Geotechnical Measurements and Explorations

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Lecture No. # 10

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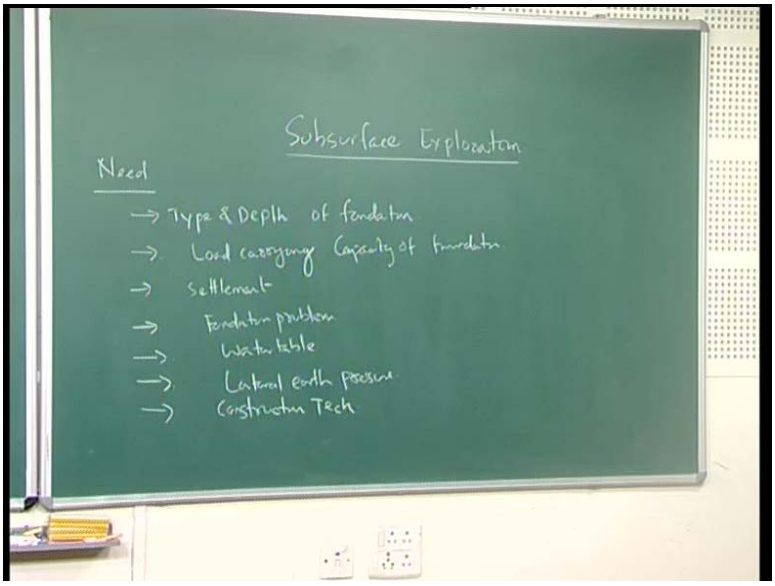

Subsoil exploration, so I already discussed earlier need type, and depth of foundation. Second is your load carrying capacity of footing or foundation, then third is your settlement, fourth is your potential foundation problem. We can say that foundation problem, fifth is your water table, then sixth is your lateral earth pressure, then construction technique.

Now with this, I will discussed last time subsurface exploration there is a need, because why you need the subsoil exploration, because to find it out type and depth of the foundation.

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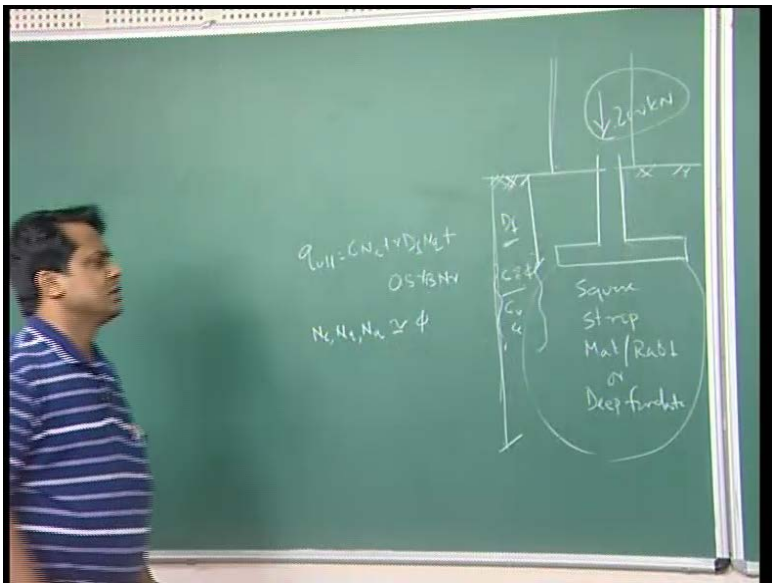

What is the type of the depth of the foundation means, the first one is your, if there is a footing if there is a footing say this is a footing. Now, say this footing will be constructed below column, suppose say column load of 2000 kilonewton or 200 kilonewton is acted. So, in this subsoil exploration what will happen? You need to find it out, in the periphery of this particularly up to the pressure valve, you need to find it out what is a c and phi? Once you will take out the soil and find it out the c and phi and also probability, then you can find it out particularly this kind of load what is the type of footing? Foundation you may, it may be a square, strip or mat, raft or may be deep foundation.

Then at what depth we are going to put your foundation, this is the depth - depth of the foundation at what depth? This all calculation will come from your soil basic parameter c phi, and coefficient of permeability C c from there it will come this calculation, this is type one, and type and depth of the foundation. Then, this is the expected, second part is your this is your load coming to the column, these are structure; in this structures in the columns are there - column load, this is a load coming on structure because coming on the column, because of the structure.

