Bulk Material Transport and Handling Systems
Prof. Khanindra Pathak
Department of Mining Engineering
Indian Institute of Technology, Kharagpur

Lecture – 5
Introduction to Bulk Material Transport and Autonomous Vehicles

Welcome back in our this module of discussions on the introduction to the bulk material handling and transportation today will be the say concluding lecture of this module and in which we will be introducing the bulk material transportation and also will be talking about briefly autonomous vehicles which are the latest addition in the field of bulk material transportation.

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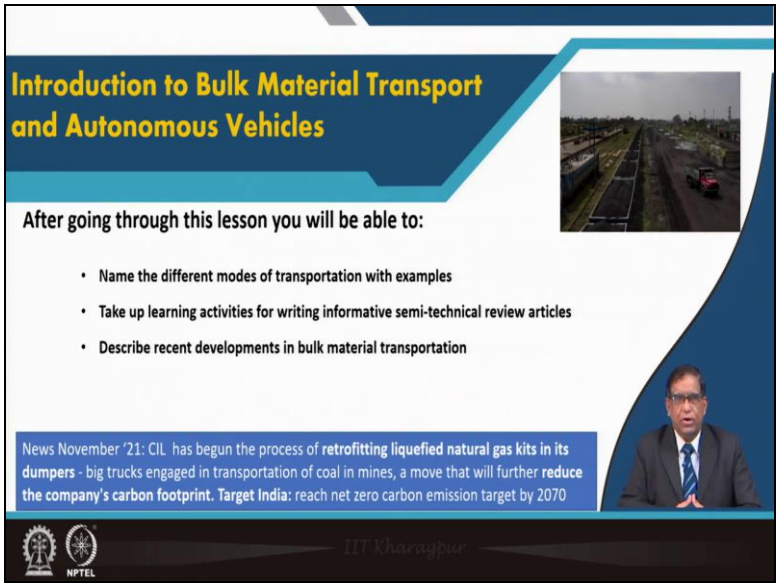

Now I hope that after this lecture you will be able to name the different modes of transportations with examples and also you should be able to take up some of the learning activities for writing informative semi technical review articles. And also I hope that you will be able to describe the recent developments in bulk material transportations. And as you know that amongst the bulk materials the main component or the majority of the transportation load is with mined product.

The raw materials for the our power stations thermal power stations coal and as you know in India we are having more than 64% of our energy is still from coal and also for the steel plants we will be transporting this iron ore. As you can see in this figure that

our railway is one of the main transporter from for long distance transportations but there are many other mode of transportations.

And one most important developments of today is that you will be very happy to know that Coal India Limited is responding to the prime minister's call ministers declaration that by 2070 we will be reaching our net zero carbon emission and for that where this company which uses about more than 2500 trucks and a huge quantity of diesel consumptions giving a lot of carbon dioxide emission and there the reduction is expected.

Because. Now, Coal India is going to retrofit its trucks with our gas fuels that is your low carbon dioxide emitting fuels will be used. Now, this is exactly by use of liquefied natural gas. So, you know that the India is taking a big step and here as a transportation sector how you can contribute through your studies and research in the coming 4, 5 years that is very important for you to note it down.

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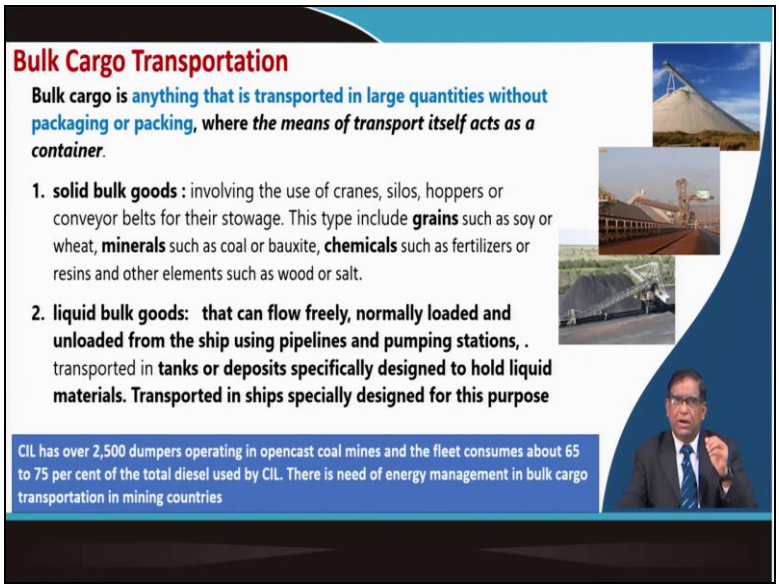

And you know that the bulk cargo transportations when we say bulk cargo you know as in shown in the pictures different type of materials which are just transported exactly without having any containment. So, that is it is a it is mainly with a large quantity and at a large rate they are being sent. So, basically the bulk cargos could be a solid cargo or it could be a liquid cargo.

Now and as we have already introduced in our first and second lecture that how we classify this different types of cargos. So, that is why when is a transportation means for transporting from one distance once point to another point in a long distance as well as there will be a transportation within the plant for a short distance. Now, well in short distance some of the handling equipment also can transfer the material but when transporting from one location to the another locations we have got various mode of transportations.

But for liquid as you know already that they are going to the pipelines you might have heard of that how Gas India Limited that GAIL it has. Now, they have started laying pipeline across the country for transportation of our gas. So, maybe in near future our cooking gases will be coming to our home and kitchen by pipelines. Similarly we have got the crude oil coming from different oil fields to the refineries all by pipeline.

So, we know about it but there are also in a slurry form when coal can be mixed with slurry sometimes this iron tailings when you are finding out new uses of those tailings they will have to take from the tailing point and there also the slurry pipeline goes. So, liquid and solid and as well as we have got this the suspension that is your two face liquid solid in liquid phase like slurry it is going over there.

