Geoenvironmental Engineering (Environmental Geotechnology):
Landfills, Slurry Ponds & Contaminated Sites
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Lecture – 32
Disposal of Slurry Waste in Ponds & Impoundments and Dry Waste in Mounds

A good day and welcome to this class, last time we started discussion on disposal of waste in slurry ponds and we will continue that topic today. What I introduced last time was that when you have a waste in the form of coal ash or in the form of mine tailings, you will have it in the as a fine powder and we have to dispose this off; and if we try and handle this waste in the manner in which you have been handling municipal solid waste, that is try and send it in trucks, then this can produce a lot of dust fine particles can blow around, and it can also be highly erodible. So, if there is rain, then this will tend to erode from an open truck and fall onto the road. So, one of the ways we handle this is make slurry out of this waste and pump it in pipe lines.

So, today we would like to see what are the alternatives which exists even when we pump, it in the form of a slurry what are the alternatives which exists for disposing this waste.

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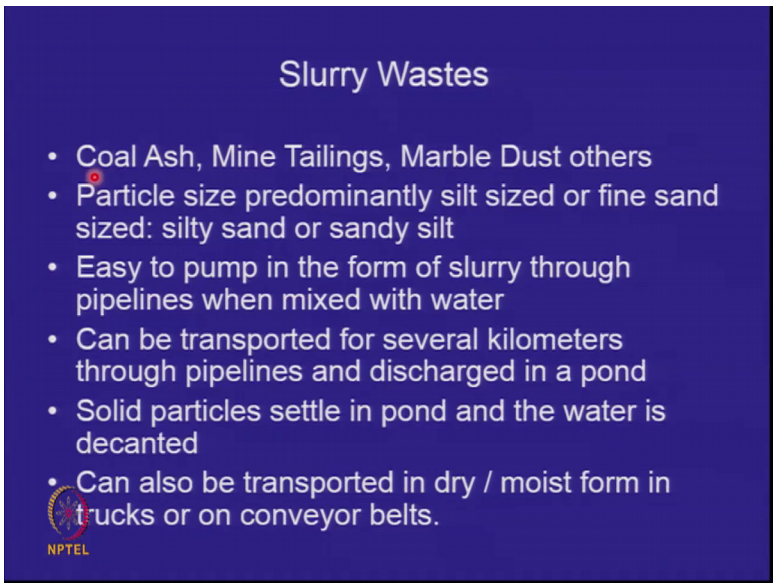

So, just to quickly recall coal ash mine tailings, marble dust and others they are all disposed in the form of slurry, the particle side particle size is predominantly silt or fine sand and you can often classify these material as silty sand or sandy silt. If it becomes coarser than that if it becomes coarse sand of gravel it is difficult to pump because you can mix it in water you can make slurry, but you need very high velocities to keep the coarse sand and gravel suspended in the water as you pump. Also when you pump coarse sand or gravel there will be a lot of erosion of the pipeline, because these particles will at the bends and at the corners they will cause damage to the pipelines.

So, it is easy to pump this silty sand or sandy silt, and specially the sand component is fine sand. So, we pump it in the form of slurry through pipelines can be transported to several kilometers. So, you may need intermediate pumping stations to boost up your velocities, but you can transport the slurry for several kilometers, a through the pipelines and then discharge into a pond. In the pond the solid particle settle down and the top water is decanted. Now these can also be transported in dry or moist form in trucks or conveyor belts, but preferably then you have to have these covered because if you are trying to send it in a truck, you will have put it in a containerized truck so that, no dust particles come out and if you send it in a conveyor same way you will have to cover the conveyor. So, that there is no erosion by air or by water.

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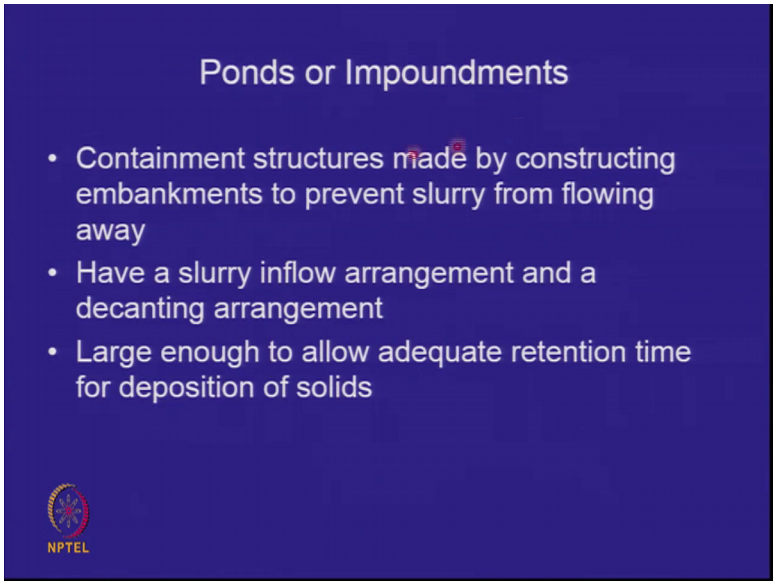

Now, ponds or impoundment that is the word that is normally used these are containments structures made by constructing embankments, to provide the slurry from flowing away. So, when the slurry comes out of a pipeline it is like water or a liquid which tends to flow away. So, you contain it by making embankments, you have a slurry inflow arrangement that is where will the slurry be deposited, and you have an outflow arrangement which is a decanting arrangement. In the out flow arrangement you do not want the solid particles to come you only want the supernatant fluid or the fluid from which all the solids have settled down, that should pass through and be taken away.

These ponds have to be large enough to allow adequate retention time for deposition of solids. So, the design of these ponds are size of this ponds depends on do you have a adequate time for the fine particles to settle down, when you take away the liquid from the top. If you do not have a adequate time the fine particles will come out to the supernatant liquid, and I showed you that sometimes you see very milky kind of or muddy kind of water coming out of the decanting structure which is not desirable.

