Course on Integrated Waste Management for a Smart City
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Module 11
Lecture No 51
Construction and Demolition Waste Management (Contd.)

Okay, so welcome back in this particular module we will continue our discussion that we were having with construction and demolition waste management. So far if you remember on the last few videos that we have on C & D waste we started looking at a C and D waste management rules which came out last year 2016. From the Indian context we had a review of that rule and then also we have defined what is C and D waste, we talked about construction waste, we talked about the demolition waste and we look at the different components, what are how they could potentially be recycled what are the different products made out of those C & D waste and then towards the end of the last video we also talked about some of this hazardous material which is present in C and D waste.

So in this module will continue that discussion and I will talk to you little bit about some of the challenges of managing C and D construction and demolition and then we will go into disaster waste, we will talk about the disaster waste and I will give you some examples of disaster waste management as well.

Especially you will see a lot of pictures and as you saw from the introduction of this during the introduction of this course did spend considerable amount of time in US so most of the disaster picture, unfortunately I do not have that much disaster pictures from the Indian context it will be really great to have some and I would request you guys if you have some disaster pictures from different disasters happening and which happened in India over the past please do share with me, I will use for people I will not use it for commercial purpose or not sell your pictures, but I can use it for my lectures and if you allow that.

So, but I will give you hurricane Katrina right now as well if you as few weeks back there was a big hurricane in Texas, but hurricane Katrina happen when I was just finishing up my Ph.D. So did had a chance to work on hurricane Katrina debris, so I will talk to you about hurricane Katrina debris show you some pictures which is one of the disaster debris. See it does not really matters this disaster the basic concept stays the same, whether we have disaster debris in India or disaster debris in US or disaster debris from anywhere in the world, the basic concepts do not change.

So it does not really matters too much like, although some people may complain that there was not enough pictures coming from Indian context and I do agree with that we should have some pictures from Indian context unfortunately I do not have some so I could not show you that, but I will talk about those I will talk about Hrishikesh incident, I will talk about the recent incident that we had during this monsoon season as well.

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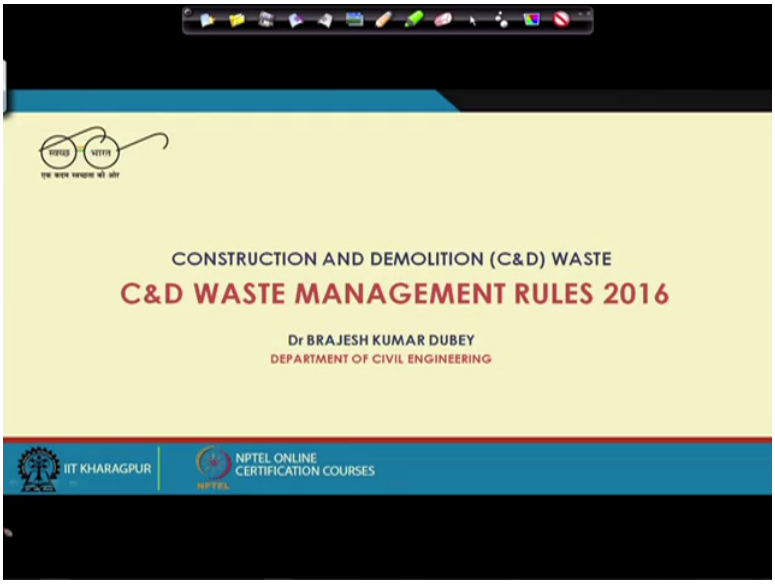

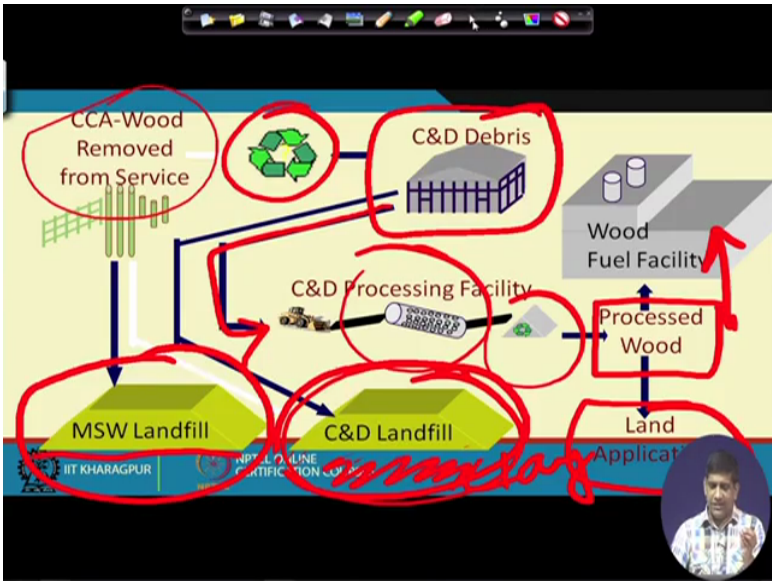

So, let us get started and first will look at some of C and D waste situation in terms of some of the projects some of the challenges. One of the construction and demolition waste and then here I am using one example and this example is just to it can be for any waste stream coming out of construction demolition waste and this is for wood waste and this is a specific type of wood waste which is known as CCA treated wood. We CCA chemical which is the

chromated copper arsenic chemical it is used as treatment chemical for wood treatment to extend the service life of lumber for a longer period of time.

