Foundation Design
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Lecture - 1B
Subsoil Investigation or Site Investigation
Part-2

So last class, we have discussed about the first part Subsoil Investigations. And why there is a requirement of your subsoil investigation; that means, what is the need. And also we have discussed different programs, preliminary information, reconcern survey as well as site investigation. I have finished up to preliminary invest information and reconcern survey.

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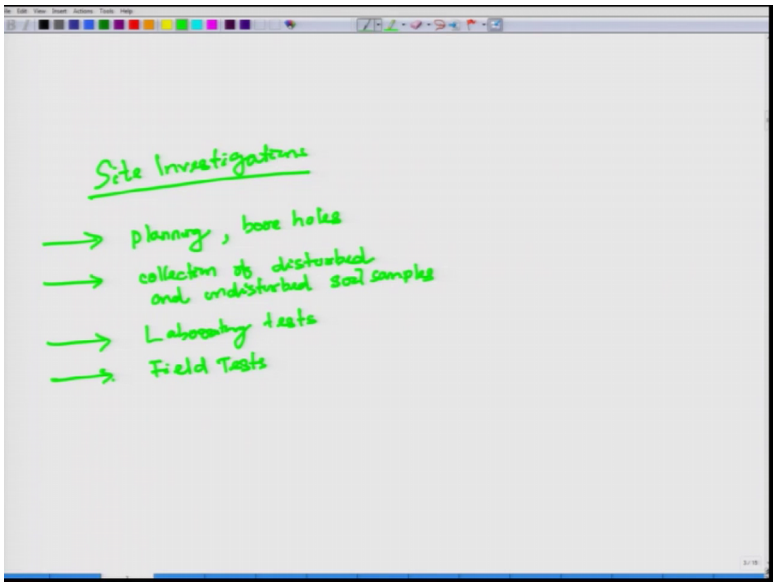

Now, we are going to start with these subsoil explorations of your third part or detail site investigations. Detail site investigations, if I say it then in this we can start with planning, making test boring or boreholes, then collection of disturbed and undisturbed soil samples. Then laboratory tests, and in this case while collecting the boreholes also we can do some, we can do if required field test. This is all about particularly detail site investigations. We have to planed and decide how many number of boreholes to be carried out.

Then once, the decision has been made then collection of disturbed and undisturbed soil samples at regular interval below the ground surface. Then based on the collection of the samples, we have to take a call what are the laboratory test we are going to do, then if required some field test also to be carried out.

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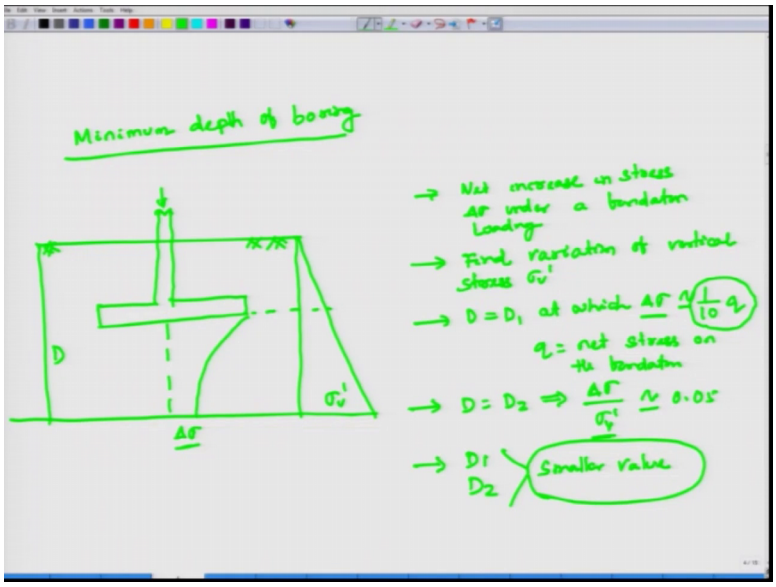

Now, if I come to part of this what is the minimum of the depth of the boring. The question asked minimum depth of boring. What should be the minimum depth of the boring? Let us take an example. Suppose single footing is there. This is your column load. Suppose for example, this is my depth D and this will be your centre line.

