**Environmental Geotechnics**
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**Lecture - 18**
**Introduction non-hazardous & Hazardous wastes**

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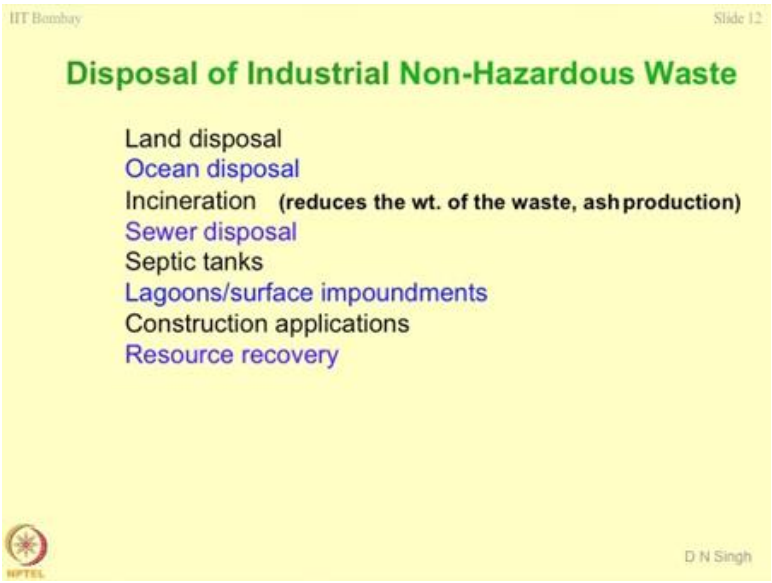


Now, the question is where do you dispose the industrial non-hazardous wastes? Somebody was talking about disposal of radioactive waste in ocean; completely don't talk about this at all. The first is land disposal, just throw it on the ground and forget about it which most of us are doing. Ocean disposal well there was a situation where this was being adopted, a better way would be encapsulate the waste in a matrix of concrete and those concrete units can be disposed of in some water body.

But this also has been stopped particularly because of lot of environmentalist and the people who are more concerned about the aquatic life. Most of the projects where reclamation is involved they all go through litigation; why? You are disturbing the complete ecology and synergy of that locality. So, there is a very strong group of people who is against this type of development in the country. Incineration that is you reduce the weight of the waste, volume of the waste and another problem is you come generate lot of ash, sewer disposal is becoming a very big issue. What is the difference between Powai lake and Vihar lake?

Student: The Powai lake is a oxidation pond and Vihar lake is drinking water lake.

Well 20 percent of the answer is correct, but you are not sure that which site is correct.

Student: Sir Powai lake and Vihar lake is drinking water (Refer Time: 01:58).

What I understand and what I know is that Powai lake is a non drinkable water, is not portable water while Vihar lake water is being used for supply of water to the entire city. So, yes, your guess is correct, that is what I said 20 percent you are right. Oxidation ponds are particularly whenever you fly over, whenever you are landing in Bombay then you can see next time when you come to Vashi creek and then you start looking down you can see the variation ponds or the lagoons at Mulund, Bhandup, Ghatkopar they are the good example of aeration ponds for the entire city.

Before disposing the sludge in the sea, they are treating it there and then slowly and slowly the discharge the sludge in to the sea. Lagoons we are talking about, these are the same lagoons surface impoundments. So, this also becoming a very big issue in geotechnical engineering, how to design lagoons you know; what are lagoons? Just now I give an example.

Student: oxidation ponds

Oxidation ponds are sort of a lagoons; lagoons are nothing but a structure is a open structure having some sort of an impoundment or retainment. So, you make these small embankments so there water can be stored. So, a salt pan lagoon is the one where salt is being produced, if you are using this land for aeration of sludge it becomes aeration lagoon our surface impoundments. So, wherever you are impounding this sludge on the surface construction applications debris and so on and then ultimately the resource recovery becomes a very important issue.

How would you recover the precious metals or the material out of it? Some time back there was a philosophy that radioactive waste can be stored in a space. So, some countries tried that also, you contain the entire waste in a satellite in a rocket and just throw it up. So, lot of people have tried that in fact, but now there is a international agency which monitors the activities associated with atomic energy and its regulation all over the world, which is known as IAEA International Atomic Energy Agency.

So, all the countries have to comply with the norms and the regulation which have been created by them and if you don't comply you know what happens. Any example which comes to your mind? Iraq war, NPTs the issues are you know at a very different level. If you don't comply this is what is going to happen.

