Geotechnical Measurements and Explorations

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Lecture No. # 38

Another one is a rock sampling as far as we have covered about how to collect undisturbed samples from the ground surface if it is soil. Now, if there is a rock mass how do collect the rock sample for testing in the laboratory.

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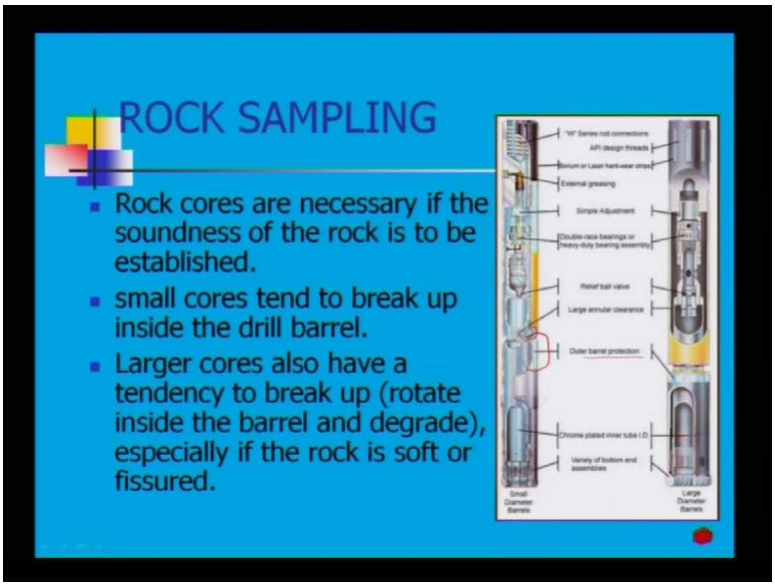

Rock cores are necessary if the soundness of rock is to be establish small cores tends to break up inside the drill barrel, and larger cores also have a tendency to break up especially if rock is soft or fissured. If you look at here, these are a small there are two two dimension sampling; one is your small diameter barrel, other is your large diameter barrel, and with this barrel there are this barrel consist of outer barrel protections. These are the sieves, this is your outer barrel protections connected with annular clearance one by one will be collected this is your annular clearance, and relief ball valve and double phase bearing also it is their bearings are there are double phase. So, simple adjustment that means after pushing there is kind of angular clearance, and by means of this valve it

will be pushed, and it is a chrome plate inner tube that means this is your inside diameter, and this is your outside diameter backside is your outside diameter.

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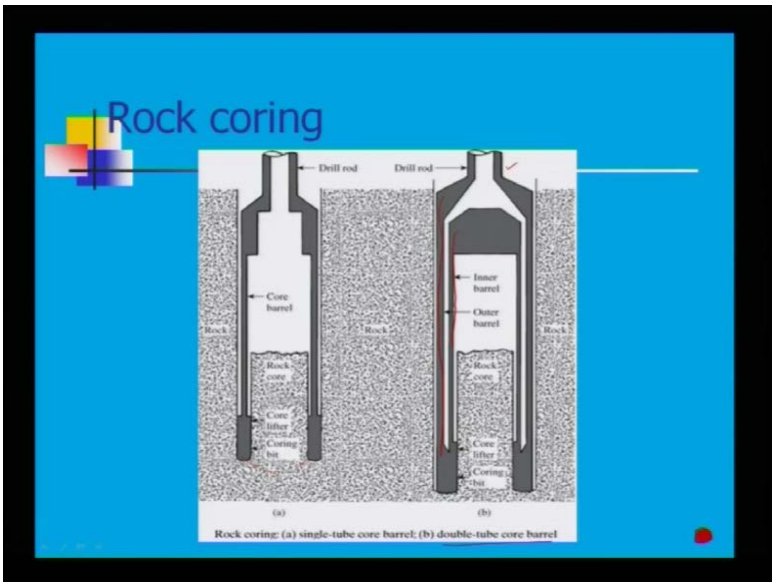

Now will see in details how this rock sampling has been done. If you look at this rock coring, now this is a draw particularly this is your drill rod, this is your bigger one and this is your small once, single tube core barrel, and this is your double tube core barrel. In single tube core barrel, if you see this is your rock mass - this enter is your rock mass, and this is your drill rod - inside this drill rod has been pushed inside this rock core by means of coring bit at the ended; these are the coring bits, this will cut the rock mass from the surface. So, that it will make a hole, and you can push inside this drill rod, and this is called core barrel. This is an empty, once you push it inside this your rock core will go inside, then you can take it out, and single tube core barrel means at least we will get a one tube. And double tube also will get one tube, but in case of difference between single tube, and double tube is there, there is a outer barrel look at here, this is your outer barrel, and there is also inner barrel; this is your inner barrel. In case of single tube only one barrel is there, this is your barrel, one barrel is there.

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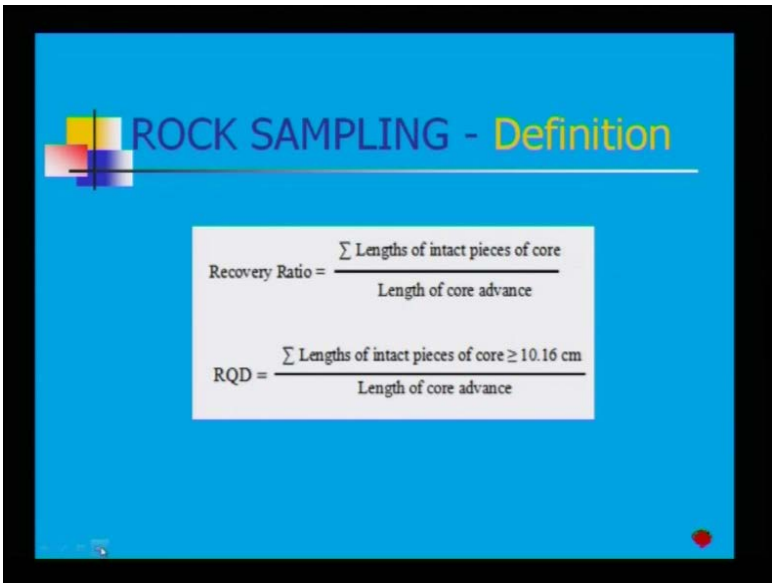

