Environmental Geotechnics
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Lecture – 09
Recent Trends in Soil mechanics

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I will continue with the basic introduction of the course and the sub topics which I intend to cover in today's lecture, so the sub topics which I intend to cover in today's lecture are recent trends in environmental geomechanics for that matter the geomechanics itself, followed by some scenarios of waste disposal. And then I try to correlate how these recent trends and waste disposal scenarios are going to be of some use to us in developing this course further.

A bit on soil improvement techniques and the philosophy, contaminant transport mechanisms - a bit of introduction, and how this subject may lead to the discussion on unsaturated soils this is what I will try to bring out in today's lecture. So, recent trends, waste disposal scenario, soil improvement techniques or the philosophy, a bit discussion on contaminant transport mechanisms and unsaturated soils.

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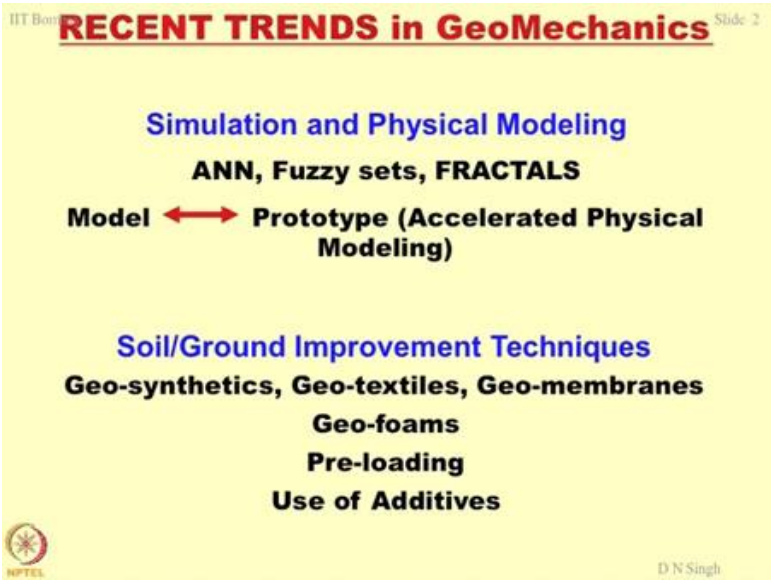

And these are the recent trends in geomechanics. Most of you might be selecting your topic for further research maybe for master's thesis or subsequently your higher studies or maybe other professional in your career. So, it is interesting to know what is happening in present day as far as geomechanics is concerned. So, my intentions are to give you a very broad idea about what are the things which are happening in our subject, simulation and physical modeling. What do you understand by simulation? Generally, what is meant by simulation?

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What is the word simulation corresponds to exactly something which is similar to another thing alright. So, here you are trying to simulate a mechanism or a phenomena and this simulation is either numerical or physical. Or when we say numerical modeling we are trying to simulate something in the numerical form, and we are trying to look for numerical solutions by keeping boundary conditions and getting a solution mathematically.

And the physical modeling basically corresponds to in total if you are trying to study how system was going to respond. So, let us say prototype modeling or centrifuge modeling where you are making models of different prototypes. And then you are trying to see how the model behaves, and similarly this analogy can be extended to study how

prototypes are going to behave. Now, this is where artificial neural networks, fuzzy sets and fractals are becoming quite useful in our profession.

They are also termed as soft computing tools. I am sure some of you must have taken up some projects related to this in your undergraduate, no? And you many of us are sorting to these techniques our colleagues' artificial neural networks, fuzzy sets or fractals, and getting a solution to the problem which is of physical nature.

Now, coming to the model versus prototype this is where you can use centrifuge model which is also known as accelerated physical modeling. And you are doing a course also on this I suppose. So, why do you say that it is always accelerated physical modeling, why not chemical modeling?

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Here partially all of you are correct. See the emphasis on the word accelerated physical modeling, now this corresponds to the limitations of physical modeling that means we can only do physical modeling and not chemical and mineralogical modeling. Why, it has something to do with the time ok, the geological time has cannot be simulated under small durations or in a sample.

