

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

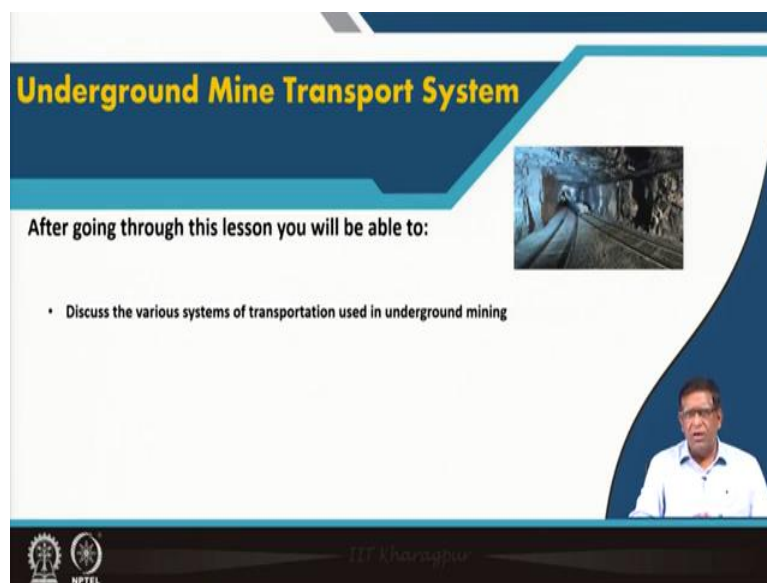
Lecture – 46
Underground Mine Transport System

Welcome today we are going to start another module in this module. We will be discussing about the transportation machinery for underground mines. As you know that all over the world there are lot of raw materials for our different purposes are provided with minerals produced from the underground mines. So, underground mining involves a lot of evacuation of excavated blasted.

This material for creating the underground space and also that taking out the material from there it requires a lot of handling operations. First, you will have to carry out all the machinery equipment and then other service materials from the surface to the underground and then again from the underground you will have to take and sometimes this quantity is huge. So, that is why we will have to have a very good, transportation system to be there.

So, in this module we will be discussing few of this machinery. How they are used? How they are selected? But today we will be giving you an overview of the whole system how this underground mine transport system takes place.

(Refer Slide Time: 01:40)



Underground Mine Transport System

After going through this lesson you will be able to:

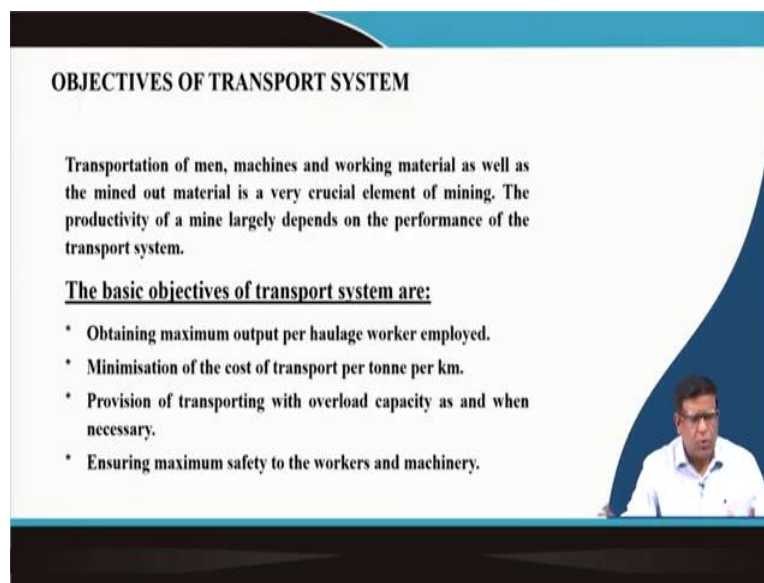
- Discuss the various systems of transportation used in underground mining

The slide features a blue and white design with a small photograph of a mine tunnel. At the bottom right, there is a small inset video of the lecturer, Prof. Khanindra Pathak. The footer includes the IIT Kharagpur logo and the NPTEL logo.

So, that after attending this course, you will be able to discuss that what are the various system existing and they have developed over the years from that your 19th century row volleys underground that on the underground track. The mine cars or mine tubs were pulled by means of rope from that. Though, this is not very clear but this is a picture is from the whale company.

The latest in the underground mine transport system is called railwayer. So, I will be introducing all these things that what are those underground mine transport system.

(Refer Slide Time: 02:27)



OBJECTIVES OF TRANSPORT SYSTEM

Transportation of men, machines and working material as well as the mined out material is a very crucial element of mining. The productivity of a mine largely depends on the performance of the transport system.

The basic objectives of transport system are:

- * Obtaining maximum output per haulage worker employed.
- * Minimisation of the cost of transport per tonne per km.
- * Provision of transporting with overload capacity as and when necessary.
- * Ensuring maximum safety to the workers and machinery.

The slide also features a small inset image of a man in a white shirt and glasses in the bottom right corner.

But before that you must know that what is the objective of this transportation system as it is in the surface mining or in case of underground mining. That is exactly the will have to do it at a less energy, less cost, with convenience without safety. Those are the general things but in underground when we talk about because it is a little bit of challenge in carrying out all those main machine and the working materials for that to this very constrained space which is exactly for working in underground.

It is created, there is always a limitation by the height limitation by the width and also the available air is also limited. Under that conditions, you will have to develop a system with the basic objective is that your maximum output per hole is because, whatever the material you have excavated or mined from the underground. You will have to take out as much as possible per hour.

That is why you will have to maximize this output and at the minimization of costs. The total cost can be for the maintaining it for the failing that is for the energy required for it or for the making arrangement. If you are having more manpower, depending on that, your exactly cost will increase. So, you will have to see that you can minimize the cost and that is you will have to have the capacity to certain you will have to design with little bit of your additional capacity.

