Geotechnical Engineering I
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Lecture-02
Origin and Definition of Soils

Welcome to the course contents and the reference books as well as the examination which is nothing unique as per the institute norms.

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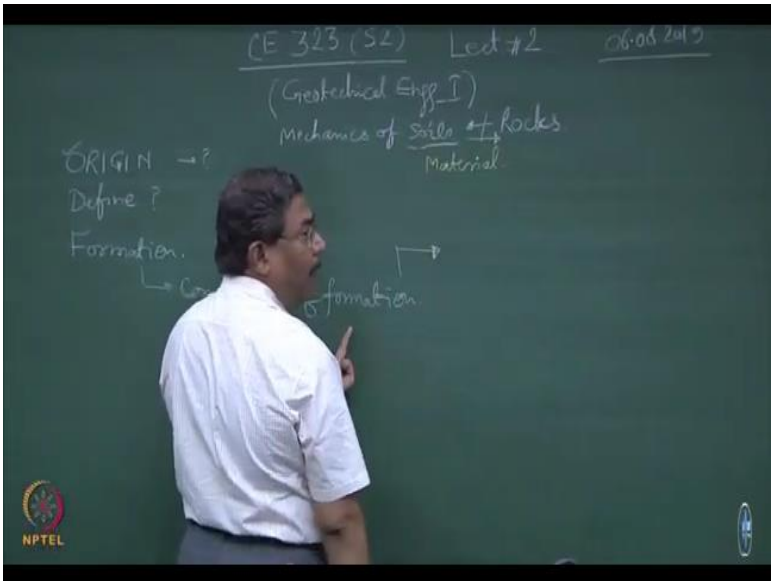

So, let us start our discussion on you know because the geotechnical engineering is basically the mechanics of soils alright. So, it so happens that this is the material and the mechanics you are aware of all of you have studied, fluid mechanics you have done any course or not yet, during the semester already finished very good. So, you have done fluid mechanics, you have done solid mechanics, you have done engineering mechanics.

So mechanics, nothing with the tools if we are using to understand the response of the material. And in this case, it so happens because we are talking about the geotechnical engineering, our material is going to be either soils or rocks alright. Now there is a very interesting interplay between the soils and the rocks. So, it is a good idea to understand what is the origin of the material alright, all of us have some heritage alright we belong to some place linkage and so on.

So the origin is the first question how soils are form. So in today's discussion, I will be focusing on how soils as a material, which is going to be used by civil engineers, particularly geotechnical engineers alright for various applications. So the materials part is either soils and rocks, and then I would like to see what forms what, rocks might form soils, which is a normal process, but it might so happen, that soils might also form rocks.

I hope you are aware of this is it not, so, it is a reversible process. Parents, definitely they give, you know, they create offsprings. Sometimes it might happen, that offsprings might also create something, which is look alike parents. So we will talk about the origin how the origin of the soils has occurred. In the process, we will also try to define what this material is. We will try to define the material soils alright.

The most important characteristic of this material is it gets formed by some process and then it gets either transported or it remains at that place only what is known as residual. Now, this is what is normally known as formation okay. So, the first thing is origin before that comes out to define this material, how the formation of the soil occurs and this is where we will talk about several issues like conditions of formation.

Now, formation is a very deceptive term alright it is a incomplete term, it might so happen, that the formation could be you know the strategy itself is also known as formation.

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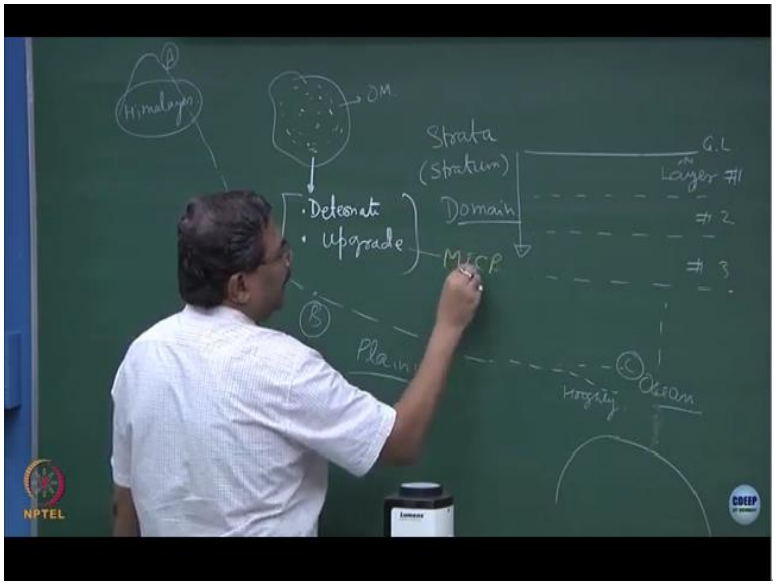

