Environmental Geotechnics
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Lecture – 31
Geomaterial characterization – 11

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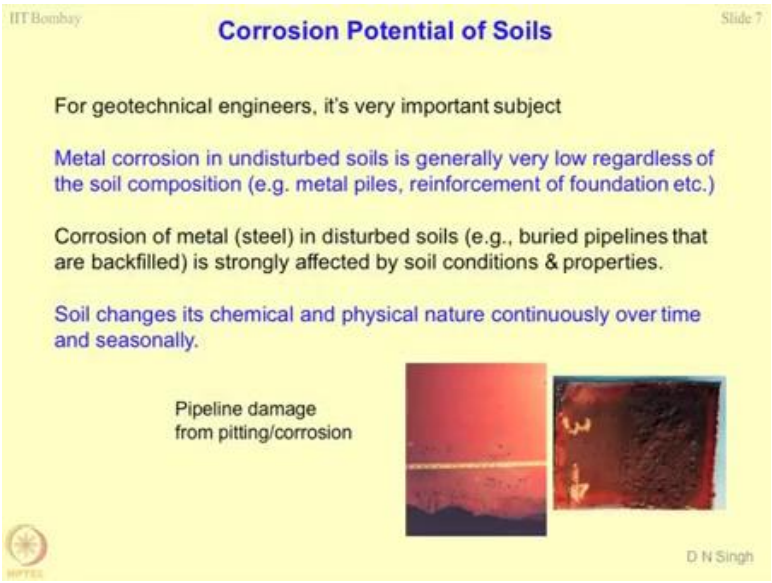

Now, let me start another sub-topic, that is the corrosion potential of soils. Why it is so important to talk about corrosion potential of soils? Have you come across any situation where it becomes essential to talk about corrosion potential of soils? Yes in foundations what happens?

Student: (Refer Time: 00:36).

That means concrete gets corroded yes and further first layer is concrete gets eroded or corroded and then steel also may get corroded. Have you ever seen such type of situations or you have only read and heard? Have you seen something like this any failures because of this type of situation? Well I will show you two photographs which you will appreciate. Metallurgists are very much interested in doing accelerate corrosions of metals and the materials.

So, they treat our soil as another material for themselves and they will do lot of accelerated corrosion modelling on soils and rocks to find out how much vulnerable the

geomaterial is against corrosion. The concrete technologist spends lot of time in studying the corrosion of concrete, which is having direct bearing on durability of concrete. Is it not? So, for geotechnical engineers it is a very important subject or subtopic you may say where most of the foundations nowadays are being led in heavily industrialized areas, particularly foundations for industries where uric acid, urea, sulphuric acid, hydrochloric acid all sorts of chemicals are being produced.

So, the biggest challenge there is you design a foundation system and in no time a situation may come where the foundations do not exist and then you know what is going to happen. So, this type of situations has happened particularly in heavily industrialized areas of Bombay, I will just try to show some case studies during this presentation. So, metal corrosion in undisturbed soils is generally very low regardless of the soil composition. Why do you think that this statement should be correct?

When I say metal corrosion basically a metal which is buried in the soil mass or even the rocks, rock and curves, rock bolts, underpinnings, below the foundations made up of metal, buried pipelines, buried plates anchors which are normally used for navigation purpose, ships all right, sheet piles which are embedded in to the marine clay. So, all these metal components in undisturbed soils are you know corrosion is not much why it is so?

Student: Sir, because the flow of air is not there. Oxidation the process of oxidation is a very low.

This right you are correct. Because oxidation is not the only problem, cycles of oxidation and reduction.

Student: Reduction.

Is a big problem. You must have heard that there are few monuments particularly one is in the Aurangabad, where three four storied are completely submerged in water since last so many years, 2 years. Suchith what is the name of that place? Suchith is there? What is the name of that place where 3-4 stories are submerged in water? This place is very close to that in Aurangabad, it is a famous monument I cannot remember the name of that place anyway.

So, because water table does not fluctuate much yes somewhere close to that somewhere close to that. So, because water table does not fluctuate much the entire building remain submerged in water. So, complete oxidation is not taking place and that is the reason that the wood is not getting corroded or decomposed. So, your answer is partially correct that metal corrosion in undisturbed soils is generally very low. You are right that it is a partial ingress of oxygen, but in disturbed soils particularly of backfills it becomes a very big problem. Why? Is not only the ingress of oxygen, but the ingress of water contaminants high seepage because even if you compact the soil the permeability will never be less than the permeability of the in-situ soil undisturbed soil all right.