Because in future, if you have to expand systems or sometimes you will have to produce more maybe that sometimes your minds are because underground minds may be having lot of other challenges. So, that in some shift the machine may not be working. But if you are producing coal for a thermal power station, the power station will be demanding a uniform quantity of coal every day.


So, that is why? If there is due to some problems in the underground mine, you cannot transfer a transport material for some time. Then, the following time, you will have to do a little bit more that is why designing with an over capacity is always a necessity there. Then it goes without saying that you must make a lot of safety provisioning. Because, while working in an underground mine itself is a there is at every point there could be some accidents if you are not taking care.

And there you are using this energy, a lot of things may be there if it is underground coal mining. If it is a gas mine all the time that there could be air and methane mixture that fire them, they can lead to an explosion. Because certain ratio they will be explosive, there could be the cold dust which will be accumulating over there even they can get they make it. Cool dust can could be also an explosive at a at certain concentration.

So, you will have to be very careful. You cannot use sometimes a your open this diesel engines, because in the diesel engines, if that exhaust which is coming, it will be very hot and if there is a some hot particles of carbon unburned carbon come with that diesel gas exhaust system, it may create an explosion in the mine. So, you can understand that the safety will have to be taken in a very different perspective.

(Refer Slide Time: 06:19)

- The mine transport system may be demanded to handle more than the usual throughput capacity under some special situation. Therefore, one of the objectives of mine transport system is to keep provision for overload capacity.
- Deployment of machinery is associated with hidden hazards which may cause serious accidents.
- Thus, one of the important objectives of mine design and operation transport system is to ensuring maximum operational safety.



So, the mine transport system may be demanded to handle more than the usual throughput capacity under some special situations. As I have said so, you will have to keep the overload capacity and it is also sometimes that that material itself could be having some hazardous. Maybe sometimes you are carrying toxic material, then this you may have to have sometimes, very big boulders may be coming.

Sometimes even very fine powders may be coming. So, from the underground you will have to design a system with a wide range of varieties.

(Refer Slide Time: 06:57)

So, that how the size of the material handle can be, as it is from very fine powders to a lump. So, that how your this transportation system will have to take care of that. So, you will have to design so, basically, your in underground mining, your transport object could be man material and that product that is coal or ore or mineral that is it could be many things, though in say iron ore in India we are doing all by surface mining.

But if you go to Sweden, they will find kiruna mine is one of the oldest that is they are getting iron ore from the underground mining. Everywhere we are having this uranium mining there. All this ore is coming out from that underground mines. We have got a gold mine in hearty gold mine earlier there was this Kohler gold mine. That gold is coming from, your that gold ore is coming from underground mines.

So, that coal coming both from underground as well as open cast, though in India most of the coal, more than 95 percent. Now coming from the open cast mines but mind it. There are a lot of coal ore lying which can be mined only by underground and then they that, because they are that, sometimes we keep them locked many of the closed and abandoned mines. Unless and until we do again, a design for that sometimes to excavate by open cast mining.

But always it is not possible because of the environmental constraint. So, to do that underground mining. How will you do the transportations? Your requirement for band transportation exactly it will have to be high speed and comfortable travel. Because in underground mine, sometimes from the surface, where you are going through the shaft and then after going down there from there that where this person is going on maybe 2 kilometer, 3 kilometer and all.

And many times our persons, who will be the mine worker. Miner will be working up to that end. Already, the half of the shift may go only by walking coming and all that is effective working hour will be very less. So, that is why we will have to have a high speed man riding system or system for transportation of people. Then it could be that is your between the mine operations and the working phase that your minimum waiting time should be there.

That is exactly when many times in underground you will have to have that one that say you are having a rough way type a person is going and then, after that again it will be coming back. There will be a queue of miners waiting for getting the ride. So, there are many things. Sometimes you will be having in underground just a bus type of things, a trolley there number of people will be sitting together and then they will be carried down to the face.

So, this is a how you will be transporting the man with that comfort that he should not be there just in a very constant manner. He can should not sit down for a long time, but that the gallery height is less. Sometimes in the past you can see that the miner can be just they can be transported, they are in a lying positions. They will be carrying out in a very different type of transportation system.

The materials that is exactly you require the all the explosives to be taken out to the face, your different, your that say for the props 10 year, for the lubricants for your if you are having a diesel engines underground the diesel, all this material will have to be carried out

and also that your the roof bolt the bolts, etcetera. Also, will have to be carried out sometimes for taking out the water.

You will have to take the pump inside the mine and to fit the pump you will have to get the pipe will have to be taken. Then, in a case you will have to take the pipe. What should be the maximum length of the pipe? Because it is case, is going directly and after that, it will have to taken up in a horizontally for a pipe. How exactly? If how? What should be the length of a pipe that you can make it to take it from there vertically.

And then you want to make horizontally all those things are a constraint in transporting in underground. Then you have got this avoid delay to productions. That is your transportation should be faster, if your that, whatever machine you are using for excavating the coal or winning the coal, their production rate and the rate of evacuation, they will have to be matched.

So, that is why? What is your coal winning system and the cold transportation system will have to be matched. So, that is why what type of machines you will be using for transportation is very, very important. Then, while this transportations at that time, the material should not get degraded that is also very important things to be noted down.

(Refer Slide Time: 12:16)

CLASSIFICATION OF MINE TRANSPORT SYSTEM

Considering the nature of working of the equipment the mine transport system can be classified as Continuous Transport System and Intermittent or Batch Transport System. Each of these categories has large number of equipment systems.

Category of Transport	Types	Equipment System
Intermittent/Batches	Rail	<ul style="list-style-type: none"> * Direct rope haulage. * Main and tail rope haulage. * Self acting rope haulage. * Locomotive haulage. * Shuttle cars.
	Road	<ul style="list-style-type: none"> * Rubber tyre haulage. * Shuttle cars.
	Hoist and Cranes	<ul style="list-style-type: none"> * Cage and skip hoist.
	Others	<ul style="list-style-type: none"> * Scraper haulage (Slusher). * Cable ways.