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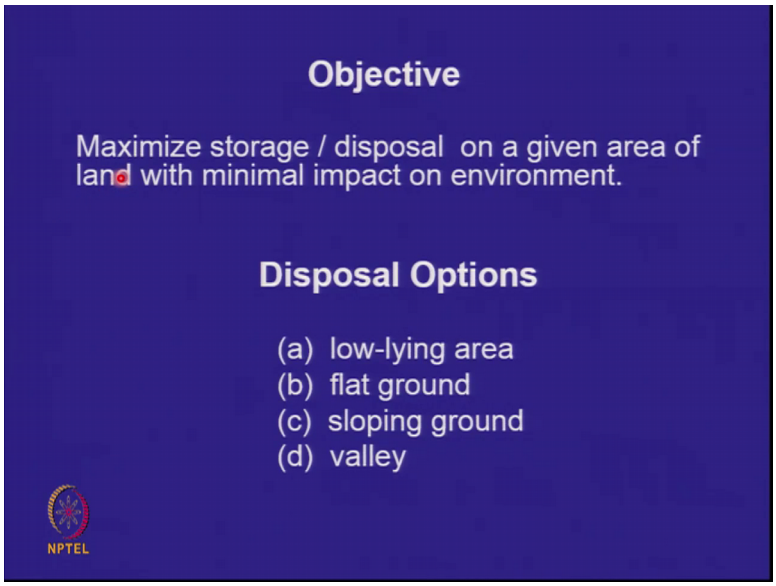

The object of course, is given a area of land, you want to maximize the storage with minimal impact on environment. So, when we dispose slurry on land we would like to maximize storage, and have minimal impact on the environment for the given area which is available to us. And the same things will govern what is the shape of the area it would not be a square or a rectangle, it will be as the land is available to us, it could be slopping

ground, it could flat ground. So, the disposal options you may get a low lying area, you may get a flat ground, you may get a slopping ground or you may get a valley.

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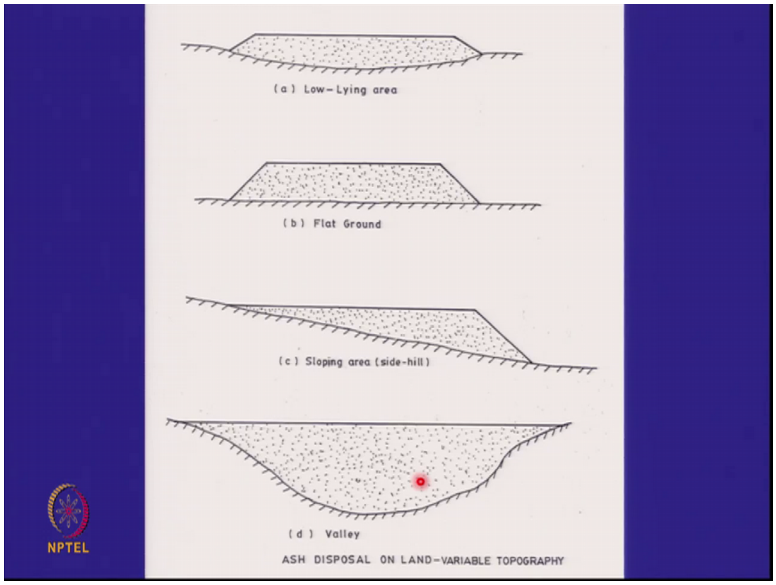

So, really this all these four forms are similar to what we talked about in terms of landfills if you have a low lying area you start depositing it in the low lying area, and then gradually the pond will rise above it. This is the final sectional view a how we contain the slurry will become evident in the next slide, but this is what it look like; if it is on flat ground your pond, will be like this sloping ground will be like a slide slope landfill and valley will be like this.

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So, the design requirements are that you have the operational phase; that means, for the 20, 25, 30, 35 years when the waste is coming, how do you operate the pond, how do you spread, how do you ensure that the waste is deposited over the entire area that you have, those are the operational aspects, how do you close a pond. Your project is over do you walk off or do you cover it, do you grow vegetation on it and how do you take care of the post closure aspects, how long do you have to monitor it, till what time is it that you can abandoned the area.

So, waste placement is an issue typically you know on a landfill that waste is coming in a truck and you are using dozers to spread the waste, in the slurry how do you do it? The physical stability of the entire pond is an issue; that means, the embankment stability how high it will rise and if it breaches what will happen. What is the impact of the slurry water on the environment on the ground water table, what is the impact of the dry fine particles blowing away in the wind, we have to look at environmental safety.

Surface water management is a major aspect of design, not only is that the slurry water, but every time it rains you gets additional water which is coming down, how do you extract and recirculate the decanting fluid. That means, suppose you are able to take out your slurry water, the solids have settled down and you can take out the water. Now if that water has got some excels excess dissolved salts or excess chemicals then how do you treat it, and then can you recirculate it or do you discharge it back to rivers do you

need a liner at the base of your pond and if. So, is at the same liner as you use for landfills, what monitoring do we have to do for the years of operation, and closure and post closure period and finally, what is the plan, what is your long term vision as to when you abandoned the ash pond what would you have returned to it is original condition or would you have, how you have merged it in to ecosystem.

So, these are design aspects which one has to consider. In the ponds do you have three systems.

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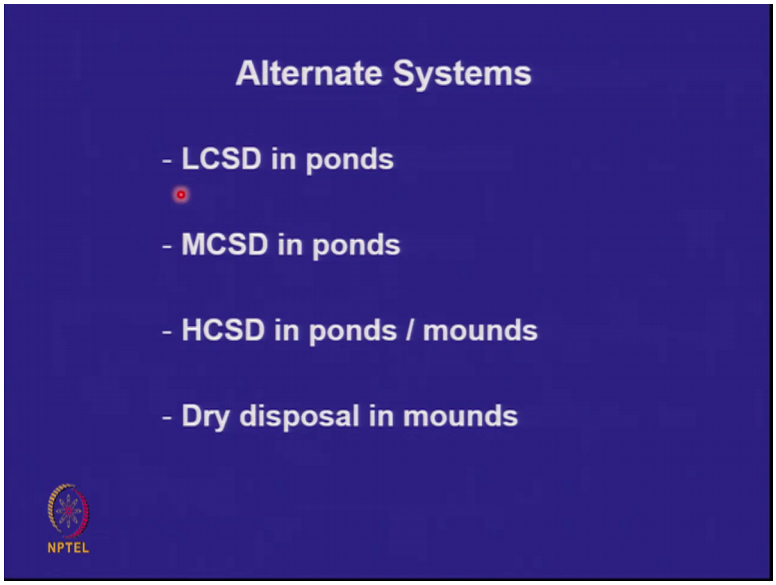

Low concentration slurry disposal, medium concentration slurry disposal, and high concentration slurry disposal. So, if you are handling your waste in the form of a slurry that your mixing it with water, then you lean medium and high. So, this is like water this is like a paste; that means, LCSD is more a very thin slurry and HCSD is a thick slurry then finally, of course, you have to compare it with dry disposal. If you are sending the material in the form of dry disposal or in the form of a dry waste or moist waste, when I use the word dry here sometimes it also includes the word moist. So, that the particles do not fly around.