As you know during the hot and humid weather in many times in our campus here at IIT Kharagpur we get lot of termite attack and do we do termite treatment from time to time in our specially at the ground floor apartments, ground floor houses, ground floor bungalows, but like why the termite attack happened? So it happens because of the hot and humid weather those microorganisms they grow very like very easily and then they start attacking. If you are in a colder climate you do not see that happening that much it is because it is a colder climate most of these biological activity does not really happen in cold weather.

So that is why in case of hot and humid weather we have to treat the wood, we have to treat the wood basically we are infusing certain chemicals in there which are toxic to these termite and insects, so that is why they cannot come and eat those woods and then our structure would be safe. So to with that concept the CCA chemical which is a chromated copper arsenic, so it has chromium, it has arsenic, it has copper, so all three has certain roles to play in terms of wood protection.

And CCA chemical was invented in India although we do not use it that much in India anymore, we do not use that much of wood in India especially in the construction sector we do use wood for only like our doors, windows and other stuff and that too also we are going away from like a real wood we are going to compressed wood, engineered wood and all that, because wood is very expensive in this part of the world.

But if you go to the Western country they still use lot of wood in the construction. So this when you use in construction have this wooden pole say 4 by 4 inches or 6 inches big-big polls sticking into the ground. So if they are sticking into the ground, they are getting all the ground moisture so this termite attack is much easier, to prevent the termite attack they treat the wood. So this is one again one example if this could be some other it could be for some other waste stream as well.

So when they are removed from service for some reason they get removed service there are different ways it can be managed, it can go to a C and D debris recycling facility and where it can be potentially recycled, part of it can go to a municipal solid waste landfill, municipal solid waste landfill which is the lined landfill. Part of it can go to C and D landfill which is you see more common.

A C and D landfill is construction and demolition landfill as I was explaining in the earlier video, most of this C and D landfill does not have the liner requirement, they do not have this liner there is no liner there. So this liner is not present in C and D landfill, so no liner there, but if you go to the MSW landfills we do have liners. So in the MSW landfill you will see the liner being at the end of the liner to prevent the leachate from going to the groundwater.

So C and D landfill although it is cited in a place with some clay at the bottom. So will try to have little bit of clay at least at the bottom, so that things when but it is considered that most of the C and D material is not that harmful, so we do not need to have liner many almost nearly 50 percent of the US states does not have liner for that.

And then further when it comes to the C and D debris recycling facility it will get processed, you can see over here the processing C and D processing facility where it goes through different types of screens those are called Trumbull screens. Other recycling process, other is then you have processed wood, processed wood could be used as a land application, land application means mulch and those kind of stuff or it can be also burned in a wood-burning facility as a wood fuel facility.

So this is what a typical waste management things happens for a construction and demolition waste and so that is how it is gets managed for C and D waste stream. So this is one example and the reason I gave you this particular example is that my initial work is was focused on this particular treated wood chemicals and we did lot of work on is treated wood .

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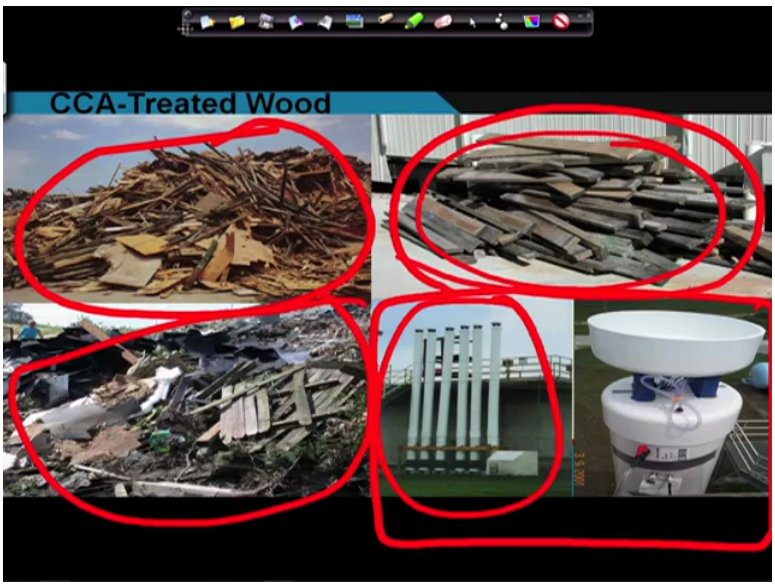

As you can see over here there the problem with this kind of wood is as top as you can see this picture, this is a mixed wood pile, lot of wood, mixed wood, some lumber, some engineered wood and other stuff. Here mostly lumbers, but and then here also combination of lumbers and other things in there. So as you can see that when it is weathered wood when the wood gets weathered, weathered means it is goes for several years off in-service the colour changes to silvery grey colour, as you can see over here this is mostly silvery grey colour that you see in this particular place.