Now, recovery ratio rock sampling length of intact pieces of core divided by length of core advance, length of intact pieces of core, if you look at here length of intact pieces of the core, this is your length of the intact pieces of this core divided by length of core in advance means how much length we are advancing. So, length of intact pieces in core should be greater than equal to 10.16 centimeter, and length of core advance from there you can find it out, what is your recovery ratio?

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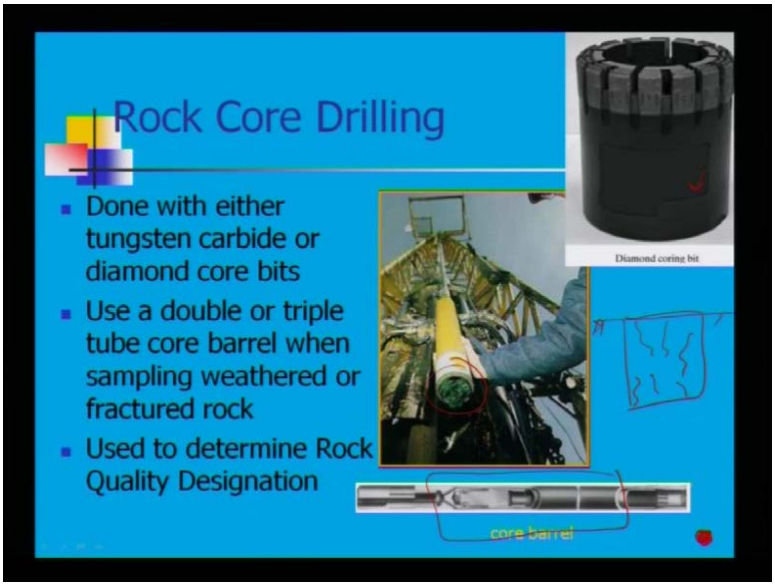

Now, done with either a tungsten carbide or diamond core bit, means how to drill the rock; rock is a very hard means once you drill it then only drill dot will go inside. So far drilling you need either a tungsten carbide or diamond core bit at the end one diamond core bit, you need it and then use a double or triple tube core barrel when sampling weathered or fractured rock. You do not know may be inside this below the ground surface whatever rock materials are available, it may weathered or may be fissured; the rock material is there solid, but it is there micro if this is a rock material is inside below the ground surface means these are the fissures are there - micro fissures are there.

So to collect particularly for micro fissured or may be fractured the because of this fissure there will be fractured in the rock for particularly fractured rock, you need to have double or triple tube core barrel. Now if you look at here, this is your diamond coring bit; diamond coring bit means if you look at here these are my threaded one, so it will rotate by rotating the rock mass will it will it will cut the rock mass, and this is your tungsten carbide. Now, if you look at this is your core barrel, the entire part is your core barrel how it has been pushed and diamond coring bit will be at the end.

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Rock quality designation, that means if you look at this it is IS means 1529 geological and rock investigation, so there are some example coring 1991, 92, 93; length is varying from 188.90, this is 188.90 to 195.05. And rock this ratio recovery ratio you can find it out recovery ratio is your 97 percent, 98 percent, 94 percent, and 98 percent; these are

how this different drill rod and different coring length it has been used, how you are getting rock mass? If you look at here, it has been marked how you are getting the rock mass without disturbing anything in undisturbed condition, how you are getting a solid rock mass by means of drilling and coring.

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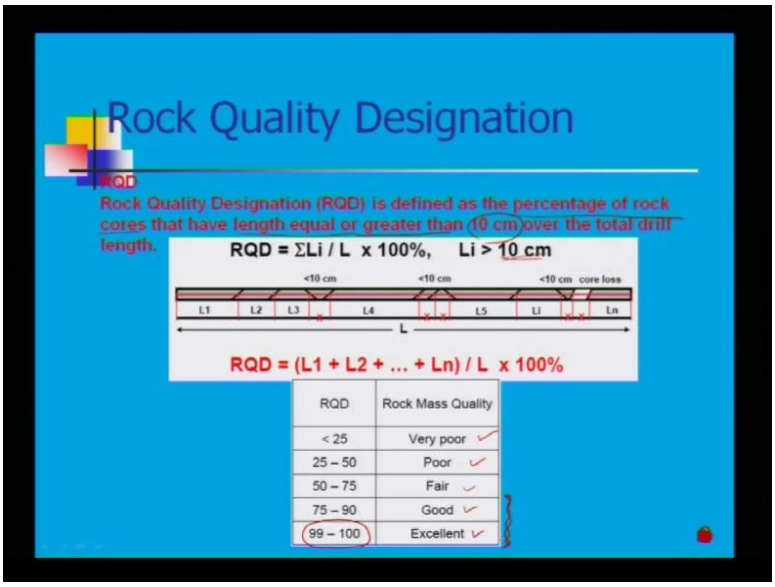

Then rock quality designation RQD is defined as the percentage of rock core that have length equal to length equal or greater than 10 centimeter over the total drill length look at this rock quality designation RQD is called rock quality designation. It is defined as the percentage of rock cores that have length equal or greater than 10 centimeter, percentage of rock core that have length equal or greater than 10 centimeter over the total drill length. If rock quality designation is L i by L into 100, L i is your length equal to or greater than 10 centimeter, look at here rock quality designation L 1 plus L 2 plus L 3 plus L 4 up to L n divided by total length L into 100.

