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

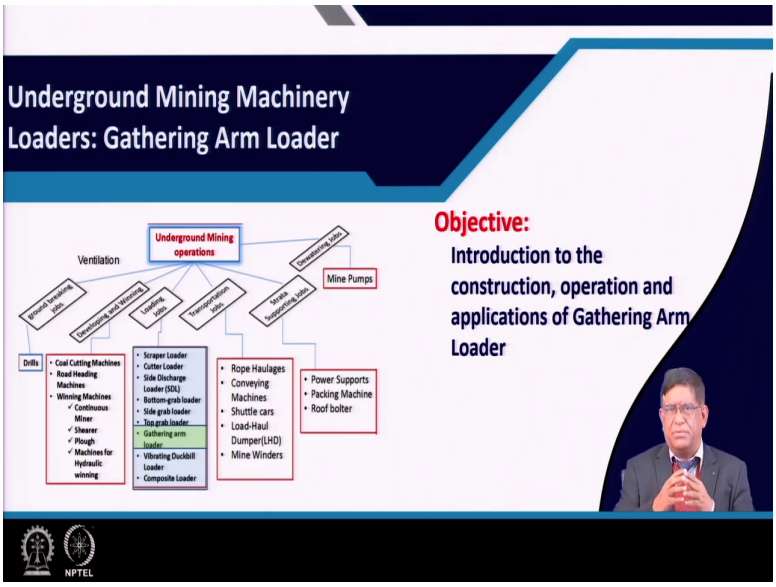
Module - 05
Lecture - 26
Underground Mining Machinery Loaders:
Gathering Arm Loader

Welcome to our study on Mining Machinery. So far, you have studied the basic introductions of the mining machinery, also the machine elements and also you have classified the different types of mining machinery. Out of that we have discussed about the surface mining machinery for cyclic operation, for continuous operations.

Now, today we will be starting our discussions with Underground Mining Machinery. There are in the first introduction class you please once again review that we have classified the underground machinery into number of groups out of which we will be going one by one, but today we will be talking about a particular machine which was used in underground coal mining in bord and pillar method of mining.

As a mining engineering student, you know about the history of this method and then it is a old type of machines still being used. So, we will be talking about that.

(Refer Slide Time: 01:43)



Because as you know that in the underground mining operations, it has got the groundbreaking jobs you have got to develop and win the mines that exactly how will be loosening the material and after loosening you will have to collect the material to put it on a transporting.

Then in underground you will have to arrange for the transportation of the material which is own or the by winning method. Then of course, there will be some machines to support the strata and also that the maintaining the environment there producing the this say air to be supplied there and then the water which get generated to be taken out. So, like that a large number of mines mining machineries are used.

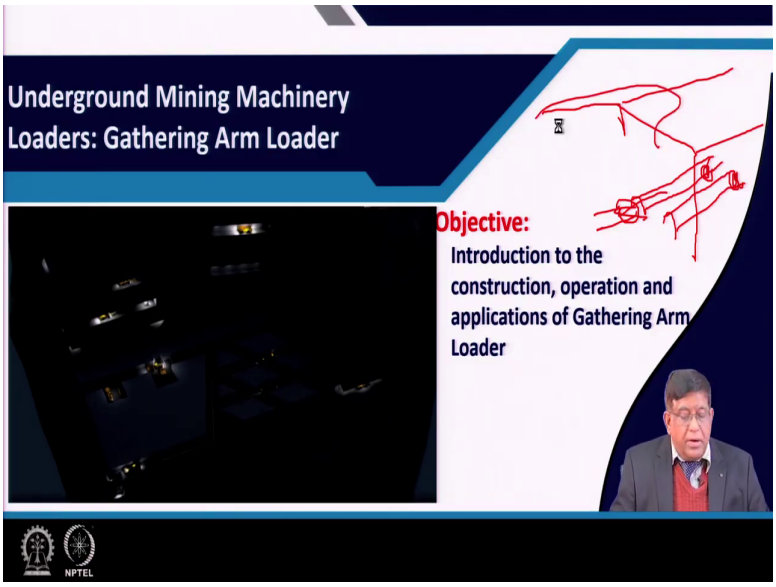
But, today we will be talking about that loading jobs, because in the method of mining you might have studied that you can do a drilling and blasting in underground that by using the

drills you will be putting the blast holes and then after excavating you are getting the loose material then how they will be collected.

There are different type of loaders are there and amongst the loaders we will be talking about a gathering arm loader which was introduced in the early of the last century and, it has been working and still it is working. Komatsu that they have procured now the Joy Mining Corporations, Joy Global they have got some gathering arm loader. So, we will be talking about that.

