Foundation Design
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Lecture - 2B
Subsoil Investigation or Site Investigation Part-4

So last class I started with a plate load test or plate bearing test. So, in this test what you are suppose to get, bearing capacity of your foundations or bearing capacity of soil settlement differential settlement, E modulus of elasticity sub grade modulus as well as influence factors.

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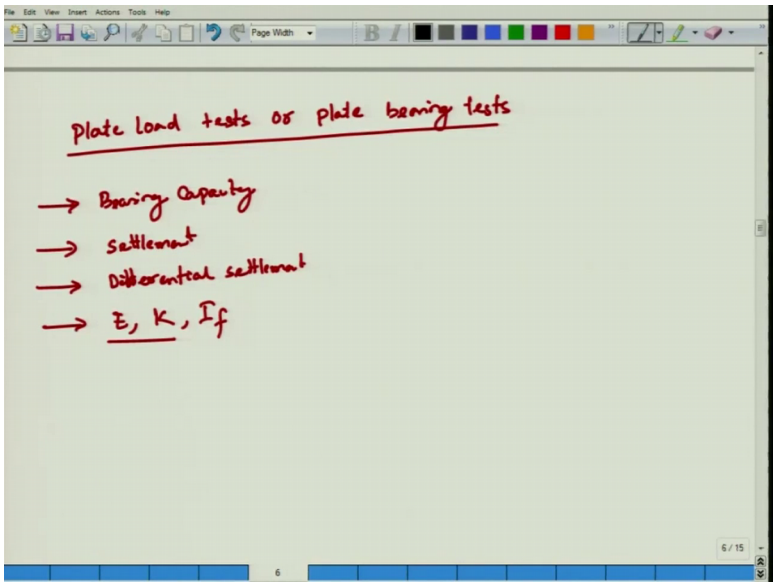

So, how the plate load test is been carried out generally it has been carried out with a pit.

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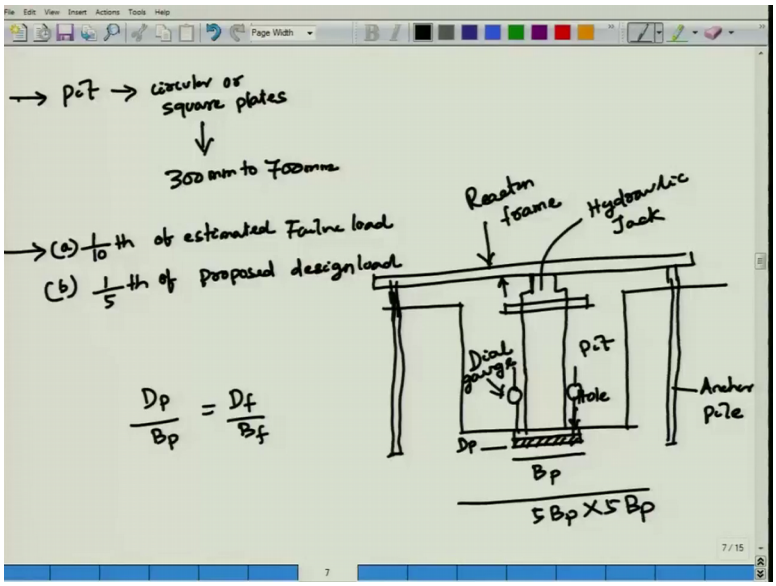

It has been carried out with a pit, with a pit it either circular or square plates. Square plates of size 300 mm to 700 mm.

So, generally what is the load, you are suppose to apply load has to be applied number one, one-tenth of estimated failure load b, one-fifth of proposed design load. So; that means, bearing capacity failure means, if you look at here you apply the load, load intensity you apply either one-tenth of the estimated failure load or one-fifth of your design proposed design load, let me have a of this drawing then you have a very clear picture. Generally, there is a pit then, it is a reaction frame here. And it is supported by piles here. Then in this reaction frame, this is your hole, and this is pit. And there is a this part is your hydraulic jack, and this is your reaction frame. And this generally you say it is Dp depth of the plate. And this generally you say width of this plate.

