Geotechnical Measurements and Explorations

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Lecture No. # 12

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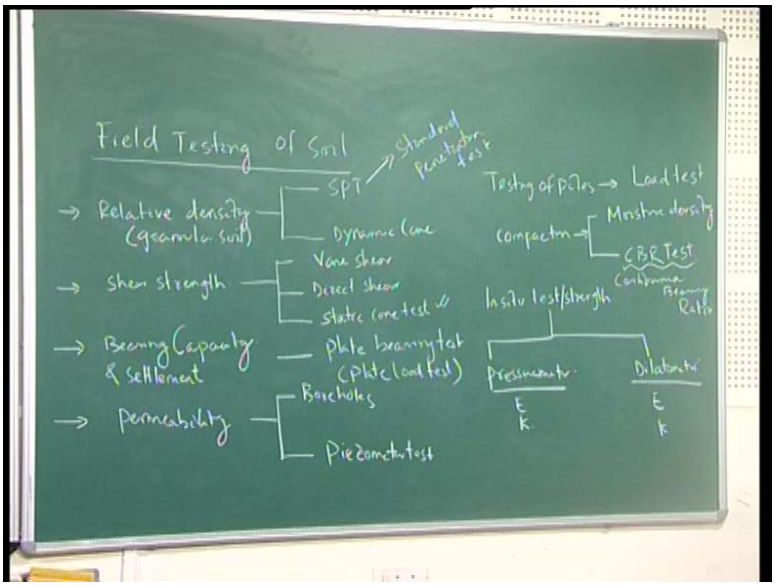

Now, field testing of soil, earlier we have discuss about the subsoil exploration techniques, and what are the process to start the subsurface explorations. So, with this now we move to field testing of soils, what are the different field tests? Relative density of granular soil is SPT - standard penetration test or dynamic cone. Then shear strength - vane shear, direct shear, and static cone test. Then bearing capacity, and settlement; it is plate bearing test or plate load test, then permeability - this is bore holes or piezometer.

Now, testing of files - load test, compaction - moisture density, CBR test, Insitu test Insitu test or strength attach to one is your pressure meter, other is your dilatometer. Now, these are the set of field testing Insitu test of soil in field, if you look out this first one is your relative density for granular soil; these are the two tests generally recommended. One is your standard penetration test - SPT is your standard penetration test, then dynamic cone test. For shear strength of soil in Insitu, that means in field you can go for vane shear, direct shear test or static cone test; from static cone test also shear strength can be determined.

Bearing capacity and settlement; bearing capacity of footing and settlement can be determined or (( )) by conducting plate load test plate load test, and with this plate load test suitable correlations has been given to find it out this bearing capacity, and settlement of footing. Then Insitu permeability test can be done by means of bore holes, and piezometer test, that means bore holes are being made from there you can find it out how much is your permeability, and from piezometer also coefficient of permeability that can get from piezometer test.

Testing of piles generally for pile load test, that means load piles, load test, pile load test in Insitu in the field to be tested, then for compaction control - compaction control generally done for embankment, that is your embankment or highways, that is for moisture density means for compaction control these are the two tests. One is your moisture density, that means this is Insitu moisture density, another one is your CBR test; CBR is California bearing ratio, CBR is your California bearing ratio test. Then Insitu test or strength test, in this case Insitu… These are all Insitu test, but from here pressure meter test, and dilatometer test, you can find it out directly E, K, modulus of elasticity, and arc pressure at rest, you can get it from pressure meter as well as dilatometer test; these are all set of field tests Insitu field tests require to find it out Insitu parameters.

