Environmental Geotechnics
Prof. D. N. Singh
Department of Civil Engineering
Indian Institute of Technology, Bombay

Lecture – 17
Municipal and Industrial solid waste

(Refer Slide Time: 00:15)

These are the examples of municipal waste; compost, compost is nothing but a manure, how it is formed?

Student: The decomposition of organic waste (Refer Time: 00:29).

Decomposition of organic waste, any example? Not cow dung basically.

Student: (Refer Time: 00:35).

Not cow dung basically

Student: (Refer Time: 00:37) Basically it is waste vegetables.

It has to be leaves, vegetables, bio organisms and how do you form compost? Any one does garden here? You do? Have you ever formed compost in your garden?

Student: Basically (Refer Time: 00:57).

That is right.

Well, this is a miniature landfill. So, what you do in a big mill landfill is the same activity at a larger scale, which you are doing in your kitchen garden. The whole idea is to degrade the waste and by degradation what is that you are achieving? You are lowering the volume of the waste which has been created.

So, one agenda which is in the mind is when you deal with waste management issues; that how to reduce the volume of the waste which is coming out of the industries clear. So, it is a good example compost; in IIT; I think we are adopting this technique. So, you might have seen people in the morning they keep on brooming in the roads and they collect leaves and all. So, ultimately where do they throw all the leaves? So, they collect it and they dump it somewhere, where they produce lot of manure for the entire campus. Scrap tires; what is meant by scrap tires?

Student: Used tires.

Used tires. So, India is becoming a major market for car companies. So, apart from traffic congestion what is the biggest threat?

Student: Disposal.

Disposal of?

Student: Tires.

Tires. So, every third year or fourth year when you go for servicing of the car; they say you change the tires. So, it is easy to say change the tires, but ultimately where you are going to dump these tires? So, this is where scrap tires becomes very important and most of the geotechnical engineers have you know got some good answers to this problems. Any guess what they are doing with this? See, I am not in favour of distracting the matrix of the soil first, adding something and recompacting it. So, those who belong to this school of thought; they should be careful.

See natural soil is the more stable condition of the soil clear, then the issue is you may dig out the soil, but where you are going to keep it in a city like Bombay, where there is

no place to even to keep the soil by digging it out of the pit. How you are going to mix something into it?

And in the larger interest you will see in my subsequent discussions that have been used by people in making embankments, roads, mastic asphalt and so on, shaded asphalt you know. They mix asphalt and scrap tire chips; I will demonstrate to you one of the methodologies of using this scrap tires for making pavements; in next class or may be today's lecture depending upon the time. So, scrap tires are becoming a very big issue; I will discuss about this; used oil.

Student: Engine oils.

Engine oils, that is right. So, most of the car companies they are very particular that the engine oil should be changed every 6 months; did you ever ask your automobile dealer that why it should be done and ultimately what do you do with this oil? You should ask next time.

Sir, basically the friction is generated the oil; the oil lubricates; it it is a its acts as a cooling down and using it again and again the lubrication property of oil decreases; so they say that change the oil.

It is a big technology and a million-dollar industry, you know this? It is not so easy to talk about what engine oil does to the engine. As I understand whatever you have said is ok, if you go in to the too much technicalities engine oil should stop the abrasion of cylinders; so, it should be anti-abrasion. Second thing is it should be thermally stable it should lower down the temperature otherwise what will happen the engine cylinders themselves will get corroded.

So, it is a big science and you say like we visited one industry in Bombay and the fellow says that he is the only one in Asia I suppose who produces engine oil. And the type of waste which is generating we are trying to utilize it somewhere else; we are trying to study the property of that waste. If you get some time we may plan and visit there; specifically, the industry which produces 2-T for the engines. Apart from engine oils what type of oils you can think of?

Student: (Refer Time: 05:56).

Sorry?

That is not very severe.

I think good example should be transformer oil which is a big challenge because of oil after certain time becomes spent to oil; that mean is dielectric constant keeps on changing the more and more it you use it. So, it will never behave like a insulator unless you recycle it, clean it of you know process it.

So, the more and more civilization is taking place; what is happening? The society is producing more and more scrap tires, more and more used oil ultimately where you are going to throw it? Where you are going to stock it? How you are going to recycle it? How you are going to clean it? So, these are becoming you know very important challenges; you may take some seminar topics from today's discussions.

Sewage sludge, I think somebody was talking about this sludge which comes out of; I think Sneha was talking about this sewage sludge. Yes, this is also one of the types of municipal waste; water treatment sludge; purification of the sludge which comes out of the water treatment plants. So, these are of low hazardasity; again, the question is you use the word low and high and medium; what is the scale clear? So, as on date there is no scale as such where you can define; what is meant by low high and medium of course, these are all abstract thinking.

But the idea is simple that their intensity is not much.