And also sometimes say in a pneumatically that solid goods can be transported as a by pneumatic lines. So, that is also a different type of pipeline transportation which is there. So, now, this as I said that say bulk cargo transportation in the mining countries will have to look forward that how we can go for an environmentally friendly transportation in which there will be two things one is the con that changing the type of well from the conventional diesel to some that improvised fuels.

And also you may be interested to know how the hydrogen fuel truck in the mining has already started in South Africa. It has been now, experimented by 2022 hydrogen powered mine trucks will be operating. So, in these fields there are lot of scopes for retrofitting many of our machinery which are at present being used. So, that is an area where you should be looking into.

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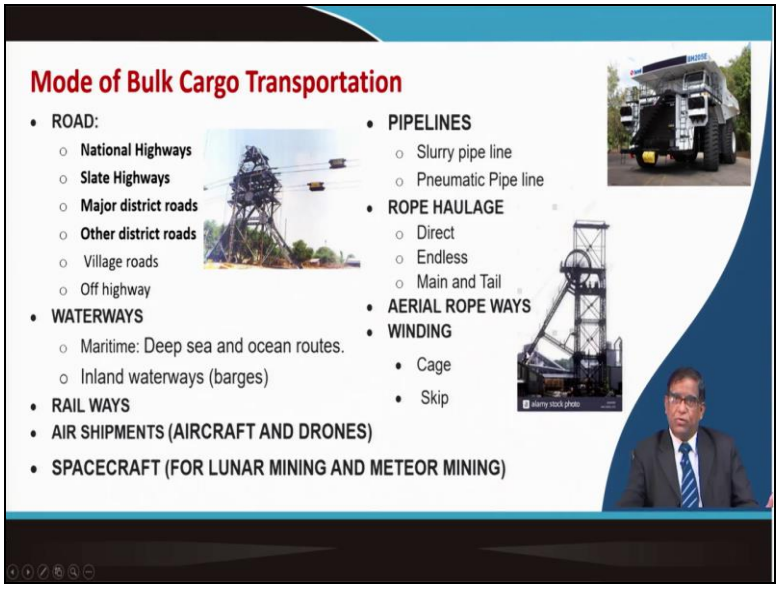

So, now, coming to this as a mode of bulk cargo transportations what are the different modes you can see that most of the time the roads are used for transportation and these roads are of different type you know that in the transportation those who are coming from the civil engineering background you may be knowing that our highways are classified into national highways state highways major district roads other district roads then village roads and also our off highway roads that which are in the mines and queries we are having those are half highway.

Their different type of transportations takes place you might have seen that say one of the pride of India is this more than 210 dump truck manufactured by BML which is now, only in 2018 they took up and it has been now, used in Indian mines. Similarly there are some different type of trailer truck this is exactly an example from South Africa in South African roads such type of in mind such type of trucks are also being used.

So, now, other than the road we have got another mode of transportation by waterways. We will be discussing today briefly that how our bulk material transportation in waterways India has got lot of scopes however we will have to do our river timing and our water resources proper planning and that under by that we can exactly go for a lot of properly managed environmentally friendly transportations.

Our river Ganges river Brahmaputra river this Mahanadi and all which are having a perennial water sources but they are very very little amount of them has been used for bulk material transportations only in the Manduvi river in Goa they have been used for

the export of iron ore when it was the very good days of Goa in I do not know exporting at that time from the Mandava river number of birds is to go to the sea and from there that transshipment is to take place.

So, those waterways are also very important railways you all know that railway has been transporting lot of material but you can think of that sometimes in some of the bulk material in a smaller quantity can be also transferred from drones and then aircrafts but as because of the cost it will not be very very encouraging. But in certain type of materials of course just like when it is a packaged material they can be transported by air but in also we can think of sometimes the spacecraft can be used for bulk material handling.

Now, you may be knowing about that people are thinking of the lunar mining that is mining from the rare earth minerals if it is available in Mars even in the that another important source of future rarer materials may be the our different materials. So, material mining lunar mining then if it is to be taken that how the bulk material will be collected from there and transporting that is another area of high end research which your generations will have to take up.

Then we are having that pipeline as I said already slurry pipeline pneumatic pipeline as well as the tower the liquid pipelines are there then rope holes is another transportation means in the underground mines that it is very common using this direct analysis and main entailed ropeways. But there are in some times when our open cast mines will be going deeper in some of the open cast mines when they will be going again from the pit floor they will be going underground at that time Rope Haulage will be coming in a different way it is possible.

And then also there are aerial ropeways which have been used in the past and there are also at present number of aerial ropeway installations are there in India which are carrying the bulk materials. That this rope was exactly on some buckets you are taking the material and they are carried over there. There are different types of aerial ropeways in during this course and we will be discussing about this aerial repose also.

And also the vertical transportation from underground mines when you are taking this material by winding that case or skip winding is there. This skip or case winding it can also be coming into the deep surface mines when our surface mines will be going more than 200 meter below at that time maybe the truck transports can be sweet can be exactly partially replaced with some of the skip type of winding systems where we can use electric power instead of diesel there are certain types of research is needed.

So, this is a different mode of transportations you should be having an idea that how what type of business will be there in near future in these areas. So, that another thing is when we are talking of this winding that winders their installations their design and then making their capacity to handle a higher rate that is one of the most important things that as our uranium mining will be going on in the country and our even in the gold mines it will have to be from the deep mines.

So, that transporting that the that mineral excavated for finding out the gold ore at herti mines will have to have the winder. Similarly at our uranium mines as well as some of the coal mines in future will have to get our deeper coal mines there will have to have this type of transportation system for vertical transportations by winding.

