Bulk Material Transport and Handling System
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Lecture – 47
Rope Haulage for Underground Mine Transport

Welcome back in the last class we introduced about the transportation machinery for underground mines. We have got a the broad classifications and then what are the systems there?

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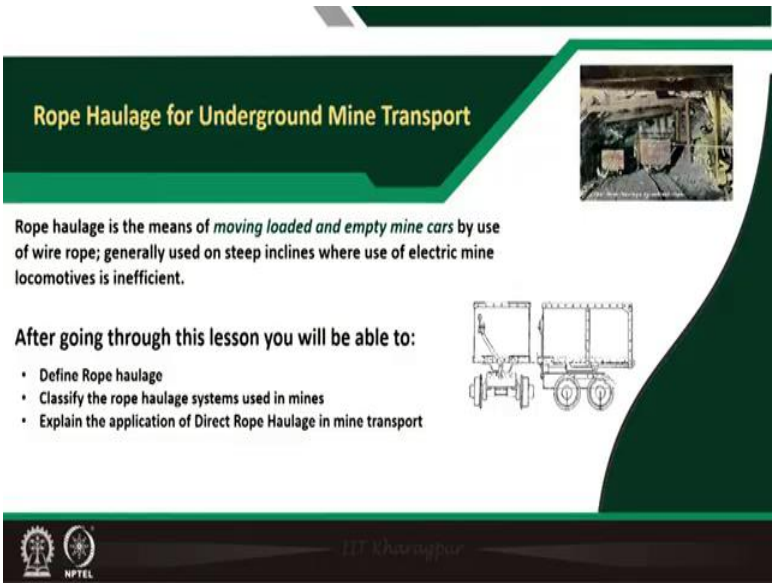

So, today we will be discussing one particular type of haulage system which is a very old one and it has been there in the mines for of the even in the 19th century and that is called your rope haulage which is a very simple system. But it has before the large scale mechanization came to mining industry. This was a means of transportation and most of the coal which were produced during the industrial revolution.

When this the textile industry, where at the peak at that time, most of the looms which were run by coal. That coal were owned from the mines by this type of haulage system. However, this is still being used in many of the underground coal mines around the world, including India. So, we need to know the system about as academically that how it grew and also how we can switch over to a better system from this.

And how exactly the changes have taken place? So, we will briefly discuss what the system is. So, that we know already we told that rope haulage is the means for moving loaded and empty mine cars by use of wear rope. You are using the steel wear rope and on that you are just making it to your drawing the all loaded, cars or the empty cars just by tying at it and then you are connecting it to a winch system. The basically the drive will be.

We are having a drum on which this rope is wound. The one end of the rope is anchored in the drum. The other end is connected to the cars. So, you can see here in this diagram that how a mine car is connected to a rope by a lashing chain here it is getting connected. So, this type of small mine cars which will be running over rails. So, the transportation as you can see here that is as your rails are there.

A tracks are maintained in underground mines and over that these mine cars are pulled. So, we will be in this class just classify what are the different type of this rope haulage systems are there? And a particular type called your direct rope full list, the oldest one we will be discussing today.

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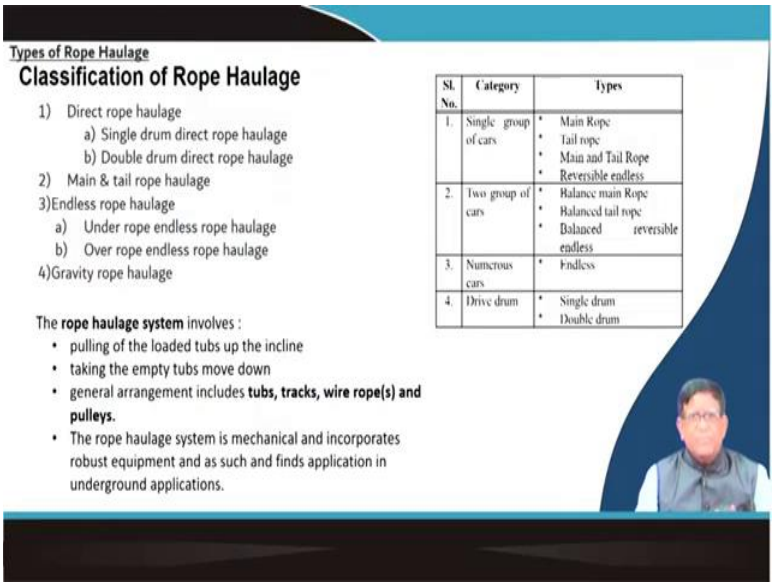

So, as you can see here that is rope, haulage classifications can be done as a direct rope haulage in which whether the rope is drawn by a single drum direct rope haulage or sometimes you will use two drums for the roping system there. It is called double drum rope haulage system. And there is a main and tail rope, we will be knowing it in the next class we will be discussing more about this main and tail rope or the endless rope haulage which are little advanced than this.

Then this endless rope haulage, it can be again an under rope haulage or a over rope haulage. Under rope means, if this as if you show here it is a over rope that rope is exactly above the truck. That is your in the whole route, it will be rope is moving at the top of the trolley and then you are connecting over there or it could be this rope if it is just running at the near the level of the track and you are connecting over there then it is called your under rope.

So, this and then another is your gravity rope haulage, where you are required to take the material down. In that case, exactly your just, it will be by gravity that your system will be pulled. Sometimes it is there suppose you have got number of empty cars their total load can be that is your equal to the weight of the loaded truck or little more. Then, while your empty traps are going down into the mine, their load will be pulling the your loaded fuel loaded tubs on the top.

So, this is the way by gravity you are using without giving any additional power. You will be only using some mechanical breaking on that system. Such type of systems are also there in the rope haulage. So, the what is the rope haulage system, then you can think this is where the pulling of the loaded tops up the incline. Incline means that your that, in underground, you are going in a inclined shaft that in on that incline.

