Geotechnical Measurements and Explorations

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Lecture No. # 13

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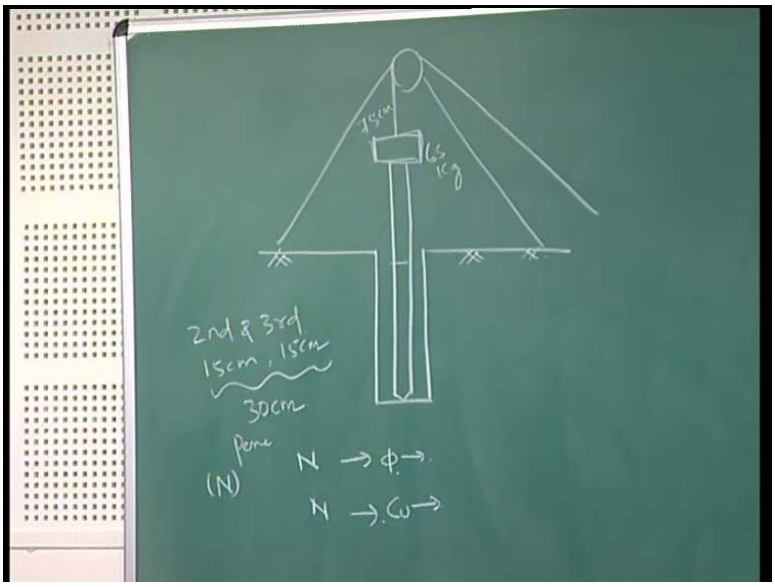

So last class, it was about standard penetration test by means of split spoon samplers and the hammer 65 kg, height will be 75 centimeter falling, number of blows recorded second and third, second and third, 15 centimeter and 15 centimeter penetration, that is 30 centimeter penetration, that is your number of blows N. Now this is all about standard penetration test; from standard penetration test, you can find it out phi, you can also find it out undrained shear strength Cu, indirectly from N, you can get also bearing capacity of footing, because the moment from N you get phi; once you get phi, you can calculate the bearing capacity of the footing.

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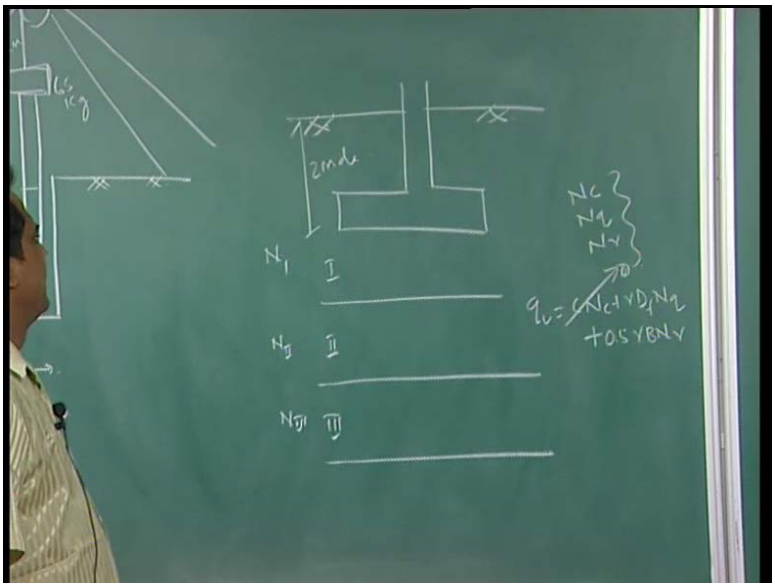

Suppose, there is a footing lies below 2 meter depth; if you have N values, if you have penetration blow values of each layer, layer 1, layer 2, layer 3, say N 1, N 2, N 3. From penetration blow value, you can find it out phi; once you get phi, then you can calculate N c, N q and N gamma; once you get N c, N q and N gamma, you can find it out bearing capacity is equal to C N C plus gamma D f N q plus 0.5 gamma B N gamma, if it is a purely cohesion less soil, then you can get gamma D f N q 0.5 gamma B N gamma. This is the utility means application of SPT - Standard Penetration Test, particularly for cohesion less soil, particularly for cohesion less soil.