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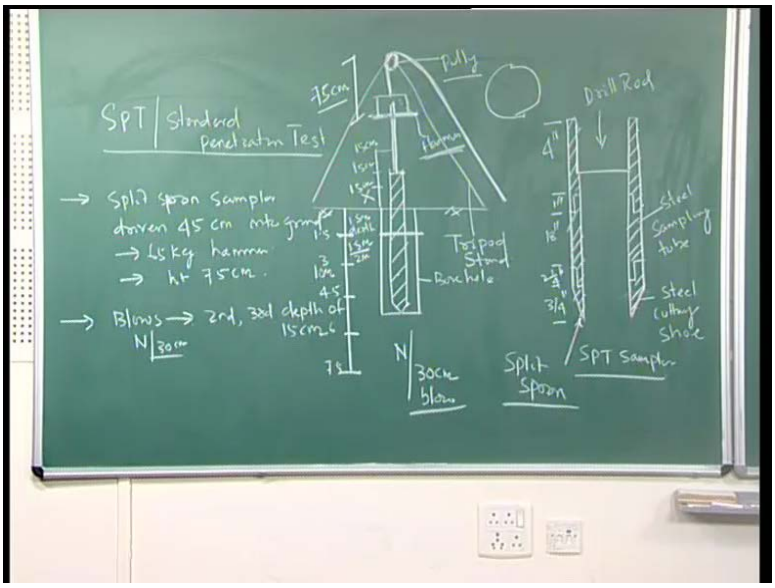

Now we will start, first one is standard penetration test - first one is SPT or it is standard penetration test. How it looks? (No audio from 07:15 to 08:15) Now, this is your it goes to drill rod - 4 inch, 1 inch, 18 inch, 2 and 1 4 th inch, then 3 by 4 th inch. This is your steel cutting shoe, this is steel sampling tube, so this is called SPT sampler. Now, how it looks SPT sampler.

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Split spoon - split spoon sampler driven 45 centimeter into ground by 65 kilogram hammer, then your falling height is 75 centimeter, blows - second and third depth of 15 centimeter, this is called N per 30. First one is your standard penetration test, if you look at standard penetration test, so how it has been performed. So first, first what to do? First in the ground surface, suppose it has been decided to get the penetration blow, below the ground surface say 10 meter at an interval of 1.5 meter depth.

Let us say this standard penetration test to be carried out from the ground surface up to depth 10 meter, interval of 1.5 meter depth each. That means, every 1.5 meter interval every 1.5 meter interval, what is your standard penetration N value. So, how the process? First bore hole has been made first bore hole has been made up to depth of let us say 1.5 meter, then then what will happen by means of a tripod stand, this is tripod stand by means of a tripod stand, the sampling SPT sampler, it is called split spoon, this sampler is called split spoon.

Why it is called split spoon? That means it can be opened it can be opened at the centre, so it is connected, it is a circular shape like this it is connected, you can open it longitudinally half - equal half, then with this help of split spoon sampler or sampling SPT sampler connected with this standard penetration rod, where this rod is there what will happen? Above this above this, there is a platform here, in this platform a hammer of 65 kilogram is there, this hammer has to raise as per a STM standard, this hammer has to be raised height 75 centimeter.

That means, what happen? First you make the bore hole, then with the help of tripod stand place your split spoon sampler or SPT sampler in position, then here by scale mark 15 centimeter, 15 centimeter, then 15 centimeter, 45 centimeter. Then by means of a roller and pulley system, you pull this weight you pull this weight up to a height 65 kilogram of hammer, up to a height 75 centimeter. Once it has been pulled, then you release. So, it will give a it will give by means of hammer, it will when it will try to penetrate this sampler - SPT spoon sampler inside the ground, that means number of blows, you go on giving the bows by pulling this hammer at a height of 75 centimeter, and leave it.

So, first 15 centimeter the movement it penetrate first 15 centimeter that you discard, that means number of blows for second, and third depth of 15 centimeter, number of blows penetration for second depth of 15 centimeter, and third depth of 15 centimeter, that is your 30 centimeter that should be recorded as SPT N N per 30 centimeter blow number of blows per 30 centimeter penetration. First 15 centimeter penetration you have to leave, because this will be your sitting load corrections, then last 30 centimeter penetration blow, you record the last 30 centimeter penetration corresponding to the number of blows, you record it. That means, N number of blows corresponding to last 30 centimeter – 15, 15 you record it, that is your SPT N value for first 1.5 meter depth.

Then, what will happen? Once 1.5 meter depth you record it, then you go for make the bore hole, again another 1.5 meter or 2 meter depending upon that requirement. So, again same procedure continue, so at 3 meter - this is your 1.5, this is your 3, this is your 4.5, say 6, then 7.5, that means every 1.5 point 1.5 meter interval depth the penetration blow; the penetration blow N for second, and third depth of penetration that is 30 centimeter you record it, and you mark it for up to 10 meter depth.