So, rock quality designation RQD if less than 25, if less than 25 rock mass quality is very poor. From this from this test you can you can you can classify it based on your RQD. What is your rock mass quality? It is a very poor rock mass quality poor, fair, excellent, good or excellent; excellent you will get it if rock quality designation RQD is 99 to 100 percent. At least up to this you have to maintain 75 to 100 percent that is called your undisturbed rock mass you are collecting from the ground surface for your testing

purpose. If RQD varying from 75 to 100; that means the quality of rock collected from the ground surface it is up to your expectation for laboratory test.

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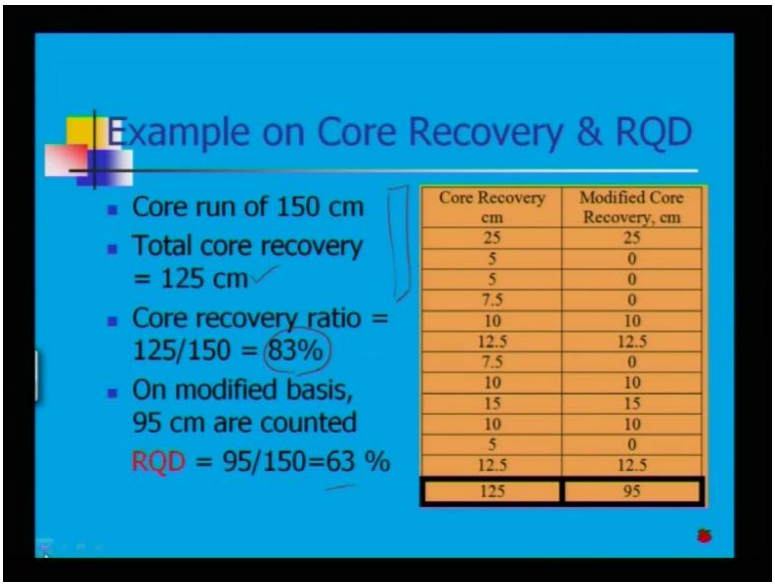

Example on core recovery and RQD core run of 150 centimeter, total curve core recovery means length is length may be 150 means how much core? How much you extract? Total core recovery is 125 centimeter, core recovery ratio is 83 percent. Now on modified basis 95 centimeter are counted, so it will be 63 percent. Look at this core recovery centimeter is your 25, 5, 5 means every 150 centimeter interval 10, 10, 10, 10, so it will be 125. Now, modified core recovery in centimeter is equal to your 95, this is how the typical example how you are going to calculate your core recovery or modified core recovery in centimeter.

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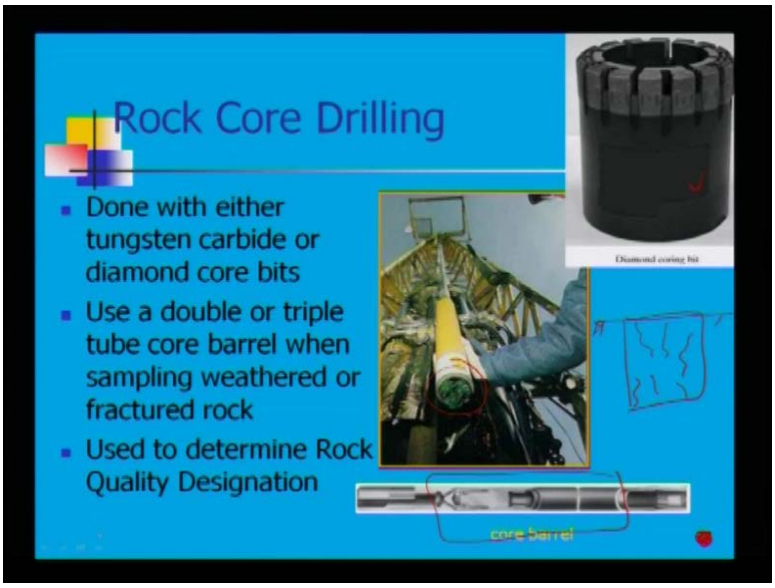

This is all about how you are drilling by means of rock by using your drilling bit or by means of other methods that means by means of your carbide, tungsten carbides; this is all about this.

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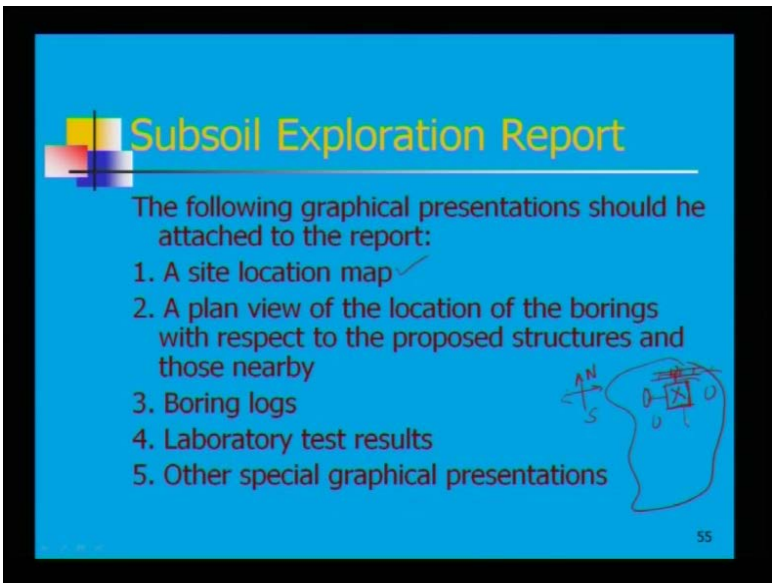

Then now will go to one more thing I want to show you, how do you produce your subsoil exploration report. The following graphical presentation should be attached to the report, that means mark it. A site location map that means where you exactly do suppose this is a total site, total area may be total area; let us for example, Kanpur city. In first I

mark your Kanpur city inside the Kanpur city, then you mark your north and south, inside this diagram you mark your north and south.