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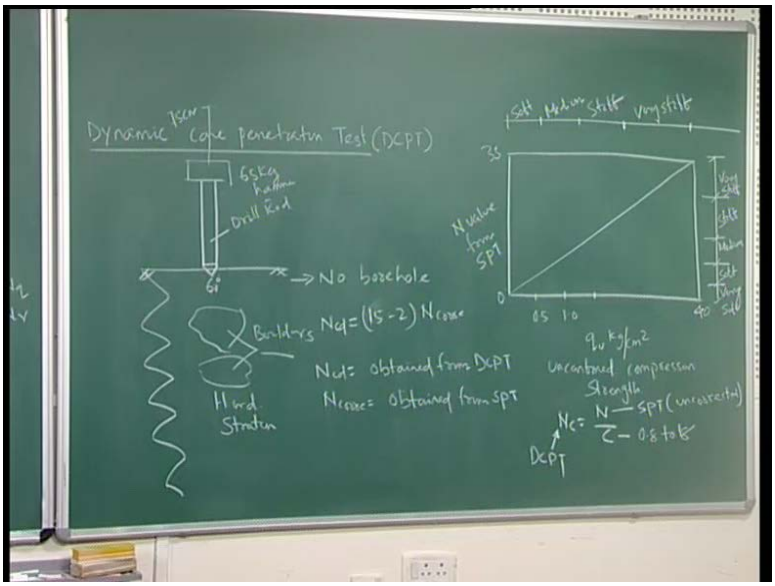

Now, there is another test that is called that is called dynamic cone penetration test.

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In dynamic cone penetration test, the difference between SPT and DCPT is in dynamic cone penetration test, a cone of 60 degree angle, apex angle attach to drill rod, this is your drill rod and soil blow by means of 65 kg of hammer, by means of 65 kg of hammer falling at a height from 75 centimeter distance. So, the difference between these two SPT and DCPT, this is called DCPT - Dynamic Cone Penetration Test; this is called SPT - Standard Penetration Test. The difference between SPT and dynamic cone penetration test: In DCPT no need to go for a bore hole, no need to go for a bore hole; you can record you can record the penetration blow by means of a cone attaching to the drill rod, and a hammer is 65 kg, it is falling height is 75 centimeter, you just… By means of hammer, this drilling rod rod has been pushed, and continuously you recorded, what is the value of N every 1 meter, 1 meter, 1 meter interval?

Now, so there is a means, the advantage is this dynamic cone penetration test is no borehole, no borehole required. Now, co-relation between SPT and DCPT: So DCPT is your dynamic cone penetration is equal to 1.5 sorry 15 minus 2 into N corrected; so N cd is equal to, obtained from DCPT - dynamic cone penetration test; N corrected, obtained from SPT. If you look at these N corrected that means from SPT whatever you are getting from field that is your N. Now as I said, SPT N correction has been made, there are two corrections; one is for overburden correction and other is your (( )) correction. If you have N cd dynamic cone penetration test, from there you can find it out, what is the value of N corrected value of SPT? This is the co-relation.

Now, if I draw a graph, (no audio from 06:49 to 06:58) it will be 0 to 35, N value from SPT, and this will be 40, 0.5, 1, 1.5, 4.0, this will be 4.0; 0.5, 1.0; so this is q u in kg per centimeter square; this is your unconfined compression strength. From this, if I draw here, (no audio from 07:53 to 08:05) very stiff, stiff medium, soft, very soft; here also it can be made it this way; soft, medium, stiff and very stiff, stiff, medium, and here it is soft. So to judge the consistency of soil from N c value, general practice is used to convert N C is equal to N by C. So, if it is N c is equal to from dynamic cone DCPT, N is equal to from SPT uncorrected; so C is a constant, it is value varying from 0.8 to 18, then you can get directly from these here you can get if you know this C value, constant value

you can put it from DCPT you can find it out N. Then once you get N, you can co-relate, you can find it out what is your unconfined compressive strength of cohesive soil.

These two methods particularly, if you look at here, one is SPT, one is your DCPT; these two two methods it has advantage and disadvantage; in these cases, in this case SPT, you have to go for borehole, the cost is slightly higher than the DCPT dynamic cone penetration test. In case of DCPT, there is no borehole, but the disadvantage of the DCPT dynamic cone penetration test, suppose there are boulders or may be rock or may be hard stratum; boulders, so this cone may not be penetrate inside the ground, it will obstruct; that means it will give misleading result.