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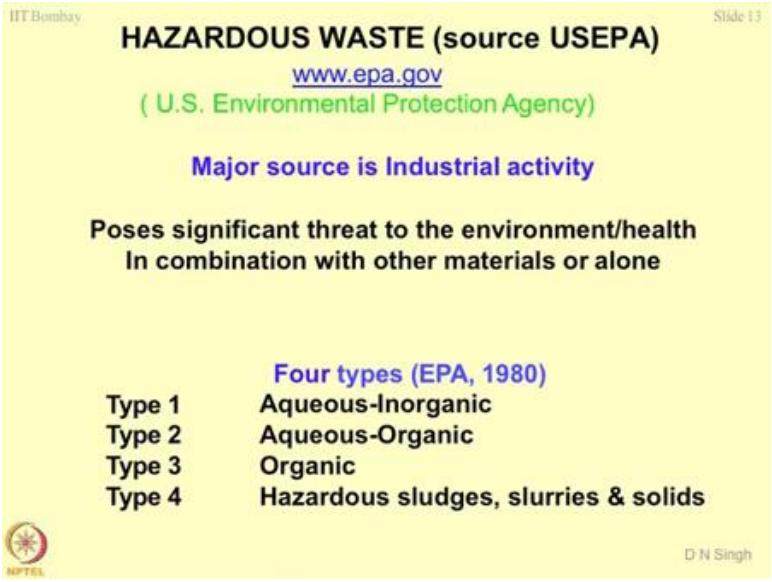


Let us talk about hazardous waste as per the US EPA that is United States Environmental Protection Agency, their website is www dot epa dot gov. So, which classifies most of the industrial activities as the main source of generation of hazardous wastes and this type of waste pose a significant threat to the environment and health in combination with other materials or alone. So, as per EPA; what is EPA? Environmental Protection Agency and in 1980 they came up with four classification schemes, the type 1 is aqueous-inorganic, type 2 is aqueous-organic, type 3 is organic and type 4 is hazardous sludge, slurries and solids.

So, this is the classification scheme which has been used for defining hazardous waste. Aqueous word is more important because otherwise it will be in a passive form. So, if you remove this aqueous form then this waste has to interact with water to become active, but organic substance does not require any liquid phase, this itself will be quite active and most of the sludges, slurries and the solids which are contained in these sludges are classified in type 4.

So, which one will be more you know intensive, type 1 or type 4? The order of activity should be increasing from 1 to 4 or should be decreasing from 1 to 4, doesn't matter what is your guess increasing order or you will have no idea. So, aqueous inorganic substance would be passive or active. Just read EPA 1980 and then find out; so this assignment for all of you.

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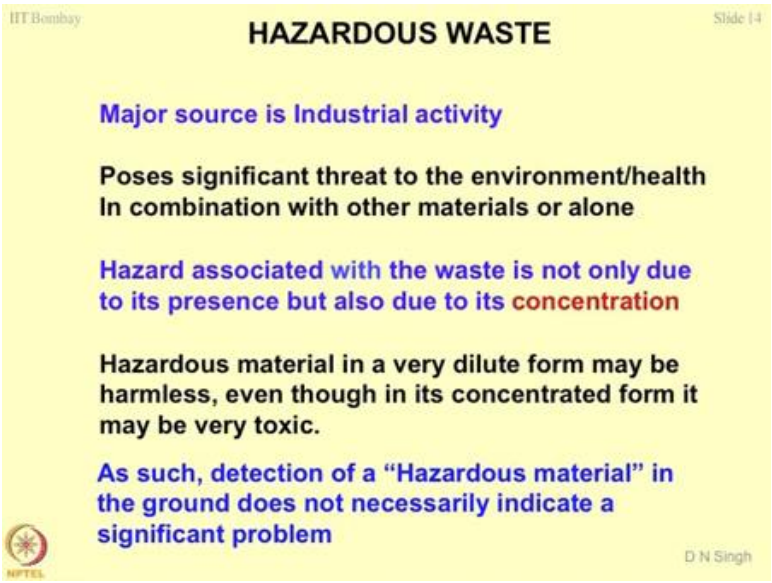


So, as we understood by this time that most of the hazardous wastes are coming out of the industrial activity, they pose significant threat to the environment health and combination with other materials or alone. Now, what is the meaning of this hazard? This hazard is associated with the waste is not only due to its presence, but also due to its concentration.

