Mining Machinery
Prof. Khanindra Pathak
Department of Mining Engineering
Indian Institute of Technology, Kharagpur

Module - 06
Lecture - 33
Longwall Mining Machinery Shearer

In underground mining, particularly in coal mining, there is one method you might have already studied that Longwall Mining method. Longwall method of coal mining is a very proven and it is a high productive mining system in which very advanced machines are being used. Today, we will be discussing about the longwall mining machinery.

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Now, as you know that this longwall mining, it is a; it is for a continuous cool winning system in which exactly the main machine is a shearer. As you can see in this diagram in a

longwall phase that shown here that is exactly a shearer which is this shearer, it is cutting the coal and this whole machine is loading the coal on a armoured that is face conveyor called AFC.

This AFC is here which is this machine is mounted on this conveyor, armour face conveyor sometimes it is also called a flexible conveyor and it is under a support, it is under a power support so that this it is working under unsupported roof so, a power support is there while this machine is working. So, this system of longwall mining is there.

And there are number of videos in YouTube you can see about that what is this longwall mining then we will be learning about this machine. So, our objectives today is to know about the construction, operations and maintenance or that exactly how we can improve the performance of this system.

So, exactly, you can see that the when a machine is working, this is your shearer which is being placed over this armoured flexible conveyor or armoured face conveyor and this is with the a support system, it is working.

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So, now, this machine when it works, you can see here there is a cutting drum, this in this one you can see the two drums are there on a arm. So, this machine is a highly productive underground coal mining machinery.

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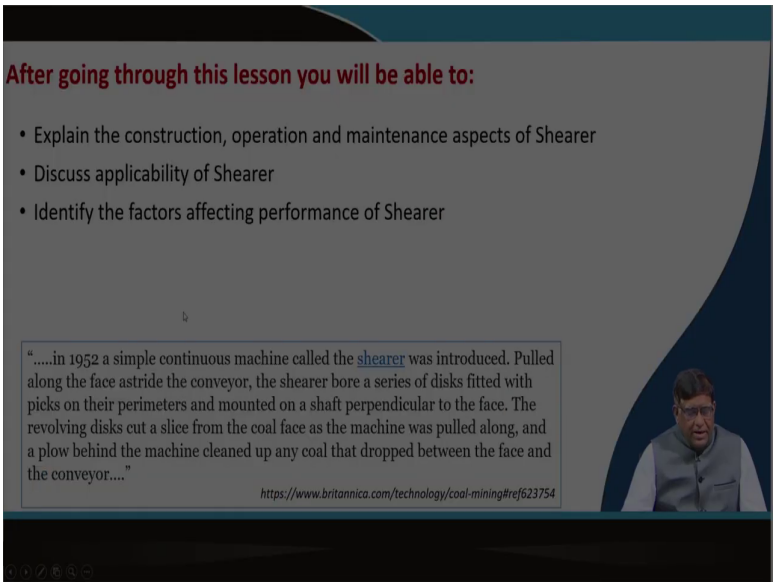

So, this lecture is mean for that after that you should be able to explain how these machines work exactly, what are their the constructions, today we will be introducing about the shearer, in our subsequent classes we will discuss about armour face conveyor that is a flexible conveyor and also we will discuss power supports and in general, we will be discussing in our future class about how these machines are exactly maintained.

So, these machines exactly is a very good productive machines that was introduced in the about in the 50's of the that is previous century. You can see here that this machine basically, it is having some cutting picks mounted on a drum and then, this is exactly the shearing actions is given that is why it is called shearer and this that the picks which are mounted on a disc are put together and then, they rotate and then, they cut the things.

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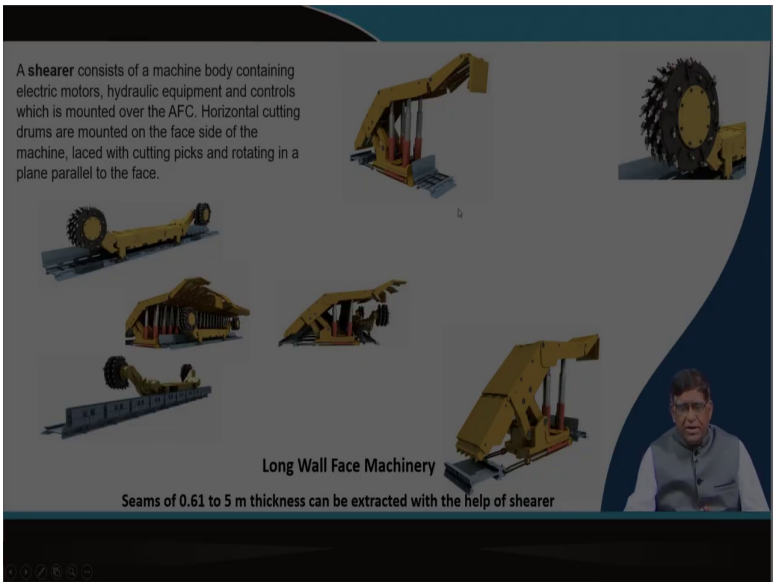

So, this is a very simple system in which you can see here, there is a machine body. This is you can see here, a machine body is there where it is locating all the electric motors and that are placed over here on the AFC. And then, this drum is a horizontal cutting drum, but there are varieties of machines in which there could be a vertical cutting drum also.

So, there is a this is in this particular one you are seeing this vertical horizontal cutting drum where this picks are there. You have studied earlier the two types of pick there is conical pick and then, radial pick, both type of pick can be used over here. And then, this as you see this, you have got the power support you can see.

If there is a very thick coal after taking some coal that is the other one, if it is advancing in this directions that can fall the roof coal can fall over here, then that also is given to another

face conveyor. So, this particular support system which is working which you can see that there are two conveyors, flexible conveyors here.

So, there are different varieties, different designs depending on the geo mining conditions it is there. So, it can work with a 0.61 meter to 5 meter. You can think of a 15 feet even more than that can be handled with this. So, this can be a big mechanizations of is possible and then, this length all along it can do in a panel of 100 meter even in sometimes longer, this longwall panel can be extracted.

So, you know that this basic component in a longwall face is your this supports, your conveyor and the shearer.

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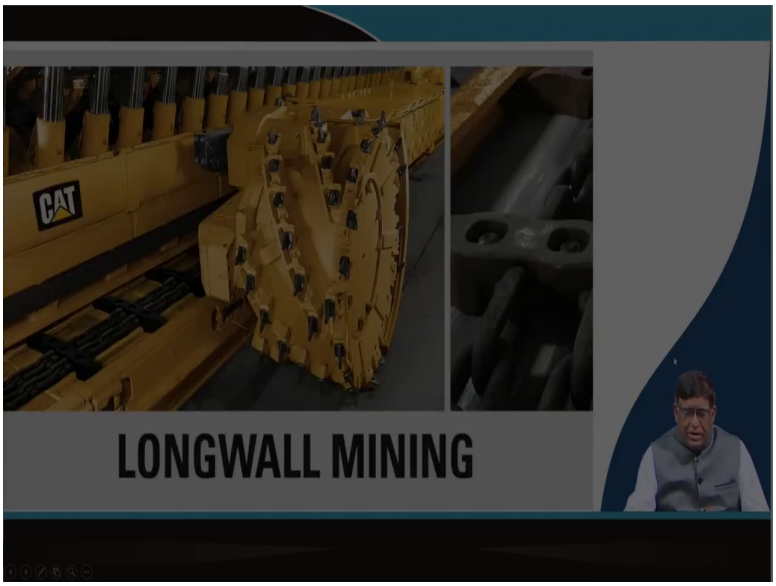

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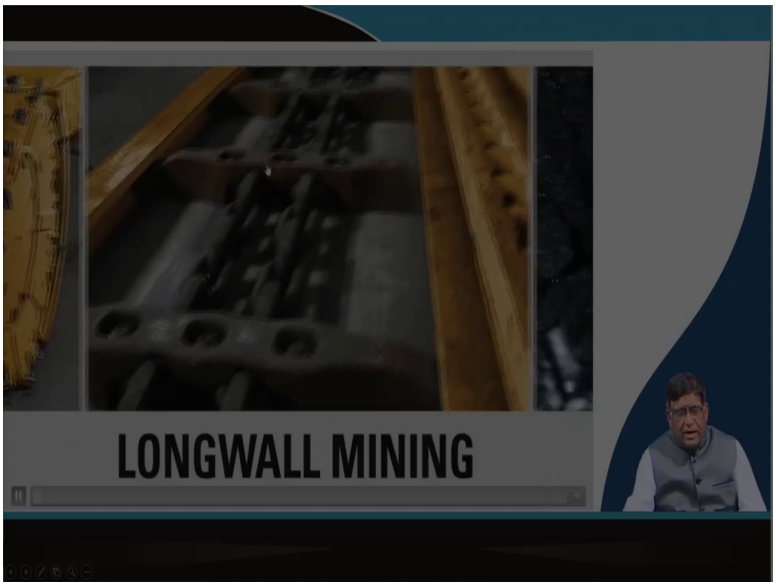

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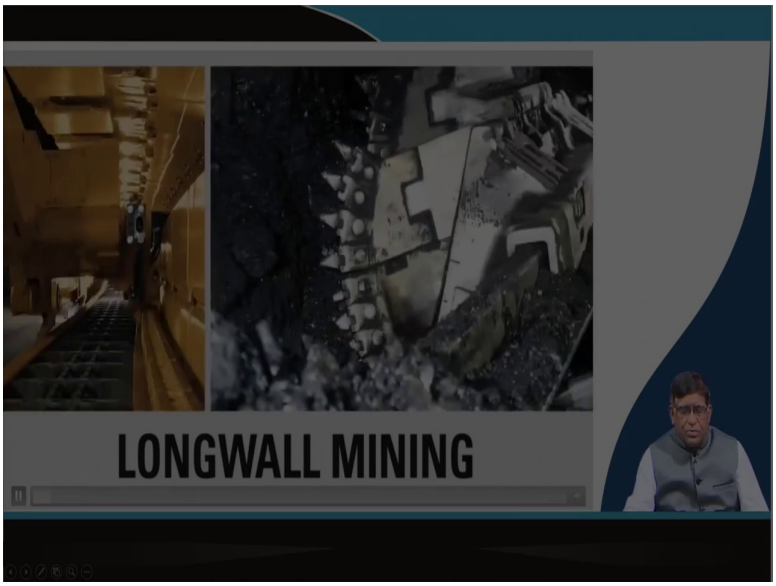

Now, you can see here this longwall mining, it is you can see in this video that how exactly that this is the armoured face conveyor in that which is a machine is mounted.

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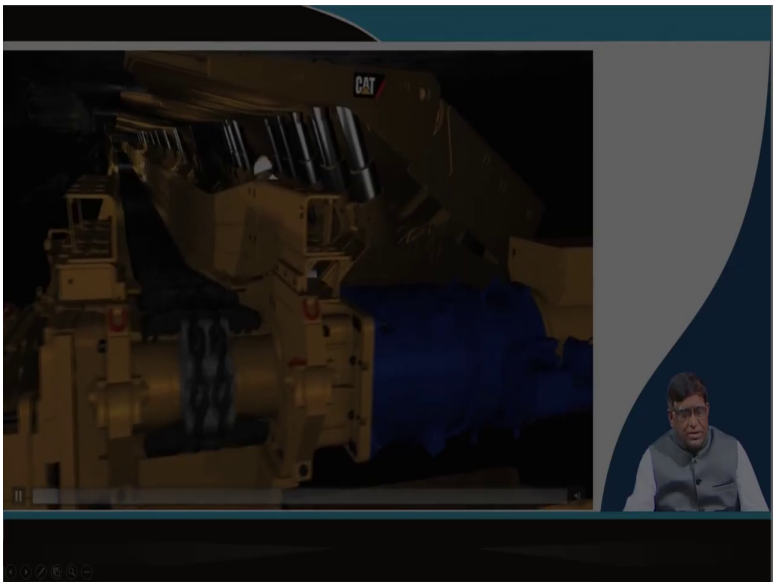

You can see the chain conveyor is moving.

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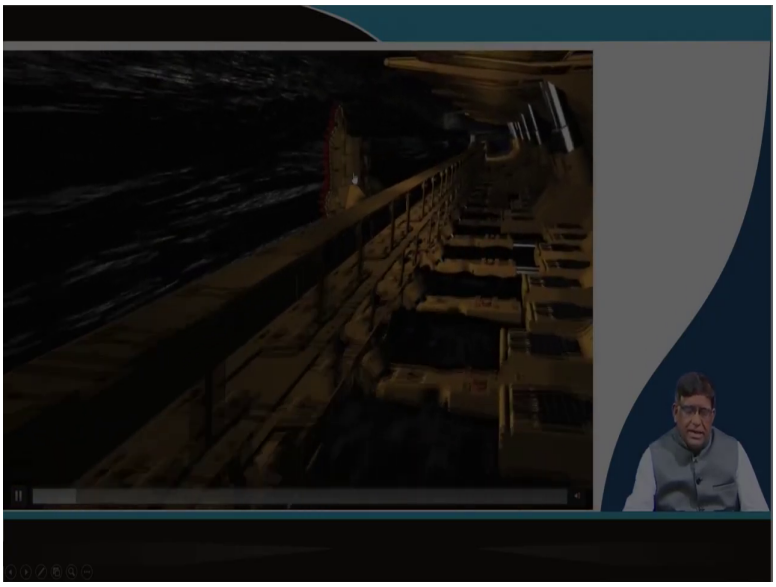

And then, your whole the persons when it will be working with this say.