Now, if you see that all these different requirements will have to be fulfilled and there could be a number of different type or category of transportations. Some transportations could be intermittent or batches. One group will be going and then again the group will be coming that

that or the material will be put in a container and then it will be going, one is going taking it out .

So, batch by batch may be your number of, the just like a you, make a train with some trolleys and that batch is going out again they will be coming back and they will be filled and they will be doing like that. The operations will be going on now for doing that. There are different system, we say it is a track system or trackless system. The track system means where you are having the rails that is called track you are having and on that your trolleys are there.

They will be there and in some types there will not be any track there. You could be having either a rubber tire or your crawler that machines can take the material out. So, in the track system there are the direct rope haulage. That means you are connecting the number of trolleys together, connect them and then pull it by a rope that is your direct rope haulage and main and tail rope haulage.

That means you are having a that is your one rope it is going over there. The other and from the back side, you are again connecting over there. So, that when you are winding or it is bringing this sides, the other one is getting released. So, like that they have got a main and tail system. There is a self-acting rope haulage that is your it will be getting activated by itself. There is a locomotive haulage in which you are having a locomotive engine over there.

And it will be carrying out the things and there is a shuttle car that another type of machines which could be tire mounted and or it could be, your electric motor will be there and then the power will be given with the cable and that machine with a limited part. It will be shuttling that is coming and going. It will take from the face and then coming to a particular place and there it will be unloading or giving the material to a conveyor belt to take it out.

So, these are the different type of track mounted systems are there and then there is a the shuttle car it is not a track mounted, but it is not a rail mounted. It is a you just please note that one. This shuttle car could be a tire mounted so on the road that rubber or tire holes it will be there. So, you please correct that one by mistake it has come there. Now this hoist and cranes sometimes you can do that is your in the underground mine.

It will go there up to the face and then they bring it to the shaft. Shaft is that vertical opening and in that this whole car will be put into a cage or another system is skipped. So, we will have to know what is this case hoisting we are taking it vertically up and then what is a? In the case you will have to keep over there, then the trolley which will be coming out. Then you will have to take this material out from those trolley and for that there should be arrangement for trains that is your unloading it by tippler.

Now, when you are bringing this car or the trains together, there will have to be a siding just like in the railway, you can see the railway sidings. That means the railway tracks will have to be connected, then from one track, then how it will be going to the other track? There will be a crossings that whatever there you can see in the railway for an underground mine transport also, a miniature of all this railway system will have to be there.

There also will be such as there will be also diamond crossing and there will be you will have to make the pit that is a layout at the pit bottom, as well as at the pit top at the shaft, where it is going to get the horizontal your gallery at that time, how you will be making the siding sections? So, that after giving the loaded car, then from the case, you are collecting the empty cars and then making them to form the train and then again you connect it to the rope or the locomotive and you will be taking.


So, these systems are there in your underground mining. And, also there are the different type of old type of haulage, because there, the scraper haulage or that slusher which is said in earlier when there are semi-mechanized or manual mining type of things. That is just like a scrapping over there. It is a very primitive way of getting the blasted coal will be there and then you keep a piston type of things and then you pull it out all the machines.

And then from there you give it to a chute and from there you connect it. So, there are different type of arrangements in the undergrounds were there. There is also a cableway that is a ropeway or it could be even the conveyor belt came over here as a continuous I will tell you about that.

(Refer Slide Time: 17:28)

Equipment system in different categories of mine transport.

Continuous	Guiders	<ul style="list-style-type: none"> * Ore passes. * Spiral chutes. * Shaker conveyors. * Vibratory Conveyor. * Endless rope haulage.
	Pushers	<ul style="list-style-type: none"> * Open chain conveyors. * Endless chain haulage. * Screw conveyors and feeders.
	Carriers	<ul style="list-style-type: none"> * Belt conveyor.
	Fluid suspension	<ul style="list-style-type: none"> * Open flumes * Hydraulic transport (pressure and suction pipe). * Pneumatic transport (pressure and suction pipe).



Say, then there are some guides that means, you will be making a trains type of things and from there you will be creating a chute and the material will be placed over there and they will go. So, that is a with a you guide, the material with a certain machinery in which there is a ore passes where it is, you are just you are making a route by cutting inside the rock and then there could be chutes that is a spiral chutes.

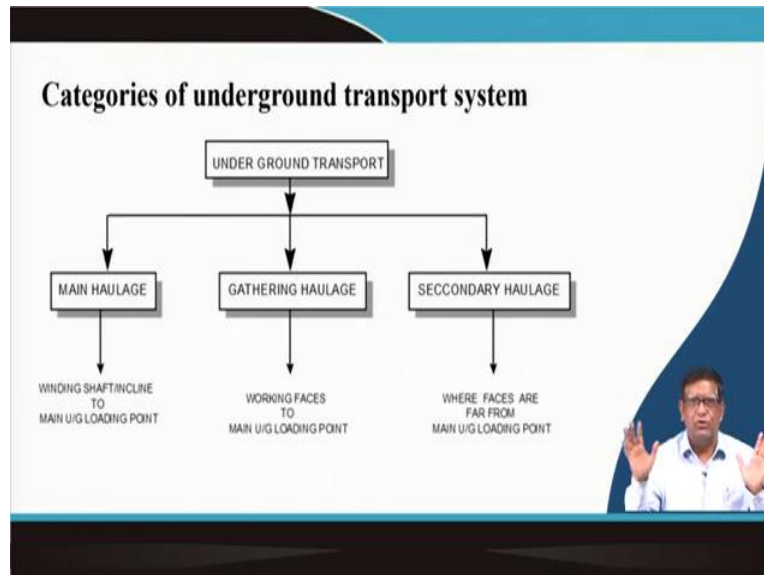
There are shaker conveyor, vibratory conveyor, endless rope haulage, these are with the help of, but there the material is continuously moving. Then there are pusher type in which you have got the open chain conveyors. There are this endless chain conveyor, screw conveyors and feeders all different type of machineries are there. When the material is pushed slowly, as as you see in a screw when, in here on any wood, when you make a screw, what is there in the screw?