Now, this I say, delta sigma delta sigma is your increase in stress, because of your external loading, then variation of your overburden pressure or sigma v prime. So, has to find it out net increase in stress, delta sigma under a foundation loading. Then estimate variation of vertical stress find variation of vertical stress sigma v prime. Then determine look at here, D is equal to D 1 first one, I say at which at which your delta sigma increase in stress equal to one-tenth of your q, q is equal to net stress on the foundation. Then D is equal to D 2 at which, that implies at which delta sigma by sigma prime approximately 0.05. Then last one is your take D 1 and D 2 and takes the smaller value.

First one is your first should be in your sub subsoil investigation, what should be your minimum depth of the boring up to what below the ground (Refer Time: 06:10) surface up to what depth you are going for your depth of the boring. If you look at here if there is

a ground surface, there are 2 ways, we will discuss later part also. You can assume some value of your foundations initially based on the column load. And with these some value of the foundations in size of foundations, then you have to take a call, if suppose this is a 2 meter by 2 meter or may be rectangular 14.

So, in that case if this is the column load. So, for example, say 1000 ton or 100 ton then what should be my minimum depth of the boring. Because it is a costly, if you go for a longer depth definitely the cost fact will come into picture

So, first to find it out net increase in stress delta sigma under a foundation loading; how do get it? Delta sigma here this is a foundation loading. Then it comes back to your basic soil mechanics. Basic soil mechanics what it will come back; that means, if there is a kind of square footing or rectangular footing, then at this center?

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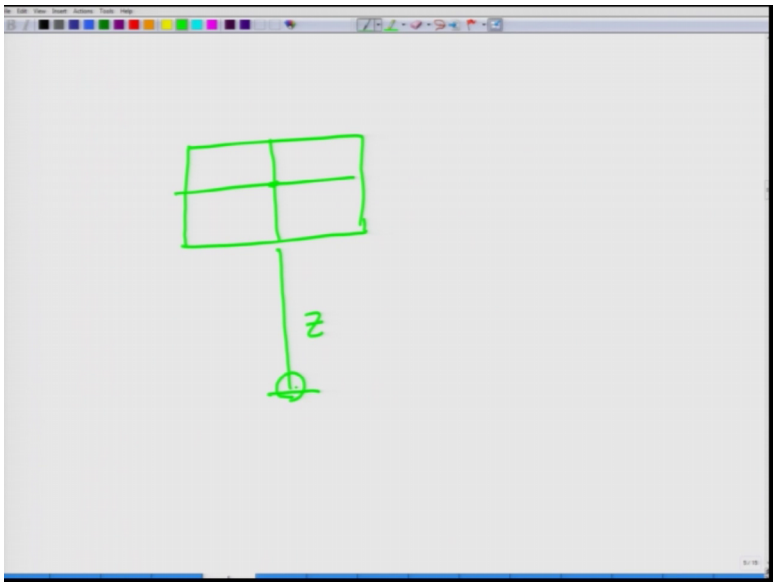

And below certain depth z, what is your increase in stress. Based on this methodology find it out delta sigma this is based on your verasonics presence.

What is your increase in stress because of your foundation loading? How much is your increase in stress you can find it out. Then find variation, variation of vertical stress vertical stress is this is gamma either effective or total in terms of edge find the variations. Then look at here if this is my depth of the boring if I say D is equal to D 1. This D may be D 1 at which delta sigma increase in stress equal to one-tenth of your q.

One-tenth of your q, q is your net stress on the foundations; that means, net bearing capacity you can say. Net stress on the foundation means bearing capacity or ultimate total stress minus weight of the foundation that is your net stress.

So, D is equal to D 1 at which increase in stress which is equal to one-tenth of q, q is your net stress in foundation on the foundations. Then D is equal to D 2 at which delta sigma by sigma 1. This is your sigma 1 or sigma B you can write it increase in stress under foundation loading variation of your vertical stress, this ratio which is equal to 0.05. Then compare this 2, D 1 and D 2 which is smaller. Either D 1 is smaller or D 2 is smaller, that depth you have to consider for your minimum depth of the boring right. This should be your minimum depth of the boring, once again D is equal to D 1 at which increase in stress under a foundation loading which is equal to one-tenth of the q, q is equal to net stress on the foundation. D is equal to D 2 at which delta sigma by sigma B prime which is equal to 0.05. So, based on these two, compare these to which is minimum that depth should be taken as minimum depth of your boring.

Now, part one is over that is your minimum depth of the boring. Number of the number what should be your minimum. How many number of the boring you are going to boreholes, you are going to extract how many there are different course different suggestions also there. So, if I come to this is your depth of the boring second part is, how many.

