Bulk Material Transport and Handling Systems
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Lecture – 49
Pit Top and Pit Bottom Layout

Welcome back students by now, you have studied this transportation machinery for underground mines but you see that we know that underground mining working conditions are different and they are working under different constraints. But let us say a very careful decisions and careful design of the arrangements for handling different equipment. Different material is very very necessary.

Now, today I will be discussing about what is the pit top and pit bottom layout. In the last class we were discussing about this rope haulage and this underground transportation. And today, I will be telling that by those rope haulage you have taken the excavated materials to the shaft bottom. And from the shaft bottom, this the mine cars they are lifted to the pit top or the at the shaft top near the surface by means of cage.

So, after bringing it there at the top from the underground when it is brought into the surface level. From there two things are necessary, first is from the car the material that coal or ore or whatever, is being brought to be transferred to next handling system. Normally there is a tippler that is tippler is a device by which you, this you transfer the material from the mine car to a hopper.

And below that hopper through a feeder goes to a conveyor belt, from that conveyor belt it goes to the bunker or a stockpile. You know the arrangements in the stockpile. So that means the mine cars when they are coming to the shaft top from there what it will do.

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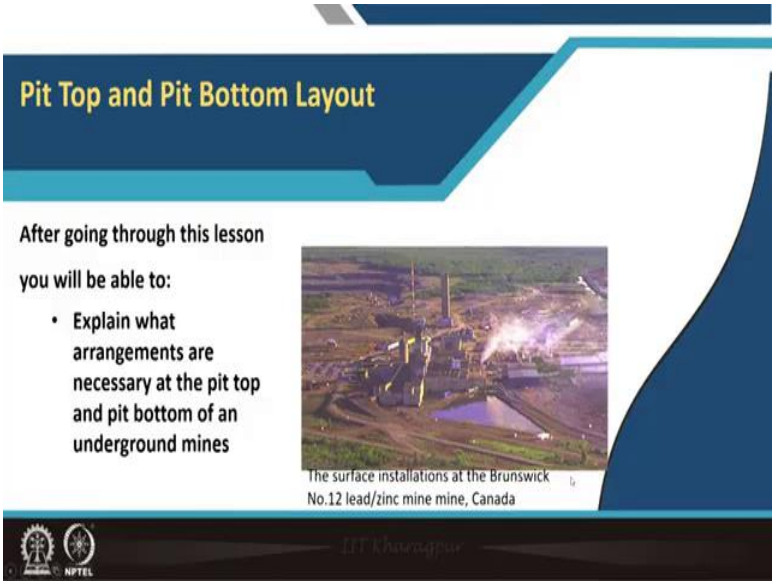

So, today we will be discussing that and there is a after this class you should be able to explain what arrangements are necessary at the pit top and pit bottom of an underground mines. So, here you know this figure, it shows a spit top. This is a Canadian that your lead zinc mine, in which, in this photograph, you can see what are the different arrangements are there. Normally, when they are coming up to the surface.

The material will have to be transferred and from there it may go to a processing plant. When you are processing at that time there will be generation of tailings or there will be this then where those tailings will be disposed. There will have to be certain tailing ponds or that after the beneficiation they will have to be stocked at a stockyard. From there it will have to be transported to the next thing.

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So, there are different facilities required and depending on the type of mine, the surface facilities would be different. If you can see here in this figure a shaft, a winder is shown. You can see here this sheave which is a your winding the cages. And then you can see one typical underground coal mine surface layout. You can see here at the pit top main production shaft is there. This you can see these are the backstairs.

That is your stress and column structure. This is the shaft and on that there is the winder house. That winder is installed over here through which the underground cages are coming out and there is always two shafts are there for the ventilation purposes. There is a auxiliary shaft here. Now, these two shafts and then there is a stockpile that is your arranging the material which is coming, you will be stocking over here.

Then there is a loading bunker is also there and there you can see this materials which are coming they are stocked over here. Then you can see that railway vagons are coming and these railway vagons they are loaded from this bunker, loading bunker. And then you can see that there are all other coolier office, their canteen and all workers places are there. So, this is a in a surface certain facilities are provided.

But though the question is this everywhere, this may not be the same type of things that is your where up to what height your cage is brought and from there how the cars are moved. That is very important but from here you know in general will have to have number of facilities to be given over here when you are going to do a transportation or material handling, designs or circuit design, you will have to make. You will have to consider this space which is available over there.

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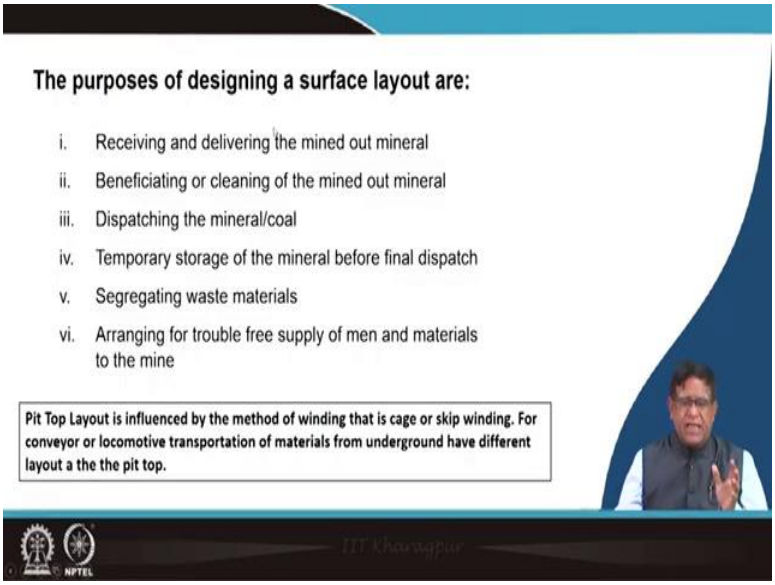

There is always a constraint in that space how you will be placing different facilities that is a important job. You have understood that we are bringing this yours top from the bottom mine cars when it is coming at the top you will have to make the arrangements for designing a surface layout. Now that main purpose of designing a surface layout are receiving the delivering mind out material that run of mines.