But silvery grey colour happens for all type it does not matter whether it is treated wood or untreated wood, so it becomes very difficult to identify. So to separate treated wood with untreated wood, because untreated wood is a good fue, it could be can be make mulch and you can do like there is no contamination, but when we talk about treated wood which has some these heavy metals you cannot really there is certain things which you should not do should not just because you will end up contaminating the environment.

So we did some like a lot of research has been done in this area and you can look at this research papers are available under my Google scholar profile. So here we had some columns this was a Ph.D. of one of my friend Gene Gemback, she did the work so these are her columns. And here she was trying to stimulate landfill conditions for the different type of treated wood and try to see what will leach out, what is the environmental impact?

So all these things known as what is known as risk assessment. You were as in talked about earlier that as well, you are trying to do a risk assessment of disposal options for recycling options to find out how much it will Leach and what chemicals it will Leach out, what percentage of chemicals percentage leeching is there, so those things can be ascertain by doing this kind of research.

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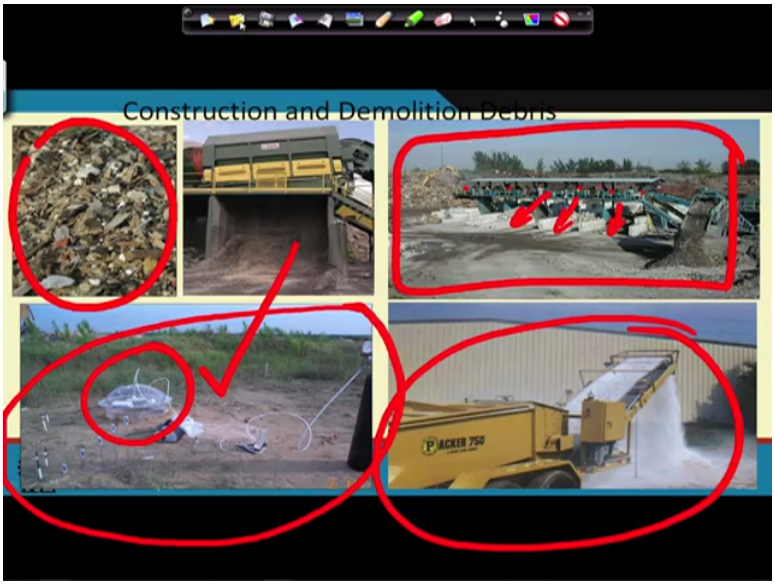

So lot of construction and demolition debris stuff that you see, you have like a mixed stuff from the C and D you have some mixed material. Here you see a picture of like a C and D recycling facility; I think you saw other same picture earlier as well. So here you see a lot of people along the line on both sides and they are looking at the C and D waste coming through, which comes through a conveyor belt at a very slow pace and based on what kind of material it is they drop off to these different kind of like a bunkers, so it just gets dropped off at this bunkers and then it gets collected and recycled.

This picture that you see over here is essentially looking at a C and D debris landfill facility. C and D landfill if you remember we talked about the gypsum wallboard and we talked about the gypsum wallboard as well which you saw this picture based on that earlier in one of the slide. But when if you have a traces of gypsum wallboard which is gypsum is calcium sulphate and this sulphate in a reducing condition goes to sulphide and then you have the hydrogen sulphide gas produced which tries to get out of the landfill. So here we are in this picture we are trying to measure the flux, this is called flux chamber.

So we are trying to measure the flux of what you whatever is the fugitive emission, what are the fugitive emissions coming out from the landfill going into the atmosphere from H2S, like how much H2S is escaping to the atmosphere. Because as you know that C and D landfills also does not have any gas collection system, so most of the C and D landfill you will not see gas collection system. So if there is no gas collection system your H2S gas will try to emit

out and we do put some bio filter and other things on top just to keep it down, but it potentially this possibility is there, that you will have H2S escaping out to that atmosphere.

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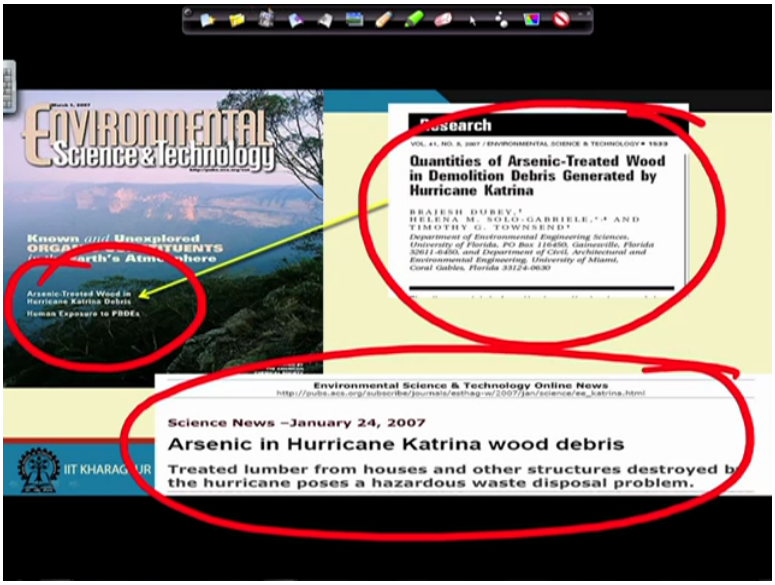