Now, second part is your what is the load carrying capacity of foundation. If type and depth of the foundation has been decided, if it rested on a soil then how much load it can take. What is the permissible load it can take, because of the soil; if this permissible load taken by the foundation because of the soil is more than the load coming to the

foundation, that is your second part. And this permissible load carrying capacity of foundation from terzaghi's equations like q ultimate C N c plus gamma D f N q plus 0.5 gamma B and gamma. If you look at here, this N c, N q and, N gamma; it depends up on phi it depends up on phi, C is your cohesion parameter. So, these ultimate bearing capacity or load carrying capacity of foundation theoretically you can calculate, if you know this soil profile below the footing, so that you can calculate how much load it this foundation is going to take or may be permissible load. So, this requires also subsoil exploration to find it out, this is the need for this.

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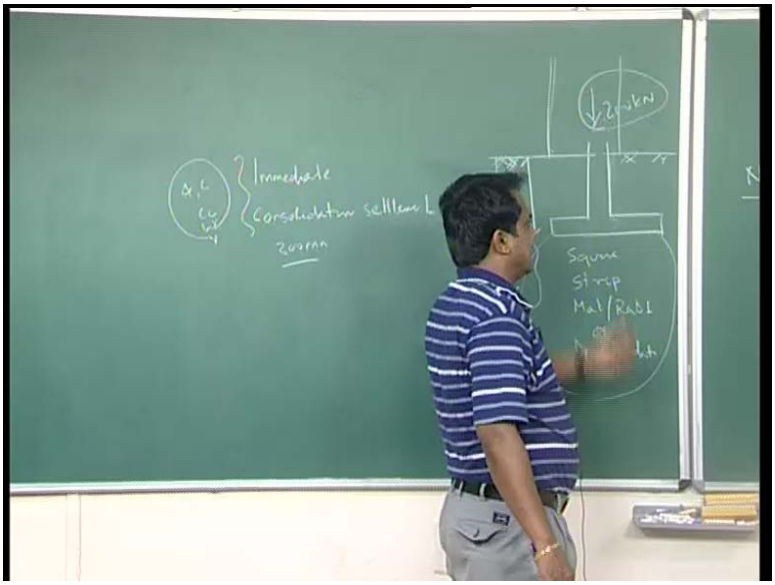

Then third is your settlement, what is your probable settlement? Because if suppose the settlement, if the suppose settlement criteria suppose settlement from this c phi you can find it out immediate settlement, as well as consolidation settlement for this you also need phi c C c, all the things water content gamma unit weight all the soil property you need. Once you calculate the settlement, means suppose the settlement is expected may you can say 200 mm or 300 mm, accordingly the size of the footing you can change later on also, that is also another need.

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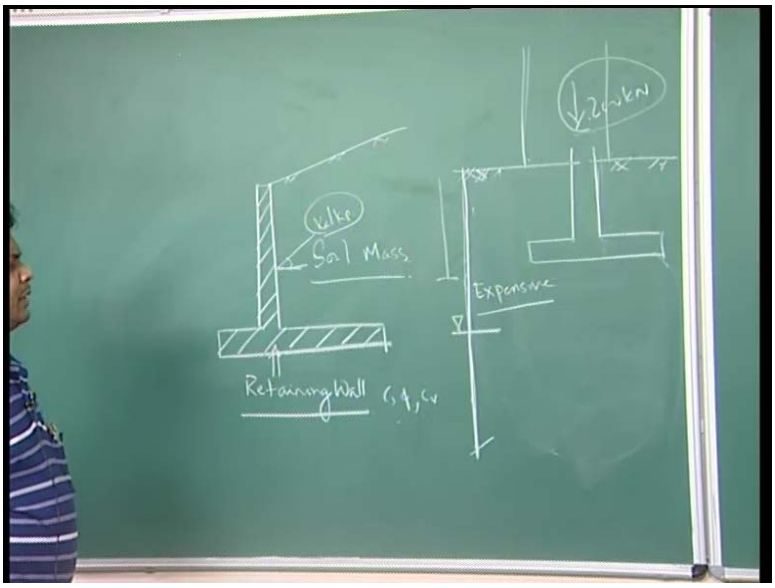

Now, fourth part is your foundation problems. What will happen, this is a this is a footing rested upon the soil, now if suppose this soil below this ground, if it is expansive. What do you mean by expansive? So, what will happen? In summer season, it will shrink; in winter season, it will kind of expand. So, what will happen? This expansion as well as shrinkage both will come in picture, so there might be because of expansion, there might be carrying capacity may decrease or increase. If there is any foundation problem before construction of foundation from subsoil exploration, if you know then some remedy or may be or remedial measure may be taken.