So, this is your anchor pile, this is your anchor pile and the pit size is about to be 5 times Bp 5 times Bp by 5 times Bp. So, generally the arrangement has been made Dp by Bp is equal to Df by Bf. So, circular and square plates bearing from 300 mm to 700 mm generally get it. So, first we prepare a pit means, where you want to find it out bearing capacity settlement as well as E and K other parameters. You prepare a pit. Generally, pit size should be 5 times Bp, Bp is your width of your plate 5 times Bp right 5 times Bp.

So, once you prepare a pit then prepare your reaction frame also your Bd also reaction frame with your anchor piles. So, this reaction frame will connected by means of your

anchor piles. Then place your hydraulic jack here, this hydraulic jack put it here and below this you put your plate. Then once you apply this hydraulic jack what will happen hydraulic jack will apply load, towards your reaction frame. Every action has equal and opposite reaction. So, because it is fixed it would allow to push your plate. So, it depends upon how you are going to apply. So, pit size will be 5 times Bp by 5 time Bp. So, then what are the other things, suppose we are consider only one-tenth of your estimated failure load or one-fifth of your proposed design load, then what happened you apply you find it out theoretically, what is the bearing capacity that part will come later theoretically what is the bearing capacity, where you decide what you are suppose to take it either one-tenth or one-fifth. Then take the load increment then apply, this load by means of hydraulic jack apply it.

And this application will be constant then measure your displacement, how you are going to displacement. Here generally are the 2 edges dial gauge dial gauge to dial gauges are be 2 edges. You provide and measure the displacement why 2 edges from both the sides, you can observe is there any deferential settlement at the both the ends.

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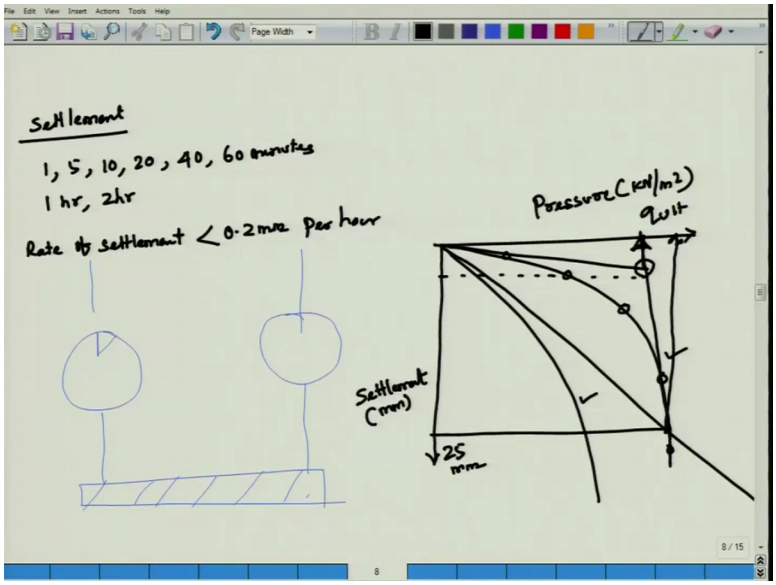

So, settlement you have to record it. Settlement record means each load increment, what settlement you are going to record, it may be 1 minute, 5 minute, 10 minute, 20 minute, 40 minute, 60 minutes. Then 1 hour, 2 hour like this we record settlements, then where

you stop it not stop, where you apply your next increment load. When rate of settlement, where is your rate of settlement rate of settlement is less than 0.2 mm per hour.

Rate of settlement is less than 0.2 mm per hour; that means, if I take a dial gauge here. This dial gauge is placed, here is your plate here is your plate. We are placing 2 dial gauges at 2 experiments. So, you have to record rate of settlement 0.02 mm per hour 0.02 mm per hour; that means, it should not be more than 0.2 mm, then at that point we have to apply next load increment. So, this is the case then you observe it 1 minute, 5 minute 10 minute, 20 minute, 40 minute, 60 minutes, 1 hour, 2 hours. Sometimes it continuous (Refer Time: 09.01) because you have to wait till your rate of settlement is less than 0.2 per hour.

Then finally, what you are suppose to get it each load increment suppose you are putting a load increment 10 percent then 20 per cent, then 30, 40, 50, 60 of your theoretical load, then you are suppose to get load versus displacement or you can say pressure versus settlement. You are suppose to get it, this is your pressure what is a unit kilonewton per meter square, then is your settlement. You are suppose to get look at here I may get this type of curve. I may get this type of curve or maybe, I can get this type of curve. This your pressure versus settlement pressure means, how much load you applied by means of you hydraulic jack, what is your load by area of your plate from there you are getting a pressure.

