Environmental Geomechanics
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Lecture 09
Scope of Environmental Geomechanics - III

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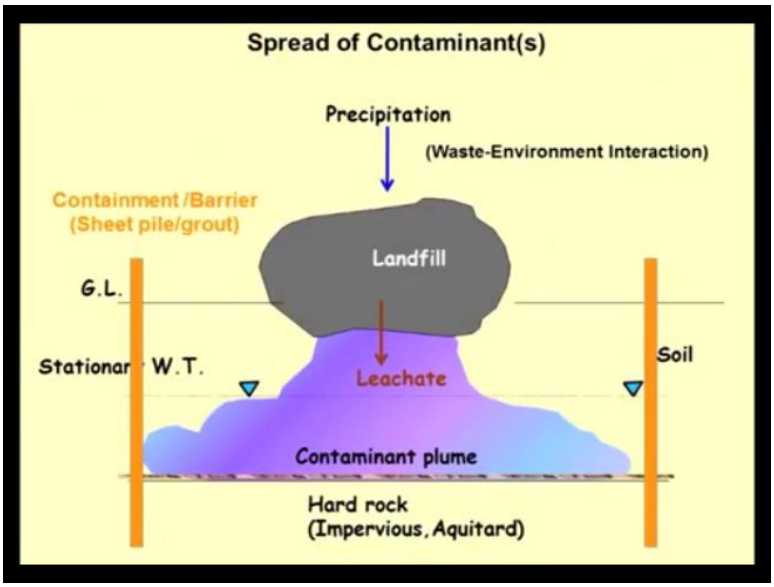

So slowly and slowly, what may happen? Suppose you have a stationary water table, this plume which is coming out of leachate in the form of the leachate from the landfill will settle over, which I have shown as a mountain on a purple colour, do you agree? There is no movement of the water table. So whatever leachates are coming out, they form a stack. If I rotate this figure by 180°, what is going to happen?

This becomes a stack or a chimney, and the chimney is throwing out all the pollutants in the atmosphere. The problem remains the same. What has changed? The media through which the transport is taking place agreed. The rest of the concepts are the same. So, for me, landfills are equivalent to a chimney or a stack, through which a lot of unwanted materials are coming out of different attributes. So, the density of this system is going to be different.

Their viscosity is going to be different because the temperatures are different. Density and viscosity are going to be a function of time. Their toxicity is going to be so much that this soil mass may not remain as what it used to be earlier. The chances are that the soil mass might get eaten up and hence the porosity the density and the attributes of the soil mass are also changing. See these are the height of complications. Now, this is a system where nothing remains constant.

I hope you are getting a feel of this, is this okay and then the question is quantify this phenomenon and give the answer. It is more realistic. Another question would be the whole process is going to be time-dependent. I hope you will appreciate. So this could be short-lived. It could be long-lived. There could be a process, which might be occurring within a few hours. At the same time, there might be few chemicals, which might take their time to get activated over a period of time.

Is this okay? "Professor - student conversation starts" Sir I was thinking like, how will we proceed? Forget about proceeding; the first thing is the assimilation of an idea that these problems exist. The first thing is to realize that, yes, there are issues in your mind and we should do something. That itself is half journey done. I am sure 99.9999 recurring populace of the country is not aware of what is happening, including the geotechnical engineers who are being churned out from these institutions, do you agree?

Sir, can you please discuss the effect of leachate in the hard rock, where you found a barrier there. Wait, wait, wait, hold on everything will follow, but as I said in the previous lecture, rocks are very stable. Why, compactness. So you really cannot disturb them so easily. They are grandparents. You keep on saying anything either they are deaf or dumb or they do not hear; they do not want, they are not interested in anything, clear, passive materials mostly.

And, hence beautiful repositories to deposit your waste, good analogy okay, particularly if it is a sound rock, granite, basalt. This is what they try to investigate, at what depth it is available, in what form and these are the repositories. The repository is the word, which is used to dispose of high-intensity atomic waste in the formations, is this okay. This is what you have been asking. "Professor - student conversation ends."

So we are still talking about the most vulnerable species, soils, the offsprings clear. It answers your question, yes. I know this takes time to understand what is happening. Yes, anything. "Professor - student conversation starts" The place where we dispose of the byproducts, and also we can make impermeable chambers. Everything comes at a cost. I have to see the repercussions of each and everything. I have to evaluate each process. I want everything in writing.

You write what you want, then the analysis of that statement is this, this, this, this, this. There are 5 situations which I will create. Out of this one situation would cost you this, one will cost you this, one will cost you this, now you tell me what you want to do? So the moment the guy takes one now, let us say we will start the engineering and for doing the engineering, I have to diagnose again clear and once I am scientifically satisfied, then I will go ahead with the execution.