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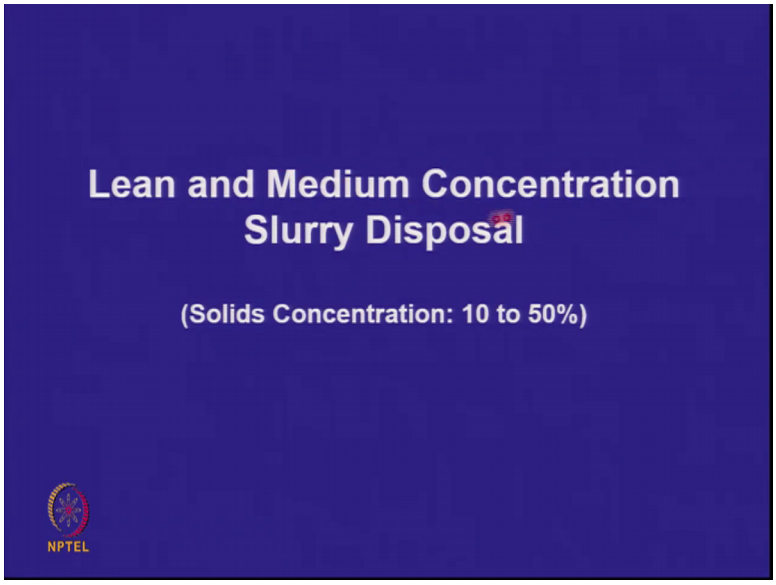

So, let us first look at lean and medium concentration slurry disposal, the important thing is that the solids concentration is from 10 to 50 percent; that means, solids to liquid ratio is 0.1 to 0.5, 10 to 15 percent is your lean slurry; that means, for every one unit of solids you have 10 units of water that is your lean slurry. So, it requires a lot of water to do this. So, that must be available to you.

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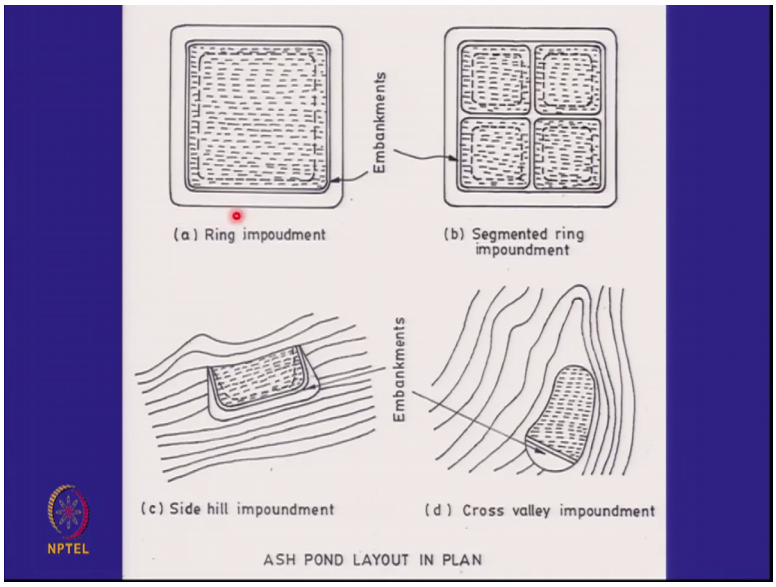

So, typically what will happen if I look at it in plan, my I can have a ring impoundment; that means, I can make an embankment on a flat ground all around like this and dispose my slurry inside it. This is the same thing as this except that I have made different compartments; one compartment may be in use others may not be in use. So, this is

called a segmented ring impoundment, in India most of the time we use two compartments, one is in use and second is being raised we will see that raise means it is being made higher.

So, sometimes one will be in use other is not in use, also if something happens to one pond you can use the other pond. So, in India typically two segments are made in a pond. If you look at from the top, if it is a sloping ground, sloping downwards like this then you can have a side hill impoundment there will be no embankment of this side, the maximum height of the embankment will be here and the slurry will be stored here. And if you have a valley in a hill area then you can have a cross valley impoundment, and here there is only embankment on these sides, the three sides are having hills or higher elevation ground all around them.

So, these are the kind of layouts that you can have. Here one is using the word ash pond layout, but this could as well be a mind tailings pond layout. So, please note that we will be using the word ash or mind tailings synonymously; there is difference between ash and mind tailing which I will do in the next lecture, but whatever we talk about one is valid for the other as well.

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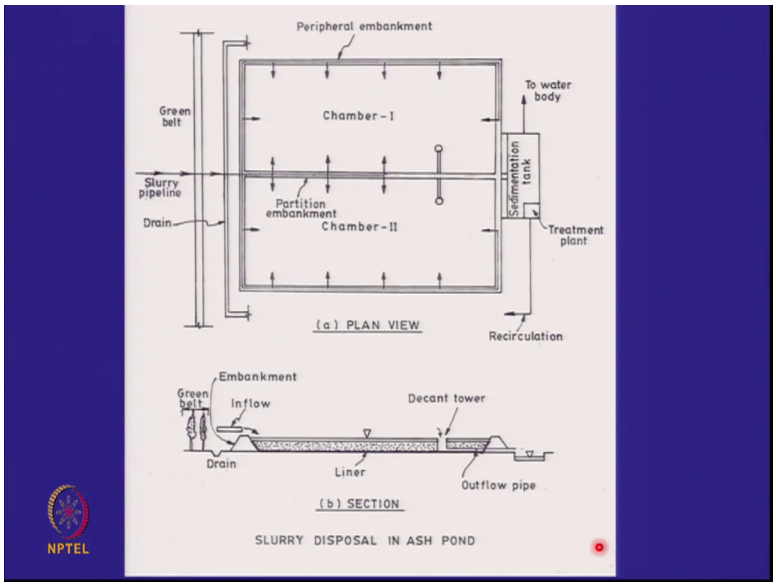

If I look at the arrangement in slightly more detail, I have to have a inflow slurry pipeline. So, I said there has to be an inflow arrangement and there has to be an outflow arrangement.

So, if I look at this section I am having the slurry coming in from this point and being discharged, and then I have an outflow arrangement these two small round circles that you see, they are showing the decant tower; that means, the super net and fluid will pass through this and come to the downstream side in to a sedimentation tank, where there may be some further residual settlement of very fine particles, before it the water is either taken away for recirculation or it is discharge back to the river or the water body. Remember you are doing slurry disposal you need water, so you must have a source of water either you should be closed to a river, or a canal or if you are very far say 10 15 kilometers, then you will have to make your own canal to get the water.

Now, typically in thermal power stations, there is also requirement of cooling water which is more than the requirement of slurry water. And also in mine mining operations there is requirement of a liquid for the chemical processing of the waste. So, you are having water coming to this site, now either you can use part of the water for making the slurry and keep on recirculating it. So, that you do not need too much additional water, but if you have surplus water there are many cases where the water is just sent back to the river. In recirculation if you have some chemicals or some constituents which are present in the dissolved form, then they keep on building up as you recirculate the water; and one day you have to do blow down that means, you have to release the slurry into the water body.