What that is called that run of mine material, you will have to receive it. And for receiving that from the mine car, how will be transporting to your section of receiving section? Then you will have to very nearby to that where it is coming. You must have the beneficiating or cleaning of the mineral. That is, you may have a beneficiation plan or a cold washing plant and sometimes even if it is not cold washed, there will be a coal handling plant.

In which the different size of coals will be separated and they will be sent differently. And then after that ROM is treated. That is your washed or it is beneficiated, after that they will have to be dispersed to the next user. And for this they will have to have adequate storage facility because if there is any problem in the mines there is a product is not coming, you will always have to have some additional stock at the surface ready.

So, for that you will have to keeps adequate space for your storage of that material and then you will have to segregate the waste materials. There are different type of waste also will be coming out of the mine. Those will have to be separately stacked and kept over there. And then there will have to be a arrangement so that the people who will be going inside or will be coming out.

The mine workers, transportation that should be also without any problem as well as there should be smooth supply of materials. Whatever is required at the for working in the underground. You will have to take different materials, maybe that you are supplying the canteen bands. That is, they will have to give the some refreshment of the workers during their working time that those arrangements will have to be also made.

Then your fuel will have to be carried out your different material explosives, your the roof bolts, those items, machine parts pairs lubricants. Those will have to be also transported. So, all these arrangements will have to be there. The facilities will have to be created. Now, this whole facility, how it will be, created, will be depending on what type of transportation system you are selecting for, bringing it from the underground.

As I already told you that you can have a vertical shaft or you can have an incline shaft. If you are bringing the material from an incline shaft by your the say, rope haulage, direct or endless rope haulage, there will be a different enhancements. If you are bringing from the vertical shaft, you have got two options. You may bring it by cage winding or you can bring by skip winding.

When you are having a skip winding then there is no curve that material will be coming and then you will have to unload it onto a hopper for further carrying, so that the system will be different. Today, let us talk today about the cage winding. That means in a vertical shaft we have brought the material in that is your loading, the cars into a cage and they have come up to there.

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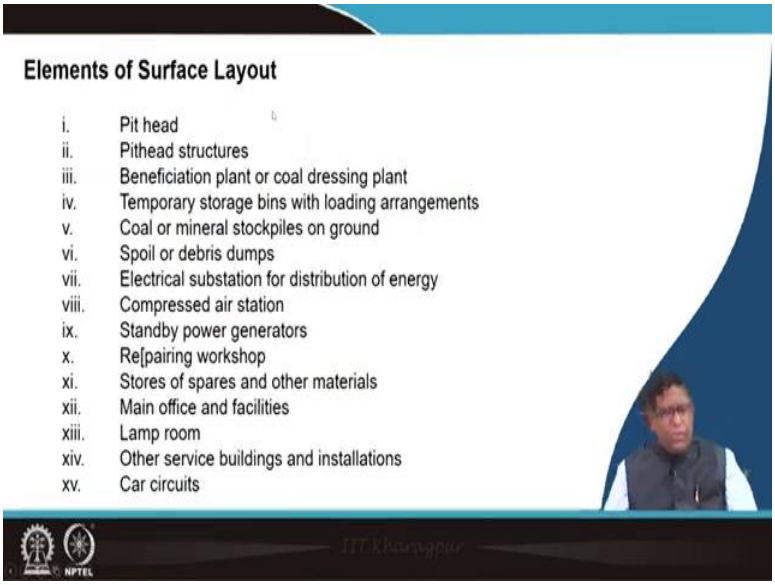

So then, what you will have to do that in the surface you will have to have different components that main elements which will be there at the pit head that is arrangements and that shaft, how the different housing will be done? Then the pit head structures that is your mainly the winder structures which will be there. And you may have it is a ground mounted drum winder will be having a different strength.

Or we may have a tower mounted a winder and in that cage the whole structures. The housing will be different and there certain facilities like when the miners will be going down. They will have to take their cap lamp so, having those cap lamp and their arrangements will have to be very side of that. That means the miners, when they will be going underground at that time they will be using the same cage.

That is why, very near to that cage, they will be having all their that they will have to have a self rescue. They will have to have their battery for the light and those things they will be picking up there that arrangements will have to be there as a facility at the surface. Then there could be as I said, beneficiation plane or the mineral or coal washing plant. There could be storage spins that I have said then the stockpiles required that is your waste material stock yard necessary.

Then electrical substations for distribution of energy that will be very much necessary that how your power supply system will be there in the mine, where there will be the transformers and from where the substations will be there. That arrangement will have to be there. Then

many a time in underground mine where you cannot use the electricity your main driving force may be the compressed air.

That is your in some of the gassy mines. You cannot take electricity over there. Then the pressure air pressure is used for running different machines, your drill and all are pneumatically driven. So that is why you may have to have a compressed air. Even the compressed air locomotives are there. That is the whole train will be drawn by compressed air driven engine. So, those mines they will have to have a compressed air stations there.

Then there could be some generators that is exactly in but the mine regulations also you cannot rely on only one type of power sources, most of the in Dhanbad area you could see that the cooliers they will be having their own generator with a boiler and they have got a steam generators at their mine site. So that type of your standby power generators could be there. Then there should be a workshop, repairing workshops.

And then there should be main office facilities, lamb room, I said then other service building installations. And there you will have to make the car circuit. So that means the basic material handling circuit or the transportation circuit is the car circuit. That means how will you accommodate that arrangements and for evacuating things.

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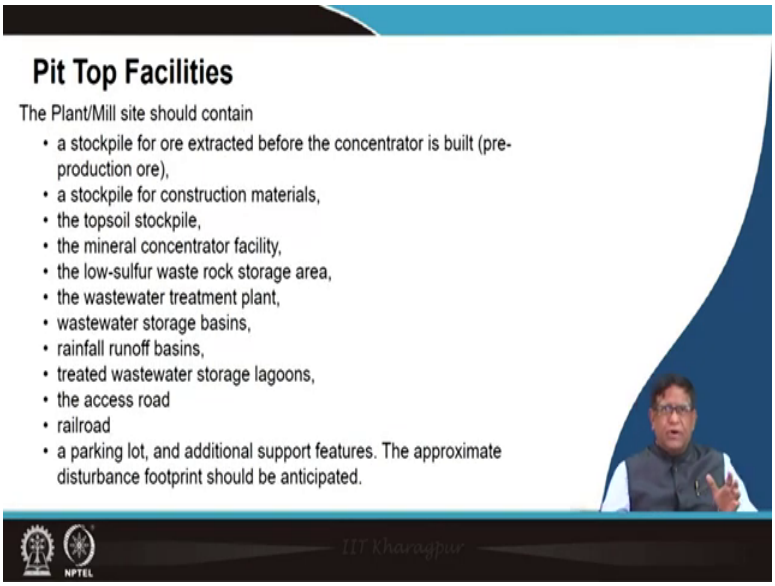

So, as you have said that this your the all this material when it will be coming.

