Foundation Design
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Lecture – 9A
Settlement Analysis- Part 3

Last class, we have covered one example.

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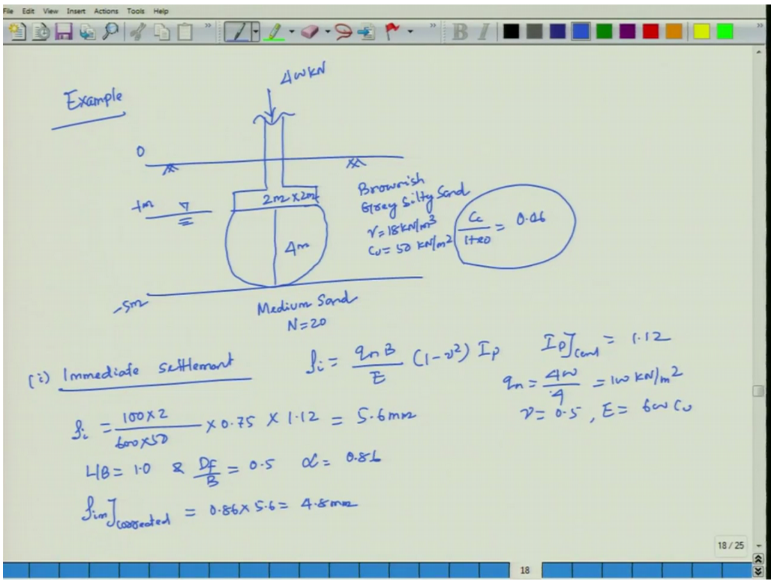

Foundation is resting on brownish grey silty sand it is completely a silty sand, and the properties has been given. And from the value of these your gamma cu ccy 1 plus e 0 all the values has been given to calculate your immediate settlement as well as consolidation settlement a water table is at located one meter below the ground surface. So, immediate settlement comes out to be 4.8 mm.

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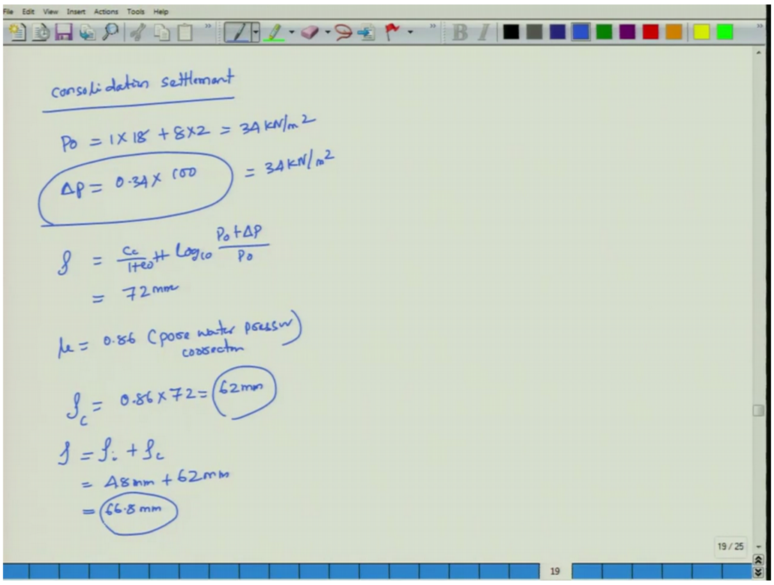

And consolidation settlement comes out to be after correction 62 mm total settlement is your 66.8 mm. Now next is your by means of stress path, how to calculate your settlement stress path it is indicate.

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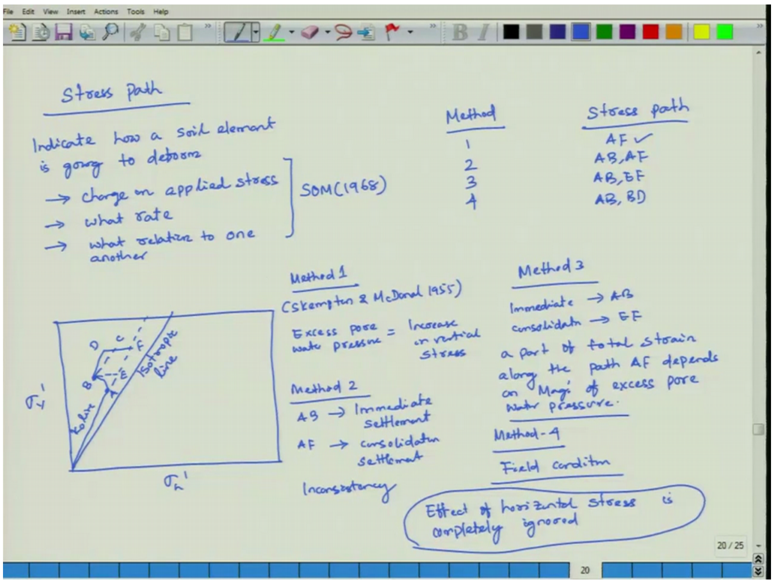