Then, this is your water table. If I if I if you do not do this subsurface exploration, you cannot locate in geotechnical point of view, where is your water table lying? It may be lying at five meter, it may be lying at four meter. Once you know the water table, then effect of water table on bearing capacity or may be load carrying capacity or may be this settlement, you can easily calculate.

Now, this is your lateral earth pressure. But design of retaining walls design of retaining walls - retaining walls means a retained soil mass. So, because it retain the soil mass, this is your retaining wall. So, it retains soil mass here, if you do not go this subsoil exploration if you do not know, what is the c phi or C v of the foundation soil as well as this soil mass which is going to retain. Then, you cannot calculate the earth pressure, because the soil mass will generate this generally is designed based on this earth

pressure, either k or k p - active earth pressure or passive earth pressure may be you can you can calculate from your subsoil exploration from the properties of soil c, phi coefficient of permeability C v, then coefficient of consolidation then C c. These are the these are the few points means why we go for subsurface of exploration, these are the need.

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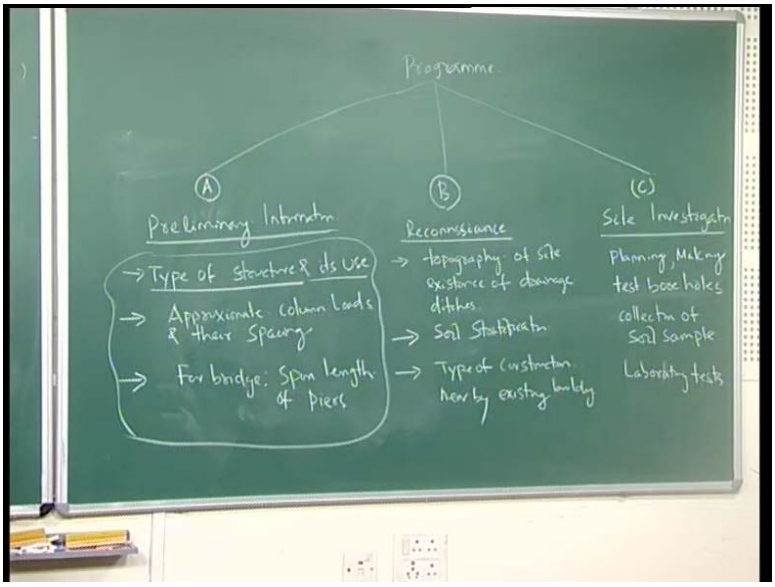

Now for subsurface explorations, what are the program if I put it - A is your preliminary information, B is reconnaissance s s i a n s s i a n c e reconnaissance survey, then C is your site investigation. If I say if I say A is your preliminary information, B is your reconnaissance survey, C is your site investigation; these three can be added, so it is said this is the complete program for your subsoil investigation.

In this preliminary information what you are supposed to get it? Type of structure and it is use, second is your approximate column loads, and their spacing, then for bridge span length of piers. In reconnaissance survey generally you have to collect topography of site existence of drainage ditches, then soil stratification type of construction nearby nearby existing building, if any. Then this site investigation, this comes under planning, making, test bore holes, then collection of soil sample, then is your laboratory test.

Now, if you divide whole program into this three parts. A part one is your preliminary information, before you go for subsoil investigation or may be site investigation. Preliminary information, you will get it from this architects or design means what kind of

structure is going to construct? Suppose there is a site, in this site what type of structure and it is use, that means whether it is just simple multi-storey structure for any residential purpose or may be for a multi-storey structure for any other purpose may be industrial or may be some machine or machinery or car parking or manufacturing. What kind of this structure are there? Particularly, what are the type of structure and it is use, that you will get it from design or may be from architecture, then approximate column loads. What are the approximate column load? Suppose to come, and what would be its spacing.