So just few examples to kind of show you the different things related to construction and demolition waste. This is another this was a study done again few years back we looked at the quantities of like this particular quantity of arsenic treated wood when demolition debris generated by hurricane Katrina. So now from C and D construction and demolition we are moving into disaster waste which is a disaster waste is more nastier than demolition waste, because everything get mixed up.

So in this particular research what we try to do is we looked at how much this what is the quantity of arsenic that got released after this hurricane Katrina. Now if you think about from the Indian context few years back we had the big that Kedarnath, Haridwar, Hrishikesh and all those slightly above Haridwar from Hrishikesh and on the way up we had a big natural disaster, which generated a lot of disaster waste.

And many of us watch those videos on our I do not know whether Whatsapp is there at the time I do not remember, but we did see on the social media, on Facebook or other places where this even some cars just washing away cars got washed away, many buildings just collapsed and part of the building got washed away as well. So when you have those things coming into Ganga river and then ultimately it will come along the way of Ganga river, not only in Uttarakhand and then it will kind of come down on the planes as well up to some distance.

And with this everything mixed up you may have some heavy metals from different lights and other stuff, you can have some electronic waste, you could have some other kind of like engine oil in the house if grease whatever depending on what kind of job you do then it is it all get mixed up and then it gets disposed into the environment. So although we will not worry too much about the arsenic disposal because we do not use that much that kind of material which has lot of arsenic, but we do have to worry about say lead and other stuff in there nickel cadmium battery, so all these went into the atmosphere.

So this particular research since we that Luciano, Mississippi and part of Florida these are very they are they have lot of use of treated wood so would be and since my research was on arsenic treated wood so we thought that okay let us try to quantify how much arsenic, we all are familiar with arsenic problem. The state West Bengal where I am sitting in we have lot of arsenic issues, Bangladesh have lot of arsenic issues and there are a lot of other parts of the country where we have arsenic issue as well specially in the groundwater which is a Geogenic arsenic.

But here we have CCA treated wood which has arsenic wood and we are dumping it into the C and D landfill, so our concerned was that if too much of arsenic is getting into the atmosphere that will lead to the groundwater contamination at least like a few years down the line or may decades down the line. So we try to quantify it and then study did get some publicity, it was put on top of our page of the journal and also they did a news article on that so as you can see it was almost 10 years back more than 10 years back where this study was published.

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So and so what we essentially did is that not in terms of New Orleans we divided we found after our like initial trip we identified few hotspots. So we identified these seven locations where we wanted to do some sampling, so we went around and did sampling, at each location we did at least 30 samples. So 30 wooden pieces we tested to find out whether there was arsenic treated or not arsenic treated and then from the arsenic treated we try to identify that what should be the arsenic concentration.

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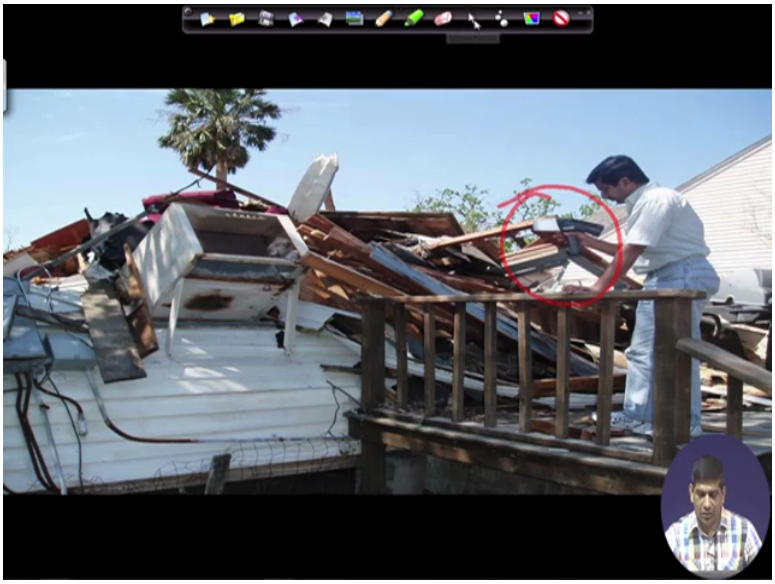

So based on this 7 sites like we had and how we collected the data. We had this small toy it is called x-ray gun so these x-ray gun was used, it is around 30-35 thousand dollar toy and you can see me and that is me, my younger version of your instructor for this course. And we took

like I went around and collected data for each of the sites at least 30 samples and many places we did much more than 30 samples and to quantify how much arsenic is coming out.