(Refer Slide Time: 07:51)

Well, as you can make out from the list of industrial non hazardous waste; coal ash that is the fly ash or bottom ash. Some people classify coal ash as non-hazardous, some may classify it as hazardous what should be the difference between the two? As you said rightly that it is airborne it gets airborne and then it may cause carcinogenic effects. You know if you breathe in your lungs may get affected, there could be lot of loss of visibility in the neighbourhood, it could form a dust and so on.

But suppose if I say its non-hazardous; have you heard of TCLP test? In your environmental engineering courses, did they talk about TCLP? No. So, it is a test basically which talks about how much concentration of a contaminant will leach out of a material. So, based on the leachability of the material; we can also classify this as a hazardous and non-hazardous. So, these things we will study slightly later. So, based on toxicity that means the amount of toxic elements which are associated with the waste, hazardicity; the amount of hazardous material which are associated with the wastes and so on.

If your coal ashes are not leaching, when they come in contact with water; that means, no heavy metals are leaching out of the waste matrix; it is non-hazardous. But if the ash has a tendency to leach different metal ions, it becomes hazardous and toxic. So, what is the difference between hazardicity and toxicity? If I take certain concentration of a contaminant; clear, it could be highly toxic. If I dilute it, it becomes less toxic; if I keep

on diluting it, it becomes less toxic very less toxic, if I further dilute it; what happens? It become non-toxic; you got this point?

So, basically depending upon the concentration of the toxic materials which are present in the system; you may say whether it is toxic, hazardous or toxic; non-hazardous not possible because toxicity is available is already associated. So, toxicity itself is hazardous, but its magnitude depends upon the concentration of the waste. So, this philosophy basically helps you in designing the code of conduct for the society and for different countries.

You got the idea? So, based on this concept certain industrial process whether it is going to be toxic or non-hazardous, hazardous is going to be determined. Most of the ferrous and non-ferrous slags are under the category of non-hazardous waste. So, when we are talking about non-hazardicity of the waste; can you think of a situation where you would like to use it? When we are saying that certain wastes are non-hazardous where can we use them GGBFS?

Student: GGBFS.

So, they may go either in construction or as the foundation material or as a fill material that is right, but if your ash is active. And if it is going to interact by any chance with the ground water or the rain water, then you cannot take this chance.

So, based on this consideration; you can use the material at the appropriate place. This is a very big concern particularly when you talk about application of fly ash for mine closures. So, if ash is reacting with water and if leachability is very high, you cannot use it for filling the mines, but if it is a passive material; there is no harm.

So, based on this concept; Government of India had come up with some regulations that every power plant requires coal. So, there was a sort of condition that we will buy coal from a mine, when you buy the coal, but the ash which is getting produced should be taken back to the mine and the mine should be filled up clear? So, this has become now a code of compliance. So, this is how the codes are formed; related to activities which may cause enough toxicity or hazard city in the environment; is this part clear?

The third applications third example is reclaimed paving materials; mostly construction materials which are used as a paving material, WBM mostly. Construction and demolition debris, I think we have talked about this in the earlier lecture in city like Bombay or all metros mega cities; the biggest challenge is every now and then you have to go for reconstruction of the buildings. So, the biggest issue is where to throw the demolition or the construction debris. By the way the road connecting to eastern express highway and LBS Marg; this was done based on the construction debris only.

So, 2000; I think they started dumping debris on both the sides of the roads. So, where you fly off right now, is nothing but the foundations are laid with construction and demolition debris. They have consolidated over the period of time 2, 3 years, 4 years and now they have constructed the whole pavement over it; earlier it was nothing but a marshy land.

Cement and lime kiln dusts, again you can use this as a construction material part replacement of construction material; which are normally used in concrete; sulphates any example of sulphate which comes to your mind which is very challenging sorry.

Student: Phosphogypsum.

Phosphogypsum; phosphogypsum is a good example of the type of sulphates which you talk about is it not? So, sulphuric acid and then it comes in contact with calcium sulphates; sulphur trioxide fumes have to be captured so that they do not go into the environment. So, this is where you create the enough phosphogypsum.

Phosphogypsum is also a very hot topic for research in environmental geotechnology; foundry, ceramic, silica fumes; we have talked about silica fumes earlier. So, silica fume is nothing but a sort of a by-product which comes out of these industries; which are manufacturing what? Sorry, alumina; it is a misnomer when you say silica fume; it is truly a misnomer which is associated with aluminium industry. Dredged material; we are involved with a project right now, we are doing it for JNPT, where JNPT has asked us to study the properties of the material which can be used for reclaiming land from the sea.

When we talk about reclaiming lands; suppose say 200 hectares which has to be reclaim from the sea so that one more terminal for the ships can be generated. This is becoming a very good subject in geotechnical engineering; reclamation of land particularly when you

go to Singapore or some other Norwegian countries, where land is scares Japan, Malaysia, Indonesia. So, this is where this industry is flourishing a lot; it has very good scope for people who want to do something new.