If you are just pulling the mine tubs up that is with the help of a rope. And the empty tubs, they will be going down and loaded Tubs will be coming up that is the system. And that is what are the component it will include it will have to have a mine car or tub. It will have to have a railway track. It will require that wire rope and that pulley, above which this rope will be moving or then exactly that pulley, on which you will have to give the drive.

That is your the you will have to connect the motor with a gearbox and that pulley, it will be by the rope, will be just getting the power from of the motor because of the friction and the pulley and the rope. So, that is the way how it would be there. In some cases it will be the drum on which this rope will be wound up. And then the rope haulage system is mechanical and incorporates robust equipment.

And as such and finds application in underground application, underground mining applications of different type. It is also used that rope haulage is also used in some of the

construction sites or some of the queries for some other transportation means also. Sometimes we make a very temporary short arrangements of moving some bulk material in the surface also, this type of systems are used.

So, this table summarily tell what are the this? You can classify the system on the basis of your single group of cars with two group of cars, numerous cars and then drive drum. So, how this is the way how you classify.

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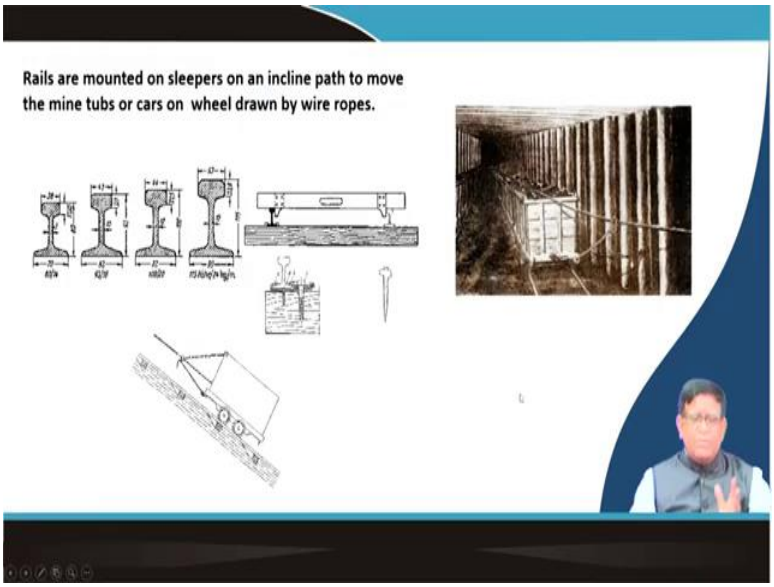

Now, as you have I have said already there the basic system. We are having a track that is railway, rail tracks rails will have to be there on the track. Now this, as you have seen in any railway system that there, if you see the rails are mounted on some sleeper. In the invariably earlier it was wooden sleeper. Nowadays, we are having concrete or metallic sleepers, are there.

And these rails which are again that they are specified on the basis of what is the total per meter how much is kg. You may see that some of the very high speed train when they move there are exactly the rails which will have to have almost 75 kg per meter is a weight, big heavy rail or some light rails are there where you can have just 37 or 40 kilo per meter or even sometimes a smaller, very light rails are there in some of this mining applications.

And that cross section of the rail you can see over here the different type of this is just like a T sections or we are having this base. It is connected to the sleeper, you are anchoring here

with the help of this clip or sometimes with this your pin, nut. And then, depending on the size of the and depending on the load there could be a different thing.

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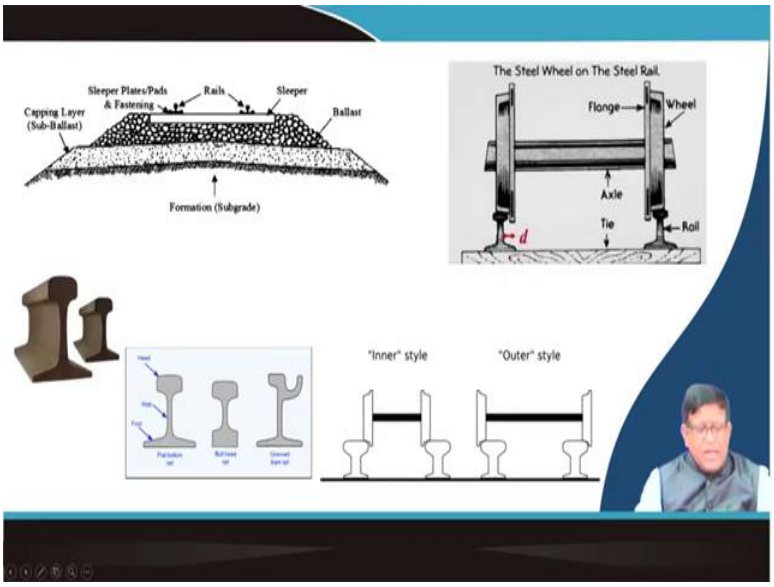

And then one thing is there that the rail cross sections exactly even in underground or in any railway you will find that the rails are placed over here that on the side that is your mainly the formation which is called the sub grid. Above the subgrade, you are having a ballast, sub ballast and then above that is that ballast. You might have seen that your in the railway line, you see a lot of stones that stone ships are there that is called the ballast.

It has got the purpose of which absorbing shocks and all and then above that how the rails are fitted to this sleeper. Depending on the type of things the rails could be of different type, like it has got that flat bottom rail or bull head rail or grooved tram rail, different rails are there in your surface, heavy duty rails you have seen. But basically in underground mines in that small also, we will have to consider in that what should be the head?

What should be this web? And what will be the foot? And then this car that is your mine cars they will be sitting on the sleeper and that is exactly what is your width of this web? That will determine exactly how much weight will be coming. And that the mine cars or tub, they will be having two axles. And on these two axles your this, your wheel is connected, wheel it this is having the wheels, are normally having a little bit tapering over here.

And that is why, at the top of the rail you will see there is a curve. So, that curve will be matching with that your the curve at the wheel and the wheel will be having one flange. That

is now that, when that your the mine car will be resting on this, you can see here. There are two styles are there. One is the inner style or the outer style. This will be in which way your, the that your mine cars will be placed.