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You can see here that in an underground mine, you are having different level that work is going on and from there the materials are lifted and brought over there and ultimately they will be brought back to the surface. Sometimes there is a decline in metal mines. You will be finding like this. That is here on a; you can have. Even a mine car will be going that your truck will be going over here.

And then it can get the material from the overpasses and then they collect it over there. So, when you see that in an underground mine, the in a very limited area your whole systems will be working. So, in metal mine, where there is a competent rock mass. There is no problem of because the truck can bring the material over here.

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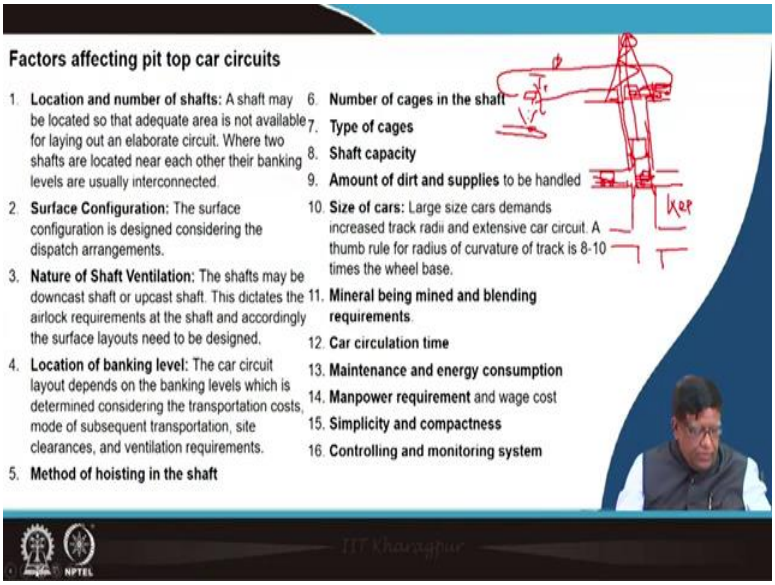

But in the coal mining the situation is not like that that you will have to rely on that working in a short gallery and by mine car you will be making the material through cage up to the top. Now that different factors they affect the pit top and the third circuit. That means the circuit means the part from where the car will be after coming into the cage at the **(()) (15:02)** from the cage manually, you will be pushing out the mine car outside.

And from there how it will be taken? How it will be that is tippler topple the material. Then the empties will be brought back again to the scal. That is why it makes a total round circuit and it is that is why it is called a pit top car circuits. Now the it is depending on the location and the number of shafts that where the shaft is located on the surface that will affect your this circuit then what is the surface configuration?

That is particularly you will have to see the layout. That is your how the terrain is where you are having? Whether it is having a level you have level it or it has got a gradient or how, in many a time when your that main shaft is created, you make this different gradient. It may be so that means when the your loaded cars are coming then whether by its own gravity, it will go up to the tippler or when this empties will have to be pushed that how they will be, can they be lifted by a creepers?

That is a chain that drive by which it will be exactly pulling that thing. So, those arrangement, the layout of the that surface configurations beforehand, is decided. Then other thing is that what is the nature of the shaft? That means whether it is a ventilation shaft that is your downcast shaft or the upcast stuff. Whether you are having the ventilation fan, it is just forcing the air down into the or you are just taking with the help of your exhaust, your fan, you are taking hole out.

So, depending on that in the in the part, your location of this car circuit will be affecting your situation. Then the location of the banking level, banking means at what level it is coming when it is coming out of the mine. That is, your cage can be if it can be there up to the surface level or it will be raising at a platform and from there it will be released. So that is exactly when it is coming and arranging at that level then it is called your banking level.

So, they say the car circuit layout it depends on the banking level means where it is made to stand that is when the cage is coming. That cage will have to be hold there at a particular

position and from there the curve will be going out. So, this is something you can see here that when you are having a shaft here in this shaft, you are having the gallery and then this is the gallery level one level this shaft can go below.

That means it can have another level. There is a mining can be done at different level depending on the type of domain and the type of things now suppose. Here you are having the whole winder here, suppose this is your winder on which you are having this sheave from that sheave your this rope is going, rope will be going down and then you are having this cage over here.

Now, normally for this cage there by the side of it, there will be this whole cable will be going here exactly you are having this cable here, you are having a shoe catching over here. So that it will be guided and this then when this cage first will be brought up to this level. There could be two cage, three cage, like that also. Suppose it is that your this cage when it is coming over here, there is a device called cab gear.

That will be coming out and then your that cage will be supporting over this cap gear. This cap will be holding the cage and then that here we are having this track on this track we are having this mine car which will be mine, car which are come brought by the your rope haulage over here. Then this car will be manually pushed inside this cage there is a rail and in that rail that car will be now pushed over here.

So that means when it is made this level of the rail up to here and this cage there exactly the wheel can easily come and get inside this. Now and then inside the cage there will be a side rod where this car will be hold. Now, when this will be lifted over here at this place, this is your banking level. When the cage will be coming up to here then here you will have to have the rail again.

And then the car which was here now it will be again pushed by and will be coming over here. So that means this banking level over here. Sometimes that is your instead of having over here the cage it may go little bit up over here and then there we can have a platform on that platfrom that cage will be left and from that platform it can go down like this and then there could be a tippler.

That means that car mine car will be coming the loaded car when it is coming over there it will be giving a almost either 360 or that rotation. And then below here there will be a hopper and the material is coming over here and then it will be going to a conveyor belt and then it will be going to the stock yard and things like that. Now, after this car is toppled then from there the car will be pushed and then it will be taking back again over here.