There is a spiral groups that when you push it over there, the wood is coming as out with that exactly it get pushed by that spiral groups. So, that type of a pusher type of conveyor is also there. Then that, as a material is carried by belt conveyors. This belt conveyor is a another form of technology you have already studied there that, whatever their pipe bill, conveyor, cable, built, conveyor, trough well, conveyor all type of conveyor can be used in underground mines.

Only will have to take some special arrangements for the safety purposes. Then also it can be used as a fluid. That means your you can transport the material sometimes that by making them slurry and you pump it out. So, that is call your hydraulic transport or sometimes by

you in a you, have studied already the pneumatic conveying system. In which that exactly the all your slurry transport or that pneumatic transport which you have already studied, can be with special arrangement used in underground mine also.

(Refer Slide Time: 19:31)

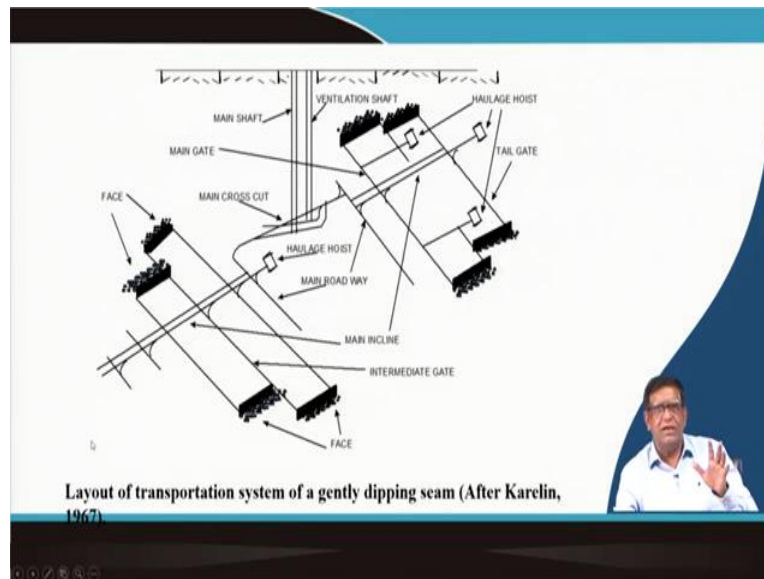


So, basically this, when you are putting the things in an underground mining system. Your underground transport could be main haulage, gathering haulage and secondary haulage. These are exactly that when you are from the winding site to an in or an incline to the main underground loading point where exactly you are doing the blasting or where your machine is cutting and then getting the material from there.

It will have to be brought to the your shaft and from there you will have to leave vertically. So, that winding to the your first that is called your main haulage. And from the working face or where the material is you own that is called your winning of the material to that your loading intermediate to a point that is your gathering haulage. From the gathering haulage it will be taking it to the maybe by incline, can come up to the top.

And that is your in a secondary haulage is a short distance underground haulage where there are not very far from this that exactly secondary haulage come together. They gather in haulage and then they get together. Then they bring to the main haulage.

(Refer Slide Time: 20:50)



So, these things will be clear from here. You can have that in any underground mining two shafts are made. One is this these two shafts, it could be quite at a not so, close. It will be at a quite a distance, it will be there. That is, one is a ventilation shaft and this is called your main shaft. Now, once it has gone vertically down after that, that is near the sub that is called your cross cut.

From that cross cut you can see that these are the gallery made and from there it is coming, this is your face. So, now that your this is the gallery by which the material. Now here from that face, the material is cut and then they are taking over here. Suppose, this is your a haulage rope haulage drum from that the winds, the trolley it will be coming over here and this route that trolley will be coming from here that they will be loaded like this.

So, there could be number of underground that is your main roadway you can see here. That is the main incline, sometimes from here bottom. This could be at a very low, level, the deeper side it is near to the pit here. The material will be brought through this incline that your gallery and then there is a system in which you are having one winding system here another over here.

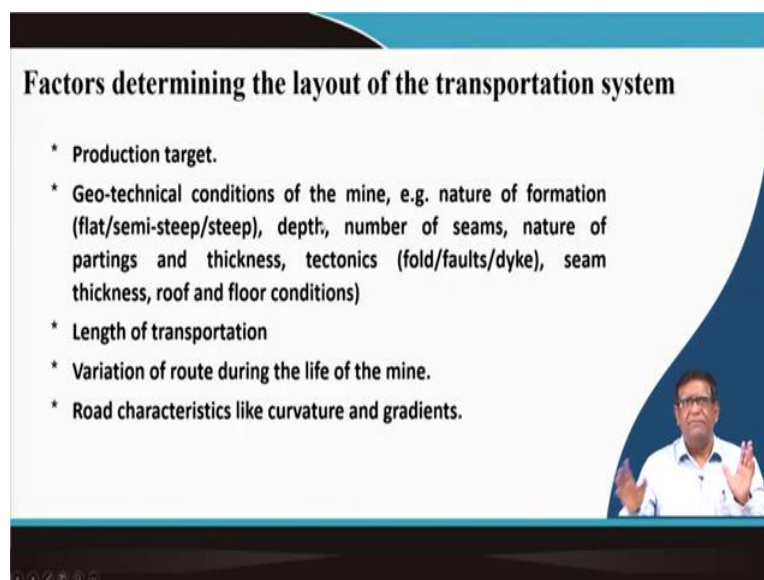
So, this two rope that your systems will be moving from the main and the tailgate that will be both sides. It will be pulled and pushed like that type of rope haulage system could be there. So, the underground mining this whole thing is there below the surface level, where this is your showing the surface level of the ground. So, now that going to the underground by the shaft opening up different your this roadways, these galleries.

