Mining Machinery
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Module - 08
Lecture - 41
Transportation Machinery for Surface Mines

Welcome. We are discussing Mining Machinery. So, on that you know that is mining operations is a unit operations. There are different activities right from your mine preparations, excavation and loading and then, transportations, then dumping, then site reclamations. These mining unit operations are now it is all mechanized.

So, different phase of mining, different unit operations we will have to get different machines. So, as mining is excavating from the mineral deposits, the valuable minerals and removing the your overburdens and then, it is basically handling a huge quantity of bulk materials.

So, this bulk materials handling whether you are drilling and blasting and then, you are excavating, you will have to transport it either from the that is just type the overburden; from the top of that, when you are taking from the seam, above the seam you are taking it out and placing it somewhere as a dump.

Or you are taking the minerals, if it is a coal, you will have to take it to the thermal power stations; if it is an iron ore, you may have to take it to the beneficiation plant and after the beneficiation, you will have to give it to the metallurgical steel plant or things like that.

So, that means, the transportation is a very very important job and that is both in surface mining and in underground mining. Also, there is a transportations in underground mining will require even how will you take the men and materials down there. There is a separate type of transportation systems are there.

So, that in mining transport, when we say there is a two types of transportation system; one is for surface mining, another is for underground mining. So, in our these discussions in this

module, we will be discussing some of this how the transportation is carried out in the surface mines and subsequently, in underground mines.

Today, I will be discussing as a general overall concept and idea about what are the different types of machinery is used. And in our course, we will be taking up some one or two very important machinery for a detailed discussions.

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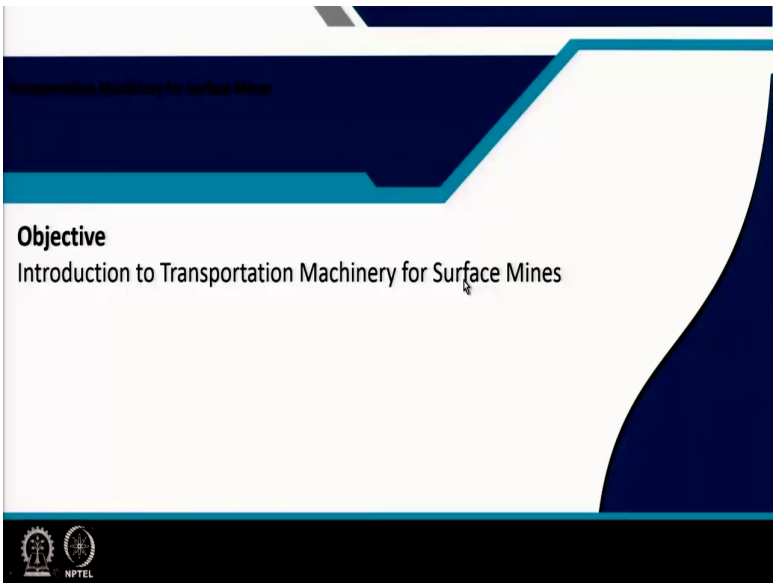

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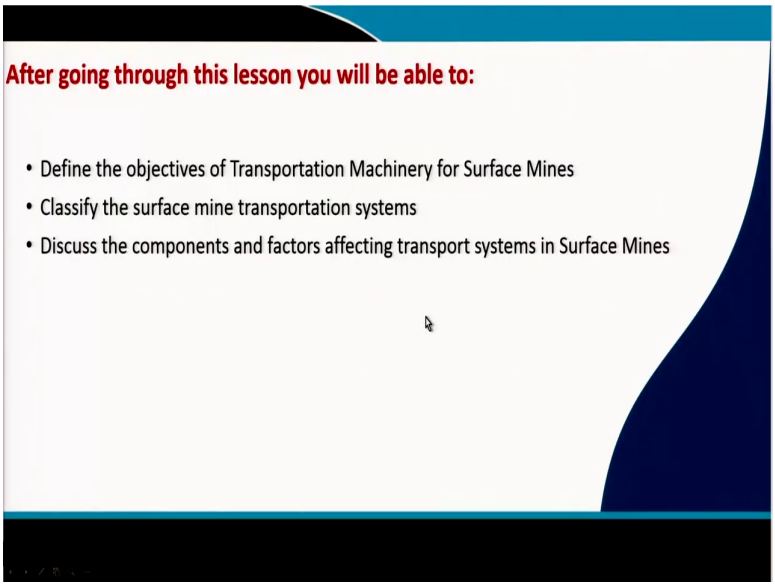

So, coming to this that our main objective is today to give you an introductions so that after this class, you should be able to define what is this objective of transport machinery, that you will be why you should use this transport machinery and if you are selecting or operating it, then what type of performance you expect from it. And then, you need to also we can classify that doing these operations depending on the method of mining, what are the things you can do.

And then, second thing we will be doing here after these things, you should be able to tell that what are the factors that will be affecting and because of these factors and because of the situation, what are the different types of equipment systems are now at present being used and how they are being developed and what they can do. We will be just giving a general introduction.

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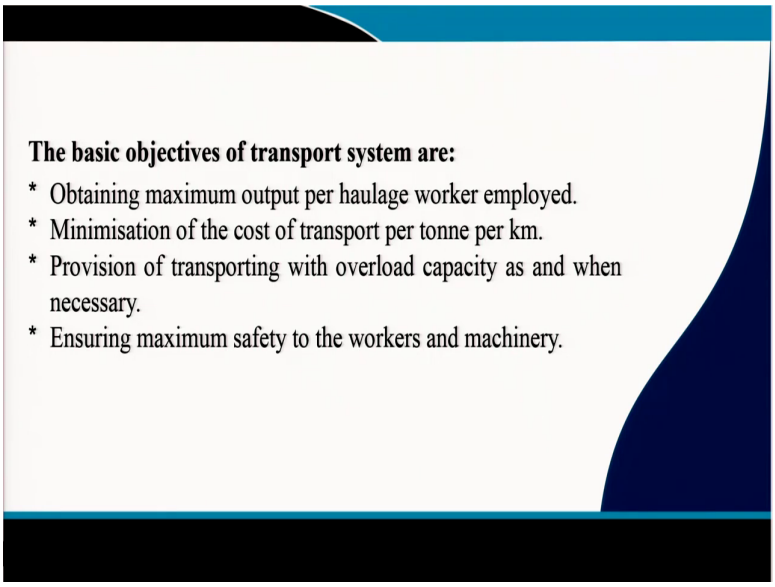

So, first, let us talk about the basic objective. So, what is that basic objective of transportations? Transportation is nothing but you are going to take material from one location to another location. Now, when we talk about this location; that means a transfer of material, it can be vertically or it can be horizontally or it can be a mixing of it.

So, that means, the whole mining transportation is done for taking out the material either a vertical or horizontal transportations and there our objective is to optimize the that is your maximize this output, we want to do in a per unit time by our haulage system, we want to carry maximum material.

Then, other objective is that to do that, we should see that our less energy is consumed, our less manpower is deployed, less money is exactly invested for that. Because that ultimately,

the if you are that amount of cost which will be incurring in transportation that will be going as your operational cost. So, that will have to be subtracted from your selling price.

So, that is why in your whole business, you will be your objective is to minimize your this operational cost. So, that is why your maximize the output per haulage. And then, this minimization of cost, you will have to see that what exactly your objective; your how many how much tonnes and how much kilometer. So, that is why a the your Key Performance Indicator, a KPI is tonne kilometer per day; that means, how much tonne of material, how many kilometers you have taken.

Say in a mine, he may take say 1 million tonne of say coal can be taken out say through a distance of say 10 kilometer in 1 year or it may be 5 million tonne going in a say 500 meter distance if it of thermal plant is there. So, this is exactly the tonne kilometer, total how much has been taken is of importance.

Similarly, your have to have an objective a particular flexibility if demands vary, that your objectives of your transportation system that it can take that much of overload when it is necessary. So, that is also there and of course, your another objective is the safe operation.

Now, transportation, it will be exactly related with a movement and movement with load; that means, a huge quantity of mass, it is moving at a velocity means as a momentum. You are working with a high momentum means high energy. Now, there is a heavy chance of getting energy released and energy uncontrolled; where, release can cause to accidents.

And you will find that the transportation area in a mining is the highest prone to accidents. So, that is why to minimize accident, that is a trouble-free operation is another objective of your surface mining transport.