So, if I compare both these cases, SPT is preferred though it is slightly costlier than your dynamic cone, because in this case, SPT you are doing the borehole, DCPT is preferred, where you will get a soil from medium to soft kind of soil or loose to medium kind of soil, where this cone can be penetrated easily without any constraint without any constraint, so that you will get N value, accurate value of N. Either of the two, if you do, then you can convert n value to DCPT value or DCPT value to N value. These parameters are going to useful for your all the designs of foundations, it will indirectly give, it will indirectly give the value of bearing capacity.

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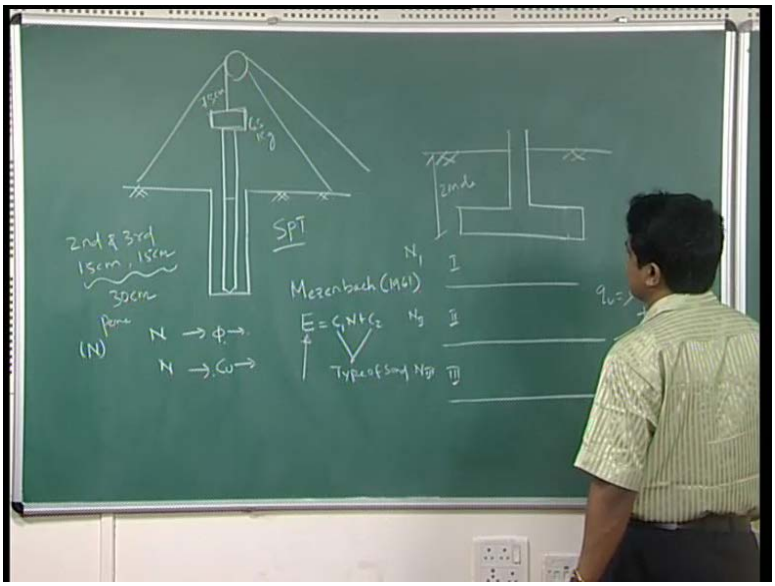

Another one is it also gives E value, which is equal to C 1 N plus C 2. This E value is modulus of elasticity, it is given by you can find it out, once you know the N value, it is

given by Mezenbach, 1961. Once you know the N value and C 1, C 2 are functions, these are the functions; it depends upon type of sand. So, if you know the N value from standard penetration test, so E value, modulus of elasticity can be co-relation from co-relation can be co-relate, you can get the E value. Where this E value is going to use? It is going to use for immediate settlement of sand as well as clay, because these are the two parameters E mu it is settlement for phi for your bearing capacity. So, indirectly or directly, you can say standard penetration test is more advantages than your dynamic cone penetration test. But dynamic cone penetration test is feasible, once the soil layer soil layer is soft to medium or loose to medium available. Otherwise because of obstruction due to boulders, it may not possible to get accurate value of N.

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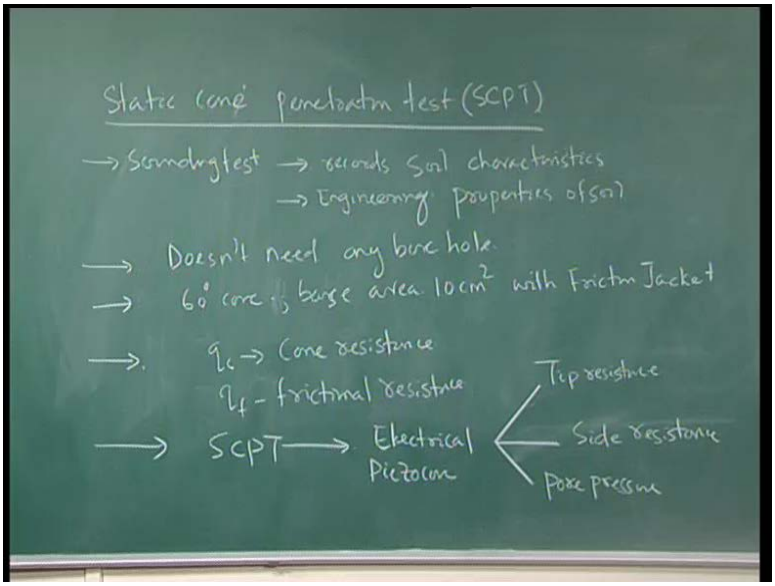

Now next test is your standard cone penetration test or you can say static cone penetration test; it is called SCPT. In static cone penetration test, it is a sounding test, continuous record of soil characteristics; it records soil soil characteristics; from there once you record the soil characteristics from there, indirectly you will get it engineering properties; it does not need any borehole; (no audio from 14:52 to 15:05) a 60 degree cone of base area 10 centimeter square with friction jacket. From here you can find it out cone resistance q c, q c and also frictional resistance. Now it has been changed, modified SCPT static cone penetration test has been modified as electrical piezocone; it has tip resistance, side resistance, then pore pressure.