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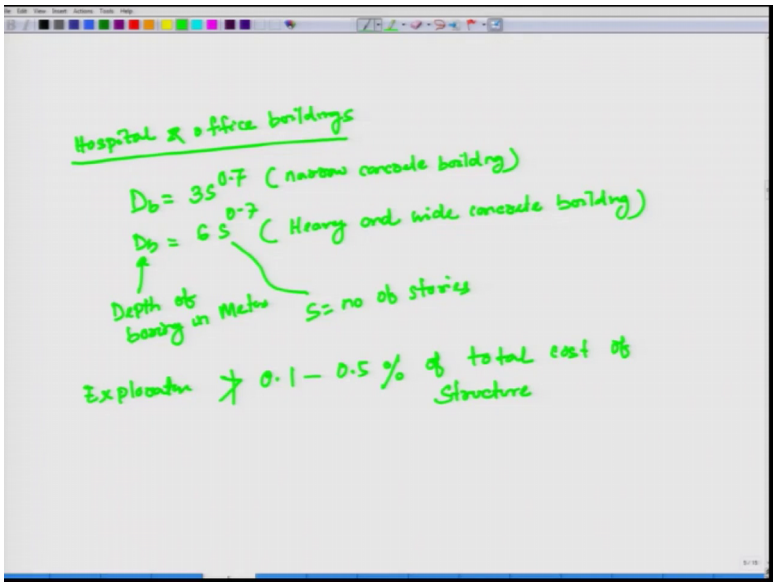

So, there is a thumb rule that is not necessarily you are going to stick to that, for hospital and office buildings, hospital and office buildings, they are db is equal to 3 S to the power 0.7 and db is equal to 6 S to the power 0.7. It is for this case it is narrow concrete building, and this part it is heavy and wide concrete buildings.

So, what is the db? Depth of boring in meters, then S is number of stories. So, these are kind of a thumb rules. Sometimes use these at kind of thumb rules. And generally the expenditure should be is should not go for a depth of the boring, such a depths it should not be more than means particularly your subsoil explorations, subsoil explorations should not be exceeding 0.1 to 0.5 percent of total cost of structure.

So, be careful while choosing your depth of the boring. Earlier what I said, depth of the boring is your D 1, D is equal to D 1; D is equal to D 2. Out of these 2 you take the minimum value. There are also thumb rules for hospital as well as office buildings, depth of the boring db is equal to 3 S 0.7 6S 0.7. And based on that you take a judgement and this explorations total cost of this explorations. That means, boring testing it should not be more than 0.1 to 0.5 percent of total cost of structure.

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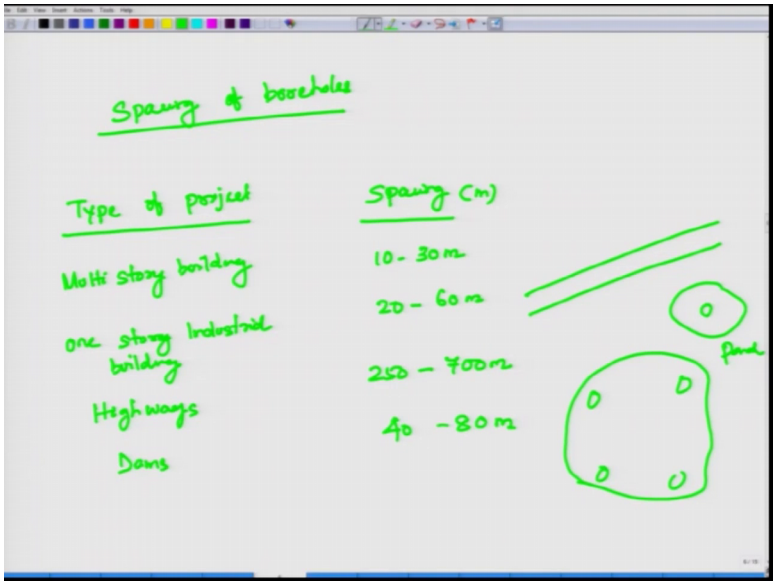

Now, if this is the depth of the boring, what should be your number of the boring, I said again and again. So, based on that how many number of boreholes you can go for I can said spacing of the bore boreholes. Spacing of boreholes, this is a thumb rule this is a

thumb rule. Then I can say type of project and here it is spacing, so multi story building generally spacing in meter. We go by 10 to 30 meter.