So, hazardous material in a very dilute form may be harmless, even though in its concentrated form it may be very toxics. So, this is the relationship between toxic and hazardous behaviour or toxicity and hazardicity, as such detection of a hazardous material in the ground does not necessarily indicate a significant problem. So, most of the time people are unnecessarily worried so the this is the catch that in a very dilute form it may be harmless, even though in its concentrated form it may be very toxic. So, that is why the best policy of disposal of waste is dilution.

But you have to very careful from where you are going to bring water, water itself is becoming a very big scarcity is it not. So, there is no water available now and your

generations definitely will face this. So, never underestimate water now. So, this is a very big problem. So, this is your recycling of water, rainwater harvesting and all those philosophies have you know come up.

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What are the sources of hazardous wastes? The first is nuclear power plants, the second is municipal solid waste landfills, but remember we need more and more nuclear power nowadays; is it not? That is how the might of the nation is being decided. So, now, we are in which group? India; G 7 G 9 or what? We are joined a league of groups you know league of nations and on what basis?

Check it out; G 11 just check out. So, this is where actually the whole country is now, you know on a cross road. We experiment a lot with thermal power, there was a time when everybody was talking about hydral power, but hydral power pose lot of challenges, it was very difficult. There was so many dams which are constructed in the river valleys in the hilly terrains and all, then people switched over to power plants, thermal power plants you know the problems associated with every thermal power plant.

They produce electricity definitely, but they produce lot of other things which are unwanted and the amount of land which is required. So, this is where actually lot of discussions were going on whether India it should go totally thermal power based or nuclear power based. So, if you want to be called as a developed nation the ideal situation should be that they should not be any thermal power plant in the country.

The entire electricity and power should be generated from nuclear power plants and that is where your role becomes very important, physicists will do this; reactor scientists will do that, but who is going to tackle the by-product that is your most of the geotechnical engineers are required. The second situation is Municipal Solid Waste Landfills MSW Landfills; chemical and primary metal industries. The Ankaleshwar in Gujarat is an example of how chemical industries have polluted the entire city and the entire region, Ankaleshwar is famous for most of the pharmaceutical companies.

Student: ONGC.

ONGC, earlier it was it was a hub of ONGC, but now it is known for some bad reasons and one of the reasons says that the soil, water is heavily polluted. Most of the chemical industries and pharmaceutical industries are located in Ankaleshwar, ONGCs in Mehsana by the way not Ankaleshwar.

Student: Sir oil wells are there.

Another culprit is paint and dye manufacturing industries, zinc and lead tin which is integral part of the paint and dye; anybody in the class from Jaipur or Rajasthan? You might have heard some time back that there was a ban on one industry which is very famous at in Jaipur; Jaipur was known for something. Marbles; apart from that there was a Jaipur print you know they used to use a dye and they used to make those bed sheets particularly. And because of this dye industry what happened to the water of the entire city? So, ultimately this was shifted out of Jaipur that and dye industry is dead no more.

Because of the dye manufacturing industries and the you know subsidiary units associated with this process of dying, most of the mining industries they are associated with the hazardous wastes. We were talking about acid mines that again is hazardous could be toxic also, but you think of the situation where most of the minerals have been taken out and heavy metals leached from them. So, this is where the mining industries and of course, milling, mining, milling tailings and the mineral tailings are also attributing allot to this problem.

Paper and pulp industries, we have talked about what are the issues associated with paper and pulp. Bhadrachalam area is famous for this and in North India Roorkee at place

Nepanagar and Roorkee area is quite famous for this, another culprit is battery and fuel cell industry.

So, present a society is now migrating from electricity to batteries. So, what is a component associated battery manufacturing which is highly toxic and hazardous, what is the name of the batteries which we use in most of your electronic devices.

Student: Nickel cadmium

Nickel cadmium.

Student: Nickel cadmium.

Nickel cadmium is the biggest culprit and electronic circuits zinc, mercury. So, battery and fuel cell industry. So, they cause too much of hazard city to the environment. Leather industry, Kanpur is famous for this and in South India Mysore, lot of tannin is produced out of this which was being disposed of in the river and the free water bodies.

Electroplating is another example of the hazardous waste generation or the source of hazardous waste generation, lot of acids are employed in electroplating process and lot of ah heavy metals you know are thrown directly into the form of the spent fuels, spent electrolytes. It can be a good research topic particularly those of you who are interested like whenever you do electroplating what is that you utilize say suppose if you are doing silver or iron, sorry silver or let us say gold electroplating.

So, from the solution you are recovering all silver ions and gold ions and what is remaining in the solution in the form of spend irons is chlorides. Now, when you are going to throw them? So, truly speaking the entire area becomes heavily contaminated with chlorides, and textile industries which is supposed to be quite hazardous wastes because they use heavily either the cleaning process, starch and you know coloring process. So, these are the sources of the hazardous wastes.