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There is another machine called ploughs, this is a ploughs or that will be working with this system. So, caterpillar produced this.

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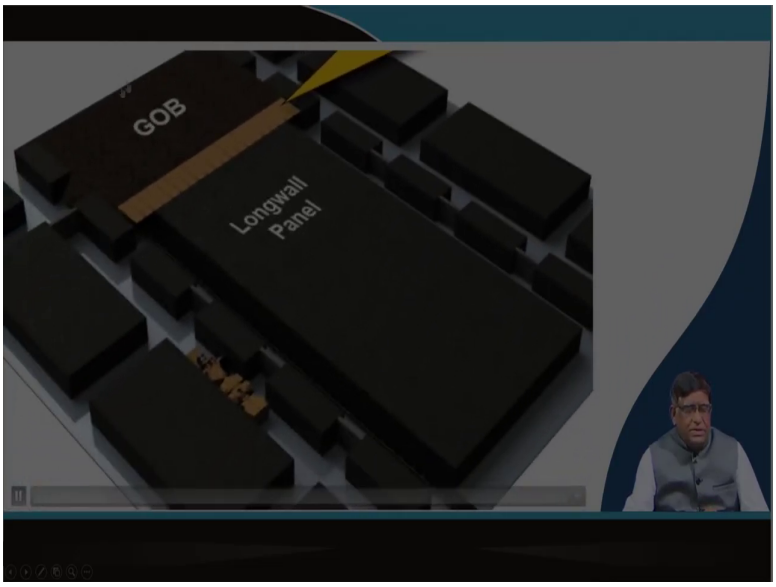

You can see here this GOB means that your excavated already, previously excavated area.

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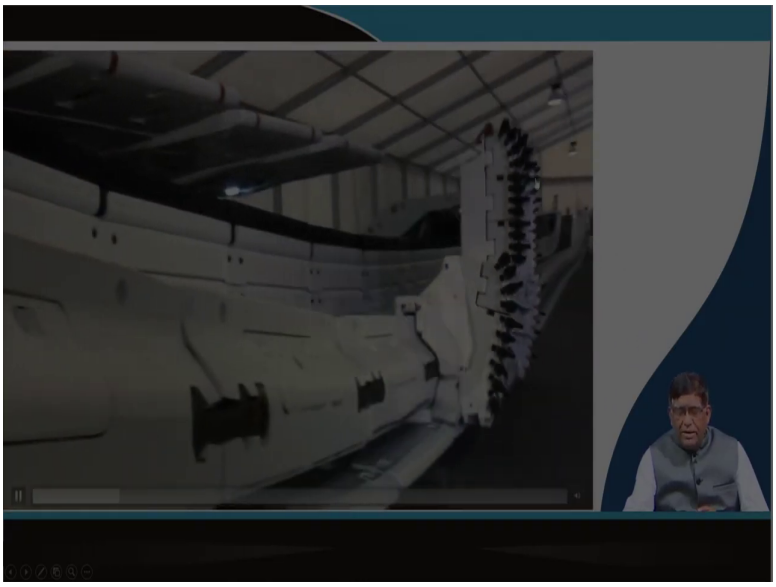

This ploughs, when it moves, it is just cutting the things and then, it will be loading the material on the conveyor. So, that is a conveyor is used for the machine movement.

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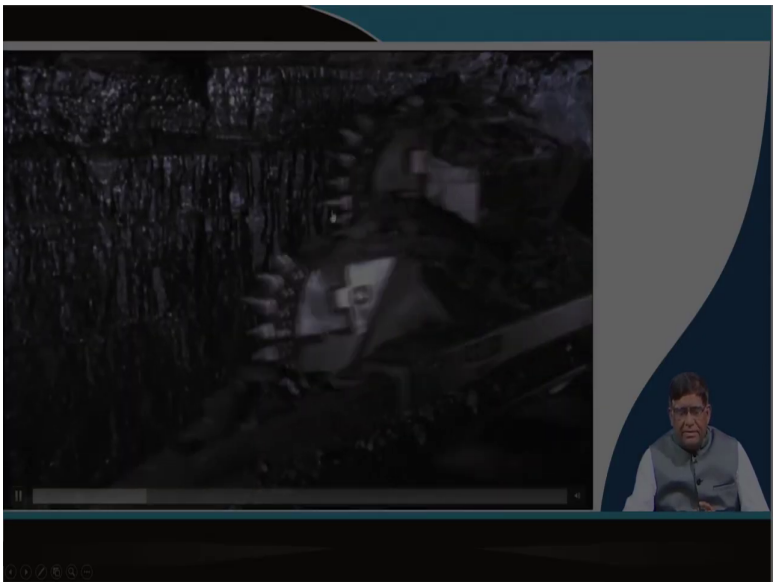

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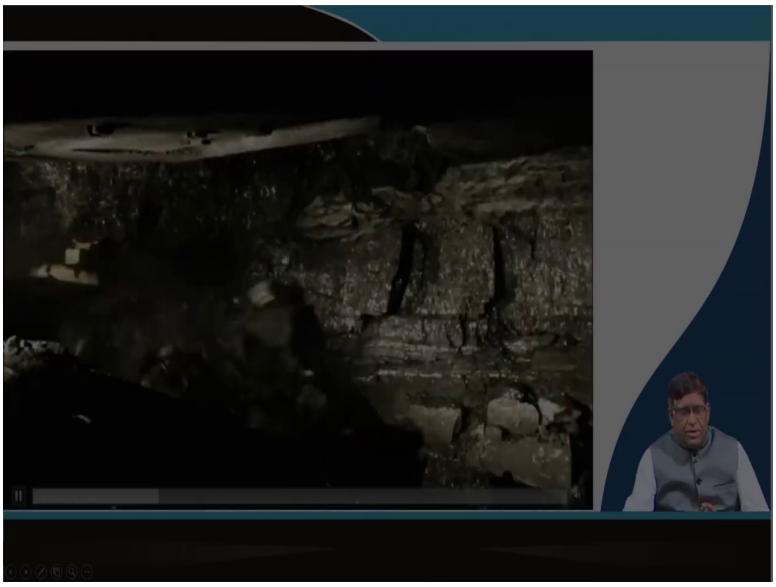

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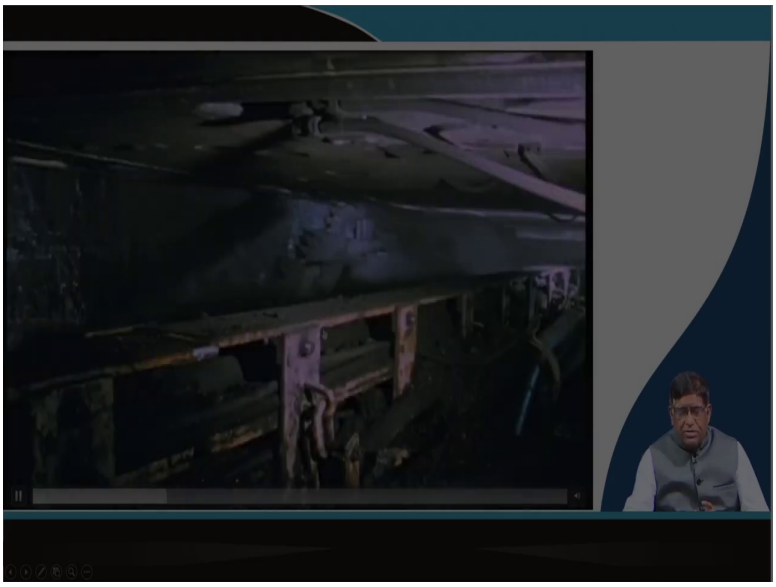

And then, this plough is not used in our country, in India, but it was tried, but it was never got any good stay in the country, but it was used in when there longwall mining was first introduced in number of countries it was used.

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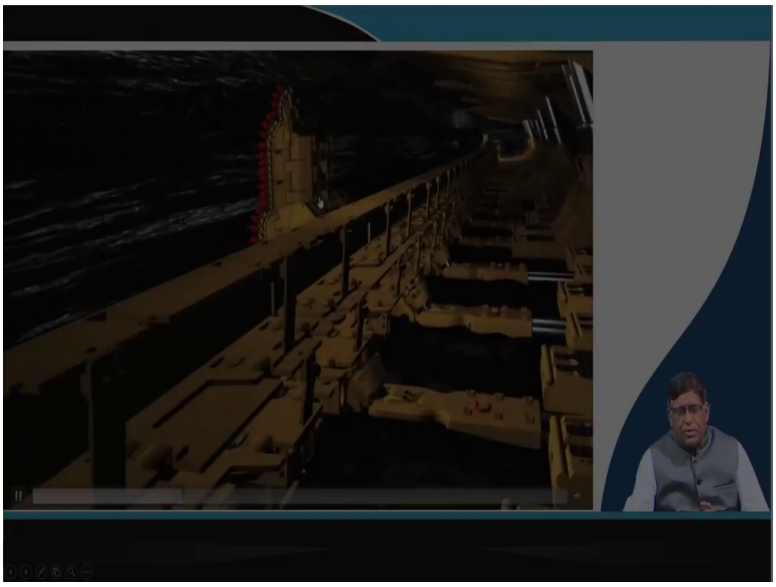

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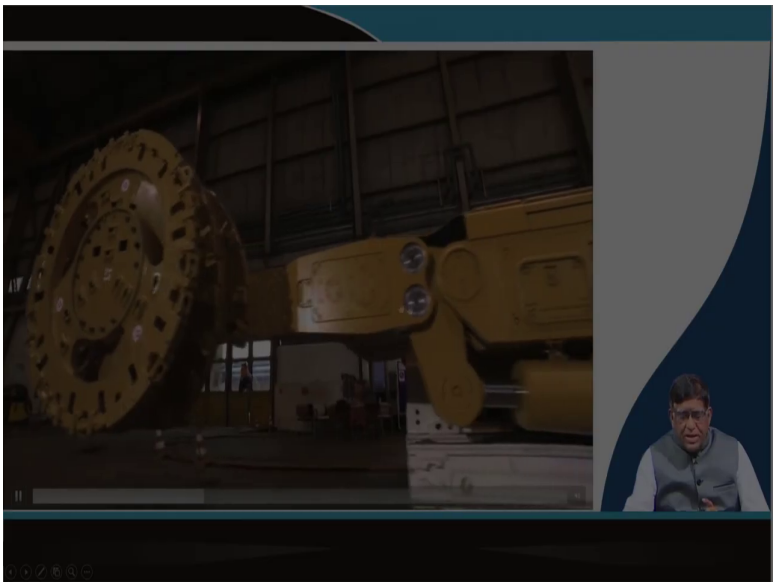

But in this shearer, this machine which is having a cutting drum and that cutting drum is moving or hauling on the face conveyor.

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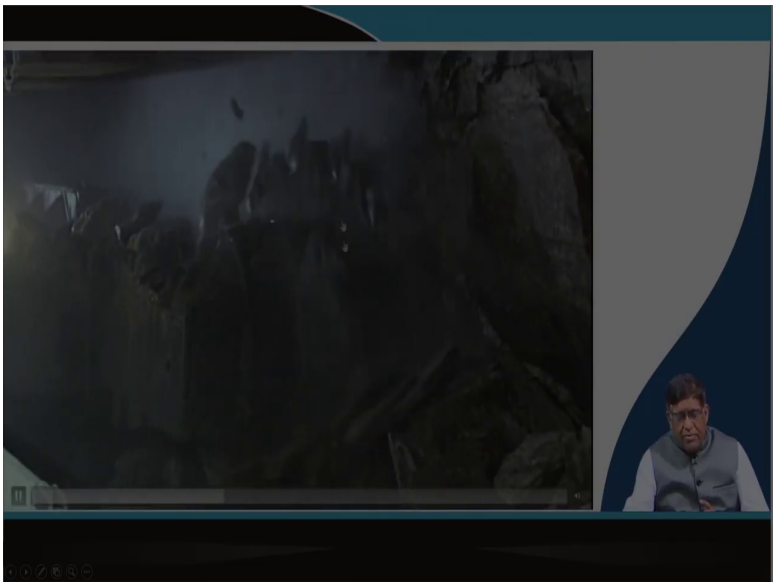

And the drum when it rotates, it does the whole cutting operation is done.