But, one thing you know that our main objective is to know the construction operation and then applications how it is there. And, then once you will be knowing some of these machines we will be able to do that how while planning the mine and for improving the productivity and then the getting a better financial results from the mining operations these will have to be studied. So, in general we will introduce this machines and then you can you get your interests to do further study over here.

(Refer Slide Time: 03:56)

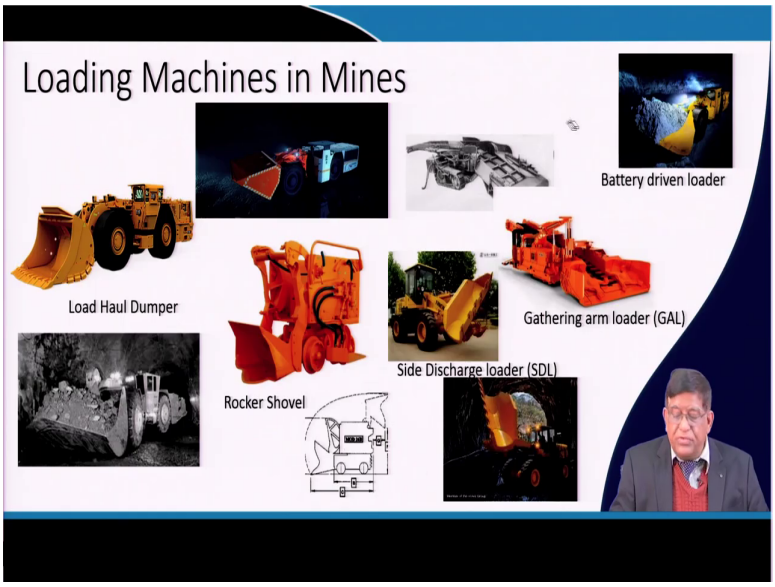


Though this figure is not very clear here, but you can see that this is a underground mining in which exactly all these machines. You can see here that all these machines are exactly operating down. So, that means, if we in a in any underground mining when you are having the say in a underground operations you are suppose this is your if you think of a underground block suppose, this block is being cut here you make this gallery.

Now, in this gallery when that some machines they will be going like that and inside that when you will be going out, there what will be here? Your transporting machines will be going inside this mine block. Say this is your surface level. In the surface when you are your this you will be below that you have gone there maybe from a shaft you have entered. Now, this inside that track will be there where the material will be going out.

Now, when you are blasting is done and there these portions, that material how it will be collected and taken out that we will be discussing in today's lecture. Let us go by that ok.

(Refer Slide Time: 05:24)



Now, basically you can see here that the loading machines may be of different type. Now, these the different machines you can see here that what we will be discussing today is the gathering arm loader. So, this machine will be our today's discussion. But, here in metal mine sometimes they use this rocker shovel, they collect the material inside this bucket and then this is this arm get rotated and the material will be thrown as a projectile from here to a transporting material.

There is a some machines called side discharge loader or SDL which is shown here you can see that the material gets scooped from that into this bucket and then it is tilted so that it can be loaded on a conveyor belt or a mine car by this. So, you can see also there is a load haul

dumper LHDs, these also are used inside the mines that blasted material is taken and carry to certain distance to put it to the transporting machines.

So, then there is the modern battery operated this these are all diesel operated in underground environment the diesel exhaust can create problem. So, because of that today this battery driven loaders are also there. So, you can see here that is this type of gathering arm loader which are used in the early 60s of last century and today there are coming this battery driven that is the even the diesel is loom removed you can see here initially there were always only crawler, now you can have these tire mounted machines.

So, there is a wide spectrum of loading machines for improving the operational requirements and also that getting the higher productivity and economic performance.

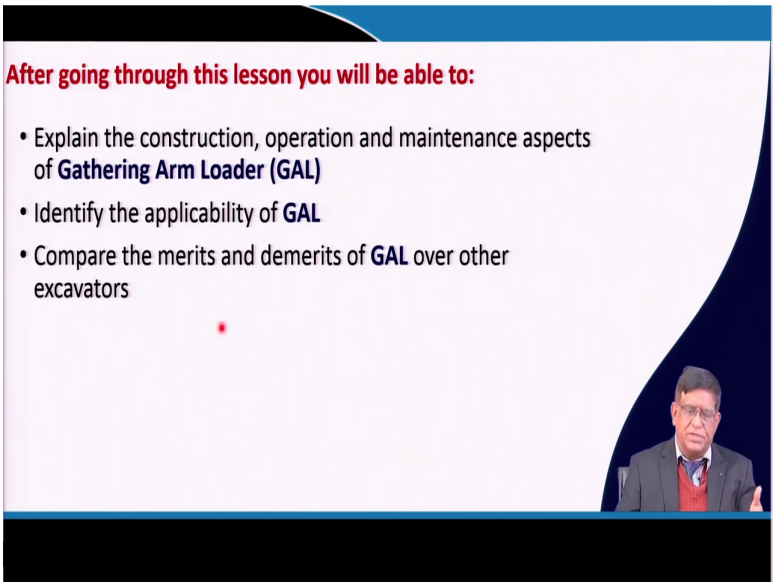
(Refer Slide Time: 07:26)