So, the biggest question is when you; why do you do dredging; are you aware of what is dredging activity?

Student: Sir, we excavate inside the sea, we take a material and we dump it at the one place to have another land (Refer Time: 17:03).

This is a very old school of thought; now a days as I said you do any activity as long as you are not hampering other's freedom you know it is ok. But when the moment you say I will dredge something here and I will dump it somewhere; the question is where you are going to dump it? Who is going to allow you to do that? So, if you have been reading the newspaper The Victoria Docks at Bombay port trust; it is a huge land, which is abandoned right now.

So, the biggest question is that what to do with this land which is in the heart of the city and the cost of that land would be few thousands of crores of rupees. So, this is where the geotechnical engineering is involved. So, what type of solutions you are going to give to the society related to these activities. Now coming back to the dredging aspect, the challenge is that dredging is nothing but taking out something from somewhere.

So, if you want to deepen rivers; what do you do? You remove the sand; you might have seen sand being dredged on the Dharamatar creek or some other rivers in your localities. At a bigger level this activity is done the sea; why? It could be maintenance dredging where you want to maintain every year you have to clean the channels so, that the ships can come up to the port.

Otherwise think of a situation where the entire siltation takes place and no ship can enter your port and your countries economy is going to affected; it is a big issue. So, next time when you go to Elephanta Caves; just look at your left-hand side where the JNPT is Jawaharlal Nehru port trust.

So, they spend huge amount of money just for maintaining their channels; the way you maintain your channels seepage channels in your houses; everyday you clean it why? So,

the logic is same, otherwise too much of siltation will take place and water will not drain out. So, there the effect is; if siltation will take place ships cannot come inside the port and economy gets hampered.

The second is intentional dredging; intentional dredging is nothing but sort of a creating something out of the material which you are dredging from the sea; reclamation. So, this is where the geotechnics of dredging comes in to the picture; a very interesting topic on which nowadays some people are working is beach nourishment. So, overnight you can create beaches. You have not heard this earlier?

Student: Sir, palm island is created like this.

That is right.

World islands and palm islands; these are good examples of the dredging process. So, you dredge the sand from the sea and then create islands and what is the cost of these islands? So anyway, so this is becoming a very good you know subject in geotechnical engineering, where some of you may concentrate later on. My idea is to give you as much as information possible and whatever I know a bit.

So, then comes minerals; mineral extraction process. So, you do waste rocks which are nothing but mill tailings, tailings. So, mill you know what is milling process? Milling process is nothing but the extraction of metals from the ores and whatever is the residue has to be disposed off and pile up. So, this becomes a good case of mill tailings; sometime they call it as tills also t i l l s; tills. Coal refuse, so one project which I did I would like to show you how we tackle this type of situation at Korba.

The washery rejects; what are washery rejects? This is the washing of coal. So, there is a big project going on at most of the coal mines; where whatever coal comes out has to be cleaned, washed, segregated and then only it can be sent for a proper use. So, the biggest challenge is how to use these wastes or the rejects which are coming out of the mining process of coal for some important purpose; phosphogypsum.

We talked about this under the category of the sulphates; you know all acids can be nullified when you treat them with calcium carbonate. But then whatever is the residue is calcium sulphate and calcium sulphate, where you are going to dispose and how you are

going to dispose is a big challenge. So, this is where phosphogypsum becomes important when you process sulphuric acid, phosphoric acid, phosphorus and so on.

Agriculture itself is an industry now a days; so animal manure becomes non-hazardous waste. Crops different type of crops and the stocks of the trees particularly and the wood; some other categories are organic and liquid waste, solid waste combustion residues; incineration process whenever you adopt whatever is left over, again requires some special treatment or a special attention of people; how to dispose it off.

Reclaimed plastic; why there is a ban on reclamation sorry recycling of plastic? That is a different issue altogether; why recycling of plastic is banned? Yes, please.

Student: release of toxic gases

That is right, that is correct sulphur trioxide. So, whenever you incinerate plastic or recycle plastic; basically, it is a PVC chain.

Polyvinyl chloride chain, so when you break it; you require lot of energy. So, the first question is from where you are going to bring so much energy? Because this is economical or not and second issue is when you are breaking these bonds; lot of sulphur trioxide goes into the environment.

And the waste glass, waste glass also is attaining lot of attention of people particularly from geotechnical engineering fraternity. I gave you an example of beach nourishment; sometime they call it as beach recreation also; you may recreate beaches you know wherever sands are less. So, a good example is our society is producing lot of waste glass; most of the drinks, juices you know, utility items they are contained in glass. So, the question is once you have used it you simply throw it.

Now, if you crush this glass; it becomes sand and that sand can be used for nourishment of beaches and recreation of beaches. I will give you one example where this type of work has been done. So, this is again interesting process; one of you should adopt this as a you know business. We need more entrepreneurs in our subject now, lot of work is required to be done in these areas; you can do very well in life.