So, suppose if I say that this is the ground level normally we define the soil surface like this, this is what is known as geo micro bio is fear. So, anything which is existing below the ground level is our domain alright. So, this is the domain in which a lot of geo is earth. And in this system, there could be microbial activity, there could be different type of activities which might be taking might be occurring physical, chemical, biological, thermal, and what not.

So, if I say that the whole strata is a stratified, strata is plural. And stratum is singular. So, each of these layer, if I say layer alright number 1, number 2, number 3 and so on. Unless you hit, remind them of the core, these are all the layers layer 1, layer 2, layer 3 alright. So, the strata is the entire thing, the stratum is layer. Now, as I was saying the formation could be connecting to please remember these few words in the beginning of the course, then our language becomes same and I hope you will not have any difficulty later on.

So, if I want to define the layer number 1, this is the formation, here now, you must realize, you know somewhere here we have hills you know Himalayas. And somewhere down the geographical line, this is you know this would be let us Hooghly and I hope you understand why I am drawing this. This is a journey which the entire system is going to traverse, traverse means travel, what is going to happen here because of various activities, the system is going to get fragmented.

Those of you who might have gone for trekking in the Himalayas or the illiterates, you must realize a lot of boulders, the big piece of the, you know, rocks they keep coming out. So, that is one process, which is what is known as whether, will discuss about this later on. So, if so happened that the big chunks of the rocks, they get detached from the parent body by some process, it could be physical, take a hammer, start hammering it, the system gets, you know, converted into small, small pieces. There could be a chemical weathering taking place alright because of the chemical actions.

And this could be the fundamental property of the soil or rocks. There could be a combination of the 2. There could be a thermal activity which might be occurring over here. Temperatures go very high and the system develops thermal stresses, cracks develop, when the rains come, all

these cracks get filled up with water and these boulders start rolling down alright. So this one actually are going to talk about.

So formation includes how ultimately traveling from point number A to somewhere in the plains you know what are planes gigantic planes. So those of you who are from the central portion of India, Delhi, UP Uthrakand not Uthrakand sudden still goes into the hill. So these are the plane areas where the slopes of the you know ground are not much and then ultimately what happens this thing **over** comes over and gets into a portion so this is okay.

So this whole journey A to B to C. We are trying to capture 2 3 things which are very important, how the fragments get form. In other words, how the soils get formed, what is causing them to come from A to B, this is what is known as a transportation agency.

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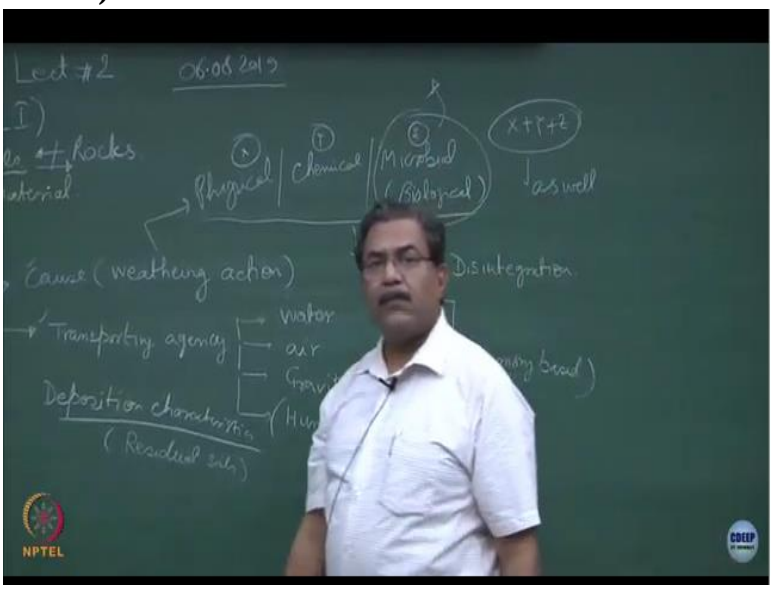

