Mining Machinery
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Module - 05
Lecture - 21
Surface Mining Machinery:
Machinery for Cyclic Excavation: Dragline

We will come back to our today's lecture on Mining Machinery. We have been discussing the Surface Mining Machinery, on that we are discussing on Machinery for Cyclic Excavation. So, far we have discussed about electric rope shovel, hydraulic shovel, we have also discussed about the that how these machines are performing in the field.

And today I will be introducing to you about another machine which is very much used that is drag line. It is a machine very used for overburden removal in coal mining and India is also deploying this machine from 1960s. So, it is a very important machine for coal mining in India.

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So, as you can see in this photographs this machine is a very huge machine and in the world I think the largest machine ever built is the Big Muskie that was operating in during 1969 to 1999 that 30 years of its life and then this got dismantled or that out of service after that.

This is one of the largest machine that worked in surface mines and today our objective is to introduce this machine to you. Particularly, what is its construction, operation and how it is maintained. So, this is a as you see this machine is such a big. You can think of it will weight is a 13500 metric ton such a heavy machine which has got a 68 meter height almost a 30 storey building.

Then it is also the width of the machine is 46 meter, 50 meter; you can imagine your 100 meter track in your field then from there you can imagine that how width wide this one machine is. And then this empty bucket such a huge bucket it is weight itself is 210 ton and it

can carry with a material with material it will carry about 295 ton with the material of your say about 2.24 or 2.5 density.

So, this machine it is again is a electrically operated machine. You can consider that or you can imagine the power of this machine because it is working at 13800 volt 13.8 kilovolt it is working and then a 5 inch diameter of cable it takes power to this machine and it has got 18750 kilowatt motor in this machine for various functions.

And there are about 10 466 kilowatt dc electric motors. So, this is also having a lot of hydraulic functions. So, that is why electro hydraulic functions its control it was a such a huge machine.

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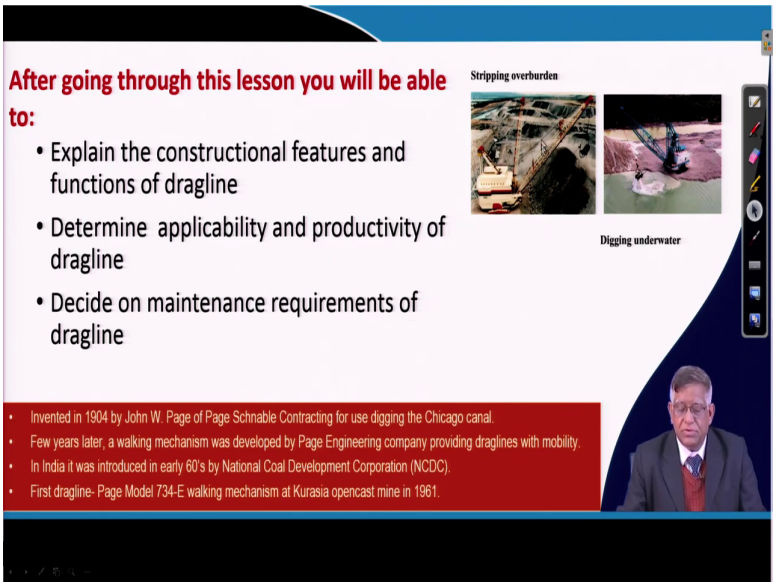

And this machine is how it is used in our country we will be discussing that. And then what after this lecture you should be able to explain the constructional features and functions of a drag line, how it operates how it operates. And then what are the basic components of this machine and then you should be able to tell that how you will be applying this machine in a different conditions.

And also you should be able to calculate the productivity of this machine. And then of course, we need to know the maintenance of it. It is a very big machines with such a power in a one hour class to learn a whole thing about the machine is not possible. So, today I will be introducing this machines to you so that your learning activities can start.

That is exactly it will be a beginning of learning a big machine and if you are going to be a mining engineer or you are working into the manufacturing companies for mining machinery or you want to work with the financial companies to give people suggestions on capital investment on machines for that this information which you will be discussing today will be very important.

But before that you can see that the two photographs here, this is also used for stripping the over burden and taking out overburden to expose the coal seam and also sometimes it is working underwater. So, it is a different multiple uses can be there. So, in the port for depending of the that removing the sand so that the ships can get is dropped or sometimes clearing some pond and all from the say so that the for pollution level can be reduced.

For that purpose also it is used. In a small capacity it can be working in civil work as well. So, this machine was exactly by Page company Page they introduced this machine in 1904 and that same Page company it manufactured a mechanically working drag line. And when our earlier NMDC was there at that the that time it India NCDC that National Coal Development Corporations it introduced in Kurasia mines that first it worked.

And then one of that machine which was introduced in the 60s, it was working up to 2023 at our sub Balanda culinary of Mahanadi coalfields where of course, that because of some like

old machine it was it required a little bit more care, but there one of the shaft broke down and that failed and ultimately that machine was discarded.

So, unfortunately we do not maintain our country the museum of things as a result we do not have this was that machine which was exactly got damaged at South Balanda or a similar machine which was working in the in Kurasia in South Eastern Coalfield Limited, where could have been a very good proud piece of a museum in India. I think I do not know what is the present status of that machine.

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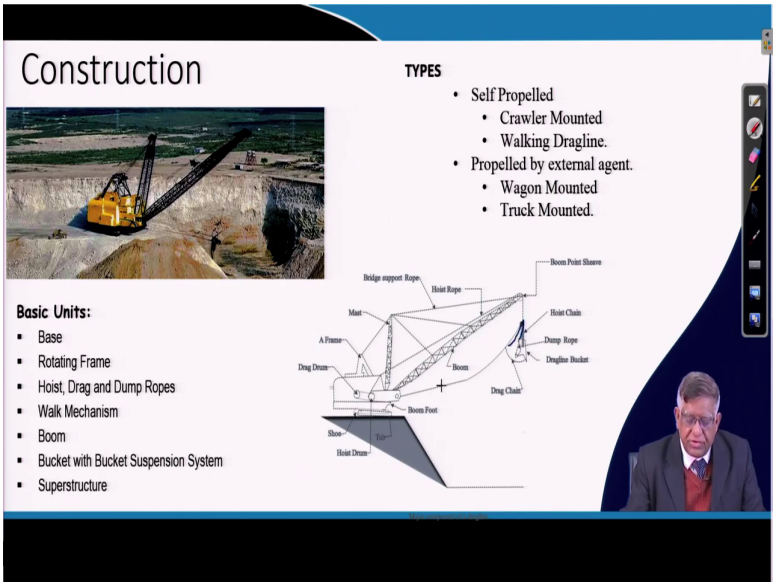

So, what you need to know is this constructionally what are this type you can have based on its travelling mechanism. It was originally there were small crawler mounted drag line for civil works, but there are many walking drag line that is it is having its own walking system that is a mechanically walker and also there is a hydraulically operated walking system.

So, there are two walking mechanism walking drag line means. Just like the human being give his stride it will be giving one step by step like that the two legs it will make it to move. Rather it will be going like both the things will be giving a pressure and then again it will be going like that it will be doing just like a crow walking type of things. So, that type of walking mechanisms are there.

So, this machine as you can see in this photograph, it has got a the if you see this schematic diagram. These machines is based it is sitting on a base or which is also called tub. It is sitting on a tub and then by the side of it, it has got the walking shoe that it has got this walking shoe which can be lowered and raised by which it will be walking.

And then it has got this upper portion which is called your superstructure that superstructure upper portion has got this housing and also it has got this your this boom. You can see that this is a boom is there and then there is a frame all these things are part of the superstructure. The whole thing can swing or it can rotate and that is why there is a rotating frame a turntable is there.