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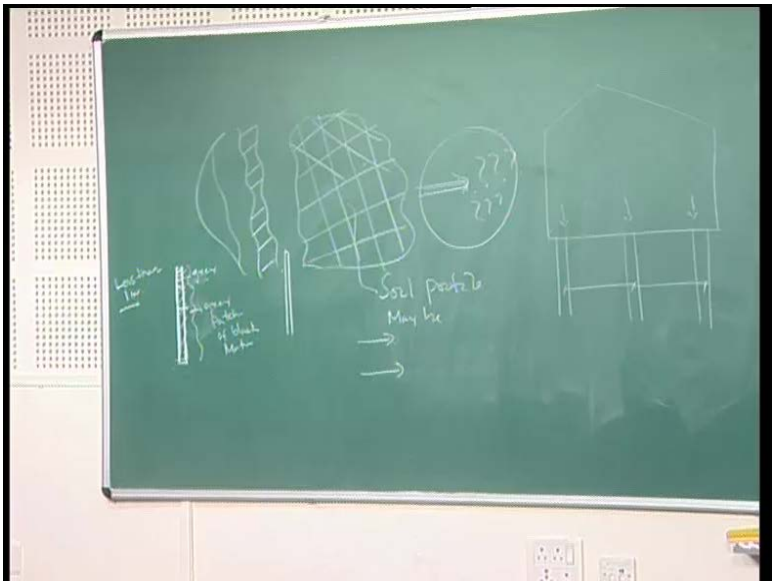

Once you decide means, once you get information of means what kind of type of structure, whether is a multi-storey or single-storey; then second part is your whether it is for residential, and or for may be industry or may be manufacturing or may be certain companies, then what is it is use means it is for storage, it is for common use. That… Then, if there there is a structure, what is the approximate? What is the approximate column load, expected column loads would come what is the approximate? Expected column loads, and once you get the expected column loads then what are their spacing.

This is the information - this information you will get it from drawings whatever available. Then similarly, for bridge - if there is a bridge what is the span length of piers or abutment, these information clearly you will get it from drawings or from the architect or may be structural engineers. These type of structure, it is use and approximate column

loads and their spacing, and for bridge span length of the piers, this you will get it from these drawings.

Now, part B reconnaissance survey from these what you are supposed to get topography of the site, suppose the site is there, site is there. So, what is that topography of the site, and existence of any drainage nearby, once you enter the site, you can you can check whether existence of any drainage or may be any pond existence of nearby existence of particularly type of construction. Suppose, here you want to go this is your, site this is your requisite site, where it has been decided to go for subsoil investigation.

After getting preliminary information in reconnaissance survey, then this gives what is the topography of site? Is there any you ask yourself, is there any drainage ditches nearby yes or no, then if there is any building nearby, you can see what kind of construction nearby? Type of construction nearby this existing building means - is it a multi-storey, is it a single storey, if you go there you can get even even if it is village - even if it is a village you can go nearby and check, what kind of building? What kind of construction these villager has done. Even if it is a residential, then you check in reconnaissance survey is that building or the structure whatever the construction they made it whether it is existing, whether it is existing is there any crack, anything else that you can see the visual inspection.

With this visual inspection you can know nearby soil profile may be, nearby soil profile may be you can say that sand, silt, clay or coarse grain, fine grain or may be some kind of soil, that is your expansive soil may be there; this gives a preliminary idea. Then, soil stratification, once you go to the site in the reconnaissance survey reconnaissance survey, where you will do you just make a pit nearby, then try to identify once you make pit try to identify, what should be their soil stratification by visual inspection. You can look at here this from the pit, you can visual inspection you see that is the soil profile same it looks like or it is changing - or it is changing from one suppose for example, once you make a make a small say less than one meter, you cannot make it this is more than one meter particularly pit, because this is reconnaissance survey - reconnaissance survey means particularly you want to give a basic idea.

That means, it should be less than one meter, just approximately you see is there any stratification varying, how do you know that stratification varying? If you look at this

ground and look at this soil profile, if it looks kind of a grey. So, throughout it should look like a grey or may be some patches or may be patches of black material black material, so with this visual inspection you can say that whether this soft soil profile is uniform or may be soil stratification is varying. This is a simple indication, this is not giving a detail program, this will give only indication of this how much is your subsoil profile.