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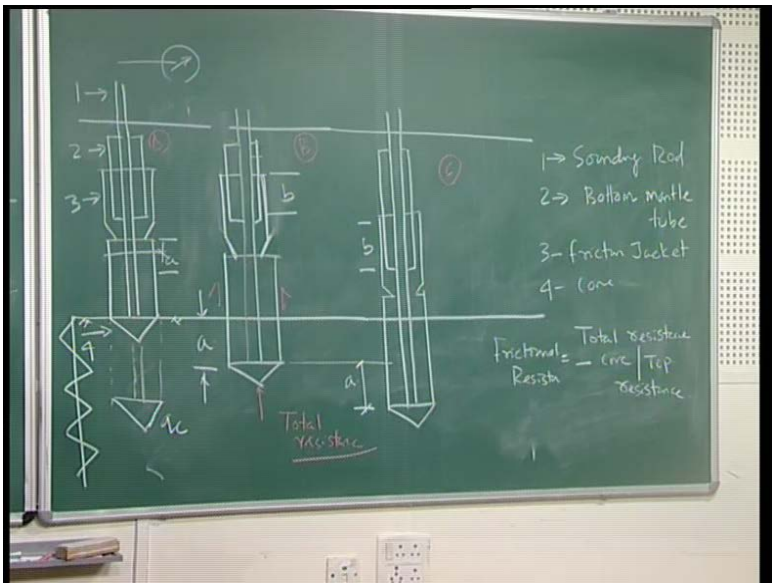

Now, how it works? If I draw it in figure, how it works?

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Look at this figure, 1, 2, 3, this is 4, this is a.

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With further down of this cone, there are three… (No audio from 19:33 to 19:43) The function has been shown in three parts.

(No audio from 19:49 to 20:18)

This is b. Now here to here is b. Now this is a. So, 1 stands for sounding rod; 2 for bottom mantle tube; 3 for friction jacket; 4 for this cone. If you look at here, this assembly, this is your sounding rod, this sounding rod is directly connected to your cone; and this has been assembled with bottom mantle tube and this is your friction jacket. Now the arrangement in such a way that once it is in the ground surface, if you lock this, if you lock this, if you lock this, now it will move as a whole, it will move as a whole; that means cone plus friction jacket will move simultaneously. If you remove this lock, this arrangement has been made in such a way that there is a lock here; if you remove this lock that means only cone will move, only cone will move; and at the surface, the

arrangement is there, you can measure the pressure or the resistance you can measure at the surface.

So, what will happen? Suppose, we want to find it out continuous cone resistance continuous cone resistance without any frictional resistance; so, what will happen? You just unlock this, so that with this sounding rod as you push it, then it will come as if a cone is moving, cone is moving below this, and this part will be remain in the ground; above the ground, this part will be remain above in the ground, this frictional jacket. So, from this, only you will get cone resistance, only you will get cone resistance. Where it is applicable? Look at this pile, in case of pile, there are different types of piles; one is your frictional pile, other is your end bearing pile, other is your friction plus end bearing piles. In end bearing piles, you want to know, what is the cone resistance or tip resistance? That means in this case, you will find it out only q c, you will find it out only q c.

Now, the moment I lock, there is a lock arrangement, locking arrangement, the moment I lock it, whole assembly will move, whole assembly will move. This is shown that this is a case A, this is your case B, this is your case C; once you lock it, whole assembly will move inside the ground, whole assembly move inside the ground means, from this what you are going to get? Because it comes inside, this will give this will give frictional resistance, also this will give cone resistance. Once whole assembly moves inside from here, you are supposed to get total resistance.