So, we will be discussing about these machineries. Now, what is that gathering arm loader which is it is a machine for losing that is it will be loading. Here you can see that this is the front part of the machines and this basically these machines comprises of this gathering head where there are some small arms the material is collected from these ones and then put into a chain conveyor. And, that chain takes the material, give it to a boom and a conveyor belt here and then the discharge boom.

So, this type of machine which is also the Joy is manufacturing these machines and they can give about 36 tonnes per minute. So, earlier the when the loose material the taken by the miner which are called a miner were called as a loader human being. They used to do the it a shovel hand shovel they used to collect the thing on some basket and then that basket they will be taking and putting into the mine car.

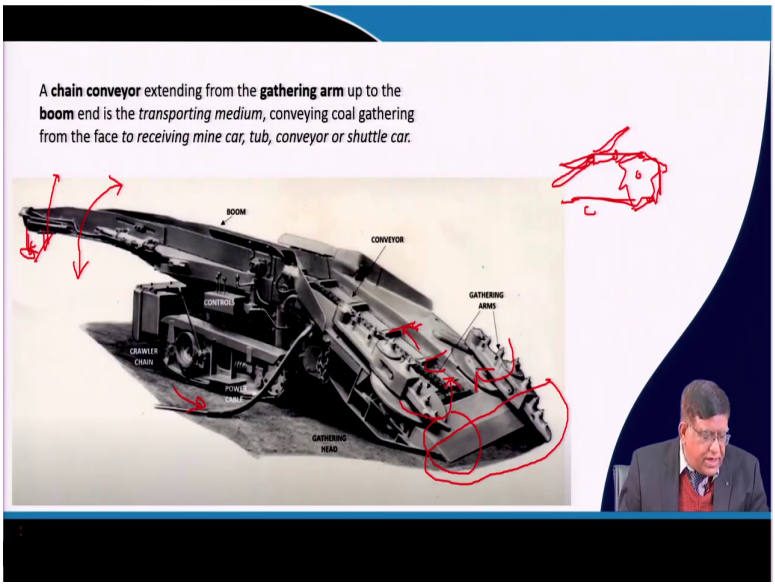
That was the things exactly that if you see our Indian coal mining up to 77 and 80, it was a having a cadre that they are called a loader that exactly large number of the labourers were mining labourers were recruited as loader and they were doing. But when these machines came in they were able to do the 36 tonne per minute or they use the capacity and by that the transporting and the production volume and the rate both increased.

(Refer Slide Time: 09:06)



So, today you will be learning about this after this lectures you should know about that what is the construction and operation and what type of maintenance are done with this gathering arm loader and then you must know that where this machines can be used and then during the discussions try to understand that what are the merits and demerits of this machines. So, we will have to make some separate study and notes on these three aspects of this machine.

(Refer Slide Time: 09:37)



Now, let us see this machine first, what is this exactly. This is a machine for handling bulk material. We can say in underground mines this machine will have to work inside the mine that is your at the surface it is there it will go by shaft or then there will be there. So, this whole machine will have to be assembled down at a below that is in the underground.

Now, that is why in any underground mining machinery, it will have to be designed in some modules and that is parts by parts it will be taken down there it will be assembled and then it will be put into operations. And, then after the end of the operation if it is to be taken from one mining's to another or a one place to another it will be dismantled and then again it will be assembled where it is to be used.

So, that is why they this machine must be of low height because it is working in a mining gallery. When you are working in a mining gallery the height is restricted. So, you can see

that this machine is very small height machines and then its weight also we will have to be as per the gallery weight. So, that is why this machine is a compact machine in which we are having the gathering arm, this front part is the gathering arm.

And, then there is a you have got a discharge boom. These two unit it is an undercarriage that is a crawler mounted frame is there. This crawler on the top of it is with this it is this two are mounted and that that way they have made it integrated. You can see a power cable here; that means, this is an electrically operated machine.

You remember, that underground coal mining when you were using electricity you need to be very careful, because in a coal mine normally this methane will be coming out and you know that methane air mixture is highly explosives and while you are doing a switch ON – OFF at that time the spark can ignite that thing and explosion can take place.

