Environmental Geotechnics
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Lecture – 03
Overview -3

Now, in the context of the next bullet which I have put here soil-water-air interaction, most of the time what people have done is they have talked about soil water interaction; any example? The whole classical geomechanics is based on the concept of soil-water interaction.

Student: Yes, sir.

You start from hydrometer test, Atterberg limit test, consolidation test, direct shear test, permeability test, shear strength test.

Student: Atterberg limits.

Atterberg limits everything is soil water air interaction ok. What is then we added here is soil, water, air interaction, why? Why air is required to be added here?

Student: Sir, air is also (Refer Time: 01:17) contains many substances in it which may react directly with soil or it may react with water and have definite effect on soil. For example, like a sulfur the attaches with oxygen, it forms a like sulfur oxygen and hydro carbon sulfur and water sulfur dioxide and water mixes and they form a H_2SO_4 and.

Correct.

Student: They react with soil and they contaminate. The best example is Taj Mahal which is been corroded by this acid rain.

Correct. In how many places in the country groundwater is in abundance? Take the example of India only, how many places can you put them, can you mark them on the map of the country that these are the places where groundwater is in abundance or in other words do you think that groundwater is scarce.

Student: It is not scarce like it had its has been like there is a decrease of the groundwater resources.

Ok.

Student: Recently like a.

Alright. So, it is becoming scarce day by day.

Student: Becoming scarce.

Alright; now the classical concerts of geomechanics are, you always saturate samples to get some property. Hydraulic conductivity how did you do the test? Compact the sample in the mold, allow it to saturate overnight or 72 hours, 48 hours and so on and then do the test. Triaxial test saturate the sample, then find out the shear strength; consolidation test saturate the sample find out the correctness. What is the meaning of this? These are the situations which you are simulating are practically not.

Student: Feasible.

Feasible. Why? I ask you the question how many places in the country have enough water. In other words, how many locations in a country have water tables which are going to saturate the entire soil mass, which lies in the zone of interest of an engineer. You agree with this? Somewhere water table will be 300 feet deep, somewhere it will be 400 feet deep, somewhere it will not exist, somewhere it will be 100 feet deep. What I am trying to convey here is in a deceptive way is the classical geomechanics type of situation where you saturated the sample to find out its property are very very rare in nature.

But, what do you do? You get the properties in the laboratory by simulating a condition which is non-existent clear. In other words, most of this soils deposits are having three phases; they have air also, they have water also and they have solids also. And, that is where you have to study the interaction of solid phase, water phase and the air phase; if you want to understand this material in a better way. And, then slowly and slowly you add the concept of contamination on all the three phases. So, you are talking about the solid phase, liquid phase and the gaseous phase in another.

Student: (Refer Time: 04:39)

Word, another form. Soils may get contaminated with a solid phase, liquid phase or gaseous phase. Similarly, water may get contaminated with solid phase, liquid phase or gaseous phase. Similarly, air may have of course, it will not have solid phases, but it may have suspensions, it may have you know liquid phase of some other material in the air form or the vapor form and so on.

So, once you put this system, I think it must be now clear that where the technology is leading to. When you study soil technology what we are trying to do is we are trying to go much more into the intricacies of the interaction between different phases of the system. And it is always futuristic; that means, what you have been doing, what you know till date you are going to add on to the presents day knowledge ok.

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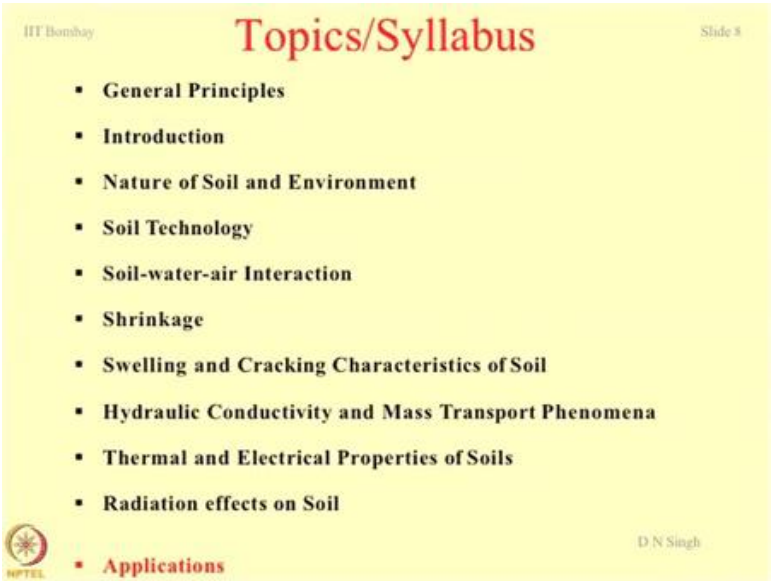

Let us see further shrinkage, people have already studied a lot this phenomenon. We will try to revisit shrinkage and the mechanisms, swelling and cracking characteristics of soil. These are the issues which require lot of attention of geotechnical engineers and soil engineers. Hydraulic conductivity and mass transport phenomena another way of saying mass transfer contaminant transport is basically mass transport.

Hydraulic conductivity is simple passage of water through the soil mass and mass transport phenomena would be when we talk about contaminants passing through it, heat

passing through it, electrical current passing through it and so on. Now, incidentally if you know these properties you may develop new models to understand the behaviour of the soil mass or the rocks. Some are in electrical properties of the soils; where would you require thermal properties of the soils to be incorporate in the model? Can you give any idea why so important?

