Mining Machinery
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Module - 06
Lecture - 28
Underground Mining Machinery Loaders:
Load Haul Dump (LHD) Loader

Welcome, we are discussing Mining Machinery. So, far you have studied, you are studying now the Loaders, that loading machines in underground mining, we have discussed gathering arm loader, we have discussed the rocker shovel, we have discussed the side discharge loader, today, we will be discussing about another machine that is Load Haul Dumper or that sometimes called LHD load haul dump loader.

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This is a machine which is very very useful machine that for increasing the productivity of our underground coal mining. This LHD, it has been working in number of underground coal mine where there is a bord and pillar method of mining. Now, mostly this machine was used. This is in underground coal mine as a crawler mounted machine and this is used to load on your mined car or mined truck.

This machine is again it can be diesel operated, it can be electrical operated, there are various manufacturers are there in India, you have got TRF, we have got this BEML and many other companies, they also assemble. There are foreign machines are also available.

Now, we need to study about that how these machines can be selected, how these machines can be operated, what are its various features that will be considered while designing a mine phase. So, let us see what is that our objective is to explain the operation, maintenance and application of this machine.

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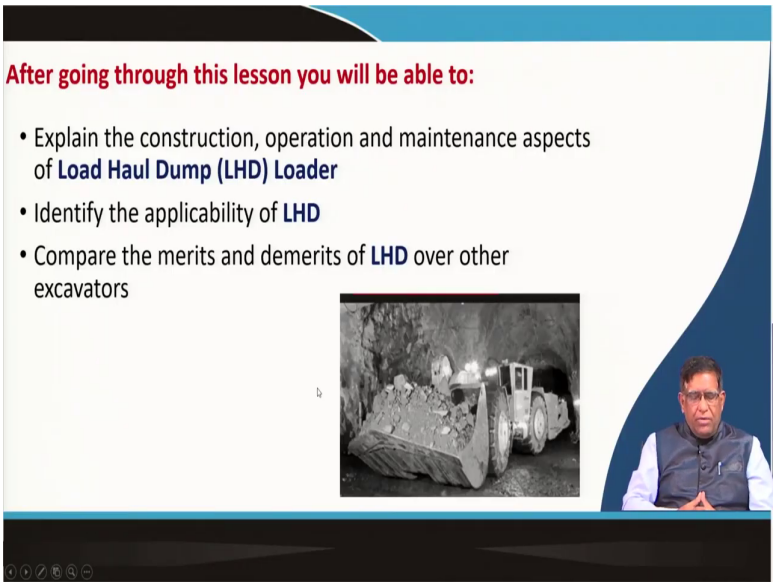

Now, after this discussion's, you will be able to really tell that what are the components, what makes what is a how this machine has been designed to do our mining job. So, it is a you can see this figure that is your material is collected on a front bucket. So, this here you can see that front bucket, there is no teeth unlike your front end loader in case of your open cast mines you have seen.

Now, this machines you can see here it is a tire mounted machine, this is working in some hard rock mining.

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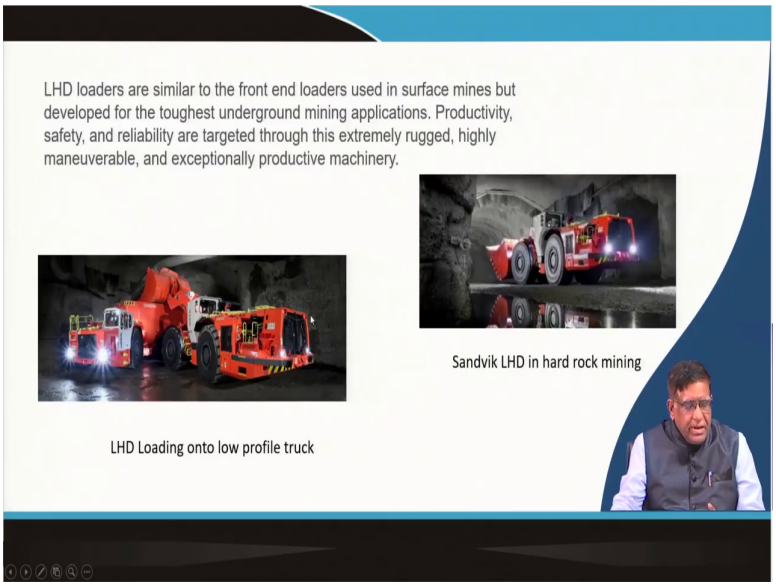

So, in this tire mounted machines as a Sandvik. Sandvik Asia they manufactured and such machines are working number of mines across the world. Now, these are front end loaders in surface mining they use mainly for that when you are having a temporary loading or temporary dumping inside the pit, then the material is collected from there and then, it load them and that is it haul the load for certain distance.

As it is the name is load, haul and dumping that means, it will be excavating or scooping getting taking the material onto the bucket, then it will travel with the material to a certain distance and then, it will be loading onto a truck. As you can see in this figure, they are the called low profile dumper.

This low profile dumper that is used in an underground mines and they are being loaded, they have this dumper come up to a certain point and this machine goes up to the phase where the

blasted materials are there. So, that say this is the way how it works. And basically, what is to be studied about that how you can improve the productivity that means, how you can enhance the capacity utilization of this machine and then, for that, the, you will have to exactly manage the timings in the system.

So, that, there is no delay if arrival of the dump truck or the other transporting machines whatever is there, it should be available and then, the distance through which this machines will be moving is such that they say the material which is get ready at the phase should be able to put it over there.

The productivity will be mainly that is the material should not travel that the machine should not travel with under loaded that is it should get its bucket full of load and if possible wherever there is a whether we are making it with a heap capacity or with a stack capacity that will have to be seen. And then, its reliability is a very very important. The reliability means, when it is exactly demanded at that time it should be available and it should not fail in between.