So, that is why while you are using electricity you need to be very careful this cable connection switch motors all are have to be made intrinsically safe; that means, any switch ON-OFF operations must not give any spark which will be causing this accident and that is why this cable and all will have to be of a permitted type specially designed.

Now, this undercarriage which is a crawler mounted you have studied crawlers a lot and you know about that crawler of the surface mining machinery which are of very heavy structures you have seen very big big crawlers, but here it is a small crawler. But, this crawler machine because of the undulated and then where this is your ground bearing pressure is not very good, there also this crawler can work.

So, if you see here this gathering arm this gathering arm or that gathering head it has got two arms. You can see these two are the arms and they have got you can see that this disk type of structures here and then this is the point.

Now, when this will be rotating this arm will be going from this way to it will be taking the material here. So, that means, your this in this machine when this arm will be rotating, this

arm will be rotating in this direction and then your this arm it will be rotating in these directions.

Now, whatever the material will be collected or that is exactly this machine when it will be moving forward, then the material which is here in this portion they will get they will get here collected and then the material will be moved to the central portions. In the central portions, you can see there is a chain conveyor.

This chain conveyor there you can see it is a single chain conveyor and that this conveyor or the chain conveyor it is having a sprocket, there will be one sprocket like that in that sprocket it will be this chain will be moving over here.

So, that is we are having the link chain. This links chain will be connected over here. Now, this same portions it will go like this now that; that means, on a platform the chain is moving over here and they are given a drive to the this sprocket will be given the drive with a gearbox and that drive motor. The motor will be connected to gearbox and they will be giving a coupling.

Now, this chain has got these are the flight bars. These bars which you are seeing exactly on that chain we are having this connected like that a flight bars are there. Now, when the material will be falling over here it will be moving in this direction between the two flight bar.

Whatever the coal material is collected that will be pushed by this flight bar and it will be given to the discharge boom. Here is also it could be a chain conveyor here also and it will take the material and that material will get discharged over here. There is a you can have a hopper here the material will get discharged.

So, you now know that this construction and this operation of this machine is now this if I ask that how the material is collected, material collections two forces are there. One thing is you

will have to move the push this gathering head into the material and that is being done by movement of this crawler in this directions.

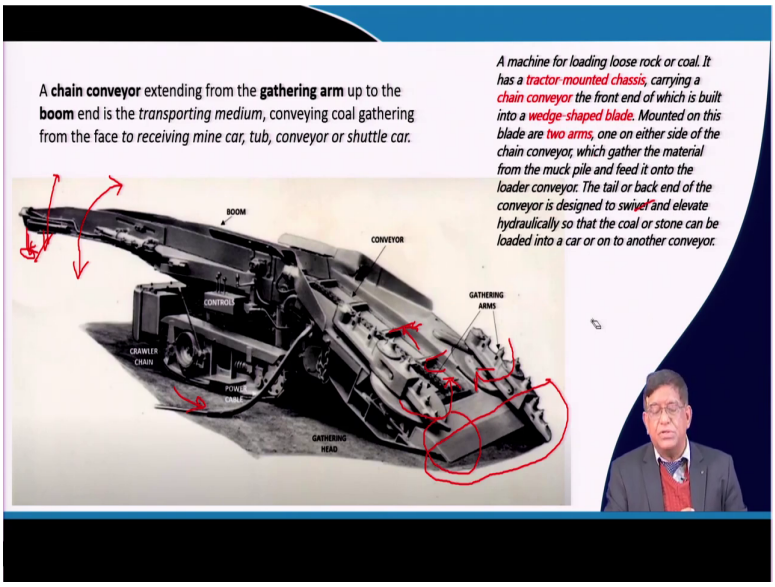
And, after that it has pushed over there simultaneously your this gathering arm it will be rotating and the material it is giving a reciprocating motions type things it will be all the time it is pushing here inside and it is coming back and pushing. So, by that way it will be and this there are different motions depending on the situations can be provided.

This boom it can also give a up and down motions; that means, you can lower and raise by which you can position it properly and it has also can give a slight horizontal movement in one particular plan, so that it can give a little swing and also putting. So, that you can load the material properly either on a shuttle car or on a mine car which that car can be it can be a locomotive can be used for transportations or the road foliage in the mines can be done.

I hope it is clear about these machines. Now, these machines do not have any operators cabin or anything like that, but there are these control knobs are there. So, this is exactly the operator will be controlling this machine from the this controlling cables are there.

This is the control portions; on this portions the with these jockeys and livers they will be doing and as a construction is very simple, but there are lot of things to be there.

