Environmental Geomechanics
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Lecture 06
Environmental Geomechanics

So truly speaking, the soil mechanics is a subset of geotechnical engineering and which concerns with the application of civil engineering and technology to some aspect of the earth, where we talk about soil mechanics, rock mechanics and foundation engineering.

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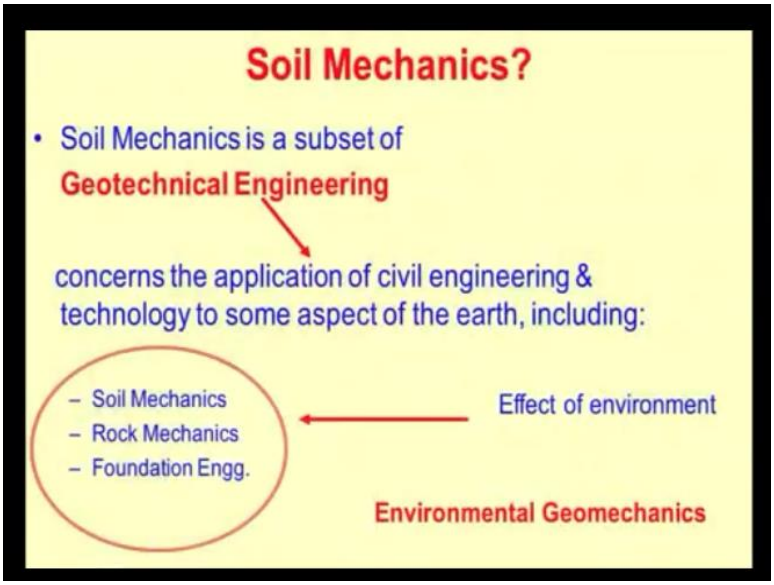

When we start questioning what the effect of the environment on the concepts of the subject is?. This is the genesis of environmental Geomechanics. Is this part clear? We had a good discussion about the genesis of the subject, how the subject was created. Is this fine?

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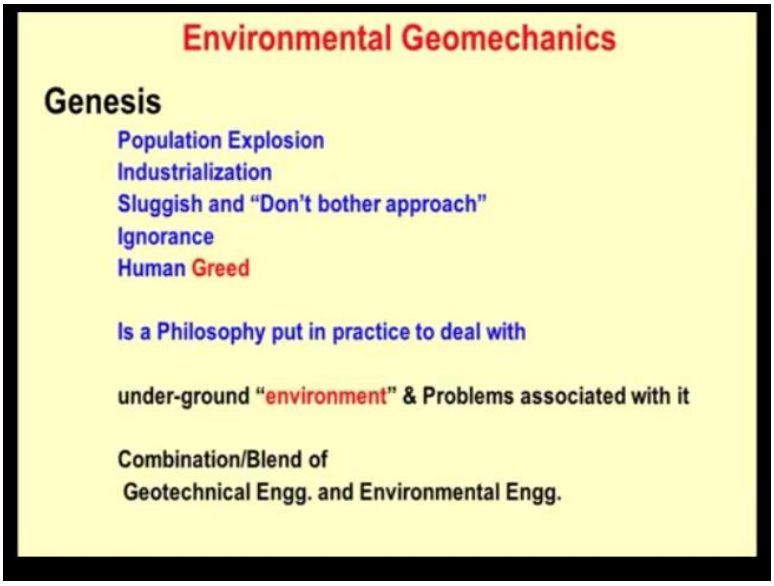

Okay. Having defined the genesis of the subject, let us talk about the genesis in the real sense of the environmental geomechanics. The first one is the population explosion. I think all of you will agree with this. Too much of a population, which a country can bear, particularly the developing nations, where most of the problems are coming forward now on our way and we are realizing that our knowledge from the past has failed completely to give us a solution.

Western world could still manage because the population explosion is not much over there. The sources are limited, but the population is also limited. In our case, developing countries, it is a reverse process. Our resources are limited, but the consumption is becoming too much, in every sense. What it affects most? Land, resources, alright and resources nowadays, I am sure are air and water and land. Do you agree?

The same volume of the oxygen, which was present maybe a few years back is still available, but how many breathing lungs are there, imagine. So resources are becoming scarce. Construction materials are becoming scarce, drinking water is becoming scarce, is it okay, and hence we are talking on sustainability. So, the more and more population explosion, a big question mark, how to survive?