So, most of the people in piping industry are having this type of problem all your you know Jeevan Vikas Pradhikaran particularly in Kalyan area, they had very tough time they laid some pipelines and in no time the entire pipeline got eroded and corroded in fact, not eroded corroded and then there was a fight between the contractor and the you know owner was saying that contractor has not laid the pipeline at all, but truly speaking the soil was so much corrosive that in no time the entire pipeline got eaten up by the soil and thus this became a very big issue.

So, fortunately I was involved doing that project, but unfortunately I cannot present those findings here this is not a very it is not a open report which I cannot really show you here, but anyway I can give you the concepts and I will talk about some of my experiences in today's lecture. So, corrosion of metal in disturbed soils particularly buried pipelines that are backfilled is strongly affected by soil conditions and properties of the soil.

Soil conditions are becoming very important parameters all right. We will talk about what are the conditions under which the soil corrosion becomes aggressive or aggravated. Now soil changes chemical and physical in nature continuously over time and seasonally. If you remember in my first or second or third slide third lecture, I had talked about soil is a living entity, clear. So, it keeps on changing like our minds. So, our minds is today I want to do this, but after 2 days you know we do something totally different.

So, this is how the soil also behaves over a period of time you know, it is behaviour becomes unpredictable and with seasons moods different type of emotions moods and

how it exhibits its response. Now this is a picture which I have taken from the pipeline damage which i was talking about you know some time back, the first figure shows the pitting. You can see small pit formation on a GI pipe and this GI pipe was quite thick you know almost 15 mm of wall thickness. But within few days or few months of laying this in the ground this is what has happened, this was the initial point ultimately what happened to the entire pipe you can see over here it got completely corroded. Now had this been situation? Would have been still better, but the situation got further degraded and they were perforations through the walls of the pipe.

So, no water could be conveyed from one point to another point in the soil media and this corrosion was very fast. Actually, this project was the initiation points for me to venture into this topic, where I realize that only Terzaghi's theory will not help you in doing geotechnical engineering practices in present day situation and scenario. So, you have to have more knowledge about you know soil and how it behaves and then only we can put these structures in it, I hope you will agree.

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So, comes the issue of soil characteristics and environmental variables. The first one the biggest culprit is chloride content even your superstructures get corroded because of too much of chlorides present in the atmosphere here in marine climate, you know suppose to be very aggressive climate. In concrete technology we call this as chloride penetration, which is a strong function of durability of the concrete. Moisture content the more

moisture content you have, the susceptibility of the material to corrode the objects which are buried in it becomes more. Any reason why? Why it is so? Sorry.

Student: Electrolytic process (Refer Time: 09:30).

That is very good correct electrolytic process starts. I will be discussing about that. So, for electrolytic process to initiate you require an optimum amount of moisture in the soil mass so, that the ionic movement takes place quickly and easily.

Oxygen content and redox potential you are talking about soil permeability and texture. Soil permeability depends upon the texture of the soil pH and acidity. Acidity is not good for human beings similarly it is not good for soils also. Temperature at very elevated temperatures the corrosion potential becomes much more. Soil resistivity when we talk about resistivity this is the electrical resistivity or the electrical conductivity which is a very important parameter in deciding the corrosion potential of the soil. Drainage characteristics of course, drainage characteristics are linked with soil permeability clear? The difference between soil permeability or the texture and drainage characteristics would be. Suppose you are working in a situation where water remains logged all the time. So, this is going to create lot of corrosion of the buried objects sulfate or sulfite contents in the soil mass.

So, microbiological activity or microbial activities also very important in corrosion of this soil corrosion potential of the soil sorry. Stray currents now this is also becoming a very important subject in present day transportation geotechnology. Have you heard about transportation geotechnology? It is a new subject which is coming up very fast in the western world why? I have given you enough example here you can make out what a transportation geo technology should be doing.

Anything which transportation engineers are doing and we work there as a support providing support as a support system, we work foundations for tracks, railway tracks, airstrips, design of airports, seaports even canals you are transporting water from one end to another end. So, it is becoming a very big theme in geotechnical engineering. If you type the world transportation geotechnology, you will find lot of conferences happening every year on the subject all over the world.

So, stray currents from cathodic protection. Actually, I wish that this topic should have been taken by somebody for great seminar for the course seminar sorry. Its if you want you can find out some information, I wanted to learn this topic. So, if anybody volunteers to take this topic most welcome. Good example of cathodic protections protection would be I had given you long back one example about sheet piles, where you put a copper plate on sheet pile particularly for water front structures all right. So, what copper does? Copper is a good cathodic protection material.