Now, that the reliability will be depending on how these machines can come to a standstill, it is unable to work that means, this machine is comprising of number of sub-assemblies and number of components. Now, these components are joined together to do the operation. So, while they are in connected that is if one goes wrong, the other cannot work.

So, to be reliable that the whole totality must be there so, which is having how much vulnerable, which can cause problem and accordingly we will have to keep upkeepment of this equipment. So, that you will have to maintain it to its maximum availability so that your productivity increases and reliability is there, it should not fail without giving any signal and whenever there is a signal, it should be caught and then the required maintenance work will have to be done.

So, the other thing is there, these machines will have to work in an underground in a constrained space. Now, why the productivity may go down? Because if this machine cannot

take a turn, it is negotiating over there while dressing the material in front of it so that it can get it fully loaded into the bucket. The machine must be able to maneuver between that.

And sometimes when from one pillar to the another pillar or where they are taking there is cross a making a turn, at that time, it will have to exactly it should be capable of and there is a very less space. So, that is why this machine has been designed as a articulated design.

You can see here that the front portion and the rear portions, they are connected by a joint and they have got a separate steering facilities by which exactly it can be negotiating sharp turn also. So, those aspects of these machines need to be observed, studied and then, need to be deployed and then, we should be able to calculate what will be the production, capacity of such machines and what are the different types of system availability will be affecting it.

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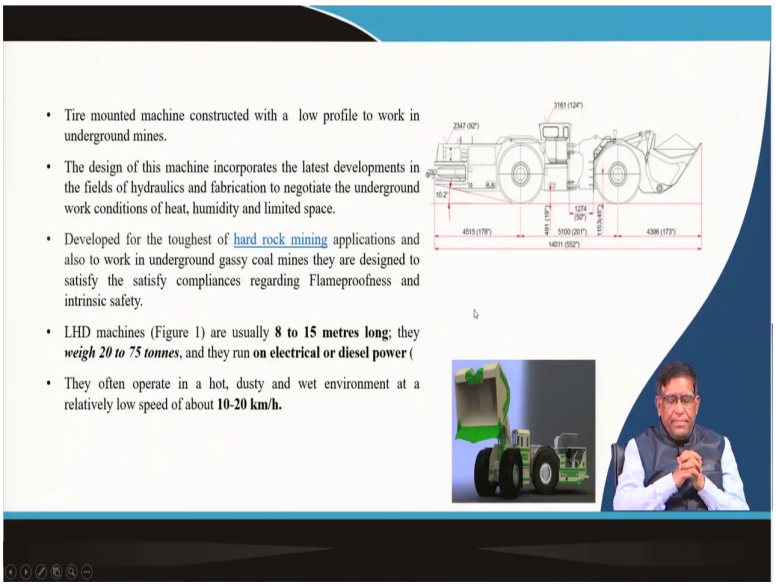

So, you can see here as the machine, when it is said an articulated, you have got this as a front part and this is rear part, these two part they get connected with a that is your, so that we can easily move around and then take a turn with this. So, this machine can be a tire mounted machine and it is exactly work, it is a design to work at a low profile that center of gravity is long below and there is a good stability of this machine.

And particularly, this drive is a it is a very good machine which deploys the hydrostatic drive principle, the power transmissions whether you are using a diesel engine from the diesel, it is exactly transmitted to the to give the final drive to the wheel. So, they use these hydrostatic transmissions and also these are working in a very tough conditions.

But there will be very it could be very high humidity, there could be lot of dusts. Under that environment, these machines are designed in such a way that these all the areas are properly sealed so that dust cannot engage and it cannot affect the things, but still you need to keep monitoring the oil levels and then the oil contaminations, so that if anything is wrong, you need to timely replace it.

Now, if this machine is a electrically powered, then there will be your motor will be installed on that machines and a trailing cable will be giving the power to this just like you have studied in SDL's. So, then what will be most important thing is if it is to work in underground gassy coal mine, you will have to have the flame proof enclosures.

And the circuits will have to be intrinsically safe that means, if there is any the switch made on-off, there should not be any spark generated that it can explode the air mitten mixers which may be available in an underground gassy coal mine that part of care should be taken.

And then, this machine it is exactly the say length is 8 to 5; 15 meter. You can see here about 14 meter it is there. So, this vary, it could be 8 to 15 meter and then, this weight of the machine could be a 20 to 75 ton and these machines it is working in that hot dusty environment and its speed is around 10 to 20 kilometer per hour. If you know the capacity, if

you know the speed and then, you can find out how much time it can exactly carry and evacuate the material from the phase to the next transporting systems.

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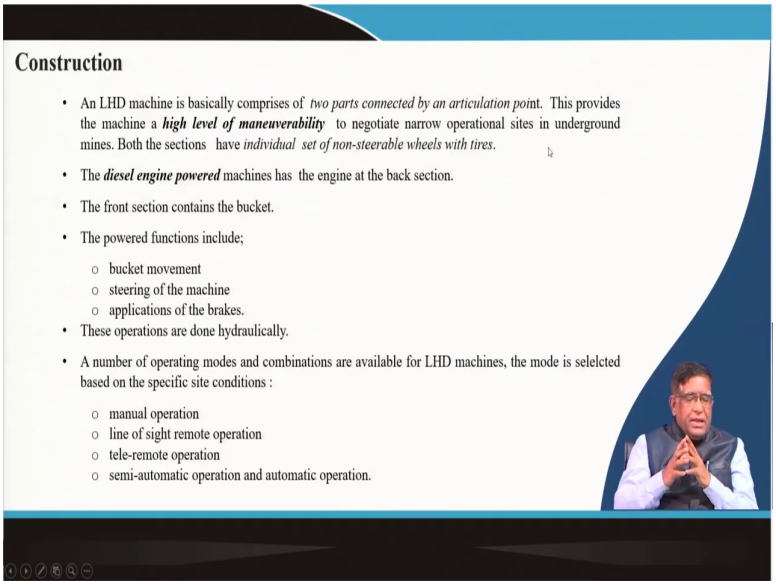

So, now coming to the construction wise, you have seen the photograph here of this machine. So, this is basically it has got this two parts, the front part and the rear part, they are connected at an articulation point so that this, the there is a good maneuverability because if the front part is connected and in between so, keeping one fixed, the other can take a turn and or distance keeping this is there, it can get a turn.