Then nearby this inside the Kanpur city where is your exact location, that you also make a site location map drawing, then with this exact this is my exact location let us say x, with this exact location near by exact location how far is there is any railway line, is there is any road, is there is any shopping complex, is there any building, so if it is there you mark it and how far this building is or how far this railway line is from your current location where you are doing going to do yours means where you are doing your subsoil exploration. That you have to approximately mark approximately mark, this is called location map.

Why location map is required? Once you provide this location map, if somebody will take this location map he can travel at that point at that location, and he can identify. Suppose layman if you give this location map by measuring this is a Kanpur city, this is the map, and this is my location map where exactly location map it located. Now somebody can say near location map, national highway is going towards Allahabad, say near the location map the main rail; rail line is going. So, how far from this rail line towards north or towards south or towards east or towards west that you mark it, then he will go there railway line and he will travel, and he will reach there. So, exactly site location map is always required, while this subsoil exploration report.

Then a plan view of location of boring with respective proposed structure, and those nearby, as I as I said a plan view of location of boring means plan view, this is the plan view of the location, where exactly we are going to do the boring to the proposed structure and those nearby. Means in this in this site what is the proposed structure? Is a multiple multiple building or multistory building or may be a garage or may be a shopping complex or may be a some industrial purpose that you have to mention.

Also any building nearby as I said earlier any building nearby that also you you want to propose a means of particularly you want mention means, you have to mention here in thus in this proposed map. Then boring logs, now I will show you just keep it here, then laboratory test results other special representation or may be what are the graphical presentation or representation that you want to also you have to mention.

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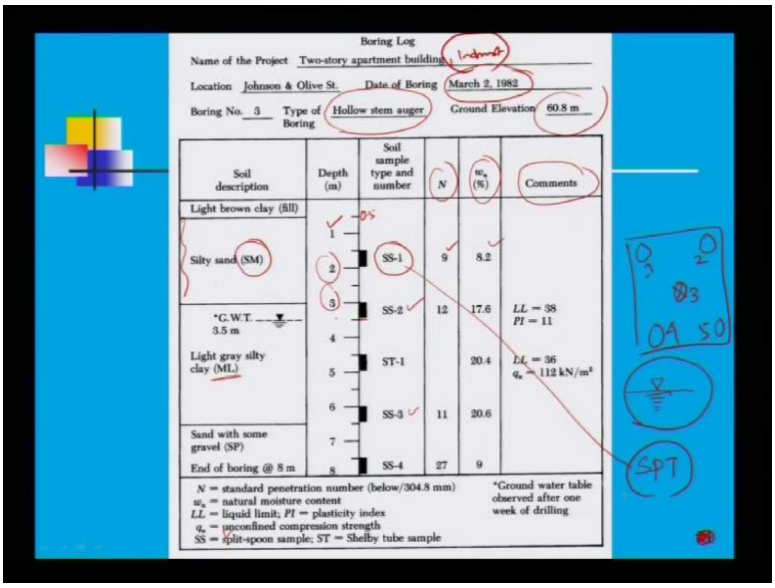

Now what is boring log? This is called boring log; each site each every bore, suppose this is my site, suppose say this is the site, this is the entire site, in this entire site you are doing 1, 2, 3, 4, 5. How many number of bore logs you are doing, boreholes - 1, 2, 3, 4, 5, so write it, this is a common format in boring log, if you look at name of the project; name of the project means, in this particularly site what is going to happen? Like here written two story apartment building, if it is not two story apartment building, you can write it industrial building means what purpose this boring has been done it has to be retained, and location where it is located it is Kanpurall, Ahabad, Jhansi, location you have to write date of boring which date you are doing? That has be specified.

Now, after the specification is that what is your exact boring; boring number 1, number 2, number 3, number 4 or number 5, because this map already location map you specified earlier. Now, you will say that boring number 3, that means the report which I am showing now this is the report where this boring number 3. Now, what type of boring you generally do means you have already performed; auger boring, hand boring, drilling how you have done, it has been done by means of a hollow stem auger. That means hollow stem auger you do it, and collect your undisturbed of sample, and what is the exactly ground elevation; ground elevation is how far from this ground that also you have to specify. This is your initial data in bore log remember may be 10 bore logs, 10 boreholes, 20 boreholes; each borehole you have provide your bore log data this is called how this boring data, boring log data you want to provide.

Now, next step after providing this now next step is your soil description look at the columns. Depth, soil, sample type and number, penetration value, this is from your standard SPT; WN is your natural moisture content and comments. First soil description first one meter or 0.5 meter, if you look at here depth has been marked here, every one meter one meter interval; this is 0.5, this is your 1, and this your 2, this is your 3, this is 3.5 every one meter interval you proceed below. Then pass up to 0.5 meter what is there, 0.5 meter earlier, ground surface is below; that means approximately above 0.5 meter light brown clay field. Above this ground there is a field soil that is called light brown clay, and below this what is that? This is your you look at this as I said earlier this is as per your classification as far as possible, this is your classification S for silt sand, M for silt, S for sand. So, silty sand S M, this is has this has been done by means of geotechnical testing in the laboratory means soil testing in the laboratory based on test, then you can classify whether it is a silty sand, sand, clay.