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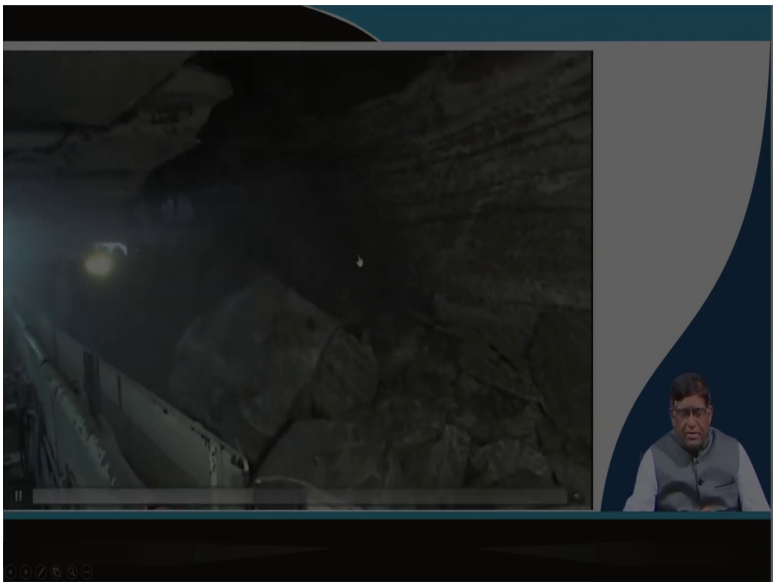

So, that means, the this machine is a very powerful machine, it is the hard rocks.

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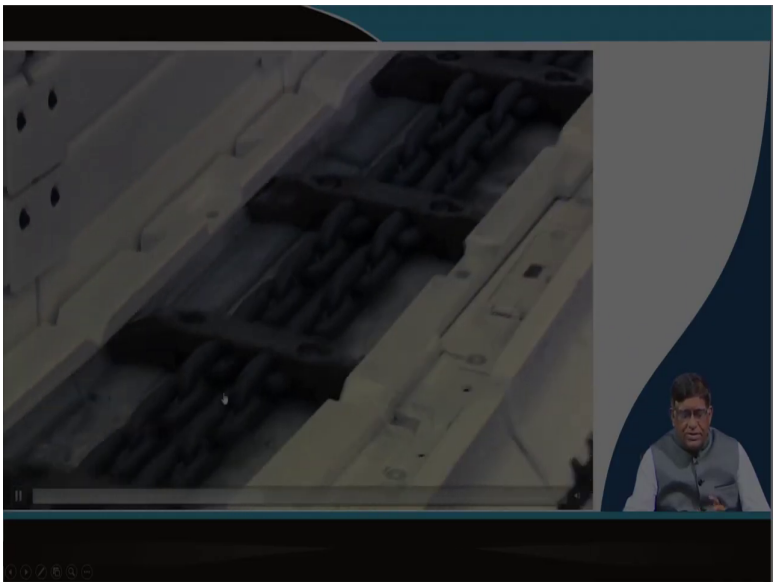

But you can see over here, it will be coming as a big boulders.

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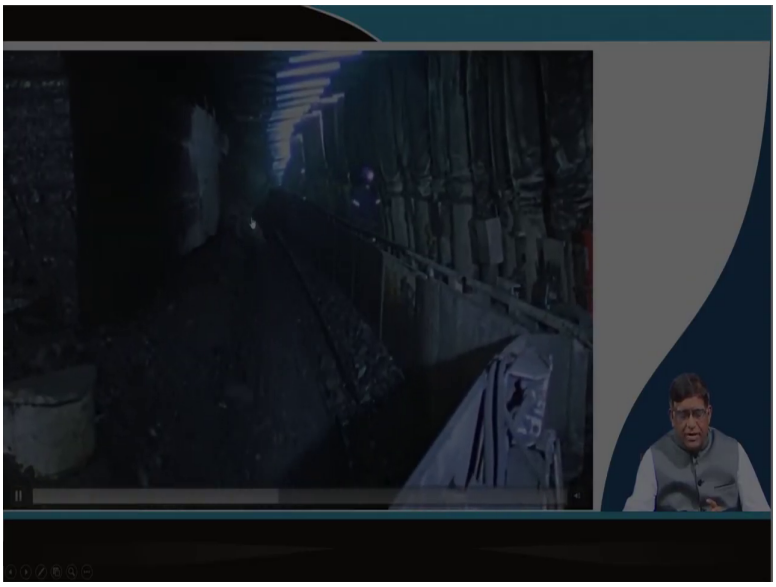

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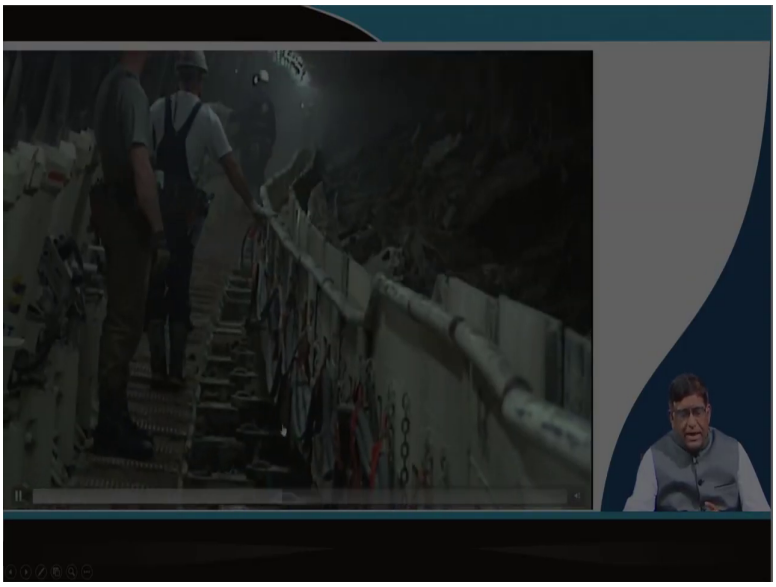

Those cut material which is falling on this armour face conveyor where a chain conveyor is pulling the material.

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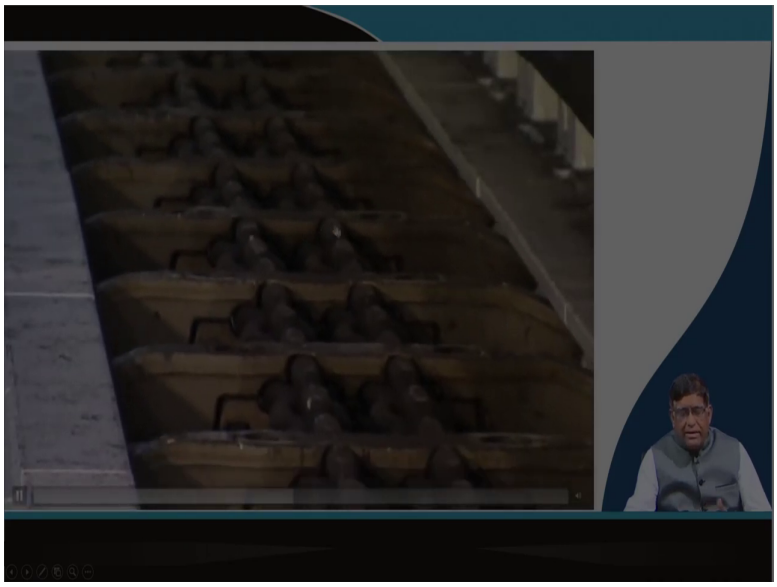

And then, it will be this whole material will be carried.

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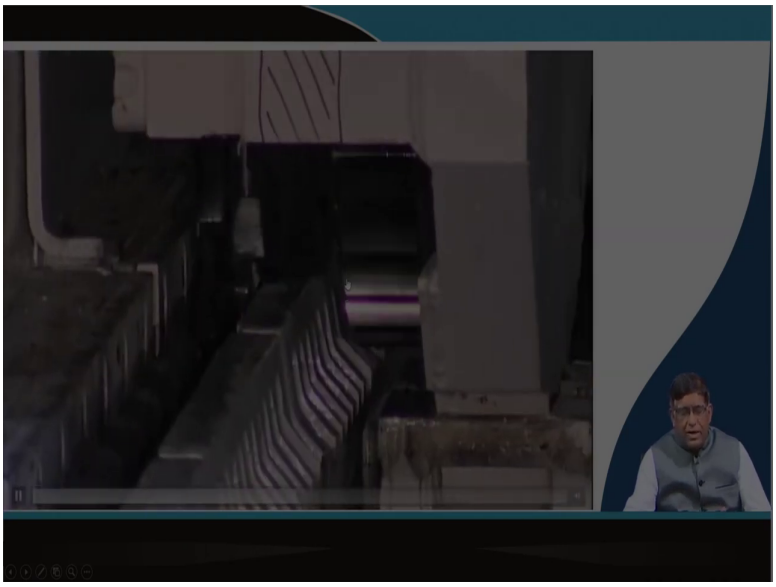

And then, it will have to be given to a feeder breaker or stage loader by which it will be broken down.

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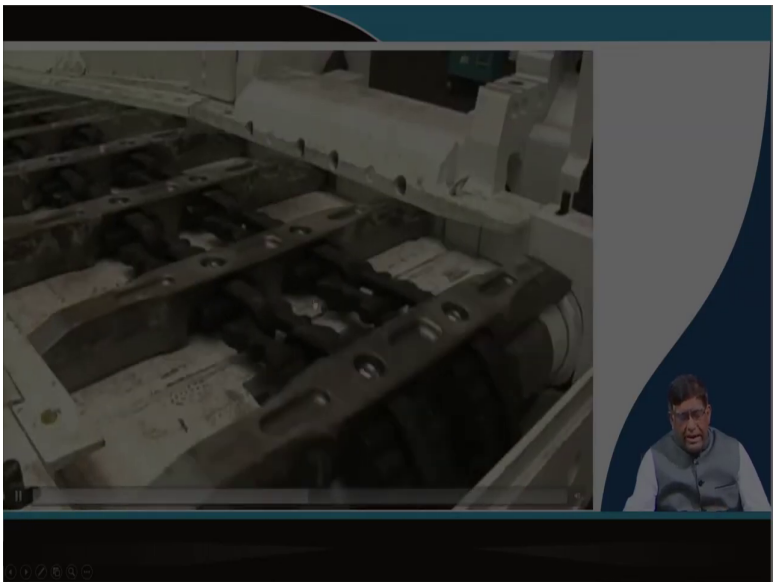

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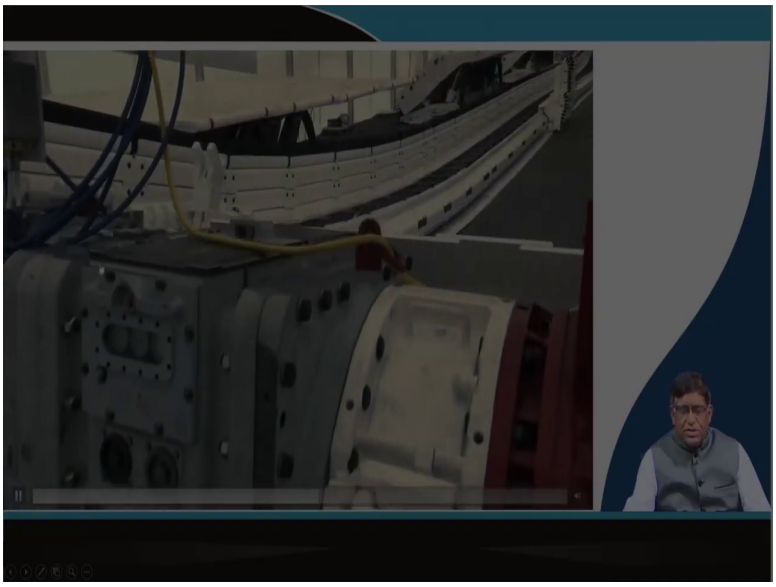

And then, subsequently, the material will be transported to the evacuation system where there will be a the this you can have the conveyor belt system.