So, because of this turning, if that is called your articulations and then, whenever there is a sharp turning is to be taken, we can steer both and can negotiate these ends. So, this because of their individual set of non-steerable wheels with tires that is there and that is how exactly the manipulation in of the machine maneuvering in a very constrained space is carried out and

this is exactly a diesel powered machines and while you are using the diesel engines, you will have to see that exhaust norms and all.

It is normally that is the standard, you know standard 3, 4 or that will have to be maintained so that the exhaust gases it does not affect the underground atmosphere. Then, the front sections will be having the bucket and the powered functions by which that exactly the operation control will be for the bucket movement. Bucket will have to be scooped, then it will have to take a raise and then, it will have to dump.

So, these bucket operations and also the machine will have to be steered for that also you need to give a power functions. And whenever it is they are working on a gradient and all, you will have to apply break or in the moving that is a break will have to be there. So, these are the controls for running that machine and all these operations these are done hydraulically.

Then, the number of operating modes of these machines that is your it could be a manual operation is possible, there is a the your you can use easily with the by a persons will be working this that your joysticks or the operating handle or it can be done from a remote locations by having a console.

He can operate the machines by standing away from the equipment. And also, there is a tele remote control is possible keeping a view of this. So, depending on sometimes you are working such machines in a very narrow stream and in that exactly, you do not go or a person do not go along with the machines, he can work from a distance over here.

And then, there is a of course, nowadays this automation is coming these machines can be made subject to the automated operations, then a man-less operation in the mine could be possible by these machines.

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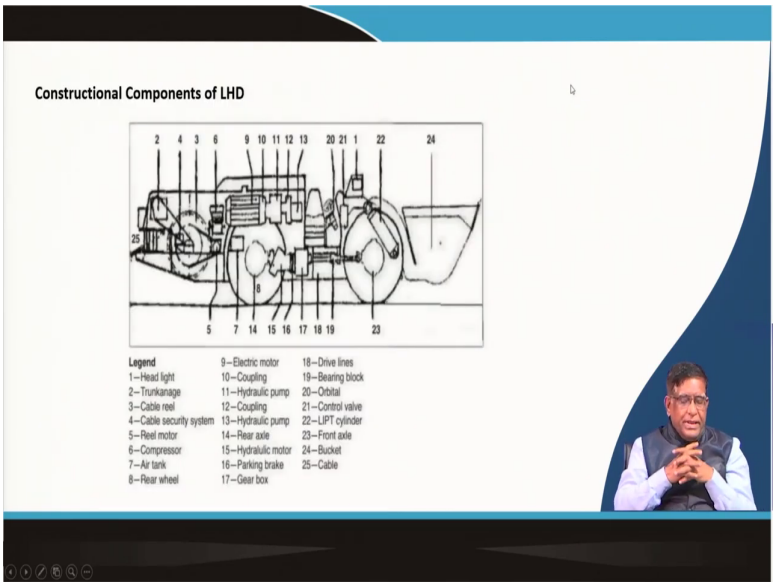

So, you can see that construction component wise, you can see here that is for the safety and all, you will have to have a proper lighting systems over there, a headlight is given at the front and then, there is a your turn cases are there so, from where you will be; you will be having this portions, this cable reel that is this electrically operated, if this is a drive is given by electrical, then you will be having a cable reel over here that power cable trailing cable will be coming.

And this will exactly operated by its tensions. So, that is when the cable is loose, it will automatically rotate and then, the cable will be always kept at a particular tensions. Then, there will be a cable security systems that cable should not entangle with others because that cable if it gets some cut or there will be a problem so, the cable observations, there will be there.

Then, the cable reel will be driven by the reel motor. In the machines, there is a compressor for the power motions. There is a air tank all the, whistle siren etcetera are given with that. It has got this rear wheel and then, there are electric motors that for different power functions it is given. So, this their motor is coupled with a gearbox and then, there is a hydraulic pump is there for all the your that is your oil to be pumped to the hose pipes through this.

And then, this hydraulic pump, they give this there is a rear axle is there and there is a your hydraulic motor, which will be giving the drive to the wheels. So, that these wheels are driven hydraulically and then, there are brakes, this is a parking brakes which will be exactly whenever the machine is not working, if it is that brake will get automatically applied so that when it is in the on positions that parking brake will get released.

So, this is a for driving that there is a gearbox is there. For that to transmit the power to the drive units that the drive lines which will be giving to the your bearing block. So, you can in this this block and there we have got this orbital and then the control valves are placed over here where the operators will be controlling all these things.

So, this this is the way, we are having these machines and the different components, the main bucket which is there this bucket can be raised and lowered with this lift cylinder which is there and then, your material can be that say whether you are pushing with the taking the propulsion of the machines, we can load the bucket and then, we can carry it and then, for dumping it.

