Surface Mining Technology
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Lecture 55
Seabed Mining - II

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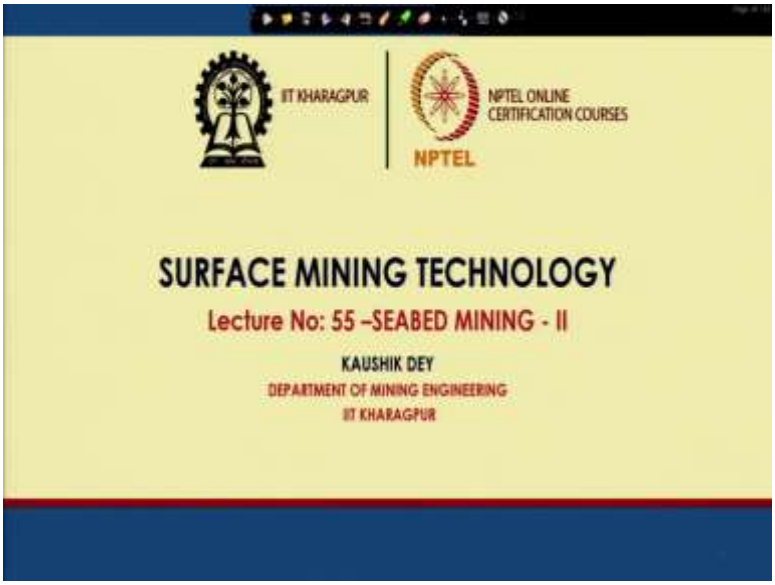

Let me welcome you to the NPTEL online certification courses surface mining technology. This is the lecture number 55, in this 55th lecture we will continue with seabed mining, this is the second last lecture on the seabed mining.

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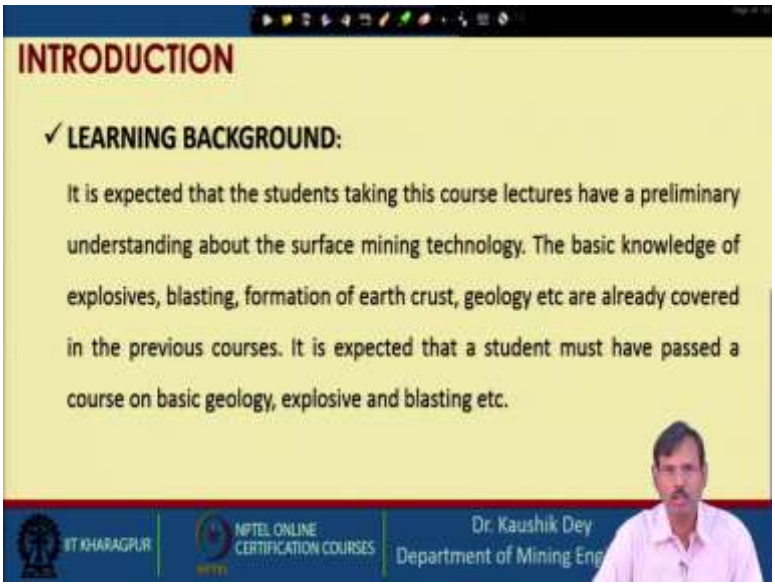

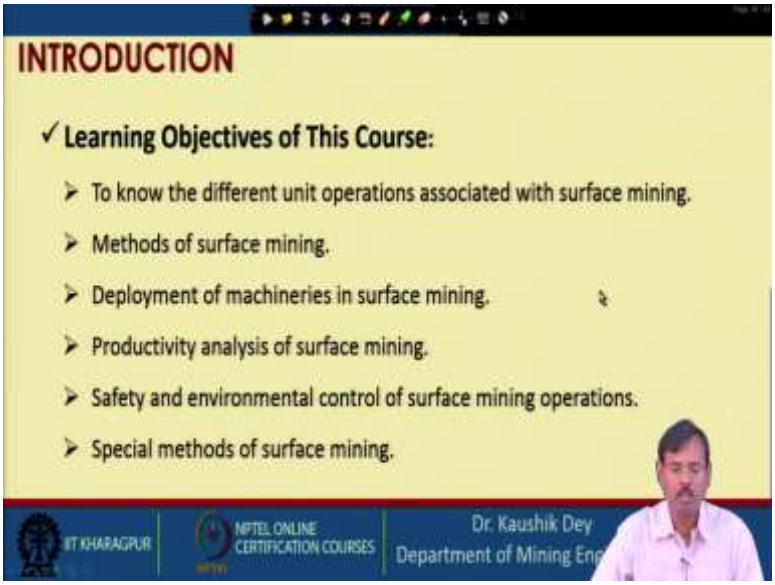

So, as we do let us have a glimpse of learning background required for surface mining technology course and these are the learning objectives for surface mining technology course set for this time.