(Refer Slide Time: 17:14)

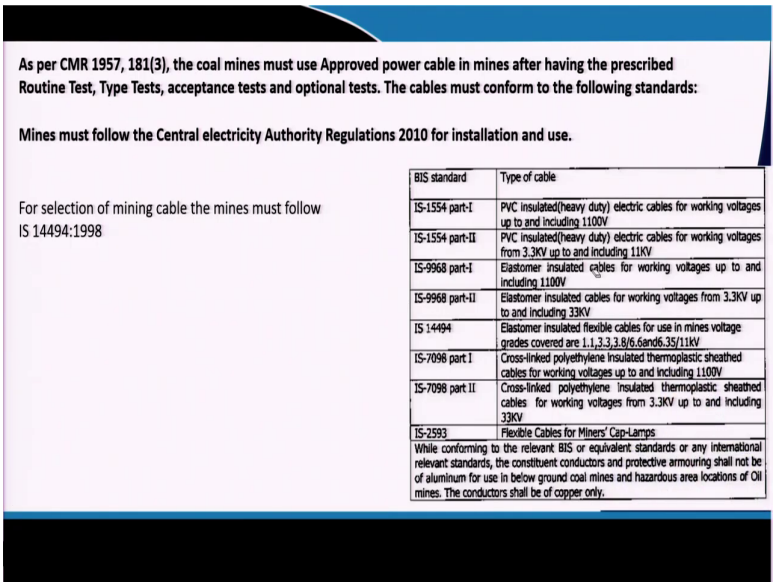


So, this is a as a this machine is for loading as you have said you can read this part that exactly this machine is for loading loose rock or coal. It has a tractor mounted chassis, that is, your crawler mounted chassis and it carries a chain conveyor at the front end.

And, then it is a it has got a wedge shaped blade that front portions, so that the material can be scooped, then mounted on this blade are two arms one of the either side of the chain conveyor which gather the material from the muck pile and the and feed onto the loader conveyor.

And, the tail or back end of that is designed to it can swivel and elevate hydraulically so that the coal or stone can be loaded into car or onto another conveyor. I think this is clear to you.

(Refer Slide Time: 18:19)



So, what is important that is how the drive? The drive of this machine is by electric drive; that means, your power is being brought and there would be your electric motor. In earlier days, there were DC motors and this nowadays of course, we can have AC motors with a proper control the lot of development has taken place over here.

Now, the most important is to bring the power up to there as you have seen in the figure there are the power cables. As a mining engineer what you need to do your safety need to be managed properly. And that is why your this cable which could be your depending on its voltage rating, your maybe up to 1.1 kV or even up to your 3.3 kV power maybe required and in that the power is brought by cable to a gate end box and from the gate end box the power is taken by again a trailing cable to the machine.

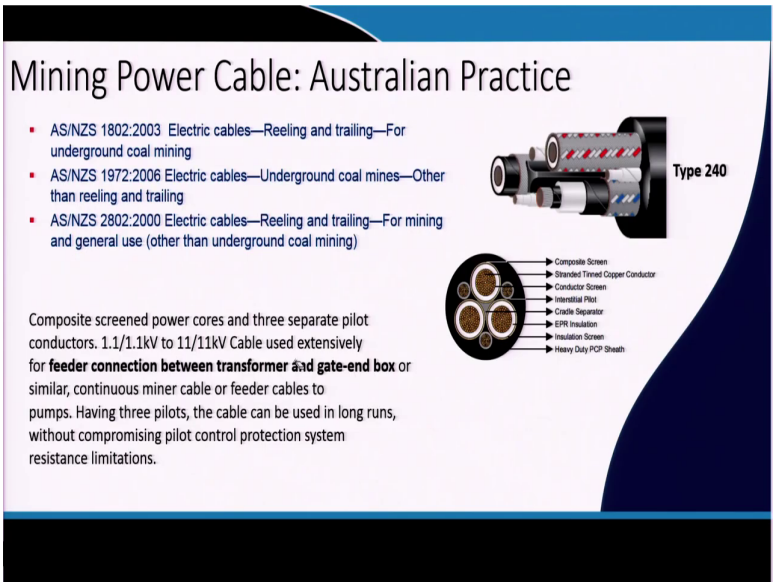
Now, this cable must be of a specially designed and approved type our DGMS you know about as a mining engineer our Coal Mining Regulations there which is an enter is in 1957 that coal mining regulation 1957 in there clause number 181 by 3, it gives that that what type of cable you can use and that approved type of cable it will have to go certain tests are done. There are routine tests there are your type tests and there are also optional tests.

