Environmental Geomechanics
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Lecture – 05
Soil Mechanics

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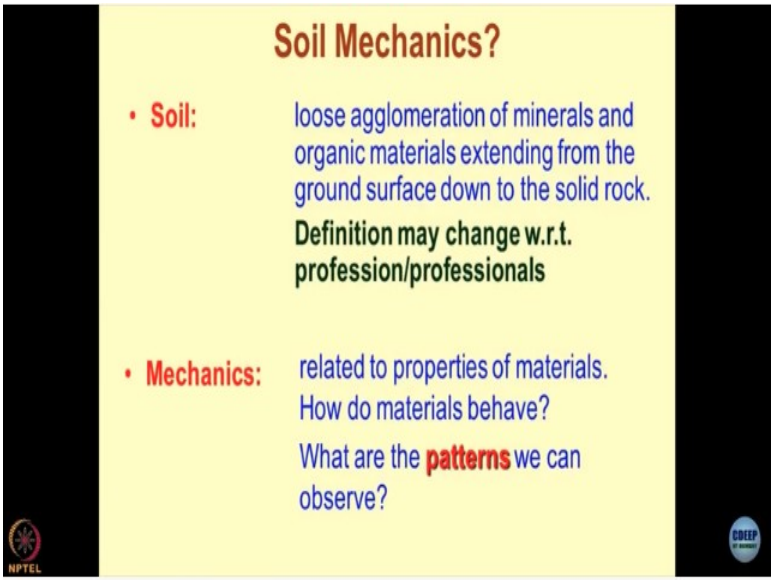

So now having realised that these soils were the offsprings of the rocks more vulnerable to the environmental attack, more vulnerable to the human attack, human interventions, human abuses fine. All these words we will be using this material becomes you know a big question mark. How is it going to behave under given circumstances? And we are talked about several circumstances. We talked about solar light UV radiations, and we talked about thermal influences.

If you remember sometime back I said the nuclear waste which is getting processed is being dumped. It comes in contact with materials and this waste is at an elevated temperature at very high concentration, the chemical concentration of chemical species. It could be also having the radionuclides in it. Now the problem becomes complex. So how soils are going to behave when they come in contact with this type of situation.

So the conventional soil mechanics does not talk about the situations I hope you will agree. Everything is within you know normal room temperature conditions, STP standard temperature-

pressure conditions. We say 27 °C and 1 atm everything is happening very nice. But in nature, nothing is happening of this sort I hope you will agree. The ample examples where neither the temperature remains constant nor the pressures remain constant.

Forget about the other activities which have been talking about. So now the time has come to question what is this mechanics of the material which we have been studying? So to begin with because all of you have studied soil mechanics? The first question is what is soil? And the second question is what is the mechanics part of this? So I am sure you must have come across this definition soils are nothing but the loose agglomeration of the minerals and organic materials extending from the ground surface down to the solid rock.

It is a very funny material because the definition of the soil depends upon the profession. I am sure you must have realized this if you talk to an agronomist, agriculturist for him the definition of soil is totally different. He does not bother about silt fraction, clay fractions, sand fraction He simply says whether this soil is fertile or not. So for him, the definitions are two fertile, non-fertile.

It so happens then fertile land you might be producing a product which could be rice where the water permeability has to be extremely low. It has to be you know puddle we call it mud and so on. You talk to a sculpturist, for him the definition of soil is totally different. The one which can be utilized for creating the sculptures. Pottery makers nothing should crack so his definition of this soil is the soil which would not crack when you are creating artefacts out of it.

So another thing is beauticians you talk to beauticians for them the soils are the ones you know you use for face packs and so on. These are all minerals which are being used in most of the toiletries what do they do? They add these minerals. So the definition of the soil depends upon the profession in which you are. We are engineers for us the definition of soil is totally different. So we started saying loose agglomeration of minerals and organic material clear.

So organic matter comes from the vegetation is a loose state of the material as compared to the rock which we have discussed and what is the domain in which it extends from top to bottom. So

this is what I discussed. Now as far as the mechanics are concerned what is mechanics in your opinion? So mechanics basically deals with the patterns of the response of the material. Remember your bearing capacity test, plate load test.

So you take a plate to keep it on the ground surface loaded from the top and then what happens? Slowly and slowly as you keep on loading the system the slip surface develops and the chances are that the plate may get embedded into the ground. So truly speaking the mechanics is nothing but, first of all, you are trying to understand how the material behaves and the second challenge would be how to quantify this?

So then you have several theories. You use the concepts of physics, mathematics and then you put them together to create you know the mechanics which is the language of the engineers. How would I utilize this concept of how do these materials behave in environmental geomechanics? That is very interesting to follow. So I have created several situations which I have been discussing.

The waste coming in contact with the geomaterials this could be soil, this could be rock. When you come across a person whom you do not like what happens? Emotions play a very important role and if your emotion does not remain under control what happens? They may become psychosomatic also blood pressure rising why? Because you do not like a person. The interaction started with the eyes. There is no physical in fact clear it is a visual interaction.