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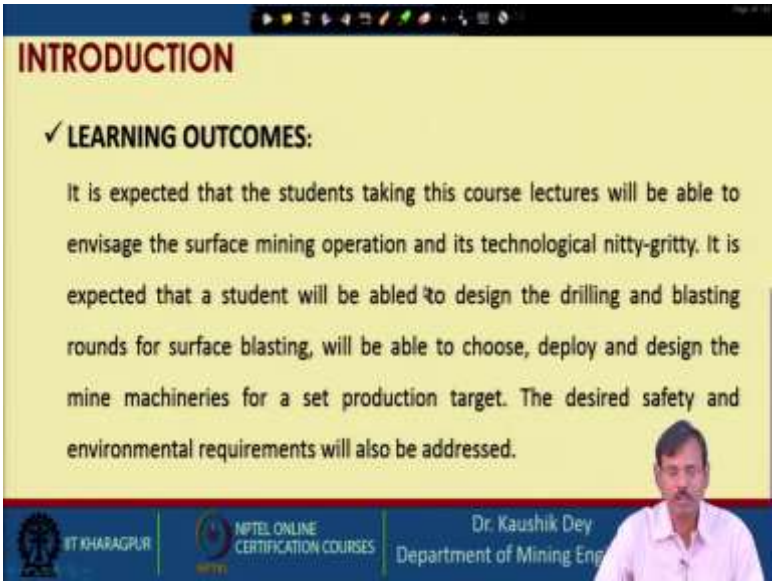

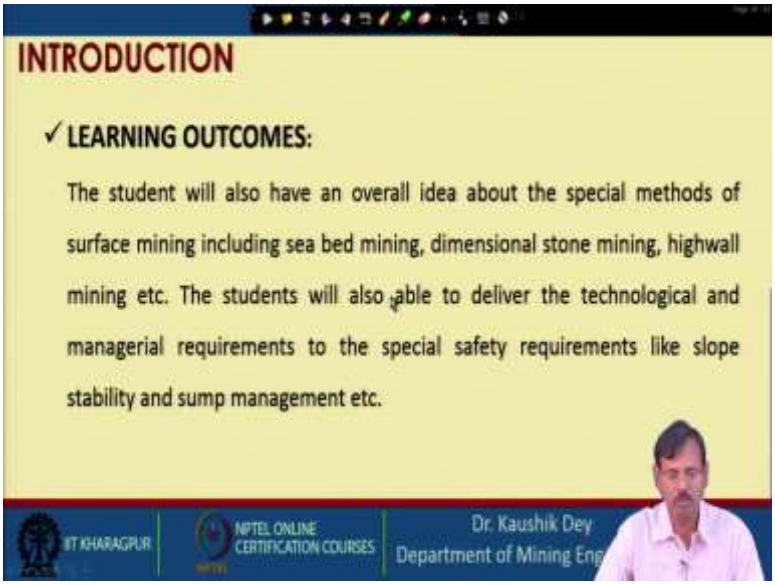

And these are the expected learning outcomes for surface mining technology course, these are few more learning outcomes.

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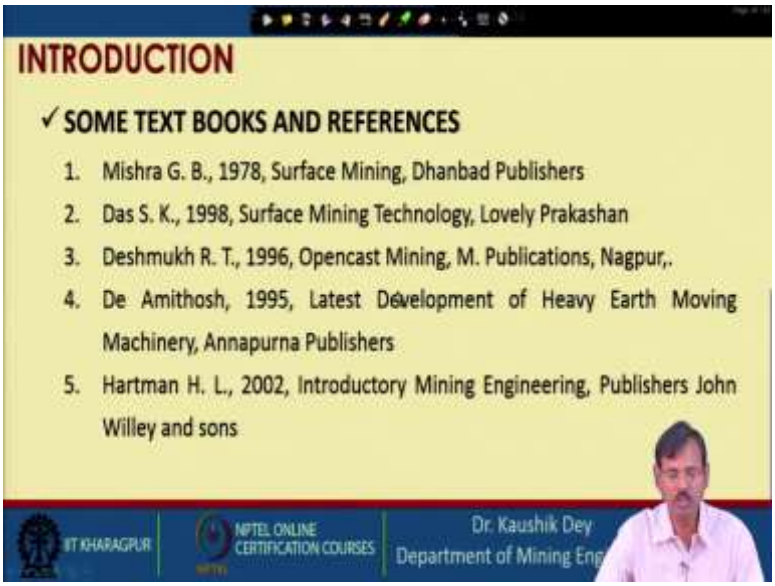

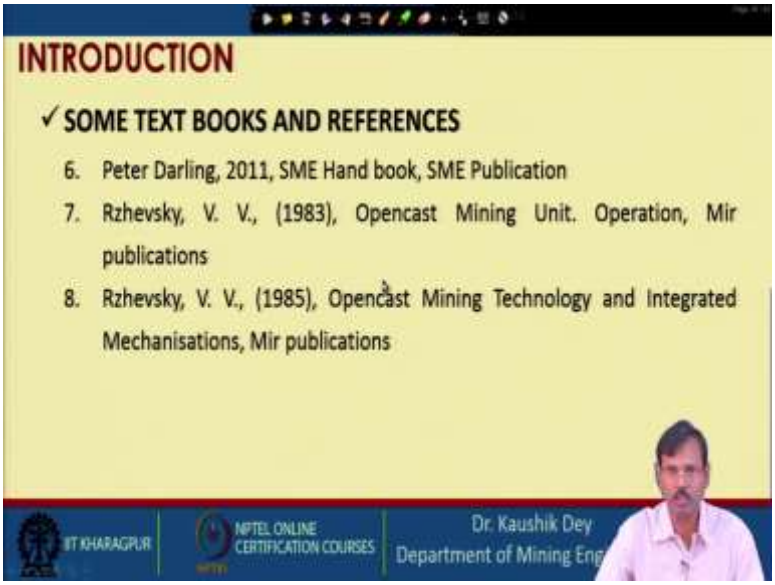

These are some of the text books and also references for the participant of this surface mining technology course.

