Environmental Geomechanics
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Lecture No. 26
Geomaterial characterization-II
(Mineralogical characterization)

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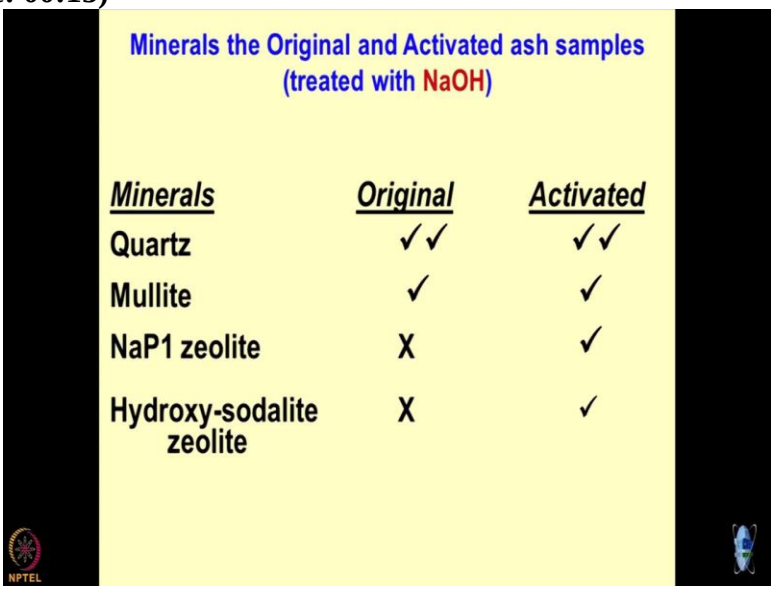

So just to give you some example of what type of R and D has been done until now, we started working on activation of slides and flashes. I think I cited this example sometime back that when contaminant geomaterial interaction occurs at elevated temperature in the presence of some chemicals, the geomaterials get altered. So, what we did is whatever happens in nature, we try to simulate in the laboratory.

So, I took sodium hydroxide, and I boiled it in a pressure cooker to start with my research because I am sure you can realize why because it is an autoclaving, which is going on at very high pressure due to the stream and achieving very high temperatures. So, what I have done is I have ripped off the external surface of the quartz by applying very high temperatures and very high pressures with sodium hydroxide, sodium hydroxide is a chelating agent.

You will learn about this once you are into this industry. It basically scrubs the surface of the quartz. This type of activity is also going on in the reservoirs and the ponds where the fly ash is being dumped. So this was my Ph D students thesis in 2001 2002. Everybody was talking about utilizing fly ash for making embankments. And we were thinking in a different direction, and I said, Look, wait a minute, let us try to analyze the samples of the flyers from the pond and the published interesting papers showing that this material should not be utilized for making the amendments and the reason is for this about to follow.

So, if you take the original ash, you will find that we have quartz, mullite and these are what known as zeolites. The activated state of the minerals was sodium alumina ratio is in some order. So, this original material gets, you need not write these are all R and D ideas, you can read the publications on this, we have written a book by the way on this. I will talk about that. And so, once you boiled with sodium hydroxide, this is what happens this is what is known as activated flash activated fly ash that is a catalyst. So, this is what the aftereffect of activation is sodium hydroxide is of the fly ash.

These processes keep on happening in nature. So, most of the rocks. To my surprise, which I was dealing with a consultant for creating the buildings and the bridges, particularly one in Bombay huge bridge. There was a bug in mind and let us see microscopically what type of minerals these rocks have and what would be their bedding capacity because bearing capacity is a macro term. Now when you look into the mineralogy. You realize that these type of minerals are not fit as a load-bearing mineral because they are hyperactive. They will be sucking a lot of moisture either from the atmosphere or when they come in contact with the water bodies.