Then here up to 0.5 to 3 meter the profile is silty sand, look at here I put it here that means somebody can look at he said from 0 to 0.5 meter is your it is a field material, and 0.5 to 3 meter it is a the soil is silty sand. Now, soil sample type and number as I said boring has been done, and you collect undisturbed sample every 1.5 meter interval and collect your penetration blow every 1.5 meter interval below the ground surface. Then after 1.5 meter SS is your soil sample collected, SS 1, SS 2, SS 3, so soil sample 1, 2, 3, 4 like this. Then what is your SPTN value? N value is your 9 based on SPTN value you can classify that this soil is in loose state loose to medium state you can say that, and what is the natural moisture content.

Natural moisture content means the moment you take out soil how much water inside naturally, so this is your 8.2 percent. Now, go to the second layer, similarly third layer - third layer you will find it out ground water-table is there, you see water-table is there. So, how you show that water-table; water-table generally shown by means of this kind of symbol, so this is meaning of by the moment you do this this is the meaning means water-table is there, which say soil mechanics or geotechnical engineers we say it is ground water-table.

So, ground water-table is located at 3.5 meter below the ground surface, below the ground surface this is 3 meter, this is your 3.5 meter. And what is your layer between the 3 to 6.5 meter, it is light gray silty clay, look at the classification based on the from the

testing ML; ML light gray silty clay - M for silt, L for clay light gray silty clay. So, from there you are getting soil sample 2, soil sample 3, and you see how you are getting you see SS is your split-spoon sample, and ST is your shelby tube sample, where this split spoon sample you will get it, it is coming from standard penetration test, it is coming from SPT or standard penetration test from where you are getting your split-spoon sample tube, you push it inside from there you can find it out SS.

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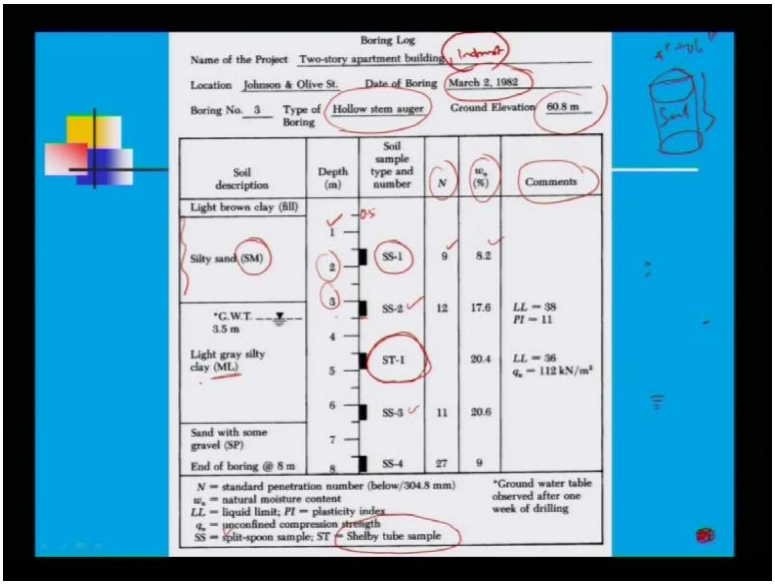

Split-spoon sampler one, sample two, sample three, but ST is nothing but your shelby tube samples that means from where by four inch diameter, as I said shelby tube sampling tubes are 4 inch to 6 inch shelby tube, and this is entirely push so entire will be your soil. So that means, this is your undisturbed sample you are collecting from where you are doing the test. Now ,if you look at all these things what I have written, because clay is there that is why atterberg limit has to be conducted, so liquid limit is 38 plasticity index is your 11 based on plasticity index you can classify

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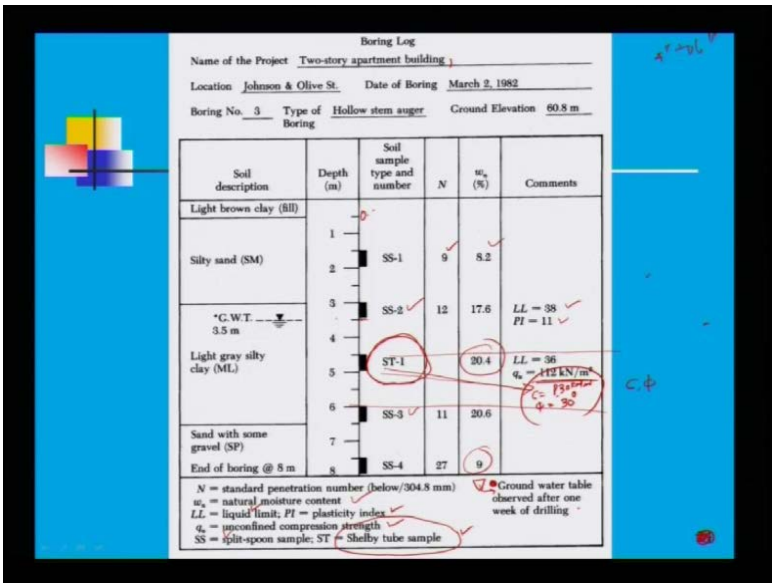

How you do the classification for fine-grained soil based on plasticity index. Now, this liquid limit and plasticity index is up to up depth of say this then from 4.5 to 6 meter, your natural moisture content is 20.4 you look at here, is it is true. The ground surface it is expose to your sun definitely the moisture inside the soil inside the moisture, it will be low. The moment you penetrate go inside soil moisture, it increases sometimes it decrease, but here you profile see it is increasing then here it is decreasing.