And then you can have underground winch. That is your and there the rope is connected and these are the tracks. From the track the main that is your from the face where the excavation is going on drilling and blasting is done. Blasted material given to the trolley and it is taken up. So, this is a just a concept that how your material will be coming, but this could be a different depending on the system.

If you are doing a long wall mining, it will be different. If you are doing a board and pillar mining, it will be different. If you are doing in underground mining, it will be different because in underground mining there is a competent rock. It could be in a very hard rock mining underground. You do not have the gas and other problems. You can very easily manage this ventilations. You can drive a truck over here.

If you go to uranium mining in that underground from the surface you can drive a that is your dumper. That is called your low profile, dumper that will go to the underground and collect the material from the ore passes and it will come back. So, that is what, depending on the type of the mines and depend on the method of mining, depending on the material being mined there could be different type of transportation system and the individual machinery will be different.

(Refer Slide Time: 23:58)



Factors determining the layout of the transportation system

- * Production target.
- * Geo-technical conditions of the mine, e.g. nature of formation (flat/semi-steep/steep), depth, number of seams, nature of partings and thickness, tectonics (fold/faults/dyke), seam thickness, roof and floor conditions)
- * Length of transportation
- * Variation of route during the life of the mine.
- * Road characteristics like curvature and gradients.

The slide features a blue and white color scheme with a curved design element on the right side. A small video inset in the bottom right corner shows a man in a white shirt and glasses speaking with his hands raised.

So, I think you have now understood that what is the need? What are the requirements? What are the existing system? What could be there a general overview we have got now? Now, while the factors determining the layout of the transportation system. Layout means how your

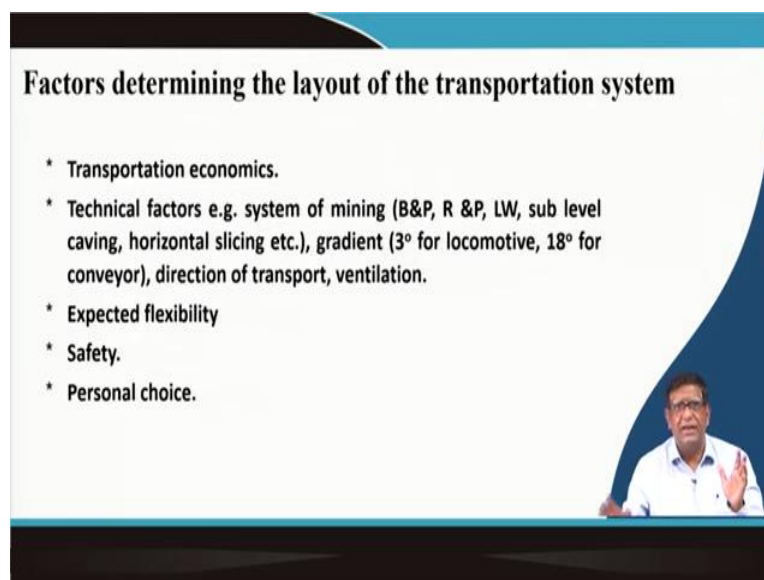
this track will be laid? How with the face it will be connected? So, in case of board and pillar mining, you are doing, if you are doing with continuous minor things will be you will have to have this.

The passes for your subtle cars and all will be different. If you are having that your board and pillar mining with solid blasting, you are doing a drilling and blasting. So, you will have to take it either by conveyor belt or by rope fullest. So, that layout, how you will be doing that will depend on what is your production target? That is, your transportation system capacity that is that your what is the your deposit available?

What type of machinery is there? How much it can produce per hour? That could be done and you get this production target. Then the geotechnical conditions of the mine nature of formation that how it is a flat shrimps or it is a steep seam depth number of seams nature of partings thickness there. What are the geological disturbances all they affect the thickness the roof and floor conditions, length of the transportations.

Then, the variation of the root during the life of the mind that how it will be changing mind life? Then road characteristics, whether the what type of curvature? What would be the gradient?

(Refer Slide Time: 25:51)



Factors determining the layout of the transportation system

- * Transportation economics.
- * Technical factors e.g. system of mining (B&P, R &P, LW, sub level caving, horizontal slicing etc.), gradient (3° for locomotive, 18° for conveyor), direction of transport, ventilation.
- * Expected flexibility
- * Safety.
- * Personal choice.

The slide features a blue and white color scheme with a decorative wave-like border on the right side. A small video inset in the bottom right corner shows a man in a white shirt speaking.

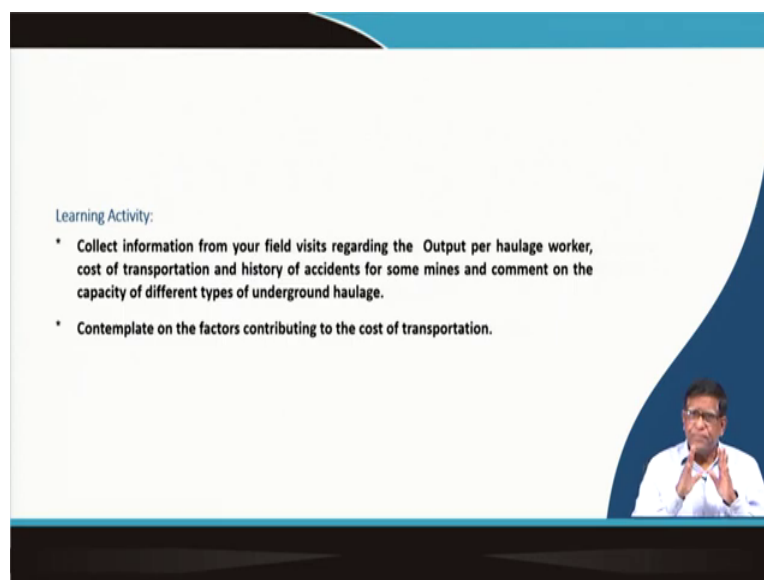
All these things will be considered in designing a mind that, ultimately, the transportation economics will affect technical factors will be. That is whether that boredom pillar room and pillar long wall sub level caving, horizontal slicing.