And last but not the least which is becoming very significant now a days is hospitals and pharmaceutical companies, see the requirement of present-day society is that everybody wants to live close to the hospitals; is it not? And without realizing that what will be the consequences having hospitals next to your door. So, this is becoming big challenge the

hospital waste which could be of bio in nature, biowaste how to tackle it and most of the pharmaceutical companies the type of waste which they are producing.

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So, some of the examples are heavy metal and the non-biodegradable synthetic organics and you do not have to remember all this is just for your general knowledge like lead is in dioxin, mercury is in DDT, arsenic kepone, cadmium mirex, these are all compounds tin PCB boards. Zinc is in carbon tetrachloride, chromium benzene, copper chloroform, beryllium and strontium PVC. So, I do not know whether you might have read this or not, people where debating whether to use a certain what you say certain brand of shoes and chappals. Did you hear this case? Some 7, 8, 10 years back it was in very hot debate, where the rubble soles leach out lot of, they are made up of PVC, is it not?

So, they will leach out beryllium strontium which are not good for a skin. Few years back there was a case where there was a ban on toys from certain country. So why? Because in most of the polymers you have these heavy metals and which kids have a tendency to chew or to come in contact with directly; so that is why there was a ban. So, every where the use the word leaching and anything which gets dissociated very easily from the waste form and it is free to get consumed either directly or indirectly alright.

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So, this I thought I will give you an example of NTPC Korba, this is the power plant from a distance and this is a railway line. When you go to Korba you will be passing through this. You will find lot of mountains over here. Now which geological formation is this? You are from nearby area and you are a geologist by profession.

Student: Coal.

Sorry.

Student: Coal.

Coal any other guess? So, let me give a hint, let me ask a question whether this is manmade or this is natural.

Student: Manmade.

This is manmade, which looks like hill ok. This is the over burden which has been dumped and lot of hills have been created in this region, near Raipur, Korba and all that belt, western coal fields are there alright. So, the more you dig out coal the more these types of mountains are going to be created, these are pure human activity.

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From a near distance looks like this; so, these are the mounds of the over burden. Over burden is nothing but the top soil which has to be removed before you dig the coal from the mines and it may range from 2 meters to 3 meters to 4 meters depending upon your luck and depending upon the circumstances. So, in order to get certain amount of coal you have to remove that top soil and that volume could be of this magnitude.

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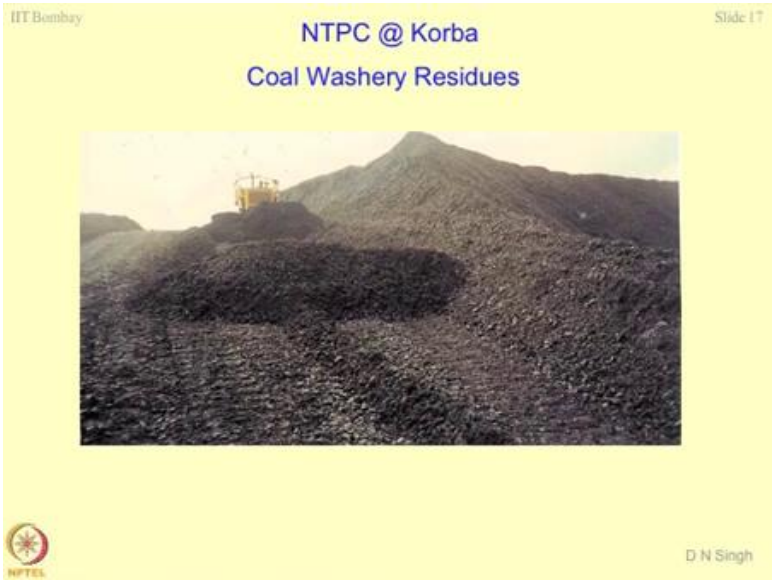

So, these guys approached us and basically these are coal washery residues, look at this. So, whatever coal cannot be used in any form has to be stacked like this. So, there was a question that can we use this material for some good applications, we did this project.

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So, this is the open cast mine alright, where they keep on removing the coal from the ground. This is another view of the mine you can see this much of the soil or the coal has already been removed and then this is how you keep on going deep up to almost 7-8 meters. During rains the water gets accumulated here and becomes a ideal candidate for acid mine drainage. So, the entire area has a big water scarcity first of all and second thing is whatever water is present is all contaminated with sulphuric acid and what not. So, those who are staying is here they are having a very tough time.

