Environmental Geotechnics
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Lecture – 05
Recent Trends in civil engineering

(Refer Slide Time: 00:16)

What are recent trends? If you want to be a matured mind or a researcher, you have to adopt what I am going to talk about here. Civil engineering without materials is nowhere. Can you give me some examples of how mechanical science and civil engineering is interfacing with each other? In my personal professional career, I have used material science a lot and being a geomaterial scientist that is when I deal with soils and rocks.

Basically, the basic component is same as any other material which a metallurgist will like to do deal with. And we understand this fact because our material also has silica alumina and iron calcium and Iron what not and the same thing a metallurgist also deal with. Something which is becoming very interesting in the profession right now is neo materials and the nano materials. Any idea about neo materials and nano materials?

(Refer Time: 01:27) Carbon nano tubes are used for nano material.

That is very good.

They have been used as a to make long wires which are very elastic and which can sustain a great amount of load.

Good. Carbon nano tubes they are used as a micro filters. You can use this filter for drinking water cleanup. Any other example?

Silicon electronics (Refer Time: 02:00).

Yes, but not in this form of silica when I teach consolidation curve in the class, I always emphasize that soil has a memory can you justify this.

Yes sir, actually it remembers the past loading and (Refer Time: 02:25).

Have you gone through my lecture notes earlier or what [laugher]. Yes, that is right. So, if you look at the NC, and OC behavior I mean soil remembers, that what was the pre consolidation pressure to which it has been exposed. So, there is memory in the material with which we work. And that is why I say that the material with which we work is say very lively material, it's a live material you cannot deal this material as a dead material there is a difference, between the material with which we deal and the other scientist deal. Neo materials, any idea?

Student: Geosynthetics (Refer Time: 03:04).

Not really. Geosynthetics are made up of PVC and new is something which is latest new, the application of new materials, where biology is adding towards now bio-technology they are trying to create artificial skins. Can we design something of that sort which becomes a artificial soil?

(Refer Time: 03:40).

So, when we talk about neo materials basically we talk about some minerals which are synthetic minerals, we talk about soils cracking, desiccating, shrinking, swelling type of soil, problematic soils and so on. Now, can I create some minerals or the material which are so intelligent which will stop this process the processes which are not conducive to construction activity. Maybe by the end of the course I may use the words as self-sealing and self-healing minerals.

So, this is where most of the research is going on particularly I am very much eager to learn this subject that how minerals can be used which can recognize based on the environmental condition whether they have to seal the crack themselves or heal the crack themselves. The application would be in concrete here we are talking about bio concrete nowadays, is it not. What bio-concrete is? Any guess? No idea what 'bio' word is doing?

Sir, it gives you lightweight concrete.

(Refer Time: 05:11).

It can heal, it can it can heal by itself and.

Which can protect the cracks in itself (Refer Time: 05:16).

Yes, true.

No, need of ultra sound waves and not retain that.

(Refer Time: 05:21) It can self-detect that internal cracks and can heal itself

Why, people are not happy with construction with soils? Why did they discover concrete? You could have made walls of soil, they can stand almost a meter and so on.

Strength (Refer Time: 05:38).

Strength.

And also the.

How strength comes? What is the engineering parameter which guides this strength of material?

Binding, binding (Refer Time: 05:50).

Go to the micro level.

Yes, please.

Sir, when you want to construct the building on suppose when we only deal with soil it may not bear the all the loadings of all these.

Agreed.

Yes, sir.

So, this is what you are saying the strength will be less.

Yes, sir.

Now, my question is why strength is less and in what way concrete is most strength full.

Sir, soil is not a purely elastic.

Do not go in all that [laugher], ok. So, when you say dense can you elaborate it bit on how density comes in picture.

Sir, actually soil is not a engineered material, but concrete is the engineered material, but we.

Are exactly when you are exactly you are right.

(Refer Time: 06:44) filling up the pores at micro level.

Where?

You can just take.

Where you are exactly?

Yeah.

So, basically the difference between soil and concrete would be the porosity. Agreed?

So, if a system has more porosity its bound to show you less strengths, as compared to the system which has less porosity. So, truly speaking all civil engineers particularly the construction specialist would be very happy and delighted if they can produce a concrete of zero porosity.

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Now, zero porosity cannot be achieved just by adding silica fumes, cenospheres, microsilica or whatever is in fashion these days. That means, a little bit of void is still left

which can be now can you complete what where we were and why I gave you so, much of story.

Can be filled by bioactivity (Refer Time: 07:41).

Exactly.

Transformer.

It can be filled by a bio-material (Refer Time: 07:47).