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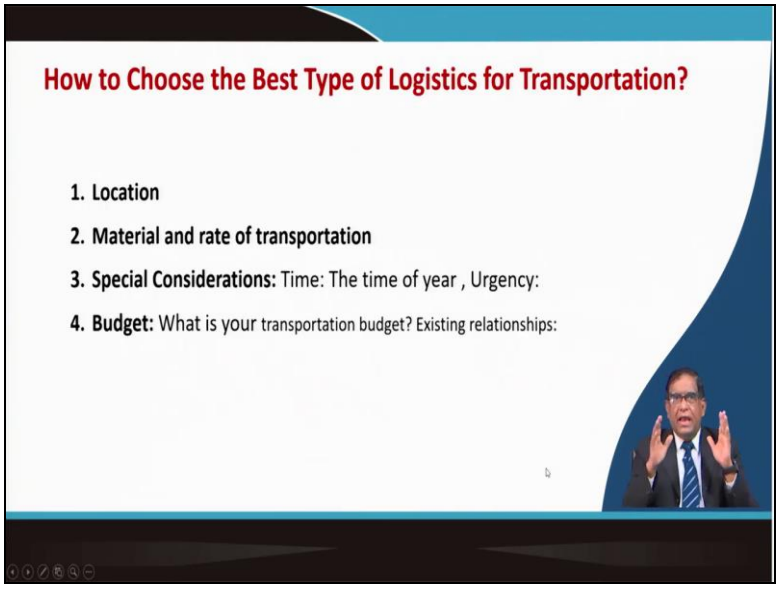

So, coming to this different mode of transportation is there but which one will be what type of logistic you will be developing for your purpose whether you are a agricultural persons we want to get your farm products to be transported and start you may be thinking giving a consultancy or you may be working for Food Corporation Of India.

How the bulk material will be stored and then how it will be distributed across the country from our main production base from Punjab.

It will have to that basmati rice will be from western up and Punjab will have to go to south and further a used transportation is there at present we are giving only by the packeting but whether that is a grain transportation scheme can also be revolutionized by different mode of transportation. So, but whole thing what mode you will be selecting will be depending on the location material.

And the rate of transportation as well as some of the special considerations the transport that how fast we will have to take these things from one place to another then this what is the budget that of course how much exactly money you will be spending only on better bulk material handling but the country must plan that for a better and environmentally friendly energy efficient safe transport of bulk material in say by 2030 a huge amount of R and D activities and research will have to be done now, it is already if not initiated it is late.

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Then coming to the road transport exactly we have got in our country certain studies have already been made that what are the bottlenecks. We are having such an export import business if we are to export an import of bulk material we have got number of big bulk material ports like your Haldia port that your Vizak port or the Tuticorin port or at the Damra port in the western near Goa where that exactly the coal are coming from there when it is to be transported to different steel plants.

Then how our road network will be supporting that that is there is a lot of studies are required in that area. But thing is that this road transport is always a very good one considering its advantages as it can be it can be applied and it has a high flexibility it can be taken to any places by making a road then it is exactly the cost of effective also but to a certain amount it is as for a certain rate.

But it also it can be accessing to the difficult places and then there are many options of this tracking can be done and also it can easily take it to wherever you want. So, there are different advantages of trucks however that one of the constraint is that is your the a truck will be containing if it is on a on an on a road that one truck cannot carry more than 40 ton but of course in a off highway there is also if you do not go for a very large trucks there will be a problem and that problem was there in India.

And mines where only small capacity 20 ton of tippers were used in mines producing more than twenty million forty million tons and the thousands of trucks were being used and that has forced India to give a call your first mile transportations a new restrictions imposed by the ministry of coal that by which exactly from the mine to the next dispatching sections you will have to transport by restrictions of the use of truck. But that is why there are certain constructions on the trucks.

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But nevertheless the truck is one of the most important transportation machinery particularly for different type of material the packet material packaged material and all

there are across the world different type of trucks you might have seen some of the carton sided truck that trucks exactly they do not have any solid wall or anything they will be just because the unit packet loads will be there and there will be a carton that type of carton loaded truck and then flatbed trucks you might be seeing.

And many of the trucks in India which are licensed from Nagaland you may have seen lot of this type of trucks on Indian roads with numbers starting from NL because there are reasons for that. But anyway these flat blade truck are a big transporter of this transport unit load as well as the bulk material. There are temperature control truck as you will be having more of this chain of supermarkets rendering vegetables and all.

And as the quality of life of India will be increasing with the whenever we will be going to the 5 billion economy at that time the demands for our that food products and then for that quality of life the demands for the refrigerated products transportations will be very important and India being a very big country the transportation of material from one corner to the another already we may be having certain refrigeration or air conditioned truck but air conditioning truck will be coming.

But this is I am just telling for your interest but not for the bulk material will not be requiring such type of things. Sometimes some of the products of the bulk material will be requiring but particularly the refrigerated truck there demand when it increase with covet 19 because when the medicines were to be transported to different places there this type of truck scarcity were felt.

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So, this box trucks is another form of trucks which is being used sometimes today they are used in the different sectors. Similarly you might have seen that car carrying trucks different type of car carrying trucks can be designed then this bulk material trucks exactly you might have seen that cement bulk carrier that we carrying cement is another big problem because it cannot be kept open and that moisture content comes then it will become hard stones.

And then even sometimes that carrying as a in those cement bags are also not very good that's why it some type of this type of bulk transporters are designed and those trucks how they will be unloaded using your that pneumatic arrangements and they will be filled into a silo which is also a airtight water tight and then there will be a gate system by which whenever it is it can be used for packaging purposes for taking into in the bigs.

So, sometimes what happens you got transporting in form of bakes small bags and all there will be more number of trucks but if you are using this and carrying it to a that is a cement distribution system can be revolutionized by different type of bulk carrier transporter for cement material. Then also you might have seen the sand trucks on the road then there will be when such type of handlings are safe of transportations from the to send trucks you might have seen with the simple shovel persons manually they are just unloading.