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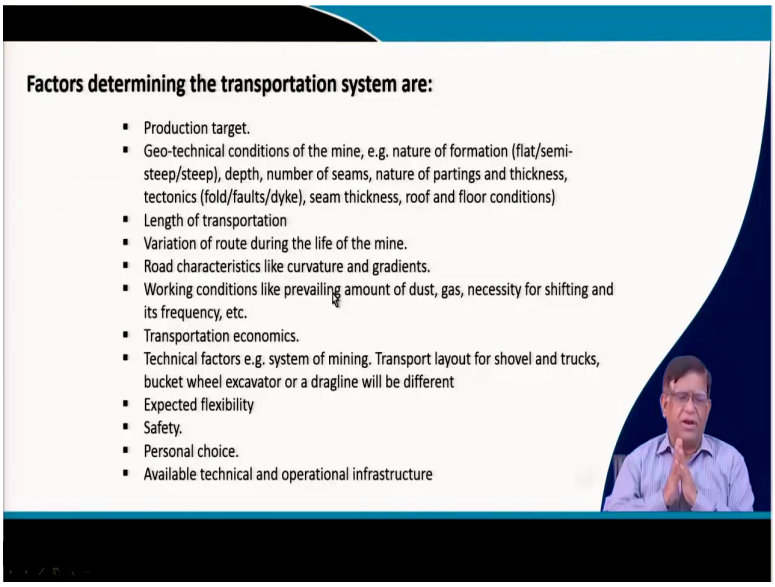

Now, so, what exactly that factor that we will have to consider before going for a machine; what type of machines exactly, we will be selecting; what type of machines, we will be deploying and then, what type of mechanizations, we will be innovating; all these things will be depending on certain factors, which is exactly the production target, how much material.

So, for example, this production target will tell what is your total turnover, how much money you are going to make. So, your machinery will be procuring entering, it is depending on ultimately everything boil down to a money; how much money you will be making that is your production target.

Now, that production target, if you are working in a gold mine, in a gold mining that your how what is the concentration of material? That is you may handle say 5 million tonne of iron

gold ore; but in that, if that your concentration level is how much? That means, how much money it will get fetch, once we extract gold out of it.

Similarly, that is your the production target, if it is you are going for producing say bauxite, then what is the market price of your aluminum and that will be depending on exactly what type of mechanization, what type of machinery will do. But moreover, one thing you know that the target is within a particular time frame, we will have to get within this time.

Because if you start producing thinking of mining and then, you will be doing taking 10 years of time for taking it out because of it takes a lot of time for transporting. Then, exactly you will loose the opportunity that is why target and its marketability that is to be decided. Then, the geotechnical conditions that is your what type of condition you are there, how deep you are cutting, whether this deposit is very steep, then whether you will have to go on doing a round away to go over there.

So, that is geo technical conditions. What is the thickness of the seam; what type of overburden material is there, whether it is a very lose; how exactly that material that responds to the rain water during the rain that is everything going to collapse or everything will be very slippery, you cannot remove a truck. So, those things are also very important.

Similarly, the distance to which you will have to transport that is normally the word used in mining is lead. Lead distance means in a surface mines from the phase to that where you are exactly going to deposit, that distance is called lead distance. In a mine that lead distance for overburden dumping, it may be 2 to 3 kilometer to 5 kilometer; but if it is more than that, the cycle time of the machines will be increasing.

So, you will have to make a large number of fleet. So, that is why you will have to consider that factor by which your investment total in the transportation machinery whether you will be going a very high large size of machine or you will be getting a small size of machine.

If it is a small size of machines, you will be having more number and that depending on the distance to be travel, at what speed you are going, you can find out that how many numbers

will be required. So, that when you are going to study transportation machinery that what will be the number of equipment required, how what should be the capacity of them, this will be discussed and we will have to study about that to become a mining engineer.

So, variation of the route during the line life of the mine because mine is a dynamic things; though mining is a temporary operation and it is a very dynamic, every year the mine shape, size all will be changing. Now, depending on this changing whether the machines which you have selected, it can adapt or is it flexible to change according to the change of the mine which is demanding.

So, similarly, the road how the curvatures will be there. The roads if it is a vertical curvatures, your horizontal curvature, both type of curvatures will have to be decided so that safety is not affected. Similarly, the most important thing is the transportation economics; how much money how much that is your how much lakh of rupees you are going to spend for transporting from the mine to your plant.

That is the transportation economics is a multi-variable function, that is it will have to have how many persons, you will have to deploy; how many equipment, you will have to deploy; how many maintenance person, you will have to require; what type of energy, you will have to give for this machinery, all these factors when it is taking, then you can develop a econometrics model for the transportation. So, that the cost of transport can be determined.

Similarly, that is your what are the technical factors that what type of system you are taking; a cyclic mining or a continuous mining, it could be depending on the type of primary mining equipment you are taking, depending on that the material is produce continuously or intermittently, then what combinations you will be taking, those are your technical factors will have to be taken.

Say sometimes if you are using a drag line, as you have studied in the drag line machine, there is no need of any truck for transporting the this is your overburden, there you do a direct casting. So, it will be exactly contributing very positively to your transportation cost.

So, similarly that compatibility of a transporting machinery with the excavation machinery is to be seen into and of course, the factors that affect is safety and also, personal choice. I will be telling you say about at end of this today's class, I will introduce you that how the Brazilian have started taking a equipment called Railveyor; it is a it is a combination of conveyor and railway, together they are making giving a name of Railveyor.

So, that exactly the owner of the mines he has got a vision and then, he make a innovative study and then, some people come and put it and they accept it. But in India, we have seen that we do not have innovations. In the mines, you will find that is years and after years, no new technological introduction has been made.

Indians have never introduced any new innovative technology, that is why my dear friends, I tell you it is while you are studying machinery, think of innovating new system by which you can go.

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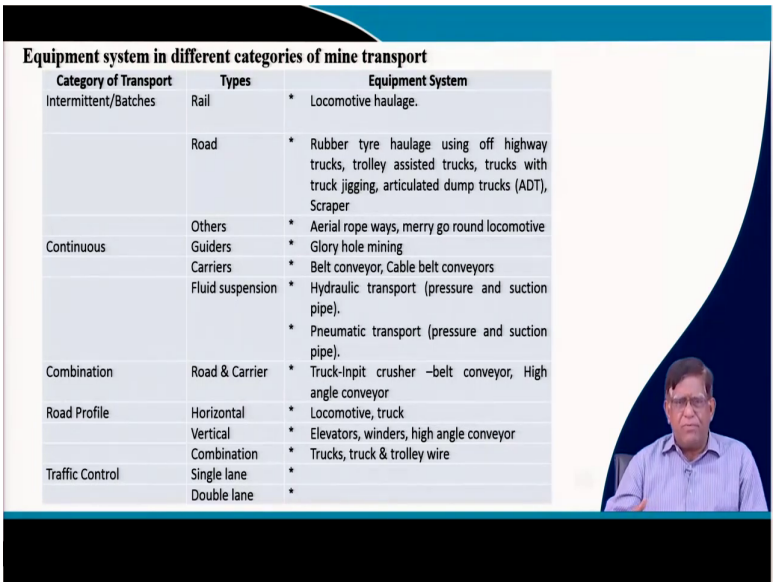

Now, let us talk about that what are those as we are not doing anything new that what existing over there in the world which our mining has our mining industry has used. Now, it is a little bit of that new innovations people are trying, but they are not taking that much risk; they do not invest, they do not dare to do a research that is why Indian mining industry has not come out with a new transportation technology for its own benefit.

But anyway, there are different category of transport that particularly, we have got intermittent transport. That is, it will be batch by batch things can be taken, just like in railway a number of wagons will be connected, they will be filled and then, they will go, carry after that the empty wagons will be taken up, again they will be putting a batch of things that is a batch type of transportations and this railway, when we go, we talk about the locomotive haulage.

So, that is we will have to know about this railway engine, how it works. Exactly the locomotive, how will you know that your say for example, have you ever thought of that is your in a train having 70 or 80 big wagons on which the coal is taken. Now, if there is a rain and that what will happen, if it is a for a gradient if it is to go, then date that type of the compatibility of what should be the engine power required so that your the 70 wagons of say 30 tonne capacity can be pulled by the railway.