Then based on total amount of disaster that is typically gets produced with this kind of disaster there was some literature data available. So based on that we estimated that how much wood will be there between or among the wood what percentage typically we see treated wood, so that data was also out there. So based on all that we basically tried to estimate how much arsenic got released because of the release of this treated wood into that in into the because of this treated wood in environment.

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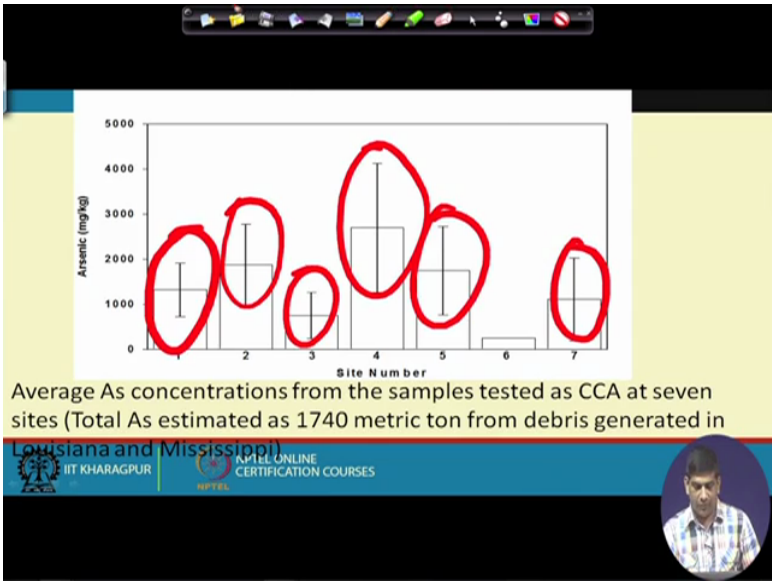

So in that case we had the 7 sites, for the 7 sites we had we plotted data and based on we what we got it is a in the X-axis here you can see the site numbers 1, 2, 3, 1 to 7, on the y-axis you see the arsenic concentration. And here you see these error bars, error bars has the standard deviation for that, so you kind of overlaps with one another and that to certain extent and then we also had so all these sites like 7 sites we did that and we found some information associated with arsenic release.

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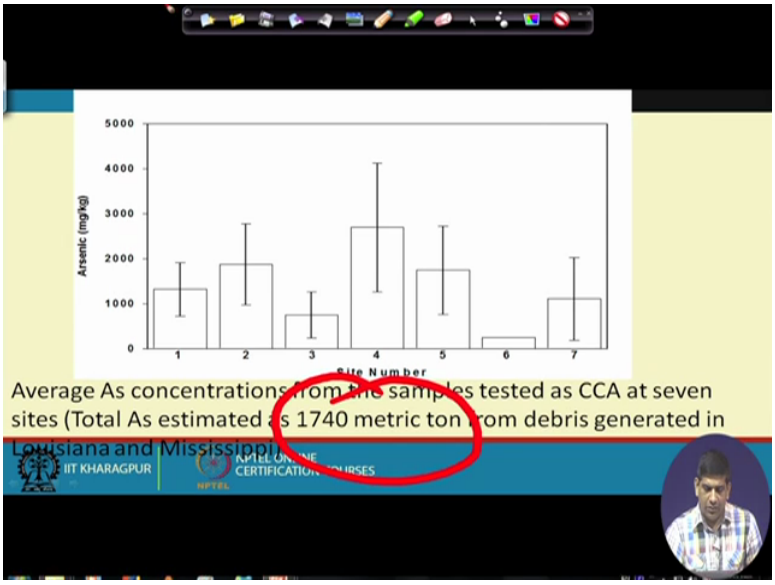

So based on this seven data sites, based on the amount of disaster debris typically got produce in this type of natural disaster, we had estimated that average arsenic concentration from the sample tested at CCA at seven sites was 1740 metric ton. So this is 1740 metric ton from the

debris generated in Luciano and Mississippi, just Luciano and Mississippi they had around 1740 metric ton of arsenic going into the environment.

So now this arsenic going into the environment that raises concern in terms of what will happen to the groundwater source or because it is going into the environment so we are actually contaminating the groundwater, so that is always a question typically asked. And then it is since it is other option is just to find out how to the managed it. So, it is off course it is off course one aspect looking at the environmental risk assessment, the other aspect is how to manage that risk, how to what is how what we should do in terms of risk management, so those things also needs to be looked into.