But there could be a good way there is a more consumptions in some of the your big construction projects or some of the big sand depot there could be a sand tippler that is

with a disposable system where you are not having a dump truck but the same truck can be just raised with a hydraulic platform. But this will be say instead of having your making a dump truck in which every truck will be having an investment for hydraulic systems.

Instead of that now the trucks are very cheaper we can use this our only road trucks but the dumping can be done at the site with the help of the stippler. So, that type of different economic decisions are taken and then accordingly the engineering designs are made otherwise that you can see some the road dump trucks are available you can see number of Volvo trucks that trucks are that on our Indian roads wherever the road construction is going on.

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But the bulk transportation trucks are these off-highway trucks. There are different types of them we will be discussing in detail in the while discussing on the mine hallways but see this size you can see over here that a mining truck it has gone up to there is a capacity of EKF Trucks of Slovenia up to 700 ton but this Bellas that that they have got a truck of 500 ton that 270 ton 340 ton like that capacity trucks are now, available.

And they are not only with a diesel they are just these are all having a big power generator over here diesel is consumed for generating power electric power and these wheels will be having the motors through which they will be driving and controlling and then sometimes in case of the mines where there will be going to a strip gradient that in

some portions it can go with a trolley assisted truck that truck will be that this is a Hitachi is also making this type of trucks.

That is from the that the overhead lines they will be drawing the power for the motors which are there on the your wheel that is a electric drive different type of transmissions have come these days for this trucks there are lot of you can make a study of what are the recent advancements in the trucks. And there the latest one is that autonomous truck that it is exactly you might have played with that small remote control car in your childhood.

Now, that has come to the mines the gigantic big trucks up to 300 400 ton trucks are. Now, you can see that there is no operator here that it is an operator list all control remotely autonomous trucks in Pilbara mines in Australia such type of trucks are that is manufactured by caterpillar they are operating which are exactly there is a very minimal manual interventions they will be automatically everything is programmed and that productions will be there.

And then all the trucks today which are working in Indian mines also they are having that mainly from the Comacho, Caterpillar trucks and then other trucks these trucks have got a lot of instrumentations and their data they go to the original equipment manufacturer also automatically. And then many a time our mine operators do not use those data there is a huge scope for you to find out that what are the things exactly monitored and then these are running as a as a automated truck.

But the most important thing is acquiring the data giving the feedback how where to go where to steer how to avoid accidents as well as the timing for the maintenance that is if that equipment requires some certain maintenance for a part that condition of each and every component the machine elements components are there. Those you have studied in the in our lectures of mining machinery you might have heard that exactly what are the machine elements which need can be sensed.

And then by giving a how we can bring the prognostic maintenance and condition base maintenance in a advanced way in this type of truck. So, these are the area where exactly you will have to develop your interest.

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Now, these autonomous trucks can reduce the operational cost of the mines by 20% and it can improve the productivity by 30% while it can reduce the accidents by 50%. So, such a thing is possibility and only thing will have to have the proper digital system digital mining systems in which the data analysis and then machine learning artificial intelligence and IOT will be going in a much bigger way in autonomous vehicles when it will be the this actually practiced in everywhere in the mining sector.

It can also enable that is your near continuous operations. So, though it is a that means you can easily schedule that your operation of the shovel and operation of the this dump truck the dumping then what type of exactly the road maintenance will be there. So, while it is moving at that time it is sensing the condition of the road also. So, if it is a particular portion it is found that there are spillage material or anything on the road it will automatically go to the again an automatic automatically operated dozer or a motor grader will be coming and doing the maintenance.

In the dumping yard also they can automatically give instructions to the other auxiliary equipment to work. So, that type of handling system and transportation systems are there. Another important thing is this self loading truck the self loading trucks are it is again as I said in the Slovenia KF company they have made it. So, it can just load the material on the track and then it will go no need of a shovel.

There could be a multi-excel structs which can give you a modular design you can increase the capacity of the truck anyway and then it can give a very good smooth

running that suspension systems and the transmission systems can bring a lot of revolutions are coming in these sectors. So, I use that you prepare a technical document on the trends of development and innovations in the trucking and bulk material.

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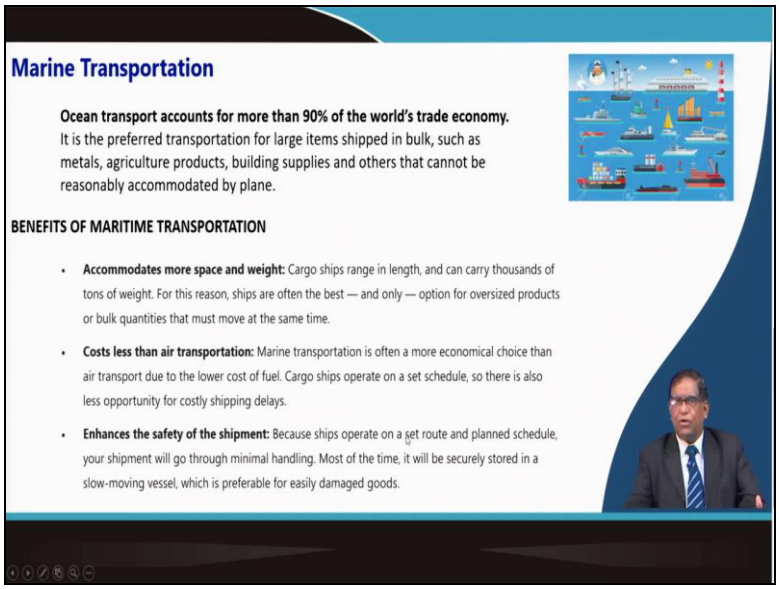

Also I just to briefly introduce you about the marine transportation system because the ocean transport it is exactly more than the 90% of trevor world economy is on the sea. Now, that is why you should have a develop an idea and interest on how exactly the marriage transportations are taking place because this waterway transport it gives a lot of benefit because there is a there are a lot of less energy required and then there is a cost is also less and it can enable that is your safety also can be enhanced.