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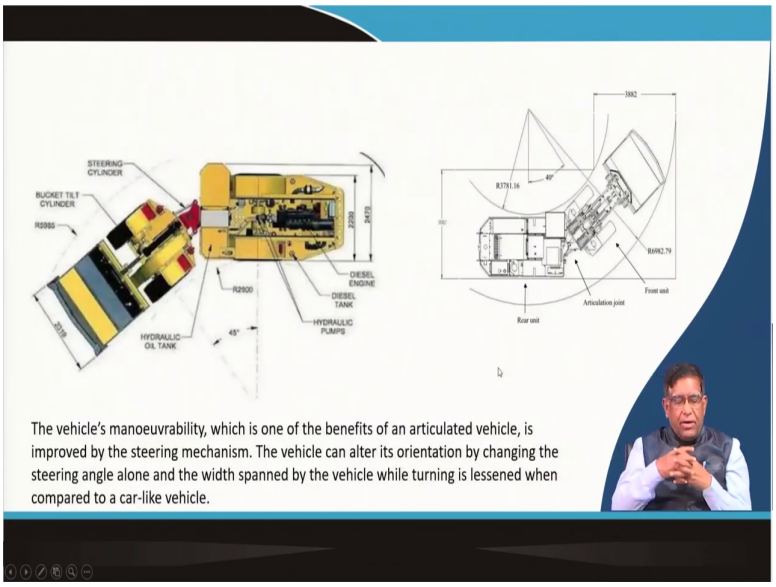

Now, you can see here the manoeuvrability that is to negotiating in the curve always is possible because of these articulations. There is a steering cylinder by putting pushing this out, you can make the things exactly keeping this one fix, you can take a turnover here.

So, the running of these machines, you can see here in this view as a top view it is shown, how the diesel engine, diesel tank and the hydraulic pumps are there and then, there is this cylinder and there is a hydraulic oil tanks are all kept over here. So, this the bucket will be tilted with the help of this. So, this is the way how it will be working and taking negotiating in the turns.

So, the vehicle manoeuvrability which is the one of the benefits of the articulated vehicle is improved by the steering mechanism. So, normally, by your that say negotiation of the curve, this comes that is your this steering cylinder, it works. So, the vehicle can alter its orientation

by changing the steering angle along with the width spanned by the vehicle while turning its lessened when compared to the car-like vehicle.

So, that means, this your machine is not similar to our car. In your car, we are having the wheels which are steered, but here that steering is a different, that is your wheel they are all driven over there, but they are pushed by another steering cylinder over here, you can just observe the difference of this machine in comparison to with the other car which we normally have that is why the operators they need to be properly trained to do it over here.

So, that is that exactly the whole productivity depends on the skill of the operator. If the operator is not skill, then while negotiating such type of curves and all, he will take some time, but with training, the people normally learn the job.

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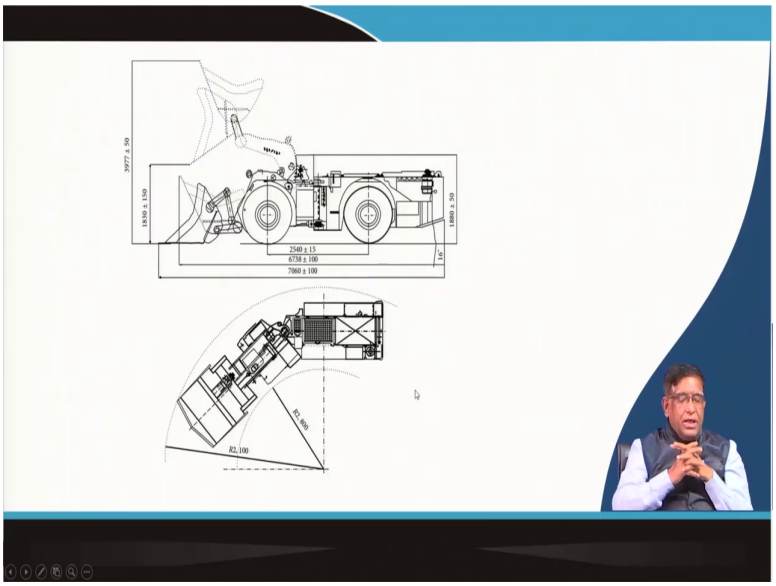

So, you can see here in this diagram that is how the machine that is your the bucket which is getting load and then, the different motions up to which that is your operating range. And then the how the lever that boom on, which this bucket is connected is also controlled by the different hydraulic cylinders with the boom with that positions, you manage the machine stations and then, when it is putting onto this form, it can load the material on the truck.

So, you are carrying it over here, while carrying the material, we can just keep the bucket in the vertical positions, now the bucket get tilted for the dumping positions. So, these operations are all controlled by hydraulic cylinders which the operators do from which joysticks at the operators seat.

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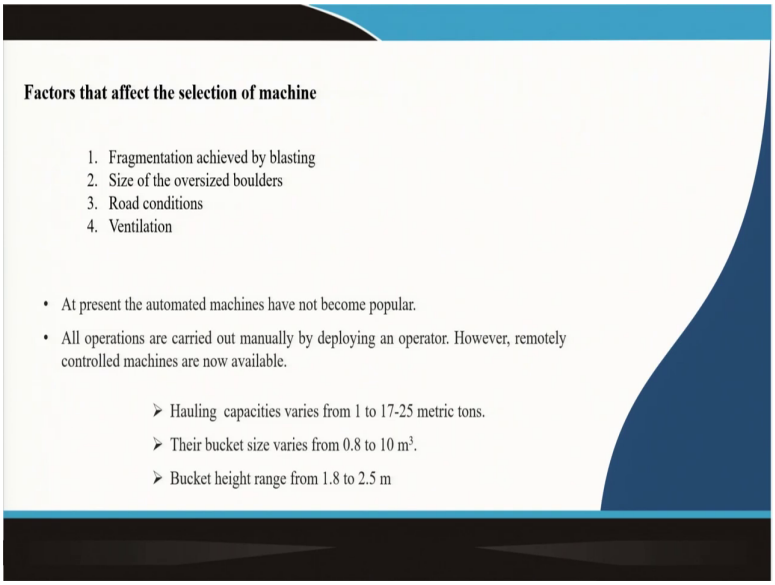

So, what is exactly the that its productivity will be affected by what? It is by the fragmentation of the blasting that is in underground, when you will be doing the blasting's, if

there is a very big boulders and all this comes, then it will be very difficult. So, the fragmentation will have to be proper and then, they say it will be giving its pushing actions by its move.