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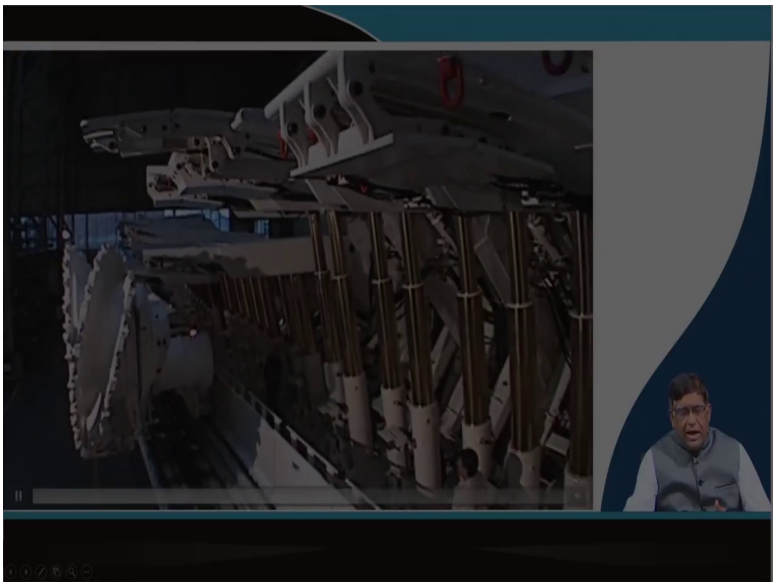

So, you can see here that is a power support which is exactly having a hydraulically operated support systems, you can see is this are there are choke seals and all.

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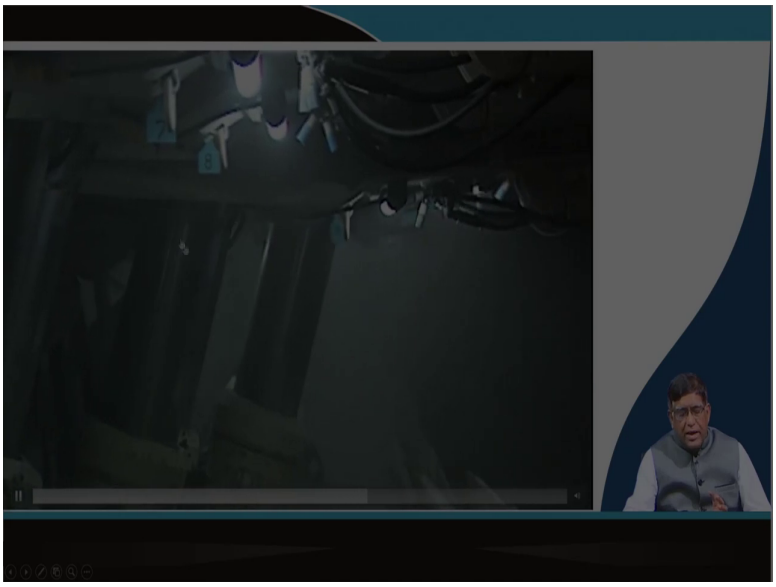

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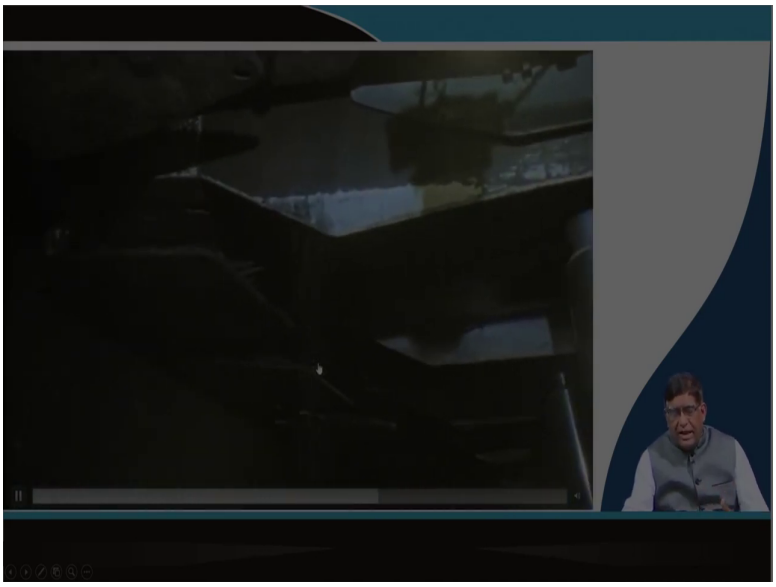

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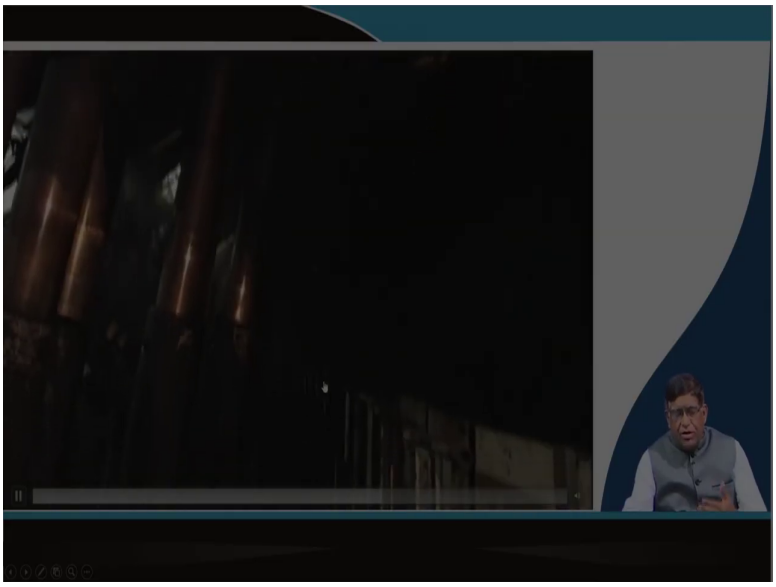

This support it is advances when you are exactly the longwall methods can be in an advancing or retreating methods.

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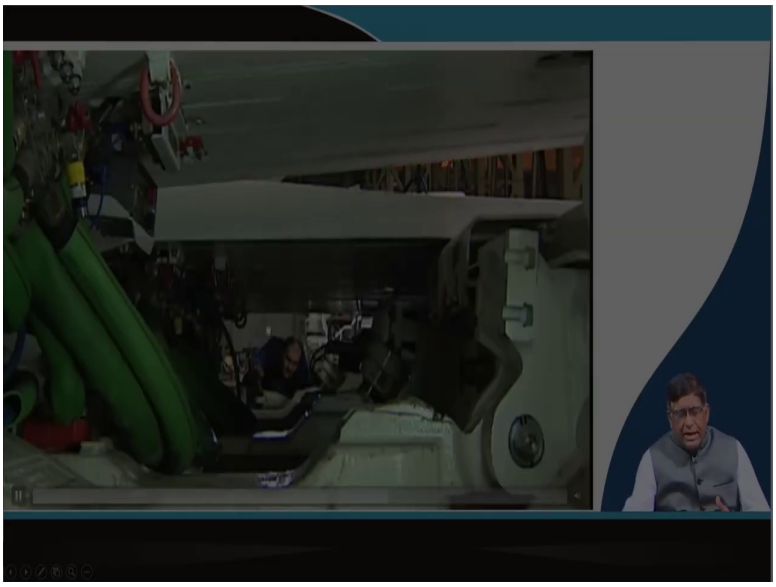

So, that means, it is just the people, or the machines are under the supporting conditions.

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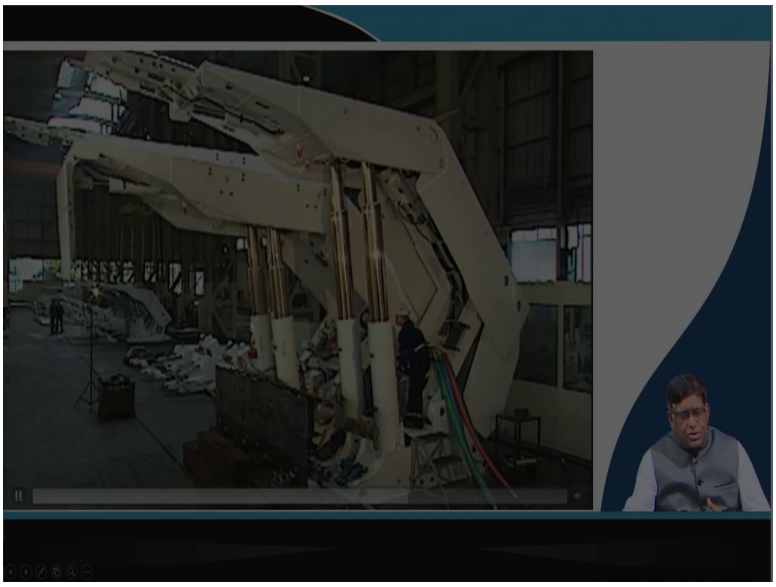

Now, there could be the power supports of different height.

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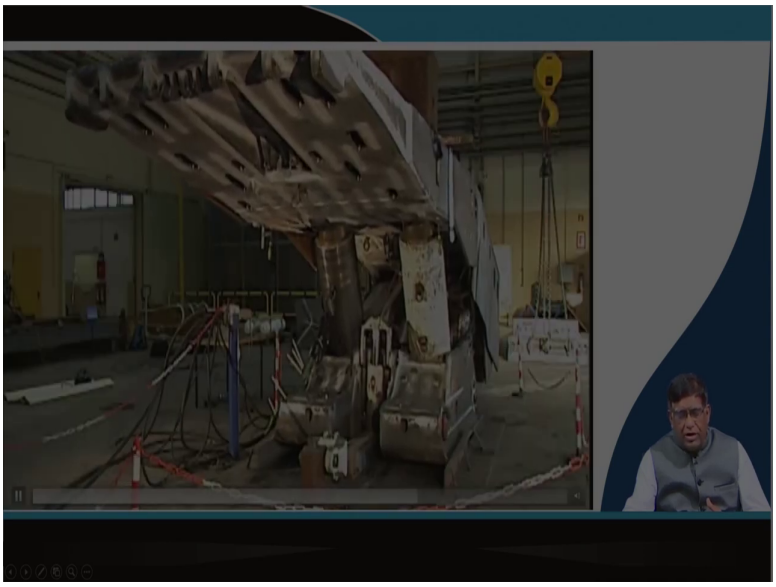

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And these are all hydraulically operated so that the machine and the people are working in a properly safe manner.

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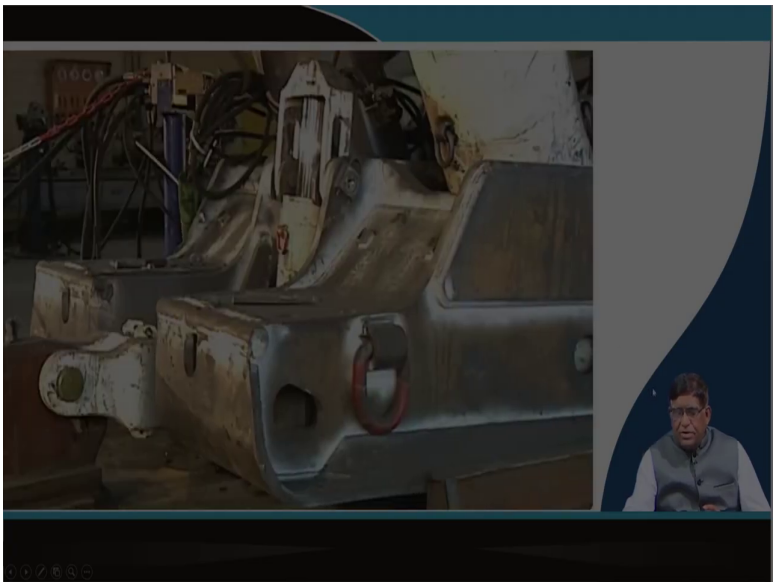

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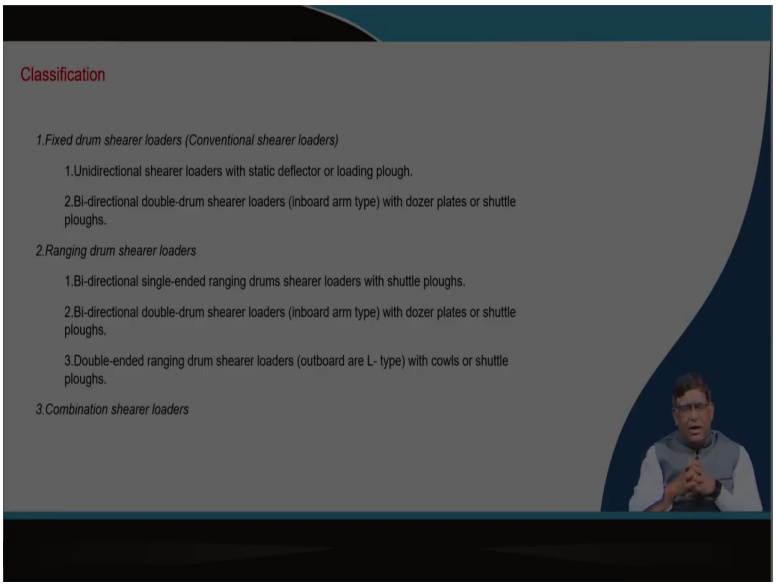

So, you can see here that this machine is a very useful machine for longwall coal mining. Now, there are wide range of this designs and the this types are available manufactured by different companies, but they can be classified as a fixed drum shearer or it that can be ranging drum shearer and this a there could be a different type of combination of it.