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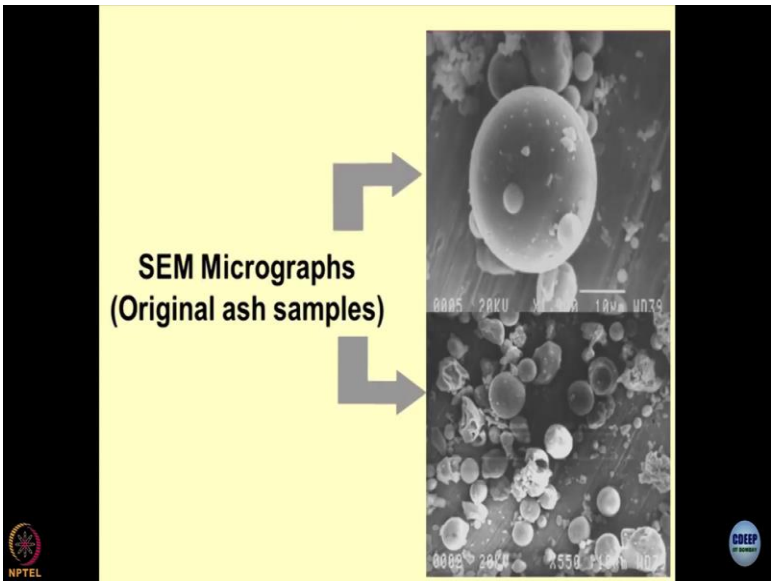

This is how it looks like. So, from this point onwards, I always tell my students that I am venturing into sukshm, you understand? What is sukshm micro Nano so this is R and D is because until now the conventional theories have been talking about the macro systems never went into the microscopic scales and the Nano scales to understand what causes turned to the matrix of the side. And that is where these tools, SEM and that XRD become very, powerful tools.

So, the original ash samples would look like perfect quartz balls and depending upon the opaque or the transparency of the balls you can make or what type of mineralogical composition this system would exhibit. This is a very different world; you will realize the more you focus on the particles, the more knowledge you get about it. Remember, this material is getting created because of firing in furnaces at the power plant. So, the coal which you bring to the power plants you pulverize it, and as a pulverized coal it is injected into the furnace.

It is not the coal which is used, because you want to enhance the surface area by pulverization. And once the surface area of each particle of the coal increases calorific value increases, these are techniques whenever you get time please go and visit a power plant try to understand how the power is produced. So, all these fly ash particles which remain in the boiler units or they could be the bottom edge also they tell different stories so; you have turbines from the colour you can make out a beautiful thing which I wanted to show you is a sort of a cup inside a cup.

You take a football and cut it. So, you have the inner surface, and you have the outer surface. Something of that sort you keep two cups one over each other. So, what happens? A cup is sitting inside in the cup one ball is sitting inside another ball. We call them as Clearosphere they have very special utility in today's chemical engineering processes. I mean, if you check on that, you will find that these type of entities are used for making bulletproof vehicles, bulletproof clothes and so on because their tensile strength is extremely high. These are perfect quartz balls. In sports, most of the gadgets they use cenospheres and Clearosphere. If you go into the chemistry of these type of particles, you will realize that during very high temperature when the fighting was done, these particles, the silica got melted. And then in the stack from where the emissions take place. These particles could not go outside, and they have to dropdown. We were talking about the hydrometer test today morning.

It is something like hydrometer test which you are doing in a stack of a power plant with all fumes at very high temperatures, and particle is dropping down. What type of alterations the system undergoes. So, in the process, what happens is a lot of air gets trapped in these particles. So, when the air gets trapped in the particles, and they recrystallize they become Clearospheres or cenospheres. And as I said they have a lot of applications,

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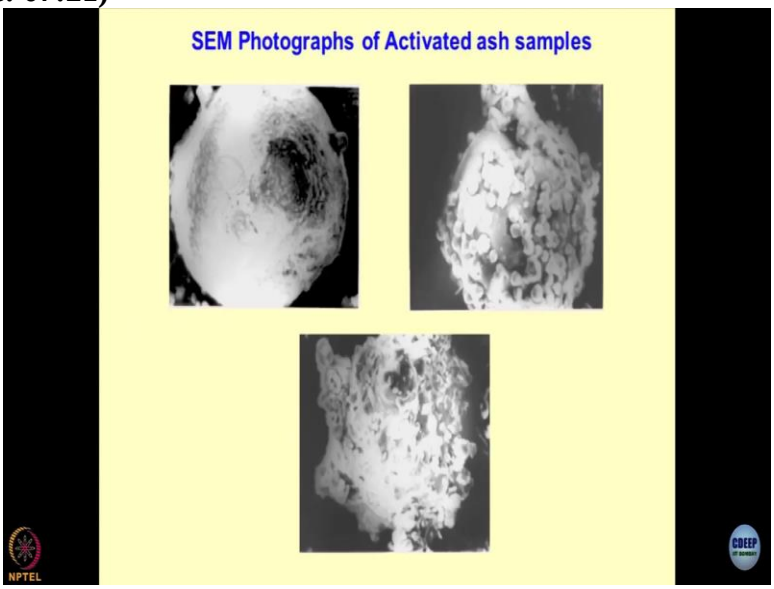

