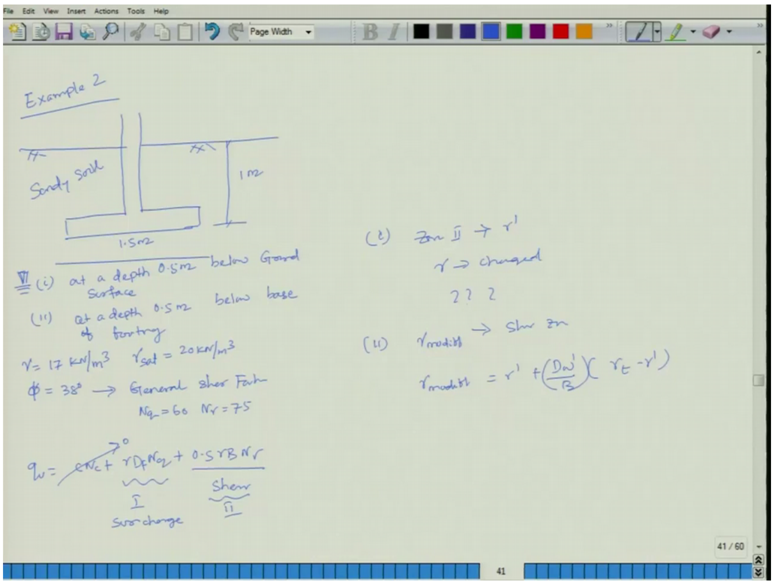

Now, next problem determine ultimate bearing capacity of a strip footing, I am drawing it 1.5 meter wide, 1.5 meter wide and depth is your, depth is your 1 meter same problem depth is your kind of depth is your 1 meter the same kind of the problems. And ground water table for water table is located case 1 at a depth 0.5 meter, 0.5 meter below ground surface. Then second part at a depth 0 point dive meter below base of footing and this soil is resting over a sandy soil its purely sandy soils. Gamma is given 17 kilonewton per meter cube gamma saturated is given 20 kilonewton per meter cube.

So, in this case also gamma is given sorry phi is given, phi is given 38 degree, phi is given 38 degree that means it is a straight forward case, N c N q and N gamma is no need to worry as phi is given 38 degree, then from there considering general shear failure N q is equal to 60, N gamma is equal to 75. So, ultimate bearing capacity is equal to C N c plus gamma D f N q plus 0.5 gamma B N gamma and this term is 0. So, this is your zone 1 or surcharge this is your shear at zone 2. Now case 1, at a depth 0.5 below the ground surface below the ground surface 0.5; that means the shear zone soil below this shear zone soil is fully or completely full up the water.

So, in that case zone 2 you have to consider instead of gamma for case 1 or zone 2 you take gamma submerged unit weight right, for zone 1 you change the value of your gamma, gamma has to be changed right. Similarly for case 2 this is what I am giving you can solve it instead of I am saying how you have to follow instead of solving you can solve yourself. Case 2 at a depth 0.5 meter below your base of the footing; that means, water table is somewhere else here. So, in that case water table is at your particularly shear zone then the modified value of the gamma, gamma modified to used in case of your shear zone, it will be gamma modified gamma submerged plus D w prime by B into gamma t minus gamma submerged.

So, once you calculate this has to be used in shear zone and surcharge zone will be unchanged, it will be unchanged. You do the calculation solve it yourself and it is for practice I will give it more and I will also solve more examples problems.

Today, I will stop it here and next class I will start it other bearing capacity factors other people have given you bearing capacity factors.

Thank you.