When we say it is a fixed drum shearer means the that is your the drum is mounted on a arm that arm is fixed, but if then the depending on the drum diameter, it will be cutting the seam. So, that is your a fixed drum shearer, but if it is having a drum ranging arm means this arm can lift and now, you can have it this positions, it can cut this positions, then lower and then it cut this. So, in that way, in two ways thicker seam can be cut.

So, that is why there are different types of the shearer, but this shearer can cut in a unidirectional, it will be cutting only while it is coming like this and then, it is exactly the

rotation of the drum is only single directional. So, that is your the bi-directional drum shearer where exactly inboard arm type that it has got a dozer plate in front and that it can shuttle both the way it can cut.

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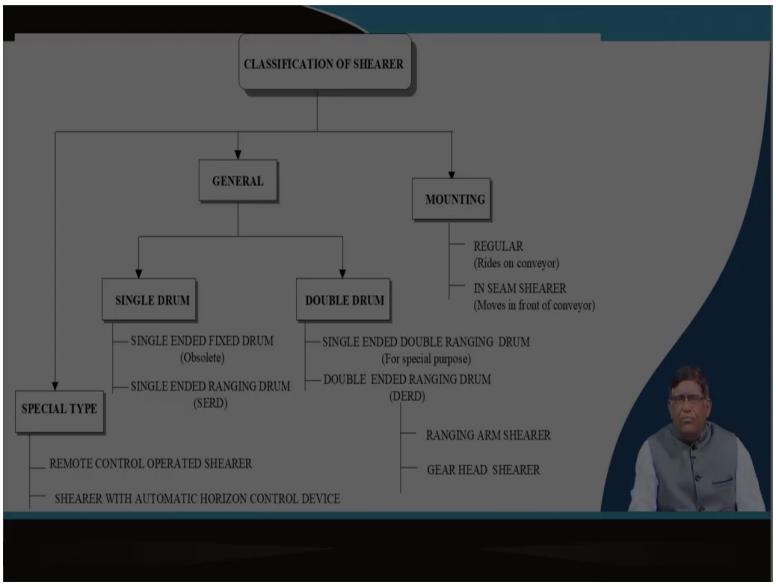

So, this type of you can do the classification of the shearer, you can think that there are mainly single drum or double drum that means both sides there could be two drums or there could be only one drum depending on that, that single drum it can be fixed that is nowadays, obsolete everywhere we are having the ranging drum that is called SERD; SERD, this is a Single Ended Ranging Drum.

And when you say it is a double ended means there are two arms and two drums are there on this and that can be your that ranging arm it can be with a fix at a gear type or it could be a

ranging type. So, this can be a special type where there remotely controls. So, this mounting and traveling also.

There are different sometimes it is having on a chain on which the there will be a the that is exactly will be having a sprocket which will be rotated on the machines and it will be by that rotations, it will move over there or there could be a skid which will be moving on to the armour force conveyor depending on hauling, we can have different classifications.

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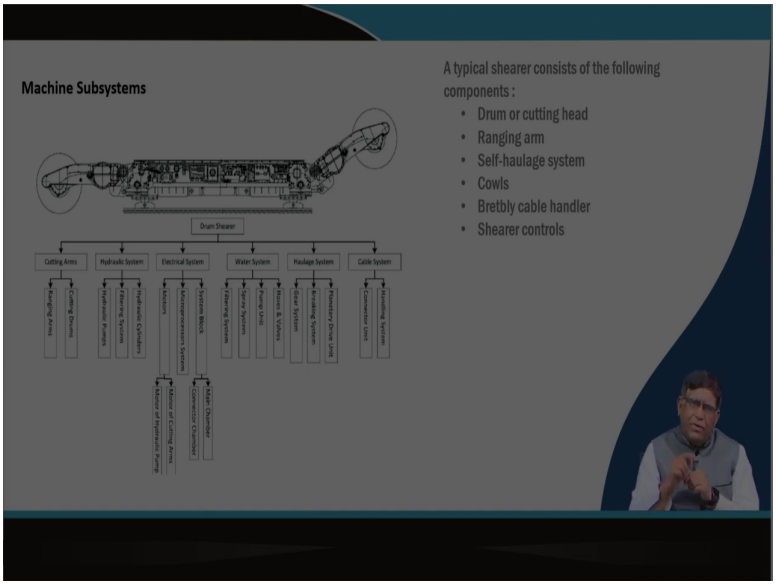

So, and this particular machine, it has got different constructional components basically you need to know that it has got the drum, it has got this where the cutting heads are there or we can say drum or cutting head which will be of where the your picks will be mounted, then there will be the arm, then there will be the hauling unit that how does machines will be moving from one end to the another.

And there is one system called cowl by which the material will be guided to the conveyor belt and there is a cable handler, the blade by depending on the company's name you can have different type of cable handler and then, there is a shearer controls how the controlling of the whole operations will be done.

So, all these things in a drum shearer, you can see here that these two drums at the two ends, there are two arms both are ranging so, this machine is a double ended your double drum ranging arm shearer. It has got number of systems, a cutting system with the cutting arms, it has got a hydraulic system, it has got electrical system, it has got water system, haulage system, cable system. These systems will have to be properly work.

As you have seen in any other machine, a machine is comprised of number of subsystems while you are operating, you are operating only with the control that means, you are as a operational person, he will be coming and he will be just trying that how to make it on and off and then, how different things can be controlled.

But as and when you will be going for the its maintenance and for its productivity improvement, you need to know how different subsystems will remain healthy. To make that, your this a cutting arms where you are having that cutting drums and that arm that means, the cutting system how that exactly the arm will be made move up and down and how the drum will be rotating that means, you will have to have a powered transmission that from the electric motor through that how it has transmitted.

So, those mechanical components need to be understood and their reliability, their maintainability and then, their equipment will be a matter of importance. So, try to understand that what are there in these components. In a hydraulic systems you have already studied in your hydraulic power transmission systems that there will be a power that is your hydraulic tank.

There will be hydraulic motors and there will be different valve banks and then, the hose pipes and then, it will be having the control that is its different actuators. And there if you

know that thing, then hydraulic systems will perfectly be ok, but only you will have to be very careful about using the fluid and then, maintaining that conditions of the fluid because this is a very dusty and humid atmosphere, there the different shields and all must be properly work so that dust and other particles do not come in contact with that.

But this is also a heavy-duty machines, there will be that while working, there will be heat generated so, the heat will have to be dissipated. So, the different parts will be having also here when we have said that hydraulic system, we have not said here there is a lubrication system.

The lubrication hydraulics also is a part of that machines where there will be a centralized lubrications and then which parts wherever there is a moving parts, they will have to be lubricated because many a time, the machine problem comes because of overheating and because of improper lubrications. That is why tribology as a subject which exactly study of the friction, wear and lubrications that part is very very important while running these machines.

The other thing is there, you will have to know the tarot technology that means as a mining engineer, you will be managing the mines, your main thing is that economics performance of it. Now, when the maintenance and that economics are met together and that you make a technology management there with the subject of tarot technology comes.

So, the tarot technological approach of maintaining this machines will be a area of interest for you and then, in the electrical system, you will be deploying the electrical engineers that what they will be doing? Exactly, there are the motors, then there are the different power supply systems and also there are microprocessor system.

Now, these motors, electric motors are there for the cutting arms, then there are also for the motors for running the hydraulic pumps. So, for that exactly, your how those power has been brought over there and then, how they have been located and placed that means, whether the

trailing cable will be coming, how the cable will be connected to that, those are very important things for having the machines properly.

So, now that say your whole water system is another very important thing because the dust separation in the face will have to be done by this water spraying. Now, that is why depending on how the water will be sprayed over there, how the dust will be suppressed that will be exactly affecting the design of the drums.

So, we will have to know about that and that haulage as I said that is exactly whether you will be in which way these whole machines will be moving on that is the haulage system. So, you will have to know about these systems of the machines.

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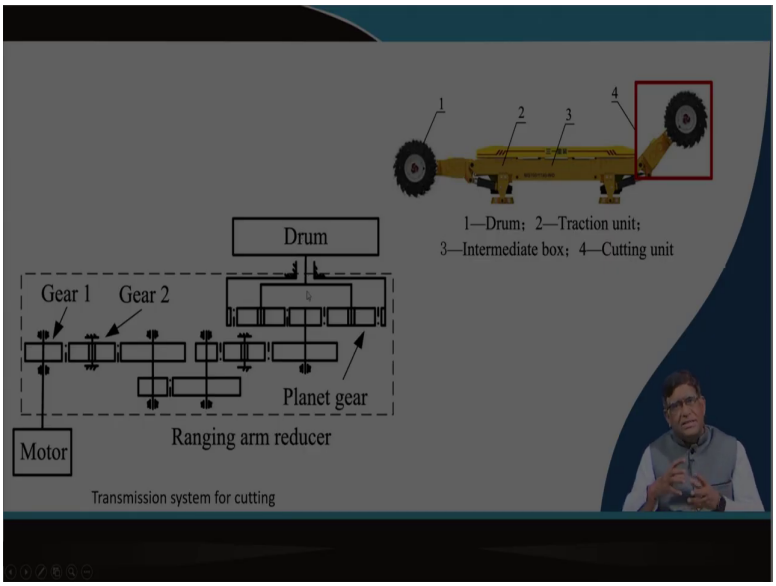

To be very frank, as you can see the block modular wise, this machine comes as a modular units which are exactly erected underground. So, this we are having the drum and then, we are having the traction unit that is the main machines, how it will be hauling.

The traction unit means it is supported on how many it is a four-point support on the your the armoured face conveyor; face conveyors on the AFC that Armoured Face Conveyors is called AFC, this machine is mounted on the AFC on a traveling this mechanisms over here.

So, these four points will be taking the whole load of it. And then there is an intermediate box, this box is where all the electric motors and other things are kept over here, and this is the cutting units we say it includes the arm and all. You can see here that mainly from the motor, it will have the power will be transmitted by the gears will be supported on some bearings and then, there will be a coupling between this.

And then, there will be the your the power transmissions through the planet gear to the drum through via this coupler and the it will be supporting on the bearing where it is to move. So, this is a basic structural things of a machines.

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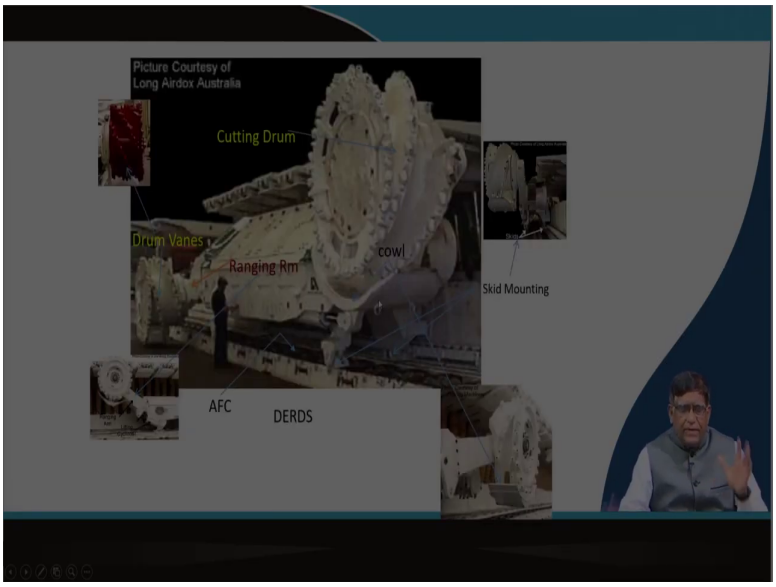

You can see here now that constructional component wise, as you can see here the drums there are these vanes on which there that exactly the your holder, your pick holders are mounted and then, you can see below this drum, there is this cowl which can be swinged. It can be swinging whether that depending on the direction of cut, you will this will be standing up to here or it will be standing here so that the cut material get guided to fall onto the that your armour under the AFC.

So, there you can see that this machine is mounted on the skid that is your on the skids below here, you can see that means, the machines will be moving on the skids and then, there are the this you can see the drum vanes, it is shown over here, there is a on this insets also you can see that how the vanes are there.

Now, you can see that groups type of things get formed so that the cut material get guided onto this. So, this while designing of this machines, these things need to be taken care of. Those of you who may get interested to your job in any mining machinery manufacturing company as a sales and maintenance engineer or as a that is your for a marketing manager, then you can study these things because by changing some design here depending on the type of rock, your productivity can be improved.

That is why the mining engineers know the geo-technical properties and the properties of coal and then, they can give a better design input depending on study of a machines. So, you can see here, how this ranging arm, this part is there and then, they have got a lifting cylinder. You can see at the bottom that arm that your drum can be disarranged up and lower end and all depending on this particular actuator as a cylinder is over here, a linear actuator hydraulic system is available here.