Bio by a bio activity.

(Refer Time: 07:49).

So that means, you think of a situation where bacterial activity fills up the voids which are present in the concrete. How this is possible? The excreta above the bacteria can be utilized for filling up the voids which are present in the concrete. So, this is the whole concept of designing bio concrete, ok.

So, you think of the materials which are going to act as nutrition which are going to support the nutrition of bacteria, ok, in a most passive form. When you design filters for let say reservoirs or swimming pools you use silica, but on silica particles you grow microbes. And what these microbes are doing? They try to digest the sludge which is present in the water.

Sir.

Clear.

Yes, sir.

So, if this type of situation occurs in the concrete where the bacterial activity itself takes care of the voids which are present in the concrete. This type of a concrete is going to be best passive concrete. Now, this is where the research is going on.

In geotechnical engineering we would like to design covers, liners. I hope you understand what are covers and what are liners these are basically compacted clays through which no water should permeate, clear, but go one step ahead. No gases should

also permeate in the environment, one more step ahead would be no radio activity should permeate out of it. So, this is where actually we require minerals which are synthetic minerals, which are much upgraded than the minerals which are already present in nature like montmorillonite, bentonite and so on which have certain limitations, ok.

So, these type of minerals are to be devised, fabricated, synthesized and their utility has to be shown. It's a very big chapter on which lot of peoples are trying to work. It is a very good research area, some of you may find it useful either in your academic career or may be as a professional carrier whatever these are very futuristic subjects.

In mining or the mineral engineering, they are used to be a time when people use to say I am a mining engineer and you are a civil engineer. Now, Kunal I think you can throw some more light on why these two subjects are amalgamating, sorry just for his introduction. He is basically a engineering geology student, doing his PhD in geotechnical engineering because our research area is happened to be common. Yes, please.

I think in mining engineering, mining and specifically deal with geological activities and civil engineers also always on the constructions and other constructions and other aspects.

Yeah. So, that thing demarcation.

There is difference little demarcation between both.

Yeah, but that is disappearing now.

When we talked about the stability of slopes.

Yeah.

You can talk about the stability of vertical cuts or shoots or internal (Refer Time: 11:11).

Yes.

So, mining is the activity where the whole idea was to take out the mineral resources from the ground, but then our role is to create a stable place.

A strength.

Place.

Yeah strength.

Exactly. So, that the production of minerals continues.

Yes

It should not stop. So, this is how you will find that this object is also picking up the attention of geo technical engineers. Geo-hazards mitigation, I am sure most of you must be aware of, lot of money is being spent by Government of India and all over the world to mitigate the geo-hazards. Can you name some geo hazards?

Yes, sir.

Landslides yes.

Earthquakes.

Earthquakes. What else?

Ok.

Tsunamis What else?

Stampedes.

Stampede. You go to a place public place where you have lot of people and then you are never know, this stampede may call so much of chaos, floods, droughts any natural activity which is beyond a certain activity level can be termed as geo-hazard fires in jungles, alright. Recently there was a case in Australia where the jungle kept on burning for few months, in New South Wales somewhere.

Now, this is where people have lot of interesting geotechnical engineering, information technology, artificial intelligence and expert systems. Though people have done lot of work in these areas, but still any example of expert systems, AI, IT where you have co relations with the geo technical engineering.

Ok.

GPS.

Something which is more to the point and concrete, soft computing in geotechnical engineering, civil engineering is gaining a lot of momentum neural networks, is it not genetic algorithms. You agree.

Yes, sir

Anything where you need a decision you may use this systems IT, AI or expert system. So, that information you will find lot of data bases are there which can give you the information about a soil in which you are interested by just locating it from the data base. So, you need not do the test.

See a modern most modern civilized society would be where I did not perform any test on any soil. I do not want to spend 7 days doing a CD test: consolidate drained test which will take at least 7 days. What I want is I want is all the parameters to be estimated as soon as possible. So, if I know the fundamental properties of soil like particles distribution, its auto bug limits, its volume mass properties and so on there are few data bases which are available if I just feed the values there, I should be knowing the parameters.

Now, what is the algorithm behind these databases? These are nothing, but expert systems. So, some of you might have done these are basically known as SQLs, Sequential Query Languages. So, you keep on feeding the commands in the system sequence sequentially and you get the response for the answer. So, if I say that the given soil has this type of particle size distribution what should be its shear strain parameters. The answer should come out by searching the data base. So, this is where lot of people are working. Any other good example of IT, AI and expert systems?