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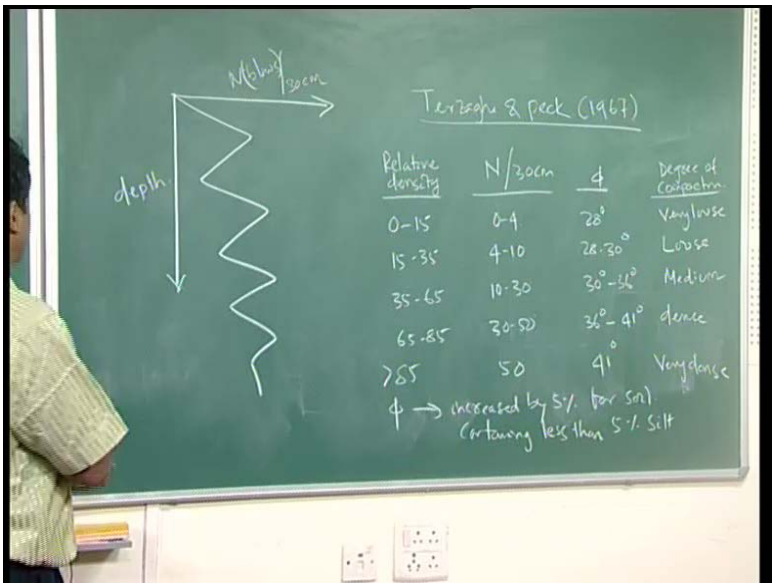

So, what it will exactly give. This is my depth, this is N blows per 30 centimeter. You will get you will get a profile, how the number of blows vary every 1.5 meter interval, every 1.5 meter interval up to your requisite depth 10 meter, 20 meter, 50 meter or may be 100 meter depth. So, some some kind of this Terzaghi and peck 1967; Terzaghi and peck 1967. They have given this relative density from the SPT N blows, so relative density say 0 to 15, 15 to 35, 35 to 65, 65 to 85, then greater than 85. So, N per 30 centimeter, this will be 0 to 4, 4 to 10, 10 to 30, 30 to 50, and it is your 50. So, phi angle of shearing resistance 28 degree, 28 to 30 degree, 30 degree to 36 degree, then 36 degree to 41 degree, this is your 41 degree and degree of compaction, this says very loose, then it is your loose, medium, dense, very dense. So, phi increased by 5 percent for soil containing less than 5 percent silt.

Now, from this Insitu test, this is a Insitu test for particularly granular soil from this Insitu test, we are going to get number of blows for every depth every 1.5 meter interval 1.5 or 2 two meter interval up to requisite depth say 30 meter, 50 meter or 100 meter based on the N value Terzaghi and peck given for granular soil, what is the designed parameter for granular soil?

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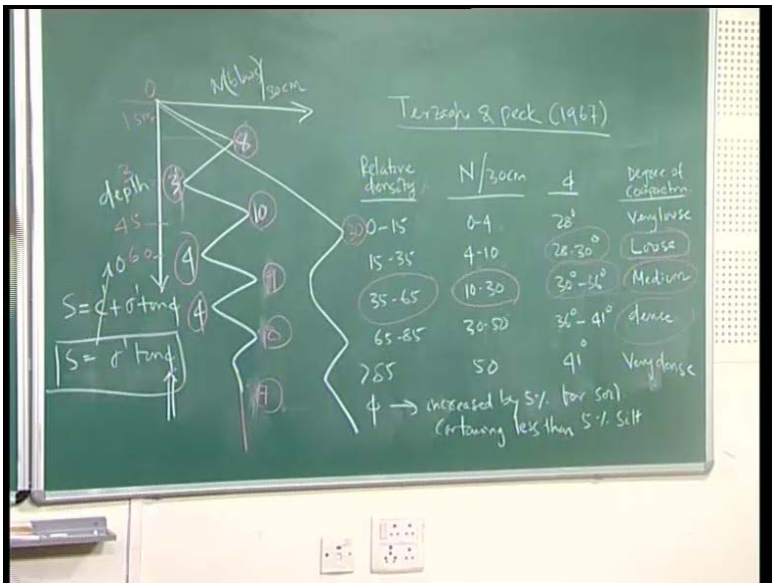