And then it has got this a rope. You can see that a rope is going like that. This is your a host hoist rope, this rope which is connecting to the bucket here. So, there is a hoisting rope and then this bucket there is a drag rope, this rope here it is called drag rope. So, this is a and then there is a one small that from the bucket from bucket to the drag rope, it is connected by a small rope here you can see.

This is called your the that is your dump rope, so that means, you are having here this is your dump rope, here this is your drag rope and this is your hoist rope. So, the three ropes are there. So, then there is the walking mechanism which could be a mesh mechanism with gear an mechanical system or it can be hydraulically operated. So, you have seen that the bucket is suspended by a three type of ropes and then there are some drag chain is also there. We will be looking into this.

So, there is the walking is based on this tub. It is a very large diameter say a you can say a cylindrical body which is made under different sections, it is just sitting over there.

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Now, why it is so? As we said it is a huge machines more than 13500 ton machine. If it requires a larger surface area to stand, so, that is why that whole thing is supporting or sitting on a base so that the ground bearing pressure can be less. Now, this machines is also manufactured in India.

India is proud that in 2019 our Heavy Engineering Corporation Ranchi they made this drag line called Agni. Because Northern Coalfield of India Limited gave order to HEC Ranchi to indigenously manufacture a drag line of this 24 by 88; that means, the bucket capacity is 24 meter cube and the boom length is 88.

That whenever a drag line is specified it is specified like this 24 98; means, that is your 24 meter cube bucket and 88 meter its boom lengths. So, this India has deployed this machine. It is now working Agni is working at Northern Coalfield and there are 48 drag lines were there earlier.

So, this drag line population in India you can see here that historically this started working in 1961. Kurasia was the mine and then there are different types of draglines are used in India.

Out of which that 545 means, 5 meter cube bucket and 45 meter boom length, a small machine to there are 24-96 that is your 24 meter cube your bucket capacity and 96 meter boom length. There is also one machine at eastern coal field I think 130 meter boom length.

So, there are in India also there is a 60 meter cube bucket big drag line which is being working in the session mines of Reliance at Singrauli Coalfield that is the largest drag line which is deployed in India for last I think more than 4 or 5 years it is working that is a 60 meter cube big drag line.

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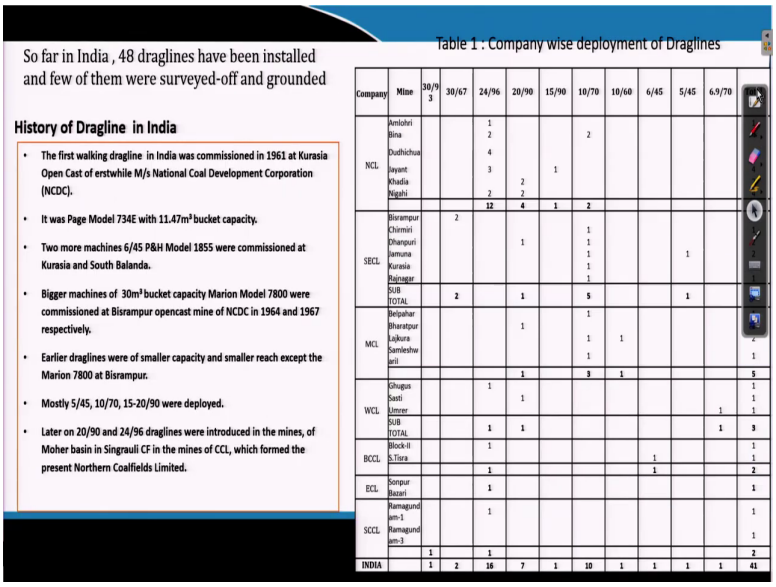

Company	Mine	30/93	30/67	24/96	20/90	15/90	10/70	10/60	6/45	5/45	6.9/70	
NCL	Amlohri			1								
	Bina			2			2					
	Dudhichua			4								
	Jayant			3		1						
	Khadia				2							
	Nigahi			2	2							
				12	4	1	2					
SECL	Bisrampur		2									
	Chirmiri				1		1					
	Dhanpuri						1					
	Jamuna						1			1		
	Kurasia						1					
	Rajnagar						1					
	SUB TOTAL		2		1		5			1		
MCL	Belpahar						1					
	Bharatpur				1							
	Lajkura						1	1				
	Samleshwarii						1					
					1		3	1				5
WCL	Ghugus			1								1
	Sasti				1							1
	Umrer										1	1
	SUB TOTAL			1	1						1	3
BCCL	Block-II			1								1
	S.Tisra								1			1
				1					1			2
ECL	Sonpur Bazari			1								1
SCCL	Ramagundam-1			1								1
	Ramagundam-3											1
		1		1								2
INDIA		1	2	16	7	1	10	1	1	1	1	41

Now, if you see some population in India we have got different that is 24-96 dragline we are having 16 and then different subsidiary of India how they are using then we are; in Singrauli Collieries Limited they are also having in the Ramagundam mine drag line is being used. So, this is a number I collected few years back.

So, I wish that you prepare and collect such type of table by getting the information's and come to know what is the business with drag line in India.

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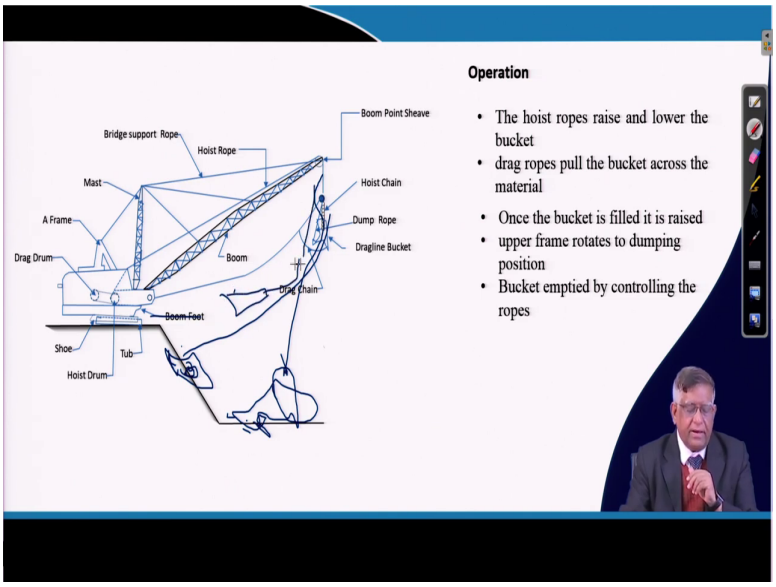

Now, if you want to see that this is a constructional components I have said already, you can draw this type of a schematic diagram. You can you should start drawing this is your working bench that is in an open custom mine drag line is working sitting at the top of the bench and this is the pit floor and this is the slope.

Now, this tub is here, you always need to make it sit down with a clearance from the crest over here. This is very important that it will drag line will be sitting like this. Now, you can there are inside this drums are here. Basically, the ropes are brought over here and the control of this from an operator cabin sitting over here he controls these ropes by controlling the rope only the whole operation is done.

Now, in the operation what it is done? These hoist rope it is raised. After raising from here by gravity it allows to fall down. When it fall down there is a teeth over there this will make a

dig. And then this rope is released with that dig part your this drag rope it drags the bucket along this floor and then the slope.

While it is dragging the bucket get filled up. So, that is how exactly; that means, when your bucket will be falling like this it will make this penetration then with this rope when it will be released the bucket will be getting that is you with the teeth inside that bucket will be taking a this shape.