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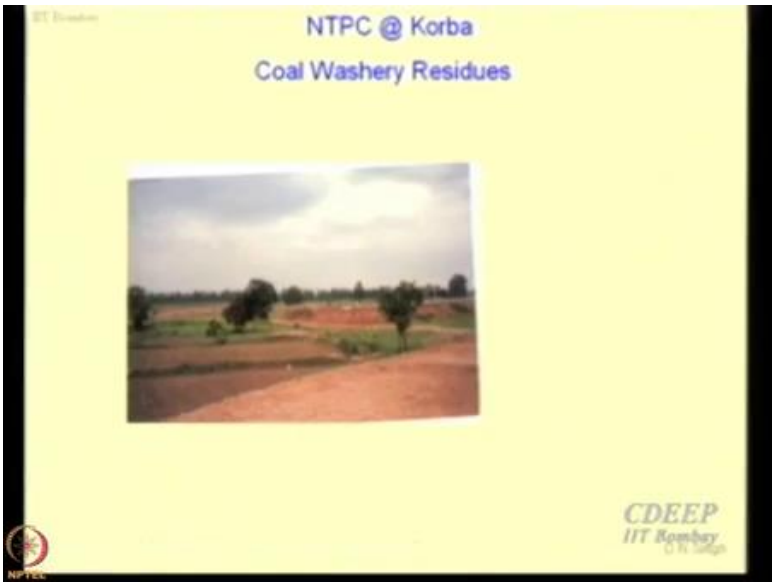


So, the immediate application of this residues was to railways wanted to have sidings and railway you know platforms for carrying the coal from the mines and then dumping it. So, this is one piece of the land, this is one piece of the land and the there was a valley in between and this depth was almost 20 meters, does not look like because I did not take a good photograph somehow, but it is almost more than a kilometer long and 20-meter-deep maximum.

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So, this is another view of how coal is being taken out from the mines and on the side, you can see the coal residues which are of no use and they require some immediate.

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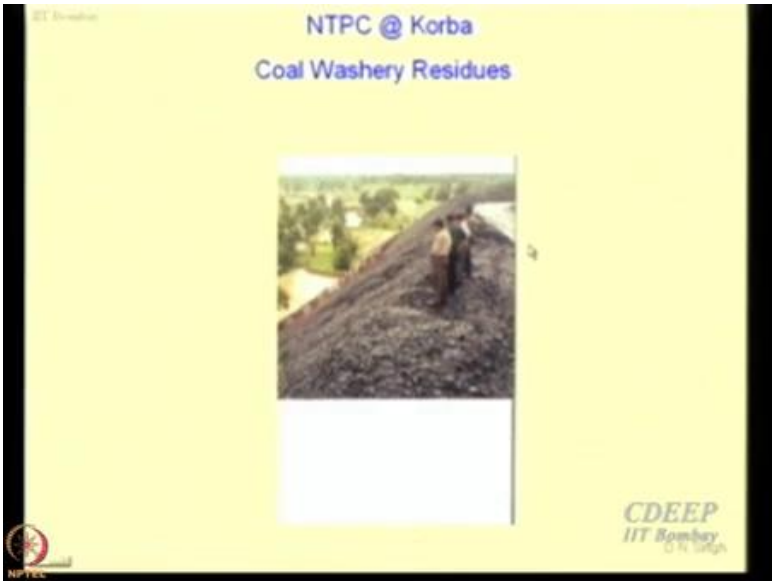


Now, this is the scenario. So, this is one of the mounds on which we are standing and you can see the ground how deep it is and there is a road in fact on this mound which has been done.

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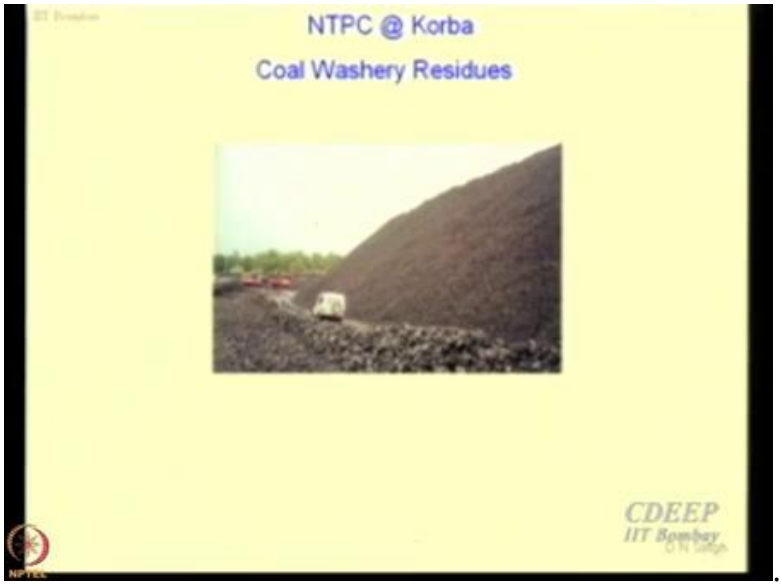