So, that means, the locomotive engine that you need to study which is used underground as well as in surface mines. Similarly, on the road you have seen, there will be equipments that there will be trucks and along with the truck, there could be there in the mining there are different type of trucks and these trucks are not just like your roadside trucks; Tata's roadside truck you might have seen about up to maximum 20 tonne capacity; but in the mines today, it is a 500 tonne capacity trucks are there.

These types of trucks are called off-highway truck. Now, that off-highway truck, their tires you can see it is a very large diameter tires, it is not manufactured in India and the price of 1 tyre is about 16 lakh to 20 lakhs of rupees and if the tyre do not properly maintained in the mines, you can think of how much money you will be losing and there were in 2006-07, there was a crisis of importing large capacity tires and our mining industry was suffering like anything and in future also, it may happen.

Because in our country, we are not producing large capacity tires then, when you talk about these a trucks, there is a something called your trolley assisted truck. That means, a very large capacity truck, you think of a truck carrying say 300 tonne of material and when it is going to a gradient, if it is to go up at that time, when it is going to climb, there will not be power that engine will not be able to do that.

So, at that time, additional load additional that pull can be given if we keep a electric line over here that just like your locomotive train, they have got this electric power. So, that from that a additional electric supply will be given so that these motors can give and the truck can

go up. Such type of trolley assisted system that means, whenever the gradient is to be managed, there will be different.

Like that there is a truck jigging, another system is there by which these are innovative things done in different country. we will try to introduce you some of this. So, that tomorrow you can come out with a new technology that can be used for truck transport. So, do not think the truck transport mines means just the truck roadside truck what we have seen. It is much more different; we will be discussing about that.

Similarly, the other one is a continuous transportations; that means, you can you have studied already bucket wheel excavator or bucket chain excavator, when they will be excavating the material continuously, so it will have to transport by continuous method. For that, the belt conveyors are there. The belt conveyors also can be of different type there are cable belt conveyor, now there are pipe conveyor, there are nowadays this railveyors and many other things continuous transportation modes are coming.

Other than that continuously you can transport as a slurry in a pipeline, you have studied about the pump. Now, if you can pump mud as we have said about the some of the mono pumps and all that pumping through a pipeline and the whole material your products can be transported as a slurry that will be continuously going.

Similarly, sometimes the transportations can be done on a that pneumatic pipeline; a pipeline is there where a compressed air is being sent and that air will be taking out the material. Many time in the cement factory and all, you can find that cement can be taken up by air as a pneumatic transport by pipeline and they take it out and then, collect it and bake it. So, that type of transportation systems are also there, that is called your fluid transport.

Similarly, there could be a different type of combinations that in the mines that half part it will be taken by truck, then it will be taken by a conveyor and for that, there will be different. One very important system is coming up these days called Inpit crushing system that is in the

mine surface mines that when you do the drilling and blasting, you are taking a big boulders are coming.

The big boulders cannot be put onto the conveyor, that is why the excavator will take that boulder to a truck; the truck will go and take it to a crusher and the crushing plant crush that thing make it a small fragmented material and they will be loading it to a conveyor and the conveyor belt will be taken out of the pit.

So, these type of systems are also there and then, there could be a even that skip and cage in underground mining use; but if in future, we will be doing a very deep surface mines. Say for example, 300-400 meter deep surface mines, from there a skip type of transport also can be coming and then, to maintain this whole safety and all these operations, there could be a lot of innovations.

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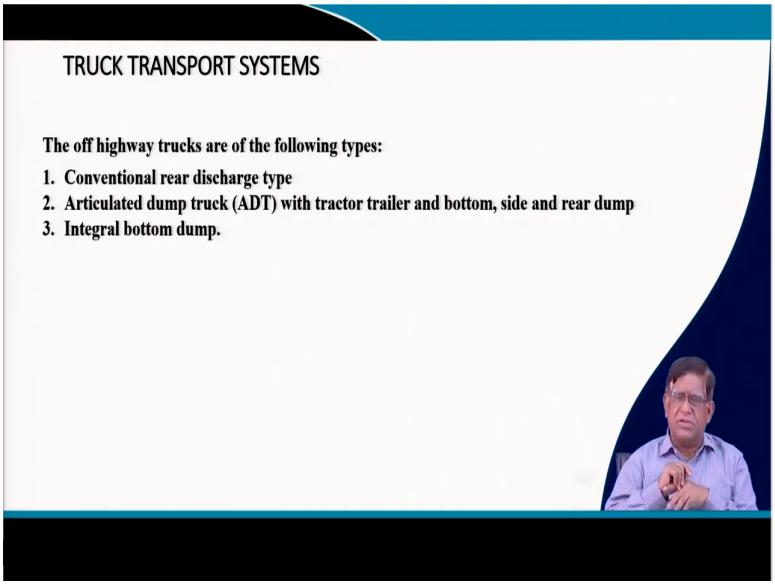

And I think some of our students are already making in a surface mining safety control by producing new app, new your I o T, new application of machine learning are being applied for optimizing the productivity of this transport system. So, if we say these things off highway truck that is of course, the very predominant because that shovel and dumper mining is a very common conventional mining. It is being used because of its flexibility everywhere. So, that is why the trucks are very much used.

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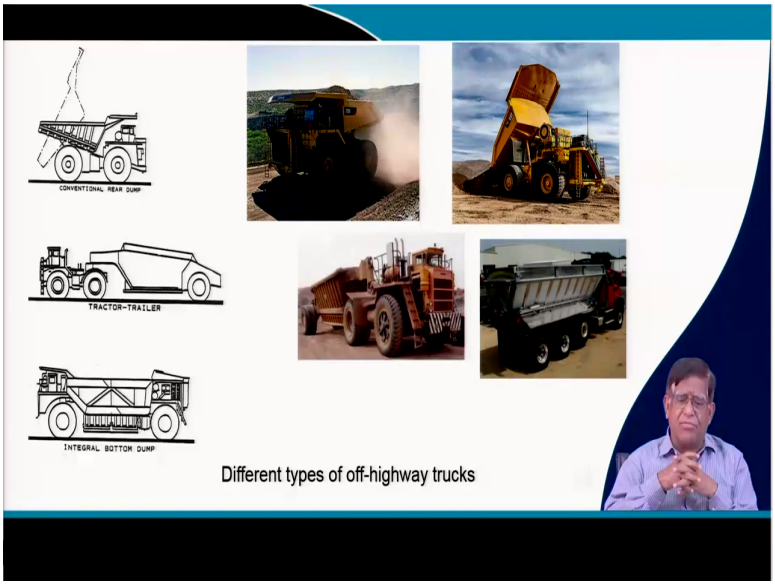

Now, what type of trucks are used over there? You can think of that you remember we will be discussing about this that the trucks can be of different type. It can be a rear discharge dump truck. Our mining trucks are not like that of your roadside truck which is normally is a fixed body.

Now, the body is hydraulically liftable so that the material can be discharged. So, this type of truck which are going to from 35 tonne to above up to 500 tonne that Belarus that country, they are making the Belaz truck which is a 500 tonne now, (Refer Time: 21:39) are also making this truck.

Now, the latest development is these trucks are now operating manlessly, there is no operator in that truck. So, there is no operator cabin, then it can run both the directions and it can be controlled remotely from the office by and this type of articulate that is your automated vehicle that is a man less truck up to capacity of 350, it is being now manufactured by (Refer Time: 22:09) in the Australian iron ore mining, it is being deployed. So, those are the latest things you will have to study.

Then, there are another type of machines that is your dumb bottom discharge dump truck. You can see here these trucks, there exactly they will go and they will stand on a grizzly, where the material is to be dumped and then, their bottom gate, it will be just opening like that so that the material will come down. So, that is a bottom discharge dump truck.

Then, similarly, there are also side discharge drum truck. The bottom discharge can be in a body itself that is a truck or it can be articulated, that collecting as a trolley.

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This one you can see as a side discharge truck; the truck is having that is your the hydraulic pistons are working from the side, unlike that rear discharge, it is a discharging at a side. Sometimes, this can be depending on the where you are loading, you can have. So, these are the innovations people have done wherever it is there.

And the articulated dump truck that is you will have to take a in a very restricted place, you need to turn over. So, what they will do? they will have a just like a tractor you have seen the front that is your engine part and the back your trolley part, in between they are just hinge operated so that they could be easily negotiated, that type of articulated trucks are also there.