If I say for granular soil shear strength is equal to C plus sigma tan phi, for granular soil or for sand this is 0, so it will be sigma prime tan phi. So far, designed parameter is your phi, angle of internal friction phi, so Terzaghi peck 1967, they have given for relative density of 0 to 15, the N value will vary from 0 to 4; that means, if for particularly this case, let us write this is my 4 this is say this is 4, this is 8, this is 10 ten, say this is 9, this is again 4, this is again 8, this is 7. I have given a typical value of N, this is 3, 8, 10, 9, 8, 7, 4, 4.

Now, look at this up to say first 1.5, this is your 1.5 meter below the ground, this is 0, this will be 1.5, this is your 3, this is your 4.5, then 6 at 1.5 meter below the ground surface, N value is your 8, N value 8 means 8 means, it is 4 to 10; 4 to 10 means relative density is 15 to 35. Relative density is 15 to 35 means the angle of internal friction varies between 28 to 30 degree, what does it mean with N value of 4 to 10, if it is 8 - it is meaning that the soil sample below the ground surface up to 1.5 meter depth it is loose, it is in the state of loose.

Now, let us say let us say 10 at 4.5 meter interval, it is 10 - penetration value is 10, that means 4.5 meter interval penetration value say 10. What is its relative density? Its relative density is 36, these are percentage 36 to 65 percent, that means this phi is phi of cohesionless soil it is varying between 30 to 36 degree, and it is in the state of medium which is greater than 30, if penetration value - if penetration value is somewhere else, if

it is going like this, like this. So, if it is greater than 30 at 4.5 meter, it is greater than 30 or then in that case N is 30, if you look at that this soil is very dense.

That means…

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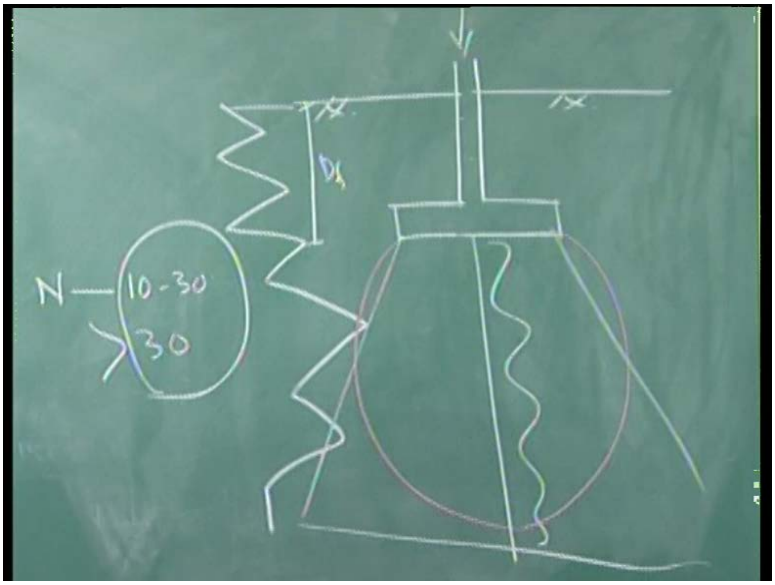

Suppose, we are going to construct a footing or foundation below the ground surface, we do not know, where is the depth of foundation means where this below the ground surface at what level the foundation to be rested. Let us say 1 meter or 1.5 meter or 3 meter at what level below the ground surface, this foundation to be rested. So, let us say with this penetration, you will find you will find a layer below below this footing, because below this footing this is your pressure bulb involvement, that means this is the transfer of load transfer of stress below this footing, below this footing, you have to find it out in such a way that below this footing, this depth this soil stratus should be hard or may be strong. So, that means I look once you do this SPT standard penetration test, you will find it out somewhere else, where is your penetration blow, it is lying between 10 to 30 or more than 30.

