Geotechnical Engineering I
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Lecture-01
Introduction

And about myself I am D. N Singh.

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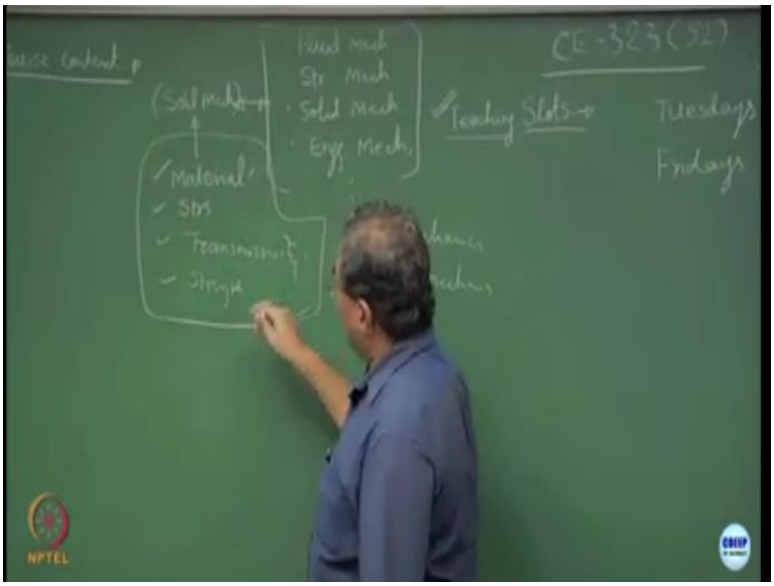

Let us talk about the course content, so let me ask you a question, what are your expectations from this course, how many mechanic courses you have done, introduce yourself, my name is Adhithya, Adhithya, yes, there will be so many Adhithyas in the class, so Adhithya Upadhaya, Adhithya Upadhaya, yes, my question is what you did not learn over here, which forces you to study geotechnical engineering I which is also known as soil mechanics.

Soil properties, ok, so let us complete this list first and then this is with a ways soil mechanics alright, which is the modern name is geotechnical engineering I yeah, you are saying something Adhithya. So, in this course we never learned about the soil properties on what the structures are built or how the fluid is going to get affected by the soil. Sorry sorry say it again how, on what the structures are built or the water the fluid how it flows and what kind of soil very nice never learnt about that.

So, you already read everything, what are your expectations, Sir I am Shishanka Shishanka Shishan Shishanka. Yes. So like this stability of structures are generally dependent on how the soil is below it, so okay, it is important, okay and sorry, since the stability of any structure which is above it depends also on the soil properties. So it is important to learn soil mechanics. Yes next, My name is Yesh sorry Yesh Yesh. Okay.

So the expectations are pretty much same sorry speak clearly how oil behaves, when it is exposed to water. How soil behaves, how water translates to how water transmits through it on light, so the property like how much strength can be a how much strength very good and nice. My name is Rohit Audrey Yes, I think that for any structure this course will help us to determine the type of foundation .

We are going to who who, who have you this idea of foundations and all, means depending upon the soil we will choose the type of foundation, where you are much much ahead of your time. You understand see right now you have to understand the soils. But that is a good application of what you're going to study over here foundations alright. So as some of you was talking about the stability of structures and all.

These things will come much later. This is the time to learn A B C of new material. So that is why what I have done is I have listed materials as number 1. You see, you were talking about fluid mechanics, structural mechanics, solid mechanics, and new mechanics, full thing it should have been a inverted pyramid, so currently we are doing structural mechanics to forget about what you are doing what exist what should be aware of.

Think about it next. Imm Your name at least tell your name. I am Shanthani Chawbaria. Okay. I am aware of this courses only as of now, biomechanics. Is this okay, yeah. It is becoming very contemporary. Is this correct or not, why. Everybody's talking about biomechanics, bio molecular mechanics, this is correct. So, let me tell you that civil engineers are not much behind all these things.

So, once you understand the material we can talk about all these things also later on. So, if you go to the web pages of some of the faculty members in the department, they are all active in these subjects, any other things which comes to mind nanomaterials, nano mechanics, you are from IIT Bombay, is it not, IIT Bombay is famous for what, nano center, nano center clear. So, nano mechanics of everything.