And with the hydraulic push that is why, it can it is not a cutting machine or a it is not a digging machine, it will be just taking the loose material on it and they say if your oversized boulders come, then just operator need to manage somehow to put it inside the bucket which may take time and if the time is taken, cycle time increases, the productivity decreases.

And then the other thing is that the machine is working in an underground road gallery, if in a coal mine, the floor it can be your sandstone or shelly sandstone or sometimes, it will be a floor wall so, maybe a coal in case of very thick seems, but if it is a shell, the main problem is in underground coal mine is there will be seepage and then, there will be water coming.

With water and shell, you all know that the shell swell and then, when the machine moves, then they break and then there will be lot of undulations and holes will be there. So, in that type of situations, this type of machines to move it will be very difficult and that the road conditions can exactly reduce the travelling speed will go down and the cycle time will increase, and this productivity will decrease. Then, the other thing is there, when this machine is working, the ventilation will have to be proper.

If you are working with a diesel operated machine, then there is a specification that is a how the your auxiliary booster ventilations will have to be there where this machine is working. If that when that is your auxiliary or that booster ventilation is not prepared that by this EMS norms, you may not be able to operate the machine over there.

So, depending on the gassiness of the mine that ventilation requirement may be different and that one will have to be looked into while you are going to select or prescribe this machine for a mine. Now, these automations that is your it has not yet come, we are in our country, we are all working with this manually operated machines. Some remotely controlled manual

operations are there where because of the accessibility, but this area is remain with your innovations and some more work you can do it.

But what immediately you can do is to how to exactly identify the parameters by which its productivity is affected. Just there will be certain qualitative and certain quantitative parameter. As a qualitative parameter, I have told that operators skill that you cannot exactly quantify, but thing is that if you find out that what are the basic operations it will have to do that means, first is it will have to do a dressing operations in this that exactly with the bucket, you will have to adjust the things material.

So, that it will get properly loaded so, that operations which will be depending on the size of the gallery and then, that is with the height and the dimensions there that machines will have to give this movement. So, you will have to study the work site there and then, you will have to identify the parameter.

Now, that is your how you can quantify the hourly productivity considering all this where the there could be a loss of time. So, that is where exactly the industrial engineers do the job by work and motion study.

So, you will have to study a site, then you will find that during the that is if there is a more water seepage or water that is in a watery seam, this machine may behave differently where in a dry seam, it may behave differently. Then, the depending on your the underground blasting quality, it will be affecting.

So, considering those things, your you will have to find out that whether exactly these machines can be a subject of complete automation, this need to be studied. Then another study, that you can find some of these Chinese have studied, that exactly how to design the curvature on which the road will be moving?

And then, wherever there we are having that from going from one block to that taking a 90 degree angle, at that time exactly. So, that it should not hit or it should not affect the size of

the pillar. So, that your with the mining conditions and these machines dimensions, you will have to make a little bit of adjustment.

Then, this is your remote control machines when you are working, one thing is there, the noise which is generated during this machine operations, it may affect the hearing of the operator. So, that is why, there should be adequate measure to be taken so that it does not become that is your whenever the noise the porter will have to take the proper PPE for working with this machine.

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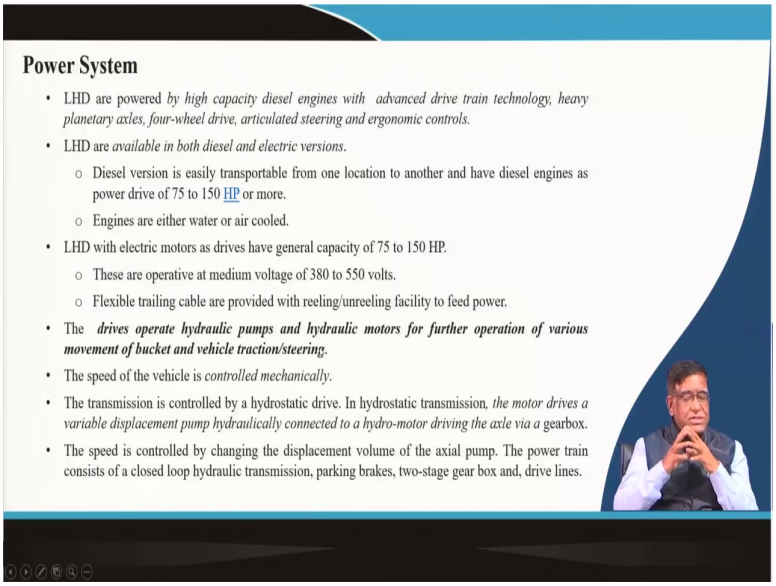

Now, it can its capacity as it is there that depending on the size of the machine, size of the gallery, there could be a different size of the bucket and then, they can work. But the power system as you can see here, it is by high capacity diesel engine or by electrical, it is available in both the versions that engine capacity it can go up to 150 HP.