Now, liquid limit plasticity index, here the c phi has been not done, because ST here undisturbed sample has been collected at a depth of 4.5 meter, here your shear strength is coming 112 kilonewton per meter square, liquid limit is equal to 36. So, if you do by means of c phi by means of triaxial test, so you will get c and phi, so then in that case you will write c is equal to this, 5 is equal to say 30 degree, c is equal to 130 kilonewton per meter square; these are the value you have to specify. This is called a typical bore log data for a for a particular boring - number 1, number 2, number 3, number 5 whatever.

So, N stands for look at here at the end you also give this specification, once you are writing a layman how you will understand, and you at the end you write it standard penetration number below 30 centimeter, W n is equal to natural moisture content, LL is equal to liquid limit, PI is equal to plasticity index, q u is equal to unconfined compression strength, SS is equal to split-spoon sample, ST is equal to shelby tube sample, and this point is your sometimes we write this way some some people write in

this way either you can show it. Ground water-table observed after one week of drilling; these are this this is the report in this way how you are going to provide means attaches at the end how you are going to attach it at the end, so what is your means? These are your soil report you provide to a client. How for this subsoil exploration data from the test how far it is required.

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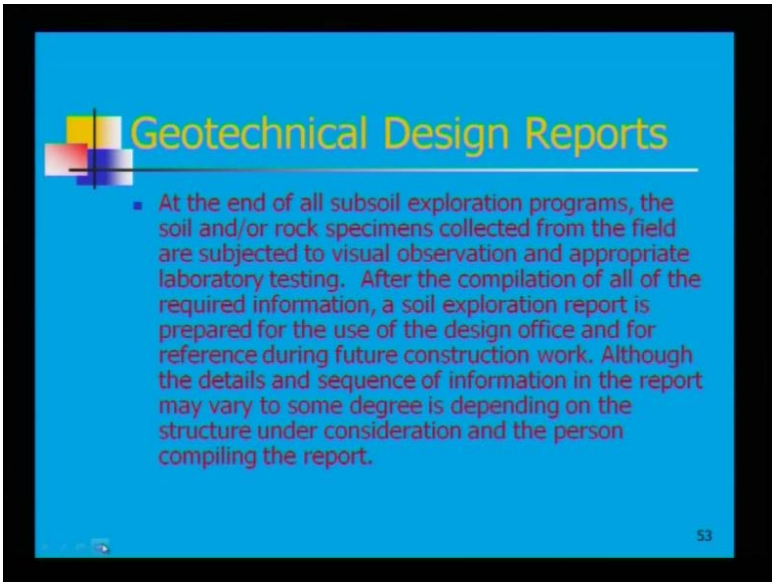

At the end of all subsoil exploration program, this soil and rock specimens collected from the field are subjected to visual observation. Whatever you collect from the field you look at look at the by your naked eye, how it looks? It is a gray color, it is a how it smell, whether it is a white color, whether it is a light brown, because if you look at the bore log data somewhere else it is retain light brown or light gray this kind of things. So, you have to see it by visual observation, and do your appropriate laboratory testing means whatever the laboratory testing is required what the client they are interested, after the compilation of all the required information, a soil exploration report is prepared for the use of design office.

Soil exploration report including bore log data has to be prepared for the use of design office, and for reference future construction work although the details and the subsequence - sequence of information in the report may vary to some degree is depending on the structure under consideration and person compiling the report. That means a detail report you need to provide, so that these data should be taken by this

people design engineer he will take these data, and he can design he can take for the analysis.

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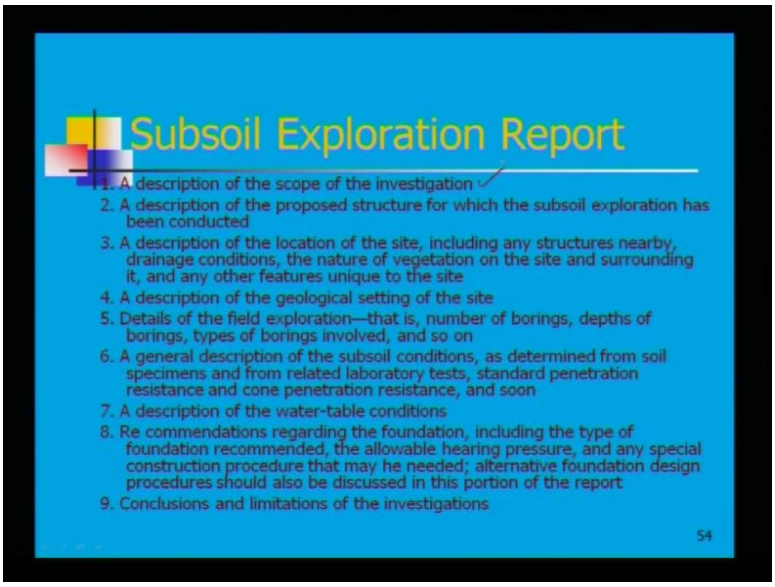

So, subsoil exploration report first one is your a description of scope of the investigation. How to prepare your report? Means it has come to you laboratory testing and everything you have done it after you doing a report has to go. What are the in that report, what is the requirement, what you suppose to provide as an engineer, a description of scope of the investigation.