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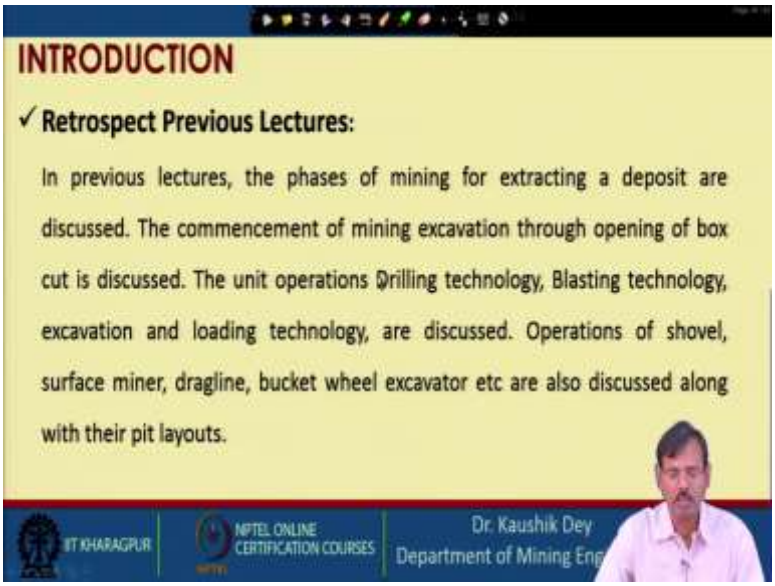

And let us retrospect so far whatever we have covered. We have covered the current status of surface mining in the country and over the world and we have also covered the phases of extraction and deposit. We have also covered the commencement of surface mining through opening of box cut, we have also covered the excavation techniques that is the drilling and blasting technique and excavation by blast free techniques that is excavation by ripper, excavation by surface miner, excavation by bucket hill excavator.

We have seen the, use of excavators and loaders for the excavated rock mass, we have seen the transporting systems that is the dumpers etc. these are already covered, apart from that

special excavation techniques like high wall mining and dimensional stone mining is also covered. We are now continuing with seabed mining methods, in seabed mining method in last class we have seen what is basically a seabed mining.

What is the acceptance up to which a nation can carry out its seabed mining? What is the rule of seabed mining, how that is being governed by the different bodies and how the exploration can be carried out for seabed mining? This is covered in the last class.

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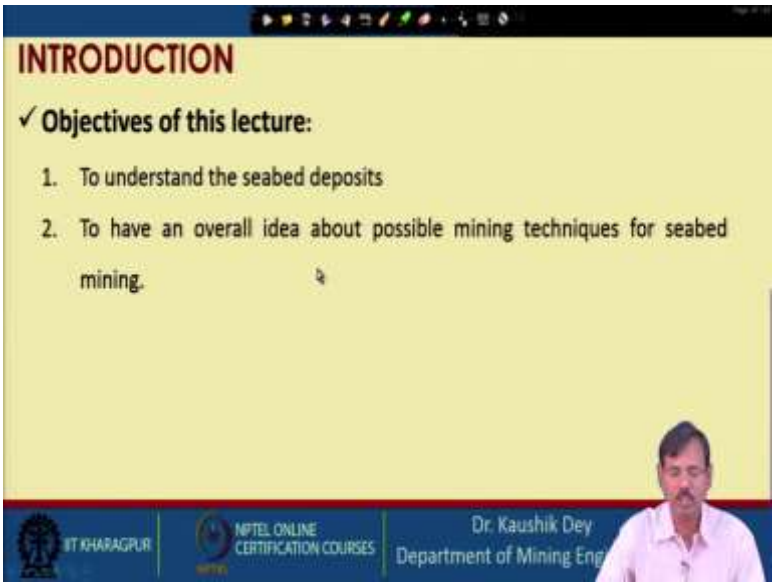

So in this class we will see the different possible technologies in details though a video of the same already shown in the last class, but we will see what are the different methods of excavation available for the surface mining as for the seabed mining, which is a part of surface mining.

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So we start, during starting, let us see one such video. This video is basically showing how the excavation is carried out. We have seen this video in the last class also, but as that time we did not discuss the excavation, as we are excavating this in this lecture let us see.