Now, let me ask you a question. What is so common between nanomaterial and files. Any guess, Mahima, yes, please. Both are small particles, both are small particles correct, how small they are. What is meant by nano, any example of soil which you think is a nanoparticle, next I am Poornima, yes, see sand, see part, next much lower in a particle size range as compared to science.

My name is Anikir. Anikir, yes. I also do not know sir okay, very good. Not knowing is not crime, myself Subam Sujith. Maybe straight away myself Subam Sujith Subam. Yes. Okay. Maybe mud so tight, very good. So mud is a layman's language, can you define your answer, what is mud, quite close clay, very good excellent. So, clays are the nanomaterials. So what is that I am trying to draw a similarity between.

Yeah. Hi, my name is Aksath, Aksath. Yes, yes Aksath what is the similarity I am trying to draw between the nanomaterials which you normally talk about in material sciences, electronics and now my question is why I am discussing this in the class, which has meant for so many years, maybe the properties of nanomaterials can be the same place themselves or in nanomaterial.

Okay, so by studying the properties of clay, we can have some civil engineers are the first to talk about the nanomaterials you know in the history of civilization. And much later came the application in the field of electronics and other fields, this is the method which I am trying to give you okay, so well you are right most of you anything which I have left over here or you have left over here which you want to include, yes Angit.

So, maybe sir different types of soil in its properties, no, no, you were talking about you know, what is that you are interested in knowing about it. So that we should study the mechanics of the

soils, which is geotechnical engineering I. Anything which we have missed out in this series, it was talking about the material somebody was talking about structures resting on the somebody was talking about the transmissivity

Fluid passing through this alright, then somebody was talking about this strength, and so on. And this guy started talking about the foundations and then I stopped them over there. I said, no, the size of this application part of it, alright, you are getting the point. So, right now, what we are more interested in is the material itself. Now, as an engineer as a technologist, slowly and slowly you will start realizing was the difference between engineers and technologists.

So why IIT Bombay gives you B.Tech and another institution gives you BE is a big question. And what should be your role as a B.Tech degree holder. I am sure you are not question this ever. So today evening when you go back, please check it out, clear. So, the funder here is right now we will just understand with whom I am interacting, who is Mannan interaction, whatever interaction I have to understand the material first clear, and then only I will jump on to whatever foundations I have to provide whatever structures I have to create.

What type of transmissivity I am going to talk about and so on, that will come much later. So first of all, what you have to do is just understand the material. So most of the emphasis would be to explain to you the material with which you are going to communicate what is the meaning of this word communication with the material. My name is Orphan Jones say, say it again Orphan Orphan yes. So what is the meaning of the word communication with the material.

Now with the properties very good. So, communication means the way you want to talk to any of your friends. You do not have a name first of all, you do not know from where the material has come, this guy has come, what is the history clear, and then you want to understand why he or she is here. And then you want to understand how I should be approaching and talking and then further on, how I should be communicating.

And then maybe utilizing the person, are you getting this feeling. So, the whole idea of teaching geotechnical engineering I is to make you conversant with the material which you have known.

Everybody is born out of soils. But you have never thought about it as a technologist, as an engineer, you have never tried to communicate with it. Now, if you travel from this place to your hostels, and you must be noticing because of the rains, how many grams kilograms and tons of soil is getting washed out, because of the rains from the Gymkhana.

Now, this is a good example of transmissivity which you were talking about, now if this happens inside a dame imagine what is going to happen are you getting the point. So, we would like to understand the material first and then we will slowly and slowly start communicating with it and then what stage will come after communication, what stage comes you start commanding, dictating.

And then what comes later on negotiation, you understand the difference between these words. So, the day you start negotiating with the material, you have become an extreme expert in the subject. So, somebody says that I cannot do anything with this material. You said no, no, no, it is not like that. I will, what I will negotiate with the material that you have to behave like this the way I want you to are you getting this idea clear.

A good example would be you are developing so many fourth, fifth, sixth cities in Mumbai you know reclamation, we will be talking about that later on. That means, neither the soil was from the local place, you brought it from somewhere else. You started dictating it, how should behaving, and then a stage came when you started negotiating with it, the look, you have to be stable here for 30 years, 50 years, 60 years.