Now, that is the bucket will be now started collecting the material and then when the bucket will be dragged that material will get filled into days. When the material will be filled at that time this hoist rope which was loose there that this rope will be drawn and then the bucket will be exactly coming in between here in that here and then this whole machine will be swinging and you will be getting the that is here from the bucket will be taken to the side where it will be dumped.

So, this machine is not loading the material on any truck or anything. So, when you are using a bucket this drag line you do not require any truck.

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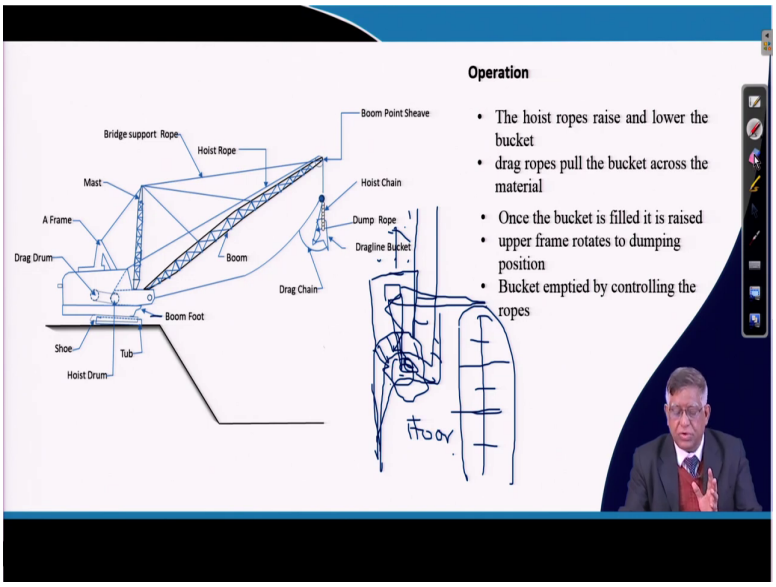

So, in a mining phase say if this is your a mining phase, your drag line is sitting over here and that suppose this is your drag line your drag line bucket will be cutting. And then you can see here this is the phase of the that you can see this is the slope where the material is there.

Now, what is here? Exactly here drilling will be done and this will be blasted. So, this drag line is sitting on blasted material. This material here is already blasted material and then that are falling like this. So, this drag line will be collecting this material and then this boom with the bucket will be that giving a swinging over here. So, the material will be dumped over here.

So, this material over this block which is cutting the machine will be moving in this direction and then the material here it will be forming a hips like this exactly the overburdens will be forming a dump over here. So that means, this is the portions when it was there.

Suppose the coal seam is here this coal seam is getting exposed this much coal is getting exposed, so, here this is the floor of the pit; that means, our de coaled area. From the de coaled area on the de coaled area you are placing this overburden. So, that is how this drag line works.

So that means, that in the operation first the hoist rope is raised and lowered the bucket drag ropes, pull the bucket then the bucket is filled then it is raised upper frame rotates and dumping position bucket emptied by controlling the rope. Now, this is how will be that the whole drag line will be working.

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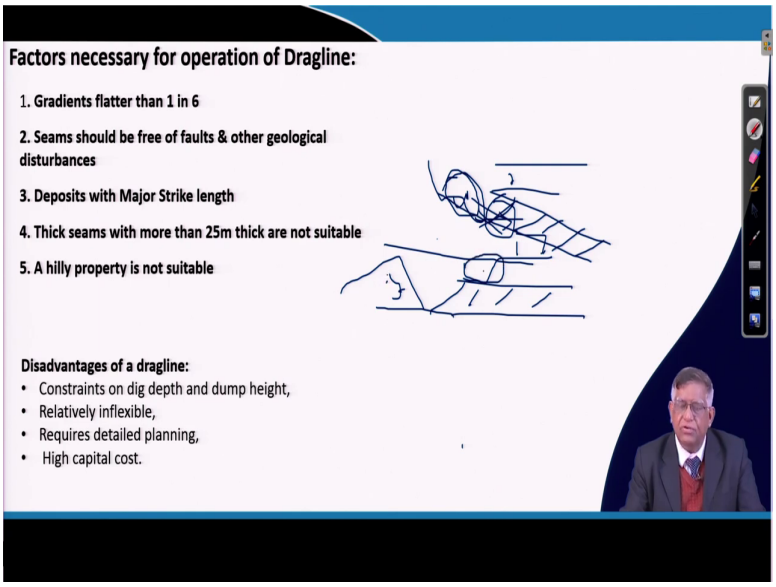

So, if you see that for the operation of this drag line to get in a particular area whether in which type of mine you will use this machine. The gradient should be flatter than 1 in 6. If it is a very inclined there you cannot do because if your this coal seam is inclined then when the drag line will be making. Suppose you are now mines has taken over here, so that if your drag line is working from here it will be dumping the material over here.

If your this seam is not flat then this material placed over here will slide. So, on that phase where the shovel is taking out the coal they will get buried. So, that is why whenever a drag line is to be used this coal seam should not be steeper, it should be if it is a flat then it is very easy because then this is your suppose the coal seam.

Now, your the de coaled area material will be lying over here and your this drag line it can sit over here and it can remove this material and then place it over here. So, that is how the drag

line work that is it should be the gradient should not be more than 1 in 6. Then seam should be free from false.

You know that is your it should be uniform. Suddenly, if the there is your seam goes down then there will be a difficulty. In your surface mining class you have learned that how drag line mining is done. And then deposit with measures strike length that is your it should be a long strike length is easy or better for operating with drag line. If the seam is thick then it is more profitable and it is if the property is on a hilly area drag line is not suitable.

And then the disadvantages: constraints on dig depth and dump height. It will it cannot be a drag line overburdened bench 30 to 40 meter we can work with, but if it is a huge overburden you cannot work with and sometimes to make it two benches may not be economic.

And then to work on two benches the drag line in a mining operation control and phase design becomes a difficult which we exactly study in our mining, how to deploy this machine in a particular phase design it is a matter of surface mining we discuss it over there. Now, it require a detailed planning and also the cost is a sometimes a forwarding factor that, it is a high costly equipment.

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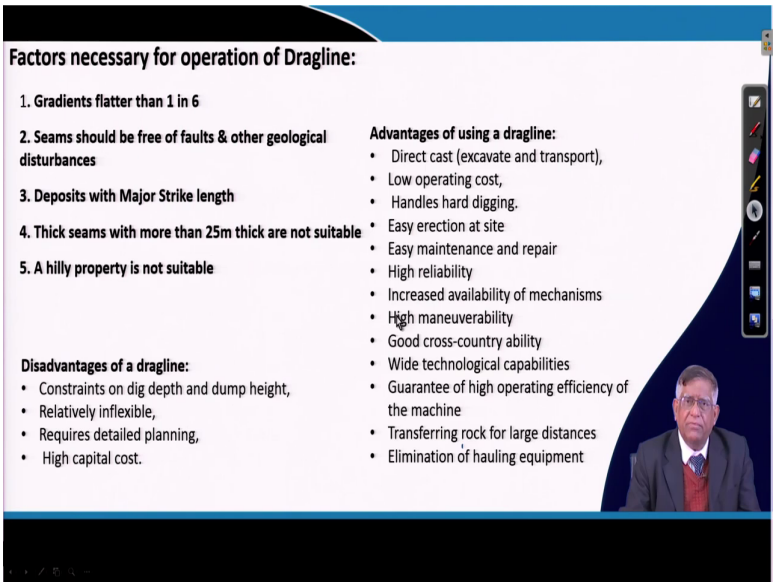

Now, if you are using it the benefits are many that is your it has got a direct cast. So, you do not require any dumper and it has got overall operating cost is less and it is a hard digging by you can it is working sitting on a blasted rock you can do it over there. And then it can be erected in the site itself; that means, their machine is a modular machine it will be brought piece by piece and then it can be erected on the site.