After those things once it is there it will also follow the central electricity authority regulations of 2010 and then only this will be used. But while using the mining company they must maintain the standards given and those standards one is your IS-14494: 1998. Now, these standards allowing as there are different standards for different type of applications.

So, why I am telling you here is that whenever you study any underground mining machinery be very careful about that what is that approved type because if you do not do that there will be a violations of the standards. And, by god forbid if any accident takes place if you are not complying with the safety norms and all you will be at trouble.

So, that is why every mining engineer should respect the safety norms and provisions out of which there are number of I have given you here that IS-1540 1554, IS-9968, IS this 14494, IS-7098 – these are the standards which specifies that what type of cable you should use in underground mines.

(Refer Slide Time: 21:31)



And, also you can see their constructions of those cables exactly in Australia also every country has got their standards. As per the Australian Standards they have got this Type 240, Type 241, Type 245 different types of cables for different type of use for different type of machinery.

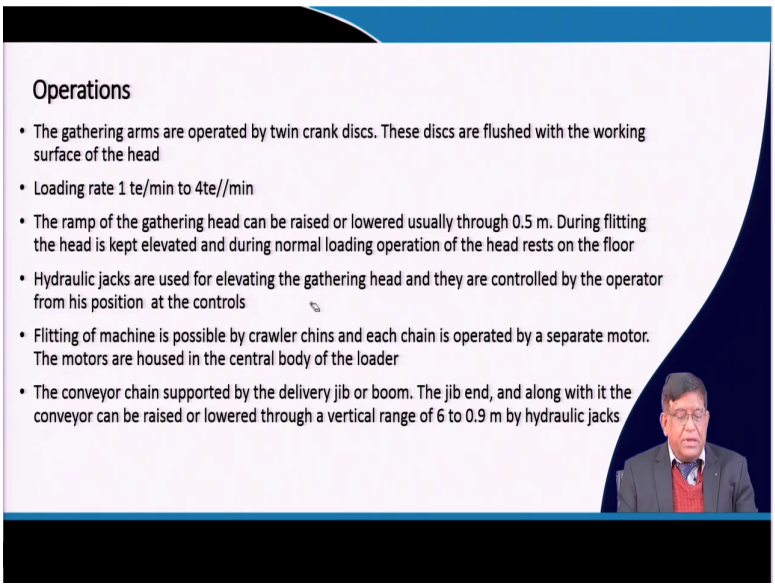
Now, if you see that cable which is being brought here this is called a trailing cable which is a flexible cable and that is constructions inside which we are having this course and then there would be a different type of insulation. So, that there is no insulation flames are there will be protections for the earthing and also for control. There are maybe 3 core, sometimes there are 5 core because there will be different purposes of this sending electricity.

So, this normally these 240 Type Australian cable you can see here that they have got a composite screen and inside that this is your insulations are there and this copper wires are

there and outside you can see a heavy duty PCB sheet is there. So, this exactly insulated sheet and cable.

So, normally no damage will take place, but still do damage take place and then that could be in underground mining you need to be very careful about it because if any flash or anything takes place because of this cable you may lead into a big trouble.

(Refer Slide Time: 22:56)

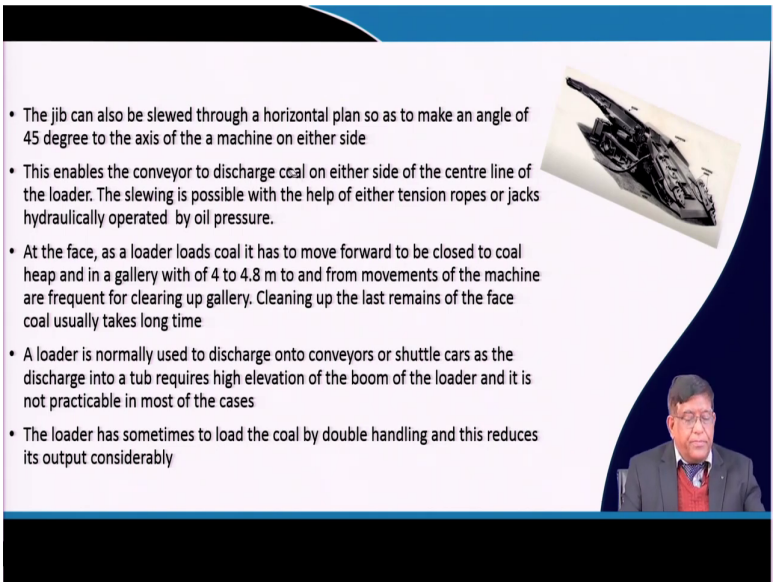


Now, this is a you can see now the operations this gathering arm loader operations. In the discussions we once again just tell you that is our that main that crank disc where these arms will be rotating like this, so that the material will be coming in front and then taking in the chain and then it will be taking.