So, initially you have your cone resistance, then you have your total resistance; if I remove from total resistance to cone resistance, then I will get it only frictional resistance, then I will get only frictional resistance. So, this is called total, how it it this is called your static cone penetration test, how what are the parameters you are going to get, one one thing you are going to get is your cone resistance, other is your frictional resistance that means the test once you are going to do. First you put in the ground, so that you unlock this, so that cone will be pushed inside, cone will be pushed inside, keeping this resting in the ground, so that first we will get cone resistance. Then what happen?

Then in the second stage, in the same same soil profile, you will lock it, whole assembly will move along with this cone; once whole assembly will move along with this cone, you will get total resistance. So if I, if frictional resistance you want to find, then it will

be total resistance minus cone or tip resistance total resistance minus cone or tip resistance, then you will get frictional resistance. Now, how this frictional resistance is useful?

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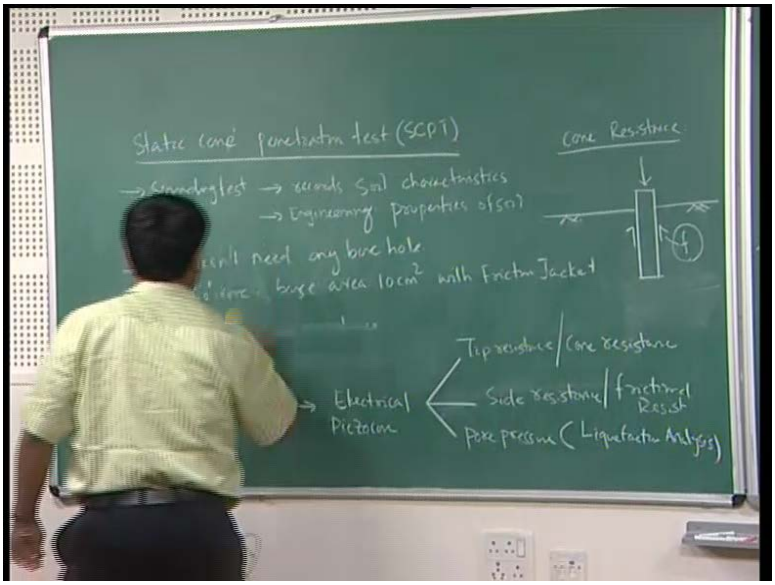

In pile foundation, where this capacity has been carried by friction piles, in that case, what will happen? This capacity will be taken by the pile with periphery or the frictional resistance. So, you will get directly from this what the frictional resistance of this pile supposed to be, you can find it directly f. Now, these are the all sounding test; in this case, you will get continuous record of the soil; and you can indirectly co-relate with this q c, you can find it out what is the engineering properties of soil; in this case, you do not need any borehole. And it is basically if the mechanism is a 60 degree cone; this is your 60 degree cone; and base area 10 centimeter square with a frictional jacket. And this is your frictional jacket; with a frictional jacket frictional jacket; and from there you will get cone resistance and frictional resistance.

Now, this this has been slightly modified over the years, so SCPT has been changed to electrical piezocone. Now in this electrical piezocone, you will get tip resistance that means q c tip resistance or cone resistance, side resistance or frictional resistance; at the same time you also get electrical piezocone; by means of electrical piezocone, you will get pore pressure; that means in the ground surface, how the variation of pore pressure is there. This will be required for liquefaction analysis.

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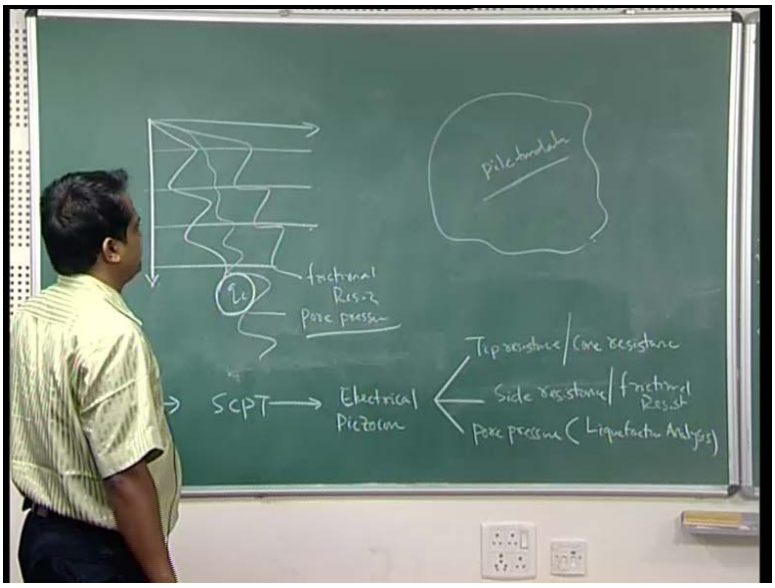