So, this is another view of the coal residues, this is from 1 mine remember, there are may be at least 50-60 mines which are legal, legal mines are about 50-60. So, this height would be about 40 meters.

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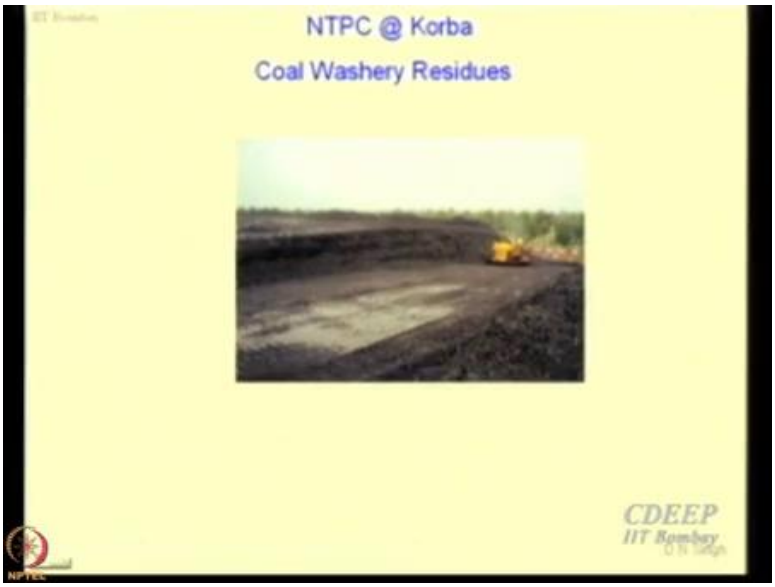


This is how the contractor makes the roads. So, that the further level of dumping can be done and the mounts are increasing day by day. So, now you can put your geotechnical engineering concepts earthquake, rain fall instability. So, all it is a very good place to study geotechnical engineering. So, rains take place, the water goes in to the washery coal residues it leaches out and so on alright.

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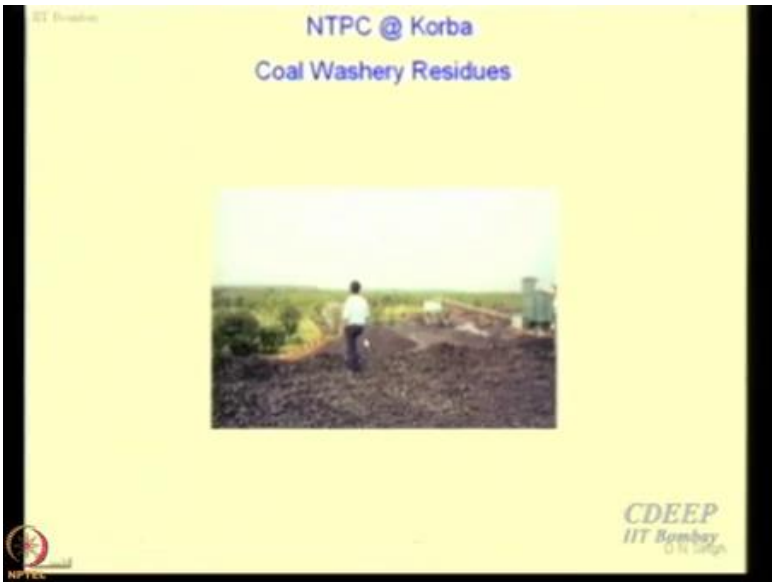


So, this is another and this is Dr. Naidu, he is standing he has gone along with me and you can see the entire area, these are the mounds you can see in the background of the coal residues ok. So, they are quite high in height about 40-50 meters these are manmade mountains.