The mind starts responding and the way look at the body is responding. Your BP goes high your palpitation changes clear. And if it goes on further what happens further? Sweat sometimes it may result in crying also. Look at the way how the body is behaving. Now, what similarity I am trying to create between the body human system and the one which is going to happen when the interaction starts.

So I created one example of the interaction between an innate material like soils and rocks when it comes in contact with environmental effects. So what potters do? What brickman does when they make bricks? As long as the bricks are green they just put them in the air for drying and

after that, they bake them. And what happens after baking? They become very strong. So what does happened? This is how the system has behaved to a situation and what is that situation? Elevated temperatures.

So the moment you put this system in elevated temperature the system became 35 MPa strength, 45 MPa strength do autoclaving. The temperature along with the steam pressure you can go very high in strength. That means now this is a combination of the pressure and temperature both. So are you realizing how situations create a sort of a response out of the material.

This is what actually we are more interested in understanding and then once we have understood how the material behaves, how the material responds to a sudden situation I would like to quantify this. Because tomorrow I am going to use this quantified version of the metal response and that is nothing but the environmental geomechanics. The tools of the mechanics will remain the same. But what we are trying to see is the response of the material to given situation circumstances.

I created a circumstance look at another circumstance you like somebody too much and the moment you see him or her what happens? Nothing of this is going to happen. The body was the same the material is the same it is responding to different circumstances. So to me, the circumstances are much more important as compared to the material, the material becomes immaterial.

You like this idea the material becomes immaterial. And what I have to do? I have to just control the situations in which the system is going to be. And then as a technologist what I am supposed to do? I am just supposed to deal with the material to tell it the way it has to behave when I order it. That is mastering the material this is the art which we are going to discuss. Is this fine? Are you enjoying the philosophy?

"Professor - student conversation starts" Mithra, Mithra is this correct, yes. So what is your reaction to this all discussion which you are having in this class? We get to see it from a new perspective like how different materials react. Very nice so you use the right word at the

beginning itself. You said that we have to look at the material from a different perspective. Excellent now this is the bottom line. So the way I have been looking at the materials, soils and rocks is no more valid.

Because we have ignored a lot of aspects associated with this and this is what actually we are going to study much more in details. In other words, we are going to look at the material more totality. Fine yes, Reshmi what you like to add? We have never come across a case where we give importance to the situation. We have always considered other problems at a certain temperature. The situations will be the same, the load we always think about the load a lot.

Correct and load also is the mechanical load by the way. We will talk about different types of stresses which a system can sustain. So I was trying to tell you a situation here where nothing is being loaded physically clear. Yeah, it is all psychological pressure which is developing inside your body and system and the way your system is behaving, reacting I think this part is clear. Yes, sir yes you would like to add something.

Sir before you compared the soil with our human nature. So the person remains the same and the situation differed. But my question is like though the person remained the same is it possible for him to see it is what to say like? It is not mandatory that he has to see a person he likes the most. So for soil environment changes so how we are going to means it is not possible for us to make a correct decision on the environment know till we are considering the situations we are using so many soft ways and then failures of course so the environment changes.

No, or you might have ignored all those factors which are causing the failure to occur. So these are your short-sightedness. That your theories do not include the influence of the factors which matter more. So maybe on the scale of 0 to 10 our knowledge is still at 1.5 or 2 at most and other 8 scales have not been fathomed by human beings yet. This could be another way of looking at things. That I know only this much right now.

I have mastered only one compartment stress and strains. The mechanics do not go beyond that and that too caused because of the mechanical loading. However, there are a lot of other things

which you have discussed which have not come into the picture yet. Maybe this is the answer to your question. Another way of looking at your question would be I can manipulate with the circumstances in which the material is going to be exposed to or might be sitting. Is this okay?

That is the technology sir I can always play with these situations; I can amplify them is this all right I can reduce them. Yes, you can manipulate yes. So that I can do manipulation there also. So this is also one of the manipulations and then see what are the influence. Now we can conclude from that manipulation. Yeah so, I can master both the situations. Either I can master the material, or I can master the situation.

Whatever you do ultimately you are trying to create a nearly perfected solution think it like this. So either the material becomes so strong that is not going to be vulnerable to any of these circumstances. Very good that might be a situation. So this is the logic which I gave. You take the clay mix it with water shape it in a brick form dip it in water it dissolves. Do the same process green brick you bake and keep it in water nothing happens.

What you have done? You altered the material. Now, this is the feeling which you have to inculcate in your mind that rather than being submissive with the materials and these situations now what we are going to do? We are going to be the masters of both yes sir. By studying both yes. And then deriving a unique solution that I could manipulate the material this much and I could manipulate the situation this much and ultimately how best the most optimal solution can be obtained. That is the art that is the technology clear.