So, once the slurry pipe lines comes in if I start depositing it here, the it is entirely possible that the material will accumulate here and not accumulate all over the place. So, you see this is called a garland arrangement, your slurry pipeline has many points for inflow, it is all along the perimeter. However, it cannot be very close to the decant tower because then the settlement suppose I was to put a inflow point here this is a very short distance, settlement time will not be adequate and the fines will come out.

So, you have to have a minimum of the slurry points away from the decant tower. So, that as the water flows from the inflow point, suppose this is an inflow point as it flow here flows here, the fines must also settle. The course one will settle immediately as soon as soon as the slurry hits the ground, because velocity in the pipe was high therefore, all the sand and the silt particles were in suspension the moment it comes out of the pipeline, the velocity falls because it is a spread over a large area. So, you have to have a minimum distance. It is typical minimum distance may be 500 1 kilometer or more

typically for the fine particles to settle otherwise you will have muddy water coming out. So, in both the chambers or both the segments you have this garland in flow arrangement garland inflow arrangement.

The others in important think about these slurry ponds, they have to go to their final height.

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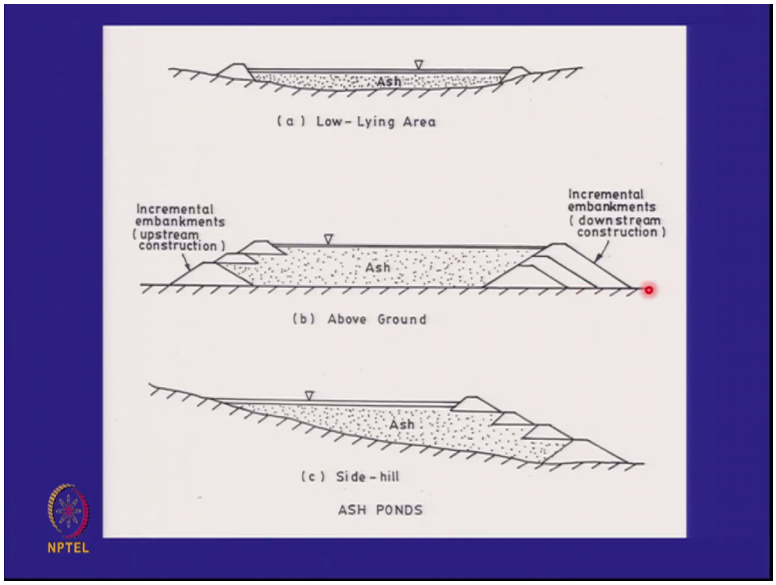

So, the final height of a slurry pond above ground let us say first let us look at this flat ground, I may my final height be 20 25 meters, a there are ponds of mine tailings which are 40 meters high and I told you the Kudremukh iron ore tailings pond is a 100 meters high, but it is only a cross valley impoundment. So, only one embankment is may and it is hundred meters high, typically on flat grounds you should be 20 25 meters high.

Now, nobody constructs the 25 meter high embankment right away in the beginning it is a lot of investment. So, what we do is something called incremental raising, every three to 5 years we will erase the embankments and do slurry deposition. Now there are different technique of raising this is called the upstream and this is called the downstream and other techniques, but what I want you to see is that raising is done incrementally in the luckily in a low lying area for the first few years, you may not even need an embankment. Because it is a little depression in the ground, but over the years you will have to start raising it if you want to higher and in the side slope, it may be like this.

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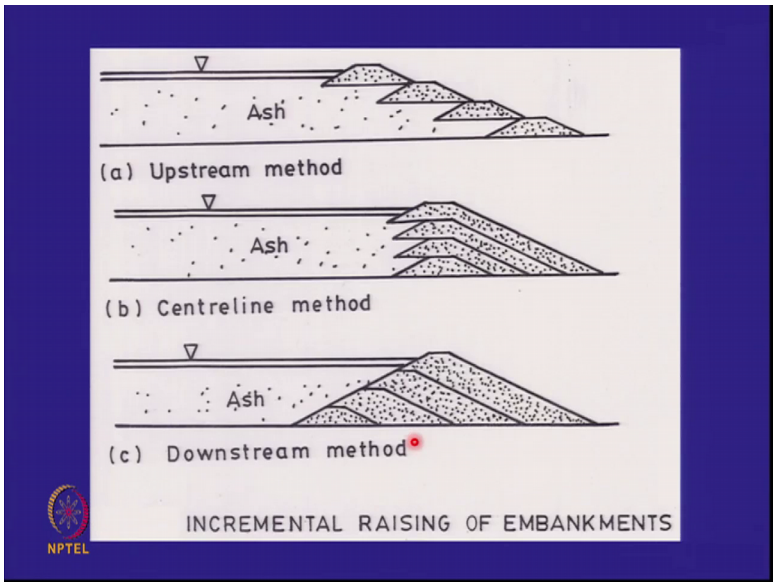

So, these are the kind of techniques, which are used and it is all staged construction or incremental raising and the three names that will come very often to you is up upstream raising you make the first embankment, and you fill it up with the solids, was the solids have come up to this line make the next embankment fill it up make the next, fill it up and this is called the upstream method of raising we are diametrically opposite to this method is the downstream method of raising; that means, you begin the starter embankment a little inside from the out outer most parameter, and once this is filled up you make the next embankment, once this is filled up you make the next and so on.

Now, the advantage of this is that you can compact the entire area with rollers. So, this can be very strong embankments the problem with this is. You are sitting on loose deposited hydraulically deposited material. So, though you can compact this material, you are not able to compact the material below it. So, this is not as stable as this. So, this slopes of flatter if you look at this slope and these slopes are stabler these an hybrid arrangement between the upstream method, and the downstream method that is called the centerline method where you raise the embankment crushed one over the other. It is partly resting on old material and past partly resting on the compacted soil we look at this in greater detail later.

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If I choose to use less water, because less water is available then I can still transport the material in the form of high concentration slurry, and here the solids are 60 percent or above this becomes like a thick slurry or a paste right. So, here the thing is when the slurry is coming out of the pipe line and it is in the form resembling water or very thin slurry it flows like water; that means, it spreads itself whereas, when I have a high concentration slurry it will not flow by itself. So, let me put the three scenarios, suppose I have this silty sand or sandy silt coming to me in the form of a truck in the form of a dry oblique moist powder in a truck.