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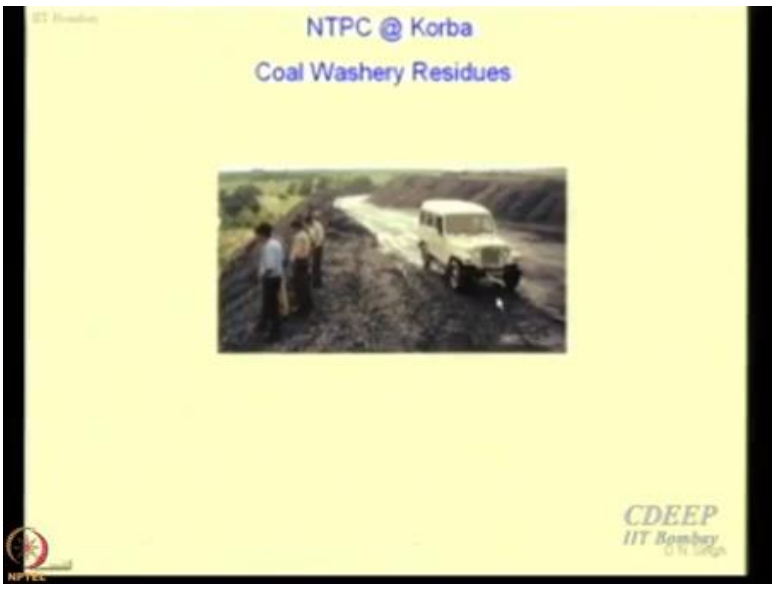


Is another view of the portion where you can very easily approachable with the help of a car.

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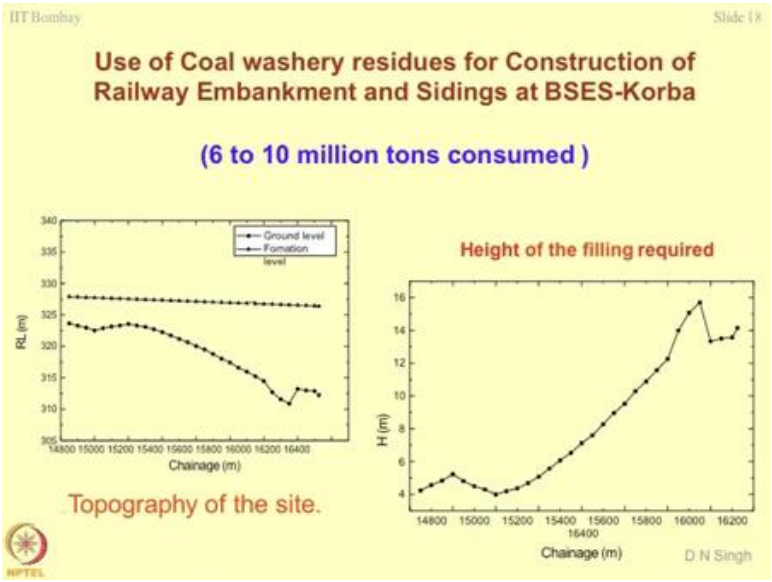


So, this is how 6 to 10 million tones of the coal residuals was used for making one embankment, and the height of the embankment was almost 16 meter 20 meter depending upon the different changes, this is the topography of the site you have RL in terms of the ground level and in terms of the formation of the level.

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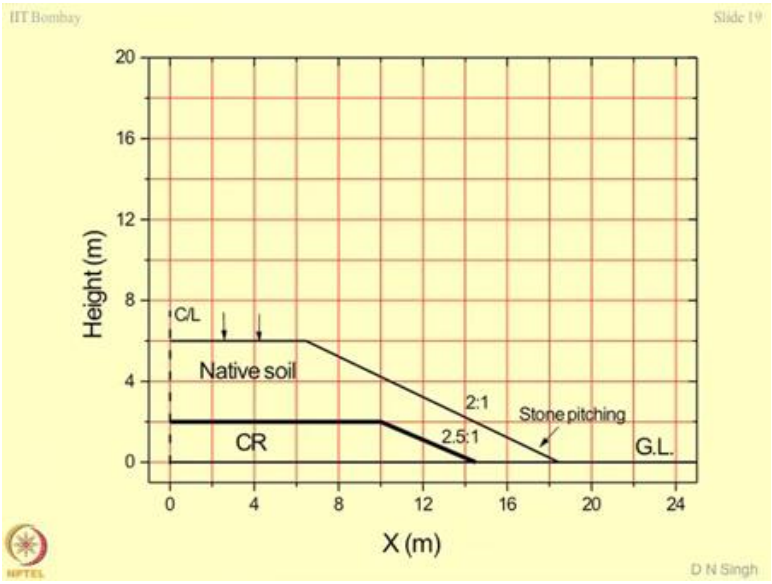


So, then what we did is we buried this coal residues use lot of native soil and made a carriage way for railways. So, these are the main and this is where the entire stability analysis was done, the idea wants to maximize the application of coal residues.