These are the mining methods. That is, though, mining engineers and then whether if it is a more than 3 degree that your locomotive you can cannot use that. If it is more than 18 degree, your conveyor will be having a problem. Then, whether direction of transport in which way will go. But though we say that a more than 18 degree, you cannot use a conveyor belt. But in the conveyor belt you can design with a different type of flight bar.

You can do it over there. You can have even a high angle conveyor system where even you can take it up to 80 degree 70 degree. Then the whatever flexibility is required. What type of safety that personal choice that is more important things exactly the mind owner the company there, the top bosses in the what type of perspective is there? What is the vision is there? But thing is that in Indian mining scenario, the innovations have not gone much.

The designer they have never put into the academics have not gone into the mine planning, because of that that India does not have many innovative designs. That is one of the very poor state of the business in India that we have never given a personal choice and then we have never taken a challenge of entrepreneurship with a new devices. Now the things are changing with the more make in India and startup. I hope there will be new innovative design of mine transport will be coming up.

(Refer Slide Time: 27:33)



Learning Activity:

- * Collect information from your field visits regarding the Output per haulage worker, cost of transportation and history of accidents for some mines and comment on the capacity of different types of underground haulage.
- * Contemplate on the factors contributing to the cost of transportation.

So, here you can take a learning activity, collect information from various from your own field visit. If you can get from your institutions, the output per holist worker, cost of transportation and history of accidents, of some of the mines and comment on the capacity of

different types of underground haulage it is there. You should develop some brooch here of yours.

You can, if you cannot go to the mines and things, but from the net and from other resources secondary sources. You can write an essay, on the what is the state of art of Indian underground mine transport? Then contemplate on the factors contributing to the cost of transportations that you can easily make out. And then try to find out what are the variables or what are the parameters? What are the factors?

And how they can be measured? and then, if you can find out those factors. How they can be correlated? So, that you can think of in the time of modeling and simulation of transportation.

(Refer Slide Time: 28:35)

Some Examples

Battery Locomotive

Weights range from 1.75 tonnes up to 25 tonnes for non-hazardous environments and 3.5 tonnes to 22 tonnes for hazardous environments.

Clayton's range of rubber tyred locomotives is ideal for use in situations where heavy loads need to be hauled up steep gradients. Pioneered by Clayton, this range, including the world's first 12 wheel underground rail locomotive, can haul loads on gradients of up to 10%.

Locomotive for underground mining

Battery Locomotive - Clayton 18 tonne, 200 volt d.c., 100 h.p. battery locomotive operating at site in China.

Clayton Equipment Limited, part of the Rolls Royce Industrial Business Group, Clayton Equipment Ltd
Hatton, Derbyshire, DE65 5EB, United Kingdom, URL: www.clayton-equipment.co.uk

Now I will briefly, within another 5 minutes I will show you that what are the different things are available. We will be coming back to discuss of these things individually that you are having a locomotive. That battery locomotive is one form of machinery which is used in underground mine.

(Refer Slide Time: 28:50)



Flameproof Battery Locomotive - Clayton 20 tonne, 200 volt d.c., 90 h.p. flameproof battery locomotive, fitted with rubber tyres to negotiate gradients of up to 10%.

And then you can see that this battery locomotive it will be even in a gassy mine, with a flame proof battery enclosure, they can work such type of things in the underground mine can work.

(Refer Slide Time: 29:01)


TROLLEY LOCOMOTIVES

This haulage system comprises two driverless Clayton 25 tonne trolley locomotives at either end of a maximum 18 car train.

The train can be directed to any one of 18 load stations from a control room situated on the surface.

Standard equipment includes *transistor control (IGBT), direct radio link between each locomotive for tandem operation and disc brakes* for both service and emergency operation.

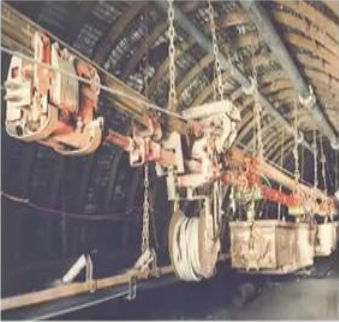
The new automated haulage system is intended to move 28,000 tonnes per day.



Trolley Locomotive - 2 x Clayton 25 tonne, 600 volt d.c., 240 h.p. trolley locomotives as supplied to Western Mining Corporation for their Olympic Dam Expansion Project in South Australia .


There could be a trolley locomotive that this locomotive they are having in underground mine. There could be electric line going on if it is not a gassy mines. It is in a metal mine, you can have a this type of transportation system.

(Refer Slide Time: 29:15)



SCHARF roof suspended Monorail Systems are suitable for negotiating dips and slopes up to 45°, steep horizontal and tight vertical curves, in addition to synclines and anticlines.

DBT Maschinenfabrik Scharf GmbH, PO Box 23 27, D-53013 Hamm, Germany, Tel: +49 2381 960-01, Fax: +49 2381 960-230, E-mail, URL: www.scharfonline.com



You can see these are a monorail on which your this you can see the carriers are, it is suspended from there. This could be a arrangement say I think in Slovakia, they have been using even in a gassy mines. They are using a with a flame proof, that electric motor and using intrinsically safe circuitry they are taking out over there. Even they are taking with a diesel engines with the special arrangements for the that is your their conditioner of the diesel.

Exhaust conditioner is used in the diesel engine and they can use an engine over here and the whole thing, it will be that with a it can driven on this rail. That is a monorail type of things, transport systems.