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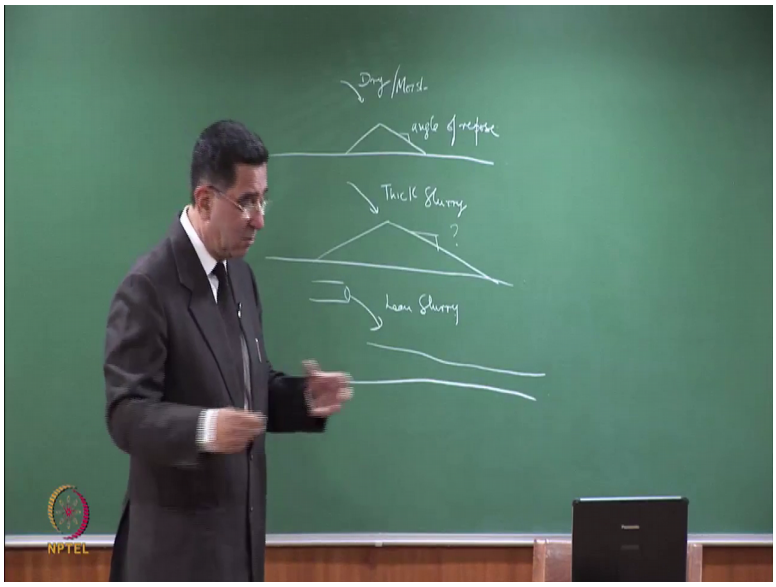

So when I append the truck, then what will the way in which my waste will be deposited in a conical form right. And these slopes what we call the angle of repose it is similar to 5 dash values, if your 5 dash to the material is 45, it will be at one is to one slope if it is 30 it will be gentler right.

Now, instead of dry; if it is moist it could be even steeper slopes why because there is some kind of a surface tension effect which gives you capillary suction. So, that might give you some kind of a artificial cohesion. It is like beach sand you go and make castles of beach sand why when the sand is dry you cannot make a vertical cylinder, but when the sand is slightly moist you are able to make a vertical cylinder because this negative co water pressure on account of the liquid present you make the sand saturated again you cannot make it vertical.

So, when it is dry or moist it will be like this, when I send it in the form of a thick slurry well it will not be as steep it is saturated, but it is not flowing type. So, definitely it is flatter what is this? We will find out soon what kind of range does it have and if I send it in the form of lean slurry which is like water then what is going to happen? If it is coming out of a pipeline, it will spread by itself it may be nearly horizontal it may be nearly horizontal.

So, lean slurry spreads by itself, thick slurry does not spread by itself. So, the now the question is how are you going to place the waste and how are you going to spread it. Dry powder or dry soil will not spread by itself; you need to spread it. So, how do you spread dry soil we get a dozer and spread it in layers, and if you want to increase the density because you want to store more material, I will compact it. So, the higher the density for the same area I can accommodate more material. So, we are going through different angles of repose as you call it, and lean slurry seems to give you an advantage that it can spread by itself.

So, let us look at high concentration slurry disposal, what is our experience so far, this a comes more from the mining industry than from the ash industry.

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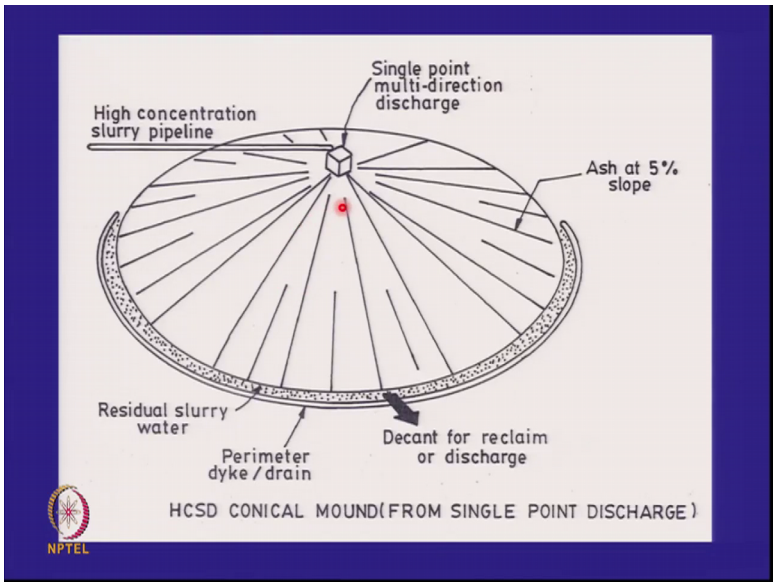

So, more from mine tailings, but it is now being adapted in India for ash as well typically the slope is 5 percent. So, 5 percent means what 20 horizontal to one vertical. So, high concentration slurry will have 1 in 20 slopes. So, it will form a conical mound, but it will very flat it will not be steep conical mound. So, how do I spread this? I can always say I will try a dozer, but the dozer will tend to?

Student: (Refer Time: 23:08) issue.

Yeah it will it will have a issue about getting bog down or rutting in to this because it may not have very high bearing capacity. So, you say no no I will use a light dozer, with the tractor with low pressure, but it may not work. So, the idea is to make as high a cone as possible. In when you when your material comes out of a track what is the height of the cone is which is formed well. You are two meters high and typically it will be two meters high, little more here little more there, but here we try to make let us take two meter higher and higher so that means, you are able to make more put more material.

So, typically this may be the height of the slurry pipeline from the ground may be 15 to 20 meters high, 30 meters you might make a little temporary tower, and allow it to fall from the top. So, you will get a conical. Now it has water it still has water, but it does not have that much water. So, what do you have you have a rock toe at the all around it on the perimeter, and then you have a small drain. So, that whatever water is coming out it

comes out through the rock toe, if there is no rock toe or no a strong material at the edges this will tend to flow out a little bit.

So, you are collecting residual water in this drain, and you may have a perimeter dyke all around it. So, you need to collect the water, but it is pretty minimum. So, high concentrations slurry pipeline, single point multi direction discharge the nozzle can be pointed in any direction and you get this cone.

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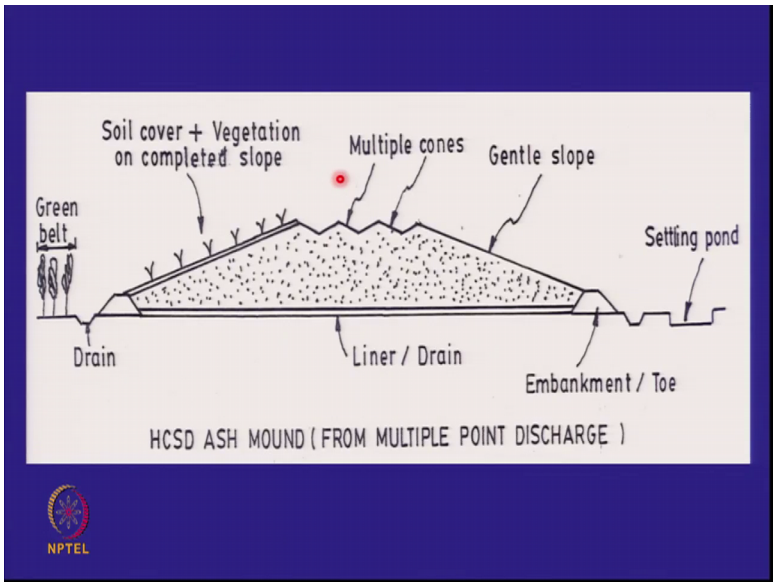

To be able to get a large capacity I have to then move the cone. So, my first cone which may be formed is like this. Now it is full please bring the discharge point here, my second cone it will be formed will be like this and keep on moving the cone forward and these overlapping cones will be your pond or mound for the high concentration slurry.