And then from this side it will be again putting that car back inside the cage, the empty car. So that is the empty will be going over here. Now that means a circuit where your loaded cars will be brought and then you are having a tippler here and from that tippler it will be giving. So now, this arrangement, when you are making over here the most important thing, is this circuit, where this exactly there will be that at a different rate.

This cars will be coming that mean, depending on the capacity of the cage, if you are a capacity of the shaft, if you are having say a multi that is your multi deck cages. And in which cage suppose you are having a very big shaft, your two cage six mine cars can come. Now that circuit will have to be made in such a way that once you have made it empty. Then the your cage will again go down when it is going down from the bottom.

Again the loaded cars will be put over there by that time, your this six car or that eight car, ten car. Whatever be there that will be triple and after that the empty will be ready over there as soon as the next car comes and then the your loaded material you are taking out then your empty will have to be put into the cage. So, there should not be any time delay. So that is exactly that how your circuit design will have to be there?

That how much distance that empty car will become if travelling? How much distance that your loaded car will be travelling? What should be the gradient in that gradient what type of energy will be there? How that car will be exactly returning back, whether you are doing it manually by automatically or by engine power or by other devices. Those are designed from the primitive mining to today's mining.

Lot of development has taken place over there. So, in this that banking is, you are exactly at that level when you are bringing and from there you are doing now the method of hoisting of the shaft. That is your, as I say, if your that is by a double deck cage or by a single deck cage

that will define. And then number of cages in the shaft and also you can there are other factors that will be your type of cages.

Shaft capacity amount of the dirt which are coming size of the cars, mineral being or blending is necessary or not. Then the car circulation time maintenance of an energy consumption, manpower requirement, simplicity of the compactness how you are giving then controlling and monitoring system, all these things to be designed over there.

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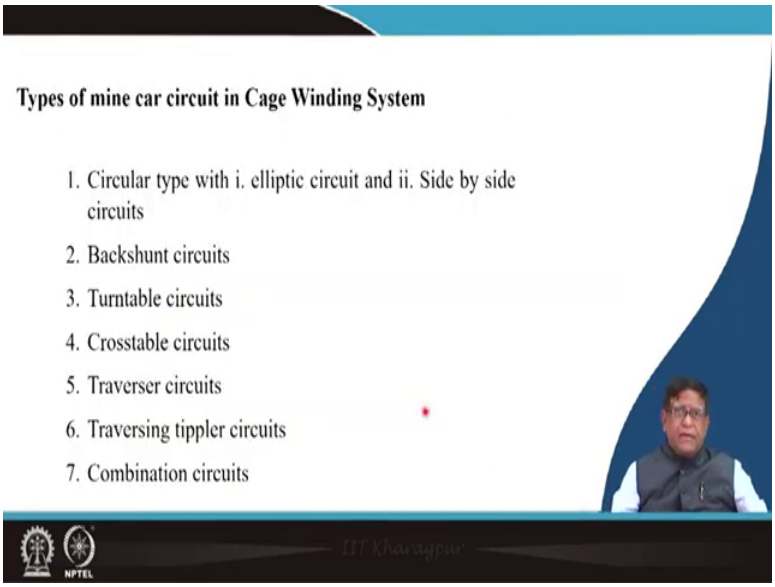

And for that that circuit could be of different type that you are depending on that could be an elliptic circuit or side by side circuit we can have and there are various approaches like that back shunt circuit, turntable circuit, crosstable circuit, Traverser circuit, Traversing tippler circuit, combination of all these things may be there.

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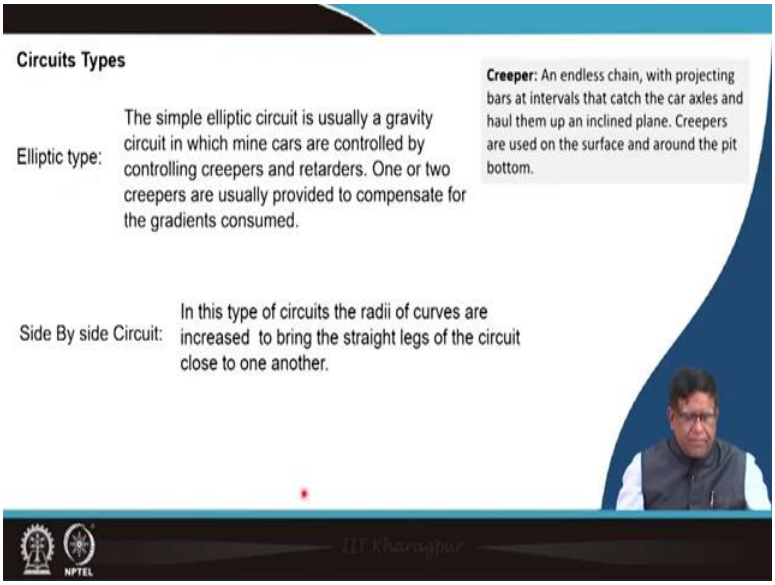

So, this circuit exactly that elliptic circuit, is at the simple elective circuit usually a gravity circuit in which mine cars are controlled by controlling creepers and retarders. One or two creepers are usually provided to compensate for the gradients consumed. Now that creeper this is an endless chain with projecting bars that chain is moving you are driving the chain with power and they have got the projected bar.

So, what it can do in a mine cars, they have got the two axle in one axle it will have it like that and it will go on pulling up when it is going to the gradient. And retarder is one that if you are going down with the own gravity, it will be having accelerated. So, at that time you will be having exactly a braking system is provided then it will be having a retarder so, this type of systems are there.