How a soil element is going to deform against your change in applied stress? Then it is what rate it is going to deform. Then what relation to what relation to one another it has been given by som 1968. So, generally widely it has been used as a based on your (Refer Time: 02:39) meter test.

Now, take a graph here. This is your sigma v prime. This is your sigma h prime. This line is your isotropic line, and this is your k 0 line. This point is your A, this is your B this is your D. Then this is your F, C, E, so there 4 methods actually. So, much studied by means of stress path method, how is your immediate settlement and consolidation settlement profile because of change in applied stress and how the settlement varies and what is your strength what is your rate what rate and what relation with one an another if I go to the method one method. This is your stress path, this is the 1 2 3 there as 4 method first one is your AF, second one is your AB and AF, third one is your AB and EF, fourth one is your AB and BD.

So method one: method one it has been given by Skempton and Mac Donald 1955 skempton and mac Donald in 1955. In this case if you look at method one, this is your AF what is it mean, if it is a AF what is it mean; that means, pore water pressure, excess pore water pressure excess pore water pressure excess pore water pressure is equal to increase in vertical stress increase in vertical stress; that means, it should be linearly and we whatever you will apply vertical stress change in vertical stress approximately same as change in your excess pore water pressure. So, this is your method one then in this case this is stress path AF this is your AF, then method 2.

Method 2 undrained loading particularly this is your undrained loading. So, first one is your method 2 AB. It lies immediate settlement immediate settlement. So, excess pore water pressure which is a function of stress is equal to vertical stress. If you look at here consolidation settlement they have said AB and AF. AF is your consolidation settlement, I will in discuss rightly. So, if you look at here how come a soil will go from A to B as immediate settlement? Then there is no continuity. Then from A to AF, there is a consolidation settlement. So, there is in consistency in consists in consistency particularly method 2.

Now, come to method 3. Method 3 is immediate settlement is a function of stress path AB. Again immediate is your AB. While consolidation settlement occurs along as stress path EF, consolidation occurs in a stress path EF. So, if you look at here. So, only total strain only a part of total strain a part of total strain along the path AF along the path AF depends on the magnitude of excess pore water pressure, magnitude of excess pore water pressure. So, method 4, method 4 is your field conditions. There is a continuity field conditions. So, if you look at method 1, method 2, method 3, method 4 all are your one dimensional consolidations. In method one very simple way assumptions rate of increase in stress which is equal to your increase in excess pore water pressure suppose you applied 10 kilo newton per meter square then 20 kilo newton per meter square, it is a kind of linear.

So, with that proportion excess pore water pressure will increase. So, it is a assumption of your one dimensional consolidations. Method 2 AB is your immediate settlement and AF is your consolidation settlement, there is no link between your immediate settlements. And consolidation settlement means if you physically interpret in your stress path AB is your immediate settlement then AF is your consolidation settlement method 3 immediate settlement is your AB which is obvious then consolidation settlement is your EF then what will happen between B and E. That means, it part of your total strain along the path F depends on the magnitude on the magnitude of excess pore water pressure in that to a person of your strain depends upon your magnitude of your excess pore water, pressure method 4 it is actually reflecting your field condition.

What is method 4 first it go to the AB increase in stress immediate settlement, then it will go to your BD consolidation settlement or primary consolidation. Then DF, it is your secondary consolidation it is following; it there is a link it will follow your immediate consolidation secondary immediate primary consolidation immediate A to B, B to D primary consolidation D to F is your secondary consolidations.

This is what your stress path followed. So, if you look at here look at here effect of horizontal stress is completely ignored, in cases if what I am discussing here; that means, effect of horizontal stress is completely ignored means if you look at here all depends upon your vertical stress increase in stress. However, effect of your horizontal stress is completely ignored in your stress path.