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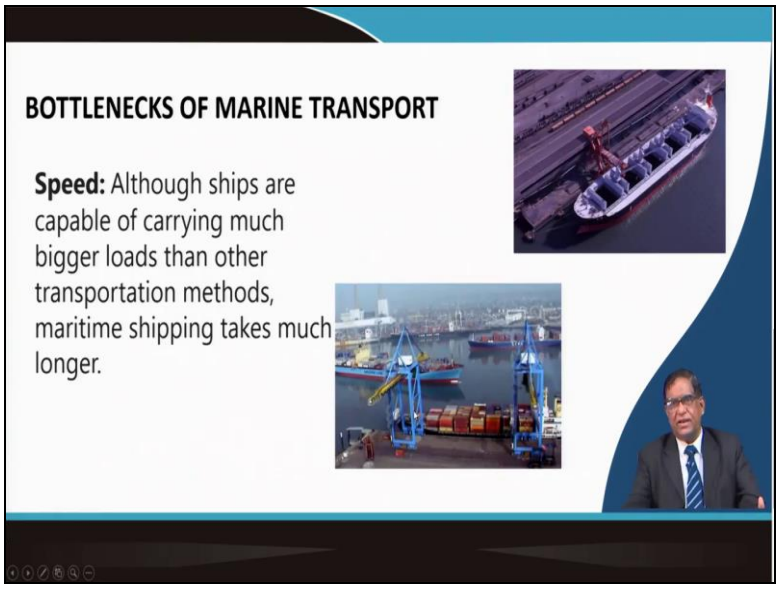

But there is a bottleneck because the that the rate and the speed is less but thing is that it can carry a lot of volume that is why that can be compensated.

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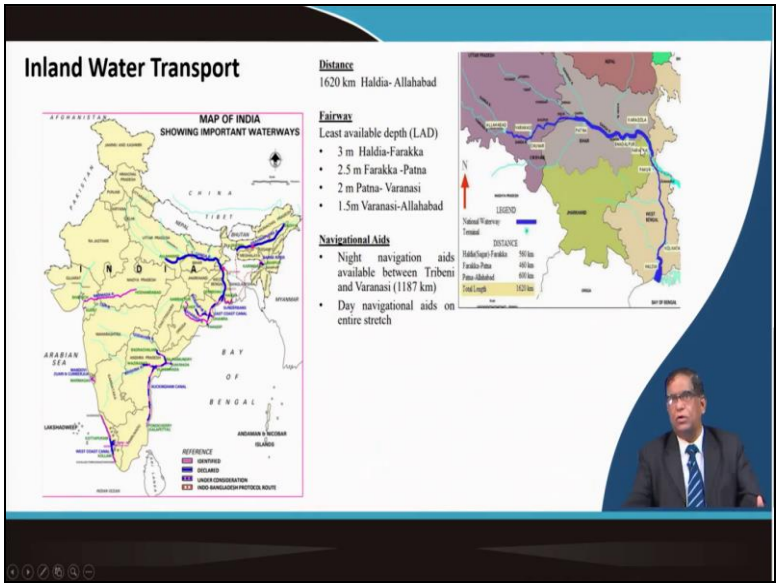

So, a lot of possibilities are there for India for getting the inland water transport. In the inland water transport of bulk material can be at least possible. As you can see in the blue color here this Ganges there is the Brahmaputra here we are having one of the Godavari and then also in the Krishna and Manduvi these reverse areas these waterways have been used.

And there is particularly there are a number of thermal power stations near here and also the coal mines are there and that is why that in the at the first phase there was a plan for this Farakka the thermal power stations how they could be exactly getting coal and even the imported coal with this waterways there are a lot of studies for last 10 years and then still it has got a opening for doing many thing.

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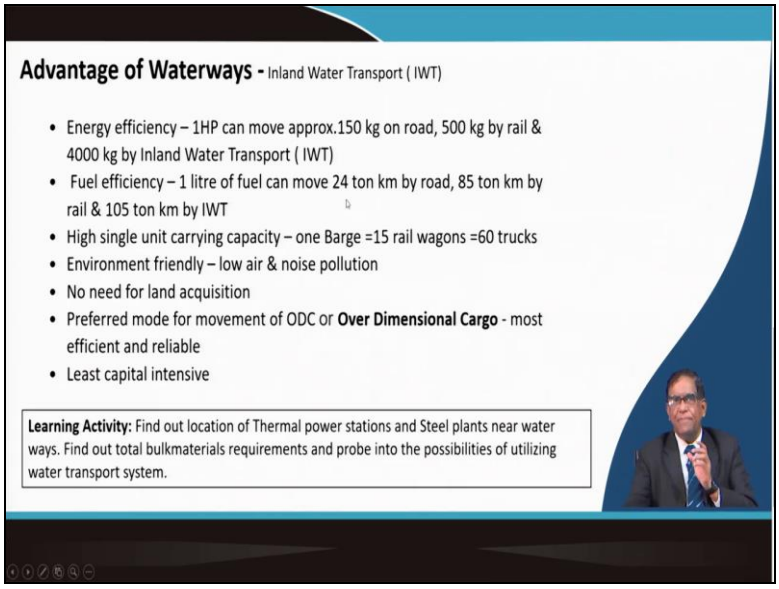

Because their waterways have got number of advantages because the energy efficiency one hp can move about 150 kg on road but under in rail it can go 500 kg but in water transport that one hp energy will be giving you 4000 kg can be transported. So, that is a huge thing then the fuel efficiency is also that is your that only 24 ton in case of road it can take one liter and then for your exactly the in case of your that your inland water transport can take 105 ton kilometer value is obtained like that.