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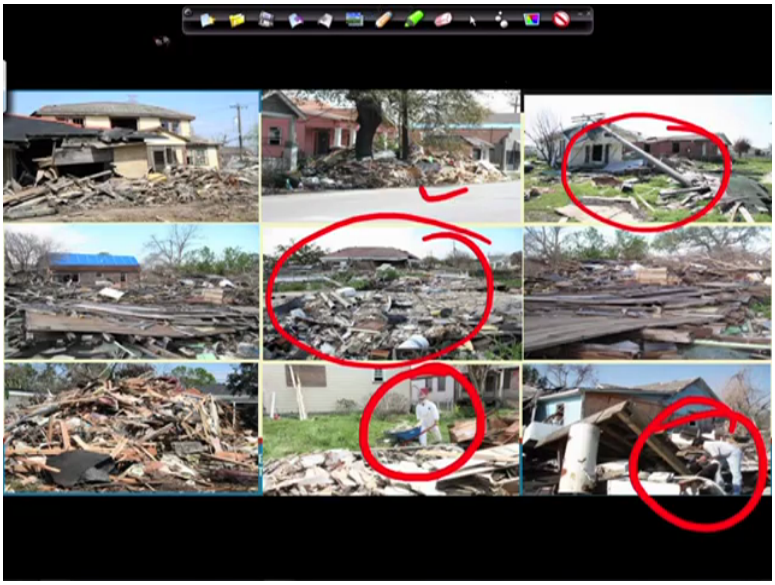

So here are those 7 sites where we collected pictures, pictures are being shown for 9 actually there is some sites it is been duplicated, I do not remember which ones, but as you can see there are these are the different places and you can see all these disaster debris, so it was not easy, it was after hurricane Katrina things were really tough in that particular area, you see some volunteers trying to help out to clean up.

This is again myself taking some sampling taking the (())(19:18) reading and then you see a bunch of like disaster. This looks much cleaner this picture but otherwise you see all along lots of disaster debris, lots of disaster and then waste all these disaster debris actually went to unlined landfill facility in the state of Luciano. So that is always a concern in terms of groundwater.

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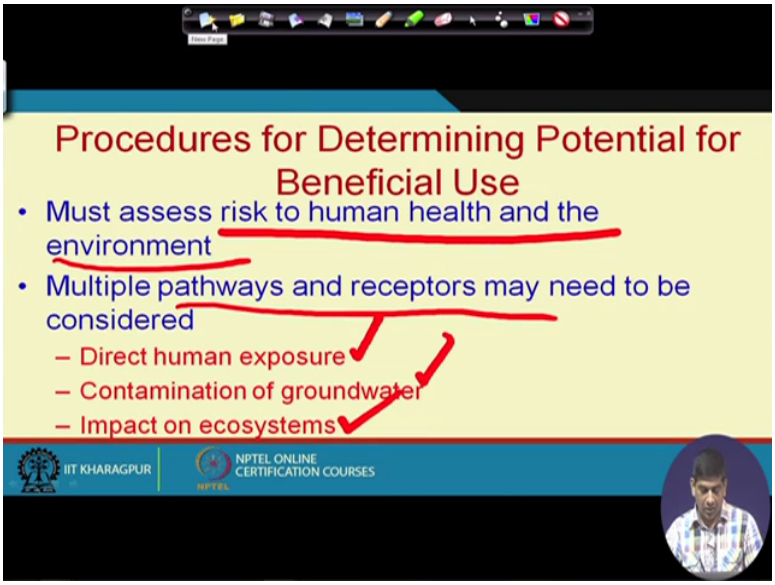

So that leads to I asked to think about what is known as the potential for beneficial reuse? So when right now as we have been talking about the government is looking at housing for all by 2020 or whatever year and we also for the housing for all what we need? We need some raw material. Raw material can come from waste material specially as we like some of this waste, construction waste, demolition waste, if things are cleaner they can be used as a potential construction material for any future construction.

So but when we go for doing that what we need to make sure that it is environmentally safe to do it. So we do not want to do something and then later on we find out that we actually created a mess. So to prevent that kind of scenario we what we do is known as the beneficial reuse risk assessment.

So it is looking at, so than how we do it? So if you have say if you producing, you are a C and D waste producer or you are a city engineer or a municipal, SPCB, CPCB, wherever whatever role you have or if you are a student you may end up in those roles and then you need to decide, that this is the construction waste coming from this particular area, it can be used for an any construction material, is it okay to use it as a construction material? There are 2 aspects for it, one is the structural aspect and other is the environmental aspect.

Structural aspect off course we can test you can make say if you are making concrete we can replace part of the aggregate with this recycled aggregate and look at the concrete strength, 7 days, 14 days, 28 eight days and all those as per IS codes. But then the other aspects which is gets neglected many times is looking as the environmental cost, environmental impact. So if

something is not like a clean and then we have to clean it before it becomes fusible, so in that while cleaning you are contaminating the water and that contaminated water is going somewhere and contaminating something else, so either surface water or groundwater.

So those things we need to look at, so in (())(21:44) cell what we do is we look at the must assess the risk to human health and environment, so we have to look at the risk to the human health and environment. So there are and then we look at the multiple pathways and receptors may to be considered.