I want to know you from the top, you are not supposed to deform at all, even if the waves come, you should remain like this. Is this part clear, any questions. So, modern day soil mechanic when I studied, I studied this maybe I do not know how many years back I am 56 pass out. So 80 280-384-1984 I must have studied solid mechanics. Those days the subject was more bookish. But now things have changed.

Everything has a practical connotation, everything has a practical meaning application for what are you studying in the classroom. Unless you have understood and application of it, you should

have stopped those sector. And as the question that I am not very clear about what is the implication of what to say. So, my intention would be, if you help me to make you a technologist of a very special material, which is known as soils.

And of course, the genesis of soil also we will study, that means, we will not only talk about the how to deal with the offsprings, kids, we will also study how to handle the parents. Many times parents require more counseling than you guys. I hope you understand this. Is this correct, why, you know the reason. So, you know what you have to do as a technologist, we have to start understanding the origin.

And then from there we have to see what type of DNA you carry. And how much I can refine your DNAs to make you a perfect technologist okay, so what we will do is, let me talk about the course structure.

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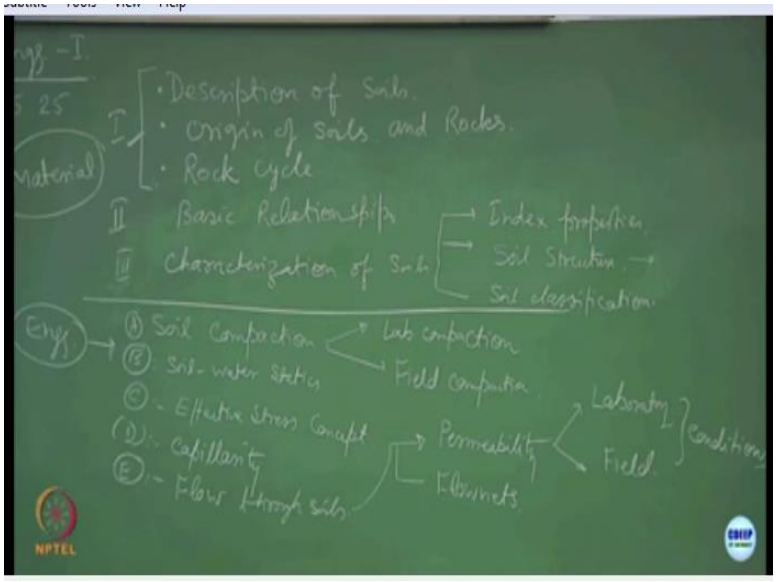

See, we will talk about this description of the material first. So, description of soils. Now, as I said, some time back, we are going to talk about the origin of soils. Because you must have realized, you know, I was trying to link the offsprings with the parents, I was talking about something related to genes and DNA. And then I was talking about refinement of DNAs also clear. So all these things are linked with each other.

So, I will be talking about origin of soils. So this is that the linkage between the parents and the

offsprings is going to be. I will also be talking about the rock cycle. I am sure you must have studied it in your engineering geology course. Is it not. Now this is to understand the material and its heritage, linkage, parentage. How many adjectives I have used is this part clear. So I am trying to link all these adjectives, heritage, linkage, parentage, and what type of kids the samples with whom I am interacting are.

And what I can do with them. How best I can utilize them. Is this correct, Now, I have not done this, I will spend some time on this because this is very important to understand your heritage, your origin, how you got originated clear and then you might have changed your study and you have landed up in Bombay change of place, so you are transported from some place to another place you are deposited here and so on.

And maybe after 10 years, you might buy a lot of things in Bombay city and you have established over here. The same thing happens in soils also clear. So, then we will be talking about the basic relationships. You say we are an ns technologies. So, ultimately we want to dictate terms with the material clear and that has to be in mathematical form. So having understood the material, what we will try to do is.

What are the basic mathematical relationships with govern its overall properties characteristics. This is what we will try to do. okay, so this is the basic relationships. Then we will be talking about the characterization of soils. You know, the best way to understand anybody is do all sorts of examinations, test clear. A good example is modern day medicine system. You go to any hospital, doctor does not want to see you, what he or she wants, and test.