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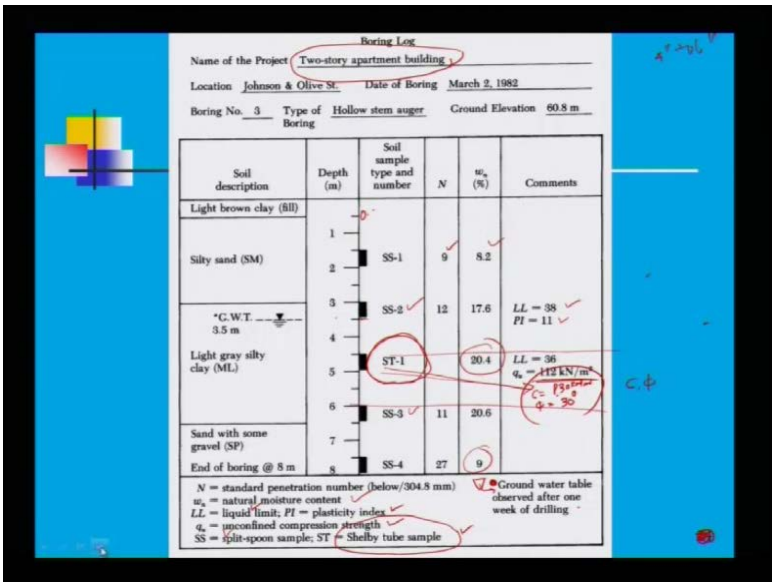

That means what is the scope of the investigation as I said the scope of the investigation you can say that the scope of the investigation is design of two story apartment building, means what purpose you are doing this, so this for design of two story apartment building, this is our scope for that design these are the soil profile calculation has been done

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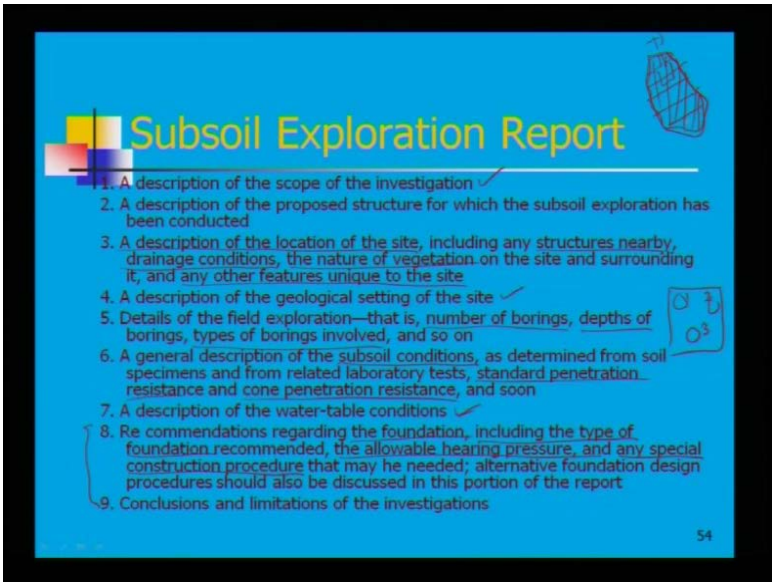

And soil profile details has been provided, then description of the proposed structure for which subsoil exploration has been conducted. Means the moment I say a two story building a description - two story building how many buildings? 10, 20 and how far what is your length width and height, just a rough description you have to provide a description of location of site including any structure nearby I have already explained. Complete description of location where the site is located, any structures nearby look at this, in this a description of location of site what are the things you want to include.

Suppose here we are going to do a subsoil exploration nearby any structure is there? Yes, then provide how far any drainage or (( )) is there nearby – yes, provide, and the nature of vegetation you can see from the ground how the people, how the farmer, what is the nature of vegetation? It is very easily vegetation can be done or you can you do not find any vegetation is there. So, if you do not find any vegetation is there, that means the soil will be like murram and where the vegetation is not possible, on the site. Any other futures unique to the site, any kind of things as I said rail line, rail crossings, roads

nearby village or any pond any any others any other nearby the site is there you have to also report it in your site description. A description of geological setting of the sites means, how geological setting how it is varying all other description also you want to provide.

Details of the field exploration, that is field exploration means in that site, this is the site details you provide number of boring. How many number of boring you have done? 1, 2, 3 data's to be specified depth of the boring, if you have done suppose I specify there are only three number of boring. Next question is is this three number of boring has been conducted from a depth up to 20 meter or like 1, 2 only 10 meter, and three boring is up to 30 meter. That has two also you have to provide means depth of each boring, then types of boring involved, what types of boring involve? You have done this boring by means of auger boring or by means of drill boring or by what kind of what kind of boring you have done that you have to provide means detail detail field exploration, you have to provide.

Then sixth point is your a general description of this subsoil conditions means a general description, how it looks? What is the parameter? What is the depth up to that the soil is there. As determine from sub from soils specimens and from related laboratory test, this subsoil condition is your based on whatever you get it from whatever you get from your laboratory test, and standard penetration resistance that is your SPT, and also cone penetration resistance. And some whatever the field test basically the subsoil condition description is based on your laboratory as well as field methods whatever you have done from there this description will come out.

Then a description of the water-table conditions; water-table conditions means how the water-table is lying. Is it fluctuating? Day to day or kind of over the period of time it is more or less constant. If you go from India from one place to other place you will find it out some someplace the water-table is remain stagnant means constant, it would not vary much during rainierah summer season, but in northern India particularly here this water table fluctuate during summer season the water-table goes like 20 to 25 meter in Kanpur yeah, but in rainy season you will find it out 7 to 8 meter the water-table is there. 7 to 8 meter depth below the ground surface ground surface, you will find the water-table.