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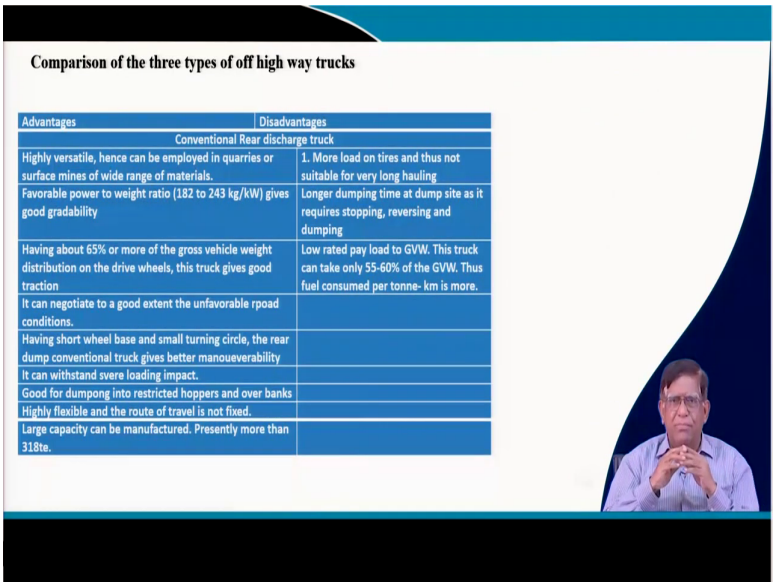

So, my dear friends, you will have to make a little bit of study. But these are all available old techniques, make a table of these advantages and disadvantages of this conventional truck transport system. I will not stop over here; I give you it as an assignment.

Please prepare that is what are the advantages and disadvantages of this truck and where are the scope of new innovation? You please go through before we discuss about the trucks, this much some exactly a innate survey you do.

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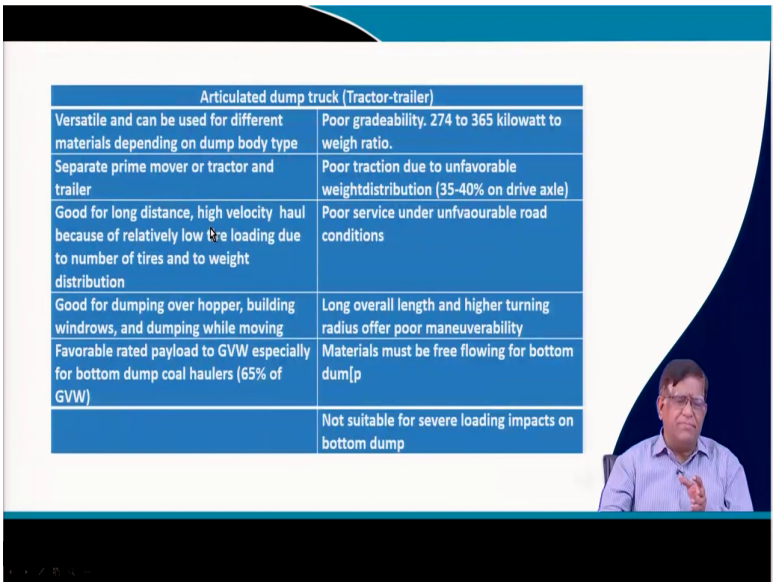

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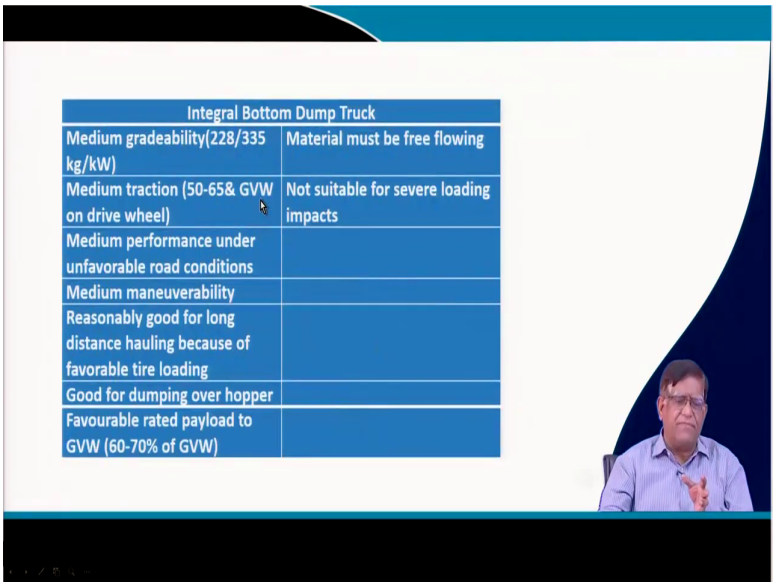

And you learn, what are the advantages or disadvantages of these three different type of trucks.

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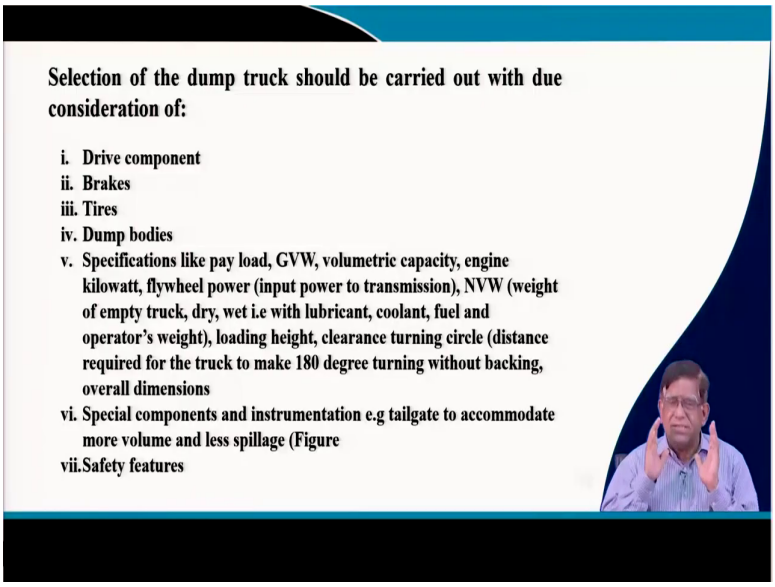

So, that is your bottom discharge, side discharge and all. Then, if you will be discussing truck, where will have to know that what are that exactly the main components will be there. Here, once again, you will be going back what we discussed in our module 1 and module 2 that is different machine elements, you will have to know here how those drive component has been put over there; you learned at that time the basic.

But you can see when you are going to study one machine, what is the latest development has taken place over here. We have talked about that is a prime mover as a IC engine. Now, that IC engine in a when it is coming to a truck is 16 cylinder engine, how they have put, how a v-line engine is exactly making that.

And then, how it is the braking system is provided over there, how the fuel injection system is provided there, how the dump lifting system is provided over there so that how the tires are

fitted there, how exactly tire to be taken out. If you say a 500 tonne dumper, it will be having a tire of it is a person cannot take it out.

So, that is a tire handler, a separate type of machines are there for handling the tire so that you will grip it and do it mechanically and if you are not doing that properly, it can lead to an accident in the mine side. So, that is why the tire handler will also a part of it. Then, the dump body on which the material is there. Now, you can think of the during the if you are in your rainy season, your that soil if there having clay, they will be sticking to your dumb body.

Now, if you are dumping, at that time, material are going to stick onto the dump body, it is not going. Then, you can think of that additional load, it will be carrying even in the return side, there will be some load and if there is a load that means, engine will have to give more power.

So, what will you have to do? That means, there is an innovative system is there at that your exhaust gas of the engine that will be that will be flowed through the dump body so that it get heated up. When it is heating, moisture will go. Even if it is sticking, they will be scaling out and the material will be coming out with the slight vibrations.

So, that type of systems are there, then you will have to know about that what is their gross vehicle weight and then, how the net vehicle weight, they will be taken and ultimately what type of engine, how the engine power is required; how will you decide that for your truck, what should be the what type of engine will have to be selected; that means, what are the different resistances to drive the truck is coming.

You can now do your whatever mechanics you have studied in your secondary level, you now can apply that calculating the resistances to overcome and for that resistances to overcome, how much power that engine will have to give. So, these are very interesting thing.

Once you just take your pen and paper and start thinking and doing the different numericals based on your physics and mathematics, whatever you have learned and that, is these are very

simple thing. But what you will have to know that the dimensions of the truck, they will play a big role.