Then, once you get reconnaissance survey means the data from here after preliminary information, then the decision has to come for your site investigation; in the site investigation planning, making, test bore holes; means you have to plan suppose this is your site you have to plan, how many number of borehole supposed to be done in the site? So that, you can get you can get the soil profiles, and what should be your depth, planning and making of borehole up to what depth you can go. Then collection of after after making these then collection of soil samples, once you collect undisturbed soil sample take you to the laboratory for testing. This comes after this once you get report from preliminary information, and reconnaissance survey; once you get these two reports, then you can decide what is your site investigation? What part on you are going to do, and planning and making of the depth, and how many number of boreholes you are supposed to do, and particularly what depth how many numbers this decision has to be made based on this data.

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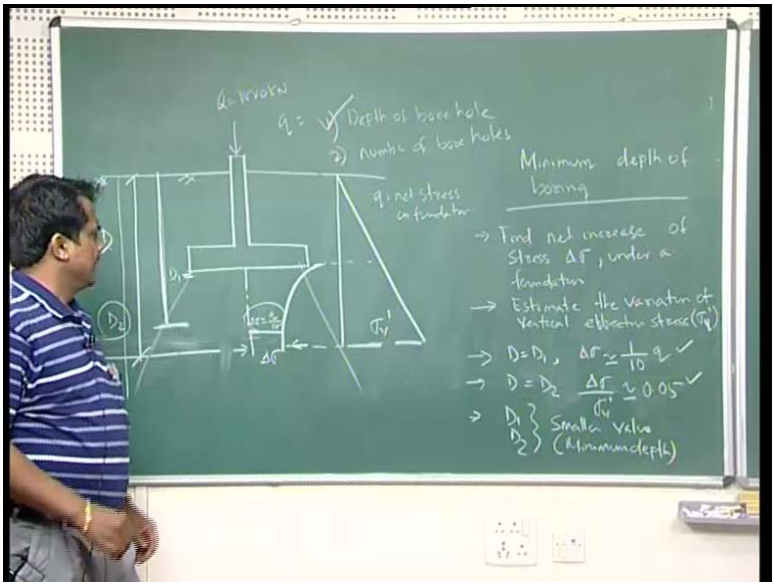

Now, if I come back to your planning and making bore holes, minimum depth of boring; these are certain thumb rules. What should be in the planning, in the program site investigation in the planning, making, test bore holes, then how do you decide what is the minimum depth below the ground surface you can go . Find net increase net increase of stress delta sigma under a foundation. Estimate the variation of vertical effective stress. D is equal to D 1, when delta sigma is equal to 1 1 tenth q, then D is equal to D 2 delta sigma by sigma b prime 0.05; D 1, D 2 smaller value is the minimum depth.

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In the third part site investigation planning, and making the test bore holes. How do you decide what is the minimum depth of boring how do you decide? So, first is find net increase in stress, under foundation net increase in stress, it may be find it out you can find it out by means of (( )) theory or by means of two is to one distribution; by means of approximate two is to one distribution you can find it out how much increase in stress delta sigma. Then, estimate the variation of vertical effective stress sigma v, means how much is your vertical effective stress variation with this increase in stress, how much it is variation sigma v. Then D is equal to D 1, you can say that D is equal to D 1 provided delta sigma that means increase in stress equal to one tenth q, increase in stress equal to one tenth of q. That means, suppose q is equal to q is nothing but your net stress on foundation.

Suppose total load is coming 1000 kilo newton. What is your next stress? Load by area minus this gamma d f. Net stress you can find it out from your load, so D is equal to D 1, it says D is equal to D 1. Now, this is depth D is equal to suppose at here it is say D 1, D is equal to D 1 when delta sigma; that means here increase in stress is there when delta sigma increase in stress, suppose this is say up to this point delta sigma is equal to q by 10. This you can measure plus this height is know, so total distance will be D is equal to D 1 - condition one, when delta sigma equal to one tenth of q.