So, high concentration slurry disposal ash mound from multi point discharge, and after this is over you have a very high exposed area, please remember that and if it dries out ash is going to fly all over the place. So, you might put a soil cover and have vegetation on it. So, these are multiple cones and if you want to keep on moving it forward. So, you will get a finally, you will get the profile like this and like that. At the end there is an embankment or a rock toe and the water will be allowed to come into a toe drain, this is a porous rock toe with filters. So, that the water can come out if there are still some fines coming though you might want to have a settling pond.

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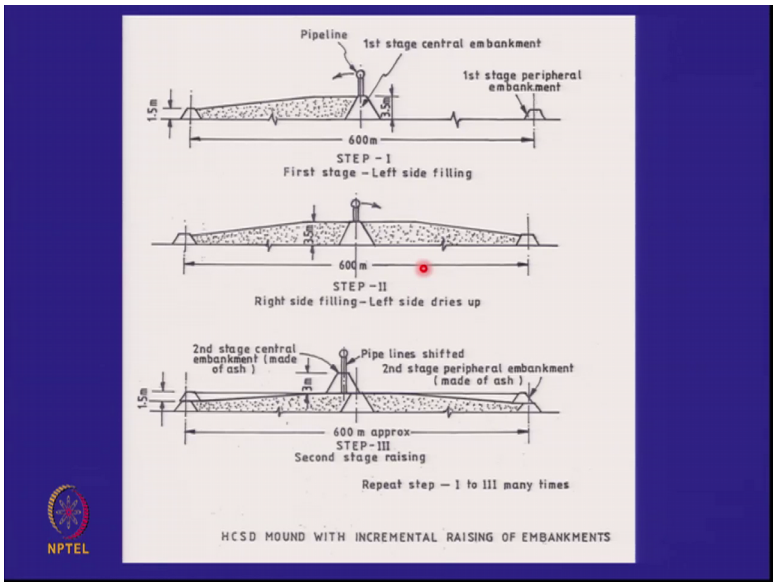

So, this is how high concentration slurry is disposed in one of the projects in India. This is how they are doing it they made the starter embankment of the starter toe and then they have disposed of from a central pipeline, the high concentration slurry and it forms your 5 percent slope, water comes out from here. Once it is filled they are taking it higher, but still remember this is this is going to be approximately 500 to 600 meters, it is not going to be 2 kilometers. As you raise this higher and higher, you are going to get 20 is to 1 then you can see depending on the height what is the distance that it will get. But typically it is beginning to look like an upstream raise pond, but in a low concentration pond one of the dimensions can be as much as 1.5 to 2 kilometers because water will drain from one will travel from one end to the other end by gravity flow, till the decant tower this is lightly different and you can raise the embankments can create your cone.

Now, let us make it even more solid; that means, remove the water from it treat it as dry or have 5 to 10 percent moisture, in it 5 to 10 percent moisture is not going to make it like a thick paste or is it when does soil begin to behave like a paste, if I have fine grain soil when will soil begin to behave like a thick paste and not like soil, can you tell me when soil will begin to behave in the form of a thick slurry, and not like soil at what water content. If I have given you clay or silty clay or clayey silt, what parameter do you need? To be able to tell me sir this much water content.

Student: Liquid limits.

Yes liquid limits. So, in the plastic limit to liquid limit, so as you go higher and higher plastic limit to liquid limit is going to be not the liquid state, it is a plastic state. It will still not flow you can make a thread right and beyond the liquid limit it is not going to behave like a solid medium it is going to behave like a thick slurry. So, depending on your liquid limit you can have 40 percent moisture content, 50 percent moisture content and then it begins to behave like a thick slurry. In sands we have all sands and silty sands where there is no liquid limit, there also you will have to be well beyond the saturation stage for the material to behave like a paste. When I bring the water content to 10 percent or below, then it is not going to behave at all like a thick paste, it is going to behave like soil. So, how do I dispose this is the same problem, we are going to get a cone when it is when you drop it you are going to get a cone from a truck. So, instead of a truck let it come in the form of a let it come on the conveyor belt why? And I lift the height of the conveyor belt very high, when I will fall down now you can understand why I want to have moist and not dry as it falls down, I do not want the fines to blow away. If it is moist they will hold them together by the capillary action.

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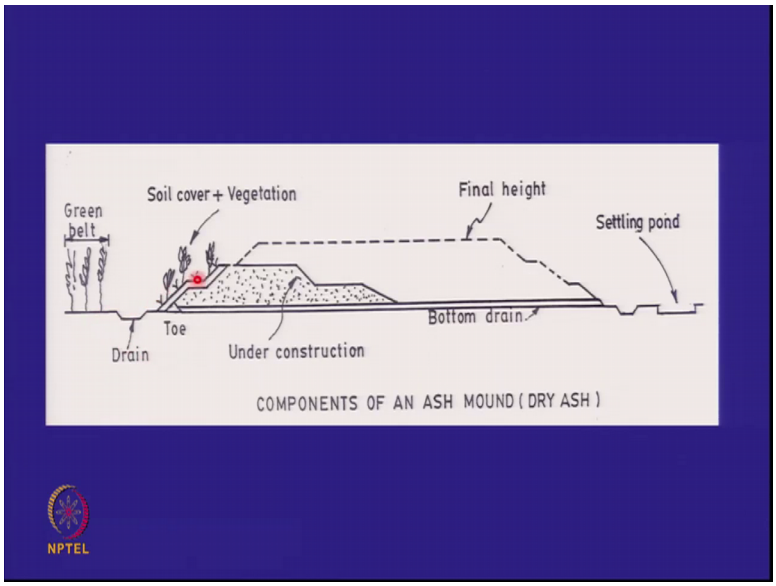

So, exactly like the HCSD but I am making cones; however, these are steeper what is the natural slope that you might expect? If it is sand or silty sand. So, less than 30 degree. So, 1 in 2.5 is something that you would expect what would be the angle of repose. So, I need an arrangement either this material will come in trucks them I will be horizontally spreading it by dozers and making building this up or if I want to high productivity, it

will come in the in a it is no longer coming in a pipeline, but it will come on a conveyor belt and I will raise the height of the conveyor belt say 15 meters high, and I will drop it from there then it will form the cone and then I will move the conveyor belt forward and complete this.