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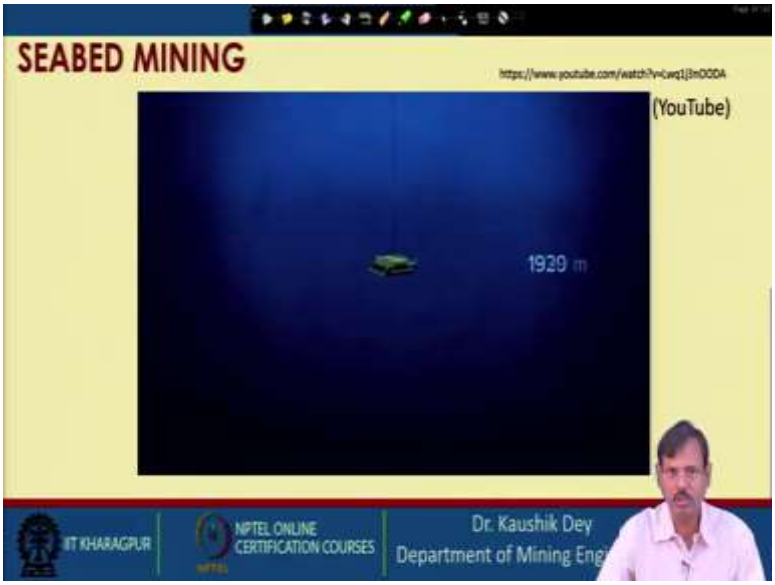


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So the method of excavation showing here is basically same as which is carried out in the normal surface mine. That means the horizontal slicing is carried out, so this machine is also carrying out horizontal slicing, and this is moving based on its crawler. So it is a self-propelled equipment, automatic self-propelled equipment and this equipment is basically moving and taking the slices. This is taking the slices and the slice material which is being excavated by this cutter arms, so this cutter arms are excavating this material, so that material is basically taken out.

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You can see the slices taken in the side can be seen, these are the number of slices and these slices are taken one by one. So the movement of this cutter head is basically guided by this, from the ship by the operator cutter head is automatically moving and cutting the material, cut material is sucked by this slurry transportation system, and this slurry transportation system is basically throwing this slurry material, this cut material in a slurry form towards the ship.

And in the ship this cut material is dewatered and then the remaining wastewater is discharged into the sea. You can see the solid part is taken away and the rest part of the water is again discharged back to the sea. This is the common technique; this is an animated video showing here.

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Now let us see our Indian status related to this. We are having ministry of earth science and this has a status and become a pioneer investor and has been allotted with a site of central Indian Ocean basin by the international seabed authority for exploration technology development for poly metallic nodule of mining. And as per the National Institute of Oceanography it has been found significant manganese nodules are found there and India is thinking for commercial exploitation of that one.

So ministry of earth science is also responsible for development of a reliable deep sea mining system, harnessing the resources from the ocean will help to meet countries growing mineral requirement as in near future. So Ministry of earth science is already behind this seabed mining, so far it is not commercially practiced but experimentally it is carried out in the Indian Ocean.

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SEABED MINING
place
Some of these minerals lie scattered
on the surface of the sea floor
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place
In India, the government is planning
to invest more than $1 billion to develop
and test deep sea mining technologies
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So this is the video from that experimental system, so subtitles are already given in this video. In exploration it is found, it is lying scattered in the seabed itself and government is investing 1 billion dollar for this. This is the sample collection instrument, and metal like nickel, cobalt are found in this.

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SEABED MINING
place
Mining companies believe that
seafloor operations would be less pollutive
than traditional mining
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place
But conservationists want to see
regulations put in place before
deep sea mining booms
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place
surface water and all these things.
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So this is the experimental work carried out by Indian authority and these are the manganese nodules. So this is the experiment carried out, so this is the collected nodules, this is the collected deep sea nodules. So, so far this is the advancement from the Indian side.

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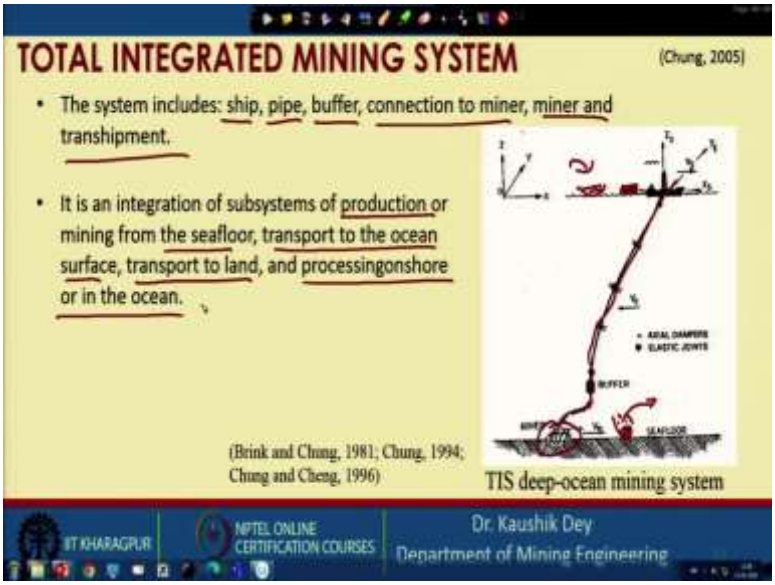

And now, let us go into the generalized technology for which everyone is thinking of so, yet not we are confirmed that this technology, how far it will be viable but this is the proposed system. In the proposed system, our requirement is ship, pipe, buffer, connection to miner, miner and transshipment, so this is the requirement. What is in a nutshell, the system is we should have a ship, the ship must have the attachment of a number of transportation ship.