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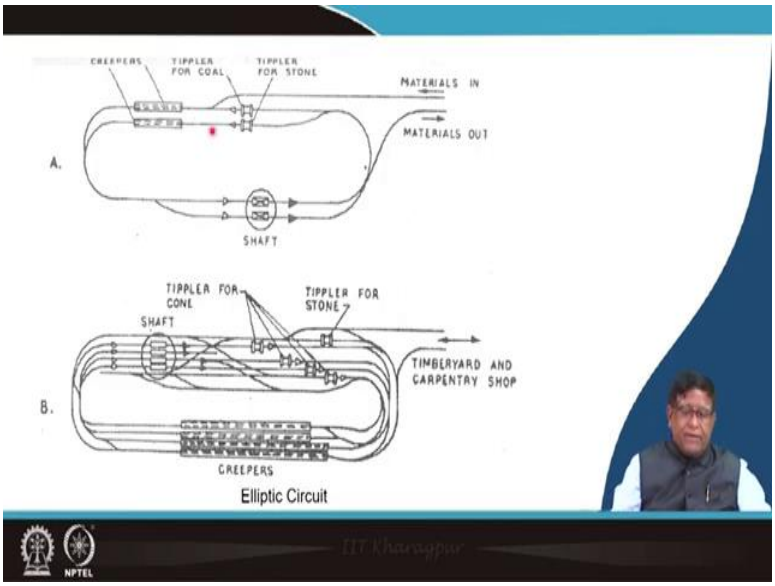

And now, these two circuits if you see here that from the shaft these two cages the material is coming up. When it has come then it has this material it has gone over here and then it is going to the tippler. From the tippler when it will be tripled and then it will be raised to a by creeper to a higher level so that after raising up to a level then it will be guided through this track it can go by gravity.

Because once you are bring it to a higher level then by gravity it can be pushed manually also. So that arrangement is there exactly the circuit and then the stippler from here the materials it can be taken out that if your empties are coming that material you can put it over there which will be now brought back here and it will go to the cage. So that your, how in's and out that arrangement in a that we can have at this type of circuit.

Or we can have a shaft number of that is your big shafts. We can have the four cages can come up there and then you may have your number of tipplers can be there. And then this will be after unloading on the tippler they will be going and by this creeper they will be raised to a higher elevation and then they will be pushed like that. So, these type of arrangements are there at the pit top. Now, you can see here sometimes this tracks.

They will have to be from that car now suppose, your this cage has come and then this earlier it has emptied over here now this the how one your this tippler is free. So that it will come and then it will change the track. So that is why, in a railway, layouts will have to be there your cross that means you will be having a switch that is by making arrangements this car which is coming over here it can be brought back to go to this tippler.

So, this control automatically also can be done it will be tracking that which car is being brought by which cage and then that car will have to go to which tippler and then from that tippler again it will be going to the which creeper because there are say four cages, four creepers, four tippler. Now, when the material will be coming depending on whichever is free, you will have to send it over there.

So that you can optimize this time so that type of control systems can be done. That is how and sometimes that students can make a simple mimic panel of this controlling they can develop the algorithm by which where it will be going and today the whole thing can be done as an automatic control system of your managing the circuit.

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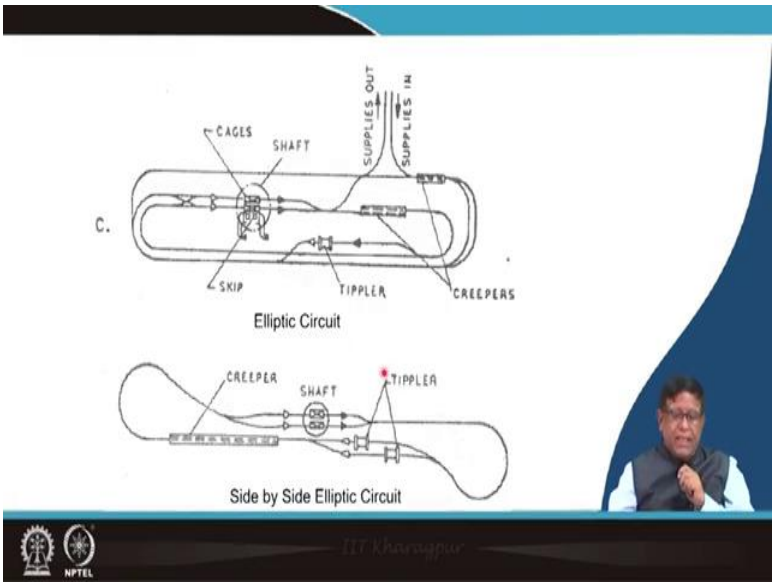

Now, there you the same thing, you can see here the different way the layout could be different in these ones you can see that from the shaft, the material it is coming over here it is doing the tippling here and after the tippling it is taken by the creeper up level and from there it is giving a turn and it is going down.

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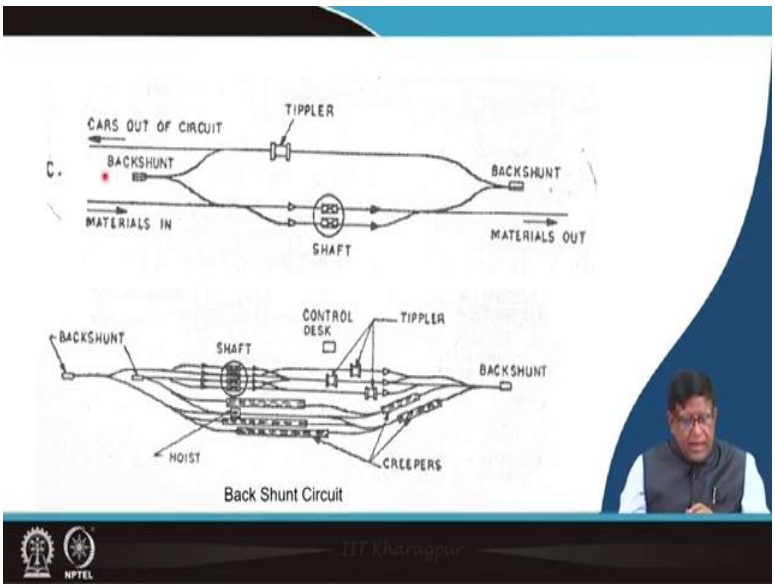

So, there could be even a another system where you can see this back shunt here this. you are not having a that type of circular part at the end, the curve is not there. The car is brought over here and then in this extended part here they will be raised, they will be allowed to remain for some time. And then they, as per that your tippler will be ready they will be coming over here.