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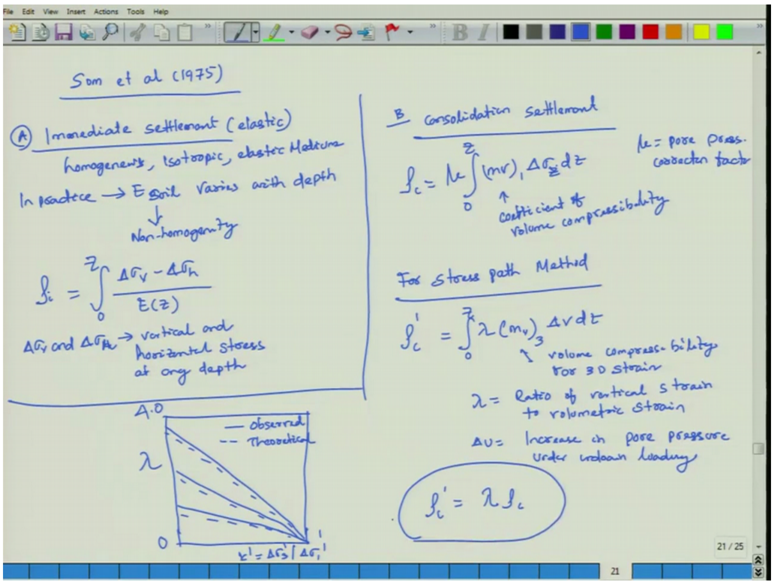

Now, come to your settlement calculations. So, son et al 1975, they have given your settlement analysis by stress path method immediate settlement immediate settlement or elastic, elastic in this case assumption it is homogeneous isotropic then elastic medium. So, in practice in practice what happened in practice e of soil, e soil it varies with depth, what is it mean if I say e of soil varies with depth? that means, it is your non homogeneity. So, immediate settlement rho i which is equal to integration of 0 to z delta sigma v minus delta sigma h divided by e into z, delta sigma v and delta sigma h delta sigma v and delta sigma h or small h is nothing, but vertical and horizontal stress. Vertical and horizontal stress is depth at any depth z, means at any depth it is your vertical and horizontal stress at any depth.

Similarly, if you come back to consolidation settlement: in consolidation settlement if I calculate rho consolidation is equal to mu 0 to z n v 1 delta sigma z D z. Mu is equal your in this case pore pressure correction factor, n be is your coefficient of volume compressibility from standard consolidation test coefficient of volume compressibility. So, for stress path method, consolidation prime it is stress path which is equal to 0 to z, lambda n v z delta v and D z. Sorry n v 3 it is not n v z it is your n v 3 n v 3 is your volume compressibility for 3 dimensional stress n v 1 is your volume compressibility for one dimensional that is; that means, vertical one dimensional strain this is your volume compressibility for 3 D strain 3 D strain lambda is your ratio of vertical strain to volumetric strain, ratio of vertical strain to volumetric strain.

So, delta u is in your pore pressure under undrain loading. You can write it delta u is equal to increase in pore pressure under undrain loading. So, if I draw a graph here, in these cases. So, it will be coming out to be it has been given in graphical form this is your 0 to 1. And this is your k prime which is equal to delta sigma 3 prime by delta sigma 1 prime and this is your lambda it is varying 0 to 4.0. So, this one is your dark line this is your observed dotted line this is your theoretical.

Now, what will happen k prime from there, if you look at here, from here there is k prime delta sigma 3 prime by delta sigma 1 prime.

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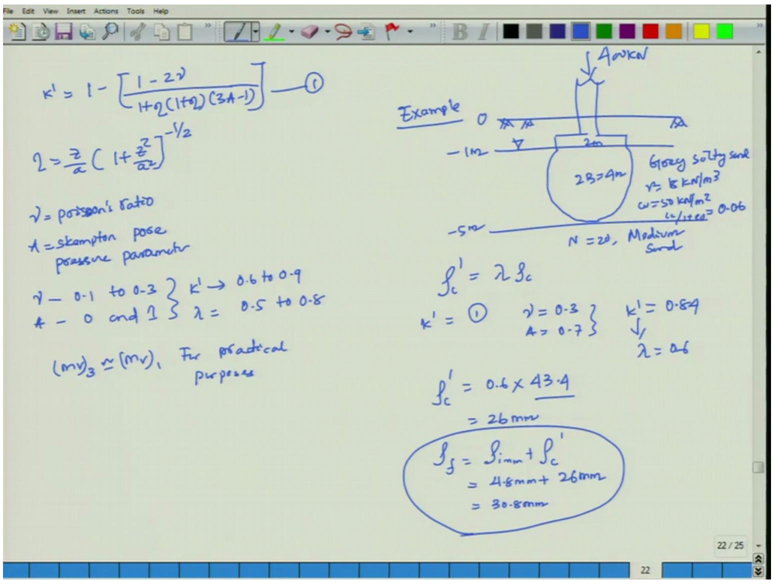