So, and settlement settlements you are getting 1 minute, 5 minute, 10 minute, 20 minute, 40 minute, 60 minute, 1 hour, 2 hour like this for each load increment. Suppose I am getting one load increment here one load here one here one here one here. So, from there you are suppose to find it out ultimate load. So, in these 2 cases it will very easy to find it out your ultimate load because either it is a single tangent or by means of double tangent. Here in this case, how I am going to get it? I am taking the linear part of this initial part, linear part at the end drawing the tangents where it inter set and mark it from here. I can get it q ultimate load of your plate I can get it from there. And this curve also I can get it ultimate load of the plate, but these cases I am not suppose to get ultimate load. Now tell me how long I will continue? How long I will continue what settlement I can continue where I can stop it as per your bureau of indian standard generally will continue, to till we are getting 25 mm of your settlement. You do it, do your plate load test you achieve

your 25 mm of your settlement in mm. In this case somewhere else I will have to stop here.

It is your 25 mm, if you are getting this kind of curve, this kind of curve that is fine. In that case you are going to find it out your q ultimate load. And corresponding settlement is your this your corresponding settlement with respect to your failure load, but in this case you are not suppose to get it, in this case you go up to 25 of mm of your settlement up to here what you are suppose to get it that is your ultimate load. Now initially it is for coarsen less soils, and it has been extended for coarsive soils sip high soils also as well as clay. For clay for clay q u f ultimate capacity of your foundations.

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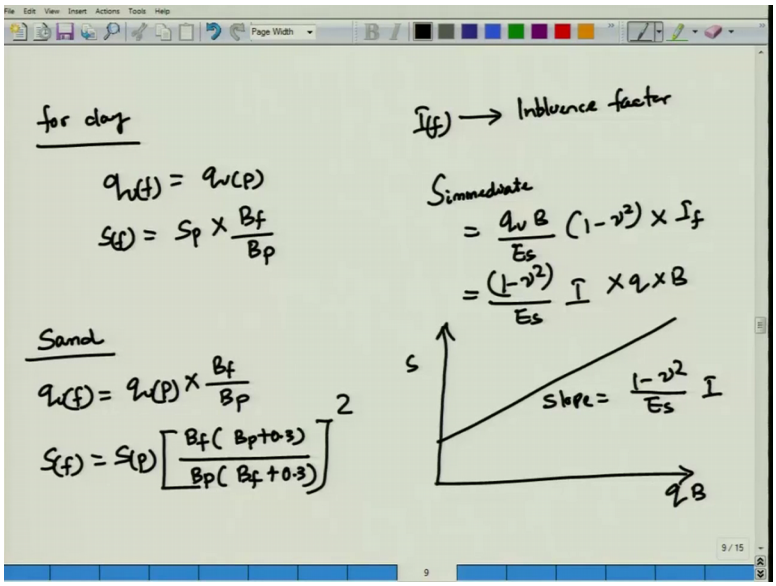

Actual real foundation equal to q u of your p, ultimate capacity of your plate. From plate load test I am getting pressure versus settlement from here, I am getting ultimate load of your plate.

Now, from there I have to find it out what is the actual ultimate load of foundations, now settlement of actual foundation which is settlement of plate into Bf by Bp. Now for sand, for sand ultimate load of your foundation are footing. Ultimate load of your plate into Bf by Bp and settlement of your footing your foundation, which is equal to settlement of your plate in to Bf, Bp plus 0.3 by Bp Bf plus 0.3 whole square. There are series of test I will be done from there this empirical correlations come out. What you are getting

ultimate capacity that is for your plate up to that depth particularly that depth you are getting plate ultimate bearing capacity.

So, ultimate bearing capacity once you know the plate for clay it is same as your plate or settlement of clay particularly for footing settlement of your plate. Settlement of plate how do you get it suppose, this is my ultimate load right. This is the failure with respect to that. What is your settlement with respect to that failure load? What is your respective settlement? So, sp settlement of your plate into Bf width of your footing by Bp width of your plate for sand ultimate capacity of your footing, ultimate load of your plate into Bf by Bp. Settlement of your footing settlement of plate into Bf into Bp plus 0.3 divided by Bp into Bf plus 0.3 whole square. Once you get a plate load test from there, you can get settlement of footing bearing capacity of footing both clay as well as sand.