And one story industrial, one story industrial building generally we go for 20 to 60 meter highways. It is a plane strain problem highways generally we go by 250 to 700 meter, then dams 40 to 80 meter. This is a thumb rule means based on your experience somebody can take a call. So, what type of project it is? If it is a multi story building you can go for 10 to 30 meter, multi story 10 story or may be more than that. So, 10 to 30 meter if it is a kind of this area will be there; that means, this spacing here borehole will be here, here will be here 10 to 30 here will be here, here will be here, here will be here.

Then if it is one story industrial building 20 to 60 meter spacings. Highways generally, highways' continuing it is 250 to 700 meter, dams 40 to 80 meters. Despite that these are all the thumb rules. Despite that they have given a kind of these are from the codal provisions, they given a kind of rules despite that suppose I am going to or we are planning for a there is a road here. And there is a structure here we are planning for this subsoil investigations as well as structural part.

Then there is a kind of pond here, pond or may be some kind of passage of water is there low living area. Even if you go for suppose for example, multi story building has to be erected here, even if a go by 10 to 30 meters. Despite that because there is a pond here you can take one more borehole here.

So, this will come from your experience. It is not like that you can take it as for as possible it should be a minimum, it should be a minimum. So, that cost has to be within your limit 0.1 to 5 percent.

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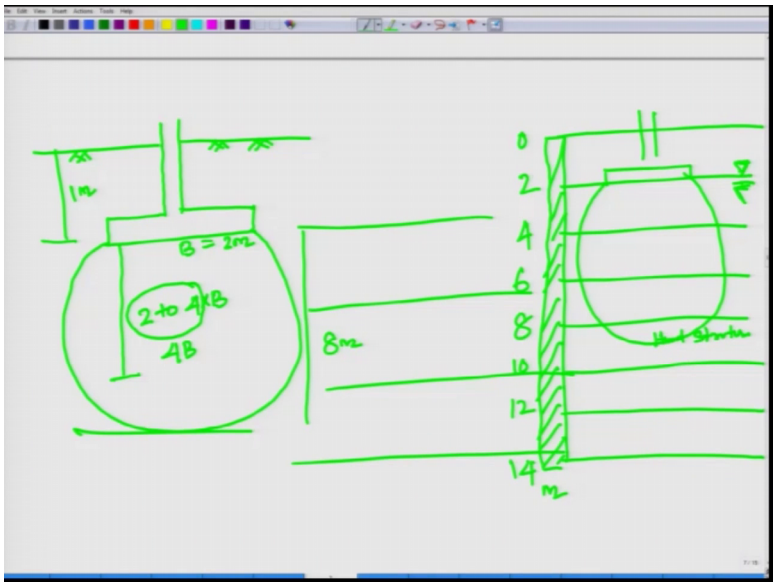

Another certain part of your particularly depth as well as size, as well as depth of the borehole, as well as your what should be your spacing. Generally, what it says I am drawing a shear shallow foundations or may be footing. In a footing what it says if there are light structures the boring should be extended at a depth equal to 4 times probable footing width. If it is B generally we go by 2 to 4 times B 2 to 4 times B. It is good if you go for 4 times B. Depth below the probable foundations it should be 2 to 4 times of a B. Why it is 2 to 4 times of B? Because within this 4 times B, there is a influence of this is called influence zone, ball said influence zone this soil mechanics part particularly verasonic sequences you know it.

So, generally the range is 2 to 4 times. So, generally it will be 4 times. So, that if you go it, because this is your pressure intensity. Beyond 4 times there is no effect. If I go by borehole beyond 4, 4 times what will happen? It will be ineffective if foundation is laying at a meter of say one meter depth below your ground surface. And you say B is equal to 2 meter width of your foundation. So, if I go by 4 times so; that means, we have to carry out up to 8 meter, 8 plus 9 meter. Total 9 meter depth will go by subsoil explorations. Beyond 8 meter below your foundation what will happen, the pressure intensity or pressure ball will be effective beyond that there is no effective means. This footing has effective up to this depth whatever is your load is coming load transport this depth. So, this is the rule generally you can go it. And other part is they are try up to a level of if you are getting a hard stratum.

Suppose for example, in this case even if it is a 4 times, in this case some cases there are layer soil. Layer 1 layer 2 layer 3 layer 4. These are all soft soils try to do boring, beyond subsoil at least one borehole. So, that what will happen; you should know up to what depth your soft soils are there. And hard stratum beyond what depth it starts your hard stratum.