Because it will have to be compatible with the shovel, your dumb body is very high and then, you are going a small shovel, they will not be able to load. So, when you study their dimensions of the machines, with that compatible machines also will have to be studied.

Similarly, that you know that in that you are loaded on the truck and then, while you are carrying, there will be a spillage. So, that so that the spillage do not take place that how exactly you will be giving a tailgate; a gate to the material will not fall. So, those are different safety features, how exactly right from the seat belt onward to so that the operator who is sitting on a chair, that is if it is a 500 tonne weight a big heavy truck, if it is going.

If there is a little undulations, you can think of how much exactly force will be coming on to the shear to give a vibrations and vertical vibration to your spine, the operators he can get a permanent damage to his spinal cord. So, that is why this that the operators chair, that driver's seat will have to be properly ergonomically designed. How will you do that?

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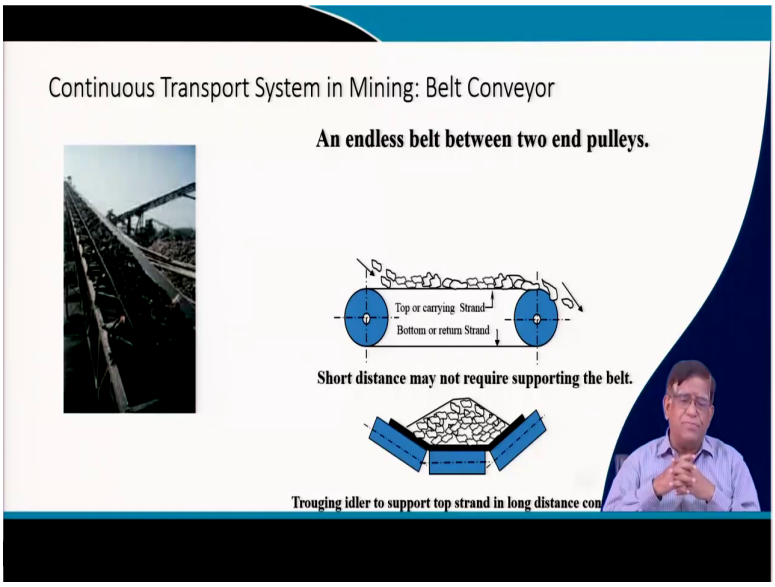

So, these are very interesting area, while you can study about the truck. But other type of transporting machinery you have seen if it is a continuously you can get it by conveyor belt and conveyor belt is nothing but a just a endless belt which will be just moving around two pulleys, your material are kept over here and it is going into the other side and you might have seen number of such type of conveyor belts are being used in the mining industry.

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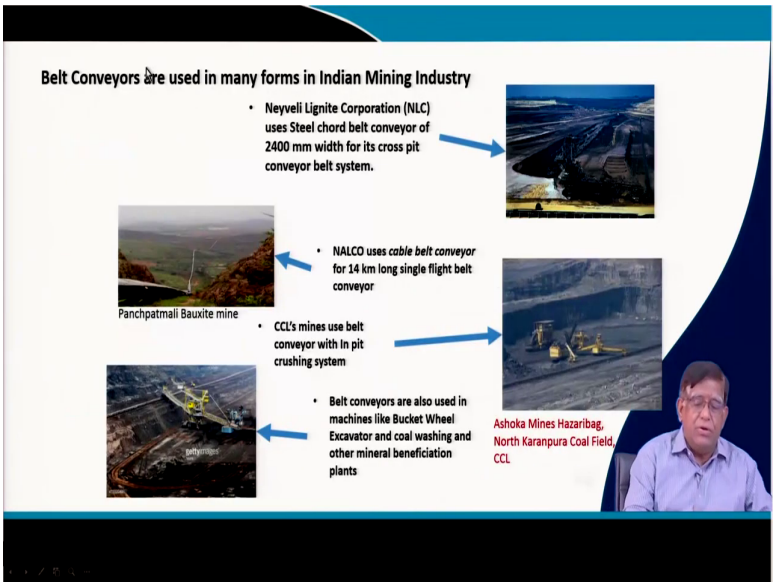

So, we will be discussing separately on the conveyor belts and there are so many exactly issues which can be studied. In India, we have got conveyor belt at Neyveli Lignite Corporation. We have got a special type of conveyor belt called cable belt conveyor at NALCO Panchpatmali mines.

We have got some conveyor belt with a crushing system plus inpit cluster system at our Ashoka mines of CCL in Hazaribag district. We have got say with this a with a bucket wheel excavator, we can load the material on a conveyor belt and going. So, you will have to study some of this case studies of different applications in our mining industry.

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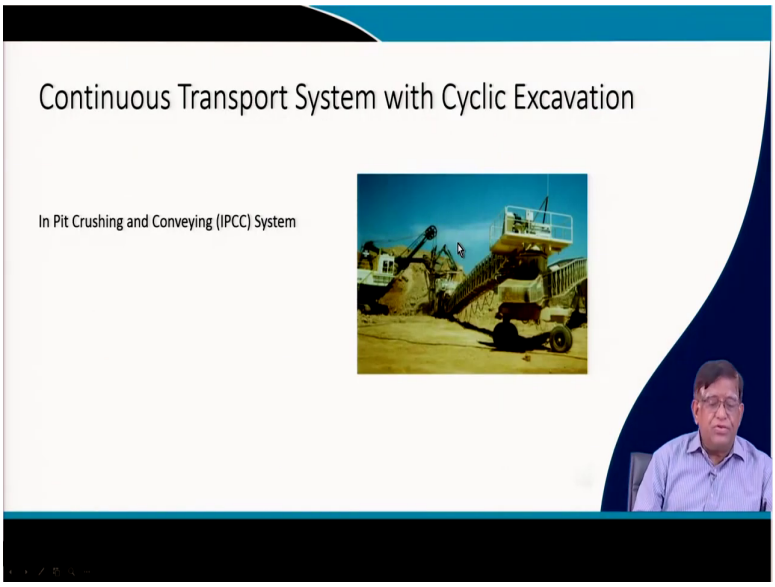

So, the other thing is we have got sometimes a in pit crusher system. You can see in this diagram; the shovel is giving. This is a crusher which is a walkable and then, we are having a mobile conveyor belt. A mobile conveyor belt is fitted with a crusher and in the query, you can do the operations very profitably.

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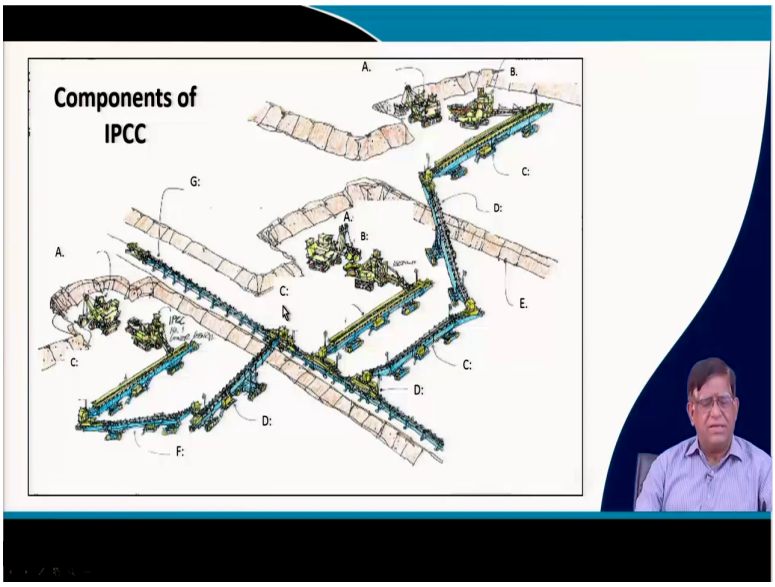

So, this metro is working this type of systems in India. That in pit crushing system equipment you can see here say this is a shovel is work on a crusher, that crusher is giving the material to a conveyor belt, this conveyor belt giving the material to another conveyor belt and it is taking out the material and this main conveyor belt can be given another system may be working in another places. So, like that in the mines number of systems combine together to get the total mining system of transport.

So, whenever you think of a surface mine, it is nothing but a transportation or it is a moving materials whether you are pumping water is also a moving material, your taking out the overburden to dump site here that is or that say they are forming the dump or they are taking the minerals to the market is also a material handling sections.