And its maintenance is easy; it is not a very complex machine, only it is large and huge to give your service. And it has that is why the reliability and the utilizations of this machine is very high. Now, it is a mechanisms are very simple that is why they are always says it is easy to maintain means, it is availability is more.

It can be maneuvered though it is a huge 13.51 13.5 kilo of the ton weight, but in such a big machine it can work and maneuver easily that walking in all it is not difficult that system has

been operating in a very successfully. And it can work in that mining terrain no problem and it has got a lot of use.

You can use that high digging, you can do the your deep digging. In the mining negotiate it can work on a even it can travel on a ramp, it can prepare; only thing is that it has got its certain constraint that is coming from its design.

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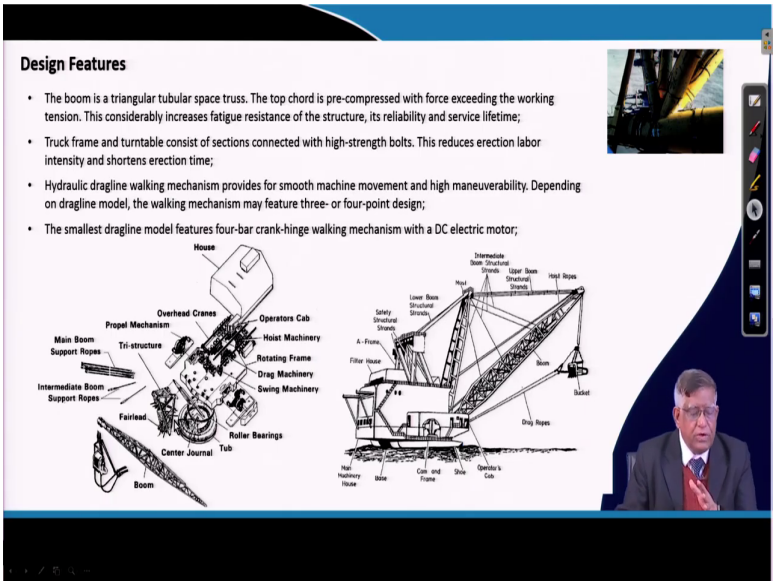

Now as a design features you need to see that there is a boom very long boom a 120 meter boom or a 130 meter boom which is to be supported on the on the base and the superstructure of the machine on a pin joint. And it is supported by a rope. So, it is just like a cantilever, but having a here it is a supported thing. So, this load of it, how it will be coming?

So, this is make a tubular. This as you can see over here in this diagram there is a tubular beam with a truss and column this structures it is designed. Now, the truck frame that is or on which it travels that is a turntable is required, the whole machines it will have to rotate over there.

So, a big sun gear is necessary for that and then it will have to be connected in such a way that; that it does not topple or it does not come out of it. Then the hydraulic walking mechanism, it gives a very smooth walking system that is its maneuverability will have to be provided. So, it is designed like that.

So, there is a it can be 3.4 point designs you know when you go and look into that. How it works you can read the book by Nichols Moving the Earth, where that how originally the page made this walking mechanism they devised in that 1906 1910. Then afterwards how the hydraulic walking systems came with the help of the tree that is your actuators operating and then the pad a pad on which the whole weight is supported, it can be moved over there.

So, then the smaller machines normally this today when we are talking about this 24-96 or 24-88, these are all having hydraulic walking mechanism. Earlier that 6 by 45 those type of smaller drag lines they had the walking shoe with a mechanical arrangements. You can see here exactly that walking mechanism that walking shoe we can see that this is in a suspended position.

Here is an eccentric. By driving this eccentric this with the help of a cam and the frame if I rotate it over there this will be coming down. So, ok so this machine when it is you have got this the component that is housing part is there this is the tub on the or the base on which this is a your superstructures is rotating over here.

Now, that all these parts they can be separately brought to the thing. So, we have got the drag machinery, we have got the rotating frame, swing machinery, hoist machinery, operators cab, overhead crane, propel mechanism, the tri structures that is or is a frame on the top of this where the ropes and all will be laid.

Then there is a different one intermediate boom as also there is a main boom and a fair lead through which the rope is allowed to move.

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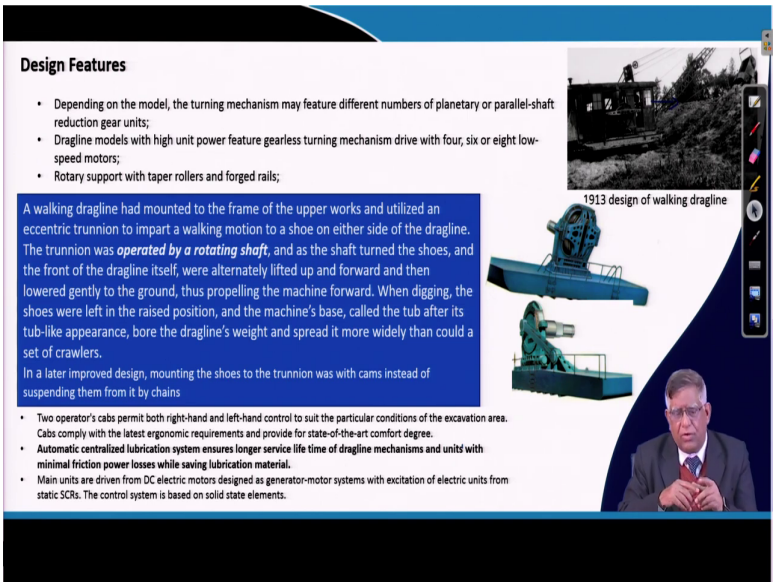

So, these are designed in such a way. You can see that 1913 design of walking drag line. You can see one eccentric here. Now, when it will be rotating this part at one time it will be giving a pressure over here that is your it will be giving a pressure over here and at that time this machine part will be moving over here and then the next time it will get raised and this will be coming and touching in the ground here.

So, that is why how as the eccentric will be moving your this shoe will be walking that arrangements were there. So, there is a you have got this a mechanism that how this; this is the your shoe and this is the eccentric mechanism. When this will be rotated by your gear

arrangements then this will be giving that walking motions to this shoe and the machine will be going forward.

Now, there is a here the whole operation it can be it is also having a lot of moving part; the drums, then your the gears of the sun gear and then even the rope moving on the strips everything some they need lubrications. So, that is why this machine has got a centralized lubrication system so that it can automatically get all the matching parts are lubricated.

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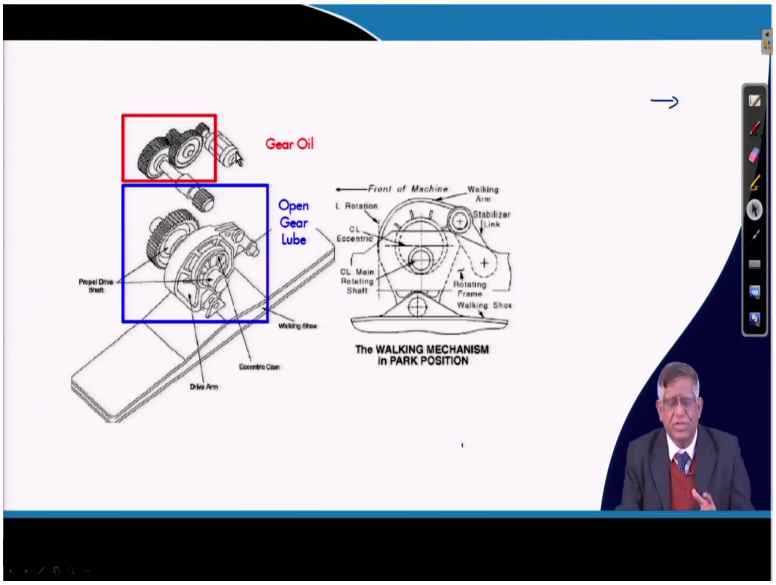

So, you can see here how the gear mechanism that is connected to the shoe and then by rotating this gear connected with a motor then you can make these things. These are normally all are dc motor and they are put over there in the machine.