That will be having a lot of things now. How will negotiate curve? How this load will be there? And then how exactly that what should be the strength of anchoring this your rail onto the sleeper? What type of clipping should be there and then what type of dangers may come? Because if this is not properly anchored and then it is particular if you are making it a going at a very high speed, at that time, this get coming out of the rail means there will be the derailment.

Many of the accidents take place exactly how the rails are connected over there, how the performance of the track is there. So, though it is a very small scale railway, but just like the main railway we need to see over here.

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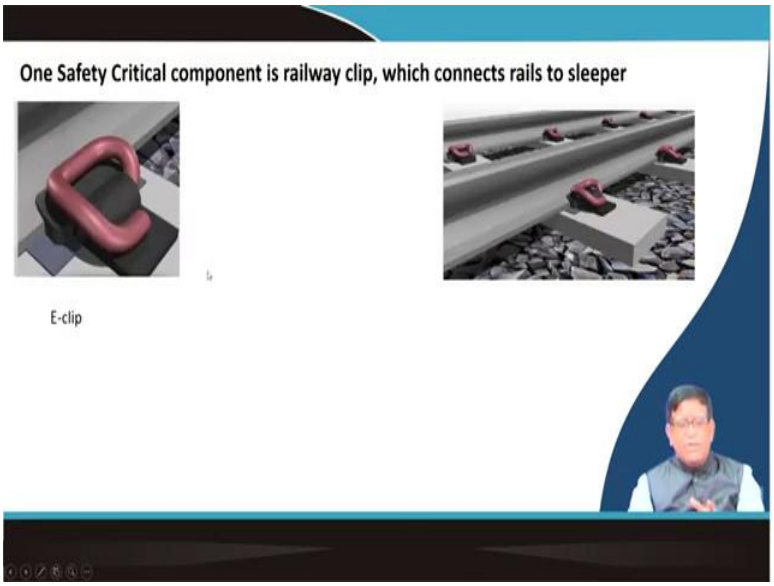

In an underground also, you will have to maintain the railway track and there this clip by which you will be connecting the rail onto the sleeper, is very very important, as in the your normal railway on the surface rail when it goes, we have got different type of clips.

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This e-clip which is very common in that you can see that the even that for connecting it there are 4 components of the how this rail will be connected over there? There is a one is call your this clip part which is there with an insulator. That is exactly there in between the your shoulder and that rail pad we are having one insulator clipped over here. You can see here. This is the insulator and then how the rail will be going.

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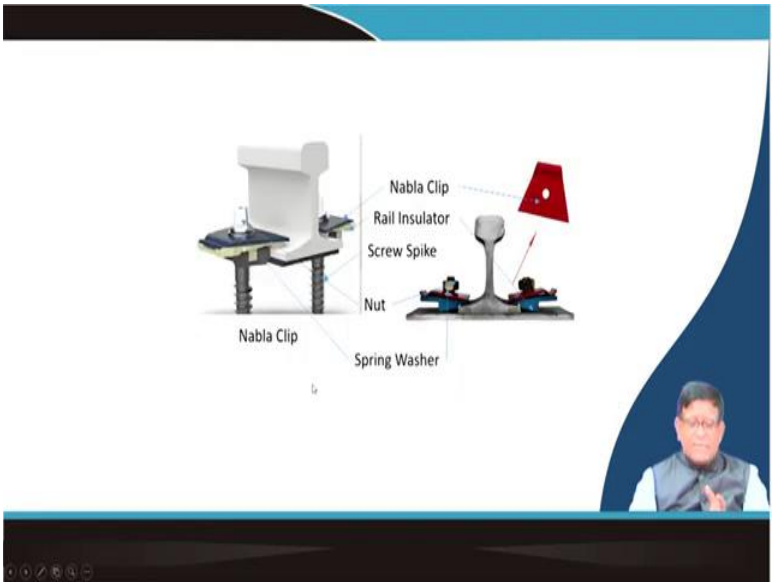

And there is another type of clip which is called a nabla clip. You can see here, nabula clip a different type of plate with a hole it is there. Through this hole, this knot will be going below the knot there will be a washer and then a screw at the pipe it is going down over there and below this your sleeper it is keeping it tight like that.

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So, there are again a different type of a scale clip which is having again this clip component. There also have this your screw or dowel is there that and then there also same like your other clip, we are having connecting these things to the that your rail is connected to the sleeper and then it is anchored to the system so, that it does not get jumped.

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So, this there is a again a very special type of very very heavy duty connections. These are not in the underground mine.

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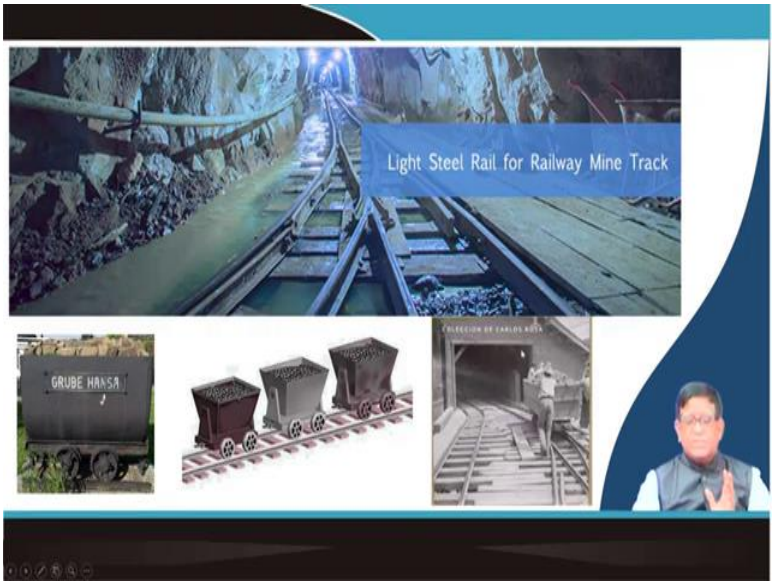

You do not use like that, but you should know that how our railway sleepers and railway clipping systems are there. But one you can see in underground mine you can see over here this is a syn from an underground mine where light steel rail or railway mine tracks are put over here. This exactly when they will be railway cars will be coming from one that is your in a room and pillar meter from one district when it is coming and then they are connecting into that main.