So, formation is going to depend upon the cause you know and this cause is going to be mostly weathering and this weathering could be either physical, chemical, it could be even microbial alright. Sometime people also call this as a biological and this could be the combination of x, y and z as well. So this as far as the formation is concerned. The second term this will be include , which I want to introduce would be, what causes soils and how they get transported. In your opinion, what are the transporting agencies, which you might be aware of, which would move the fragmented portions of the rocks from A to B and B to C very nice.

So, transporting agencies would be either water yes, in most of the cases, this is water sorry rains, wins, air nice good, next sorry very good, it could be gravity yes why not, what else so, it so happened that something detaches over here because of the weathering action. So, weathering is nothing but disintegration. This causes disintegration alright is this part clear, are you realizing the material with which you are going to work is this okay.

So it depends upon all these things. It is a big matrix, water, air, gravity, anything apart from this, which might be transporting agency sorry is living organisms will not transport the soil. Their role is different. So living organisms, what you are trying to convert to is microbial activity, that is responsible for creating the weathering process or disintegration of the rocks. Fine, I mean, I cannot justify your answer.

So, anybody else you think that living organisms, yeah, human beings if you are saying then yes, that is possible. We are the biggest culprit. Is this okay, so mostly, you know have you have water, you have air, you have gravity, you have human activities. Another interesting thing over here is see some very intelligent material soils. We will talk about this later on, why it is so intelligent.

Because simple answer is it gives rise to the entire what do you call it, life is a correct or not life originates from soils. So, we talk about the cause, we talk about the transportation agencies, there are few materials which get disintegrated, but unfortunately they cannot get transported. So, we talk about deposition characters and normally we term them as residual which one is going to be more experienced, more knowledgeable, more workable all adjectives which you can think of if you attribute to this.

A person who stays all the time in his or her home or the one who comes out travels leaves people takes his own decisions, a lot of similarity between what we are studying and what I just said, look at the process, they were formed somewhere because of some external agencies, fragmentation took place. The second thing came in the picture transportation, it carried the material up to a certain distance and this distance could be geological distance of few 1000s of kilometers agreed.

Then the process what is going on. All these agencies are giving a lot of rubbing effects, abrasive effects, you must have seen when you go to the Himalaya you know big big boulders are lying over there. But as you come down towards let us say Kanpur, Varanasi, Gaya and all these areas. What happens, all the big boulders are about converted into the small particles sands clear. So, this in this process of branding.

The type of branding which you are going through what IIT Bombay what is happening, you are becoming more knowledgeable or no whatever it is. So you are getting exposed to different type of environmental conditions. Is this correct. So a system which gets transported because of the transporting agencies, keeps everything in its memory. So it is not a inert material. It is not a dead material. It is a very intelligent and live material alright.

There is another attribute of the soils. So this is memory based. And no wonder why silica is used as a basic ingredient for design. chips. Now, because the basic constraints of the entire thing is silica, we will talk about this memory effects in the material alright. I will be using this term quite a lot. What is memory of the material. There is no other intelligent material like soils in the history of civilization.

Still, do you really talk about the memory effect, you talk about how it was formed, do you talk about how it was deposited, you know, how it is going to behave, how it is going to react. No, we do not use these terms at all. So that is the difference. And that is why it becomes very important to study the mechanics of the soils. Is this part clear. So we will talk about all these things, coming to the second thing, which was talking about depositional characteristics.

How deposition is taking place, whether the soils are residual or they are transported. So I was getting a logic, the guy who never came out of the house, he was born in the same house alright. Attend youth in the same house and became a big person in the same house and is also going to die in the same house, something of the sort residual. Residual means the disintegration took place over here.