This is number one parameters. As earlier I have said we are suppose get it bearing capacity of foundation or footing. Now were getting settlement of foundation or footing were also getting now come back to influence factor. How we are going to get your influence factor? Influence factor if I write it immediate settlement, yes is settlement immediate then it is q u into b by Es 1 minus mu square into If, this is your influence factor. So, from there if I make it rearrange it, 1 minus mu square by Es into I into q into b if I plot it plot a graph q into b here, and S look at here. The slope is slope is equal to 1 minus mu square by Es into I. For a particular soil mu is particularly that depth mu is known, elastic modulus is known, then influence factor then you are getting a influence factor at the centre as well as at the edge.

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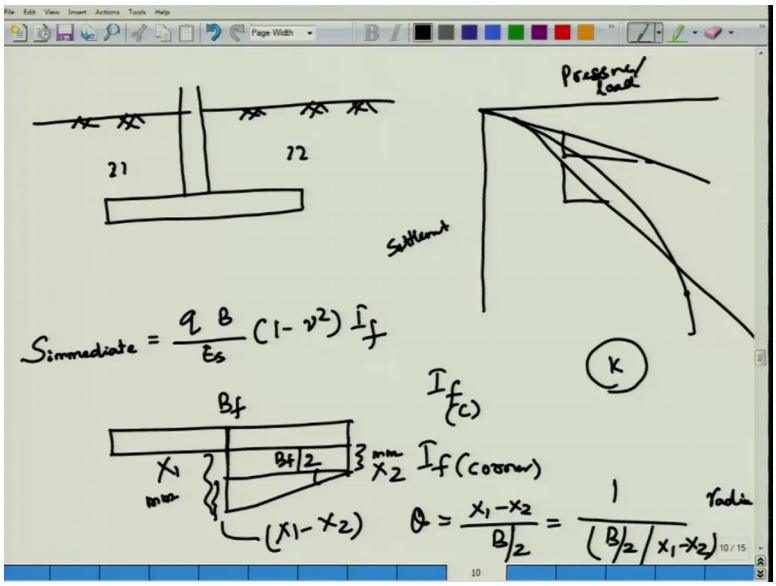

Suppose this is a plate or this may be a footing. So, what will happen if I say influence factor is here, I is something. Here I is something what is my immediate settlement immediate settlement is your qn into b by Es 1 minus mu square into I, what I am suppose to get it? I get it at the edges some part, I will get it. At centre there is a settlement at edge there is a settlement. So, I can get it influence factor, I f, I f I write it. I f c, I f at centre, I f corner at the corner, so from there, I am getting 2 immediate settlements, one at corner one at the centre this is sum mm this is sum mm, this minus this and if this is b of footing.

So, it will be Bf by 2 width of foundation by 2. So, this will be if it is X 1, if it is x 2, and this part will be x 1 minus x 2. So, then theta will be, theta will be this by this, theta will be x 1 minus x 2 by d by 2, which is equal to 1 by b by 2 by x 1 minus x 2. So, you are getting in terms of radian. So, this gives immediate differential settlement. So, you can get it whether this differential settlement, while doing your design later part from plate load test you can get deferential settlement whether this differential settlement is within this permissible limit. And not if it is not permissible limit then redesign or change this soil conditions. So, this is a vital parameter you are suppose to get it higher.

Now, another part how I am suppose to get it E, E of the soils pressure, this is your pressure or I can put it other way around, this is my pressure. This is a settlement. I can make it to load versus settlement. Suppose I am suppose to get this kind of curve, I can

get it either by means of E a initial tangent modulus or second tangent modulus. So, initials tangent modulus what I am suppose to get it from your initial part is linear. I draw a tangent and with that slope I am going to get it Es and second tangent modulus with respect to working load, I draw a tangent from there I am suppose to get Es. Similarly, you can get sub grade modulus K, sub grade modulus K generally. It has been used for your modelling this part I will discuss later while doing this foundation designing analysis this K part I will discuss it later. So, this about your plate load test how you are doing plate load test what are the parameters were suppose to get it.