Food scarcity, I am sure, if you check on net, the biggest problem is the ultimate ill capacity of the soil is same, but the population has increased. So, the place from where you come, what

people have started doing? They started over-fertilizing the land and then there was a movie Udta Punjab. It has a direct relationship with environmental geomechanics. The concept is the same. Do you know what they did?

They were overdosing the lands to grow more and more food and then ultimately, what happened? The entire land got contaminated. Now, these lands have gone beyond agricultural limits in terms of the constituents, and hence crops cannot be done over there a big question mark. Now this question economist and farmers, agriculturist should have answered, but my question here is who understands first better, the geotechnical engineers.

We understand minerals better. We understand their porous structure much better. We understand the matrix better. We understand these three, four failed models much better, clear. So that means, truly speaking, the time has come when environmental geotechnology should intervene and give the solution to the society, and that is what most of us are doing. So, I will introduce the concept of soil, roots, bacteria, environment interaction.

Until now, what you did? You never talked about this. So the soil is important, in which the roots are going to develop and for this process, the bacterial activity is important, and the bacterial activity depends upon the environmental factors. So our system is a four-phase system. We are talking about soils, in which the roots are present, bacterial activity is harping and then how the environment is influencing this balance.

So this is one of the ways to come out of these questions of how the population explosion is going to be sustained in terms of the yield of the crop. I did 2-3 projects from the agricultural organization, being a geotechnical engineer and I am quite happy and satisfied and very recently I have been doing a DST project on soil fertility chart, which has been initiated by the government of India. You know, what is the role of geotechnical engineers?

We will discuss quite a lot, but you are quite close to the answer, surface area and god knows what. The second one is industrialization. So if you want to sustain the population explosion, what we have to do? You have to do too much of industrialization, you know, per capita income

has to go up. People have to have jobs. They have to survive. That means, the more and more population in a society, the more industrialization and the more industrialization, what it causes?

All these what you have seen pollution, all sorts of pollution. Your rivers are polluted, your soil is polluted, your air is polluted, your drinking water is polluted, and so on, clear. Unfortunately, industrialization is also because of the poor economy of the country. In the western world, what they have done. They are very easy and conveniently offloaded all the industrial processes to the third world. Why? They started mining also there. They do not do any mining.

They have money power; they can export the finished product from here at a much cheaper and lower price. Is this part, okay? There is a lot of economics and politics also associated with this environmental geomechanics, which you will enjoy slowly and slowly. So too much of industrialization too much mining, clear too much industrialization too much power requirement. the more power you require, from where you will bring the power?

Burn more and more coal, the more and more coal you burn, the more and more mining you have to do. The more and more toxics you are producing in the air, the more and more toxics you are staking on the soil, catch 99 situations. So what should be done? Should we stop industrialization? We will discuss several examples of what industrialization does to the modern-day society and how come industrialization and its effects are being questioned by environmental geomechanics guys.

Then, of course, the sluggish approach, I do not bother. I will go to a picnic in a place. I will enjoy, at the end of the day, there will be a lot of garbage which are stacking. Whatever foodstuff I will be carrying, I will be just consuming, and all the discarded material is going to remain there forever. The best possible example of this would be the Himalayas, Mt. Everest. So many expeditions used to go. I am using the word, used to go.

Now there is a strict warning by the administrators that you are not going to create a landfill, which is located at the highest point in the earth. So, whatever materials you are carrying along with you, you have to bring it back along with you, as sailors do. So whatever they collect from

when they are onshore, all the inventories when they have been consumed, the remaining part of the inventories have to be brought back and offloaded from the ship.

They are not free to just throw it in the open sea, the way we do it from our balconies and the windows of our houses, you know. It does not matter where it falls. So, this is what the sluggish and do not bother approach could be. Ignorance, lack of education, so we do not know what our activities are going to do to the environment in what way, clear? This is ignorance, less education, less straining of the minds to preserve your environment might be ignorance, clear?

But no more ignorance is bliss these days, because we realize that what ignorance has done to us. See our earlier generations very comfortably ignored all these aspects and hence, what has happened? Look at the height of the landfills in every city. They are more than 40-50 meters now, at least the metros. This problem should have been solved at least 30 years back. What would have happened then? You would have been living comfortably.