So, basically as you are saying correctly that this is the acceleration of the process of the mechanisms which normally takes place in nature, and you are interested in seeing how a system corresponds to or responses to. The second big topic on which many of us are working is soil or ground improvement techniques. Though people say that has become quite saturated, but still lot of challenges are there, and this required attention of researchers and scholars. You must be aware of geo-synthetics, geo-textiles, geo-membranes, geo-foams, pre-loading and use of additives, is it not. What type of additives we use for modifying or improving the ground?

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That is right. So, a simplest possible form of additive would be lime or cement mixed with lime or some pozzolana mixed with lime. So, this is what is coming on since long nothing new. But then why people are not satisfied with this type of ground improvement, why should they be studying this further?

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So, this is this is pro use of resins. But my question is why people want to augment additives or this technology further, why there is a want be use this first of all?

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Well, right, you can actually easily by putting lime or cement lime solutions.

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Good that is right. Then the question is how do you define durability?

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So, one of the attributes of durability is something which last long that is correct. So, again the question is why people are not happy with conventional additives which have been added to the soil mass, any guess? When, when you say durability that means, you are trying to say that conventional additives were not durable that is right, but can you justify it why they are not durable? Yes.

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Yes, yes, true, yes. So, what happens if lime reacts in water then what is going to happen? There is a diffusion of calcium you know which takes place over a period of time any example where diffusion of calcium takes place in human body.

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Bones. What is the disease known as osteoporosis all right, osteoporosis? So, what happens your bones become quite perforated, they become porous. The same thing happens if you are injecting lime in soil mass, you cannot control water table you cannot control flowing water. So, what happens, in the due course of time all this additive diffuse because what you are doing is you are creating a concentrated source within the soil mass of this chemicals. And we have been discussing this quite a lot, but never there is a concentrated mass of some chemicals, but diffuse of contaminant transport will take away.

So, truly speaking this type of methodology is not lasting long and that is the reason why people are still interested in you know creating new additives and another thing is lime, cement and all these are precious materials. So, there is an environmental hazard associated with mining of lime itself that is the natural resource. So, how long will be digging out mine from the nature and then using it for some purpose, so that is where actually people are trying to work on new additives which is of the type of resins or PVC granules or polymers and so on.

So, this is where geo-mechanic interfaces with you know applied material science also particularly PVC and so on advance materials. And good example is geo-synthetic, geo-textiles, these are nothing but PVCs which are being used by geo-textile engineers in a good form.

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Another big challenge is selection of fill material. Why do you think that selection of fill material is becoming such a big issue, can you justify this?

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No, first of all the natural resources are depleting. There is a ban on using the top cover of soil itself for making bricks in most of these states in the country. Why, it is a natural resource. And this also is used for agricultural purpose, purpose. Now, if you are digging

out the soil of the top cover which is very vegetative, very fertile, what you are left with. So, this progress people do think again for selection of different types of fill materials.

Where do you use fill materials in geotechnical engineering for making foundation parts, filling purpose, embankments, retaining walls, back trails and so on. So, this is a you can use coal ash fly ash, mine tailings, I am sure you must be aware of water mine tailings, no? Any guess? Yes, Kunal. Sorry.

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What is meant by tailings of mine? Mine tailings are nothing but tailings of mines. So, after extraction of the ore whatever is left over, it is known as mine residues or ore residues, the better name is mine tailings. So, the biggest question is how to dispose of these tailings, this is becoming a very big environmental issue. So, the more and more extraction of metals ores you go for the biggest challenges that you are creating tailings of mines. And then how you are going to deal with them, it becomes a very big issue. Now, this is where mine tailings can we used as the back fill materials provided they do not interact with water and nothing leaches out from these materials because of environmental interaction. So, it should be a passive material.