Go to pathology, get these tests done, report comes on my screen, take appointment deposit money, I will tell you what the diseases, is this correct, same is our profession. We have an idea about what the origin is, what the description of the soil is, how it was formed, where it got originated, from where it came to certain place, what happened later on, develop some mathematical relationships.

And then try to characterize it, so that we can understand it better. So, when we talk about the

characterization of soils we will be talking about index properties. This is the best way to understand you know, it is similar to the pathological report, the way the doctors sitting in their cabin, diagnose you as a patient sitting while in office and depending upon my laboratory staff, whatever properties and the parameters come, I can create a hypothesis in my mind.

That look this is the material which is prevailing or which was, you know, available in this portion of the country or the world and what I should be doing with it, are you getting this point, are you getting a larger picture out of this, yes Sidhanth. Yes, Sidhanth and you told that whenever you hear any type of soil, it creates a hypothesis in your mind very good . That what could be this hypothesis, hypothesis maybe about the properties of the soil are.

What is the hypothesis of a captain of a playing 11 cricket 11, what is that, what is the hypothesis having in his mind when he is on the field to win the game, no, to strategize very good, what type of strategies which at what time, what decision should made be very specific what type of decision field placement okay, how to utilize the filters, how to utilize the bowlers, yeah, how do utilize the batsman strategy, strategy.

Now same thing I can do by characterizing of soils. That means if I have the blood report in my hand, if I have all the properties, what I can do I have a strategy in the mind that look I should be using this material for this purpose, you got it whether this is going to be a good material for creating a foundation or not, whether it is going to be a good material for stopping the fluid flow transmissivity.

There could be situation where I would like to enhance the transmissivity, there could be a situation where I would like to reduce the transmissivity. So, the way I am speaking what feeling do get I am the master of the material and the master of the situation. Are you getting this point, the material remains same. But what I am going to do, I am going to create a strategy in my mind that how I should be utilizing this material.

So when he says permittivity and if I am a let us say, petroleum geophysicist whose job is to dig oil well and produce more and more hydrocarbons for the country clear. Transmissivity should

be more, the more and more production you should be doing are you getting the point. But suppose if I am creating a dam, where the whole idea is to stop simple water so that the water remains in the dam for entire year.

Otherwise what is going to happen. This clear it has rain, you are not sure about what is going to happen next year. So that means the same material, I should be able to create a strategy to either allow permission of the fluid to take place or not. Now that art you can learn, when you understand how to read ECG, how to read characteristics of the soils, and so on, which is mostly being done by the laboratory staff which does not mean that you should never learn it.

You should also learn how to characterize the soils by your own self, then you have more command on the things. Okay, so now, what we will do is index properties yes. We will talk about the soil structure. Now the way I am sure this, my dear friend must have used this word structure, structure has a I do not know some one of you have used most probably you Is it not? So the structure has different connotations in sighs mechanics and geotechnical engineering, what type of structures we are talking about.

Let us first talk about the structure of the soil itself. Understood, and then we will talk about the structures which are going to be sitting on it or made with this or made in this how many terms I have used. And I have to spend a lot of things. I was talking about structures made by this material made in this material made on this material. All are contextual. So, slowly and slowly, remember the material remains same.

But what I am doing I am creating different situations. So, God willing this we will be discussing in your next course, that is the application of all these concepts which you are going to study in this another 30 35 lectures. So, more emphasis would be to understand what the material is and then negotiation and mastering the material will start in the next semester. But here has the stage will be set by the end of this course, that you should be able to do net practice.

What is net practice, you understand what is net practice, is this clear, very good. So, now, what we will do is we will talk about soil structure is something different than what you might be

understanding right now. So, suppose if I asked you what is the difference between your T shirt and his T shirt, structure is different, texture is different clear. So, mostly the guys who are into fabric technology what do you call this as is of course, textile engineering, but they normally talk about the fabric of sorry structure of the fabric.

Here we will be talking about the structure of soils, is this clear. No structure is resting on this. No structure has been made by using this material. No structure has been made into it. I am just talking about the structure of the soils. Incidentally, these 2 guys out of ignorance are talking about sands and clays and mud. Each of this word has a connotation. When you go and speak in a scientific world or in a international forum or national forum, where the technical guys are sitting.