This will be the main your gallery through which it will be put and you can see here how the switches are there. So, that it can be connected that wire if the rail coming from this directions if it is to go over here, this switch will be operating this will be push to connect over here and then the track will be changed. So, you can see that this is manually also done in the mines that people will be pushing the car over here.

The two to three tonne of material will be done in that railway siding part in the underground. So, that the material is carried then put and there will be the two cars they will be connected by coupler and then from the front they will be connecting to the either this rope by a elashing chain and clip.

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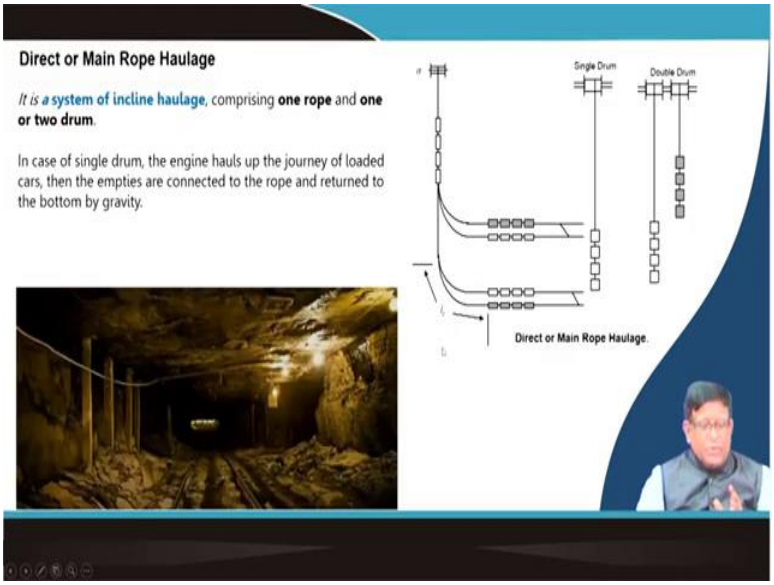

So, now we have seen in that basic system of your rail track car and then the driving system is the rope. Now the most common thing is your direct or main rope haulage. Now it is what is there at a higher elevation and the mine then your material from carrying down from the bottom it is being pulled up like this. So, where it is getting pulled at that time that is, you are having a drum and this is the rope and here suppose your mine phase is working over here.

You are having two tracks, now when this your desear loaded cars or this loaded cars will be pulled like this and it will be coming over here. From here they will be disconnected from that rope and it will be pushed to the cage and that car will be taken up. And the empty car whichever will be coming from the cage will be brought over here in that siding and then they will be pushed and they will be connected to the rope.

And it will be lowered down in the case. So, this is where how the with your drum you are connecting it could be one that it is just bringing up to here after breaking up this drum is given by power. And then when the material is collected at that time again that bind cars will be connected to the rope and then by gravity it will get unwind and go down. And there could be two drums, one is when it is, this loaded is coming up, the other that is your empties are going down.

So, by that, what is there? We are doing a balancing that the motor power required will be reduced by using this your while using the power of empties going down to pull the partially the power required for pulling up is given. And that is why it is called your direct main rope

haulage. So that, in case of the single drum the engine hall sub journey of loaded cars, then the empties are connected to the rope and return to the bottom by gravity.

So, what is required here? When you are bringing it up near that shaft that is called your pit bottom in one of this may be, will be coming in the next class I will giving you the layout of what will be that in the pit bottom and pit top, how the layout will be made for doing this transportation system, because that is very important. Your the operations will have to be arranged in such a way that in an underground space how will you create the space for that empties to go.

And then that is will be placing the empties which are coming from the case at one place and all the your empty will be putting down. And when the loaded are coming, you will have to have a place for keeping them separately and then to pushing them to the shaft.

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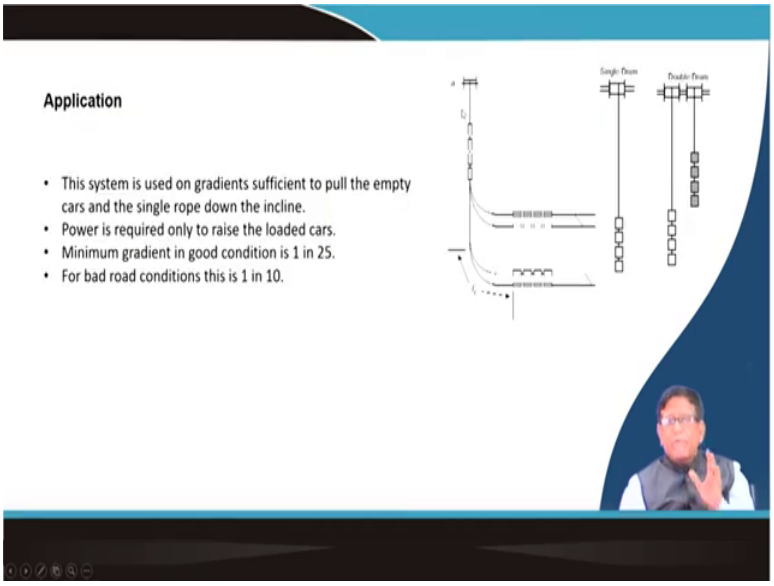

So, that arrangement which is done, that is call your in the shaft bottom or the pit bottom layout for doing this haulage system. So, this this type of direct rope haulage system, it is used on gradients sufficient to pull the empty curves and single rope down the incline, so, your all system cannot be used everywhere. We will have to calculate in that particular mine, your in which way from the bottom you have errands.