So, there is a it can load at a router at a one tonne per minute it can do in a some bigger machines, it can do a 4 tonne per minute it can do it. And, that day the gathering head as I showed in the figure they can be raised or lowered also depending on the situations.

Then your the hydraulic jacks as if you see that the there will be the for raising and lowering of the your booms or the head, we are having hydraulic system. The machines to get that exactly to scoop the material, to push it over there, that is done by the crawler movement. And, then the conveyor belt that conveyor which is there that for the bulk material which is a chain conveyor which is there at the your gathering head as well as at the discharge boom.

(Refer Slide Time: 24:09)



So, now you are familiar with this gathering arm loader; this is we can sometimes you can see the jib also. This front portions this also can jib also can give a slewing motions like that so that the collections can be better ok. So, this loading and unloading, and then the operations

how you are giving, how much push you are giving this whole thing will be affecting the productivity of the system.

Now, the material that the exactly it is working that is your the gallery with your that only 4 to 4.8 metre and is a that is why the your production capacity is restricted you cannot make a more than that because you are at how much you can move and how much exactly it is the chain conveyor at what speed it will move; that means, your exactly how much rpm that sprocket can be given on that everything is related.

So, sometimes what happens this machines as you have seen at the discharge end at the discharge end here, some collecting machines will have to come and then only it will go. Sometimes it happens that this is exactly not properly organised so, they will be handling the material dump it over here again there will be that when the vehicle will come it will go and then put it over there. So, like that some rehandling operations also it is there.

(Refer Slide Time: 25:50)

So, and then as in the previous figure I have shown you can start getting the some of the specifications. Whenever you are studying a machine you should try to understand the specifications exactly how to have an idea of the size of it. So, this is one particular model that is 14BU27 is a model manufactured by Joy company which is now taken and marketed by Komatsu.

You can see that 36 tonne at that metric tonne per minute is its capacity and this conveyor on that that conveyor this inside conveyor you can see that this that width it is your 965 millimetre. And, is the loading arm you can see here this arm has got at least 1500 millimetre. So, one 1.5 meter only this much is that also this it can gives you how small and compact this machine is.

Now, to keep improving the productivity, now the modern developments have come. Lot of mechatronics involvement has been done and their continuous monitoring is introduced and they say a smart conveyor packages come and in which that whole operating parameter that is the tension of the chain, tension of the that is your what is the pressures of the fluid all this things can be centrally monitored by acquiring the data electronically.

Now, there is a trade that is your trade that particular that Joy and Komatsu they are using one drive attraction system called OptiDrive it is their patented method by which the transmissions can be done smoothly; that means, they are they are taking the electric motor then from the electric power, how exactly it is going to the motor and how it is operating the boom slewing and then the chain conveyor this depends on that after the control that they have given.

Now, there is a the control it is a; it is exactly need to see at what speed you will be working and then how you will be you are abusing or using properly the machine it depends on those controls. So, there you need to be very careful about it ok.

Now, this motors which are used they have got the lubrication system, but also the ventilation air that ventilation air is also going to cool it. Now, one thing is very important here to see that the these type of machines they need to be cooled by the ventilated air. So, that is why while designing you must see that there is a good parts that they are get circulated over the motor fringe.

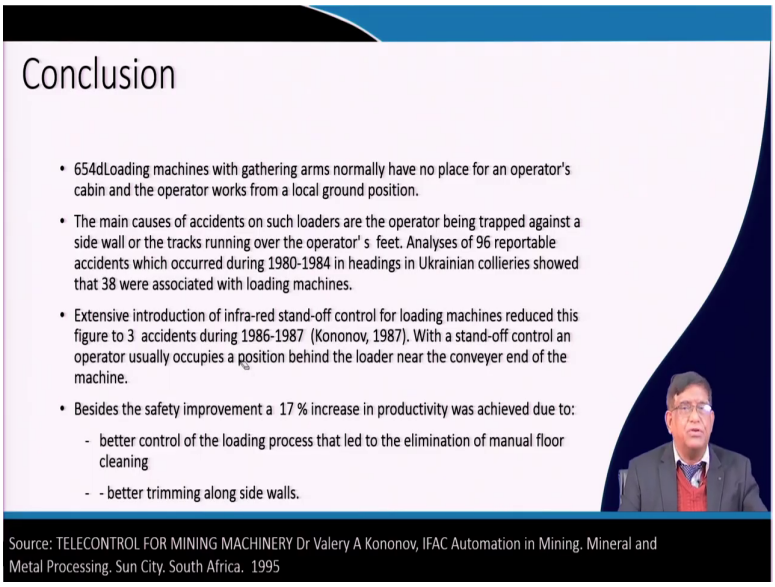
Now, this is sometimes that in some of the advanced machines when we use this dust separation for water it can be incorporated as well. So, now with this machine sometimes we can add other features like say for the roof support here you can see or for the roof bolting that is separate a drill machines the auger type it will put and then build a roof. So, that can be combined with this machine so that the utility of this machine increases.