So number of boat which will take the material and shift back to the port for the dumping, so there will be a number of, so this is the transportation system, number of boat as a transportation system must be there. A cutter head or miner is there, this may be of self-propelled may be of propelling guided by the sea, but expected that it will be a self-propelled one. Then this cutter head will cut this one on cutting when the material is cut immediately the material will be sucked by this pump.

There is a sucking pump so that sucking system will take this one, then a slurry transportation system is made and there is a buffer. Then this is allowed to shift up to this then the dewatering will be made and the main material will be transferred to this one, and this will work like this.

This is a general form, so as an integration of subsystem production from the seafloor transport to the ocean surface then transport to the land and then processing of onshore and

then the system has to carry out. So in a nutshell this is the overall system of the seabed mining and there are variations in this miner, there are variations in the transportation systems that can be made.

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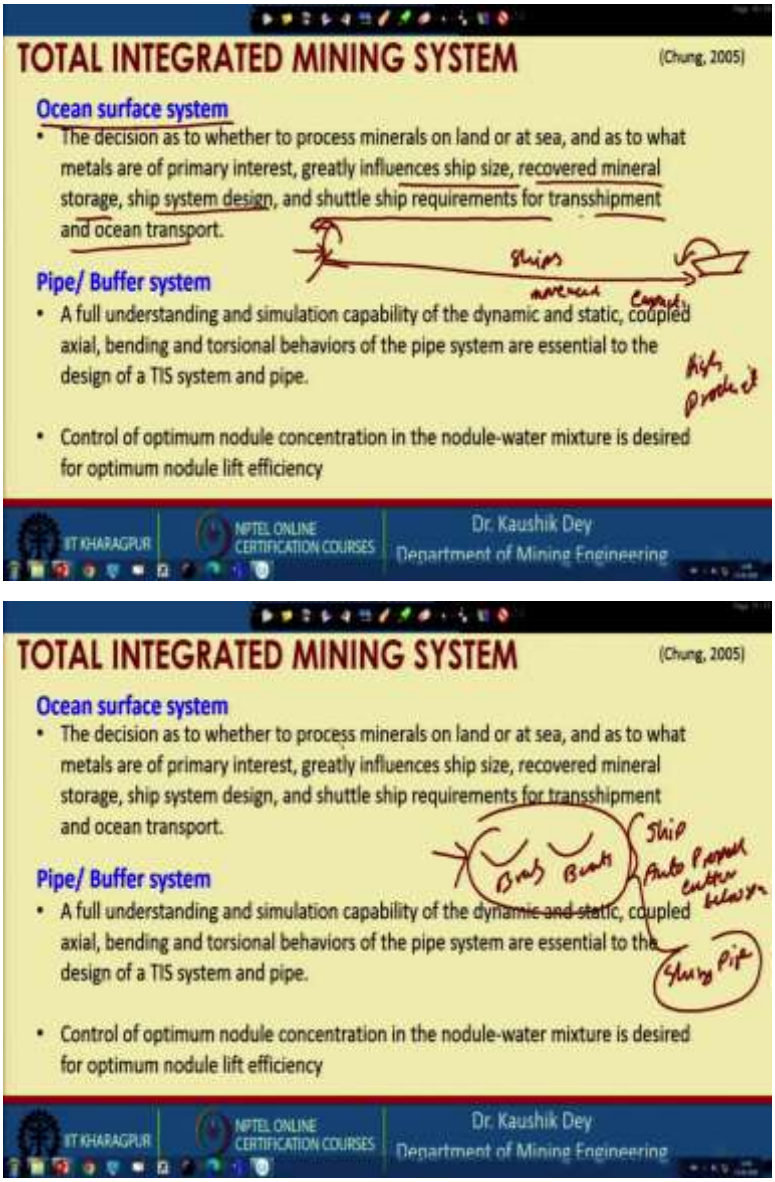

So, first is the ocean surface transportation system, we are coming from that ocean surface transportation system, these are the process minerals so that the transportation can be carried out. So ship size, recovered mineral storage, ship system design, subtle shift requirements for transshipments and ocean transport.

These are the essential part, that means when a ship, that is the excavating ship is operating at this place and the land is at this position, from this point to this point how many number of ships will be there? What will be their movements? What will be their capacity? And what is

the transfer system from ship to this boat and here unloading system from the ship to the boat is also very, very important.

Generally, these systems are in general not very fast system, so a proper transporting system has to be made so that the high production capacity can be achieved. Why this is required because the capital investment for this is very high, the ship is very costly. The auto propelling cutter below the sea, so that means all the cases if it is electrically operated ceiling of those systems, all these things are very, very important.