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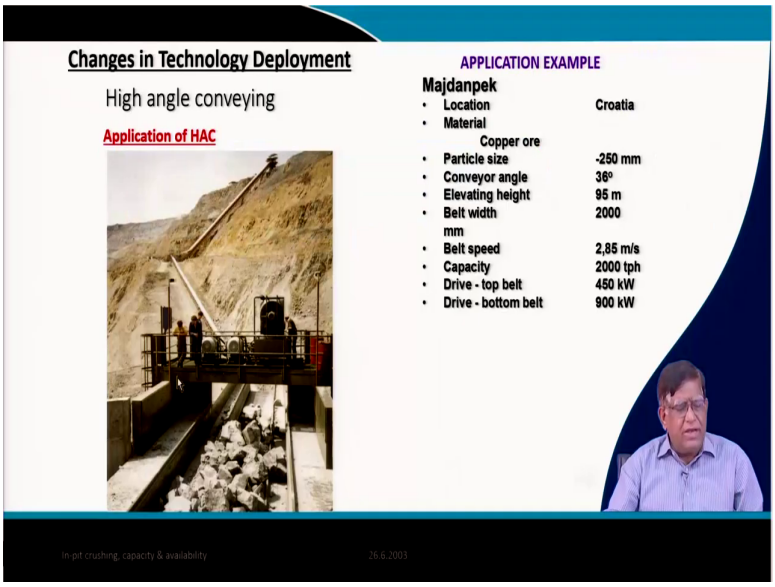

But there, this conveyor belt normally the conveyor belt cannot go more than that is a angle of repose. Because if a conveyor belt you have took the material, if the material angle of reposes, its normally it will slide down with that. If the angle of inclination of the conveyor belt is more than this, this angle, if it is more than the angle of repose, then the material will slide down.

But then, you can see a conveyor can be placed in a very high angle also. How? This is here normally it can work in like this; but with a special arrangement of high angle conveyor, you can get it even up to 90 degree. So, then how will you do that? These type of applications are there in different parts of the even a small country like Croatia, they are having this.

In our country, we have got so many number of mines and all that thing, we have not introduce such type of systems which is now not at all a new system, this high angle

conveyors and all started operating in 95-86. Similarly, that your pipe belt conveyor, it started working in 90s and all that thing. In India, it got introduced only in 2006. So, that means, we are slow in incorporating advance technology and taking benefit of it.

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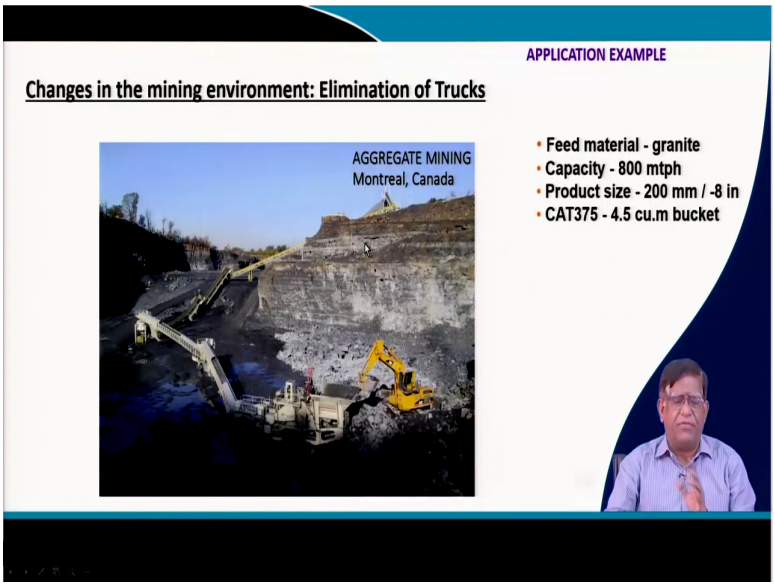

So, you can see here that is a without truck, there is no truck, so no maintenance of haul road, you can just do a query operations by this. There is also this is a metro a companies, they have given a this type of mobile conveyor system. There is a conveyor belt over here, which is mounted on these tire mounted systems on which it can move, it can make number of them combining together and taking out of the pit.

So, this is a innovative transportation system. There is a one name they have said there is a grasshopper conveyor they say.

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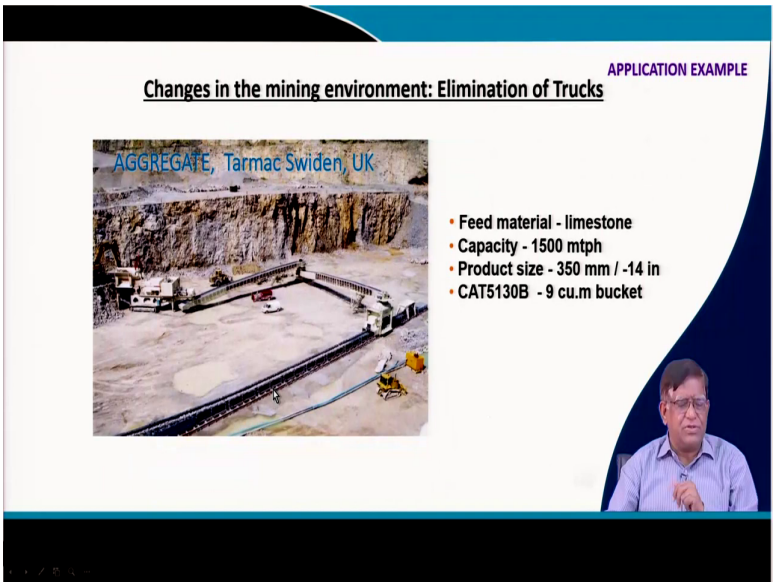

Grasshopper means it will look like a grasshopper of different one after another that type of systems are also there. You can see here how our elimination of truck has taken place by in pit crusher, mobile conveyor and then, there is a land lead that is your own main conveyor belt.

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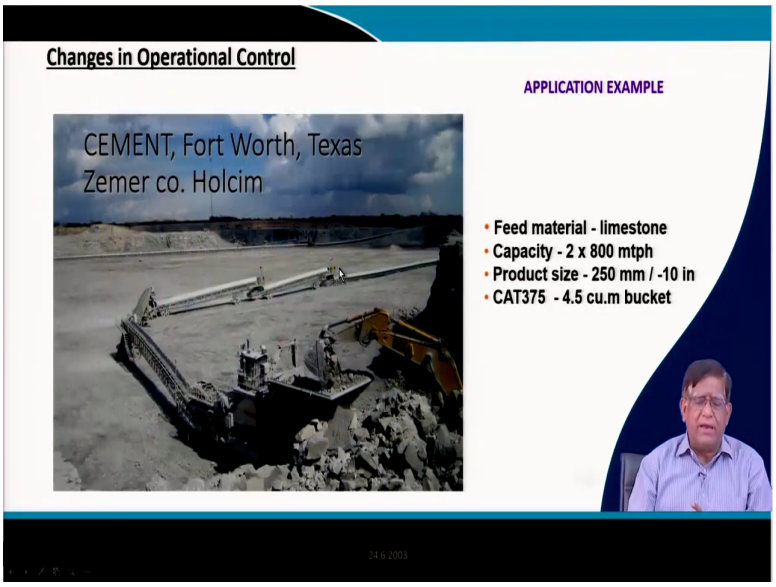

So, by combination of different machines, we can get a very beautifully you can keep the mining very environmentally friendly because if there is no truck, there will not be dust generation, it will not go.