Now with a single test, this is your depth, you will find it out, this is my q c cone resistance, you also find it out, how much is your frictional resistance, also we can find it out what is the variation of pore pressure. If you know variation of pore pressure in insitu condition, then easily you can analyze for liquefaction analysis or may be earthquake analysis, whether if there is an earthquake, then pore water pressure will rise, then soil will soil soil will liquefy or not, that can be analyzed.

So, frictional resistance frictional resistance you will get Q f by area of friction; so Q f load of friction you will get it total resistance minus resistance by cone, total resistance minus cone or tip resistance, it will be Q f minus Q c divided by area, area of the frictional jacket; you can this is, this diameter is given, length is given, you can find it out from the diameter what is the area, area of friction? Once you get the frictional resistance, you can plot cone resistance, frictional resistance as well as also pore water pressure, resistance you can plot it.

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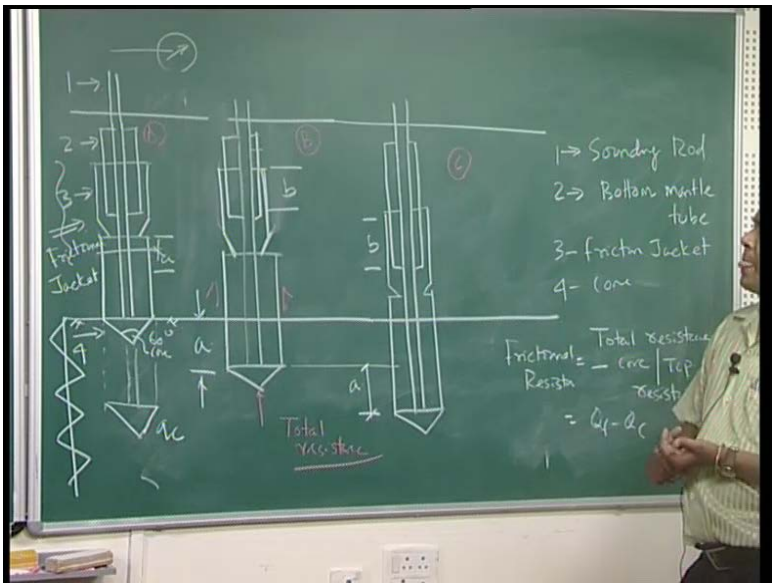

Now, next step is these are the free prime test; one is your standard penetration test, other is your dynamic cone penetration test DCPT, third is your static cone penetration test or cone test SCPT. These are, these particularly this three test, it has wide range of application. So SPT basically, first one SPT is standard penetration test, SPT is for particularly cohesion less soils, you can find it out phi. Also SPT can be carried out particularly, C phi soils also, from there are co-relations given by (( )). Once you know the N, from N value you can find it out undrained strength undrained shear strength of the soil; you can classify whether it is a loose soft or may be stiff, very stiff.

Then third one is your cone resistance or static cone resistance; in this case, the advantage is if there is a pile foundation is to be constructed or may be a purely clay soil is there, purely cohesive soil is there, from there for particularly that you will get q c end bearing of cone; if there is a pile foundation, suppose this is an area, this is an area, where it has been decided, where it has been decided pile foundation pile foundation construction. So, for pile foundation, you need to have your, what kind of piles you are required; either it is a end bearing or friction piles or both end bearing and friction pile. In that case you should able to say that each layer, layer wise each layer, how much the tip resistance, how much the frictional resistance, how it is varying? So that you can decide, if you will go for file foundation, what should be length, what is the diameter of pile you are supposed to do?

So suppose it is an end bearing pile then in that case, you have to pick only only q c - tip resistance. Suppose, there is say, it is the pile foundation to be constructed, so that it will take load by means of friction or frictional resistance of the pile, you can get it by means of frictional resistance of your cone. If it is a mixture of if it is a mixture of, it is a like the pile may be considered as both friction as well as end bearing, then in that case you take into account of your total resistance; total resistance is nothing but frictional resistance as well as your tip resistance.