(Refer Slide Time: 30:00)

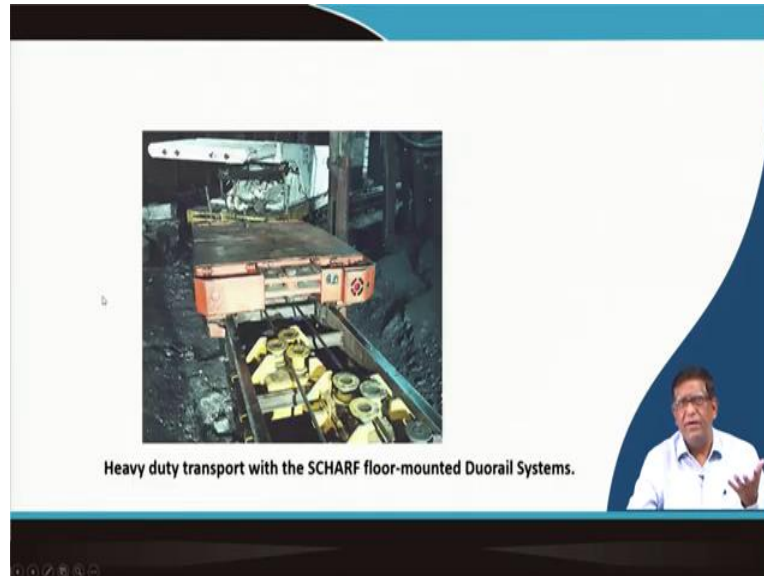


SCHARF Monorail Diesel Locomotives - especially designed for economical manriding and material transport in widely spread gateway nets with alternate gradients.



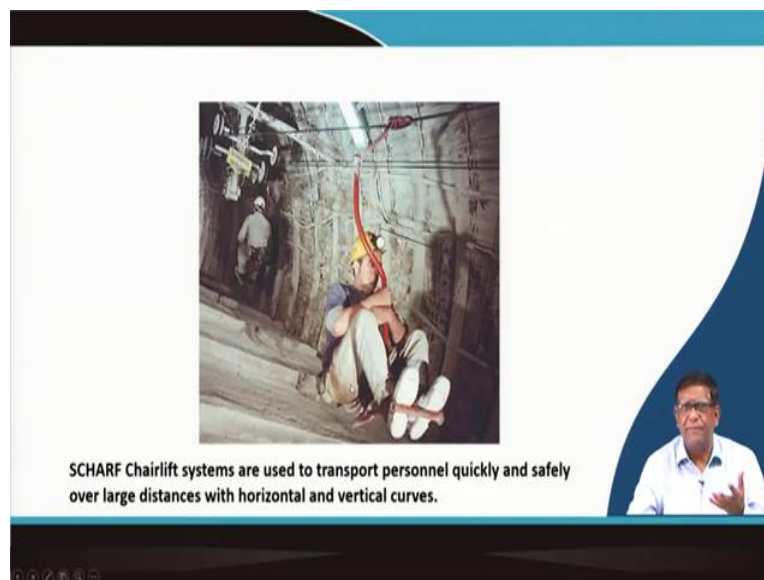
You can see here how it in this is a mono rail. On that, this trolley is suspended and with the battery it is just going on running these things. The whole thing as a train you can collect at the back. It will go either for man riding as well as for material riding.

(Refer Slide Time: 30:16)



So, these are exactly sometimes for transporting different material on the rail you can see here. This is the rope, this rope is pulling over there. That rope haulage can be used for transportation of this machinery say here. A power support is being taken out to the mines by this transportation systems over there.

(Refer Slide Time: 30:35)



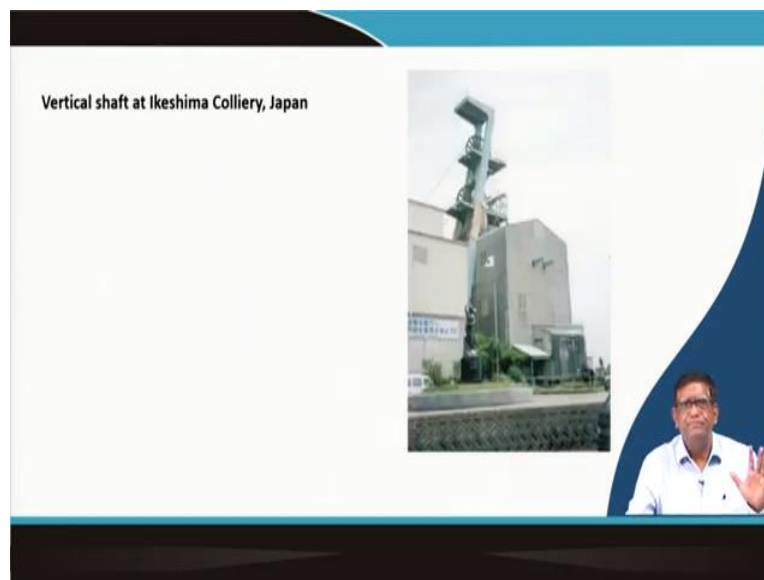
Then you can see also how the main riding system is there in underground mine. How you can have a that. We have said the aerial ropeway that aerial ropeways. This is the thing that rope is here and it will be moving over and there this hanger is put it over there and the man

can go on travelling like this. And this is the way quickly you can take the miner to the face. So, in India also number of mines nowadays it has come but India took a long period.

It is very unfortunate only in the last 7, 8 years. We are having some main riding system in Indian ranch. But before that for more than sixty years that, in some of the mines in the terrier coal field, there are no man riding system even in the mines with that is your (()) (31:25) where there is one 4 gradient and the people is to say that that incline shaft they gave a name is Dukhiram.

Because it was a very problematic for the people to go walking down to the face and coming back. Same was there even in the (())(31:42) which is one of the most mechanized and advanced (())(31:45). There also the people used to walk down about more than one hour for going into the face. Unless this man riding system came up there in last 4, 5 years, I think now they are working.