These all are costly, slurry pipeline system maintenance in this high wiring condition, wear and tear condition is also costly. Apart from that keeping those transporting boats those are also costly. So that is why the total system expenditure capital expenditure pertaining to this system is very high and that is why if a high capital intensive system has to be incorporated then the production requirement is also very high in this case.

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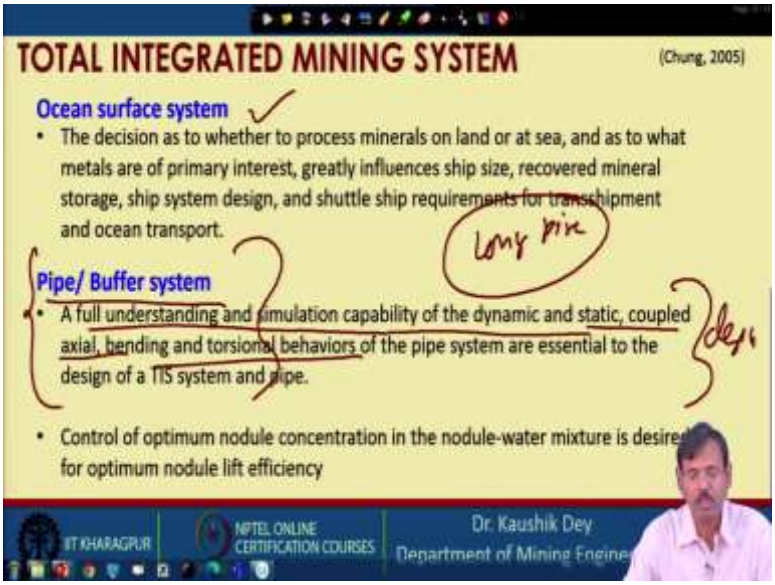

Second is that we have to think of the pipe and the buffer system. If a fully understanding simulation for dynamic, static loading, coupled axial, bending torsional behavior then the load dynamic load due to the waves storms, all these cases has to be incorporated while designing this complete system. The designing of this pipe or buffer system is itself is very challenging, in fact ocean surface transportation system also can be a pipe system but in that case a long pipeline required, which may not be possible.

It is over say 100 kilometers, that is not possible that is why ship transportation system may be a better option for this. So these are very, very important aspects but this point is little bit

acceptable, but here the dynamic loading of the sea is very, very challenging and needs to be taken care while the designing is made for this system.

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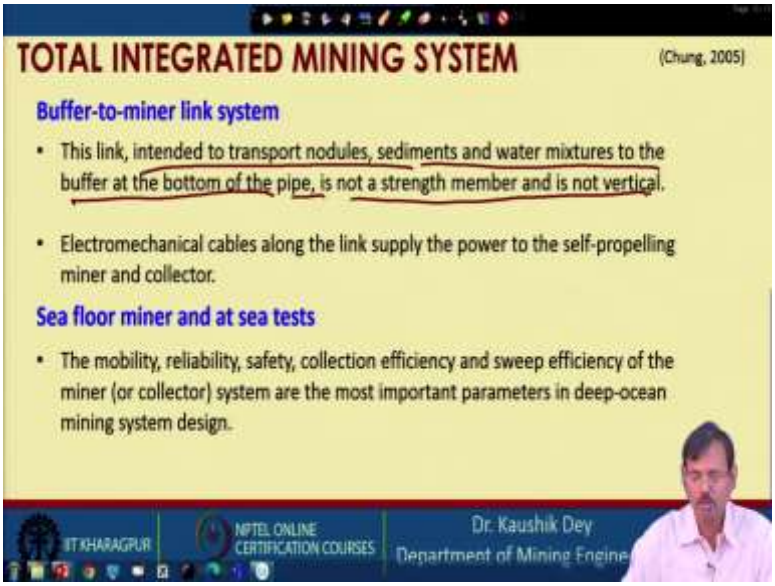

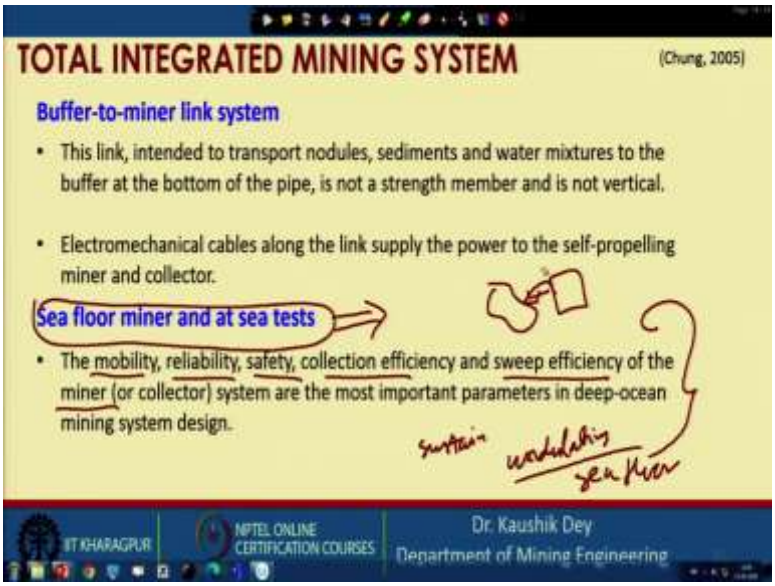

Then buffer to miner link system is also very, very important. So that the miner should have the power to send the slurry transport, the material to the buffer can be made very easily. So intended transport nodules, sediments and water mixture to the buffer from the bottom of the pipe, is to be designed very suitably.