I think this is what I have been describing the spread of contaminants in the geo-environment and remember geo-environment is something beneath the ground, beneath the ground surface constituting of soils, rocks, groundwater and the entire geomicrobiosphere. So geomicrobiosphere, so once I say that this is the sphere which is located beneath the ground, everything comes into picture, flora, fauna, geomaterials, soils, rocks, groundwater.

Now suppose, and I think I have answered your question Famy that if what about the rocks. If rocks are intact, igneous in nature, I need not be bothered much, and I am sure you will agree with me the deeper I go, I will find a place where the hard rocks, which are intact are available. Nature has done great justice with us. Unfortunately, we have been exploring only up to a few meters on the surface, and we say, what to do?

Go deep in anything you get the answer to your question. So normally the waste disposal is at greater depths. It could be kilometres deep also, and whenever you get a chance, please visit, these are the repositories. We have beautiful laboratories have been developed 100s of meters deep inside the ground, rooms like this, people observe everything and these are the guys who are running the whole country. Look at the second situation.

The second situation is the one where the stationary water table is moving. Now the situation is, if I do not want to allow the spread of these contaminants, you know, contaminants transport up to infinite domain, what I have to do? Suppose I have another industry or premises over here and because of my activities, the contaminants might reach their premises, because when they operate their tube wells, when they withdraw water for drinking, they will realize you know, all these species are coming.

And if they analyze and they come to know that this is what you are producing in the nearby, then a file is a suit against you. This is what is going on right now, clear. You have to be very careful. So what you want to do? Answer to your question, I would like to confine this, contain it. So I can create a containment or a barrier by putting a sheet pile or by grouting the entire area clear, though it is going to be expensive, this is the only solution.

Nobody can share it with you and then you have the concepts of how to create barriers, how to create you know deep grouts. Suppose the water table is moving, now what is going to happen? The entire plume is going to migrate. So my question is which one is a better situation, the first one which I showed where the water table is stagnant, and the entire plume takes a form of a volcano or this one, where the plume is moving from one place to another place.

So it is again a very dicey question. So slowly and slowly what will happen, if you have contained yourself also and the more and more leachates are filling the space in the microbiogeosphere, what is going to happen? Now you cannot even use the water, because every time you drill a borewell hole or a tube well, what you are going to get, whatever you have disposed of there. So not a very good situation, you are sitting on a volcano, be careful.

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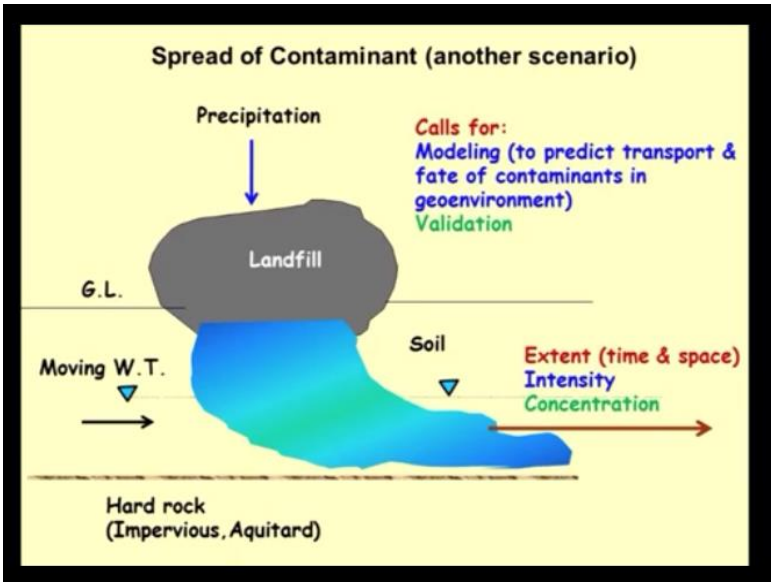

This you cannot afford why, because the neighbours are going to complain. So what should be done is a big question. So I now I have set the stage right for you to understand that most of these situations do not have clear-cut answers. Did you ever feel this type of problem, when you were solving a problem to compute bearing capacity or foundations? You said, well up to third decimal place the answer is 10.43 T/m^2. You are so confident.

Now, what is happening? You are shaky, why, because even if you are writing something and reporting something, you have to take care of all these unseen forces, which are going to get affected by your statements. So what we are supposed to do? In this case, we are supposed to find out the extent of migration of contaminant. So most of the establishment when you visit like nuclear power plants or atomic power plants or thermal power plants.

You know, there is a zone of influence they call it. I do not know how many of you have visited such type of establishments. When you start approaching them, there is a warning zone, no rehabilitation within this limit. Mostly atomic establishments have a limit of few tens of kilometres. Why answer comes from here. So if I am dumping a waste over here, if I have the waste disposal facility over here, I am going to do the analysis up to a certain extent in distance domain and time domain.