So, that you can get an idea so that you can take a decision where we are going to put your foundations, then these are all you tentative. What will happen? Once you finish your subsoil investigations, once you finish your subsoil investigation, you are supposed to get soil properties. Soil properties every 1.5 meter or 2 meter interval. We will get back this is called bore log data. Bore log data, you are supposed to get it soil profile every 2 meter. So, what will happen, suppose I am getting 0, 2, 4, 6, 8, 10, 12, 14 meter?

Then I can cross check. These are my tentatives; I can cross check where I can put my foundations. So, what will happen suppose water table is at here, water table is at here, and then where shall I put my footings. So, then I can take a call, fine up to 10 meter, it is not soft. It will be kind of hard stratum. Then I can place in such a way that my footing will be line somewhere else here. Then the entire pressure ball covers your hard stratum. It should not go to your soft soil. So, that bearing capacity or the capacity to take the load will be in safe or safe region.

So, this is one way around other. So, you go for subsoil investigations 10 tentative dimensions, and take a call how many number of boreholes and what depth you are suppose to do. Once borehole has been made you cross check whatever your column load is coming whether with that column load are at what depth we are going to place your footing below the column, then below this this pressure ball should be within your safer zone or may be slightly harder stratum.

There are many things we will add. I will discuss, as we are going to progress, I will discuss. Now come to, this part I am going to start it boring.

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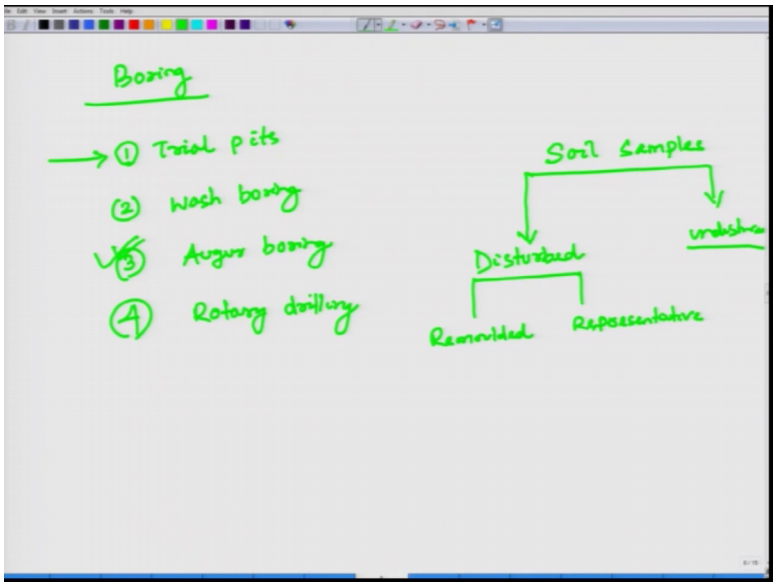

So, there are different type's merits and as well as demerits also is there. So, first one is your trial pits. Second one is your wash boring right. Third one is your auger boring. Then fourth one is your rotary drilling.

How you are going to do the boring, what are the different methodologies? So, how we are going to collect in the boreholes, how we are going to collect disturbed as well as undisturbed soil samples. First one is your trail pit you can go for a trail pit and one what condition this trail pit you have to implement. Second one is your wash boring, what condition what are the soil conditions. Third one is your auger boring. Fourth one is your rotary drilling, what you are supposed to get. These I am suppose discuss in detail what we are supposed to get from these.

Suppose I am taking it by means of auger boring. First one is your depth and numbers of boring you have taken a decision. Then once you have taken a decision of your depth and numbers of borings then you go for auger boring. Suppose we have taken a decision in (Refer Time: 24:46) auger boring, what we are supposed to get it, we are suppose to get it soil samples soil samples. First one is your disturbed and in this disturbed soil sample, it is your remoulded and second one is your representative. And this one you are supposed to get undisturbed.

Once we are doing a boring every 2 meter interval. You are supposed to collect disturb soil samples as well as undisturbed soil samples. In disturbed soil sample once you take

it to the laboratory some soils it will possible you can remould it to it is original state. And other is a representative and in representative soils particularly it will go for classifications. And undisturbed soil samples generally used for your string test like trakseal consolidations mean string test you can use your undisturbed soil samples. Then there are different samples are there samplings are there that part also I will discuss. I will stop it here.

So, may be next class I will start of boring and what are the different methodologies. How with this, I will discuss in details trial pits, wash boring, auger boring, rotary drillings and what are the different field test we are suppose do, and why? This is what I am going to discussing.

Thank you.