Penetration blow 10 to 30 or may be more than 30, 10 to 30 means 10 to 30 means penetration blow, it says it is medium; if it is more than 30 it says it is a dense conditions, that means soil strata is very hard or in medium. That means, whatever pressure intensity

is coming here in the footing, if I place in such a way that below - below the footing the soil strata is very hard or medium, that means it can easily carry the load, it can easily carry the load.

So, this is an important parameter for design consideration of foundations in cohesionless soil, if you say this foundations in cohesionless soil that means from N value you can get your phi; no need to go for laboratory test. You can get from N value, you can get the phi value, so this is the correlation given by Terzaghi and peck 1967 for cohesionless soil.

Similarly, similarly for cohesive soil (No audio from 27:46 to 27:55) though standard penetration test is exclusively for granular soil. So, similarly for cohesive soil also, if you go for standard penetration test some correlations has been given.

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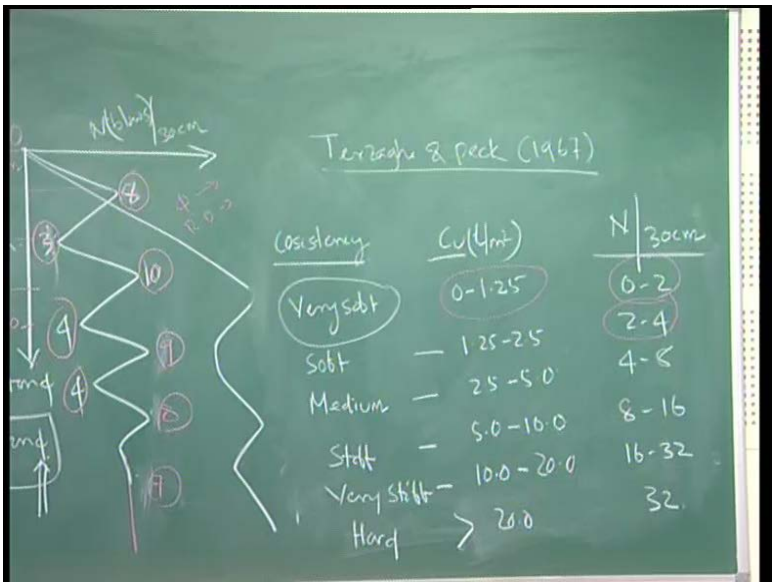

So, this is your consistency, then undensed shear strength C u ton per meter square, then N per 30 centimeter, number of blows per 30 centimeter, very soft, soft, medium, stiff, very stiff, hard. In very soft - it is 0 to 1.25, then 1.25 to 2.5, medium 2.5 to 5, stiff - 5.0 to 10.0, very stiff – 10.0 to 20.0, hard greater than 20.0. So, number of blows will be 0 to 2, 2 to 4, 4 to 8, 8 to 16, 16 to 32, and here it is 32. Now, SPT standard penetration test is exclusively for cohesionless soil, if it is a C phi soil or some kind of cohesion is there the standard penetration test can be conducted.

Some correlation has given, if it is a very soft say from consistency if it is a very soft soil, very soft clay; in that case if it is a very soft clay, in that case this C u undensed shear strength is varying from 0 to 1.25 ton per meter square. So, in that case number of blows per 30 centimeter is 0 to 2.

Similarly for soft soil 1.25 to 2.5, so number of blows is 2 to 4; that means all for particularly C phi, and phi soil indirectly if you have number of blows per 30 centimeter, from there you can get a range get a range, where this soft soil is lying it is in the range of soft medium or very stiff or also you can get the strength. How much how much is your undensed shear strength of the soil. Similarly for cohesionless soil, if you know N blows then you can find it out how what is your value of phi? What is your value of phi? And what is the relative density D.