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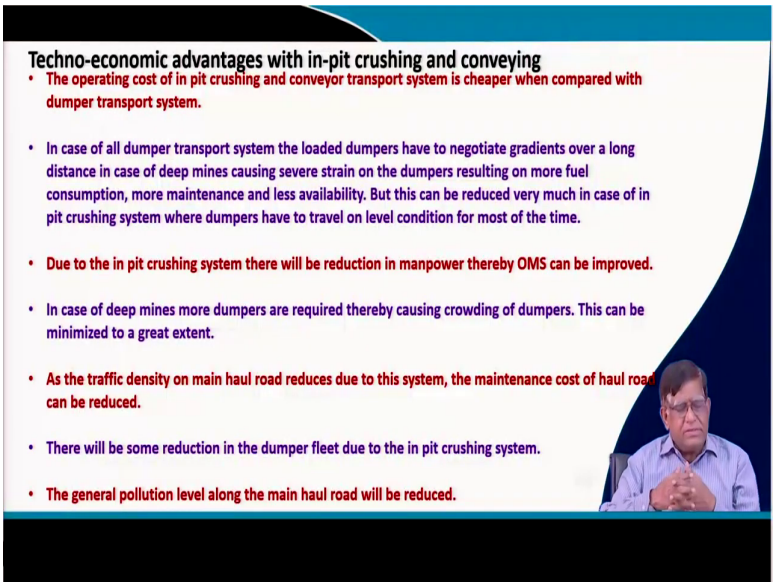

Because the trucks are bound to give a dust. So, there are different advantage of this your advantage economically for this in pit crushing increasing system. Because it is exactly eliminating dump truck means, that is if a mine is to produce a there is a fleet of trucks will be there and the fleet of trucks means every truck will have to have minimum 3 operators and 3 shifts.

So, that means, your manpower will be very high and then the not only deploying the person will have to consider in the mine, the education of the children, their quarters, their medical all other facilities. So, the liability of the company will be increasing by having truck system. So, when you go for inpit crushing system; but you will have to first evaluate what are the technical the conditions under which you can put it and what are the economic viability of deploying it; whether you will get some advantages.

Because if you are having a dump truck, you will have to use a say for your dust separations, you will have to have a water sprinkler, you will have to arrange for water and in the mines if there is a crisis of water, you cannot suppress, then the dust. Then, a pollution control board will come and say some day ok now you close your mines, you are doing lot of air pollutions from there. But if the trucks are not there, such type of problems will never come.

So, that means, the techno economic viability of a new systems can be determine from different different way.

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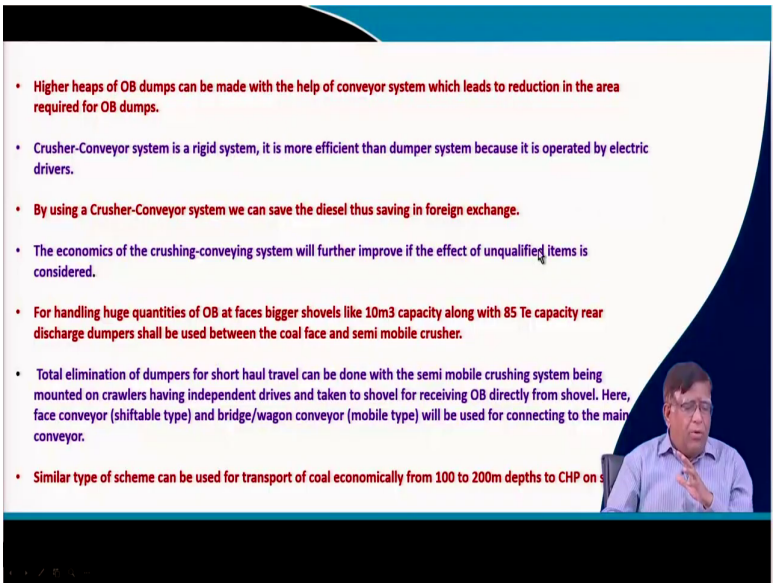

Nowadays, your conveyor belt systems can develop different your even the overburden dumps and all these advantages, disadvantages you now just study yourself from different

sources. We will be discussing the technical that is your features of each of the system, where you will be getting a your own insight.

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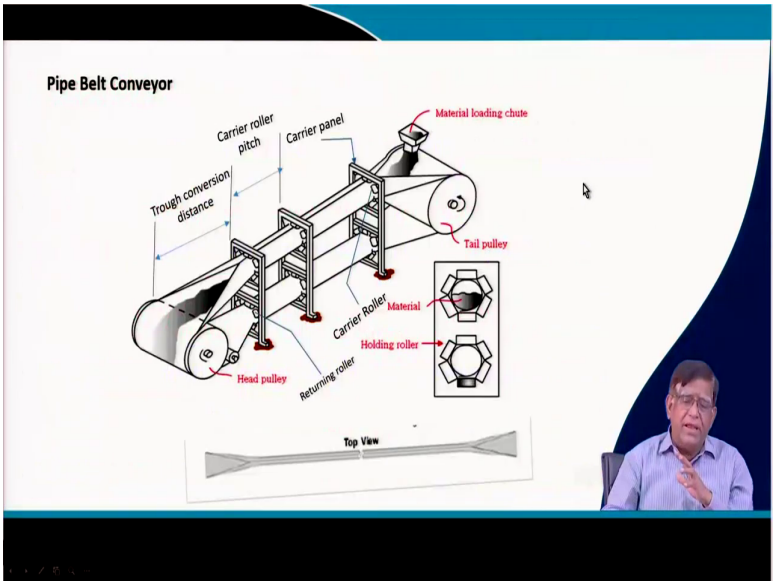

So, our main thing is from that techno economically feasible and viable system when you select, you can adapt new technology. As a pipe belt conveyor as you say this is a pipe belt conveyor, where the belt instead of going as a flat, it has been made to form a curve that is your it is holding everything.

So, that the dust and all, they cannot go out of this. So, this type of conveyor belt system, where that is a pipe belt conveyor that can be there; the cable belt conveyor, where it is a cable on which the conveyor belt is there.

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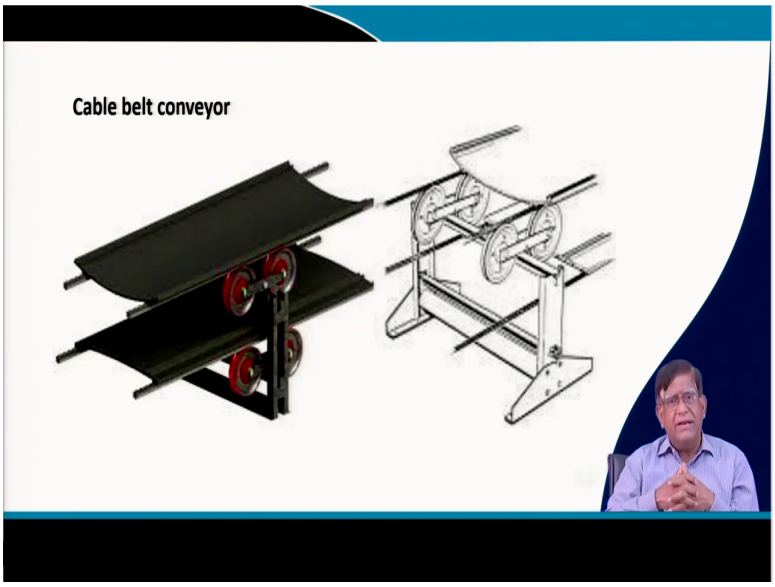

So, your driving force is just only a rope drum and it is moving on ship. So, that in a conveyor belt lot of idlers need to be move. So, that means, lot of energy waste is there. So, that type of cable belt conveyor is a energy efficient system which was introduced in India in 1982 in the Neyveli in your Panchpatmali, a NALCOs mines and that was one of the very first that with a French collaborations they made.

But there are no never any replication of it in our country because there were certain disadvantages and all.

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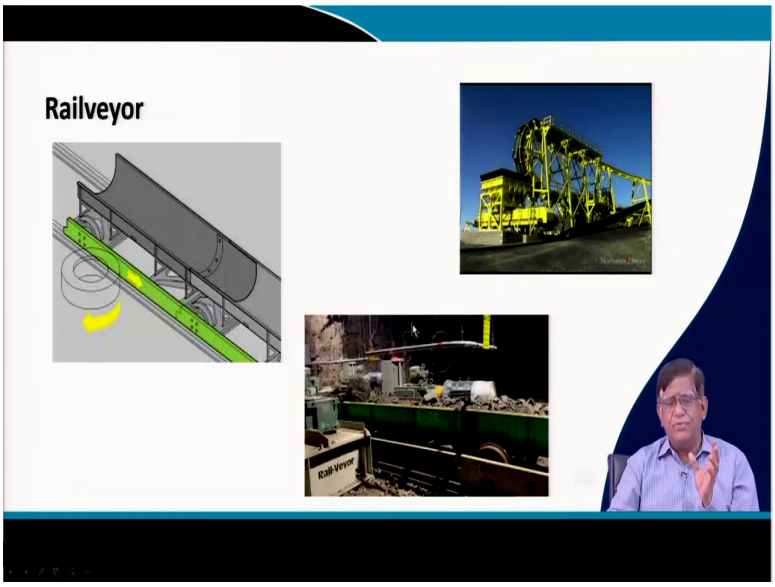

But you need to know how you can improve such type of system. Then, as I said that in the Brazilians, they have made this railveyor exactly this is a part, where you can see here this is wheel is running on a rails. But this is a conveying system, these rails it is not driven by anything, outside there are a number of like that wheels is a vertical wheel it is a in a on a horizontally, it is rotating on a vertical axial, this wheel is rotating.