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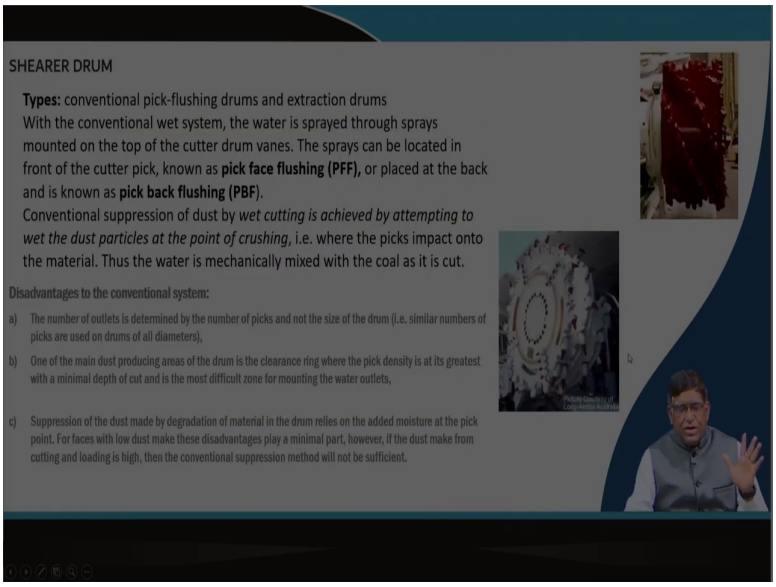

So, I hope now you have understood that what is this machines constructionally. Then, you may go on studying the type of drums which can be there. There are different types of drum depending on how the flushing or how that water spraying is done that is why they have got two types; one is your pick face flushing and pick back flushing.

This pick face that basically how the water is sprayed and from there, how it is collected that makes this advancement in the drum. So, this is a there are the conventional systems where there is it was just only putting the mount without considering that way, the dust will be affecting that gives a problem.

And also they that your how many number of picks and how what will be the size of the drum, this need to be very carefully selected depending on the your thickness of the coal

seam, hardness of the coal seams and then, about intrusions of the other material which is coming.

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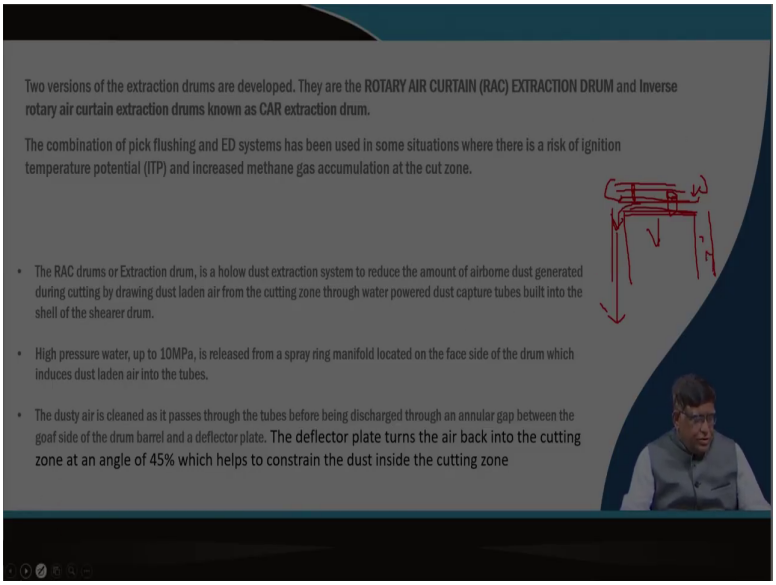

So, now that this there are two type of these drums, one is called RAC drums which is rotary air curtain extraction drum and the other one is exactly your ignition temperature potentials depending on that, they have exactly put that this whether your this that when the air will be sucked in, how it will be moved into and then, they were going to collect the dust in that system.

So, that means, that your whole there is a extraction drum, it is basically a hollow dust extraction system and that it reduces the amount of the airborne dust generated during cutting by drawing the dust laden air from the cutting zone through water powered dust capture tubes

built into the shell of the shearer drum that is what is exactly the advancement came over this for the dust separation system.

Now, normally, up to 10 mega Pascal water pressure was a high pressure is released from the sprays to ring so that this every particles whatever is there can be taken out from the face and get that your drum kept clean and then, so that the cutting will be better.

The dusty air is cleaned as it passes through the tubes before discharge through a annular gap between the goaf side and the drum barrel and the deflector plate. So, there is they exact the orientations of the machines and all it depends on because when you are working in underground, you know in a longwall panel, you will be having this two to that your roads will be made on which that will be exactly your in any longwall system.

You have already learned that in any there could be a retreating or a that is your advancing. What we do? You make these two gallery type of things, now this is your panel say if this is your coal block, now what happens? Your armour face conveyor will be placed over here and then, your shearer will be mounting over here.

And then, this shearer will be cutting this coal and then, it will be that your power support is from here, it is supporting over there and that your hydraulic panel, it will be pushing the your power support towards this directions and your main conveyor belt for evacuating will be here. And then, the coal which is when it will be the shearer will be cutting from here that a rib a way will be cut and that material from this will be transferred which can be via another stage loader or a feeder breaker cutter will be there.

So, this approach of longwall mining, you can see here all these other systems your dust collecting system, your water spraying system, your hydraulic power pack and all everything will have to be accommodated in this constrained space. So, that is why in a longwall mine which is this a very mechanized mining though it requires a specific attentions for the design as well as for the whole operations.

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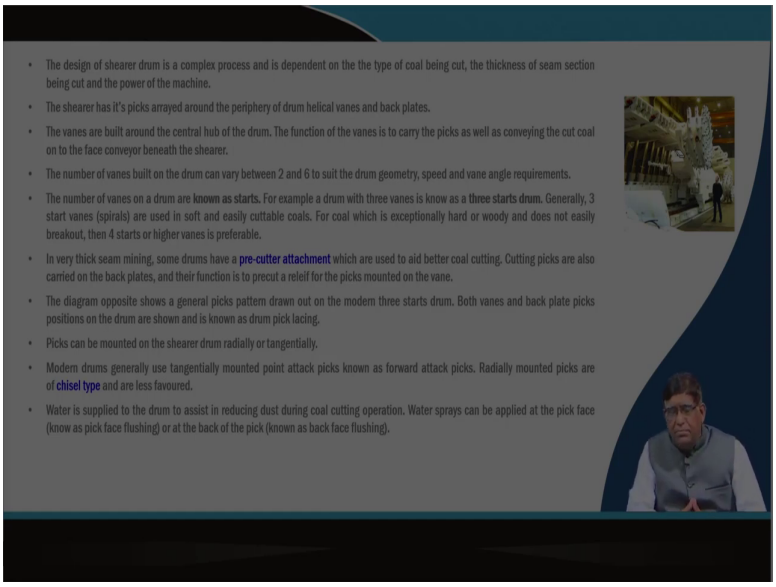

So, this is a there are shearer drum design, it will have to take account, take into account that how the extractions will be there, how the dust separations will be there and then, they that is why the whole arrangements will have to be based on the geotechnical conditions over there.

So, as such in the machine while you are learning about the machine, sometimes there could be a pre-cutter attachments that means, if it is a very hard rock so that the coal cutting can be better so that is allow before the picks, there will be another precutter which will be weakening the rock and then, the that your main cutter will be giving a better things.

So, one thing is there depending on the type of coal, the life of this picks that will be and then, the as if it goes if it wears faster that will lead to your more the replacements of it which will

require more timing and then, that is your the whole operational, that is your efficiency, this will take it will be taken.

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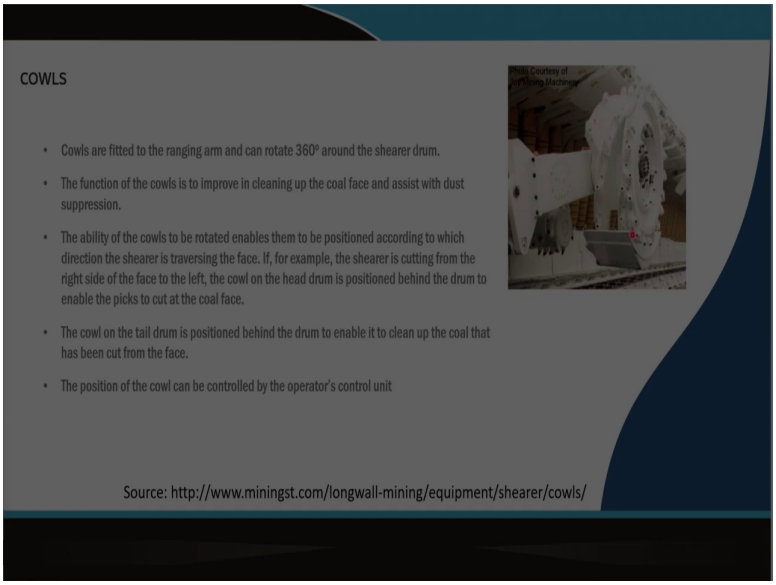

So, as such for this purposes, your these machines component wise you need to know. As I was telling that one major component is that cowl that means, when this shearer will be rotating like that, it will be cutting say if it is rotating in this directions from the bottom to top it is moving, then this material will get guided over here so, this vane and that this cowl will be guiding it to the that your armour face conveyors.

So, cowls are fitted to the ranging arm and can rotate 360 degree around the shearer drum. Why? Because it can be placed wherever it is required say depending on the direction of cutting. The function of the cawl is to improve the cleaning up of the coal face and assist the dust suppression, so that depending on the direction of the cut how the dust will be exactly

the fine particles will be thrown and then, it should get retained over there that will also lead to that bigger particle will go.

Only the smaller particles which are going to that air then the spray will be guiding them to fall. The ability of the cowl to be rotated enables them to be positions according to which direction the shearer is traversing the face that means, if the shearer is cutting from the right side to the face to the left, the cowl on the head drum is positions behind the drum to enable the picks to cut the coal face.

And the cowl on the tail drum is a positions behind the drum to enable that clean up the coal that has been cut from that face. So, that is it what is called your this tail drum means when there are two drums, one is the head that is if you are following in this directions at that time that will be the head drum, the other side arm drum will be called the tail drum. So, there is a this how the operator can make this cowl to move and then, wherever it is required, he will be positioning it there.

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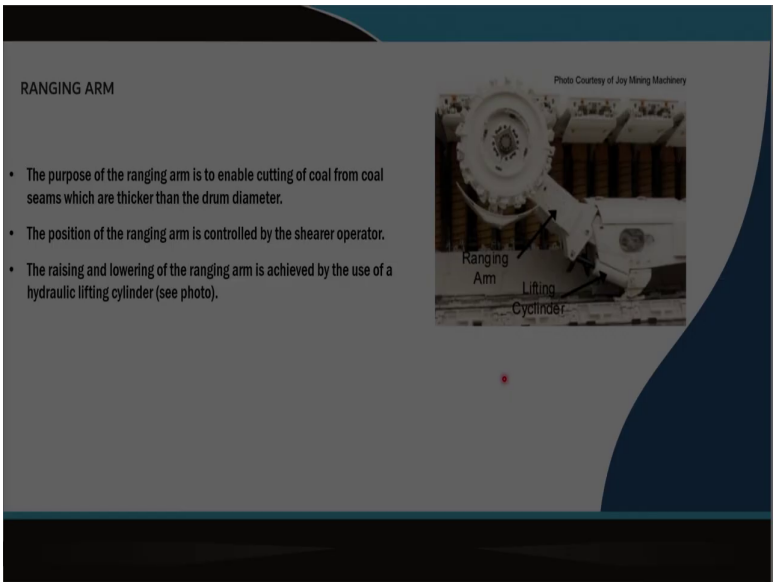

So, there is the operators and that is ranging arm, you have seen that the ranging arm has got this your the control with the lift cylinders.