So, complete description of the water-table conditions how it is there, then recommendation; this is most important 8 and 9 recommendation regarding the foundation. If you are doing a subsoil exploration for particularly a building of two story building as I said, then give your recommendation what kind of foundation, you you want to prefer means you want to recommend based on your soil profile. Including it includes types of foundations, and the allowable bearing pressure; allowable bearing pressure means if suppose this structure is there. How much pressure it comes to the foundation, how much load it can take allowable bearing pressure of foundation.

And any special construction procedure, like if there is any eccentric load you find that land is not available - properly land is not available, land is very restricted, sufficient land you are not getting but multistory building has to be constructed. So, in this case as there is no sufficient land, so what happen because of this multistory building has to be constructed this footing exerted kind of a eccentric loading, vertical as well as moment. For eccentric as I said any special construction procedure, for eccentric loading for different type of loading, how to do this construction in the limited space. This generally happens particularly in metro cities; metro cities where land is very limited with that limited space how do you do your construction, and what is the procedure you follow.

If you give some special type of construction procedure then construction, then you have to provide also procedure. Then alternative foundation design procedure should also be discussed in this portion of this report, because once it has been provided you want to you you have to give the detail report; based on the report you have to also give your recommendation foundation as for as possible; it should be cheap, it should be cheap as compared to other foundation means cost wise it should be cheap is should not be so costly

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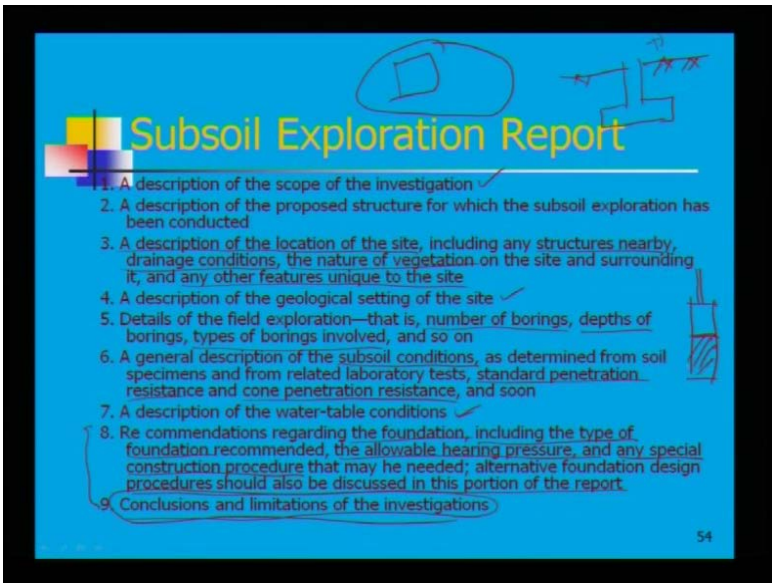

So that means at the same time also other type of foundation possibilities, suppose this is your area, in this area particularly here the multistory building has to be constructed. Initially you have given a footing, you have given footing kind of strip footing or square footing or rectangular footing, you recommend foundation. What are the other possible? Other possible mat, raft, slab or may be ring putting or may be square rectangular that also discuss, so the particular design engineer he can say that; this is the best possible way they have given then, then remember do not forget that, do not forget to write your limitations.

Because the moment you are doing subsoil exploration, these are the difficult phase in the laboratory, as well as in the field there may be encounter, it is not always true it looks very easily outside that you penetrate you go inside, and collect the sample undisturbed sample which is not always true. That it may possible that sampling tube we insert, once you insert the sampling tube by means of drilling rod, what will happen? Half the soil sample come not full. What are the limitations that you be specified, so based on the limitation somebody can get an idea; these are all limitation partly limited part. So these, these are the things.

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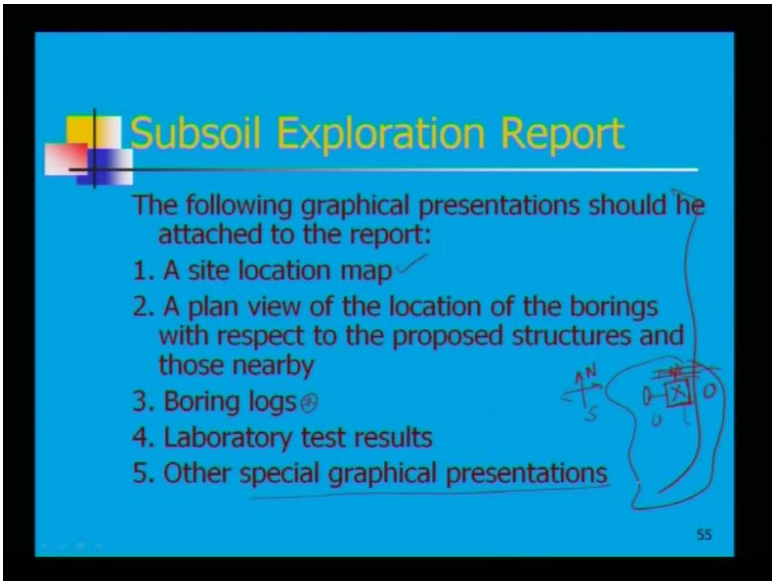

So, this is the entire subsoil exploration report how you are going to provide. What is your boring log data? In that boring log data, data logger what are the things you are going to provide. And at the end as I said some what are the report? How the report it will be followed in this report; site location map, plan view, boring logs, this is your report it is a writer part. In the writer part in annexure you have to give the map, plan view, boring log all the laboratory test remember liquid limit, plastic limits, shear strength whatever you have done graphically whatever you plot, that also you put it. And all in terms of graphs, you put it at the end. This completes your ground subsoil exploration report or subsoil explorations this completes. Thank you.