Environmental Geomechanics
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Lecture – 04
Civil Engineering and Soil Mechanics

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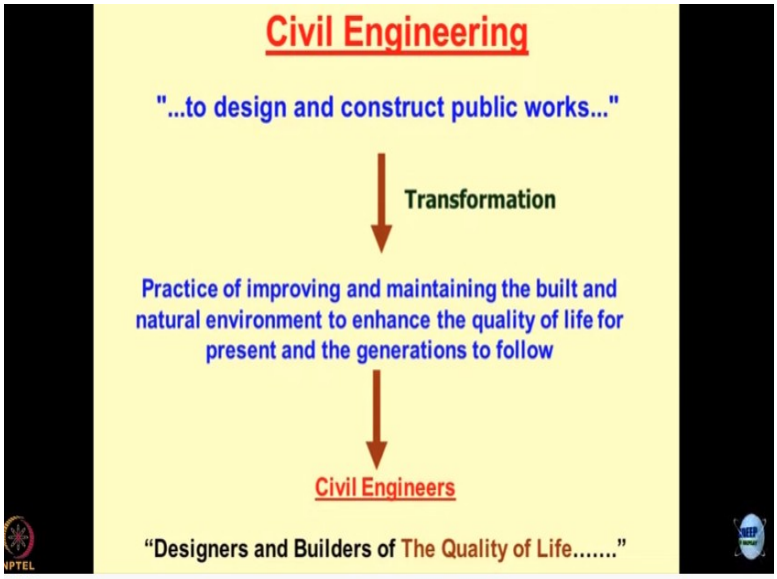

Let me introduce the topic and I will start with civil engineering. Most of you are civil engineers and all of you are civil engineers. So if you go to the copybook style of the definition of civil engineering it tells you that our activity is to design and construct public works and this has been coming on since long since several years and sometimes, we also say that we are the designers and builders of the quality of life.

But over the years this definition has got changed and there is a shift and this shift is a transformation. So why there is a transformation because the society is evolving and when the society evolves the old concepts keep on changing over the period of time and so has happened with civil engineering as well it is not the same civil engineering what we used to study when we were students and what we are professing now as a professor.

So you will observe that there is a marked difference between what you used to be and what it is going to be and what it is right now. So if you read this statement carefully the profession

revolves around the practice of improving and maintaining the built and natural environment. To enhance the quality of life for the present and the generations to follow. So what comes to your mind why there is a shift like this what has forced this shift to occur.

If you read this definition, again and again, you will get this feeling that things have changed and why things have changed is what is written over here. So civil engineering is mostly the practice of improving and maintaining the built and natural environment. So the definition of civil engineering itself includes the environment into it and when we talk about the built environment and the natural environment.

What we are converting to is the naturally given environment like you know where our predecessors are living in caves in jungles and in forest areas and from there the transformation has occurred to the built environment which is a mandate. Is this fine the emphasis is on improving and maintaining both the environments it is not only the creation now when you talk about the improvement and maintenance what are the obvious things which come to your mind you know what type of materials, but I am also going to use number one.

What type of practices I am going to use what type of optimization techniques I am going to use to optimize the materials which I am going to use and the type of techniques I am going to use, and this is where we also talk about the sustainability. So sustainability term has got inbuilt over here if you read the last line, so this is a quality of life but keeping in view the sustainability issues and this is what is meant by present and future generations.

That means you are talking about the improvement and maintenance of the structure which we are developing which you are creating in a sustainable manner. So the most recent term which has got added to a profession is sustainability. So this is what actually I am going to elaborate more in this discussion under the realm of environmental geomechanics.

So if you read again the definition of civil engineers who are the designers and builders of the quality of life the sustainability term was missing in the earlier definition and that is what actually we are trying to cater to. So this is the main emphasis from civil engineering to civil

engineers what shift has occurred in the recent past and that is what actually environmental geomechanics would try to touch upon.

How this transformation has occurred if you remember in lecture 1 & 2, I had talked about the need or the requirement for changing the concepts of the classical subject and redefining them. So whatever exists cannot be applied several times. So now we are going to change those concepts to solve the problems of the present-day society in a most sustainable manner is the basic theme of environmental geomechanics.