So, ignorance is also a culprit. Do not bother approach is also a culprit. I do not want any botheration because of none of my headaches. I have to live another 10, 20, 30 years. After that, let other guys face it. There are a lot of interesting issues, which are associated with the genesis of the subject, psychology, sociology, economics, politics, international politics, then comes the law, the rules of the land, which are governing the entire thing to happen and their violations.

So most of the time, I tell my students, and when I talk to in public places, environmental geomechanics is mostly a sociopolitical, technical, financial, legal, industrial profession. I hope I have covered all the aspects. Social, political, technical, economical, legal, everything, so when you are giving a solution, you have to keep in mind all these facets of the answers or the solutions, which you are giving. Your solution cannot be economically infeasible.

Your solution has to be within the laws of the land, clear or you have to create new laws. Your solutions have to be socially and politically acceptable. So the more and more newspapers you read, the more and more census of the news you do, you will realize that the technological solutions exist, but unfortunately, what is the problem? God knows, read more and more, clear.

Are you able to link all these? “Professor - student conversation starts” We need to be socially aware of what sorts of things are happening? You have to be versatile, professional.

Gone are the days when you are designing a foundation system without keeping in view of all these 5-6 issues, which I have talked about. So even the conventional practice of geotechnical engineering cannot be done unless these 3, 4 things are intact, clear. This is what is happening in the present-day context. “Professor - student conversation ends” Human greed, do you agree? The major culprit, I am mining barren, I want to extract even the smallest tensile of the mineral, which is available.

I do not want to leave it for next-generation. Why? I have to fill my pockets. Extra deep mines is a recent trend. We are doing two projects on that. Extra deep means 350 meters deep, 600 meters deep. The sky is the limit for your greed. Check it out, what is the deepest mine, which has been done in the history of mankind and what are the geotechnical issues associated with that. The more and more you go deep into the ground, what is going to happen and cut the ground.

The water is going to flush in; it becomes stability associated with the seepage, pressures, clear. The minerals, which are present in the ores are going to start interacting with the environment. They may get oxidized; they may get reduced, you know oxidation, reduction, the chemical process, and what is going to happen. Once the minerals start interacting with oxygen, they might get oxidized; they might get reduced, and from there, when the rain comes, they find out a pathway, and they travel from one distance to another to another, to another.

I hope this part is clear. So why human greed? I want to extract everything. There are several cases you must be studying in a newspaper where the villages do not have water to drink, but these are the places where most of the soft drinks are being produced. How and why? “Professor - student conversation starts” If you go to any nation, they have a strong. All soft drinks, so people do not get water to drink, but what is happening?

Greed, I will extract out even the last drop of the water which is present in the aquifers. Why, you have to fill my bottles, which are going to be sold at a certain price. The mining industry,

food processing, beverages, and so on. Why are wars created? Let us talk about the philosophy of war. Beautiful examples, you have in the middle east in the last few years. It is oil. Oil, human greed. “Professor - student conversation ends.”

If I cannot extract what I wanted, what I will do? I will burn them so that if I could not use, you will also not be able to use. Where did it happen? A few years back, I think you can relate everything. So now the domain is going international, international politics. So the greed is not limited to only my continent, not to my nation only. I will drill a well. It will go up to vertical up to a certain place, and then it will become horizontal to suck out all the resources of the neighbouring country.

You call it as directional drilling. Read on this, and it is a beautiful subject. Directional drilling, from directional drilling, I can get the resources crossing the international boundaries without anybody knowing where what I am doing. This is also a beautiful example of human greed. I can suck out all the water which you have. I can suck out all the hydrocarbons, which you might be having, and you might be thinking it is my property today.

This, in short, is a philosophy to deal with somebody was talking about, you were, I think, asking this question, Vikram. Environment and geomechanics, alright, so truly speaking the domain is limited, we are limiting it to make our life comfortable. Otherwise, these are all three dimension. So we talk about mostly underground processes. Logic is simple. Whatever emissions are taking place in the air, in a particulate matter form, normally they precipitate back when the rains come.

And life becomes simple. So environmental scientists take care of most the emissions in the atmosphere. Geotechnical engineers, who are dealing with environmental geomechanics, would normally consider underground space first of all, beneath the surface and we talk about the underground environment. So when you enter a mine, you know underground mines, that environment is different. How many of you have ever been to a mine? No one, sure.