This back shunt this space is given for keeping the empty cars that is so that there is no congestion of the cars over here. And that whole operation is can be also controlled from the control desk. That is your how many cars are coming when more number of cars are coming. Just like the previous one, your. How many cars will be in the shunting? That is, you might be hearing that word railway shunting?

That means you are pushing that cars to stay there for some time and then as and when whichever is free, you are sending it over there.

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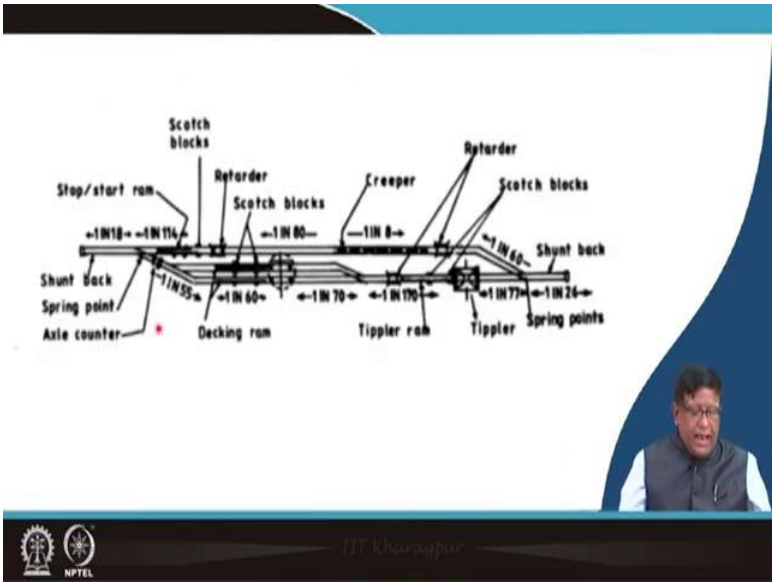

So that is a back shunt arrangements and this this is again that shunt back arrangements in a different way the circuit has been made over here. A large number of variations could be possible at the pit top.

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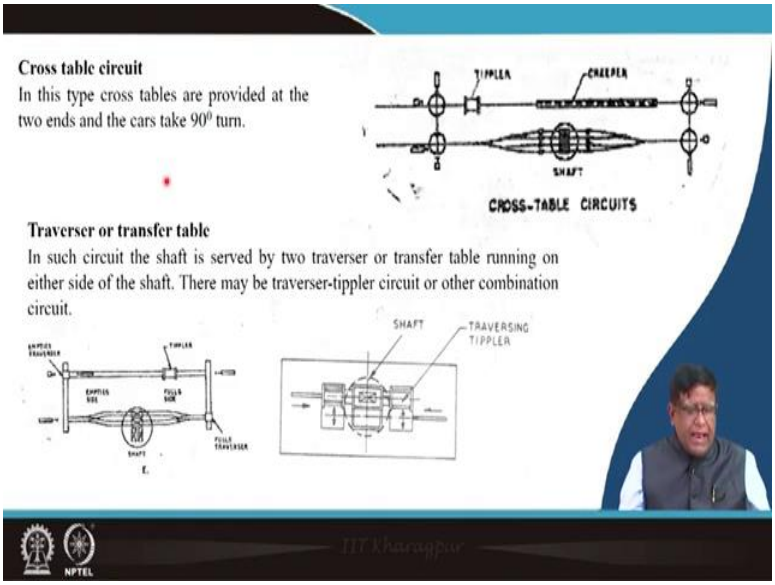

And then there is a cross table, in this cage what is happening? From the shaft when it is coming that car it is coming over here after coming from this, it take a 90 degree turn that car is pushed to this and from there again 90 degree turn it is going to this tippler and this movement is done with the help of this your traverse. That is your that transferring after that it will go through the creeper.

It will be going to a higher level and that traverse will be bringing it over here and from there it will manually get pushed into the cage to go over there. This is called your traverser. That traversers can be organized in different way that mind to mind it will vary.

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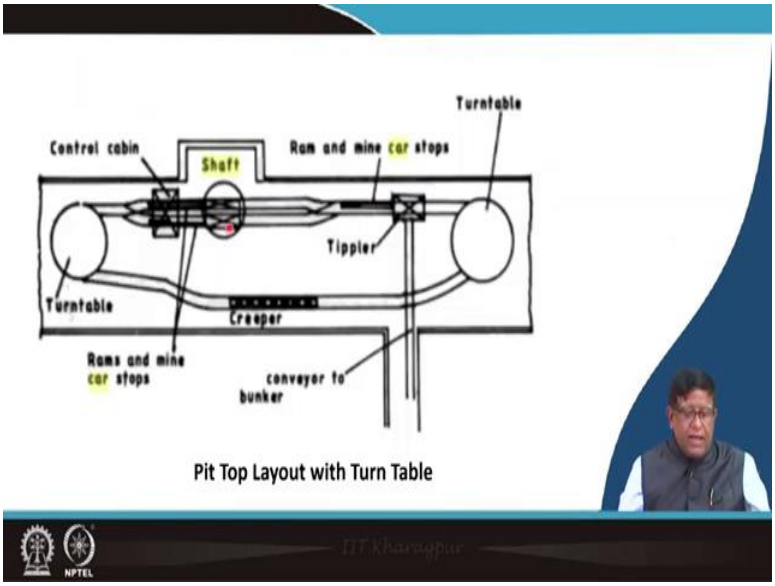

Then you can see here that sometimes, instead of that reverse or traverse car or transfer car or the sandbox or that your same parts turning, we can have a turn table. What is there? This

from the shaft the material is coming. It is just getting your tippler, it is tipple after tippler it will be going to a table here that car will get a turn by push. That is, it will be accelerating over here. The car will be because this turn table will be rotating over here.

So that the car coming on this on the track. It will go and it will come over here this momentum what it will get which this it will be coming up to the creeper. That creeper will be raising it to this and will be giving to this turn table from this turn table it will come to the cage. So, just like that such type of systems are there when there are more underground mining in India, say **(()) (32:31)** they had a very good turn table system in b c shell.