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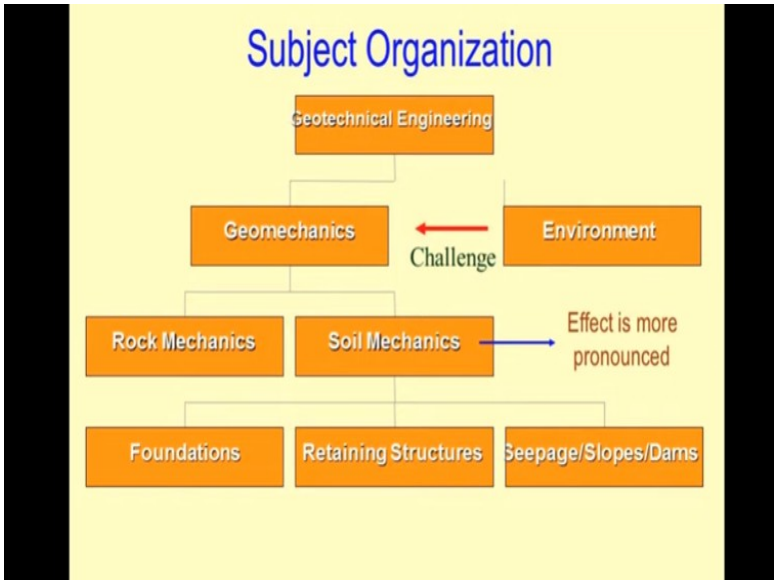

So if you look at the subject organization and what is the genesis of environmental geomechanics this is an interesting philosophy. Basically, all of us are geotechnical engineers civil engineers converted to geotechnical engineers and now we are in the process of getting converted to environmental geotechnologist.

So if you look at the subject organization geotechnical engineering which basically deals with geomechanics all right and when we say geomechanics we talk about normally rock mechanics and soil mechanics and these are the tools like sea rock and soil, or the materials and the mechanics is the principles of physics to apply a problem by using mathematical tools.

So when you are dealing with the materials like rocks and soils and you are applying the concepts of mechanics to solve the day-to-day problem like foundations retaining structure seepage, stability, slopes, dams these are the applications or the concepts this is what is classical. Now so what has happened in the past we have been talking about only the materials, rocks and soils without realizing the effect of environment on the material.

There are several activities right now which people have identified both naturally occurring or man-made where rocks and soils might get affected when they come under you know the threat of extreme climatic conditions. So, I do not know whether you are aware or not say any country's nuclear program everybody every country wants to become an atomic major is it not that is what you are reading newspapers.

So there is the role of geotechnical engineers in what way they can help the nation to become a nuclear power. So most of the time the ore comes because of the mining clear we call them as the mining issues sorry environmental effects on mining processes or sometimes we also call it as the influence of mining activities on the environment. So when you start from the process of the fuel cycle let us say particularly for either thermal power or for nuclear power.

So the first step there is you do mining you take out the ore it could be coal also which is used in the furnaces. It could be the ore which is containing you know nuclear activity also clear so a good example would be uranium let us say. So from the mining, I get these ores I process them some portion of this is unused which is known as tailings we discard them somewhere.

Whatever is the process part we bring it to the industry we use it for our purpose and then again, we produce a lot of waste out of it. Now, this is the catch, and this is the beginning of the genesis of the subject environmental geomechanics. Now, how you are going to link it with the rock mechanics and soil mechanics.

Rock mechanics gives me the concepts of the material like rocks which are very impervious but might be fractured also but they are solid bodies in which I can dispose highly of toxic waste material and because of its low permeability the geoenvironment is not going to get affected. So

this is one situation where whatever industrial toxic waste is coming out of the industrial units can be disposed in the rocks by virtue of their extremely low porosities and extremely low permeabilities.

But in the process what is going to happen when you are dumping the waste over there which might be having chemical attributes like the concentration of chemicals associated with this or very high temperatures. These are the two attributes which we are interested in right now they are going to affect the rock mass in which the waste has been disposed of this is one of the examples of what I was citing about the man-made activities which are influencing the geomaterials all right directly or indirectly.

There could be another situation where whatever industrial waste is coming out, I might be discharging it directly in the ground all right surficial discharge. So in that case what happens the top layer of the geomaterials are soils they might be getting you know interacting with the industrial pollutants or the ways which you are discharging. So this is where the material like soil comes into the picture.

In other words, what is happening is by human activities or natural activities the geoenvironment is getting affected contaminated influenced and that is what I have written over here as far as the classical concept is concerned, we do not talk about any contaminant, presence of a contaminant in the system everything is very neat and clean. Most of your experiments you have done by using distilled water or tap water and this type of situation is not going to occur in the field ever.

The chances of studying hydraulic conductivity of a porous media which is located in the natural deposits with freshwater supply are extremely less in present-day context why? Because too much of industrialization is occurring. So everywhere the pollutants are being discharged either deep inside the ground or on the surface and hence what is going to happen is the way we used to consider the mechanics of the rocks and the soils is bound to change.
Because the effect of the contaminant or the human activities is going to be much more on these systems and I cited some examples. Now out of the two if I consider which material is going to get affected much and why? Rocks or soils so what is your guess why? So the question is out of

soils and rocks which one is going to get influenced because of the environmental directory more and why **"Professor - student conversation starts"** hello yeah maybe soils are more affective things or compared to rocks because they are more permeable or porous.