So I am sure now you must be getting an idea about what we are required to do is this okay. So we are going to play in both situations. Yes, as I said at the beginning of the class this is more of a philosophy. So what I am doing? I am just creating philosophies you agree. Both the philosophy of the material and the situations yes please what you have to add? So I felt we have to go so far on this topic. Like we never considered the environmental effects.

Does not matter whatever does not happen do not bother about that. Is this okay? Sir, you gave me that example of brick immersing in the water. So maybe the condition of that water can

change know. Oh then now you are complicating it too much. So this could be seawater, this could be acidulated water, this could be basic water, this could be water having a lot of bacterial activity in it, lot of pathogenic activity in it, sludge which is coming out of the sewage plants.

Nice is the sky is the limit of your imagination. So the more and more you imagine you achieve near perfection and I am very sure now you can realize that when you did hydrometer analysis you simply dipped the particles in water. You did not bother about any of these things. And of course, as you said the integrity of the material itself. Who knows that the soil was so organic that it will get completely eaten up by the chemicals which you added to do hydrometer analysis?.

How many situations I am creating one by one? Imagine just realize okay so shall we proceed further? We need to look at the all possible infinite situations and we can modify the material we have more control on material rather than the situations so we can make. Yeah, a simple example is when you are working let us say the same concrete which you are using for non-earthquake zones and highly active earthquake zones what do you do? Your design practices change.

So what you have done? You are taking into account some other factors which are going to create a sort of instability in the system. So you are extra cautious is this fine? That is it so the material could remain the same. The situation may vary the situation could remain the same. The material may vary I may have to see on both the ends and then derive a solution which is going to be more practical, optimistic, optimal. Yes, you want to say something yes please carry on.

This course is all about realization nothing more than that I hope you can realize this. Is this correct or not? The statement the more and more you close your eyes but not shut down your mind and ask questions? We also tell what I am doing and why? The answers come that yes this is what should be done. Yes. I was just saying that the control over material there is more than that of the situation. So we can make our material more and more.

You have seen microwave ovens yes sir ovens for any for that matter. Yeah, right there is a wide range of temperatures at which you can bake the cake. It depends upon how much in hurry you

are. That is it. So I can create a situation in which I can create a response of the material which is controlled. So when you are a technologist look this is the difference between engineering and technology.

I hope you are now realizing the question which I asked normally. What is the difference between engineering and technology? You have mastered both what engineering was doing? Try to question? Somebody said last 40 years this has been then you keep on doing this. I said no I do not want to do this. I want to understand what has been done. Why? What are the failures? And how to rectify them? And how to get a better answer? By using a better technique is this okay. So we will be talking more and more about all these things.

Yes, sir, I can relate this to that Chernobyl nuclear disaster. Good. So where people say like the radiation effect is like trillion bullets to a human being. So before that, we cannot like we will not foresee the conditions of the soil present over the Chernobyl. So how to quantify that much amount of radiation. Like we cannot simulate the conditions in the laboratory. So what is a solution for that? Yes, that is right so we will get these answers. This is what the modelling techniques are.

Sir for example if we see gas hydrates, we are simulating the pressure. You are passionate about gas hydrates. For example, yeah okay but further like soil at Chernobyl we cannot like predict the radiation. So it is very huge that it is equal to like trillions of bullets to a human being. But what about the soil? So how to like design that soil or buildings. Correct yeah, so all these things we have to discuss.

We have to question? And if there are no solutions given in the books we have to create them then only people will remember us this is correct if I am just reading books without questioning and without finding out what does not exist makes no sense. The world has to go on. Knowledge has to be explored further it has to be created yea fine all right. "**Professor - student conversation ends"**.

Okay so let us go ahead I think we have created enough situations.

And I am seeing how the material is responding. This is also very important. What are the patterns we can observe? Clear so a simple example is when a landslide is occurring you know the mechanistic approach is small boulders a small chunk of the soil getting detached from the parent body and sliding over a slip surface okay. What is the next statement?

How many things have ignored? How many processes related to physics and mechanics have ignored? Whenever a slippage is taking place whenever a cracking is occurring whenever a mass is moving with respect to a surface lot of friction is getting generated and that friction might be elevating the temperature. There is a detachment there is a sound all these things they have ignored you agree.

So when the new mechanistic models for the landslides would be where you talk about all these things together in tandem. In tandem means when all these processes get attached to each other. So material getting detached from the system lot of sound comes out, lot of dust is created, a lot of slippages is taking place, lot of friction gets induced, lot of heat is going to get generated. What does heat is going to do to the material?

How the moisture is changing? How the shear strength parameters are changing? And so on and you were talking about the material particle becoming you know either bigger or smaller because of its interaction with the water, air, microbes and whatnot. So we would like to see what are these patterns. So if I say that if I apply a certain force on the block and block is moving on a rough surface how much heat gets generated? It is a pattern.