Now, here there is no embankment at the toe, does no rock toe to collect slurry water because there is no water. There is a drain here so that when it rains, and if there is water infiltrating into the ash or in to the mine tailings it will come down here and it will be collected in the drain. But per say we are not having a water at any structure all around this the parameter also that is the main difference of a mound.

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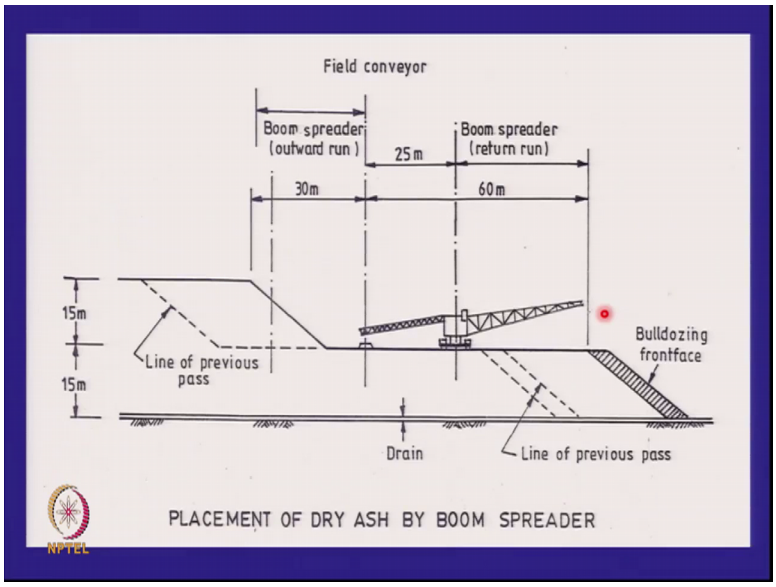

And this is the we have only one dry mound in the country at dadri, this is a something which is using a device called a Boom spreader. Now the boom spreader is no other function, but to make a cone. Now let me ask you if I make a cone is this loosely deposit material medium, dense material or dense material.

Student: Dense material.

So, pardon.

Student: (Refer Time: 32:01).

Yeah. So, when it is deposited it is in the form of a raining of the particles, normally this is loosely deposited material. Someone said the height of fall may have a role to play in it, but it is no comparison to a compactor or a vibratory roller, which is if you were to use it to with the dozer. So, most of these are loosely deposited mounts, where we are making a mound and your you cannot move this material with the dozer, if it if you want to move it with the dozer it has to come in lower quantities.

So, this boom spreader what is the advantage? This can go up and down like this, and it can swing around in this boom spreader, this boom can go up and down and it can swing around. So, here we have a boom spreader which will drop the material 15 to 20 meters high. So, this is the previous lift this is the future lift, here is the conveyor belt. So, the material is coming on along this conveyor belt, goes up this goes to the boom spreader and it is dropped at the moment what this has done is this has built this up this boom spreader has dropped the material on this existing slope and built this up then it will turn around and built this up. This boom will turn around completely and drop the material here, and in this manner just like you made the progressive cones, in the progressive cone the pipeline was being moved here the boom spreader is being moved. So, the boom spreader when this complete placement is over, when this complete placement is over, this boom spreader will be then dismantled and reassembled at this higher level and then again it start raising the height.

So, basically you are making cones and basically you are using a mobile top; that means, you make a cone and then you just shift it a little bit, shift it a little bit and they will overlap each other. This is the essence of both dry and as well as high concentration slurry disposal. It has a very large surface area which is exposed. So, you have to take immediate corrective action such that either there is local soil, which is placed on it. So, that turfing can be done.

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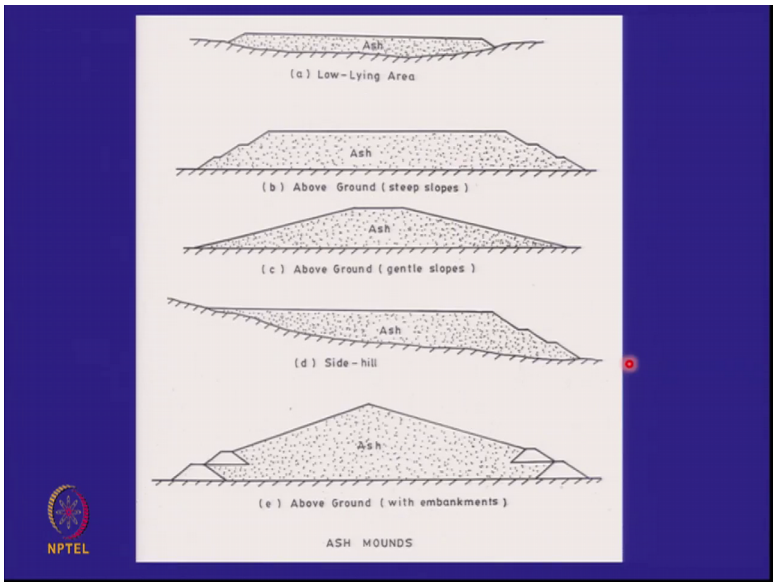

So, ash ponds ho I it can be an ash pond or an ash mound the shapes are going to be similar. The only difference is that when you are using lean concentration slurry disposal there are embankments at the edges up stream method or downstream method, and there is the slurry deposit waste in between. Where as if we are doing in the dry form, there are no embankments at these edges there will just be a thin layer of soil for vegetative growth. So, if you are having high concentrations slurry disposal or if you are having dry mounds, they will not have any embankments. Occasionally you will find that to raise the height, you might put some strong embankments at the sides to get your steeper slope then the gentle slope that we get with loose loosely deposited material.

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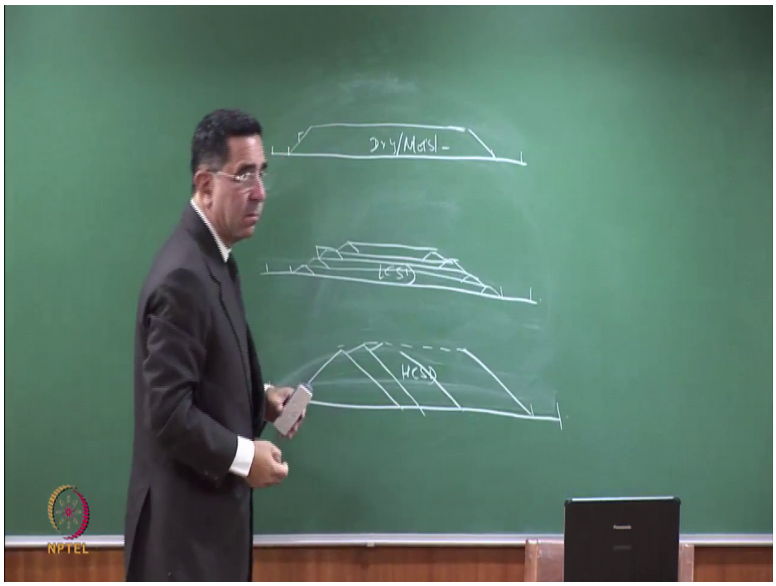

So, the forms and the shapes of the pond and the mound are similar, let me just quickly explain this, this was the land which was made available to me I left some distance at the sides. So, that I could put a peripheral role the drains the green green belt and all that. So, this is the area on which I have to make the store my waste. If I am doing dry disposal, it would be like this, if I am doing slurry disposal lean concentration slurry same area let us say this is 20 meter of high.