So, in a big truck exactly one hour of running will be say a 270 under truck may call may consume about 130 liter of diesel every one hour. So, that is a huge saving will be there if you can get water transport also it can handle water over dimensional cargo and all. So, I request you to take a location of the thermal power stations and steel power plants in our country and find out what are the nearby waterways available and then you can exactly plan.

That is a by what type of water management is required in our country. So, that we can get use of that is a benefit of such type of that is your fuel efficiency and energy efficiency.

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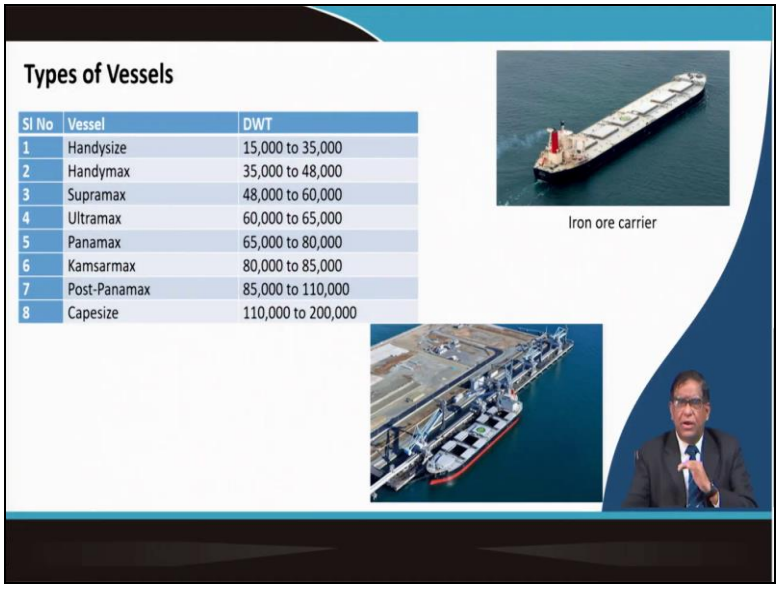

Then you know in the ocean also in the sea route we can have a lot of facilities there are different types of vessels are there that handy size vessels which are being used in our country but there are you can have a just general idea about what are the different type of vessels. And there as a handling machinery lot of handling machinery will be required the handling system will have to be developed for loading and unloading of ship that part also I think in my previous lecture I have just hinted.

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But the rail transport is the one of the most commonly used and it has got lot of benefits in our country and that is why we have been used as because it offers a high carrying capacity it reduces the delay also in the as happens in the road and it minimizes the environmental effect exactly then your transit time is also beneficial it has got access to many places.

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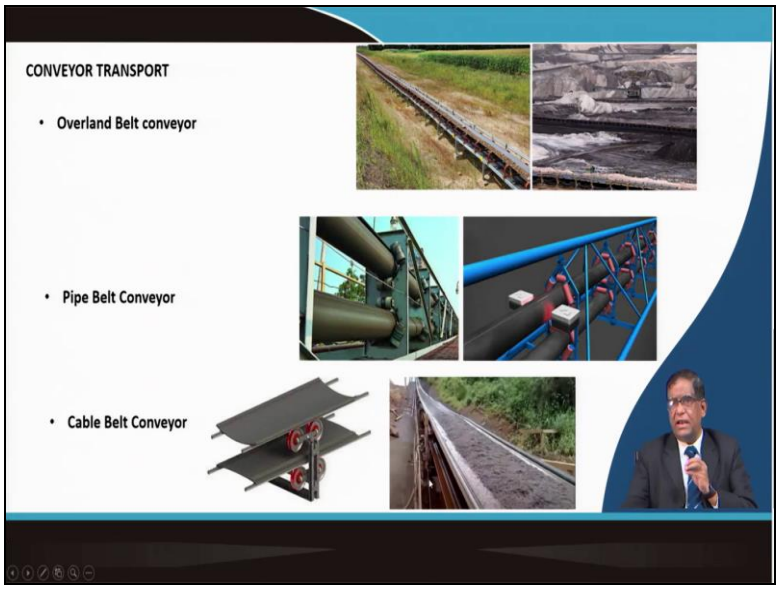

But there are some other advantages that is your conveyor belt transports have come the latest conveyor belt is the pipe build conveyor which is being introduced in our country for from 2006 onwards I think when one of the Jindal minds they started working it Tata steel also developed got one installed a pipe built conveyor. Overland conveyor is a very India is famous for it naval ignite corporation mines very high continuous mining is going on over there with more than 10 million ton from one mine they get transported by his network of conveyor belt.

That pipe build conveyor and land-land conveyor along with that there are cable built conveyor if you see about the NALCO our aluminum sector in dementory mines they have been from the 80s you know what these conveyor belts are working over there and they are giving really high productive there are some pros and cons of this you will have to see that how what this rope cable belt conveyor are there.

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Then this latest in the world is the RopeCon which first came into the Sandberry mines of Papua New Guinea in the gold mines from the goldmine 64 kilometer they were taking up like this from one island to the port for transporting it to Australia that gold ore. So, this is another revolutionary development because here that within the convert belt there is a shaft and then these wheels are there which is running over a rope in case of cable belt the that is exactly the belt is moving over that on a wheel.

But here that inside the conveyor belt that shaft is going and then this is there that rope con has got a different but the conveyor belt has got a side wall. So, that it can take evenness high higher elevations also can be managed with that you can see the check how it is there. So, that rope con is a latest device but in SAIL they thought of once they did some study for that taking it from the Syria area but Syria mine project has not yet come up.