Now if you say mud, the connotation is this. If you say clay connotation is this clear, so you have to be careful. Anyway, you will learn this. Then we will be talking about soil classification. Because the classification of soil is based upon whatever we have studied by this time starting from its origin, the way it was created, the way it was transported, the way it was deposited, clear, forgot about the basic relationships, index properties, which are very, very particular to and the signature of the material alright.

Signature means, I do not know what how do you define the word signature of a material . The best way would be, this is what the material itself is uniqueness. And then comes the soil classification. So, once you tag C 323 S2 division, it is a classification, it is understood that these guys know all these things, whatever has been discussed in today's class. Is this part clear or not. That becomes a class.

And then people start saying he is in a class apart. No, what of the meaning of this word, you are representing a class which is totally different than rest of the things. This is what we will try to do, we will try to put a material into a specific class so that I did not have to talk about much of micro details. I will simply say this is a class. Use it like this strategy clear. So I will be using this materials in the last the depth overs clear.

These materials will be in the middle order, and so on. So that strategy comes from here. Now what we will do is we will go ahead with the now comes the engineering properties. So this was as far as the material properties are concerned. Draw a line over here. So, this is mostly on the material how are you going to do engineering with this material fine. So, engineering aspects would be we will be talking about soil compaction.

Any good example we are compaction you might have heard of rollers perfect cricket matches mostly is it not, they take light rollers, heavy rollers, id you have the question why, we might get some answer from here. So, soil compaction is an engineering property of the material. Here we will be talking about you know laboratory compaction techniques. And field compaction.

Any other examples where you think competition becomes important, packing in a suitcase is also good, yes, yes, yes. Okay you are compacting the material there alright. Apart from that do not pack your suitcase right now you have come from home. Okay. Any other example where you think complexion is critically important, you might have seen roads yes. So you are aware of this alright.

Now, having done this, let us put it as a class A of engineering properties alright, so the first name property is complexion. The second ending property would be soil water status, the statics. The best way to learn soil mechanics is follow the art of making pictures, so cricketing pictures, cricketing tough, tennis tough, hockey tough, football tough you know why, all this is very practical and highly applicable to preparation of a tough, any type of tough clear, the tough material might change the complexion level may change.

So sometimes captain say dry rolling, sometimes they say sprinkle water and roll. So look at this what I have done, I have related soil compaction this soil water statics, okay, so we will talk about this. Now from this point onwards, we will also talk about effective stress concept because when you are conducting something truly speaking the complexion is by applying certain weight, it could be static, it could be dynamic, it could be impact.

Trains which are moving on the railway track are beautiful examples of what type of

compaction, see the railways which are moving on the track and that sound come cut cut cut cut cut is it not what is that yeah vibration is induced, we are talking about the compaction first, rolling is taking place clear, the self ride is there, impact is there, clear so 2 there could be I can apply a huge load static condition.

Suppose train stops on the railway track and then their load of the system is getting transmitted on to the railway tracks. Through that sleepers, which are resting on ballast, and ballast is resting on the foundations. Yeah again the mechanics of the material, how the loads and the stresses are getting transferred from a system on to another system and how it gets dissipated up to the foundation level.

So, when you talked about the foundation, I am sure you were talking about only the foundations of the buildings. Now I have created a situation where I have given an example of foundational railway tracks got it. So foundations is a very general term. Is this fine. So we will talk about the effective stress concept. We will also be talking about the capillarity phenomena which all of you have done in your 10+2 physics.

Now, the time has come in to utilize the concepts of 10+2 physics into the real life engineering. So we will develop few simple and basic models will try to apply these concepts into a system like soils when they get compacted clear and there is some soil water statics which is going on, because of which the border pressures may develop. I am sorry, I have used the technical word today, I should not have used. So I withdraw it, we will talk about this later on. So because of this system, the effect stresses are developing the system and the root causes capillarity.

Now comes another engineering aspect. Is this okay if I write like this, the another one would be flow through soils, what we were discussing flow through soils. I think this is what you were talking about. And I think I gave you some examples also. There is a very significant phenomena we call it the permeability alright, so we will discuss about this engineering property in detail.