So we looked at what kind of receptors are there, whether if it is a we do have lot of animal activity, we have lot of bird activity, for example Bharatpur century what we here is now the type of birds coming into the Bharatpur century the variety is going down, many of these birds are not coming these days, so this is concern in terms of the typical ecosystem in that particular area. So that needs that can also one of the receptor we have to identify how the receptor when you will choose.

So in terms of looking at use of waste material as a beneficial reuse or reuse whatever we call it, it is we need to make sure that there is no risk to human health and environment or there should be manageable risk to human health and environment. And then there could we looked at what are the pathways, what are the who are the receptors that needs to be considered, like we have for look at the human exposure, contamination of groundwater and as well as the impact on ecosystems.

So those three aspects we need to look at in terms of coming up with like risk associated with reuse of certain like use of certain waste material as a construction material. Waste is a mess-mess resource actually waste as people I have a bit reservation calling waste to wealth, because waste can create wealth but it requires lot of investment, lot of training, lot of everything to really make waste to wealth worth, because even today if you go to Canada, Europe or anywhere you have to pay for waste to waste disposal fee.

So it is not really they have not able to reach the stage where you can make some so much money out of that, that becomes kind of self-sustainable over long period of time. So they do rely on government support from time to time, so similarly here there will be those kinds of scenario will shows up.

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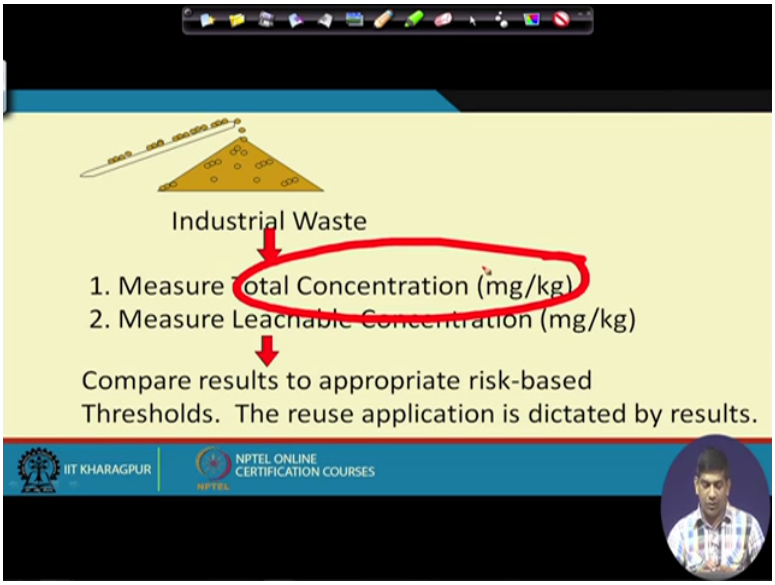

So let us look at this beneficial reuse risk assessment some of the basic concepts and in terms of the basic concept and if you have any industrial waste or construction waste or demolition waste, first thing you need to do is measure the total concentration, how much is the total concert concentration of the contaminant, you can also go for either XRD, XRF to find out what kind of metals could potentially be present there and based on that you look at the total concentration of those metals in this particular like a those metals in this particular waste stream.

And then you measure the leachable concentration, because there are 2 ways things could be exposed when you have this hand to mouth activity. When the small kids when they go and play they have a tendency to touch like they will touch something and they will put the same hand in their mouth, so that is called hand to mouth activity. And since their hand is dirty with some of these heavy metals which is a dusty particle and then kid is putting this fingers in their mouth without washing it properly and that becomes your like a risk from things coming into your ingestion trout.

So first we need to look at the total concentration, what are the heavy metals present and all that. Then we also measure leachable concentration, leachable concentration is to find out what essentially actually leach out? There could be certain element which is present which will show up in our XRD in those results but it may not Leach and the legibility maybe almost 0.

So in that case it is still a risk from a direct human exposure point of view, from hand to mouth activity point of view, but it is not a risk when we talk about like a in terms of groundwater pollution or if you are using the water wells, it may not even go to the water wells it will not leach out, so those things we need to find out, so total concentration and then we do the leachable concentration. Then we compare the results on appropriate risk-based thresholds and the reuse application will get dictated by with the results that we get.

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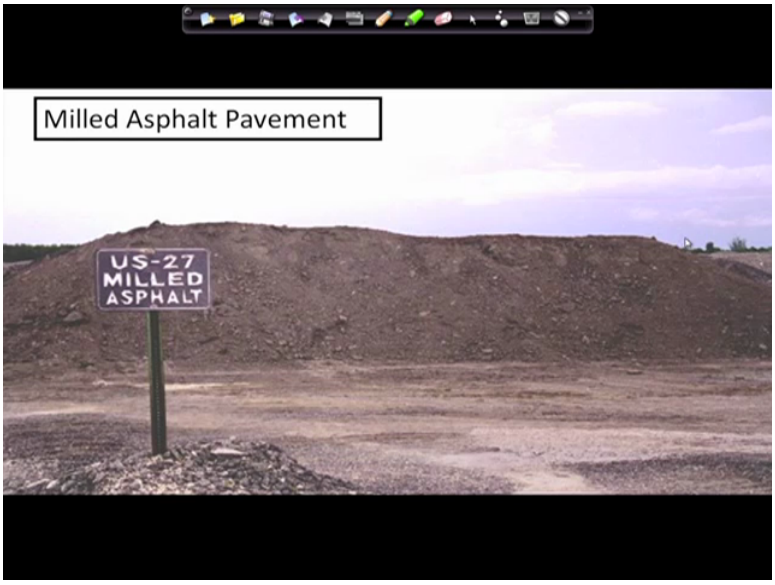