Unfortunately, there was no transporting agency, transporting agencies nothing like teachers like us who might be carrying you along with us to some destination is this okay. And then depending upon your fate, you may get deposited somewhere, you may settle down in a profession clear. So, this is what the positional characteristics are. There are few guys who remain in the profession for 20 years like me, 25 years, 30 years, they might be getting lot.

And there are another breed of the people who keep on changing their jobs every now and then. Another similarity are you getting this point, so these guys are going to have a very different type of characteristics and memory in their brains. So, this is a very interesting thing which we can use for designing our structures when we are dealing with the systems which are either transported or which is this residual is this part okay.

Because what is my job, my job is to put all of you in order. I told you 2 o'clock, this 2 o'clock, everybody is there. So I am going to dictate tomorrow with this material as another this material. Look, this is how you are to behave. Because I am a technologist, I am an engineer, I want you to behave like this, are you getting this point, and that is what the engineering is all about. That is what the technology is all about.

So, I have a material clear, I would like to dictate with it, how I will use the principles of mechanics, which is nothing but the physics and mathematics put together tools. Understand, and in the process, all this happens, ask any question, I think I have given you the preface of today's discussion, rest is all bookish. If it is not clear, please discuss. So, this is the preface of today's discussion. Anything which you like to add.

So, suppose somebody asked you a question introduce yourself, you are asking something. Last week you remember nondescript yes, but suppose somebody says introduce yourself, how to introduce yourself, this is the introduction of the material clear, now make it a habit wherever you go in life today onwards. Google, where you are, what type of soil deposits are available there. You will learn a lot of things.

And if possible, make it a habit to collect some samples also, system retains what has happened in the past alright. So the memory is what when you came here you are carrying some imprints of what happened in your childhood alright. When we talk about the engineering issues associated the material, we will talk about what the material carries in its mind clear, and based on that it has a tendency to behave to exhibit its response.

So my name is Ankit, Ankit yeah. So microbial weathering takes place. Okay. That is the interesting thing. I think you should search it out on Google, read some papers if you are really interested. What micros produce, any idea, microbes in soil produce gases, and these gases could be hydrocarbons agreed. So imagine the system is like a control volume where there is lot of organic matter, I do not know I should not have introduced this word right now.

But I am introducing you can capture all these things. So, this is organic matter, alright. So, there are the organic matter is the bacterial activity is going to have, this is the bacteria inside and what this bacteria is going to do organic matter provides nutrition, carbon, nitrogen, sulfur alright like, hydrogen, oxygen and so on. Now, what is going to happen. You have provided enough food to the bacteria what is going to do.

It is going to be active, what it does, it eats up the material disintegration started as a microbial or biological disintegration of the material, deterioration of the material clear lot of R and Ds being done in this context. And those of you few are interested in going for higher studies should note the words carefully. Geotechnical engineering has a lot of potential for R and D both in the industry as well as academics.

So, my emphasis is to give you more ideas about what's happening in the world today rather than bookish knowledge alright. So, is this part clear. So, what micros do, they try to eat up the system at the same time they might create the system also. So, they act both ways. So, they may deteriorate or they may upgrade any system. A good example of this is please go and check in on the net MICP, these are all research ideas.

This is a very interesting area in which lot of research has been done in the area of geotechnical engineering, soil mechanics, microbial activity and just check it on the net. Is this okay, so what bacteria does this one of these things processes, if this is happening, I should not bother, but if this is happening, the system follows the chain this onwards correct. So, this is the microbial disintegration fine. I just wanted to provoke your thoughts what humans are doing.

I want to create a Tajmahal in Bombay Antalya from where I got all the materials, geo materials from somewhere in the mines of Rajasthan clear or let us say from Orissa or some south you know there are a lot of stones which are available in Kadapa region. So, humans also transport the material. A beautiful example of this would be reclamation. So, most of the islands which are being created all over the world.

How many islands have been created last 2, 3 years. Look at the geography of the world is not stationary. You know, when we were kids, we used to use the same book for 30 years that less. Now that was happening. Atlas keeps on changing every month yesterday, something happened. It is a good example you know so what has happened. The geography is going to change.