Paper pulp, why some environmentalist are against paper industries, cutting of trees that is one. Second if you related with geotechnical engineering, what is pulp of the paper, you will find lot of papers and the journals on related to paper pulp disposal. The paper pulp is nothing but after processing the paper whatever is left out is nothing but a silt sized particle. So, it is a slurry made up of silt, which requires your attention to be disposed of properly. I am sure that you are aware of that when you are making paper you use lot of chemicals. So, think of a slurry which has lot of silts particles or silt sized particles plus chemicals. So, now the question is the more paper you produce, the more slurry you are producing, and the question is where to dispose of the sludge. So, this becomes a very big environmental challenge or question.

Blast furnace slag from any iron industry metal forming industry, we will produce this in abundance ok. So, whatever the residues are in the boiler unit they form the blast furnace slag after the recovery of iron from the ore, and then question is how to use this. Now, if you granulate this if you powder in this material this becomes GGBFS - Ground Granulated Blast Furnace Slag alright. So, it becomes GGBFS and its reactivity is very

high. So, this can be used as a replacement for cement. But in the core form, in the pellet form, you can use this as a good foundation material as a fill material.

What would be the problem suppose if I use this material as a replacement of soil ok, everything has a pros and cons. So, if you use this material as a fill material, what are the problems we speculate? What is the specific gravity of iron?

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Sorry, 7? That is right, not 6, it should be 7 plus. What is this unit a specific gravity of soil 2.6, 2.7. So, you are using a material which is almost three times heavier than soil mass. So, what happens ultimately if you used as the back fill, what is going to happen? So, your active earth pressure, passive earth pressures will enhance by 3 times. So, this is one of the reasons why people are skeptical in using this material; otherwise this can be a good fill material for the foundations and foundation slags. Another problem sometimes is if you use blast furnace slag directly as a foundation replacement, it may consequently react with water and iron and iron oxides may leach into the water table. So, this may also cause a problem.

Fibre-glass, sorry. Can you give an example of what is fibre glass and how this its production is creating more and more environmental issues? Most of the nations have becoming IT major. So, the more IT expansion related work, the more and more glass fibres cables are required. And what are glass fibres, these are nothing but the industrial waste when you are producing fibre glass. So, whatever is remaining amount requires a very special attention to be disposed of properly, because this is a very fine silica material, and this silica happens to be highly carcinogenic, may cause cancer if you inhale it, highly active material. So, these were people try to mix glass fibre with soil and then dispose it, this is one of the techniques.

So, these are the issues which are also gaining lot of attention of people, particularly people who are related to environmental geomechanics type of work. And of course, the national environmental geotechnology, where the issues related are what type of waste disposal strategy should be adopted, which are going to be beneficial.

In the previous lecture, I was telling you the now a days the concept is not to dispose the waste of only, but you would like to use this waste after certain time. So, the intention is

today's waste may become tomorrow's utility or necessity. So, the disposal should be in such a way that tomorrow if I need this material again for any specific purpose, I should be able to take it off easily. So, solid waste management becomes a very big challenge, particularly when you talk about hazardous and toxic waste like radioactive waste management and so on. You must be hearing in newspaper now India is an atomic major, is it not, what has happened recently?

Nuclear treaty management.

Not nuclear treaty that was long back, recent, most recent one, five days back. Yes please, I think you are from the forces yeah Vindhya.

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You are from Indian forces know Navy.

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Army ok, but you should be aware of ok, what are the developments atomic submarine. What is the name of the submarine?

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Aryan, that is right. So, the more and more industrial activities are taking place research oriented weapons and so on. Radioactivity is becoming a major issue you know in our environment. And this requires attention of civil engineers and particularly geotechnical engineers how to deal with soil contamination its containment and remediation, these are the steps which we had discussed in the previous lecture.

And ultimately environmental impact analysis what type of impact a system is going to have if these practices are not correct or the disposal of waste is not done properly. What are the consequent effects on the environment, mankind and so on? So, these are the issues which are you know quite major and important in today's profession. Anything else which comes to your mind should be added up here?

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Yes, bio waste should come under solid waste management. So, you can talk about here chemical waste bio waste you know and bacteria bio everything will come in this, waste from hospitals, waste from industry, research laboratories, toxic waste, hazardous waste and all those thing should come under solid waste management.