Then I started growing different types of minerals on the particles of quartz or the fly ash particles. So, what you are observing here is the culturing different types of minerals on the

surface of the quartz to make it more hyperactive. So, this was the work which was done by my students, Dr. Kolay, Dr. Nevin and Dr. Jha these are the guys were published at least 50,60 papers on zeolitization potential of fly ashes and their applications in environmental clearance. So, remember, when you are dealing with the quartz ball it is inert. But I have used quartz ball to create a different type of protrusions on the surface, which act as a sort of a filter, sieve molecular sieve we call them. Which will have a very high affinity towards cations so any cation when it comes in contact with these materials to extract over there, because of very high cationic exchange capacity and surface area. So, these type of systems are quite required in the modern industry particularly, when you valorize the fly ash, fly ash which how lying as an unused unattended material has been converted into a catalyst. And I can use this as a biofertilizer also.

Because tomorrow micronutrients and the bacteria and microbes will come in contact in these protrusions and they will live over there. So, imagine a soil which was earlier barren have rejuvenated. So, these are the concepts that people are trying to work on the industry. This is where the interesting ideas are in r and d and applications, read the papers by Bhagwanji Jha and there is a book also on zeolites and their industrial applications. And if you go to these papers, you will realize how the whole process is done. The bug in our mind was that the interaction of contaminants with soils is not inert.

And many times this interaction might alter the fundamental characteristics of the soils also, so this is what actually we wanted to show. Particularly in case of the nuclear industry, this type of consents are very useful where you are dealing with atomic waste of high toxicity, and it is a big challenge to dispose of the waste and isolate it from the geoenvironment. So, check the thesis which has been done by Dr. Ravi Linden Rakesh and Dr. Gurumoorthi. These are the guys who are sponsored by the atomic energy regulatory board of India and BARC.

And they have done wonderful work on nuclear waste disposal from different atomic power plants and how to isolate them from the environment. Hope you are getting me. I do not expect you to remember and learn everything. I am just trying to give exposure to what is being done and what has been done already. And we are heading to that is more important. Is this correct?

It is not that you should mug up and remember all this thing this is just maybe a different domain of activities of a geotechnical engineering profession. So, in which way the activated ash sample is different property wise first thing in the mineralogy, remember this itself is different here you do not have any zeolites in the original fly ash and once you have activated is you can create the zeolites of your liking. Only thing is you have to just regular the process.

So, if agriculture industries have contacting what type of zeolites you should produce. Engineering properties, Ya so, engineering properties if you read the paper which is written by Dr Kolay in Canadian geotechnical journal 2001. ASTM there we have talked about these type of systems have a tendency to retain water, and they become very fluffy specific gravity decreases because what you are doing is you are digesting silica by using sodium hydroxide all right.

So, they become different material which cannot be utilized for load-bearing, but it becomes an interesting material or application in environmental issues and leaving a solution to the environmental problems, cleanup programs, when you have mercury vapours, dioxins, very high concentration of cations. Their take up capacity while more if you put them in the soil, they will not allow anything to go out of them even if flooding takes place.

So, when you construct a dam, the biggest problem is soil becomes barren. I think we discussed this. The biggest issue is why people are against this construction of dams. It is not only the dislocation of the people the seepage lines. What do they do? They take out all the minerals from the soil as an exit gradient. So and waterlogging downstream. So when water-logging occurs, efflorescence takes place, and all the minerals get washed out from the side sensors become lighter.

So, if you want to rejuvenate all these types of things, you should have a metal which is hyperactive old, let things go out easy. There are several applications of this metal in modern-day medicine. I was dealing with some of the business all over the country where they are trying to create control drug delivery systems, where these things become the basic component. Most of the diarrheal medicines, anti-diarrheal medicines.

You use these type of systems where you inject a mineral in your spine which has a very high capacity soft water. So there are two ways of interpreting how one is to read and get how it has been done. Second is answer yourself if you have a question that if tomorrow somebody comes to you to create a technology, you take this question as a challenge and give them a solution so in an industry right now want the solution are you realizing this it.