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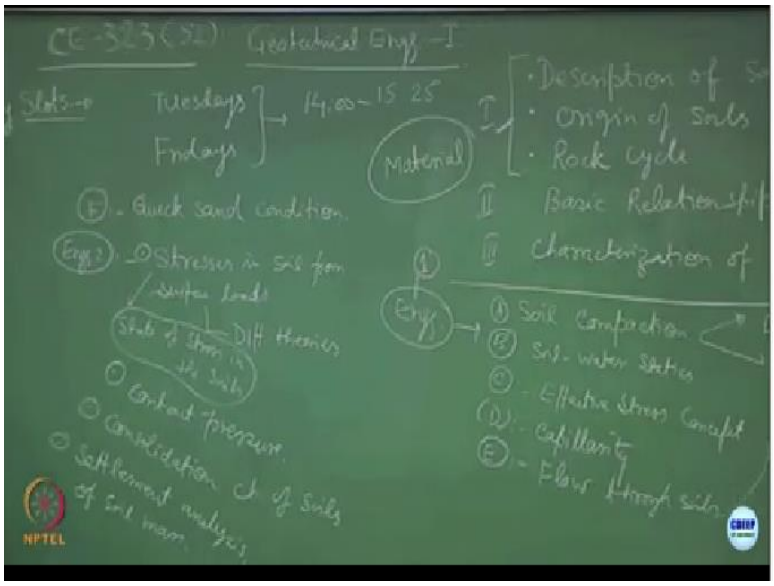

There is something known as a quick sand condition. There is an advisory during each monsoons, why you should not be going close to the beaches, seashores and the areas which are very susceptible for quicksand condition. It gets drawn in the sense very good, perfect. So that is the condition which gets created in beneath the buildings. And no wonder when you get up in the morning and you read Times of India you say one building has sunk now you know the answer. clear.

So, as an engineer your job would be how to stop this condition to occur in field. See here when we talk about the flow through soils, we will be talking about the permeability. And then there are different types of tests which have to be done. There are different types of tests which have to be done, some of them are laboratory. Incidentally there is there are 2 types of tests normally either laboratory tests or field test.

And we are supposed to do both to understand how the material behaves in controlled environment which is the laboratory and under natural environment which is the field condition. So, laboratory and field conditions alright, those of you who are interested in joining after your fourth year oil and gas companies. Believe me, your fundamentals are absolutely 0. And most of the time I have been previewing you guys and fortunately, nobody knows me.

And what I realize is that absolutely no understanding of the basics of the subject, but your aims

are very high. You want to get big salary packages without knowing the basics of the subject. So all these oil and gas companies they rely too much on and simulation. So nobody is going to take a risk of making an oil well you know, unless you have done the simulation, we will be talking about the flownets.

Flownets are nothing but the regime of how the seepage occurs through the compacted soil mass or the soil mass itself alright. So this is also an engineering property. Now, shifting this concept, so let us say this would be engineering 1. And engineering 2 would be the stressors in the soil. I think I gave an example of the moving train the stresses in soil from surface load. Here we will talk about different theories.

How to compute, what is this known as is state of stress in the soils, those of you who would become an expert in transportation engineering they would require it a lot because of ignoring this effect, you can realize the state of our roads alright. So, how would you do the best possible engineering to design the best possible pavements. The answer comes from here, what type of stressor are getting induced on the surface because of a moving vehicle.

It could be aircraft, it could be railway, it could be a road transport, bus whatever clear. So, how this stresses are going to generate in the system, what is the state of stress in the soil at a given point, this is what we are going to spend time on. We will also be talking about the contact pressures. Now this contact pressure is between the loading area and the soil mass. Here comes the example what you are citing.

So there is a foundation which is sitting on a soil mass, what is the contact pressure between the 2 original interface or at the interface. So this is what actually will talk about contact pressure. The most important thing we will be talking about is which is stress induced, what is known as consolidation. So consolidation characteristics of soils and what is their applications. So, all of you who are interested in infrastructure related jobs should be very thorough with these concepts of you know what type of loads come.

How do they get dissipated in the soils, how the consolidation occurs. In short, consolidation is a

phenomena where the compression of the oil mass takes place over a period of time because of external loading, clear, we will discuss this in details. And then we will be talking about settlement analysis. So this is the settlement analysis of soil mass, the course content appears to be quite elaborate as reasonable.