That is your when the shaft is going vertically down from there, then your mining is going on somewhere down below then from there up to here, how it is put? You may be having your that haulage drum somewhere over there. It is coming from there. It is coming and when, at a

particular point it will be disconnected from the rope and it will be brought towards that. So, there will be a level side up to the level point it will be brought by the your incline through this rope haulage.

So, the application of the system it will be first, it will be depending on how the underground mine is designed. And then power is required only to raise the loaded cars. This is done in such a way that your that when your empties will be going down by itself you will not be requiring power. And the minimum gradient in good condition is 1 in 25. That is and then your for bad road conditions. This can be 1 in 10. Now, what is this bed road conditions?

Means you may be having the incline, but in an underground mine, it is very difficult to maintain the road, if we do not know if the mine is having a lot of water percolation and then the floor of the mine, what type of rock is there we do not know if it is having a lot of sail, then, when this water comes it swells. So, that is why the track can be undulated and then there are many times your the roof they may fall.

And rock and all that thing may coming over there maintaining in a very small site. Sometimes the resistances and all will be difficult and because of these things, moreover sometimes because maintaining the geotechnical pressures underground also lot of conditions may coming. But a good road in an underground mine is of course, in a metal mine when this is a competent rock, no much problem, no water is also not there.

They are maintaining a track and all could be very good and safe and also it could be maintained very nicely.

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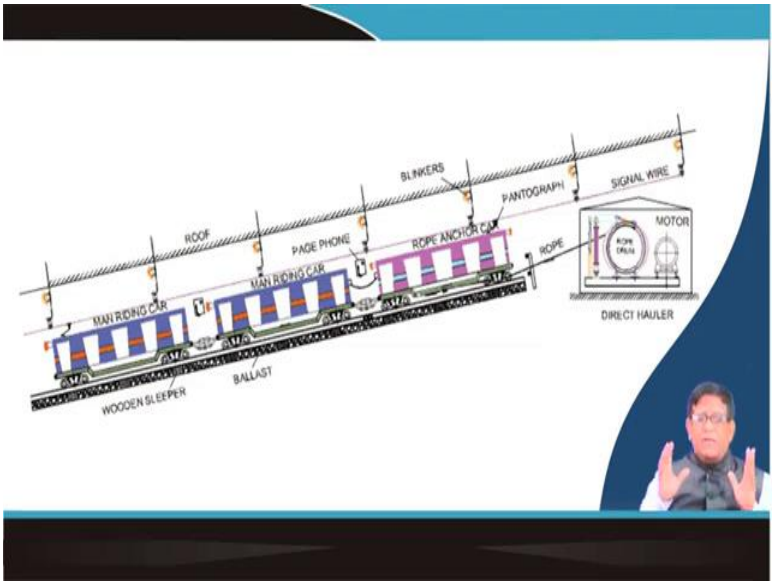

So, that, depending on the mining conditions, you may have a different thing. And then your many time in underground mine you use this man riding car, here in this diagram give a good illustration of how the system is introduced. You can see here your you are having a motor and then your this is the whole driving drum where you are having the braking system and that is a brake is the only control or you can have a gearbox to make it at a different speed.

That system could be there and this rope is wound on this drum. And you can see here this is a rope, is an under rope or here and there we are having one rope which is over here. So, this rope it is connecting at this point, but there with the help of this pantograph, we are having this on the roof. You are connecting that and this rope is going all along. You are having their your man riding cars are here and your rope is anchoring on to this car.

So, you can have even that your electronic communication systems, your pagers, all these things could be there. So, only thing that the T 2 that your main riding cars are coupled by the coupler over here and you can carry it like this. So, when this is to go down, it will be just control by its own weight it will be going in this directions. So, this type of systems are used in underground mining.

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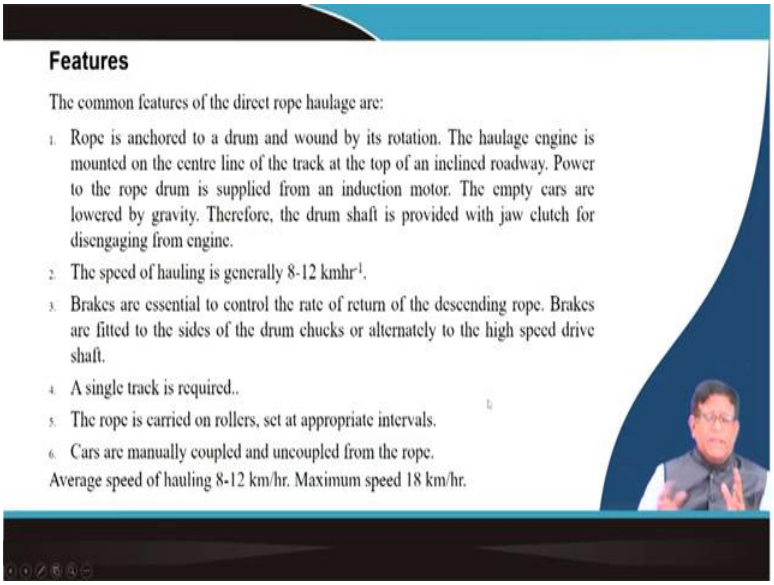

So, if you see that what are the main features of this, the common fissures of the direct rope haulage systems are the rope is anchored to the drum and wound by its rotation. The haulage engine is mounted on the center line of the track and the top of an inclined roadway. Power to the rope drum is supplied from an induction motor. The empty cars are lowered by gravity and therefore the drum shaft is provided with jaw clutch for disengaging from engine very simple mechanism.

We are having the motor from that you are just connecting that engine to your drum and drum is can be rotated by this motor with that simple, your that with a you can clutch and the clutch for with that, when you are keeping it going down, you are declares from it and by its own gravity it will be pulled the rope will be going down and the materials will go down. The speed it can go up to 8 to 12 kilometer per hour.

And the brakes are essential to control the rate of return of the descending rope. Because by acceleration due to gravity depending on the degree of inclinations the down going cars will be getting it will be accelerating and will be attaining a speed. At that speed what may happen that is your from the rail it may get topple out. So, that is why you should not allow to increase the speed beyond the limit.