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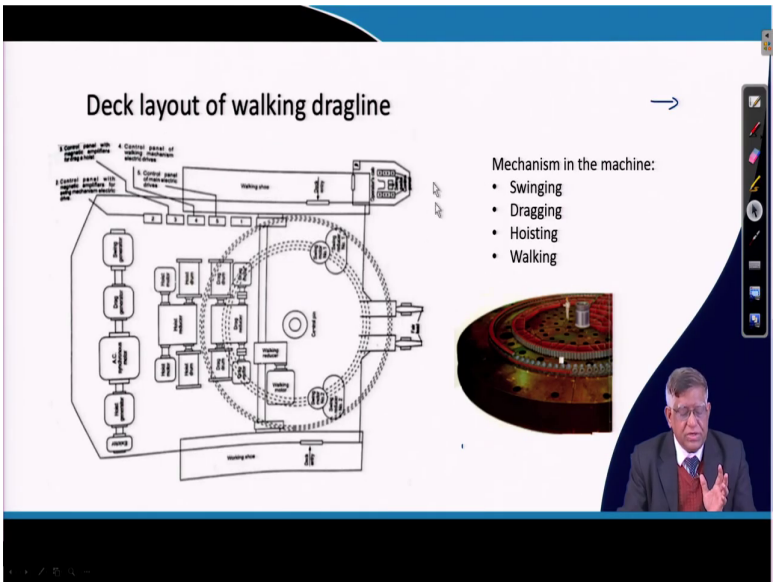

So, if you see a deck layout that is this is the tub on which the machine is a central pendel on which the upper superstructure is sitting over here. This is that top at the bottom. At the top this is the deck on which you are having a motor generator set that is your ac induction motor is there.

This motor is generating dc and these are going to the different that say here we have got this dc motor that is your motor for hoist. There is a motor for drag. There is a motor for swing. This is two motors are here which is exactly giving to this pinion which will be moving over inside this your sun gear and then it will be as.

You can see here this is the inside that on which this upper portion is running then because of the swing motor the swing a gear pinion will be rotating over here as a result this table which will getting a turn. So, this is the mechanism which is there. In a the operations of this mainly

the swinging, dragging, hoisting and walking these four mechanisms are given by means of this power.

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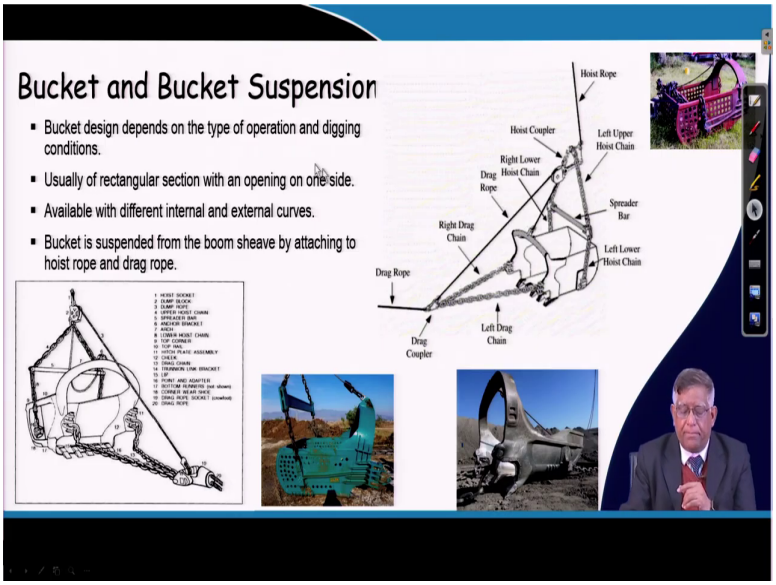

Now, the most important thing is the how bucket is suspended. The bucket is having is as you can see that it is only the top portion is open. In that bucket there is a trunnion point on which a hoist chain is there and then there is a spreader bar. So, that when the bucket is moving this bucket edge should not get touched this chain and should not get damaged that is why a spreader bar is there.

And then there is the upper hoist chain which is going to a hoist coupler one which we are having a shave where one rope from this arm of this bucket this rope called dump rope it is connected to a yoke or which is also called a coupler. On this coupler or the yoke there is one

chain is going. This is a clevis or a hook by which you are fixing one chain. This is called your drag chain that two clevis points are there.

The bucket has got a front lip and on the front of the lip there is a teeth and this is how and then from here a hoist rope goes and here a drag rope goes. So, you can study that this is a bucket how it looks like in real. You have got this is the clevis point and here is this is a drag chain and then this is the teeth of the bucket and then there is a; this is a trunnion point on which this is saying.

Now, sometimes you see in a watery muddy things when you are to collect the things there is all perforated. So, that the weight of the bucket will be reduced and the material and the water are all will be falling it out through this. This is also a type of bucket they used. Now, here you can see that different parts names are showing. So, you will have to draw maybe this diagram will be easy for you to draw.

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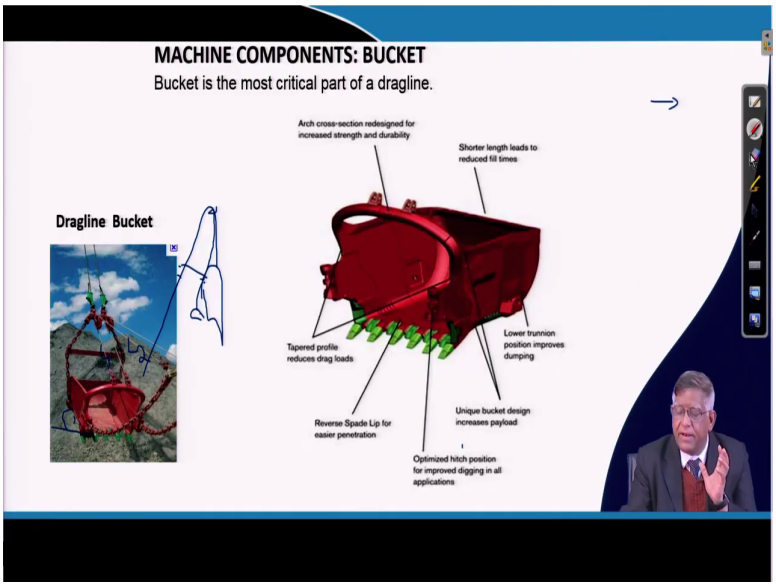

Now, this exactly shows how the bucket is suspended. Now these angle you can see with the horizontal with the horizontal and angle is made. Now, this angle will be a function of that is your whether this portion of your dump rope and this portion of your dump rope.

This l 1 and l 2 their ratio will be exactly making this angle and then how that ratio l 1 and l 2 ratio will be maintained exactly, how much of the drag rope is released with respect to a particular location of the hoist rope. So, that is why the if this angle if you can make it the bucket can be putting it like that position; that means, here when there is a hoist rope is there that is your you are making this your the rope.