So, k prime which is equal to 1 minus, 1 minus 2 mu divided by 1 plus eta, 1 plus eta 3 a minus 1. So, where eta is your z by a into 1 plus z by a z squared by a square to the power minus 1 by 2. This is your poisons ratio. A is your skampton pore pressure parameter. So, this is what you can find it out from once you know the poisons ratio, once you know the eta it is depth by your a small a, z by is your total a is your distance how far is your distance it is there from there. So, once you get the a, then from their 1 plus z by a square minus 1 by 2 a is your a is your pore water pressure parameters.

So, most of this soils if you look at here most of the soil poisons ratio varies us between 0.1 to 0.3, a is varying between 0 and 1. And from there k prime is coming about to be 0.6 to 0.9. And lambda is coming to be 0.5 to 0.8. For practical purposes what happened, for practical purposes n v 3 is equal to n v 1, n v 3 is your n v 3 is equal to n v 1 for practical purposes. N v 3 is what coefficient of volume compressibility volume compressibility n v 3 for 3 dimensional strain n v 1 is your volume compressibility for one dimensional strain that is your vertical directions consolidation theory.

Now, this is about your stress path. If you go back to that example earlier example we can solve it by means of stress path method we can solve it then we can find it out what is the immediate settlement, what is your consolidation settlement some example previous example. This is your k s, here it is your water table here is your putting is line. Here it is coming out to be 400 kilo newton. Here it is 0, here it is minus 1 meter, here it is minus 5 meter and this is your 2 meter it is of 2 times B which is equal to 4 meter. So, then beyond 5 meter n is equal to 20 it is your medium sand grey silty sand grey silty sand gamma is equal 18 kilo newton meter cube, c is equal to 50 kilo newton per meter square cc by 1 plus e 0 which is equal to 0.06.

Now, if I start with this now from the by means of stress path method by means of stress path method if you look at here, rho c is your rho c prime is equal to lambda times if I put it volume compressibility in 3 D strain for practical purposes is equal to volume compressibility for one D strain, then I can put it in such a way that so it will be rho c prime which is equal to lambda times into rho c. So, if I go to here, it is your rho c prime is equal to lambda times rho c. So, k prime which is equal to k prime we can find it out from here equation 1, here it is your equation 1.

So, you assume for this case poisons is ratio 0.3, a is equal to pore water pressure parameter 0.7. So, from there k prime is comes out to be 0.84 and from there because once k prime we are getting it is your 0.84, 0.84 you put it. And from there you can find it out lambda is equal to 0.6. And from there rho c prime is equal to 0.6 into 43.4. 43.4, if you look at here it is your consolidation settlement, comes out to be your 43.4 mm which is equal to your 26 mm and total settlement total final settlement is your immediate settlement plus consolidation settlement by means of stress path method.

So, immediate settlement for this case, immediate settlement for this case is comes out to be this is the same problem. Immediate settlement is your 4.8 mm. So, this is your 4.8 mm plus consolidation settlement based on your stress path. This is your 26 mm and which comes out to be 30.8 mm. If you come back here, total settlement is coming here as for the earlier theory in immediate and consolidation settlement 66.8 mm. More you are getting by means of stress path method total settlement is coming 30.8 mm. Almost it is more than 100 percent double, 30.8 mm here it is your 66 mm. So, this is what is calculations of your settlement calculations I will stop it.

So, next class I am going to start incentive stresses and stresses due to foundational loading. Once it will be completed then I will solve more problems. Then after words I will straight way go for your foundation designs start with your shallow foundations, then followed by different type of shallow found foundation as well as raft map foundation complete design.

Thank you.