And there you will have to apply this break which will have to be used there. Then, you have your for these things you do need only one track. So, gallery need not be very wide because in that track that when it will be going and then in the same track, the loaded curve will be coming. So, that is why a single track. Now, this is a very important thing, because in

underground maintaining the haulage means your how exactly you will have to excavate that thing.

And then go it out if it is a wider road, that means you will have to get wider material that to take it out whether it will be able to support the roof and all there is a condition. So, lot of geotechnical and safety conditions will have to be looked into. The rope is carried on rollers. That is the rope which will be pulling and down now when it is there that between the track, there will have to be some rollers.

Otherwise the rope will be having a frictions with the track that root material it will get wearing out. But when you are making some rollers over there, this rope will go and that rollers there you will be keeping proper lubrication so, that the rope wires do not get worn out. Because if the wires of the rope get worn out and come out, then the strength will be decreased and the rope may get broken and then it will be leading to accident and failure.

So, cars are manually coupled and uncoupled from the rope. You will have to require persons to connect and disconnect and average speed you can go this, as we have said 8 to 12. But sometime the maximum will not go beyond 18 kilometer per hour and as because each and every tub will have to be connecting, disconnecting from bringing from the phase to the whole systems by pushing it manually at the at the end.

Also disconnecting it then pushing it manually, taking it to the case, because of this you will be hearing that in underground mining, a large number of labours need to work. Miners numbers are more and that is the reason why many of the mines in our coal mining, the underground mines, are always making loss or very less profit because huge number of persons are working.

And today they will have to be given the salary and all that thing, as per the our labor law. And because of that many of these mines operating with these systems do not become viable and number of underground mines have got closed down. And India that is why, today not even five percent of its total production is coming from the underground mine, because that is the mines did not get changed to adopt a better technology and then to do this challenging job quite differently.

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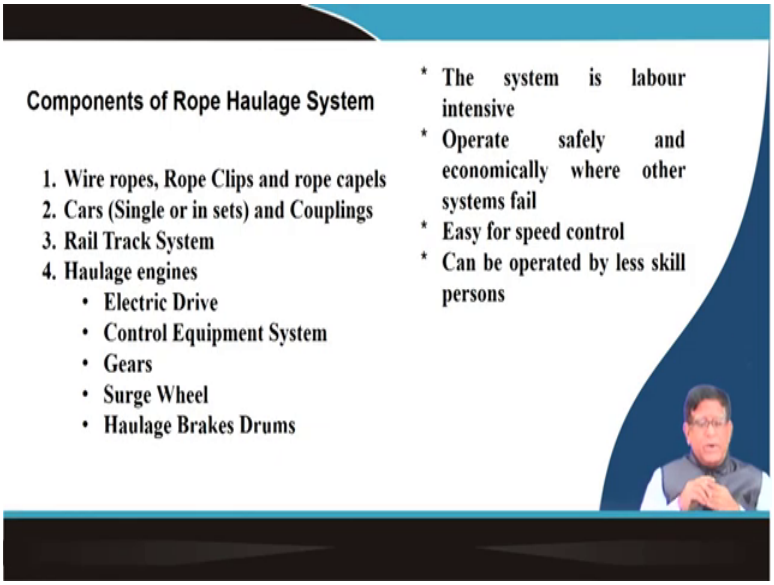

So, that is where your the systems will have to be improved that our the components of the rope haulage as I have already told you that is wire ropes, rope clips, rope capels. Rope capel means how the rope will be that exactly terminated. That how, in the drum that rope will have to be fixed and then how that is done. That is your exactly you are anchoring the rope within the drum by using a rope capel called short cappellanol.

That is a different may be in the winding sections we may discuss about it that cars that will be your single or in a state of car, can be done with the help of coupling railway track system. I told you haulage engine basically, it will be electric drive, their control equipment, gear, surge wheel and the haulage brake drums. These are the main things and if you see the fissures of this, it is a labor intensive, operates safely and economically.

When other systems fail it is very simple, so, you can have a control over here and a easy for speed control can be operated by less skill persons, no much bigger technology it can be used over here.

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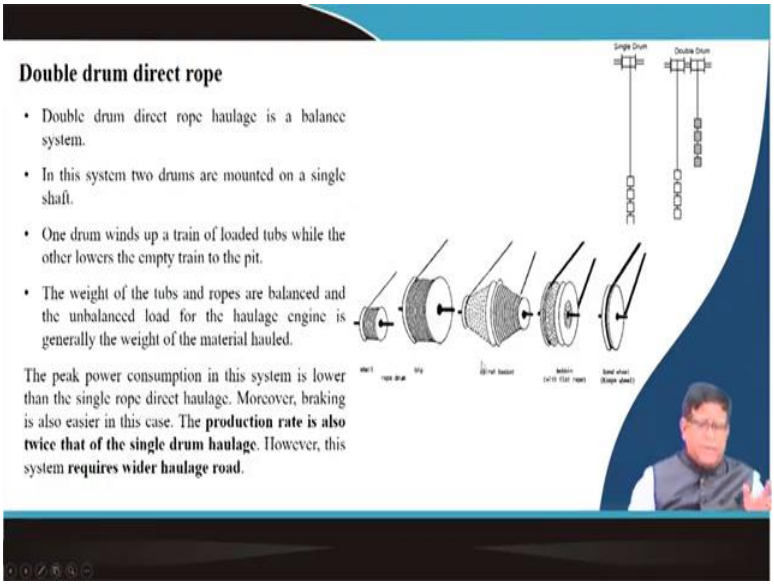

So, that it is rope haulage can be by it is drum. This can be single, drum or double drum and there could be depending on that rope drum. It can be a small rope drum or it can be a bigger rope drum. It is having a your that is your conical drums, biconical drums, you have got bobbin type, you have got a shiv or pulley type, just lot of different way these ropes can be given the drive.