So, there is a still possibility of this rope confusion in India then apron conveyor it is used in the plants as well as in underground mines which is a steel plates on a chain chain that plates are there on which the material comes they are used.

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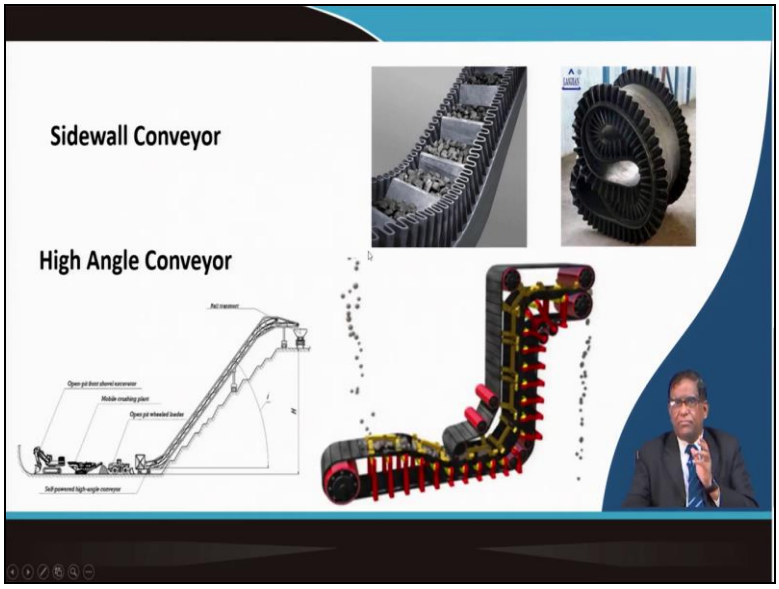

Then another thing is your side wall conveyor you can see the conveyor belt having got these cleats and then the well you can see the belt how it is manufactured. It is a very interesting development in India we do not have much of this manufacturing has not come but near future we will be having lot of demands on this when will be going for the high angle conveyor.

In the high angle conveyor we have got the sidewall conveyor can also be used there is a another concept of sandwich table conveyor which are used in the high angle conveyor in the conveying technology when we will be discussing will tell about it.

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Similarly the other thing is the screw conveyors in plant that material can be transported by screw just like a auger takes off the wooden material from a wooden when you do the

ordering see the same principle the screw conveyors can work. Then there are the chain conveyors used in underground mine bulk material handling quite a lot.

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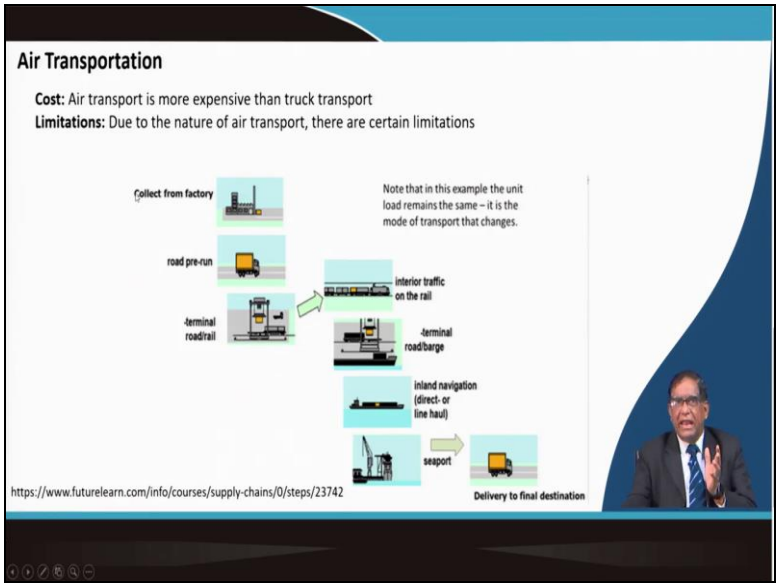

Then air transportation as I said the air cargo only the your unit material is there bulk material it is not there but the inter model transportation in which you can mix up from the ship it is coming then it is taken by the truck from the truck it is going to the rail from the rail it is going to the again for a maybe going a small distance inland waterways from there again it can transport to the delivery. So, there may be a different mix of mode and then it will be giving for our betterment.

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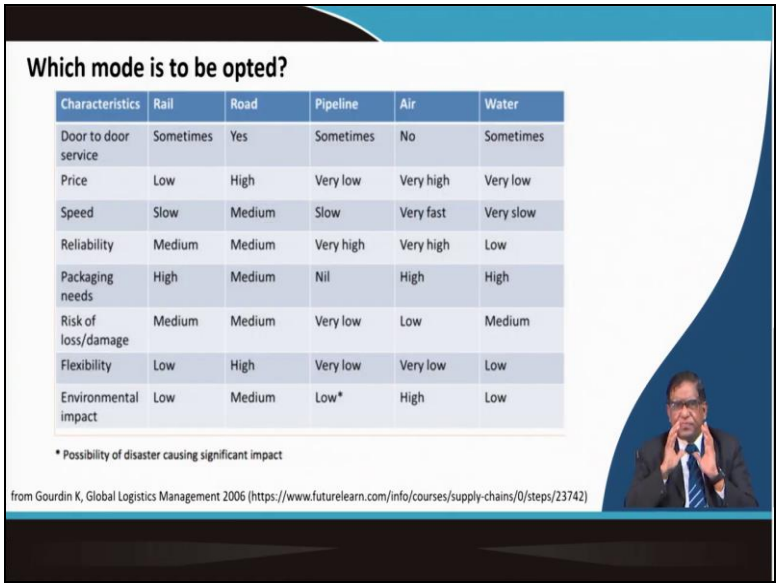

So, in a nutshell to summarize there are different types of you please prepare such type of table that how the red and different mode of transportations on the basis of some

criteria you take that whether it is a go to those services their price their speed their reliability packaging need risk of damage flexibility energy consumption channel you can make a number of criteria and find out first qualitatively what are they.