So, it will stop corrosion of the material because of protection which is being yes. So, normally this type of situations occurs in DC traction systems particularly for trains, metros and so, on. So, stray currents become a part of the soil mass and soil gets influenced by the stray currents and this is where again one has to study the electrical properties of soils to design the foundations properly. I will discuss these things when I come to the electrical characterization of the soil mass.

Suchith you want to add something here? So, this I think will be covering when we discuss completely electrical properties of the soils and a spillage of corrosive substances and pollution particularly. So, these are the factors which are you know responsible or these are the environmental variables which are responsible for changes in the soil characteristics. So, when you talk about corrosion potential of the soil mass, we have to give due weightage to each and every subtopic which is listed over here then this becomes a very wide study and a complete study. I will try to cover a few aspects in my lecture today.

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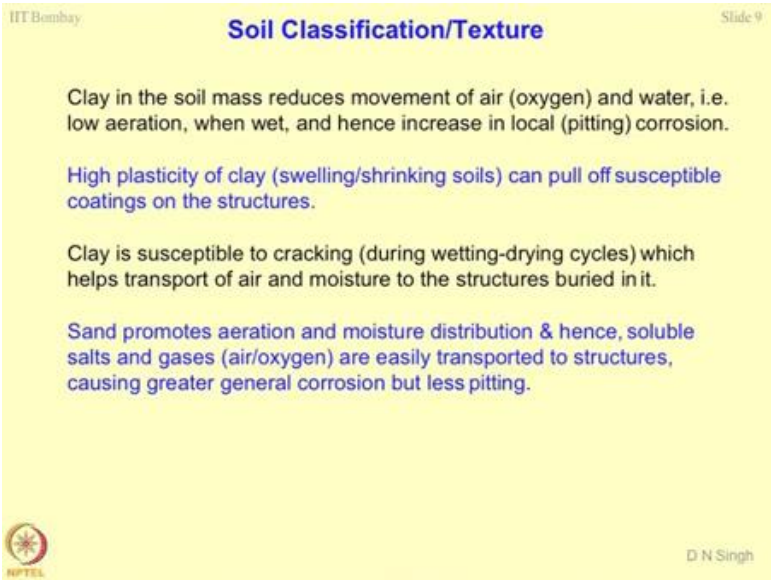

So, the first one is soil classification or texture. Clay in the soil mass reduces movement of air that is the reason why agriculturists they do not like clay is it not.?

So, what do they do? How do they alter the state of the material? If you have only clay is present, they add manure. So, manure gives nutrition to the plants as well as makes it more permeable. See they always said granules should be added, manure should be always added in granules. So, when you add granules to clay what happens? Is a composite system which is more permeable.

So, water a permeates faster they will not be any water logging; air permeates faster goes up to the roots and the plants become healthier clear. So, the same concept remains here also clay in the soil mass reduces movement of air oxygen and water; that means, clay soils will be more prone to causing corrosion of materials and that may one of the reasons why backfills are never used of fine grade materials water retention capacity is more.

So, you want to avoid this type of situation where water gets stored in a material which will corrode it further. So, this causes low aeration when wet and hence increase in local pitting or corrosion takes place high plasticity of clay that is the swelling and shrinking of the soil can pull off susceptible coatings of the structures, particularly the coating which you are putting on the yesterday I told you that even the driven piles all right are coated with some epoxy or resins. So, if you are driving these piles in the soils which are

active soils, chances are that the coating of the pile itself may get taken off by these types of soils.

So, clay is susceptible to cracking also; that is during wetting and drying cycles and once the cracking takes place the cracks will mediate migration of water and air into the soil mass, and hence your buried structures come in contact with atmosphere of the environment. On the contrary sand promotes aeration and moisture distribution and hence soluble salts and gases are easily transported to structures causing greater general corrosion, but less pitting.

Now there is a fix now what should be used as a good material for pipeline design? I have given you two extremes even clays are not suitable and even the sands are not suitable then what should be done? There is a complete book on piping technology by very famous guy known as Jey Palan he has written a very book on piping technology, where one full chapter is dedicated on the selection of borrow material and the backfill material for designing the pipelines and placing them sorry.

Student: Jey palan.

Jey palan. He is an authority in this subject.

So, this is where the question comes that once you are filling the buried structures of doing the backfilling what are material should be used? We started this course by talking about minerals, we should be very active you know and they can withstand even thermal gradients, but forget about all those situations the simple possible situation is whatever backfilled material should be used for laying the pipelines so, that the pipelines do not get corroded easily.

So, you have to go for either a mix of the two or you have to classify the soils first based on all the parameters which you have listed, and then select the most ideal material. And please remember why these studies are becoming important? They are becoming important because most of the activities related to geotechnical engineering is now taking place in adverse circumstances.