This that normally this drum on which it is there, there you connect the powering system. So, the double drum direct rope haulage is a balance system. This is called a balance system in this system two drums are mounted on the single shaft you can see over here and then one drum wins up the train of loaded tub. Other one is allowing this empty tubs to go down the weight of the tops and the ropes are balanced.

And the unbalanced load for the haulage engine is generally the weight of the material haulage that much only the power which will be required. The peak power consumption in the system is lower than the single rope direct haulage. Moreover, braking is also easier in this case. The production rate is also twice that of the single drum haulage. However, this system requires wider haulage road.

Because, if a two lines to go that means two tracks are there. If you put the two tracks your the gallery, width will have to be increased.

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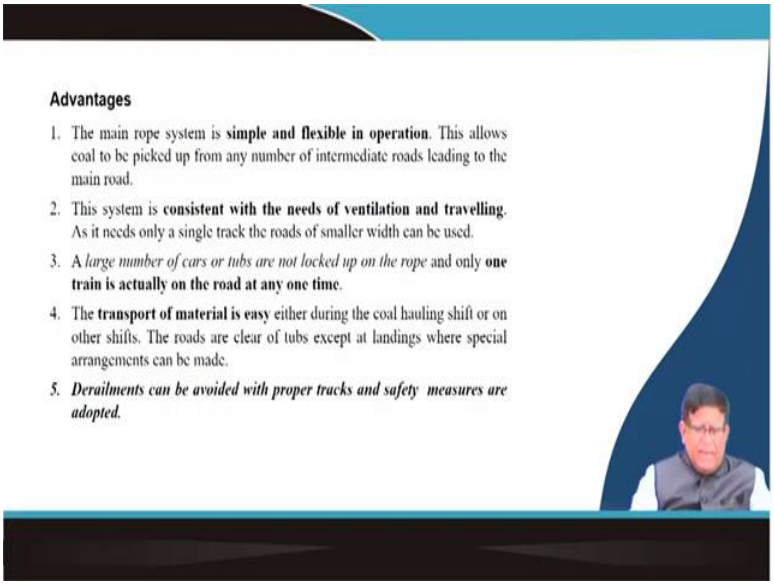

So, there are many advantages because it is a simple and the flexible. You can easily install the your operations are you can easily instruct even the unskilled manpower can make the whole system working. And it is a consistent with the needs of ventilation and travelling. Whatever your ventilation, we are sending air to the underground mines. With that same here it does not create much problem.

Say because it is not having any diesel engines or anything by which exactly you need to give a more. that concerns of the ventilation design. Then it a large number of cars and traps are not locked up in the rope. Because in endless will discuss later that there number of cars may be connected on the whole system. Here it is not, it is in a one train and that train is going and that other train is coming up.

So, your at any time all things are under control and the one problem is that derailment do take place here. Because, while going it down, this is an unmanned system, normally that is to it get derailed and for that lot of precautions and then lot of safety provisions are made by that only it can work better.

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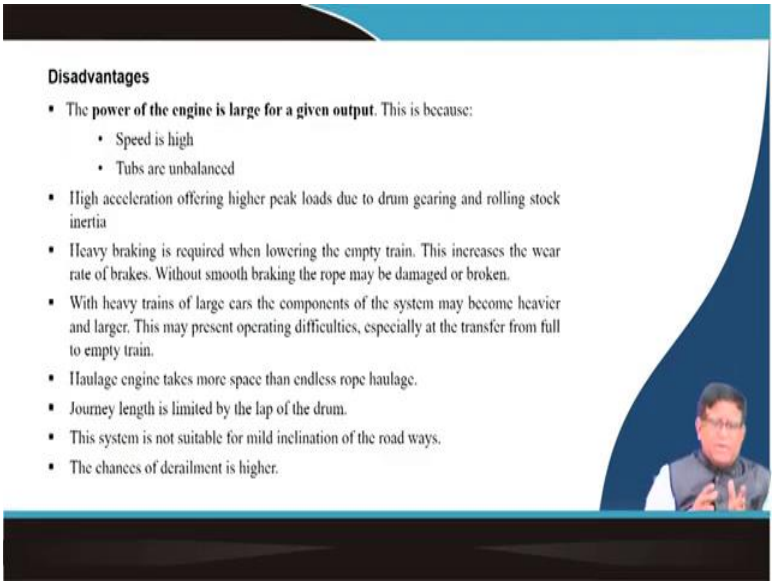

So, the main thing the power of the engine is large for a given output. You will have to more energy will be required there. But they its a because it will be working at a high speed and tubs are unbalanced because of that the your power requirement goes high, then acceleration offering higher peak loads due to the drum gearing and rolling stock inertia. For that you can calculate out how much will be the energy required, considering the frictions and the conditions over there.

The heavy breaking is required because that for avoid over speeding, then with heavy trains of large cars, the components of the system may become heavier and larger and this may present operating difficulties. Especially at the transfer from full to empty train when they will have to be loaded at the siding, you will have to do a lot of work management. Then the haulage engine takes more space than endless rope haulage.

Here you will have to excavate in the in underground mine. You will have to keep some space for connecting the for placing that mounting the motor, gearbox, drum, brake, root system and from there again to connecting to the rope and then making a siding for the or the place where the your loaded cars will be coming. Where you will be placing the empty cars? And then those empties, how it will be connected to the rope?

For that lot of space arrangement will have to be made in the underground system. So, this sometimes creates certain disadvantages.