Then, there is also there are that voltage that what voltage you will be getting that means, where the transformer will be there in case of electrical machine electrical operations that where your gate end box will be there and from there, the operations will be restricted by the excess of the cable and how the turning can be negotiated.

And there will be the main function of the that equipment will be depending on the hydraulic systems. So, that the pump which is there will have to be properly that is maintained so that it does not fail during the operations. Then, your, the speed mechanical control is there, your operator can control the speed, he can apply the brake.

So, these are the drive of the machines. So, as we said in the initial study that you will have to identify what are the functional component that is powered functions are there so, the power function is the bucket movement, the propulsion movement, the steering movement so, this wherever the powered function is there, how the power is transmitted from the source that means, from the diesel engines, it will be given to the gearbox and then, to get that thing you will have to have a coupling.

And then, there will be the power transmissions lines up to giving to the final drive and then, where the brake locations will be there, so that the component in the machines breaking down, you can find out that how it will be working.

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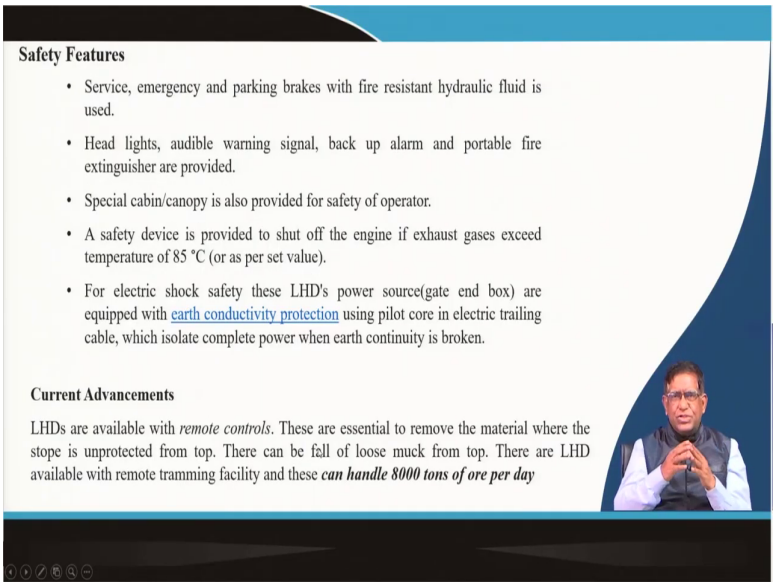

And then, that you need to keep a record of which component is failing how much, then this is your then if there is a frequent failure, you will have to try to find out that what is the mean time between two failures or how much time exactly mean time to take it to repair, those are taken and then, you identify which are the critical components they require to be maintained well.

And then, as a manager of the mine you will be finding what is the economics of deploying these machines. A study can be taken out and that that there exactly what will be the manpower required for operating with these machines, besides that your driver or the operator of the machine will have to have a standby or also that what type of maintenance crew will be required, there will be maintenance mechanical maintenance, there will be electrical maintenance.

So, and then also the economics will be depending on if that what type of spare parts need to be frequently changed. So, those are the things which you study in your means engineering and managements, in this industrial engineering paper that how will you maintain the inventory for these machines and that could be again studied it could be a simple mini-projects for you to find out the economics of deploying a that your load haul dump.

Now, there are different safety features which is another important things that it has the brakes, it has got the lights, it has got the warning systems and then, it has got the other inherent system wherever there is an electric motors and all, it will have to have the overload protections, over current protections that is and then, it will have to see that this is if you are using a three-phase motor.

It should not get single phasing because if the single phasing takes place, then there will be a problem even sometimes there is a that a persons may get even shocked. And so, those type of things that is your you do not get an electric shock and then, the cable which is there if it get a cut, then there will be a flash over which can be again a problematic.

And then, you need to be doubly sure that there is no spark and if it is a gassy underground gassy mines, you will have to follow all the that is your DCMS rules and regulations for this. These are all stipulated. I wish that when you will be studying your the safety and legislation at that time, you find out what are the special statutory requirements in deploying these machines.

So, now there is a modern things are it is a very big machines are coming in for working in a (Refer Time: 31:13) and also there is a remote control is coming, automations and then there is a data diagnostics are done that means, if there is any problem is there, the warning system is proper.

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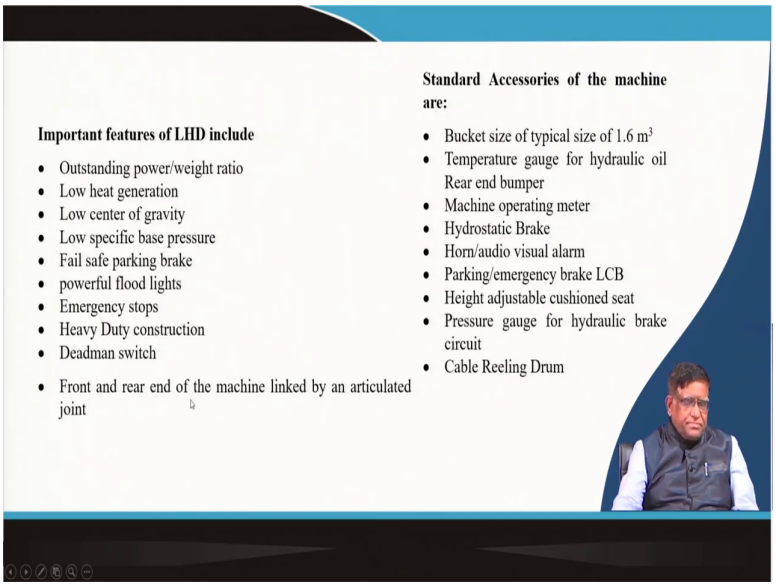

So, there are many features are there particularly, it is an outstanding power to weight ratio, whenever you are going to select a machines this is a parameter you need to find out that is it is a what is the install power and what is the total weight that ratio exactly has an impact on your operating cost.