So South China see what is happening. China is expanding. Next time when you go to Singapore when you are landing, just sit on the seat number A, or last one H and tip down. What we will see a lot of activity going on in the ocean. What do they do. They bring soils from different places, they dump them over there, and they are creating islands. We have got the answer to your question. So humans are also becoming extremely notorious in transporting the soils.

But this also how the civilization is, how many islands and has constructed last 5 years. All strategy check it on net. You understand, so the geographical boundaries are changing why, because it is my wish I would like to bring material from somewhere and dump it somewhere. The same process I am falling look at this, the material was created by human activity by minute, I got it in the barges over the pipelines or whatever, I transported it and I deposited it agree.

So what nature was doing in millions of years, I have done it in 5 years, 10 years. Palm islands, Pearl islands, while islands is a beautiful example of creation of land. Okay, so human activities

associated let us say with the land reclamation, search it out more yourself about this thing. This itself in the formation of rock, shall I add manmade this is okay, microbially induce calcite precipitation.

Now because of this what is coming out of the bacterial secretion, the system gets upgraded, formation of rock takes place. I can use it for my different applications. Very good, good question. Yes, sir how a chemical can now use can chemical suppose if I go somewhere on the hill iterance and I carry say 100 liters of sulfuric acid, concentrated 5 molar sulfuric acid and I will pour it on the system what will happen, chemical interaction clear.

So you are adding something chemically to create disintegration or weathering of the material clear. So, this could be by hammering as I said physical, it could be chemical you add some chemical compounds in it, have you ever seen any blasting which was done in any of the projects you know in the rocks. So, what do they do. They drill holes, they put chemicals and then they wait for 24 hours and what happens room clear.

The rock becomes disfragmented, is the chemical induced weathering of rocks for making highway projects. Is there any natural chemical phenomenon of weathering. Good question. Have you heard about arsenic oozing out of soils in the western eastern part of the country. This is one of the chemical processes which might be bacteria driven. If you see any acid, acid range pH it will be in less than 4.5 but go to the genesis industrialization and too much of industrialization means that most of your industries are emitting socks knocks socks.

So, all these things will be the environment and then what happens. So, when clouds forms this gases will also get trapped inside the clouds okay. So when it starts precipitating rains precipitation means rains, rains when start precipitating that sulfur dioxide knocks in nitric oxide anything will get mixed with water and it will turn it into acid weak acid yes weak acid. So, it will get precipitated on the rocks like if possible such kind of rain happens in the region of Himalayas.

So the kind of chemical that precipitated over there might try to might trigger the disintegration of the rocks correct. Any other example, which comes to mind is this okay, you have understood. Acid rains are a good example of how human activities are going to create more and more chemical weathering of the system, including the buildings that you have constructed.

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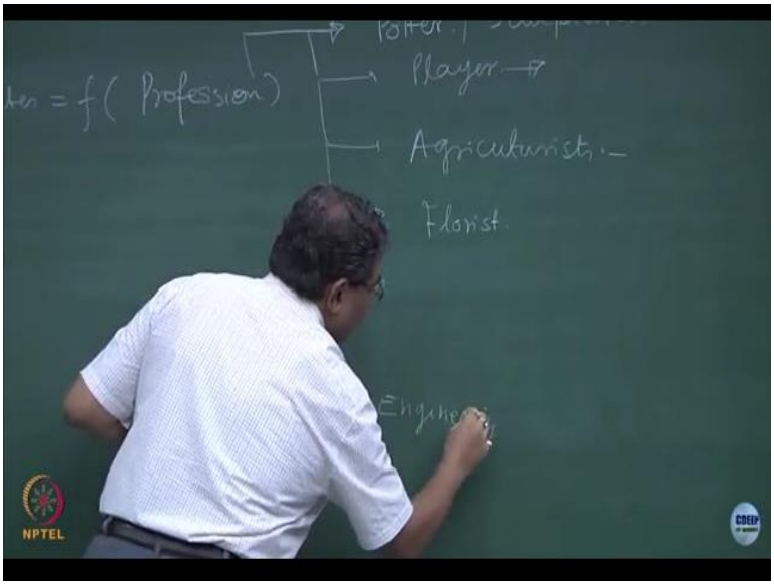

So let us start now with the conventional discussion. Let us say how to define soils, you suppose to know that this is the material which has several definitions. You know why. So, everything is a material. So, when I say define soils, this boy is not very good, very casual remark. Oh, he is excellent is a 10 pointer whatever. You say like this you define a person by using some attributes.