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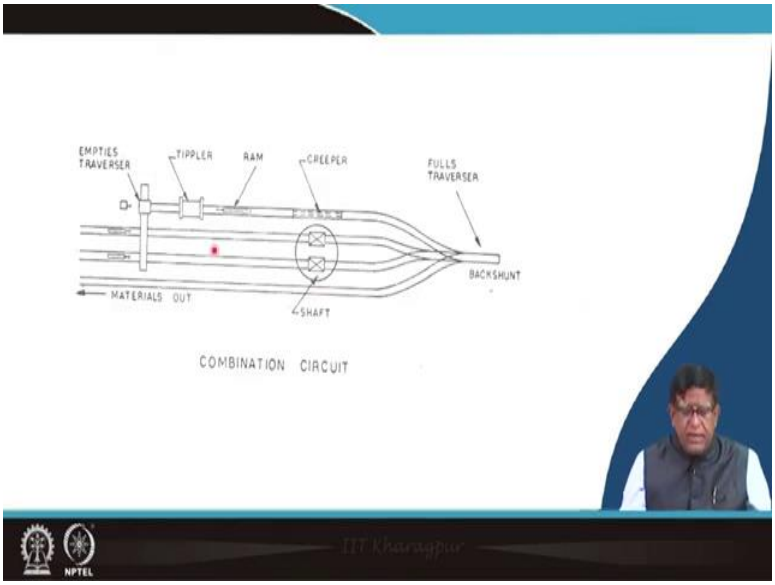

So that sometimes it can be a combinations you can see here is a traverse and then your the traversals tippler is there creeper arrangement there also, you have a back shunt. So that as a combination of different type of circuit also could be done in while designing a material handling system for the or pit top layout.

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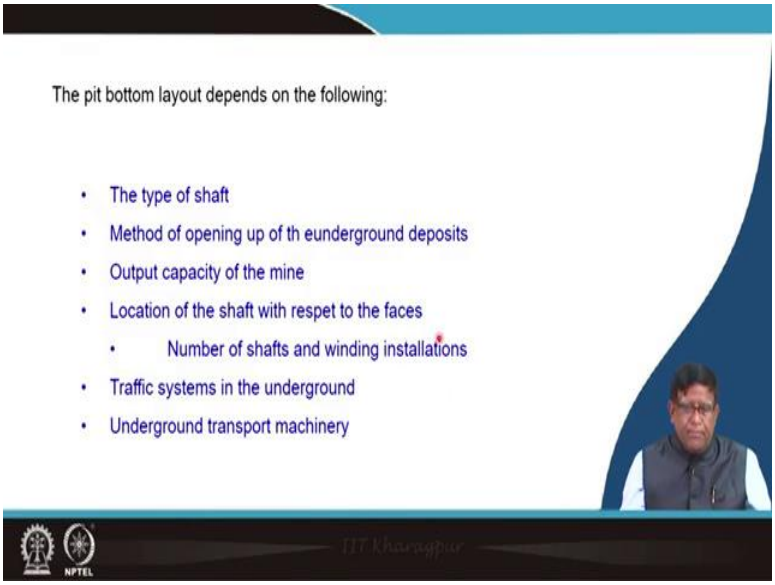

But at the peak bottom there is also challenge because now that pick bottom, you are creating some space near to the shafts. That shaft is designed for the whole life of the mind. So that is why there, how you will be making this arrangement is very very important and depending on the type of shaft, there will be a different layout. And then they, if it is an inclined shaft layout will be different. How the material will be brought near to that shaft?

And then, if cage of your, how the traffic systems in the underground? Your because in underground also there we are having a different type of that is mining. Particularly we are talking about this type of haulage system is used in a your room and pillar or board and pillar mining. Suppose this is a shaft and then the whole coal it will be excavated by in some of the pillar it will be cut.

That means, the whole mine if you take a top view, it will be looking like the number of coal pillars are there and then these are the gallery or that which is brought over here. So, now from at this near this bottom here suppose your now your this is suppose your mine phase is working over here from here. You can bring that thing through rope haulage over here.

Then you will have to make a place where your this cars will be coming over here and from there that cars will be pushed and there on that cage the material will have to be taken. So, now this place that means near the shaft. You will have to create a space where your this tracks will be there. So that your the material which is brought over here will be that loaded cars will be waiting here and the empties will be coming they will be put over here.

And then they will be forming a train and then they will be again send it to the your phase. So, this arrangement of how you will be placing or how you will be taking up the your different type of that how you will be taking the cars and then how will be putting them together for that whole operational facility will be depending on how you design the layout.

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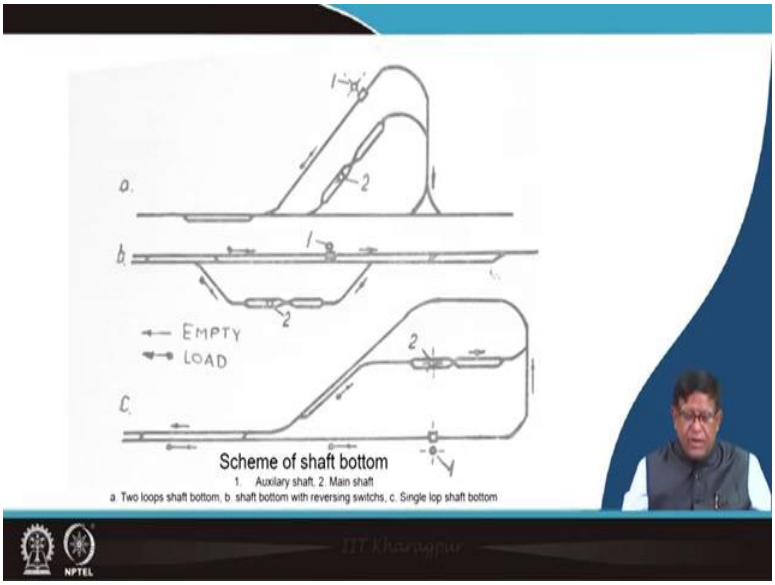

So that is your normally that how your empty this is your loaded are coming over here and then there, this is the sub locations that will be there. So, this whole circuit which will have to be made, it is in an underground mines. You will have to create the space over there with that thing. That is your there will be all other places is an intact coal and there you are making this gallery and the part and there you are maintaining this type of tracks on which this car will be coming.