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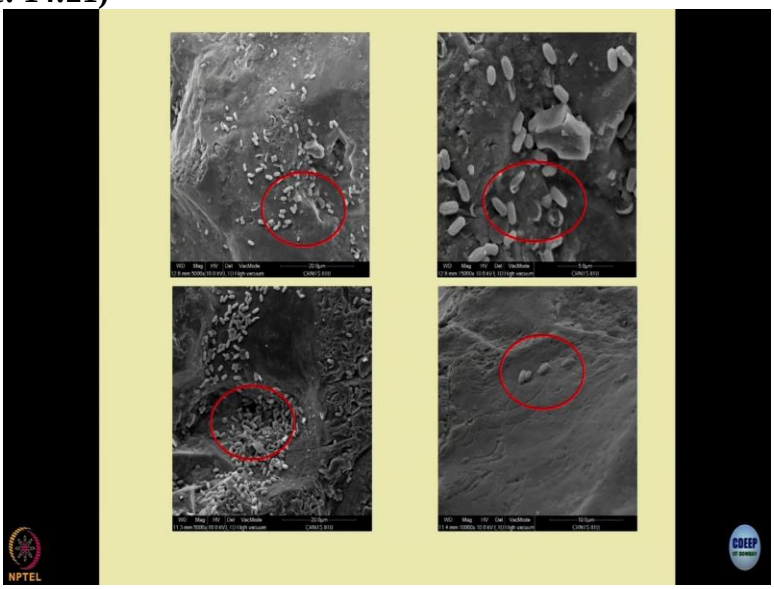

This is another example of how is scanning electron microscopy can be utilized to understand the surface features of the soils. You have these pictures taken up at different magnifications it is written over here 5000 times 10,000 times 15,000 times and what we are trying to show you that the sand which is supposed to be very passive contains a lot of bacteria on this and as one of the applications could be in designing the water filters.

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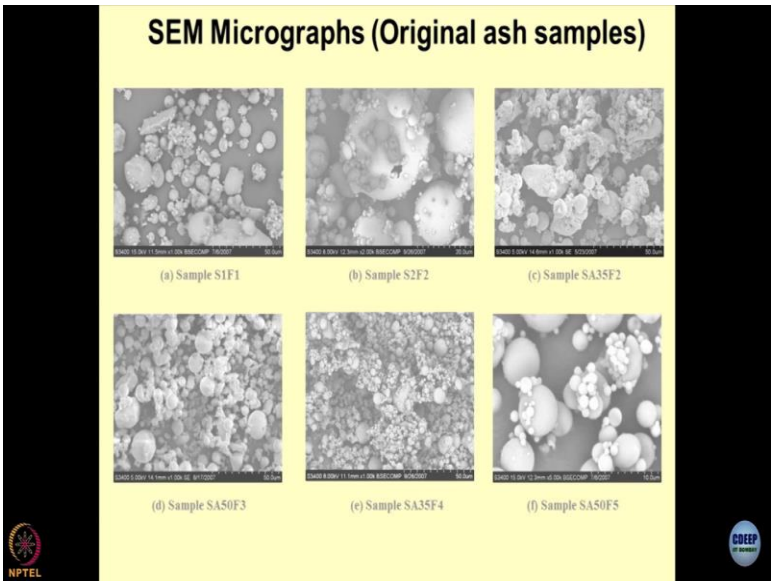

So if you look at another industrial process, which is known as is a dual flue gas conditioning, DFGC is known as dual fuel gas conditioning. This is normally done to trap the fine particles which are going out of the stacks at the thermal power plants, earlier days these bag filters are not designed or they were not available in the market. So, bad filters are the ones which are installed at the exit of the chimneys.

So, that they will collect dust particles and the dust particles will not get emitted into the environment. When you say the size of the particle which goes into the environment less than 1 PPM 2 PPM then there is an index also which most of the time people talk about when the case of Delhi is discussed, you must be aware of that particulate matter PM index. So at power plants because a lot of fine particles might go into the environment they nowadays installed dust collectors these are bag filters now bag filters material again come back into the stacks, and we will get deposited the chimneys.

Now, if you want to sell your fly ashes to different, let us say agricultural units. So, what we showed we have shown is that the flash particles which have been collected by giving treatment with the flue gas can be utilized as a good fertilizer. And this was a project which was sponsored by one of the consulting groups and one of my Ph D scholars Dr. Shantha Kumar worked on this. So, what you are observing here this also answers your questions Shrikanth that.