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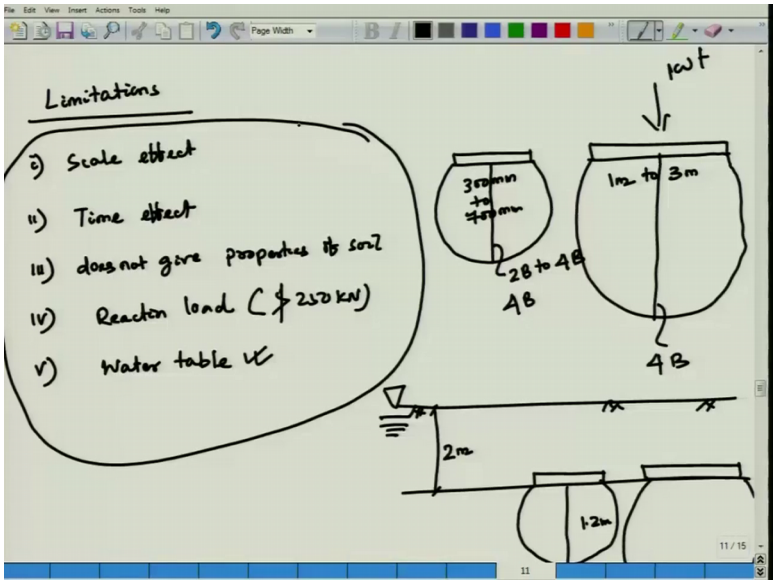

Now, come to the limitations what are the limitations. First one is your scale effect then second one is your time effect. Then third one is your plate load test does not give properties of soil. Then forth one is your reaction load, it is generally not more than 2 50 kilonewton. Fifth one is your water table limitations scale effect time effect doenst give properties of soil reaction load water table. If you look at here scale effect. Generally, what happened plate size is, I put it in this way this is my plate size. Generally, it is 300 mm to 700 mm. Now look at the foundations are actual footing size footing size generally bearing from 1 meter to 3 meter or more what is scale effect. Now the pressure intensity of this plate will be this is your pressure ball. So, generally the influence will be 2 b to 4 b, I can put it 4 times of b.

Here pressure intensity will be, I put it 4 b. 4 into 3 here it will be at the depth of your 12 meter look at here. Suppose it is 300 mm into 4, 1200 mm 1.2 meter. Here it is now we will need I can say. So, this is my ground surface we intend to conduct a plate load test suppose at a meter of 2 meter depth, suppose your conducting a plate load test below 2 meter depth below the ground surface; that means, pressure intensity is about to be up to 1.2 meter 300 mm plate if I am taking. Now up to this pressure intensity you are getting your bearing capacity settlement, but actual footing whatever you are giving it here, if I am taking a actual footing laying it here then it will be much more deeper side.

So, this is your measure scale effect despite that it has been used widely everywhere else then time effect, the plate load test has been carried out for short term basis. You look at 5 minute 10 minute, 20 minute, 40 minute, 60 minute, 1 hour, 2 hour. Then you stop it 0.2 mm, but here it ignores about your long term consolidation settlement. Plate load test basically gives immediate settlement value. And another disadvantage is it does not give any properties of soil psi phi gamma, it does not provide anything else reaction load. Maximum reaction load you can go 250 kilonewton, but actual footing you can look at here actual footing, here is may be 100 ton load is coming there. So, basically reaction frame we have putting it reaction load you are putting it maximum capacity, it can take it up to 250 kilonewton beyond that you cannot take it.

Last one most important when there is a water, table here water table is here. What will happened it will be very difficult to carry out your plate load test.and it is not going to reflect actual value; that means, once there is a water table what will happened gamma will be gamma is all most. So, bearing capacity will be half. So, how we are going to do it to take out the water, by means of pumping then do your plate load test. These are all your important limitations of your plate load test. Despite this limitations the plate load test has been widely used everywhere else to get bearing capacity settlement, differential settlement, modulus of elasticity, sub grade modulus. Sub grade modulus I am not discussed; I discuss slightly later.

So, I will stop it next class, I will start standard presentation test as well as cone presentation test. I will go slightly faster because we will go to your foundation design afterwards.

Thank you.