You might have done these type of analysis where we call as time-domain analysis and distance domain analysis, clear. So extent both in terms of time and space, after 25 years how this activity is going to influence the settlements, villages, clear. The second thing is beyond 25 km, whether there is any influence of this activity or not, both ways I can look at. The second one is the intensity of the activities and their concentration, temperature, chemical concentration, radioactive concentration, microbial concentration, and so on.

Now if you do this, this is what EIA is, because of my activities, how I am influencing and how much I am influencing, in how much time the geo-environment is a big question. "Professor - student conversation starts" Yes. Shall we adopt some ground improvement techniques, so that the leachate does not come into contact? I wish life was so simple. Here you are not aware where the plumes are existing. Can you see through, clear? It is very difficult.

So then you have to evolve techniques, which can detect the plume itself first. Imagine, close your eyes and imagine you know when this type of plumes are getting formed there in the 3D and what is the depth, what is the extent x, y, z, and t. So that part you have to imagine first. Yes, if you can, definitely go ahead with the remediation. So first is the diagnosis, understand the problem, diagnose it well. The third is start giving; I will talk about that.

Now, this is what is the requirement, and you have to do modelling. So when you do modelling, you want to predict how the transport of contaminants is taking place and what is their fate, whether they become more aggressive after certain time half-life of an isotope. You must have studied you know 10+2 physics, is it not? So if radioactive waste is there, radionuclides are there. They might get fused. They might show fission. They might create daughter elements.

What are those daughter elements going to do? What is the parent element going to do? This is the fate of the system. So, a species of the contaminant, how it is going to be in the domain of x, y, z, and t is a big question, which and everybody is trying to work on and having done this, I will ask you a question. Well, very good, you have done a lot of studies, lot of analysis, you have come out with the recommendation, can you validate it?

And once you validate it, I am ready to appoint you as a consultant. I am ready to spend the money which you are asking for. So, both the things go together the creation of hypotheses, development of the mathematical models and followed by recommendations.

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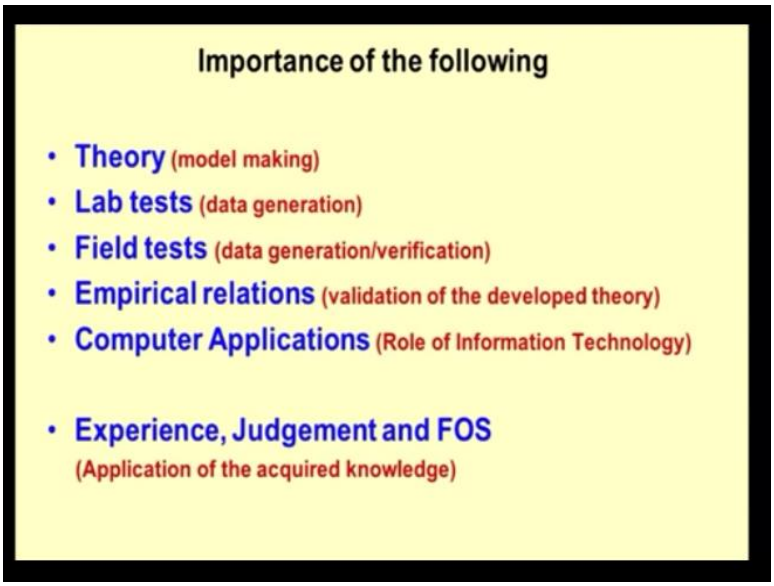

So this is where the importance of the following becomes very important. The first thing is you have to create a theory. The theory is because of this activity, something is getting adversely affected, how we should come out of the situation. Do the lab tests. So all you are saying is I will take out samples, bring them to the laboratory, understand the material, what type of soils are these? Sandy soil, the spread is going to be more.

Clay soil, the spread is going to be less extent, lateral extent, vertical extent, and so on. I will do field tests also to make sure that the type of data, which I am getting from the laboratory is correct, alright. Based on these two data, lab and field, I will create empirical relationships. So most of the geomechanics, the relationships you must have seen are empirical in nature. CC equal to this, this multiplied by LL - 20 and so on, clear. What are those equations?

Empirical relationships, but they are better than having nothing in the hand. Then because of the computer age, you will like to put all the information in computer application, artificial intelligence, the role of information technology and so on. We will discuss this later on and then

ultimately what will happen? Having done all these models, I would like to define a factor of safety. I am giving a solution. What is the guarantee?

The person is spending money, how comfortable he or she could be at the end of the day. So this is nothing, but the factor of safety and what is the factor of safety? My judgment, my experience of the past, and how conveniently I can handle the situation is the factor of safety. That is the application of the acquired knowledge and knowledge could be either build on your own experiences or by reading or by hearing, whatever.

So I hope this concept is clear to you based on today's lecture that what environmental geomechanics guys are at. Is this part clear and what our activities and what we are supposed to do? So once we have understood our role, things become more streamlined. We will discuss this.