So this electrical and mechanical that linking is very, very important for both the cases, and final one is the automated seafloor miner, this designing itself is very, very challenging, its mobility, reliability, safety, collection efficiency, sweeping efficiency, and minor efficiency

and while these all are there, apart from that it is also the ability to sustain in the undulation. In undulating seafloor how this will work that is also very, very challenging.

So in undulating condition it has to carry out mining, it has to carry out movement. So all those are very, very important and that has to be taken care by this. Suppose a big chunk of boulder is coming in front of the miner then how the miner will go, whether how it will detect it, how it will avoid it?

These things are very, very important and all these things has to be controlled, has to be suitably designed. It should have a sufficient artificial intelligence here also as well as it has the real time control along with the operator sitting in the sea. So these two parts has to be incorporated for the miner which is designed for this excavation system.

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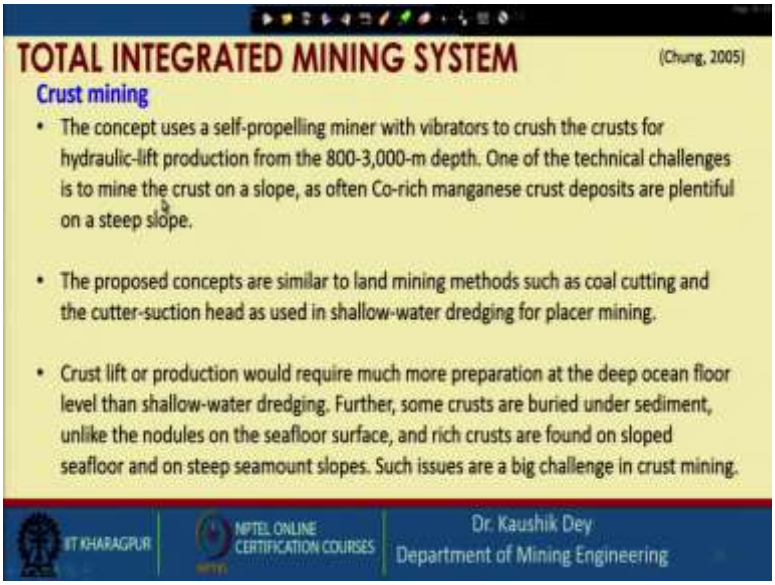

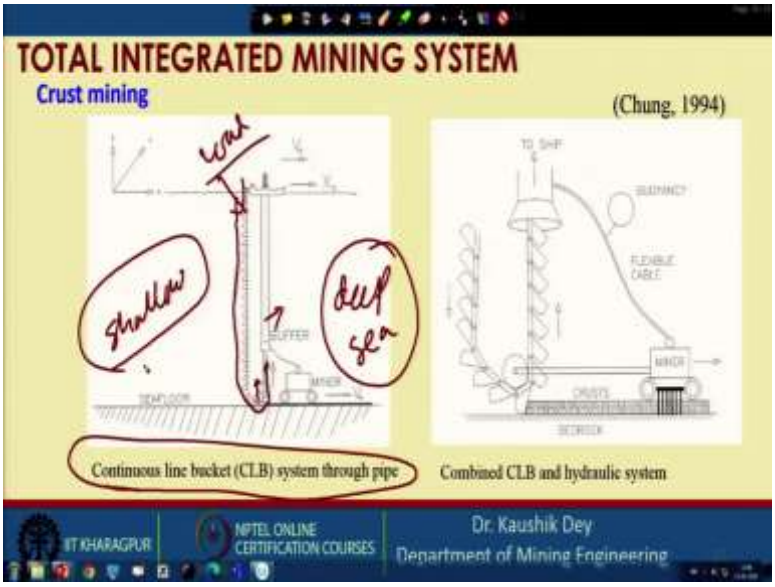

And, generally the crust mining has to be carried out, so this is basically the cutting of the material so the material has to be cutter head has to be provided. And this may be a possible excavation system where from the sea the bucket chain excavation is carried out. This is a one type of bucket chain excavation, but bucket is loaded with a guiding wheel at this position. Then this is basically excavating this material and this material is then not only coming here it is also sucked at this position, so take out the material to the surface itself.

But this type of continuous line bucket system, this type of excavation system probably always not possible for a very deep sea, the reason is then the load coming on to the cable will become very high. That is why there are some limitations but for a shallower depth, this system may be applicable. These things are very, very important and that must be considered while designing these type of systems. So this is a combination of both the system, continuous line bucket and hydraulic system.