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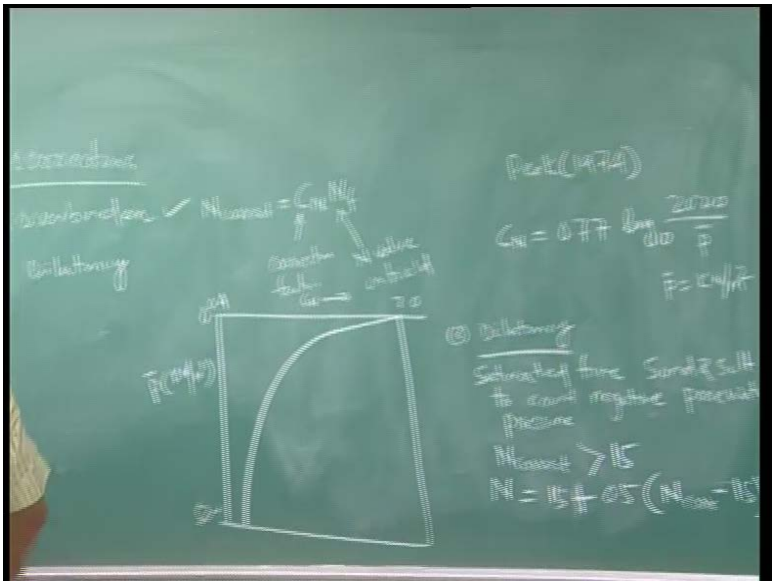

Now, there are 2 corrections in SPTs standard penetration test. There are 2 corrections; correction due to overburden, then correction due to dilatancy. So, N corrected for overburden, N corrected is equal to C N into N f; C N is your correction factor, N f is your N value in field N value in field. So, correction factor you can get it from it is given in the code or you can utilize this direct empirical means formula. 0 to say 500, here C N it is varying 0.4 to 2.0; this kind of charts are already there, if you know the overburden from there you can find it out C N or you can get from relation given by peak 1974, C N

is equal to 0.77 log 10 200 by P bar; P bar is your kilonewton per meter square. P bar is your vertical vertical overburden pressure, then your dilatancy correction.

Second is your dilatancy - dilatancy correction is recommended for saturated fine sand and silt to count negative pressure to count negative pore water pressure, so it will be applied if N corrected from overburden N corrected from overburden is greater than 15, then only dilatancy correction has to be applied. So, in that case N is equal to 15 plus 0.5 N corrected minus 15.

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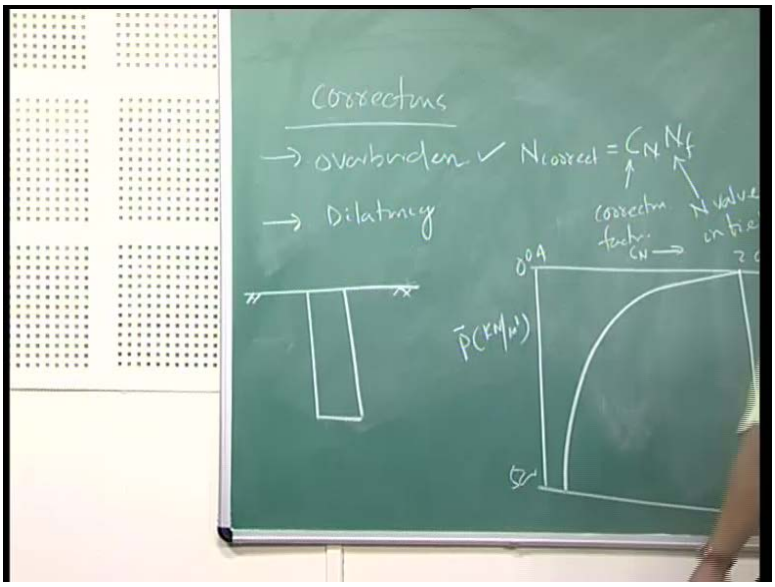

Now, there are two corrections: One is your overburden, other is your dilatancy. Why these corrections required? If you look at this from SPT - standard penetration test, how the standard penetration test has been conducted. First, up to that depth bore hole has been made.