The name is different which is known as data mining. So, your computer science friends must be using these jargons and you can use these jargons in your own profession. What is data mining? Data mining is again nothing but a SQL, sequential query language. So, you write a program in such a way that you have 5-6 queries from database and the data base gives you an answer. But philosophy behind this is that everywhere in every continent, every country people are trying to characterize the soil. But ultimately can we dump all the data somewhere where this information can be used by anybody rapidly,

alright without testing the soils physically. So, this is where the concept comes virtual laboratory, visual computing and so on, virtual data analysis of the soil mass.

So, this is a very new concept which is now gaining lot of momentum and people are trying to work on this. In my research also I use expert systems like soil vision which are very useful in giving you the information about the material properties. A very recent development is bio-geo interface which is talking about the molecular mechanics, last year in our Goa conference which we organized we had lot of papers in this subject about 25-30 papers across the world where people are trying to interface biological concepts with geo-technical engineering concepts. Any guess how they can correlate these two things?

Something like that yes.

Yes, right basically when we talk about molecular mechanics. So, clay happens to the most active mineral and this is a still a natures gift to man mankind and totally undiscovered I would say, still even after so much of research have been conducted on this. You will agree with this fact that till now civil engineers have not given due to interaction of soils with anything living you know in nature, while this type of interaction goes on in nature quite a lot. Now, based on this philosophy in fact, some people have started saying that where the role of civil engineering stops that is where the biotechnology takes up or takes over.

A good example is that atomic energy is facing this problem quite a lot. If you want to cutoff atomic base completely from the biosphere, no leakage in terms of gases, no leakage in terms of liquids and no leakage in terms of a solids you not have here. I am sure you compact the soil to any extent is still porosity remains, clear. You load the soil as much as you can, but you still porosity remains that means, under no circumstances if you are working with soils alone the system can become totally impervious or near impervious.

Well, the answer was the people went for concrete, they adopted concrete in their designs and they came up with concrete wallet, vaults and so on for isolation of the waves. But what happens is the concrete itself is degrades because of the activity of hazardous like radio activity. Now, this is where actually people have realized that we have to take help of a biotechnology. You grow some bacteria which can nourish

themselves on radioactive waste and they can reduce the intensity of radioactive waste, clear.

So, this is where I said that whatever civil engineers could not do that part has to be taken care of by nature and bio-activity happens to be a part of the natural phenomena. After this twin tower collapse in New York, people have started talking about fire protection engineering and this has become a very mandatory part of civil engineering. Earlier we never used to design structures for elevated temperatures, alright. So, now, this has become a new subject on which lot of research is going on, people are trying to understand how fire production and safety should be imparted to the structures.

Another interesting trend in civil engineering is infrastructure engineering. It is a very big world, what I am trying to connote to is the land creation. The best way we can create land is either from sea or from rivers or from lakes, alright. Of course, this is against natural phenomena natural activity, but a still if you move across the or all along the coastline of India you will find that so many ports have come up in the recent time. Cochin port is a good example; Jawaharlal Nehru Port Trust is a very good example these are all man-made ports.

So, majority of the work deals with land reclamation. And when you say declamation this is from the sea, alright. So, basically what look likes see today may be after 5 years, 10 years the tendency is to utilize it as a utility land. Similarly, lot of airports have been developed in sea, there are floating airports, Changi airport is one of such type of airport which is basically has been reclaimed from the sea, Boson airport in Seoul is also a type of this airport and so on. So, infrastructure engineering picking up a lot and some of the IITs have already started a course on infrastructure engineering as a masters Kharagpur particularly. And so we are also in the process of floating this course.

Preservation, restoration and rehabilitation of monuments and old structures; lot of geo techniques is involved in these type of activities where you want to preserve restore and re-habitat monuments and whole structures. In India I think Ajanta caves and Ellora caves are under severe threat of you know deterioration. So, this is where you they need your help from geo technical engineers. particular in designing some systems which are leak proof. So, the paintings and the history of India does not get destroyed. So, when I visited them some 3-4 years back, I was associated Ajanta caves and all in restoration

process, I mean like just imagine that the entire caves have to be covered with some minerals and these minerals should be eco-friendly.

You are not suppose use cement there, you cannot take the vehicles even there. So, this is how actually these places are so sensitive. I don't know whether you have heard about arctic soil mechanics, cold region. There are many countries which have done very well in soil mechanics, but truly speaking, what they have what nature has given them as soil is nothing, but thermo frost Norwegian countries, Scandinavian countries, Canada, some parts of US and so on where you will not get these type of soil per say this will be only frozen soil.