Now, part two if D is equal to D 2 D is equal to D 2 , d is equal to say this is d two delta sigma by sigma v prime, that means increase in stress divided by vertical effective stress - vertical effective stress should be 0.05. That means below the foundation it should be delta sigma by sigma b prime should be 0.00 0.05, that is your D is equal to D 2 with these two conditions - one is your D is equal to D 1, other is your D is equal to D 2; with

these two conditions whatever value you are going to get it, that is your smaller. Suppose, this is my D 1 depth, this is the D 2 depth, out of D 1 and D 2 which is smaller; suppose D 2 is smaller, that means up to that distance, this is the minimum depth of subsurface exploration means below the ground surface, you will have to go to the depth minimum depth up to this. Beyond this if you go that is also fine, but this is the minimum depth you can calculate.

Now, one part is over in the site investigation making test bore holes, that means what depth? Depth of the borehole has been discussed with this depth of the borehole this is D, and this is D 2, this is D 1 and D 2; with this D 1 and D 2 what is the minimum? Once you find it out the smaller value is your depth of bore hole; once the depth of borehole is decided, once we decide that means minimum depth of bore hole. Here minimum depth of bore hole somebody can go up to the maximum depth holes up to minimum, maximum you can go beyond this.

Second part is your number of boreholes, once depth has been decided in that particular area, how many number of bore holes you are supposed to do? In that particular area, how many number of how many minimum number of once again I am saying how many minimum number of bore hole supposed to be conducted.

Now, for example…

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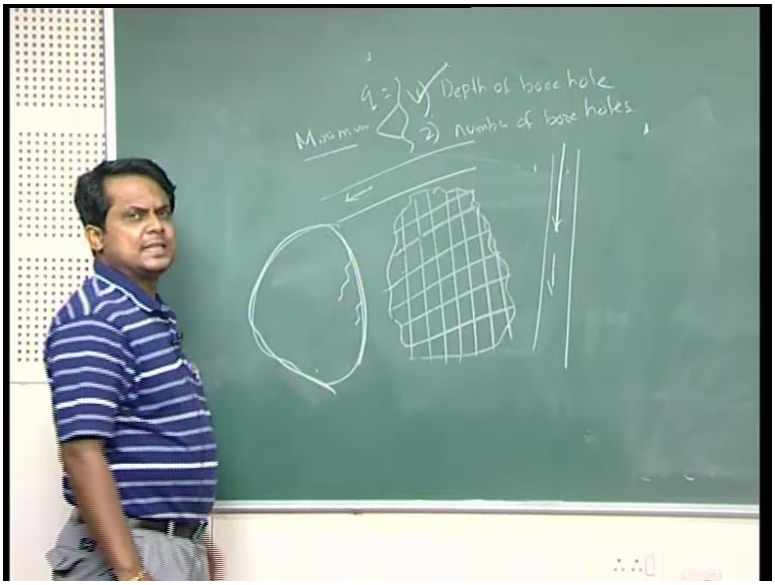

This is the area under consideration, means where you are going to do may be high raise building, may be multi-storey building to be constructed. Now, you have collected preliminary information, that means type of structure is multi-storey, and it is usually suppose say residential, and approximate column loads you collect and their spacing. Then also a topography of the site, and soil stratification, and type of the construction; these two you got it from this preliminary as well as reconnaissance survey. Now for site investigation you got the minimum depth of bore hole.

Now, before you decide the minimum number of boreholes, minimum number of boreholes, you have to take consideration nearby is there any nearby is there any railway track is going, is there any nearby there is any pond, if nearby there is any pond. What is that water table varying, if there is a nearby rail track is going, how the trains means nearby the trains - is it a local train or high speed trains or may be express trains are going, how far it is it is a you can say multi-track rail or single track rail, suppose nearby another road is going, this road is a highway - national highway road or this is a simple road. Because based on this - this will decide, if suppose why I am saying suppose if you do not consider this parameters before taking number of boreholes.

Suppose number of boreholes, suppose say two or depth you got it based on these parameters that up to ten meter. What will happen? Once this rails or roads are going it will impact vibration on this building - nearby building, once it impacts if you have not taken sufficient measures against this, then this there may be might be some cracks or may be differential settlement or may be something will occur in the building. So, if once

again, if there is a pond here, how far from this pond this structure is there? Where you are going to construct the building, this is very close; once this is very close what it impacts? There might be a chance, that it may erode the soil sample. These are the factors before deciding number of bore holes to be considers, and may be tomorrow I will discuss this, what are the numbers of bore holes to be consider.