And then rotating wheel is taking a frictional touch with this side and then, it is pushing that thing and from underground mines to surface mine, it can bring over there. The whole material will be getting turn over here and discharged. So, I will be discussing maybe will see some videos of how such type of equipment work so that you can have an idea about what are the different innovations came.

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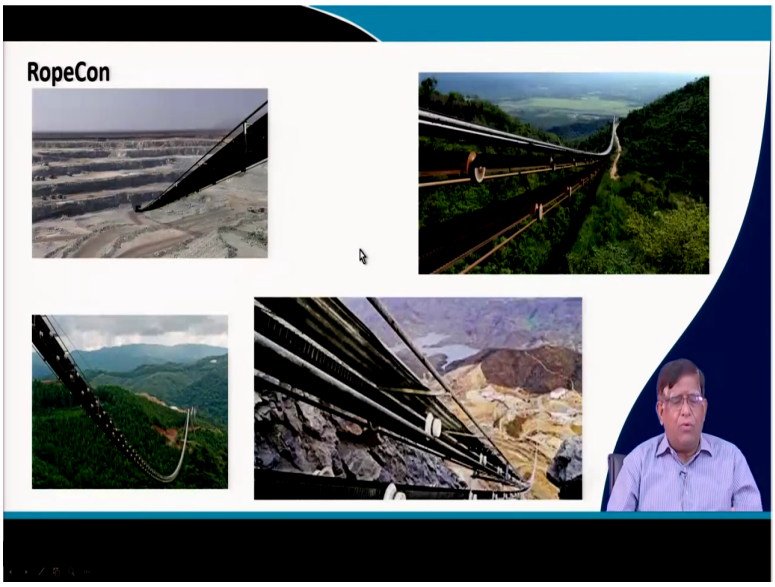

This the rope con is another one we had been telling it about that it is a advantages; it has been used, but in about more than 8-9 installation in the world is there. In Papua New Guinea and a Shin-bet island, where for a gold mine the 64 kilometers, one this type of conveyor belt is going.

It can go you can see here the profile, it can go vertically down like this because this conveyor belt has got a side wall and inside the material is there. And then, there are some your elastomer type of wheels, these wheels are moving on these ropes, these are the exactly rope at the side.

And over there, this whole conveyor is a box type of structures which is you can see here, these are the side walls of the conveyor belt; the side walls that whole thing is running on as if instead of rail, it is running on the rope and then, these wheels are there as an integral part of

the conveyor belt. This is a rope con system. Every new system, hardly I think it is a it first introductions were there in the about 2003-04 and by 2006, a number of countries have used these things.

That company Doppel Mayr company from Switzerland, I think Doppel Mayr who were giving this your the aerial rope was and then, some of this luxury cab for going from in the hill one hill to another hill that company Doppel Mayr, they came out with these installations and there are few in the world.

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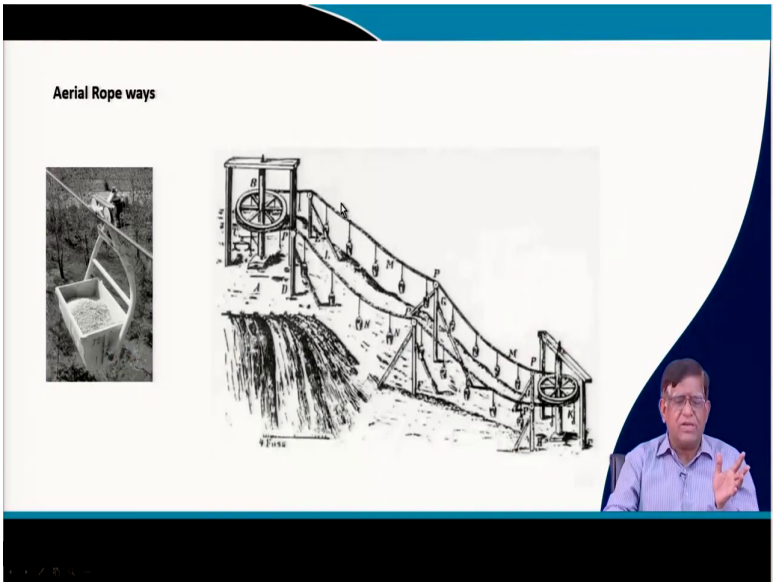

So, you can see this rope con and then, you can study. Then, there is a aerial ropeway which is a one of the very old system, still it has got lot of potential for using many of the places; but because of its low capacity, because of its intermittent nature, it has not been used.

But it is a one of the very low cost systems which could be used in India, it was used for sand stowing purposes, Tata steel and all, they had this aerial rope ways to take the sand from the river side to the mine, for putting it for stowing purposes.

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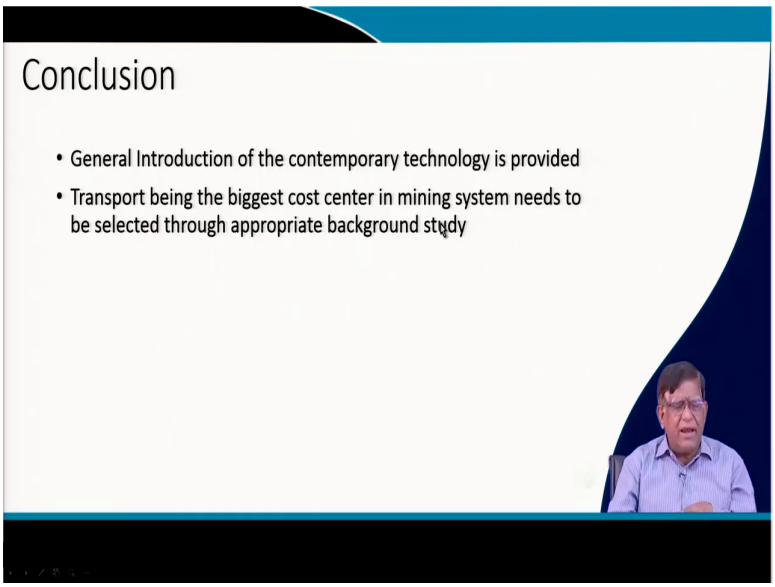

So, there are different type of conveying systems are there; material transportation systems are there; we will have to study and each and everything.

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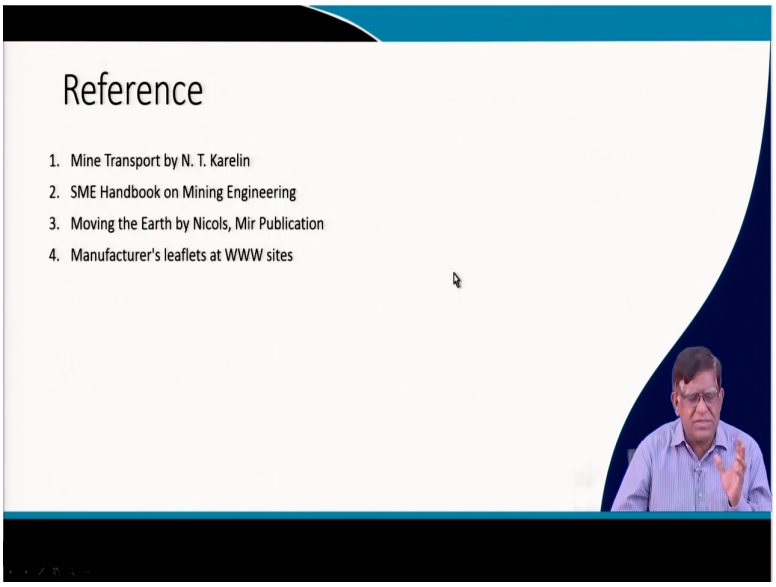

So, today, I have just introduced you these systems. There are some books, there are things; but we will be going to discuss different equipment one by one from our next classes.

Thank you very much.