Be attentive in the class because the best way to learn, I can assure you though I am going to give you a list of the books that you should be following. It will be very difficult on your part to refer to these books, but you should refer to this books particularly. It is not that I am selling my subject. Please do not mistake me. It is a very important subject and all the everything rests only on the ground or the soils alright.

So the 2 things which I wanted to convey to you, I am going to give you a list of books. But please discuss in the classroom, do not hesitate if you are not following anything, and make sure that if you are not following anything, your next neighbor you know your neighbor is also not following anything. So they should not be any hesitance or maybe resistance in your mind that you are not going to open up.

It takes time to pick up the concepts. But once you have picked up the concepts you become you can discover your own charts. Okay, so let us stop books.

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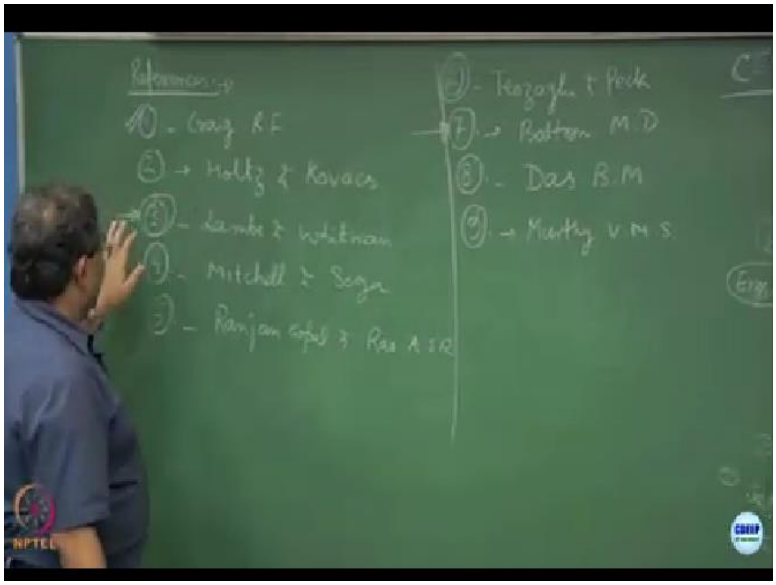

But whenever you get time, please get a hold of some of these books you know, the first book

and the best book in the market would be Craig. I am not writing the full form what I will do is I will send you the list of this on email. So those of you who are interested, I can either buy it or maybe keep it with you in case you go for masters or higher education or you become a consultant tomorrow , you will declare these books remember.

These books will haunt you throughout your life as a civil engineer. It is a must to read this books. The Another one is Holtz and Kovacs, very high corner book. So if you do not have time, do not bother about this. At least you should know these 2 names. The bible on the subject is by Lambe and Whitman. Most of the titles are soil mechanically like the first one is great soil mechanic. The second one is an introduction to geotechnical engineering.

The third one is soil mechanics. The fourth one is Michell and Soga excellent book for the guys who really want to adopt geotechnical engineering as their profession, another good book by Gopal Ranjan and A.R Roa basic and applied soil mechanics, they all the time and most of us used to read the books which are written by the father of soil mechanics, this is Cultur Zaggy . If you are really interested, try to get hold of this .

This is mo by Terzagi and Peck when you do a course on foundation engineering, you will come across this name of Peck Hanson and Tornbern. Fortunately, my master supervisor was a student of Peck. This is the linkage, heritage, or what do you call it parentage it is very important, you know, another interesting book are you should study but not during your B.Tech plays we went to pass out know.

It is an interesting book which is written by Malcolm Bolton. This is an sort of a autobiography. And there was a professor at Cambridge. So, he has written about his experience a guide to soil mechanics by Emily Bolden, Malcolm Bolden. The other good book written by B.M Das, this is principles of geotechnical engineering. Try to get hold of these books. Some of these books are available.

But my recommendation would be at least have a copy of this because I will be following this once in your life, read this book. And if possible, read this book. This is okay. And of course,

this one you should keep when you if you want to become a consultant. This is a must for all undergraduates. I will be following mostly this book whenever you get tine in a leisurely mode, please read just, follow this. And this again is a Bible.