Well, I can always compare soils in such a way that they may become extremely impervious maybe because or maybe I am just countering your logic no it's not possible all the time because the soil naturally occurring it is not so compressed. So well I can always compact place to get a permeability 10^{-11} and for rocks, 10^{-20} m/s is practically the same both are impervious all right.

Dumping area may be soil is not so compressed way or not that okay this is one of the logics correct yes. Same soil will be affected apart from this way give it thought it's all about reasoning it has more surface area than rocks so why? Yeah, you are right your answer is correct soils are having more surface area then rocks why? Because of particle size smaller no, what is the correct answer look at the matrix in which they are bound?

All the minerals in rocks are bound in a very very compact matrix as compared to soils do you agree. Yeah, that is one of the reasons yes you want to say something. So my logic is soils are the offspring's of the rocks and the chances that the offspring will get contaminated adulterated deviated are much more than their parents you like this logic. They are kids so the chances are they may get more influence from the environment in which they are kept.

So your logic is also correct but the way I am looking at the material is like an offspring of the rocks and then I am saying this a young material as compared to rocks. So the chances are the young material will get contaminated, adulterated are much more as compared to the parent material and then the logic comes porosity is less the matrix in which the minerals are bound is extremely compact.

So if you consider the permeability the granite is extremely low why you know that matrix is so hard, so compact, so intense that the minerals are not free to interact with the environment is this part clear this sounds good "**Professor - student conversation ends"**. So I have used a

lot of adjectives I have used a lot of definitions I will a lot of words to define why this material is inert.

So this is the first time I am using a word inert for a geomaterial is this okay and just to create a relative comparison between the rocks and the soils I have said that the rocks are inert, but the soils are not. So if this logic is correct, I would say that soil is the material which gets influenced by the environmental activities much more and when this happens, we have to include whatever changes the material is undergoing when it comes in contact with the environment fine?

And how to quantify this and this becomes a big challenge and that is what we say the influence of the environment on the practice of geomechanics is going to be extremely challenging. So what we are going to study in environmental geomechanics is, first of all, we will try to understand the fundamental properties of these soils and the rocks what properties make them very conducive or vulnerable to the environmental impact and once we have understood yes, the environment is going to impact these properties more the next question would be how to quantify this.

So that once the quantification has been done, I can utilize this concept in my design practices is this part clear. **"Professor - student conversation starts"** After quantifying we can go for what can be the effects of yeah once quantification is done, I know how good you are as compared to me otherwise this is all aspect it is qualitative, I cannot fit this data in a computer program.

But the moment I have quantified a number the moment I said this property has changed to this by this number I can do mathematical modelling, I can do numerical modelling, I can do modelling later on. So the big challenge is, first of all, try to understand the material try to understand what is the influence of the environment in which it is kept, and this could be natural as well as man-made and once we have understood this, we will try to quantify how much changes the system exhibits because of this interaction.

A good example of environmental influence would suppose you are making embankments. Now embankments are exposed to the sunlight forever. Do you perform any tests in the laboratory to show or to exhibit how much the material is getting degraded because of the sunlight for 40 years,50 years,100 years this is a quick example so when you make railway tracks embankments all right when you make dams, they are getting exposed to the UV light from the Sun.

We never talked about how the material is deteriorating over a period of time is this part okay because the conventional subject does not include these effects its a quick example how the material is getting deteriorated, how the material is getting upgraded because of some other activities. So this is what actually we are trying to focus upon in the conventional design like embankment design for the design left we treat the materials even soil is inert.

Like I presume that my grain size remains the same it would not alter very good so why failures are occurring you are using the best possible software's you are using the best possible design techniques. Even then the failures are occurring so what comes to your mind the patient is not getting treated even after giving the best possible treatment and diagnostics. So what is the problem?

Treatment failure can be due to like design problem also know I said I am using the best possible design practices. Nowadays the best possible design software's are available I can get the best possible design parameters also by doing very sophisticated instrumentation and testing. But even then, failures are taking place why? So are you realizing the shift now at every stage I am asking you a question why?

So she said you know surface soils are interacting more with the environment my first question was why, and somebody said rocks are not really interacting with the environment again the question is why? So we are going to ask a lot of whys? how? when? where? so what? so the more and more you question what happens the more and more answers you get.

So truly speaking environmental geomechanics is nothing but asking more and more questions to yourself and challenging what exists in the practice. Have you come across as any case in which

you have seen that every design and every parameter were okay, but they have not taken environment effect, and something has failed so many buildings are failing in Bombay city and cities Delhi and so were everywhere in the world why? Calcutta bridges are failing why? Bridges are collapsing dams are collapsing why?

Imagine seeing these are the questions which people are asking these days. So whatever was done 50,60 years back yes it has lived its lives we live for 60 years, 70 years, 80 years these structures there will live for the same time **"Professor - student conversation ends"**. So the way you want to retrofit your body rejuvenate your body these structures also have to be rejuvenated. So we will see how to do all these things. So this is only the preface of the subject which I am talking to you about.