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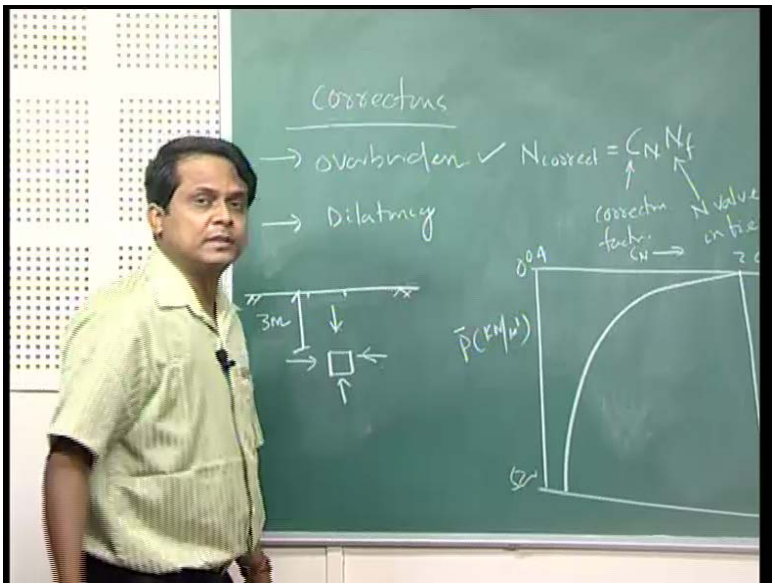

So, initially ground surface in such a way that ground surface, so that it is before making this bore hole before making this bore hole, the ground surface if you look at here, suppose soil at this position suppose say at 3 meter depth, there is overburden pressure acted in the soil as well as lateral.

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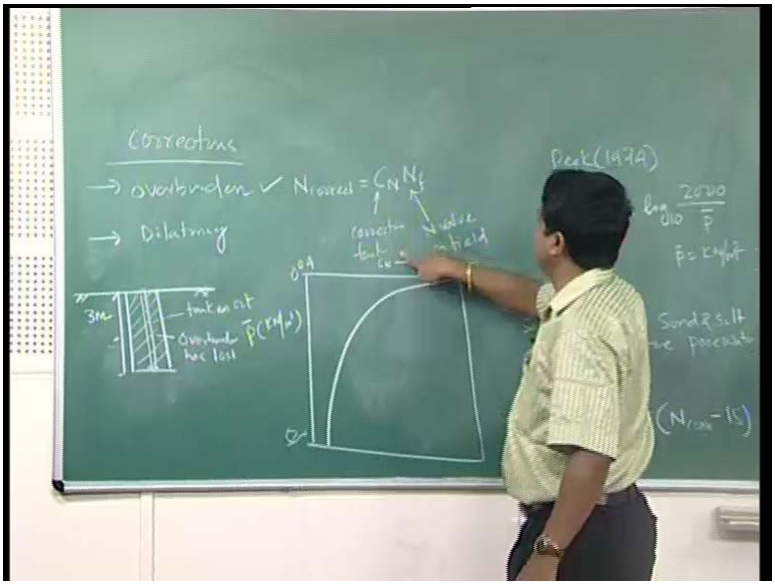

The movement at 3 meter depth, you do this bore hole and measure this SPT, that means penetration blow. What will happen? This soil samples once you make the bore hole up to 3 meter has been taken out.

Once this soil sample has been taken out from this bore hole, that means this overburden has lost. If there is overburden, then definitely whatever you are getting this N value, it will have different N value to correct that overburden, N corrected has been made C N; C N is your correction factor, N f is your N value in the field. Whatever N value in the field, you are getting that is your N f, so C correction either you get it from chart, it is there in I spot or you can get it from peck 1974, they have given C N is equal to 0.77 log 10 2000 by P, this is your overburden pressure kilometer per meter square.

Then, come to second correction that is your dilatancy corrections; dilatancy correction is there, if there are fine sand or silt, and water table is there. What will happen? Fine sand and silt with water it will give negative pore water pressure, negative pore water pressure it will give to take account that dilatancy correction is required. And dilatancy correction will be applied only when N corrected from overburden, N corrected from overburden is greater than 15. If N corrected from the overburden is greater than 15, then only you apply dilatancy correction that is your N is equal to 15 plus 0.5 into N corrected minus 15, this is your dilatancy correction. Remember particularly in standard penetration test overburden correction comes first, then your dilatancy correction, and dilatancy correction will go provided overburden correction N corrected is greater than 15.