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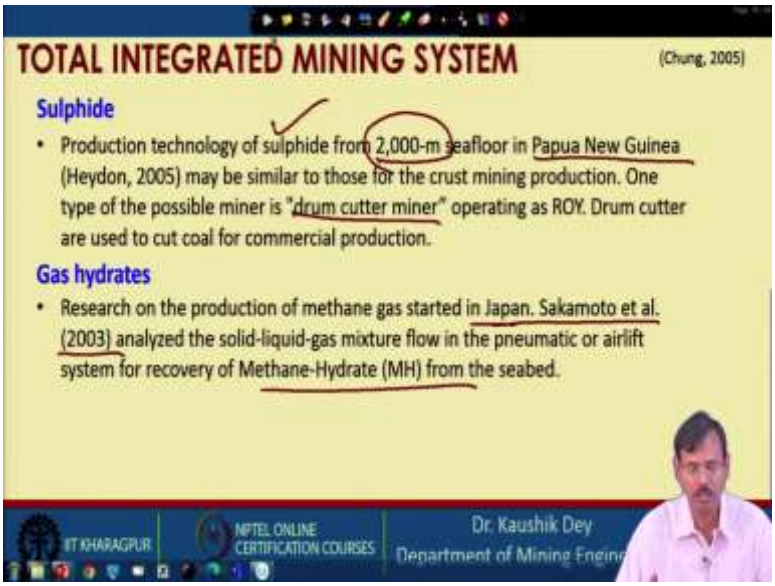

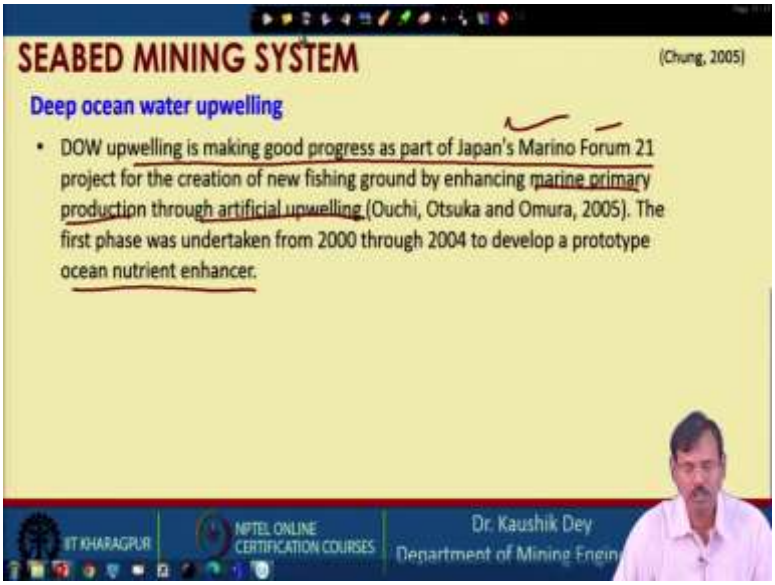

These are some of the experimental case studies in Papua New Guinea from 2000 meter deep seafloor, sulphides are experimentally excavated using a drum cutter miner and the gas hydrates are excavated, started excavating Japan in 2003 and methane hydrate is also experimentally excavated. So these are the experimental system which is used.

And this is the one another case study, deep ocean water upwelling is Japan's Marino Forum project which is continued. Here the artificial upwelling is carried out by enhancing the marine primary production and in which the ocean nutrient enhancer are used, which is basically a water quality control system in other way you can say.

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So apart from that we are having provision, we can carry out underwater blasting also prior to excavation of the material. There are some shorts, videos are available for underwater

blasting, though these are not in for the deep sea mining but we can have a view of this videos which are underwater blasting.

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This is for the how the charging is carried out in a underwater blasting, say the diver has to jump, then the diver has to put the explosive inside the drill hole then he has to place them. This is the explosive without detonator he is placing, now the detonator and explosive is placed this can be either electrical detonator or the detonating fuse or nonel can be used for this type of excavation system.

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If the electrical detonators are used, then also it is properly sealed so that there cannot be any charge loss. Now the best part is that it need not to be stemmed, it is auto stemmed due to the height of the water column the stemming is already achieved in the hole. So after this blasting you can see the cracks here, how the drilling and blasting is carried out let me show you in this place.

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Generally, from the ship itself, say if this is the ship, from the ship itself the drilling is carried out. While the drilling is carried out during the drilling, casing is provided. Basically drilling is carried out along with the casing and the full hole length is expected to having the casing.

Then the casing is kept in place, drilling rod is withdrawn and after that the charging is carried out after charging the casing is withdrawn from this place and then the blasting is carried out at this place. So the important part is that there is a likely chances if the casing is removed ahead of the charging then the hole may collapse.

Because the sand materials are lying at this position so the casing has to remain there, this casing has to remain there, so that the hole will remain intact and the casing will be removed at the final stage only. So that is the way generally under water drilling and charging is carried out.

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This is a video one can see for the underwater blasting, this is the underwater blasting you can see the enhancement of the wave. These are all in dam not in actually in the sea bed, so raising of the water levels occurs; basically a wave occurs it can be understood. So this is another one, these are some of the underwater blasting.

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So this ends the, these are the references, this ends the seabed mining. Thank you.