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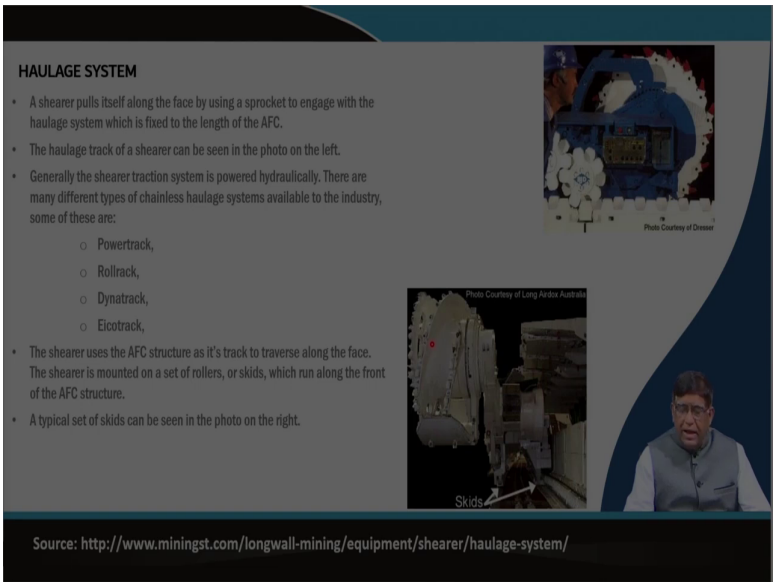

So, then the haulage of this that how this machine moves exactly you can see a trucks can be kept on the that your the armour face conveyor on the AFC, it can be as a rake and pinion or it can be a chain on which a sprocket will be moving that this that pinion or the sprocket is a mounted on the machine and then, when it will be rotating then as it is a fixed rake or a chain that machines will moving.

And then, it has got exactly that if there is no track that there are some trackless systems have also designed and there are number of the Dynatrack accompanies this particular design system, they have separated, and it is profited to the shearer. So, shearer as it is moving that the whole machines can be you can see here that there are the skids that skids will be pushing down as this will be engaging with the trucks your haulage system.

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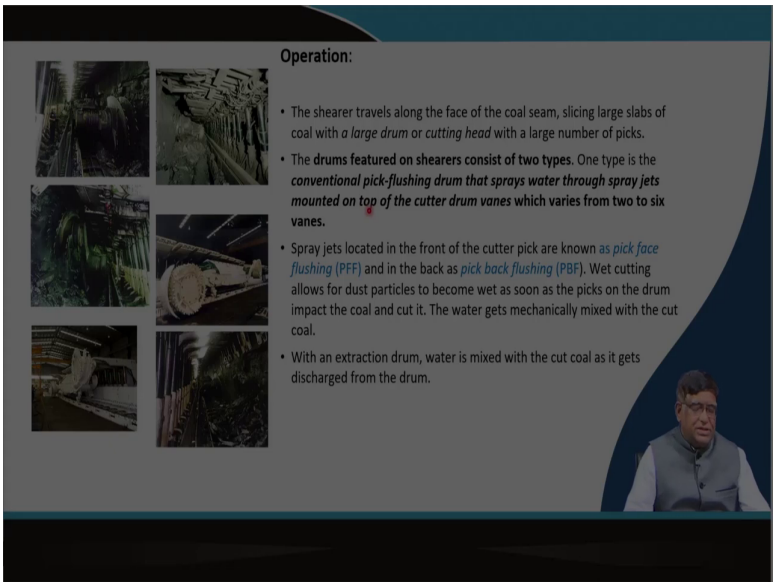

So, you can see here different pictures in the applications that your how that shearer picks are attacking over here, how this is under the power support it is working and this exactly, it travels from the face of the coal.

So, main cutting of the things is how the how much amount of coal it will get cut will be depending on at what rotations this shearer is rotating and what is its total thickness it is taking up and how much exactly the vane, what thickness of coal is getting cut and at what speed the your shearer is moving.

So, this while we take care of that, it can be when you go for performance calculations, we will be doing over there.

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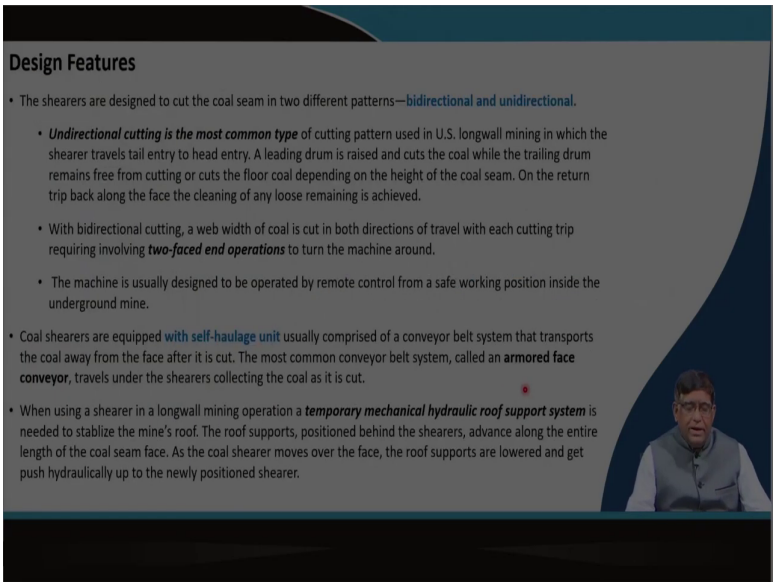

So, that main design features is whether it will be your unidirectional or two-directionals and whether it has got your a automated self-haulage unit or you have got a separately from outside, you need to give that chain can be moved separately and then, the machines will be moving. So, there could be a different haulage systems there.

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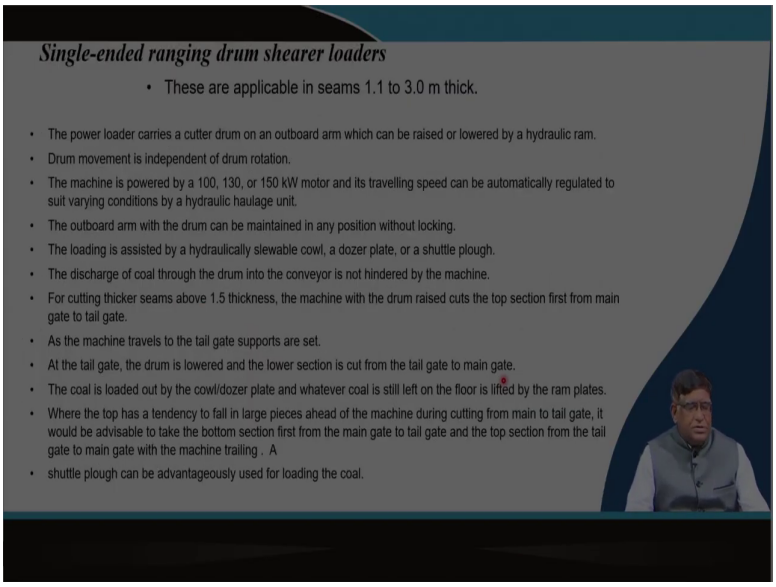

So, there is a that the single ended ranging drum shearer which can be used for single ended means if you are having only one drum, it will be cutting like that. Now, if you are having two drums, one cutting from here, another cutting over there that means, the total thickness can be managed. If you kept two drums position like this that means, from here to here, this part of the your coal face can be cut.

Now, that is a it the power of the motor it will be depending on the size, how much cutting resistance is coming it can be 100 kilo Watt to 150 kilo Watt motor depending on the requirements it is design.

So, there is a the total productivity calculations is depending on exactly what is the length of the your the main longwall panel. So, as when you study the longwall mining at that time

your whole productivity calculations and then what is that, the operational managements to be done that will be taken care of.

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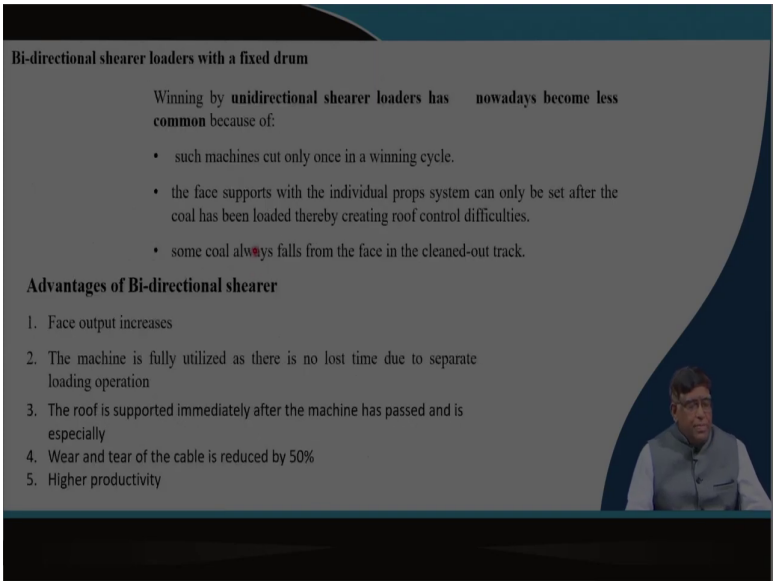

So, that is your the bi-directionals, when you make that cutting in while both the directions you will be cutting, that has got that advantage because it can give a more output because total overall cutting time is more ok. So, then if you are that main importance of the bi-directional shearer is you are fully utilizing the available time.

And then, this is a the here, the support, roof support is that is when while working the power support it is given and then, when you are retreating that side is the goaf, the whole roof is allowed to fall. Now, the problem come sometimes if the roof do not fall, a big void is created, then suddenly after if it is a very long, if it is not falling down, then there is a

problem and we may have to induce some additional technology to make that roof fall in the goaf.

So, this is a managing the goaf is also a part of longwall mining. Then, we need to see that this the while operational, there no entanglement in the cables and all, they should not get damage.

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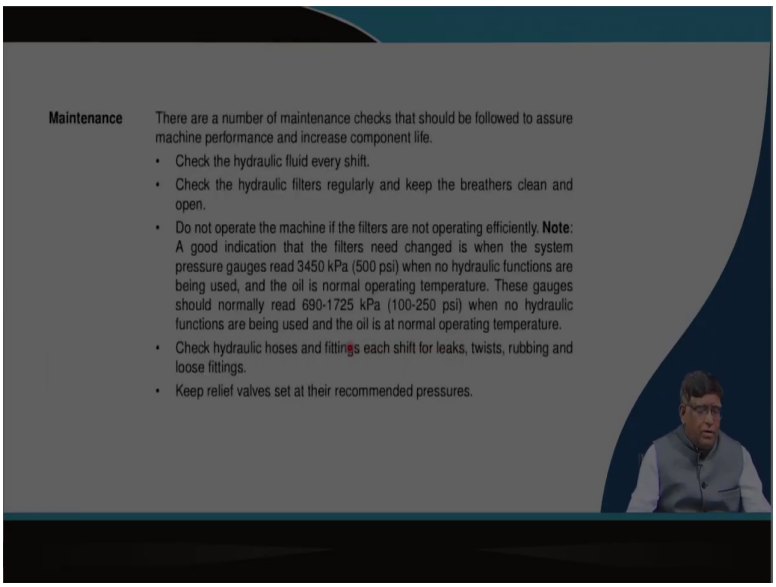

So, overall, this machines need to be maintained properly and that maintenance depends on the how your the hydraulic system, mechanical system, electrical system water systems, they will have to be maintained as per the week daily maintenance, weekly maintenance and monthly maintenance schedule as given by the manufacturer.

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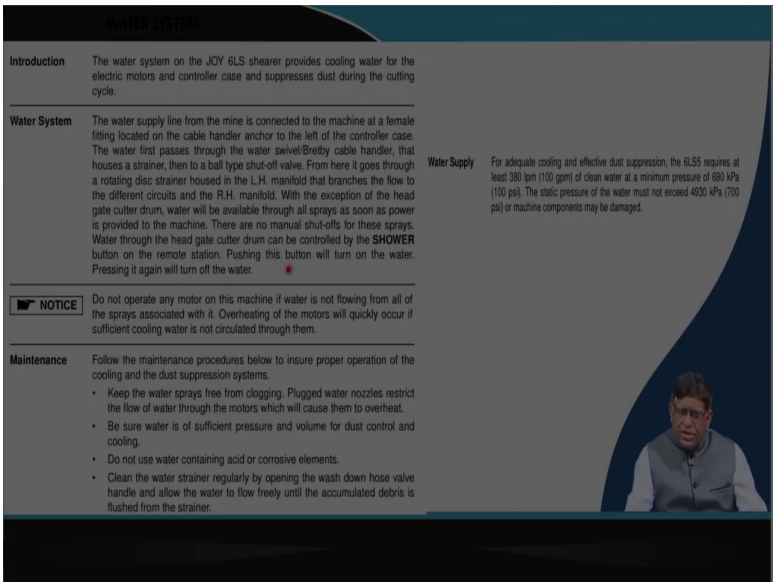

So, that they give normally, all the manufacturers they give this maintenance checklist you will have to follow that.