Say this is this rope l 1 and l 2 as I said by their ratio you can make it that bucket is totally upside down, which will be at that position of dumping it will go. So, controlling this angle is

a very very important things and which can be it is a very simple mechanics by which you can calculate.

You can see that you can if you have studied in your theory of machines that what is called your degree of freedom that is a what is the number of degrees of freedom and what is the constraint based on that you can calculate out that how these links that mechanism will have to be controlled that is a very interesting problem.

If you are interested in kinematics you can do that control this ones and see that how we can express this angle of the bucket bottom with the horizontal, how it is related to this is a dump rope ratios and how it will be exactly with the hoist rope and drag rope to be controlled that has that type of study can be made. Now, you can see the teeth's are there. The teeth having a tungsten carbide tip, so that is wear is less.

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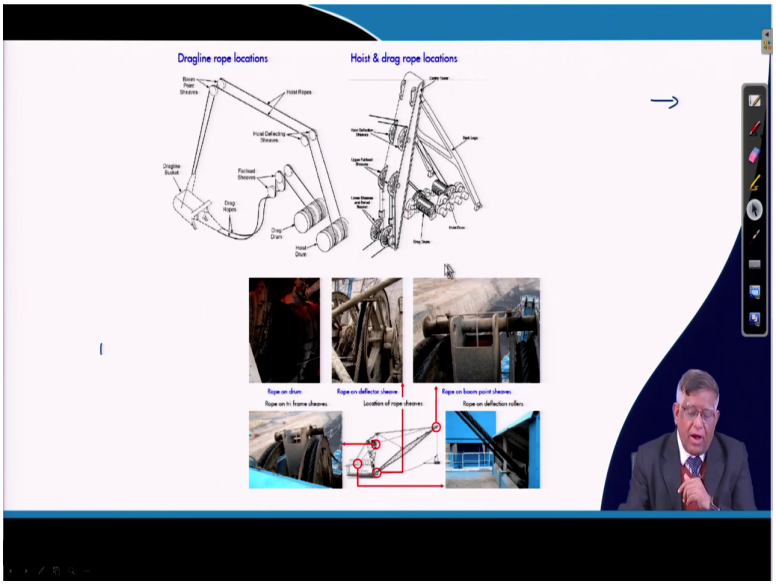

And then next is how the rope is reeved. You can see that in a drag drum and this is the hoist drum that hoist rope is connected to the bucket and drag rope is connected to the that is your with the drag chain. Now, this drag ropes they are coming through a your fair lid.

That fair lid that is your drag rope as a in front of the machine like that you are a sheave is there through which this rope will be moving here. This portion here you can see that this is the where the boom is having it boom point is there. Near that only this fair lid is kept. This fair lid is kept so that the rope goes smoothly to get wound on the drum.

Otherwise there will be if there is a sheave then you cannot. You might have seen in your some cotton reel when you take it over there if your needle you have put after that and then the when you buy a new reel of your thread for your needle it is so nicely wound on that, but thing is that after you put it over there it gets this bundle.

Now, in think of things that is if your this rope is not properly laid on the drum then there will be a rope will be going another rope in across manner. So, there will be a friction there where rope may get damaged. So, to protect that we are having this fair lid so that this rope laying is proper. Now, this is how exactly the rope is guided from the drum to the machine.

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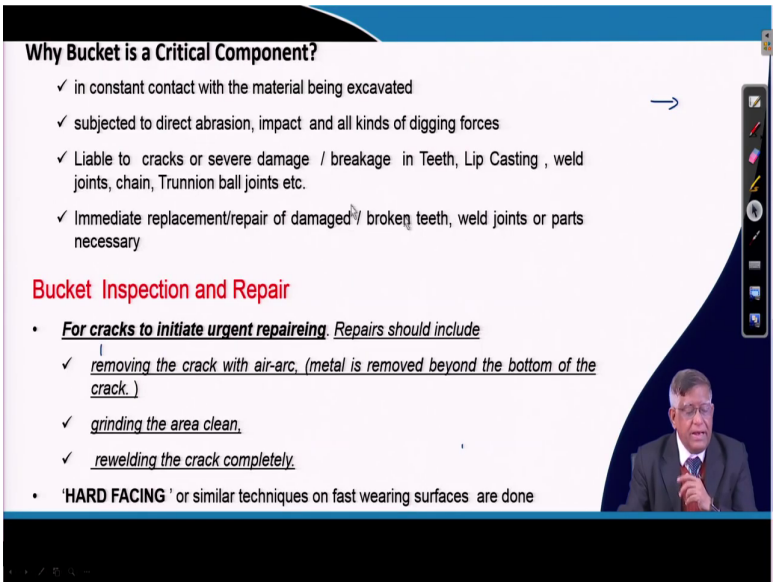

So, similarly this bucket is a very critical component because if it is any problem is there then the whole operations of the that is your production and productivity depends on the bucket. So, that is why you should be very careful about the bucket inspection and repair.

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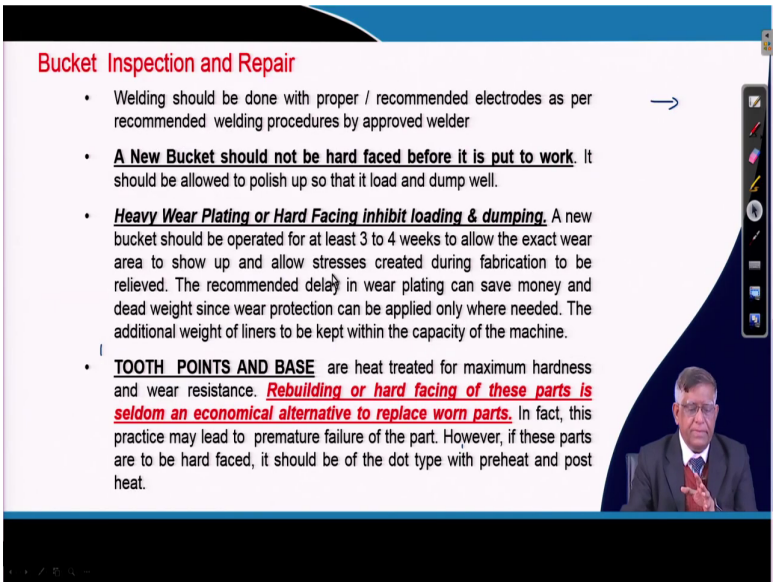

Now, what you will have to do in a bucket trip inspections? There are different welding points. There are teeth then there are that exactly many a times lot of material may get stick into it so that the bucket must be kept clean. And then the lip, the base it should be seen for each wear because if anytime the hook on which it is mount, if there is any slip or any breakage then what will happen?.

The whole bucket may fall down and when it is moving over here then if there is any dozer and other equipment are working below. If that cleavage point has got wear and in sometimes under load it gets snapped then there could be a big accident. So, those type of things will have to be kept.