So, now in this lean slurry disposal I will start with an embankment right, and then when this fills up with the waste I will make the next embankment eventually. So, what I am trying to show you is both of them look similar, may be the steepness of the slope will be different. However, the shape the final shape whether it is a pond or a mound is identical, it is an it is some material which is raising above the ground, and if you are going to have high concentrations slurry disposal, then again same land we will start here, and then you may have like that who still in the end the shape is going to be the same.

So, remember to the same height, I should have been sorry this is a little higher, all the three shapes dry oblique moist, we are going to give you the same material has going to be stored above the ground level.

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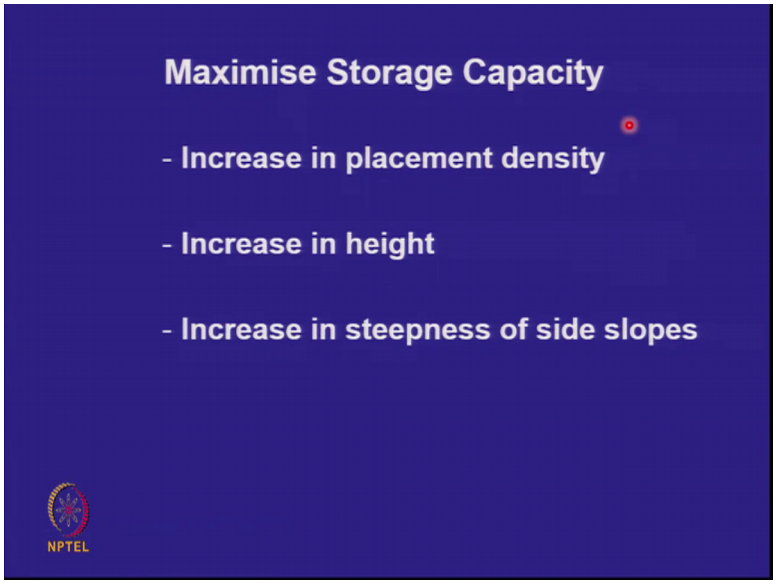

We want to maximize storage capacity what do we have to do? We have to increase the placement density; anything which is slurry deposited or just rained from the air or allowed to fall under it is own weight is not high density. So, we lose because we do slurry deposited waste or because we do waste which is falling from a height we do not have high densities.

If you were to use dozers and will compact it in layers, you would be able to accommodate perhaps 20 to 30 percent more materials in the same area. Because there is shortage of land we always want to increase height and I have told you that mostly our heights are 20 to 25 meters, but heights of 40 to 60 meters are not unheard of and finally, we would like to increase the steepness of the side slopes. If you look at the 3 diagrams which we had shown here you do want to increase the steepness of the side slope because when the slide slope is flatter the volume that you get is lesser and. So, I would like to show you this final diagram.

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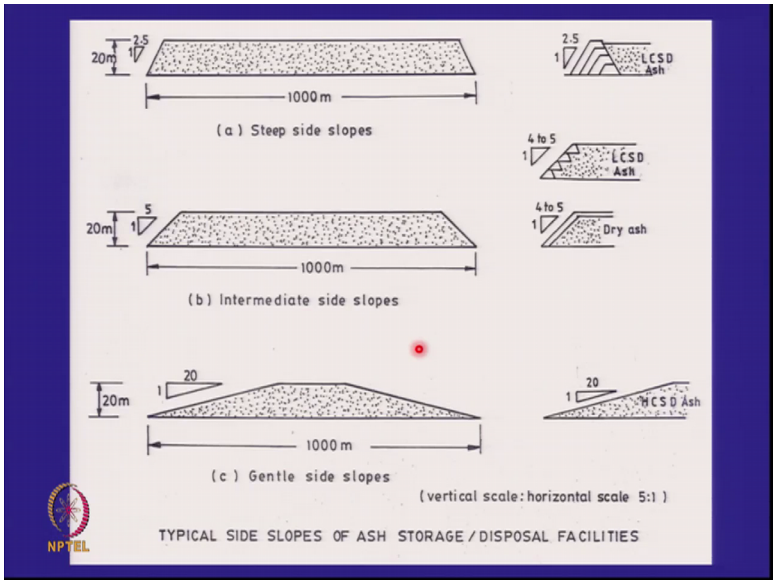

I want you to look at this diagram, this is one kilometer is the base the slope which I am showing is 5 is to 1. When does 5 is to 1 slope occur or 4 is to 1 slope either of the 2. When I am using lean concentration and I am raising my embankment by the upstream method I normally get 4 is to 1 because this is on hydraulically deposited.

Similarly, dry mound also I tend to get 1 is to 4 because this is loosely deposited ash. When I am using lean concentration slurry deposal, but I am using the downstream method of construction please note; that means, all this material is compacted then my downstream slope can be typically 2.5 is to 1. So, this is a steeper slope well you might say sir this is too much foreign soil therefore, we are losing this much capacity, but if I am making these embankments of the same material as the waste, then I am able to store a lot of more material. And when I use high concentration slurry disposal I may have a final slope of 1 is to 20, which will means that for the same base area this is less material this is higher material and this is the highest material.

So, it is important that we should design structures which have high density of the material, and if we cannot have high density of the material we should at least have high end slopes so that we can accommodate more material. So, these are the various ways in which the powder silty sands sandy is silts coming out of burning of coal or out of mine tailings is stored on land. So, thank you we will stop here and if you have any question. So, as I told you I think we have about more than a 150 slurry ponds in the country, 80 to 100 for thermal power plant waste and 450 or above for mine tailings and other types of waste. We are one dry mount that is the only one which is operational and only recently

we have started using high concentrations slurry disposal in one or two thermal power stations across the country.

So, lean slurry or lean concentration slurry still remains the main method of disposal, because maintaining the pipeline is much simpler, it is very lean it does not cause that much erosion and if there are less break downs, but with high concentration there is issue of brake down and even with a boom spreader please remember there is just one boom. If it breaks down then you have to have an alternate available. In a slurry pipeline you can you can lay two or three pipelines side by side, if there is a error in one place you can for some reason you have to stop that pipeline you can move to the other pipeline and dispose off and the garland inflow arrangement you have many points of in inputting the slurry into the pond. We will stop here and take up discussions in the next class have a good day.