So, that it can give you a scope for research into a quantitative research for evaluations and selection of this.

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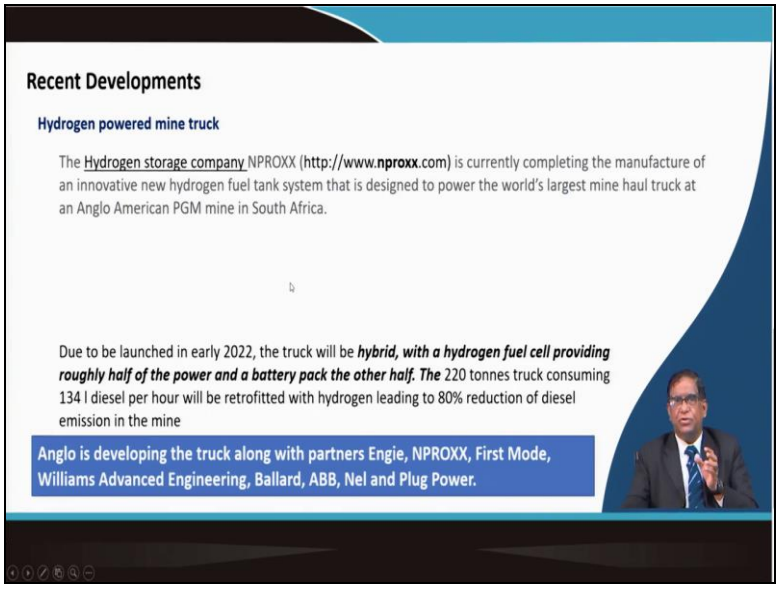

So, there are hydrogen pod mine trucks as I said it is already in that is your German is that nproxx along with some of this company that Anglo-American there in South African mines they have started introducing this. So, there will be hydrogen powered will be running in the next year in number of mines.

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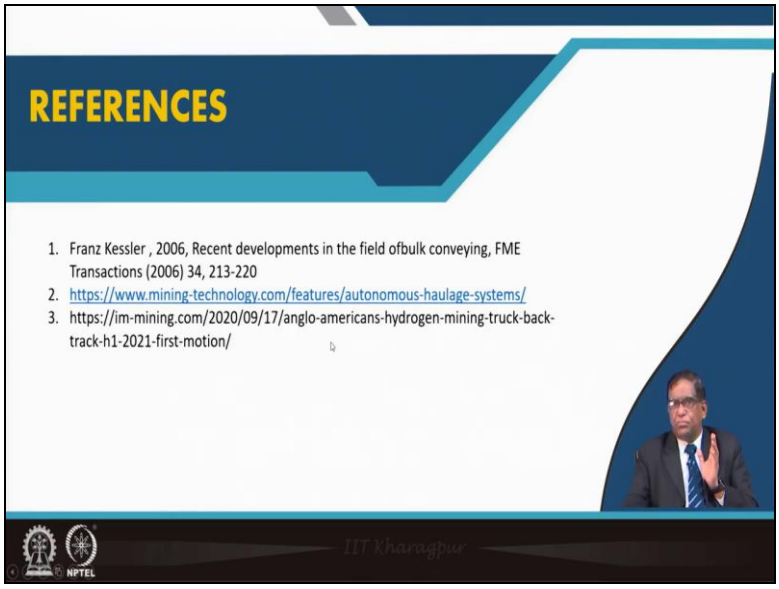

You please go through different that articles in the net you search it and if you have got interest definitely there will be lot of learning activities you can carry out.

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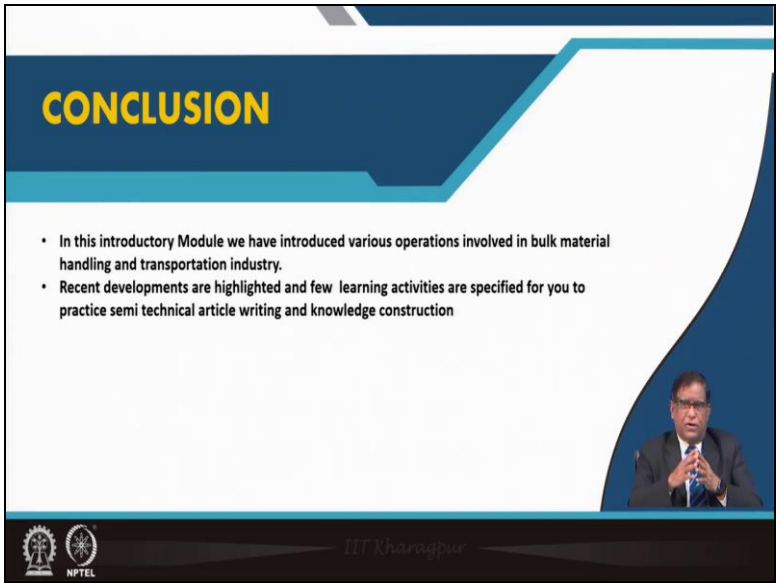

So, we have in the last five lectures we have introduced you that what is the bulk material handling and transportations and we will be revealing one by one in our subsequent classes going to individual topics. But as from this five introductory lectures you might have understood that there are lot of opportunities and scopes provided you study it little bit more in depth.

And for that I have given some of the learning activities if you start collecting the information and practice how to write a semi technical article how you should imagine because for going further to get innovations to get things done in a better way you will have to imagine and for that I think these introductory lectures are enough. I hope some of you will be started working and writing semi technical articles on it you can post it and you can intimate us and if you need any help we are there with you can communicate at any time, thank you very much.