(Refer Slide Time: 31:56)





So, this again, the vertical transportations could be done by that mine shaft. That is your winder here we can see a vertical shaft with a drum winder. Is there you can see this that shift and there are different type of winding system. We will be talking in one of the class that how the winders, whether it is a copy winder or a drum winder.

(Refer Slide Time: 32:19)

Inclined Shafts or Inclined Drifts

Many inclined shafts that are equipped with rail tracks and a winder. Winders are electric powered drum types. Old winders were controlled manually, however, currently all installed winders are automatic




How they will be carrying on the material and then there are this inclined shaft that exactly you can pull it by rope haulage connecting it over there. All this material can be taken out by an inclined shaft that is a inclined opening to the underground operations.

(Refer Slide Time: 32:34)

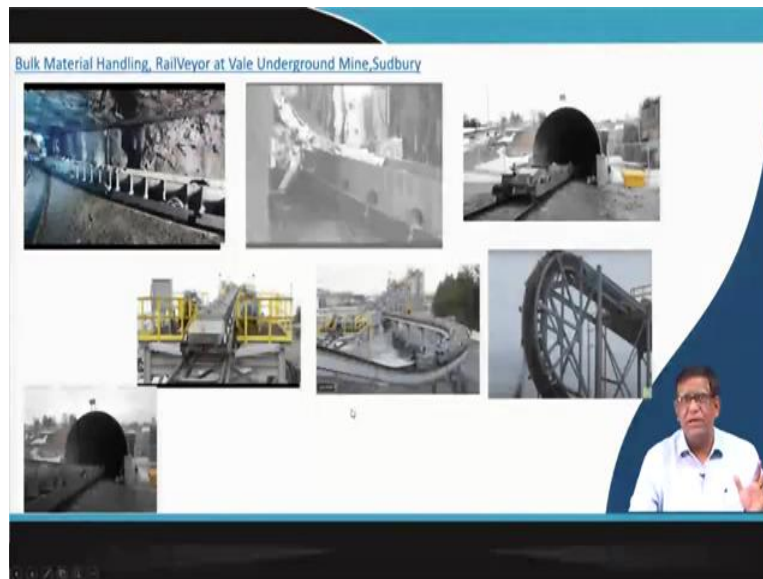
Factors that affect the selection of the materials and equipment transport system

1. Quantity (volume and weight) and size of materials and equipment.
2. Access method to the destination.
3. Transport roadway size (height and width).
4. Transport distance and transloading points.
5. Roadway conditions (gradient, undulation, soft floor, etc.).
6. Relation to the personnel transport system.



So, these are the factors that, while selecting you have to think of the quantity, what is the excess method? What is the roadway height? What is the distance to be transported? What is the conditions of the roadway? And then what is the personal transport system?

(Refer Slide Time: 32:51)



You will be figuring out now that railway which is the latest things I told you. This is exactly it is a railway and conveyor they combine together this conveying part that here there is a group of that your container, they are bringing it over here from the underground. It is loaded and then taking it out when it comes out of the that your underground through the incline, this whole thing go over there.

Then the material which is there at the top here, this material which you are seeing. This is just like a trough type of things here. The wheels are there and the outside this plate which you are seeing exactly there is a horizontal motor, it will be rotating over here and they will push this plate forward. And that is why how the that the car or the train that do not have a driving power externally the motor is connected over there.

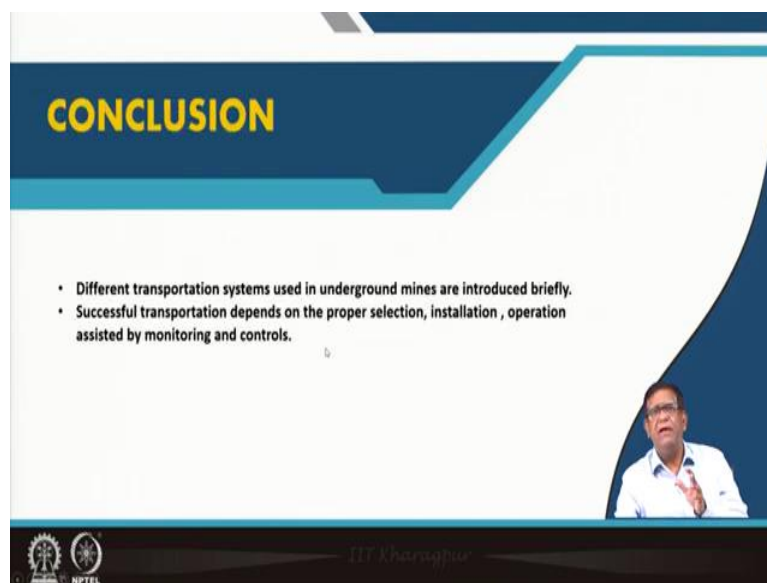
Just like a tire, the tire will be rotating on a horizontally and then when it is rotating, this will push the whole conveyor system over here. And then, when it will be coming over there to unload the whole thing is coming and the material is falling down from here and after that that your the whole system is now upside down. That your wheels and all are coming over here that will go down over there and then again it will take and its it will come again downside.

It will become again into the normal and now it is for going ready for going to the underground and it will now entering into the underground. This type of it is a innovative system railway, rail and conveyor together that is why it is called railwayer. That is your whale in, I think, in in Brazil. They are using this railway system in Sudbury.



We will be discussing this system, but meanwhile you can study about that that encyclopedia of life support system. They have got a civil engineering section in this and their a underground mine transport has been discussed by the professor of Kyushu university of Japan and their professor Matsui lectures are there. You can go through that.

(Refer Slide Time: 36:29)



And so, today we have discussed only the general systems how it is there? And for the successful transportation you will have to do properly, select, install, operate and for that it will have to be monitored and control. So, that advancement which is coming towards this monitoring and control here, the whole systems will be brought in the digitizations and lot of things can be done, provided you are interested studied. Thank you very much.