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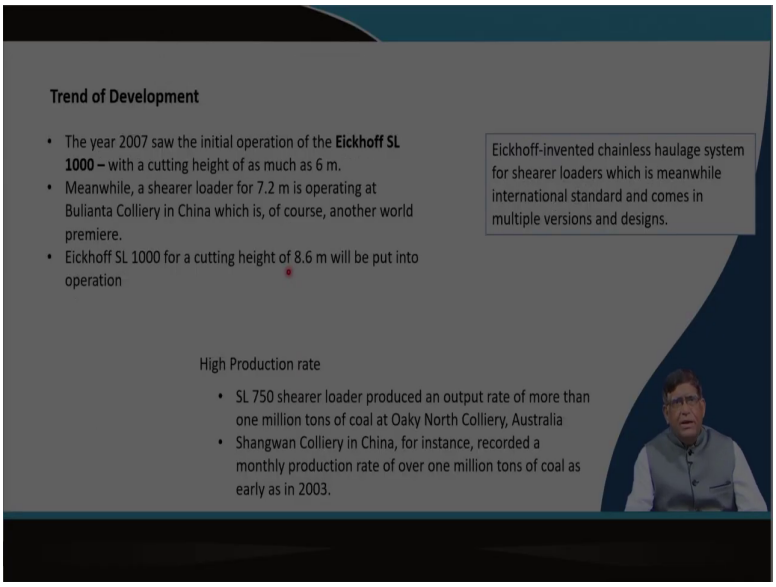

Now, there is a this shearer, it has develop from different time by different manufacturer.

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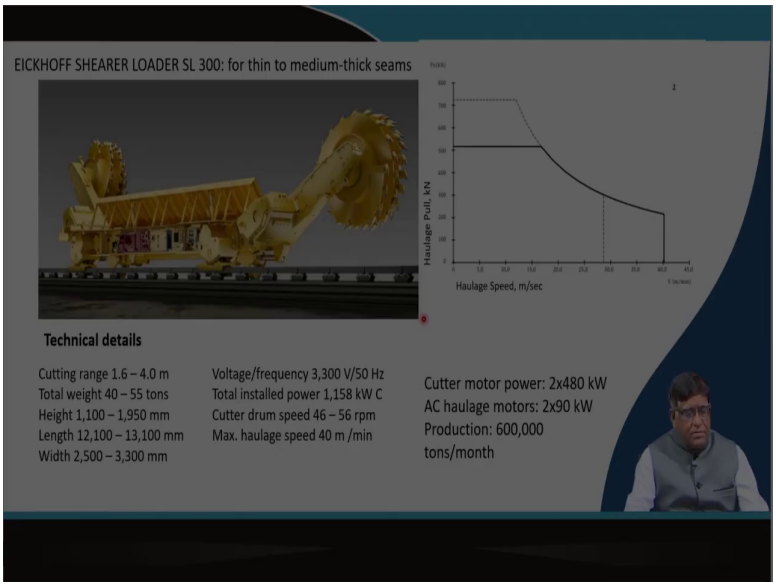

So, if you see that is there to get the high production rate that is a different way it got developed say I am telling as an example Eickhoff SL 300 and this SL 300, then came SL 500 then came SL 750, SL 1000 big machines. You can see there, how much haulage pull is there and how much haulage speed is there. This curve that exactly shows that how much kilo Newton haulage pull can work with that, what is that velocity?

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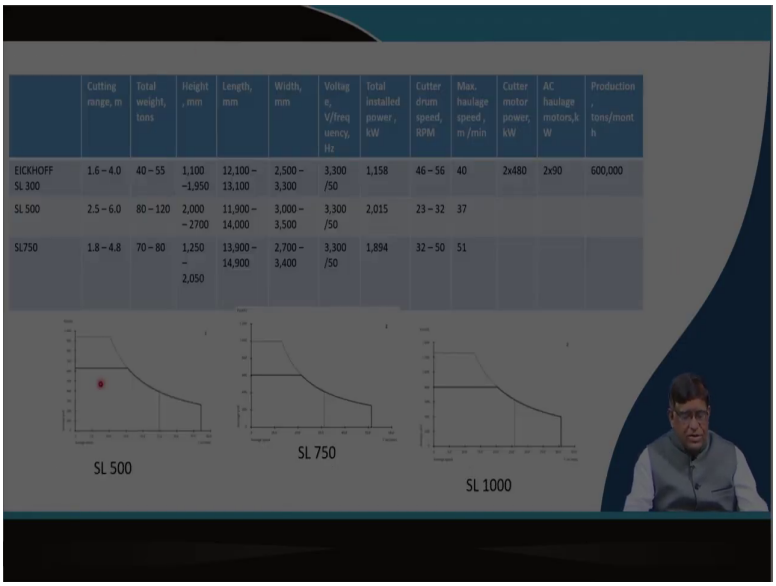

You can see if the machines capacity is increases, how this curve get change you can see over here. Say I have just populated this three data from the operator that leaflets available in the web, I just noted down that what are the more important thing you need to know about the cutting range, total weight, height, length, width, then what is the voltage and frequency, total installed power, total installed that is your cutter drum speed, these are the parameters which you need to study.

So, you can collect from the leaflets and from there, when you put it over here, you can see that is your when your size of the machines is more that capacity increases at that time, your this velocity which can that exactly give a change, you can compare these velocity ranges which is less. So, like that you will have to study from the different operator's manuals, different leaflets.

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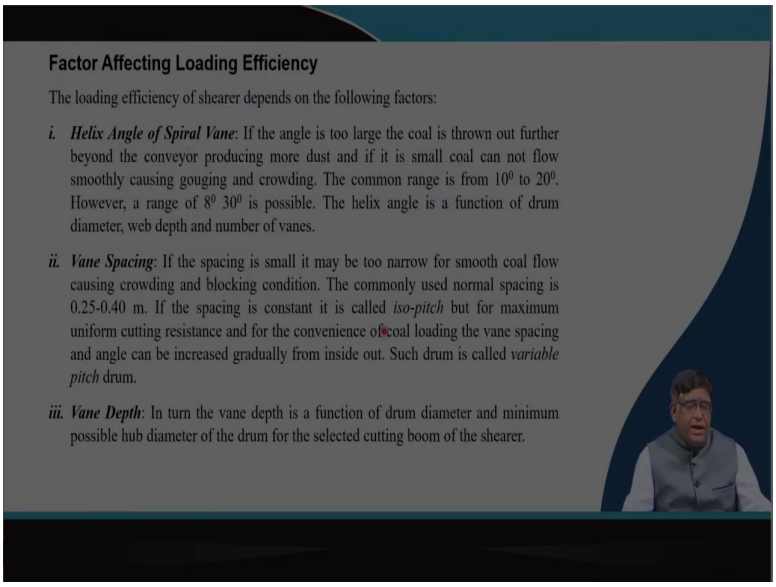

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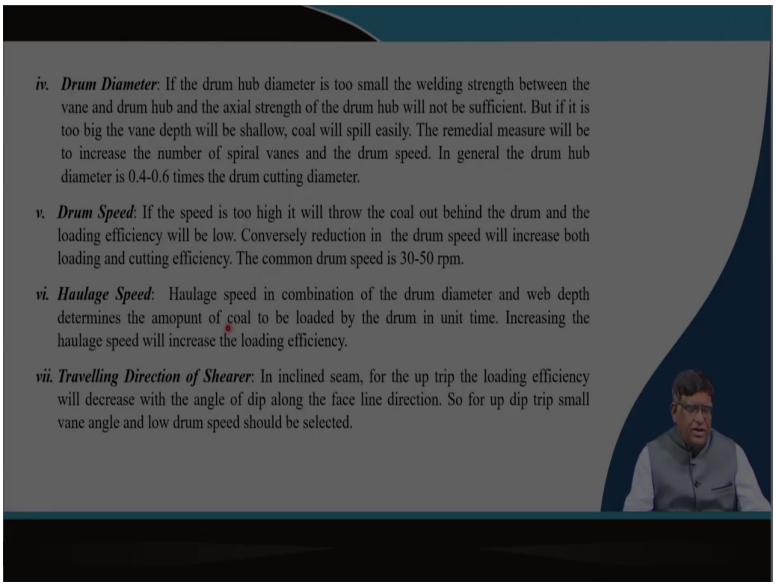

And then, you can find out that how you can do that your loading efficiency you can improve by that factors like your helix angle, by your vane spacing, vane depth, drum diameter, drum speed, haulage speed, traveling directions.

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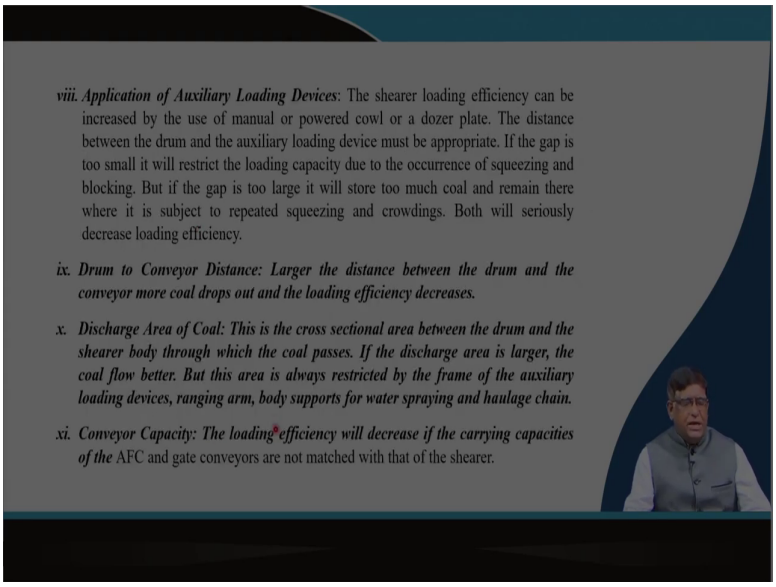

Then, your auxiliary loading devices which you are having, then your what is the distance between the drum to the conveyor, how that exactly discharge of that discharge area for that coal, your conveyor capacity all those parameters need to be studied.

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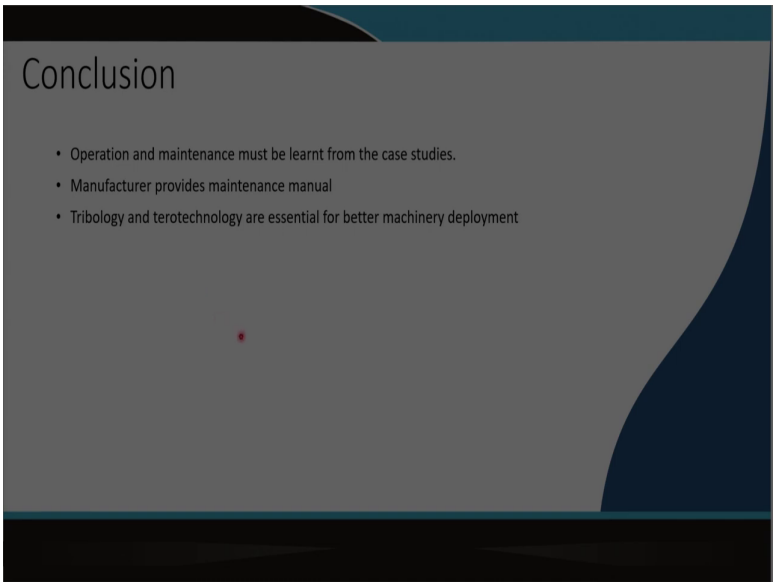

So, to be very this is just an introduction of a shearer. Shearer is a vast subject, you will have to take your mini projects to detail understanding of this, but what I have told you is a constructional and then, their operational and maintenance aspect in a very briefly, but this should be making you to understand that you need to study, and you need to go through the manuals and different research paper.

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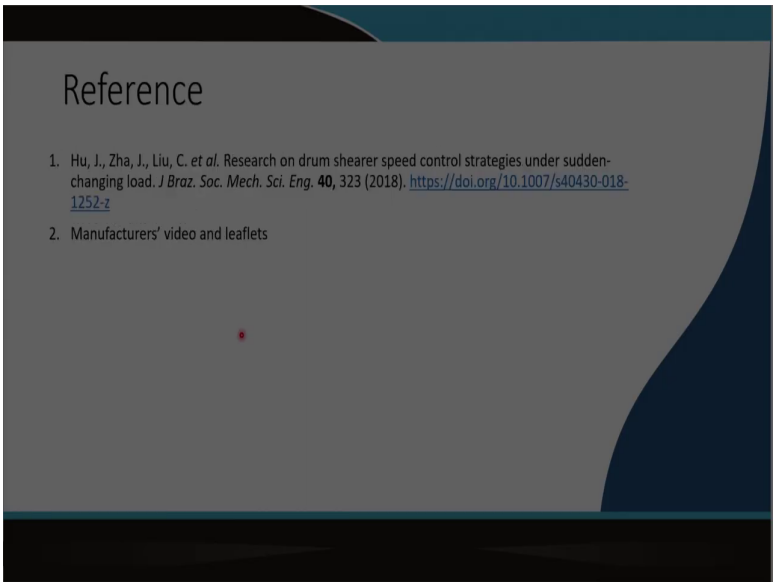

Please read some of the research paper and then, leaflets so that you can also conduct some of the research so that your innovative ideas can improve the operational efficiency and performance of this machines in our working conditions.

Thank you very much.