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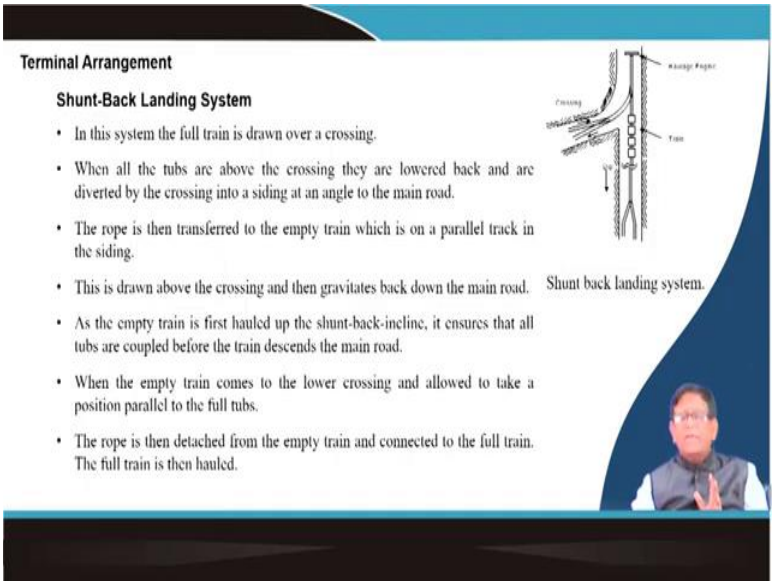

Now this terminal arrangement that means when they are bringing up to this is the drum positions exactly from the bottom. When it is brought up, we always give a crossings. This part will have to be excavated that is in the down underground you will have to make some space in area. Another sort gallery in which this empties will be, it is a loaded will be coming and then they will be placed over here and then when it will be taken from here to the shaft.

That if the shaft is here after that, the empties will be brought over here in another line and then these empties will be connected to this rope and go. So, this arrangement which is called your shunt-back landing system that will have to be made. So, this is shunt-back landing system, in the system the full train is drawn over the crossing and when all the tubs are above the crossing.

They are lowered back and are diverted by the crossing into a siding at an angle to the main road. So, these arrangements exactly as a mechanical engineer or any other engineer who is going to work over there they need to know now how that space excavation the mine has been planned. In underground, particularly near the shaft, how the crossing has been given and how the layout is there that you have to understand.

Then this and the work component which is there that they will have the rope is to be transferred to the empty train and then on the parallel tract in the siding. So, that peak bottom layout that will have to be properly designed this when they will be doing that you are using the gravity for lowering the your empties. So, you will have to see that how many numbers will be connecting to there so, that it should not get over speeded.

If you give a number of thing the weight will be increasing. It will be and so, those depth care should be taken over there. So, the empty train is first to hold up and the sun back incline. It ensures that all the tubs are coupled before the train descends the main road. When the empty train comes to the lower crossing and allowed to take the positions parallel to the full tubs.

The rope is then detached from the empty train and connected to the full train. The full train is then pulled that is at the bottom part of the thing.

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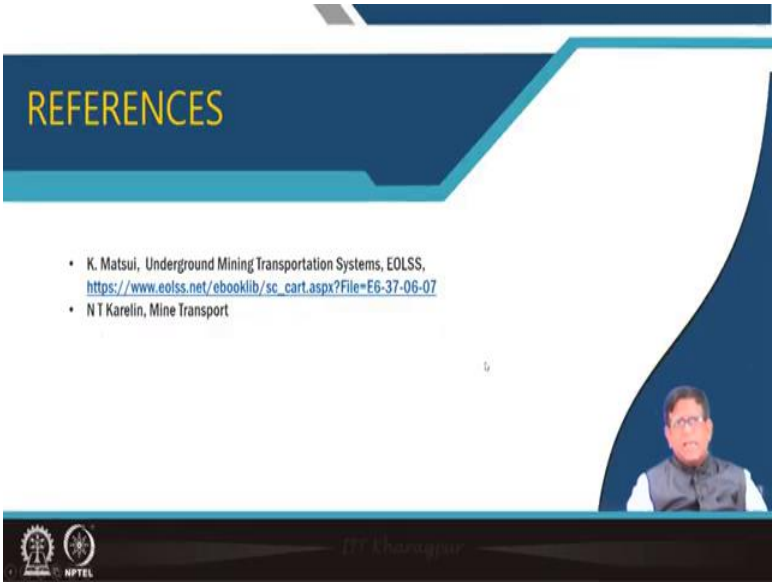

So, these are the very simple arrangement of this particular system. There are books, but these systems were very well described as an old system. So, if you get hold of that Statham's coal mining practice of very old days there, these are discussed, but this I am telling you for your the understanding of this whole system that rope haulage, they how it has developed will be discussing this part only.

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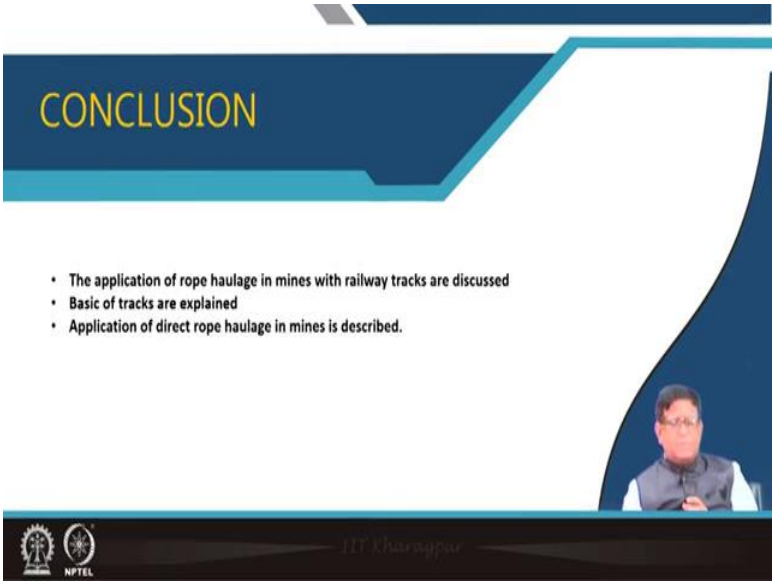

And from there that what are the modern systems, how will be incorporating over there will have to do it. So, here you need not put much effort to learn the systems in detail. But, some simple calculations of how that it is done for your academic understanding will be necessary. So, this as today, we have discussed the application of rope haulage in the mines and basic cracks are explained over here and the direct rope haulage is increased in our next class. Also, we are going to discuss some of the rope haulage systems only. Thank you.