You are trying to grow different types of deposits on the particles. And what you observe is something which is very deco rational, and it has a lot of value in the ornaments. If you create this type of structure, they shine in the night because of their efflorescence this is all calcium deposits or it could be sodium sulfate which is coming out of the soils. So, what I am trying to show you here is that depending upon the requirement, you can create a solution.

So, here the objective was how to create a situation where the fine dust particles which are going out of the stacks of the thermal power plants can be collected, number 1 without bag filters, number 2, whatever gets collected, what to do with that, can this we used as a resource material so the answer was yes this material can be utilized as good manure. So, we created a sellability for this material sellability in the market.

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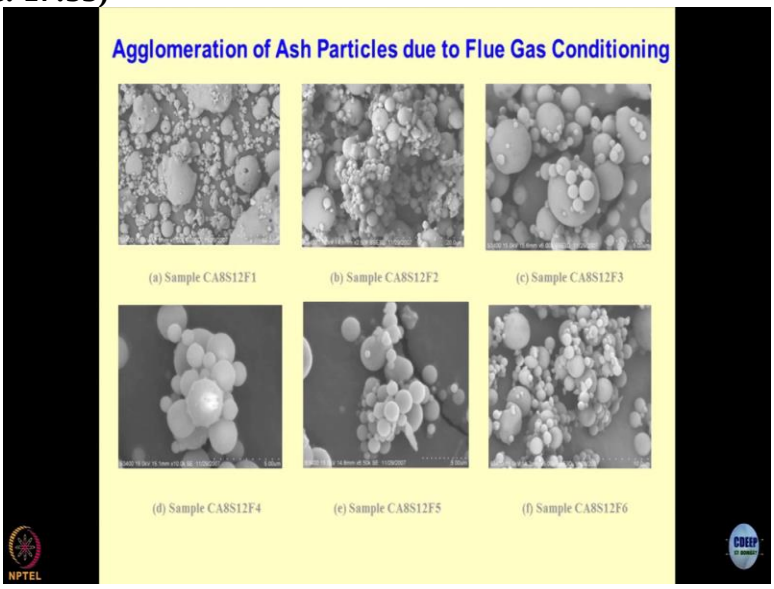

These slides also show the importance of scanning probe microscopy in advance geotechnical and environmental geomechanics. Some more examples of how agglomeration of the ash particles can be done in conventional geomechanics you use the deflocculating agent as sodium hex metaphosphate to deflocculate the system here I want to create flocs so that the emissions in the environment reduce. So, now, you can see by injecting ammonia gas, I can create deposition of ammonium sulfate on the particles, and this is how the agglomeration looks like.

So, they inject ammonia; sometimes they inject sulfur dioxide sometimes they inject carbon dioxide sometimes they inject water flumes in there they describe the particles with water, a lot

of techniques which are being used, I mean, you should realize the boundary-less approach in geotechnical engineering. That is what I always say. All of you have studied this stokes law and suspension depositing in the water column. And my mind is to say that why cannot we do this in a column of flue gas in which the particles are settling down, so this started. Abstract thinking makes your research more interesting.

And then you create a requirement in the market by doing R and D and showing to the rest of the world that what you are thinking is correct. So most of our projects are like this. Where we create value out of a material. And then we create a situation where industries get attracted towards research, and they fund them funders, and then this is how the whole system price. You mentioned that you use those fine particles as many of farming does that affect the population of groundwater.

so imagine them the surface area and increased cation exchange capacity has increased in case of extreme desert conditions also you can grow the plants because as I said these material have a high affinity towards moisture will not let moisture go out so that means throughout the year you can have welting point maintained. Which plants can use to survive themselves? So, this was very revolutionary thinking; otherwise, sands alone cannot sustain the plants in extreme climatic conditions in deserts. And then comes, Of course, the first thing is creating material, and then mechanics of this material suppose if I have to create a filter bed out of this.

As she was asking, we wanted to do some experiments to show how plants growth can be controlled by using this type of concepts. I mean, you will be surprised to know that all these types of systems that are very much useful for poultries, where you have a lot of foul smell in poultry and aquaculture and fish culture, these things are becoming a pool because they have a tendency to solve foul gases H_2S particularly as the animals and birds do not fall sick so there are a lot of applications.