Then, there should not be generating heat because in underground mines, your air that ventilation air is limited. If the machine operation is generating more heat, then you will be requiring more air there and then, it should be having a lower center of gravity. So, that this stability is maintained, it will be a fail-safe parking; parking brake should be there. the good flight light so, that illumination level is good.

And you should be able to stop if it is a, if the operator is not there and that is sometimes it is called a Deadman switch. You might have heard that Deadman switch is that exactly if the machine is the operator is not there at a certain time, it will have to get automatically.

This Deadman switch concept is there very much in underground mining if any accident takes place and that operator is unconscious, he cannot do the things at that time, the machines will have to take care of its control by itself and that is the switch by which exactly the machine will be switch off.

If the that where that operator should be there alert all the time, those things if it is found that it is not alert or if this is not working, at that time automatically a safety system will be working that is called your Deadman switch which is there in SDL, this is there in LSD's.

Then, there will be a heavy-duty construction so that it can withstand that robust and very rugged conditions in working under that. Then, front end and rear end of the machines linked with an articulated joint. These are the special features. And some of the accessories which will be there as a say pressure goals for hydraulic, then your cable reel drum, then some of the indications it will be there.

So, you will have to monitor the oil level, oil temperatures and in general, you need to get the upkeepment, but you must always make a habit whenever you go to mine, try to see the log book of the machine, how the operators and the engineers are doing. And the most important thing is that whatever the logging data is generated, how these data are analyzed and periodically report is generated.

In our mines, many a time data are generated and that they are not done very meticulously, and the data is never analyzed to take a future decision. So, the new generation engineer, you will have to do that.

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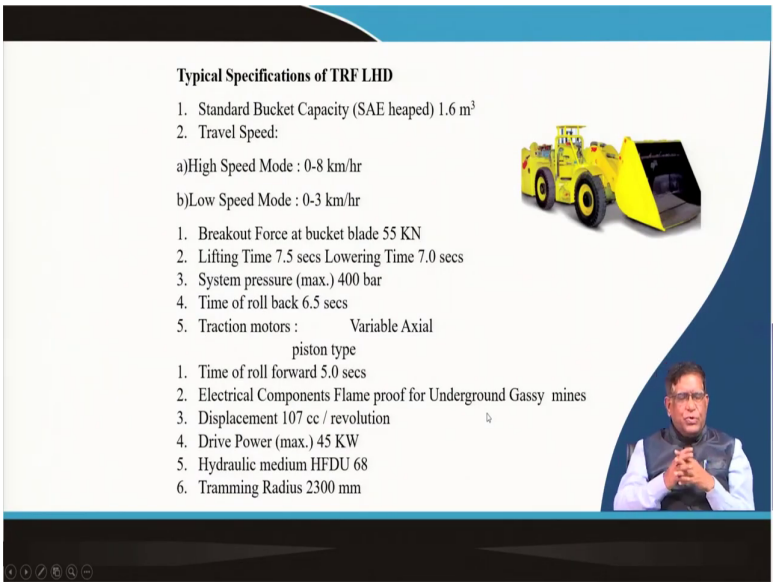

And this here, you can find out in the net, number of different manufacturers like Sandvik. Sandvik has got, TRF has got and also this our there may be many Chinese machines are also available in India, get and read the specifications and see that how these machines can be made useful.

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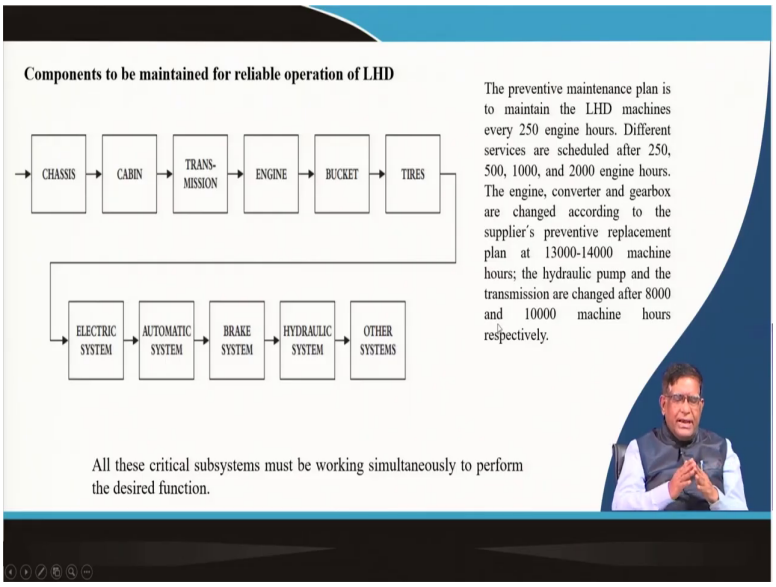

But you will be knowing that the component wise, in the machines has got the chassis, cabin, transmission, engine, bucket, then tires, then electrical system, automatic system, brake system, hydraulic system and other system. So, each of the systems reliability you can study that could be another innovative work you can do it over there, how exactly you can store the data, you will have to have.

Another things you must know that all the modern machinery, they have got a lot of mechatronics applications that means there will be electronic sensors for controlling the mechanical activities and those data can be there put inside that that is exactly the data is collected and stored over there, periodically, you can retrieve it over there and then you can analyze and do and find out where is the problem of this machine.

So, basically there are the services or maintenance are done as a 250 hour, 500 hours, 1000 hour or 2000 engine hours maintenance. So, that is after each of the things, when your oil will have to be replaced, when you are a particular tightening, it will have to be checked and done these are given as a checklist.