So, this becomes a very interesting problem, but the issue is that you will appreciate, you will not get much native soil there because that land is famous for giving coal not the soil. So, it is very difficult and you want to reduce the thickness of the top cover.

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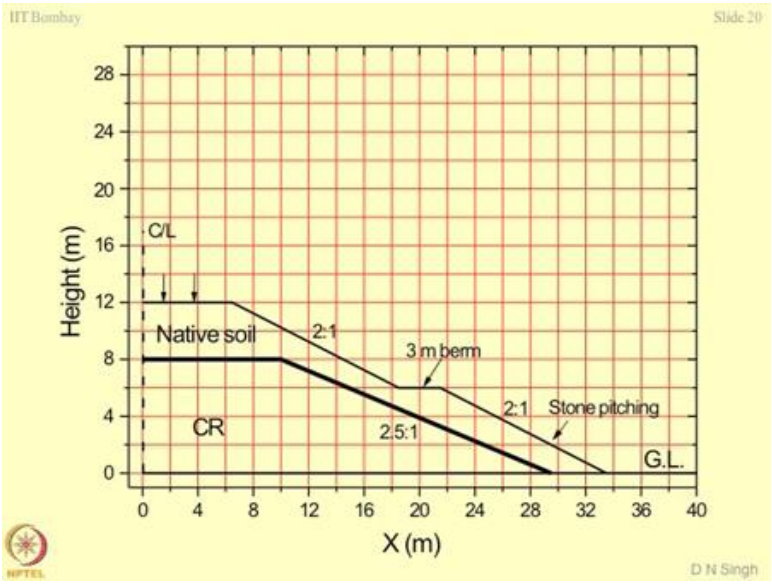


So, then keep on reducing the cover of the native soil, maximize the volume of the coal residues and then keep on doing this stability analysis. So, this was the ultimate design which was subject, which was given to them the height of the embankment you can sees about 16 meter and the width is about 45 meters. So, huge construction and, but now if you look at the from the other angle coal residues are going to be active material.

So, which say is a biodegradable material, is it not. So, how you are going to make this system remain stable over a period of science. So that they should not get this disintegrated, otherwise we will find lot of corrugations and distresses on the surface. So, there was some treatment which was given to this coal by sprinkling basically lime solution or lime slime and slurry cutting it off from the environment. So, that it does not get oxidized it is a very active system.

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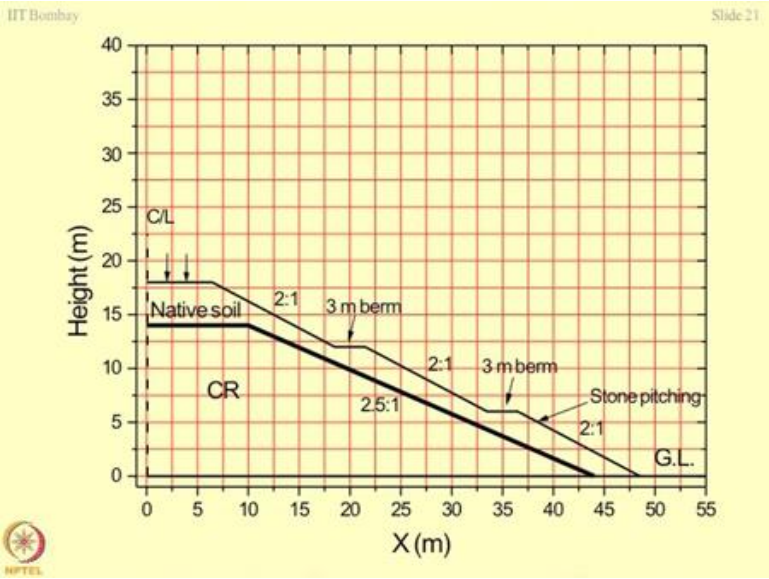


And this is how one job was completed, the challenge was to use the maximum amount of the coal residues I thought I will share this with you in the class.

I hope you are appreciating now the applications of geotechnical engineering in the real life these problems are mostly associated with the day-to-day practices of engineering. The irony of the situation is that power plant cannot be closed because it is a coal belt, but the more and more coal you extract from the ground you are dumping is on the surface and you are creating more and more manmade environment which is detrimental in the due course of the time.