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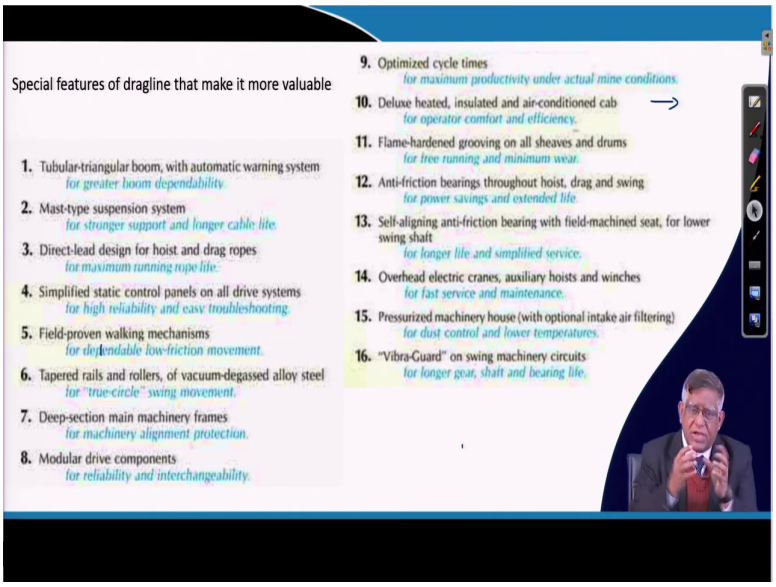

So, now the special features of the drag lines. It is exactly a tubular triangular boom. You have seen that boom made of the tubular cross section of truss and columns it gives a very good reliable boom. Now, if the boom will be taking a lot of stress, so, there may be crack developed and things like that.

But, when you are putting a tubular you put a nitrogen or inert gas inside that. If and that gas pressure is monitored centrally, if there is any crack on that boom then what will happen? There will be pressure will be going down and you will be knowing that is the way how the boom condition is monitored.

Similarly, the suspension system is of must type. It gives a very stronger support and longer cable life is given over there. Direct lead design for the hoist and drag ropes for your rope life

is increased by giving the fair lead design. Then it has got the control panels on the drive system so that everything is monitored.

Nowadays, a lot of vibration monitoring is done on the drag line; your boom, then motor and all because so that the if the surf alignment is not proper then the vibration will be there and that may create damage to the machines. So, that signature of the machine for the normal and perfect operation is taken and any deviation it is taken care of.

So that means, vibration monitoring for a better amount maintenance of the machine and also to give warning. If there is an impending danger because of any cracks or other things are nowadays possible. Now, there is a there are many other features. Say it has got a optimized cycle time, it has got a that flame hardened grooving on all sheaves that is different rope is moving on the sheave. Then the sheave on which the rope is moving with a heavy load on it, so the wear and tear of that need to be controlled.

So, these are the very good the development of the machine design and the materials by which exactly this made this machine to work very reliably. So, you will be getting this power points studied over here.

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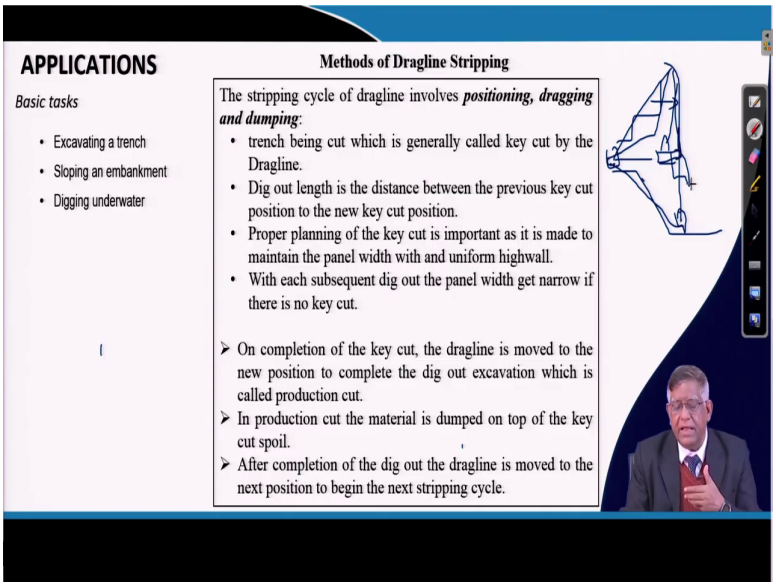

Now, one thing is the whole application it can be there for excavating of trends, sometimes you can do a smaller machine for civil work. You will be doing for the sloping of the embankment. You can raise the embankment in a mine then also digging in the underwater. These are the civil applications other than our overburden removal. That while operating it will have to be positioned properly then it will have to drag and then it will have to dump.

So that means, whenever we are making this machine to work it is sitting over here and that the boom is here that the from the boom you can see here this is the boom and that bucket is lowered over here and then it is just cut over here and then this is exactly dragged on the basis of this.

So, at any time then when it is coming over here after it gets filled that bucket will be suspended like this so that it will be in a horizontal way and then in this suspension mode it

will be brought to the dumping positions and then this bucket will be allowed to come in this by releasing the drag rope and we will be submitting the material. So, this is how exactly positioning, dragging and dumping these two operations are done in case of drag line to work with.

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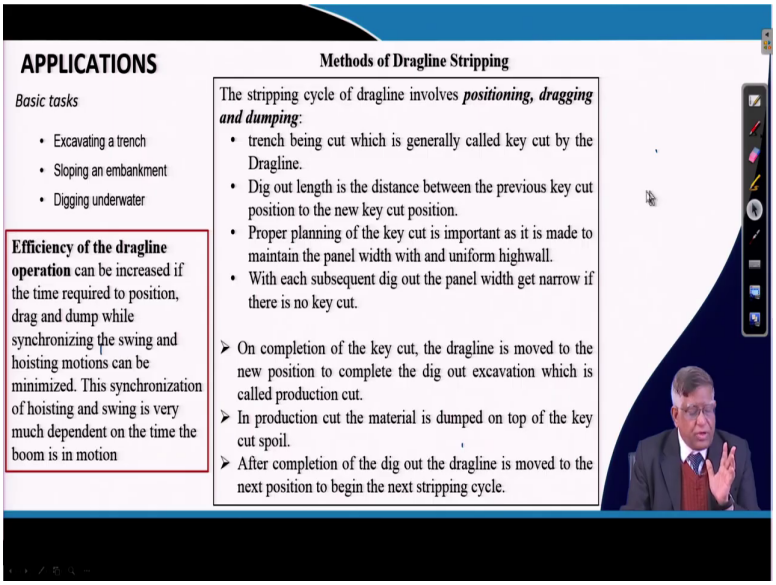

So, the other thing is that efficiency of the drag line operations can be increased if the time required to position drag dump while synchronizing the swing and the hoisting motions can be minimized.

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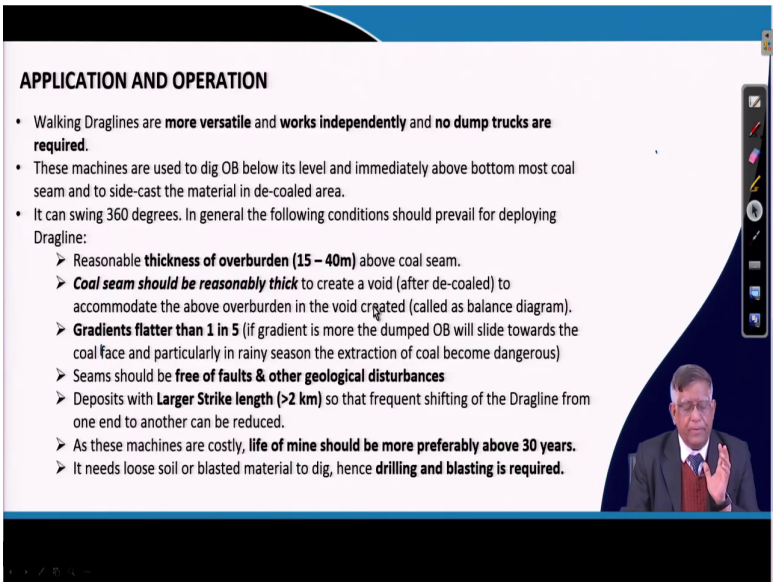

So, the application and operations: it is you should collect the information that the thickness of overburden can be 15 to 40 meter can be done. Coal seams should be reasonably thick because if it is a for a very small that is your thickness then you will not get a enough space for dumping the material.