And those checklist maintenance or it is called the planned preventive maintenance on these machines will have to be carried out and then, there is a specifications that after what time this whole machine need to be overhauled. There is overhauling and measure repair also is a schedule activities by which you can re-juvenilize the old machines.

So, it is a things you can find out, there is a if you go to the industry, there may be a some LHD's or SDL's are working now 15, 20, 30 years, it may. So, happen, but thing is that sometimes it is systematically, you need to study what is the remaining life of different components that is another study which is can useful.

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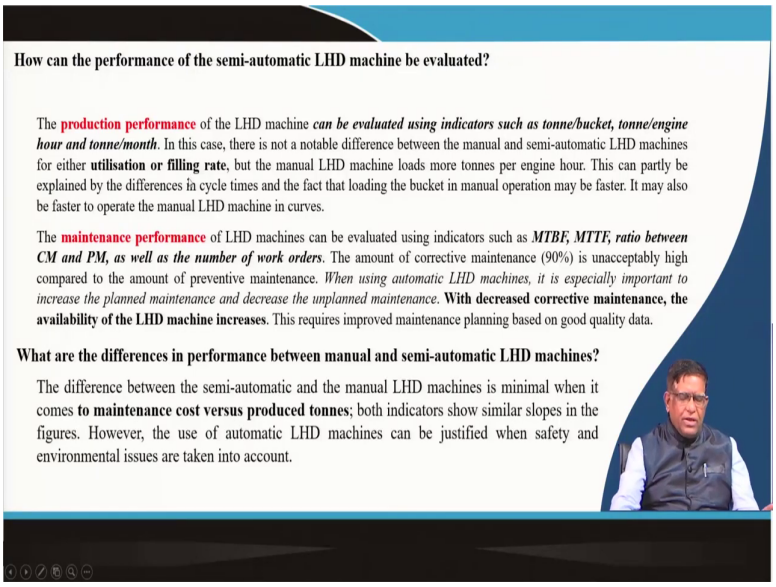

So, that is your main things, you try to find out, how can the performance of the semi-automatic LHD machines be evaluated that is a performance evaluation is a most important thing that mining engineers must do and accordingly, because if a low performing machines with a high capital investments if you keep it over there, the mining economics will be badly affected.

Then, also you try to find out what are the differences in performance between the manual and semi-automatic LHD's so that whether you will be investing in automatic LHD or you will be doing a semi-automatic that type of decisions you can take it. So, these are that your production performance and maintenance performance that is your we say that as a KPI, what is the key performance indicator?

You will have to identify those indicator which is nothing, but hour or ton per month, how much ton per bucket it is coming, how much ton per engine like that you will have to take out an indicating parameter and then, you keep on see whether your operation is improving from the last month or getting down in the last month that type of periodic things will have to be there.

Similarly, these maintenance performance indicator are your mean time between failure, mean time to repair not this is not MTTF, it is MTTR. Then, ratio between the your corrective maintenance and preventive maintenance. If you do not do many preventive maintenance, there may be more corrective maintenance required. So, those type of parameters need to be find it out ok.

So, you can do this whenever you are going to use these machines, develop a users plan that is how exactly your everything should be in a that is your scheduled, maintenance with a responsibility assigned to a particular people and for that those people and then who will be working in the field should be properly trained and then only the systems will be going to give you the best out of it. So, that is how your these machines will be working.

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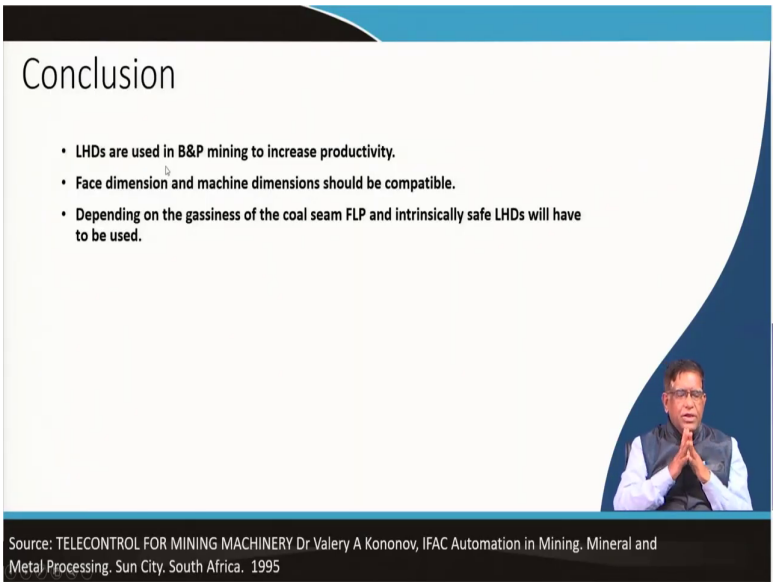

So, LHD's are used in bord and pillar mining and their increased productivity, however, there is a need for its proper technology management and for that proper technology management, you will have to know the construction and operation of these machines and try to see that in which way to be planned, where exactly your penny may get wasted. So, that is most important thing that.

And selecting the right machine for the right job is very important thing that is why the your face dimension and the machine dimensions, their compatibility need to be checked and then, if your binding condition is a very gassy mines, then you will have to take certain precautions, do not do any mistake while doing that.

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There are lot of information's available in the net, you will have to see, and I suggest you see some of the operators, the sensor operation of this video operational video. Nowadays, it is available in YouTube and then of course, we will be putting your as you can see that this whole course can be available in a model, in the model you may get some of the video cassettes, just watch that and learn these machines.

Thank you very much.