So, right now very conveniently you talk about 3 phase system soil, water and air. Now, there could be a situation where any of these phase may get disappeared or may get added up to the model. So, you are working right now with 3 phase system. Go to cold countries or partially cold countries, there the call of the nature is to develop a 4 phase multi phase system. You agree? So, this is how actually transformation of the knowledge which you have keeps on changing.

Similarly, lot of work is going on lunar soils. When I was student, I remember my Professor. Prof. Yudhbir, he brought some sample of lunar soil and he wanted to characterize them, at that time in 1989. Now, it is picking away, any idea why people want to characterize lunar soil? What is the reason?

They want to build a house even on the Moon.

That is right there was some news that the booking is already on [laugher]. So, unless geotechnical engineers help structural engineers cannot do much [laugher]. Similarly, lot of information is required on Martian soils, and you know explorers which had gone they were trying to collect the soil data from the mass. Right now these two I would say planetary sciences are coming in the preview of geo mechanics. I hope you agree.

Did you have wonder that your soldiers remain in Kargil, how do they stay there? Antarctica, your scientist go how they survive there if you do not provide them good shelter, what type of foundation engineering you are doing setting in IIT, Bombay or sitting in India when you cannot provide foundations in Antarctica for your own

scientist. So, this is the biggest challenge. So, you have to provide foundations which can take the moments of the order of wind speed which you expect in Antarctica.

And what is another challenge? The level of the foundation keeps on changing every day. Why? Because of either snow either it melts or it freezes. So, [laugher] think of the situation where the soil mechanics would be and where the foundation engineering would be if you take in account all these things, you agree or no. So, it is a world full of complexities. What we have done is very conveniently we have taken out few concepts from the literature and we say that we are experts in these areas. If the situation changes and we are handicapped.

You think of a antenna which is of 25 meter, 50 meter in diameter which is normally used for early warning systems. So, you want to house this type of a antenna for scientific study as well as for strategic studies. So, how these foundations are going to be designed for this type of system which is 50 meter in diameter and its going to face the wind speeds of 150 kilometers per hour, alright. So, this is where lot of conferences are being done in different parts of the countries where people talk about cold region geomechanics.

Of course, I am yet to see a dedicated conference on Lunar and Martian soil mechanics, but I am sure by the time you became a professional you will find that such type of things will be in fashion. And those are few working in this area will be having a very high status in the society.

Another interesting subject is forensic engineering. This is a very interesting branch of engineering which requires attention of a any civil engineer I would say, not only geo technical engineering. Why? Why it is so? Most of the projects which are being executed are mega projects in civil engineering, and unfortunately many of this projects fall in the category of what, legal problems or legal situations.

Now, this is where the court cannot decide anything in favor of anybody unless a professional like you goes there and helps the court to understand what is gone wrong and who should be penalized and who should not be penalized. Now, this is becoming a very good profession particularly for upcoming people and growing professionals like you guys. You can adopt this subject and you can become experts in what is known as

engineering aspects of legal problems associated with any project, where lot of concepts of civil engineering and geotechnical engineering are required.

One good example would be even after doing band drains and ground modification settlements may occur, alright. Now, why it is so? The cost involved in this treatment is very much, now your client is not going to leave you if you find that after spending crores of rupees even then the ground settles, you agree or no? But unfortunately, sometime it happens because the nature is so unpredictable and your practice of poring PVDs and pre-consolidation or preloading may not be so effective.

So, these type of scenarios are actually becoming very very common in our profession these days. So, this is where I say that to me it look likes that forensic engineering is going to be the subject of future. Any other example? In city like Bombay every year one or two building collapse after the rains, you must have heard about in news paper, sometimes in Thane building will tilt, somewhere the building two floor will become a basement, sometimes the entire 17 storey building will collapse in 10 minutes and so on.

Now, who is going solve these type of issues if not you. Those who have done only law cannot take any decision on this. So, this is where actually forensic studies, forensic engineering are becoming very very important in our profession. Sometimes I call them as postmortem of a project also. So, you start from the backend and do the forward analysis and find out what went wrong so that this type of disaster has occurred, ok. So, I hope, I have tried to give you some idea about where we can you know proceed further in our careers.

Unfortunately, I am not sure that [laugher] how many people aware of so many upcoming fields in civil engineering. Specifically, the more you adopt it to you the more and more questions and answers come to your mind. Any suggestions? Anything further you want to add here which comes to your mind and I have not included.

But incase apart from the geotechnology observation people have started reusing and recycling materials.

Yes, very good. In material science you can have neo, nano materials and recycled materials that is right, ok. So, try to think of something more and you please include in this list.