Student: Sir, (Refer Time: 07:08) study the soil water interaction or soil material interaction can use a electrical, we can use a electrical concept in the soil.

Sorry.

Student: To study the interaction of soil with the another soil having different characteristics of like this we can have the (Refer Time: 07:31); like clay has a charges on, clay has positive negative charges. So, can use the electrical properties of soil (Refer Time: 07:42).

Any other simplest possible situation which you may come across everyday, see what is the difference in designing the foundations for a simple residential building and the buildings which are going to have some industrial units. And, to complicate the problem further, if I say that this industry happens to be a forging unit alright. Forging units or there are the furnaces are there; what would be the difference in the foundation of a residential building and the building which are going to house this type of facilities?

Student: May be power supply cables that might be in the soil, they might be have buried in the soil. So, whenever there is current passing.

Good.

Student: Properties may change.

That is one of the examples that is right, yes. So, because of this thermal cracking may take, any other example the question which I have ask which I was asking you. So, if you have forges or if you have furnaces for which you are going to or let us say underground storage of nuclear waste.

Student: (Refer Time: 09:00)

Radioactive waste or let us say hazardous waste at elevated temperature and so on; what should the difference in the foundation and the type of properties of soils which are required? Now, this is where the thermal effects are going to come on the system. Please understand one thing, till now you have studied only the response of mechanical loading on the soil mass, you have never bothered about the loading in the form of excessive heat, thermal gradients, how soil is going to behave clear and so on. So, this is where actually in this type of problem as she says rightly buried pipelines, cables, conduits, refrigeration systems, forgings, hammers, ovens, furnaces; you know designing these foundations.

Plus, in nuclear waste, hazardous waste, the waste which are at very high or elevated temperatures you have to understand the interaction between heat and geomaterial and contaminant. This is what you have been asking it is a good example of how environmental conditions will augment or change the interaction properties between different attributes. Electrical properties as some of your answer yes, I think you are quite close that electrical properties because of surface charges passing of current, earthing of electrical utilities this is where actually you require to study electrical property.

These are some new concepts which we are talking about, apart from all this you get some idea or hints where these properties can be used. And, I will answer this question, these properties are being used for modeling purpose. Just to give you an example: if you are talking about soil water air interaction and if you are going to do your conventional hydraulic conductivity test, where your saturating sample or the water is seeping through the soil mass, what happens to this air component? There is no air component; that means, truly speaking by doing conventional test you cannot capture the response of a system in three phase, clear. And, this is where you have to use some external amount of energy or external type of energy to model how hydraulic conductivity phenomena can be studied, can be understood and so on.

Now, this is where actually if you pass current through the soil mass, you must have done in your undergraduate some experiments.

(Refer Time: 11:58)

You have that teledeltos paper, you cut out the returning sorry your sheet file or a dam and by using copper sulfate solution you can pass the current through this (Refer Time: 12:09) teledeltos paper and you can draw the flow lines and equipotential lines. I hope you might have done this experiment. This is one of the ways how electrical analogy can be used to define the porous media properties clear. In a slightly complicated way, if I know the electrical properties and thermal properties of the soil mass I can model its property and its behaviour in a better way; keeping all these three phases intact.

Now, did you ask a question to yourself ever when you are doing hydraulic conductivity test by mistake, if you leave the samples let us say for few months in the permeameter; what is going to happen? Why you should do this test only for 72 hours? There is no interaction in nature which is limited to only 72 hours, you agree? Then, why should I simulate a condition for 72 hours interaction only in the laboratory. So, these are the typical question questions actually which are coming in the minds of the researchers you agree.

So, how to get the answers because, no interaction is limited to 72 hours or 24 days or whatever or 28 days of curing of concrete and all. Once the structure is existing in the environment it is going to be there forever at least for 25 years, 50 years. And, in a climate like Bombay, what you did not like about IIT Bombay? The first sight you go to IIT Kanpur, IIT Delhi or some other place you may like to see something which you are not finding in IIT Bombay.

The quality of the building, why? The environment is so aggressive here, why it is so aggressive? Sea shore. What is in the air? Humidity. Humidity carries what? Not sulfur chlorides and these chlorides keep on penetrating into the concrete. What happens? The average life of building here is hardly 7 years, 10 years, 12 years at the most. This is what is known as chloride impregnation in concrete on which lot of research is being done. So, these are modeling tools, these are the philosophies by which you can understand how a system is behaving. And of course, the radiation effects on soil India is becoming a superpower in terms of atomic energy.

But believe me we do not have people who can handle the issues which are being asked or questioned by the atomic energy. Why? Our civil engineers are not trained for dealing with the challenges associated with radiation effects on soils. So, this is the need of the

hour where you should have all these things when the entire course cannot be limited to only this. But of course, these are the few major I would say topics or sub topics which have to be included in this type of a scenario, existing scenario. Anything else which you like to add here? Having studied all this you are talking about the application part. So, the whole idea is you study everything, but then ultimately you have to apply it somewhere.

So, whatever research or whatever concepts you are revisiting or you are evolving they have to be applied in some form. So, what are the applications of these concepts? Unfortunately, the course may not be in a very systematic or a organized manner you may find it, but on and off I will be giving examples which are related to these topics. And, again as I said that this subject is in a very nascent stage. Frankly speaking even I do not know many things my selves and I am trying to get the answers from my students like Seema, Sujeeth and Kunal who are working on different problems and giving me answers and educating me every day. But of course, it is a learning procedure its process goes on and on.