In this case, what happens is most of the attributes are a function of so if so happened that these functions these are the functions of the profession you understand it is such an interesting material. What is the meaning of this, what is your name, say your name at least Ashis sorry. Y you can follow my words or what. So, the definition of the material depends upon the attributes which are profession dependent.

How would you complete the statement depending on what the soil use for the other such properties, the function or the function of the soil, I said the definition of the material depends upon the attributes and one of the attributes is the profession in which you are, what is your

hobby, what do you do. Apart from that, poetry apart from that so suppose if you are a pottery maker, many people who do sculptures is it not.

How do you define soil, by the way, most of my research on cracking characteristics of soils, you know, my guru was the guy who came from modern indigo who are doing your pottery making. I call him the lab. And then after that I might have guided I do not know 2 3 pages and several papers which I have written on cracking characteristics of soils and my question to him was that why your thoughts do not crack.

Because this is the answer, which basically I was looking for. And I was a consultant to this is a I hope you are aware of before 2011 World Cup, I made the pictures I gave them a recipe. So my big question in the mind was that let me create pictures which will never crack. Of course, I spinners will not be very happy with me. So why I am telling you this is the story is because if I am in this profession, what would I like.

I would not like any system to crack. But just now what I had said if I am creating pictures a spinner would like this to win the third hour of the match why. Then we have so many in our team who will go and play the game in 2 days you are getting the point. So what I bought this are given the material is defined by the attributes which are mostly dependent upon the profession. So, you might be a border sculpture or you might be a you know a player.

And what type of games you use soils and what type of sports you use clays, soils or what, number 2 yes. okay. See my connotation is more on the turf. Very nice good in Lawn Tennis, how many types of tennis you have, varieties why how many types of course you have. Yes, now you would link the subject with a practice. Are you getting the point. So why do they have these 4 grand slams.

Why they want to test whether this guy is going to be a winner on all types of terms are not remember. So you have clay ports clear, you have glass ports also which one is best ports, football excellent, you are right. So, that means depending upon what sports you are playing and

what are the requirements, you can play with this material you can define the material, is this okay, football is not a very direct answer.

It should be either mostly tennis where the ball impinges and then you must have studied in your mechanic course reverse English forward English, all those things you have heard or not Arshnic 10 +2 Physics. No so in why the wall sinks like cutter in cutter, all these things are derived by the material properties if I can control over here, everything the response is going to be different. Understand there is nothing but the engineering properties which I have to modulate and the pictures are ready.

So tennis ports is a good idea your cricket which is a very good idea, anything else apart from that, basketball not going to be of much because the basketball you do not impede the ball intentionally on the ground when you are playing of course we are bouncing all spine. So anyway so this is where agriculturist, it is a big profession is not farmers are the country how they check soil.

They do not have a laboratory, what do they do. They will just touch the soil, they will rub it, add some water again rub it smell it and they will tell you whether this type of soil is good for this particular produce or not. Why, why they are so experienced. I mean they must be checking some attributes. For them the requirement of the soil is different fine. Suppose I am a florist you know what is florist level guy was producing flowers.

They are very particular about you know a type of soil which should be used for creating a certain breed of flowers is a big business, apart from this any other profession quickly tell me what are the other professions where you use soils sorry yeah. Construction okay. So we will keep ourselves we will place ourselves engineering oh electronics, not in the soil form so is expected form of let us say silica, which is one of the constituents of the soils.

So, I will not put it in this matrix because of this reason alright. We are talking about right now natural systems and professions. Okay, but your answer is good. At nano level we can think of yes. Any other profession, sorry. Mining will come in engineering SNT let us say science and

technology, beauticians, skincare, whether they use soils you know bothered about it you know Bargavi. Bargavi yes, please talc okay, nice so.