(Refer Slide Time: 29:22)

Now, coming to see that the how it looked like your this figure you can see that this is a how the arms it is a robust steel structures made and now, it has been a part of a museum. This is another thing we appreciate that some of the in abroad they maintain a very good record of the how technology developed and the museum. Unfortunately, here in our country still we do not have a proper mining museum.

So, these some of these machines need to be known by you as an academic exercise to see how the development has taken place and how new innovations and creativity has done. So, make it a habit that there is some small some sort of museum is there at CMPDI Ranchi, but that is not enough. So, I request you to go through the internet web where you can see some of the old.

(Refer Slide Time: 30:39)



So, this is a from the archives of some other mine, so, you can get these things. I have given in the reference, please go through this and see how the mining industry got developed. So, to conclude here one thing is very important that the loading machines they as because there is no operators cabin and it will have to work from the ground positions he will have to move in between when this is there.

Now, that it could be a leading to some serious accident and there had been cases where the operator had to they succumbed even death because of this they get stuck between the wall and the machines. And, then there are certain operational problems because that cable will have to be handled in such a way that the cable is not overridden by the crawler.

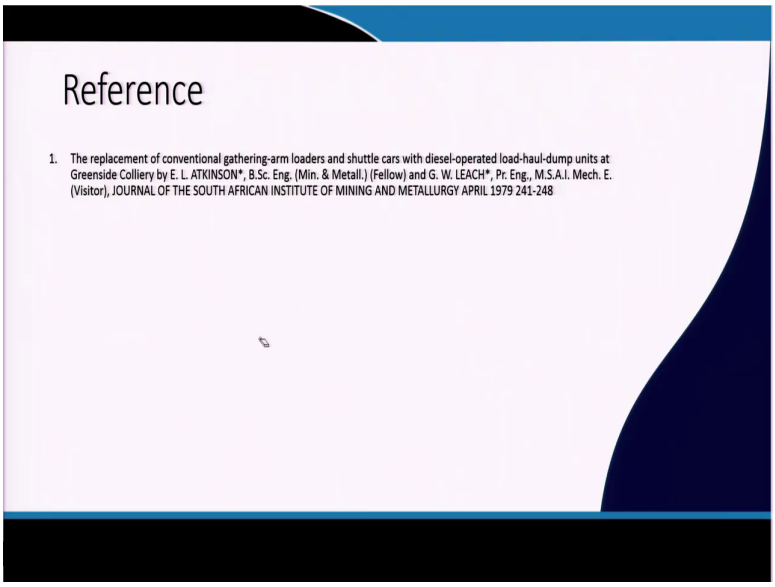
So, this and then the most important is this is working in a 4 point 4 to 4.8 metre 5 metre gallery in which exactly in a compact there is no enough weight, there is no enough light, they

are working with the whatever the mine illuminations and on their cap lamp. So, that is why they in a conclusion side say that you need to follow the safety norms whenever you are using any underground mining machinery and then when you are operating with it.

So, as a maintenance part, it will be very regularly you will have to do the preventive maintenance, so that the surrounding activities, so that these operations can be smooth that inspecting the where worn out parts and wherever the replacements. Your replacements will be the chain and that there are wear and tear and the chain links may get broken and sometimes some flights may be going. If you do not do that maintenance, what will happen? The productivity will be going down.

So, you will have to control the loading machines through in a such a way that there is no accident and the productivity increases. So, for that these with a remote type of manual control it is useful and this by introducing some automated control you can improve the safety as well as you can improve the productivity.

(Refer Slide Time: 33:12)



So, I hope you will be studying this machines and collect the relevant informations and think of what type of new innovations can be incorporated and then the your productivity as well as the life of this machines can be enhanced. So, in a nutshell I have given you about what is a gathering arm loader. Mind it; it was very much used in the 60s, 70s, 80s of the bygone century.

Today, there are advanced machines and there are advanced systems, but for going to learn about that please go through the simple machines maybe some of the articles you may find in some of this mining journals in the 70s and 80s where a lot of study regarding that safety regarding which control were there.

So, with this I thank you very much. Our next class we will be coming out to discuss about some more loaders in underground coal mining.

Thank you.