So these are some examples of different types of construction waste crushed concrete, which is again it can be used back in as a concrete or as a filling material, it is used a lot. Milled asphalt pavement, asphalt pavement we talked about the other day. Asphalt is the bitumen asphalt cement is the bitumen actually and this asphalt pavement is kind of everywhere in the

world, so you can once that some of these damage is there in the road and part of the road is taken away that can be used as a milled asphalt pavement and that is can be sold off for different applications.

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And chipped wood, we already talked about the wood, but chipped wood is the wood which is cut it down into smaller pieces as the name suggest. So that is used either as a mulch as you can see on this picture over here that is a lot of you see some mulch which is used as a mulch and this is some of the processing facility and you have some other spray and some other stuff coming up which shows up in this particular picture over there.

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And then this was other work where we try to separate recovered wood waste using automated x-ray detector technology. So we had a x-ray detection which was we set up in over there and here essentially what will happened is this mixed with waste stream of the wood waste will come in and based on the result from the from this particular instrument we can find out whether it is treated or non-treated and based on that we can divert it either to a treated pile or untreated pile and use it for different purposes. So that is it has been developed and it is being under operational in South Florida, so that is where it has been used.

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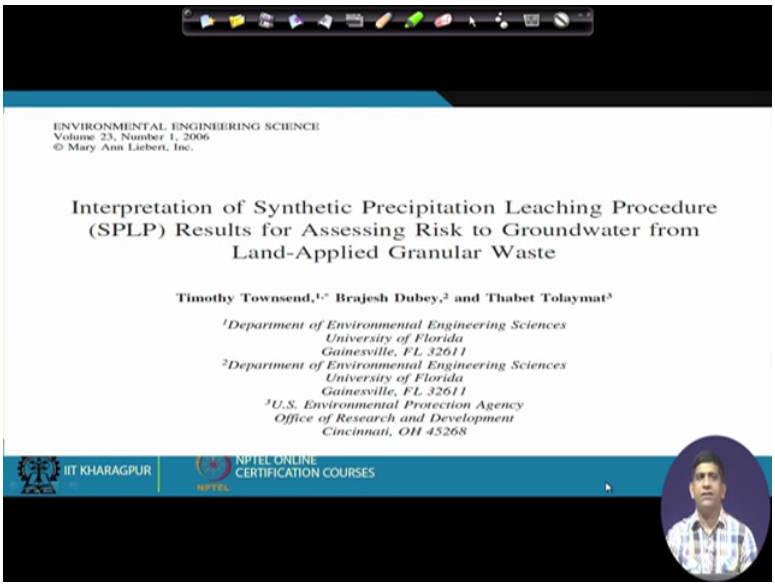

Asphalt roofing shingles we already talked about, that is the reuse as a asphalt, so there is no problem there. So in terms of this all these beneficial reuse risk assessment we need to

understand what exactly we are doing. So in terms of what we there is off course we try to stimulate the condition in the lab and when we try to simulate conditions in the lab one of the important test in terms of beneficial reuse risk assessment for construction material, industrial waste is to look at our like how much will Leach out and what that leaching test really me.

So in this particular paper which is showing up in the slide right now it is what we try to do is we try to interpret the synthetic precipitation leaching procedure which is known as the SPLP results for assessing risk to groundwater from land applied granular waste. So we had different types of waste being used and that waste gives us some idea of how things are in terms of like a different like a beneficial reuse risk assessment site.

So with that is kind of gives you little bit of overview of different kinds of project, different kinds of stuff. Again as I have been telling many times in this particular course, we need to be careful in terms of what we are getting out from here my goal is off course to make you a critical analyser in terms of different solid waste management options that is what we have been trying to tell in this particular course you think that is very important like why, always have that question why.

Say for example like we will try to do a composed plan, okay that is great, but why only composed? Why not some other processing facility? How composed is better than other stuff? So those are things should come to your head, especially when you start working as a professional. So with that let us this is the last slide for this particular where this paper is available it basically tells you what how to understand this SPLP result.

So if you have any questions, always you are more than welcome to send your questions on the discussion forum and we will be more than happy to respond to that and I hope that you have also registered for the exams. So let us close this video and then we will get into the video which will essentially it will be lots of pictures and that will complete the C and D waste management. So okay, thank you.