You should get a chance. You should go and try to see how many meters you can step down and what is going to happen to you, when you breathe there psychosomatic syndrome. So what is the

situation? I am talking about. Why am I saying this? So lack of oxygen could be at high altitude also, as well as at the low altitudes also, in the different environmental condition and then psychosomatic syndrome that you are entering a space, which is beneath the ground.

Yeah, it is an environment. They have created. So go and spend some time over there, take your friends. It is an interesting feeling. Right now, the metro work is going on -75 meter, -80 meters deep in Bombay, again the point is unless you are physically fit, it is difficult to take you over there. You have run 5 km before you enter tunnels, nonstop endurance test minimum, yes. Then only, you are allowed to enter.

You have to be physically fit to be a champion of environmental geomechanics. I can show you some of the videos which are quite, what you call as they may create uncomfortable situations from people. I mean, it is a different subject altogether, but yes, as an environmental geotechnologist, you want to do profession, you have to take these challenges. Anyway, coming back to the point, you have to talk about the underground environment and the problems associated with it.

“Professor - student conversation starts” Sir, I am actually amused by the vastness of the subject. Half an hour before, we were discussing a small soil, contaminant and all, and then we went to like international issues, social and everything. Yeah, it is super, supersonic aviation. I want to discuss a situation, which is mainly related to this subject only. Old byproducts are there, so after years, the disposals may go high and high, so in winters maybe, mainly in winters, the old byproducts automatically heated up.

We could have temperature changes or pressure changes, and ultimately, the whole disposal gets heated. I do not know what is the phenomena behind it, but it happens every year. Where? Around the mines, where they dispose of the byproducts of the coal. That is the overburden. So what happens, say it again. They get heated up, the whole disposal in the winter season only. You could have a temperature difference, maybe or pressure difference maybe.

I do not know the answer, but I am just discussing. I do not know maybe you collect some information on this and then let us discuss it technically. Yeah, this is something related to the environment change or things. It is too early for me to understand what you are saying. Sir, my question is they are kind of close situations which affect soil negatively. Is there any situation that will affect like positively, influence it in a good manner.

Oh, yes, why not? Can you give us some example? You can also answer. I am sure you are aware of all those situations. For agriculture, what is required? You have the field, and then you plough it and then leave it for aeration, that is the best answer. What we have done, we have rejuvenated the soil, simple thing. This is going on since the last 5000 years, is it not? Do you agree? One example, at the same time, try to read from the net what is the influence of more organic matter present in the soil.

How is it creating havoc? See, agriculture is they want to create more and more organic matter in the soil, but what is happening, because of the presence of high organic content in soils. A quick answer will be the decompose and when they decompose, what happens, read all these. Yes. Sir, in Punjab actually in Ludhiana, we have highly industrialized zone, so what people they are doing, they are dumping the waste is underground without telling the pollution board, or they might be knowing it.

So I will positively try to learn in this course the phenomena how it interacts with groundwater, like if you dump 2 meters, 3 meters say industrial waste, how it goes, I will try to understand in this course. Yeah, most of the soil in Punjab and Haryana has become whitish. You must have observed, because of the fertilizers. Now excessive fertilizers, what do they do? There is something known as uptake upsetting of plants. So, if I overfeed you, what is going to happen?

That is also a problem, is it not? Overfeeding is also a problem; underfeeding is also a problem. It should be optimal feeding. Now, who will discover the optimal dose? That is science and technology, which people ignored. So they thought that just over inject, overdose the fields and the crop will be much more. In the process, what happened, now going to the mechanics part of

this, so the more and more organic matter you are adding to a system, the system, which was earlier quite fertile, why, because the aeration of the system was excellent.

Now by adding organic matter what has happened? All those pores have chocked. The water stagnates there, and when water stagnates there, organic matter decomposes and when organic matter decomposes, what happens? All the pores are chocked, weak plants cannot get any fresh oxygen and air; what will happen? This is the whole cycle. Now convert the entire model into a mechanics model. Is this part clear?

So first we created a hypothesis and now what we are trying to do? We are trying to use tools of the knowledge in all subjects, and then we are creating a solution, and when you create a solution, it is mostly quantified.