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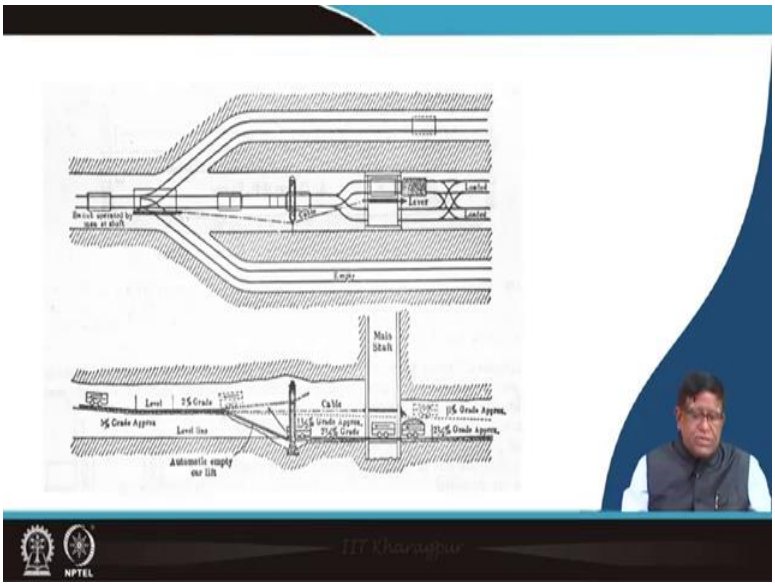

So, you can see over here. That is your this is a great they maintain a one and two like that and here they are giving this is your that main shaft on that main shaft now this loaded coal it is put over here and then the cage will be taking over there. So, there could be different arrangements depending on the mining. So, as a material handling engineer, we need not worry about that how the space will be created, how that will be there but what we need to know is exactly in that siding how will be handling this cars?

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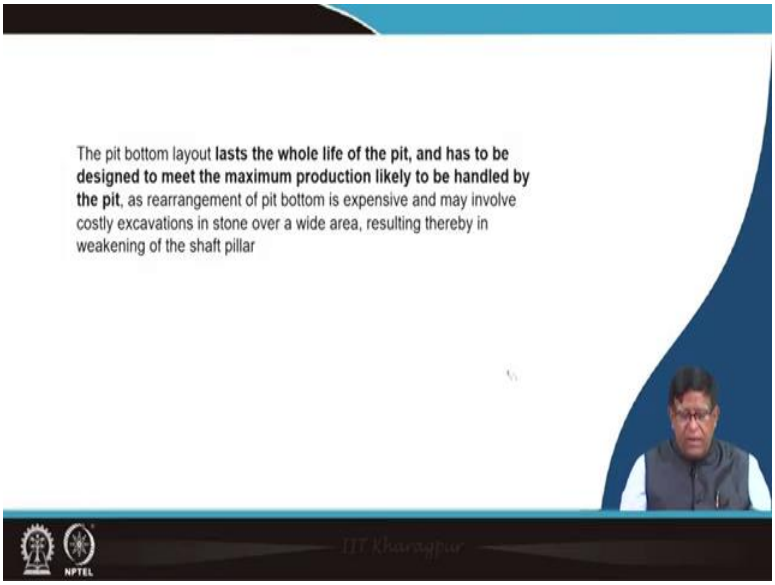

So, as the speed bottom layout, it will last for the whole things so that what type of arrangements there will have to have our illumination there will have to have our that coupling devices there will be if it is endless rope haulage. Then, what type of clip will be there and the whole engineering part will be looked into by it.

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So, there are the basic books you will have to read that principle and practices of modern coal mining by professor R. D. Singh. This book it gives this that how exactly our that in the particularly in coal mining that whole pit top layout and pit bottom layout, how it were designed. And then what are now at present existing system. You can read from this book and basically you need to study these things.

There are number of colieries in India where the systems are there which need to be modernized by retrofitting advanced technology. So that is why, unless and until you know how these are designed and how they are operating, it will be difficult for you to bring new innovation and creativity over there. So, I will suggest you please go through these books. Try to understand what this whole layout and things are and if you are really interested to work.

You will have to go to the field, see at least one mine and from there you can think that how you can use the modern technology of monitoring and control. There could be a lot of mechatronics applications. There could be lot of other activities you can do with this for study. So, design and take your learning activity that will be helping you.

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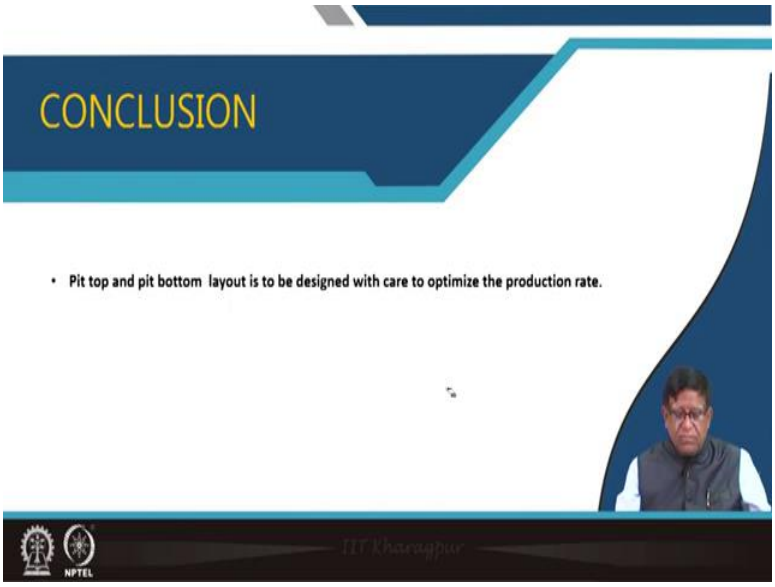

So, the pit bottom and pit top layout is designed with care because it can optimize the production rate. So, if some of you are interested in operation research, you can do and study over there a time and motion study and you can develop an algorithm by which what type of control of the winder and what type of control of your this circuit that is your transportation system.

You can exactly improve the productivity or you can improve the capacity utilization of the install facilities. So that is where you will have to work. Thank you very much.