In mining we discussed about that how we should what will be the proper dimension of the machine for a particular coal seam thickness and then overburden thickness can be decided. The gradient as I have already told.

Then it is the geological disturbances should not be there, strike length should be more than 2 kilometer preferably and the life of the mine should be also longer. That means, the deposit should be having a enough reserve so that the mine can run for more than 20 to 24 years.

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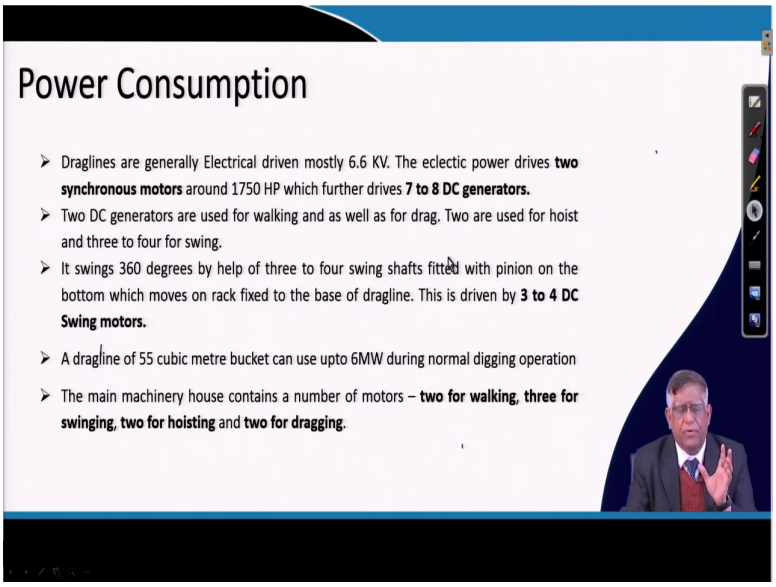

And the power consumptions: it is exactly highly electricity dependent machines. Because there are a number of motors as we have already said and then it can go up to 6 megawatt power is necessary.

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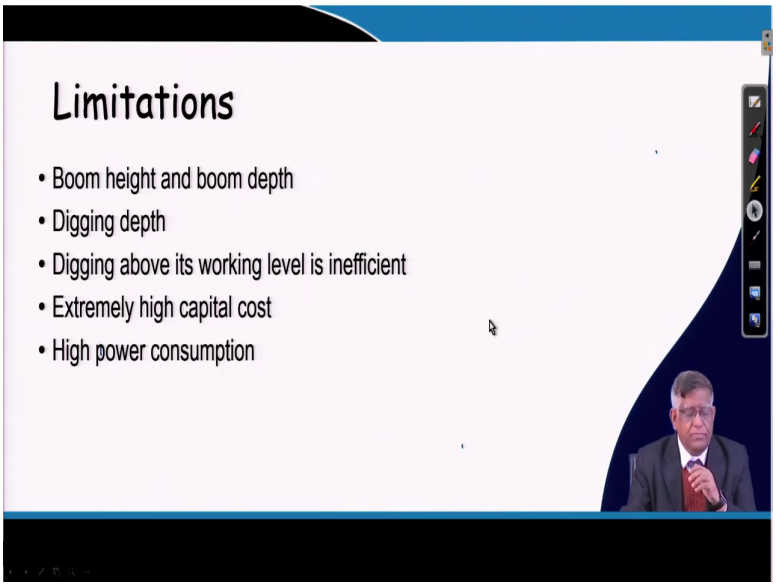

So, this is what you will have to know that this machine also. The main limitation is height it is digging depth it is a digging above the working level is also inefficient and there are very high capital investment is necessary.

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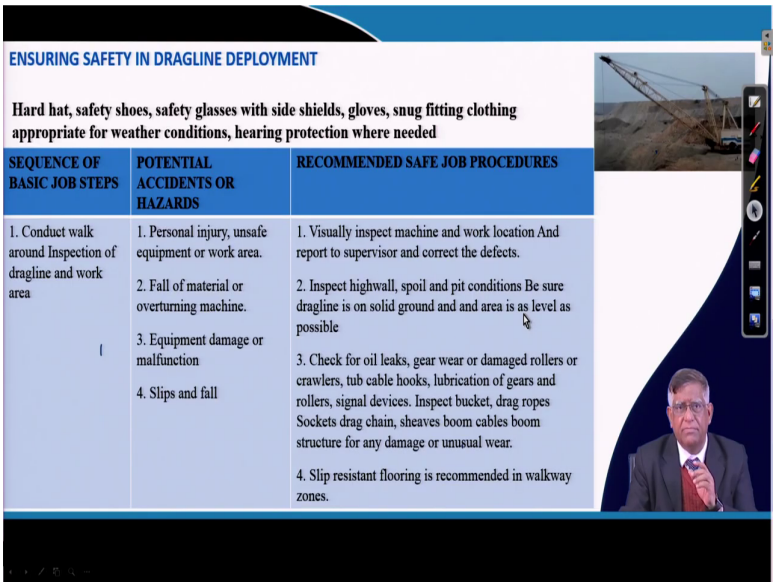

So, that safety of operating this machine is also very important and for that you will have to make a particular inspections. And then find out where what type of problem is there. So, you will have to make a inspection walking. So, as I told you earlier also as an engineer you must develop a very good observation quality. How you observe?.

When you walk around you will have to see that if there is any problem and that every engineer must be a very good quality observer. So, and if you do not do that you may miss sometimes that what type of safety or personal protective equipment you must wear while working these machines. And then if there is any fall of material or overturning of material, if there is any possibility where people can slip. So, you need to check those things.

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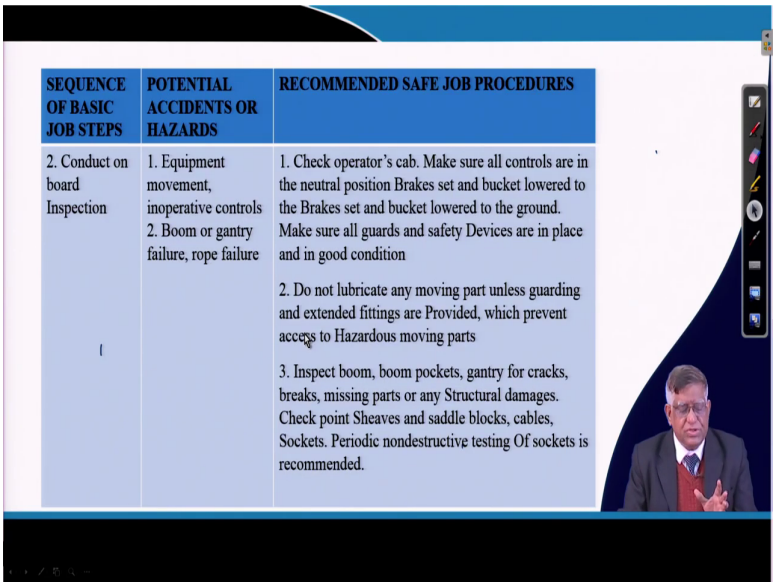

Number of that how you will be going climbing the machines and then you will have to observe that how the machines are moving. And then industrial engineer they will be studying about exactly how much time is there. The whole cycle; that means, one taking the digging and then swinging, dumping, coming back this whole thing should not take more than 40, 45 second.

So, if it is taking more; that means, your swing angle and then your the dragging work that need to be seen. So, in a workplace geometry and that velocity of the different motors they need to be properly set to get the optimum productivity.

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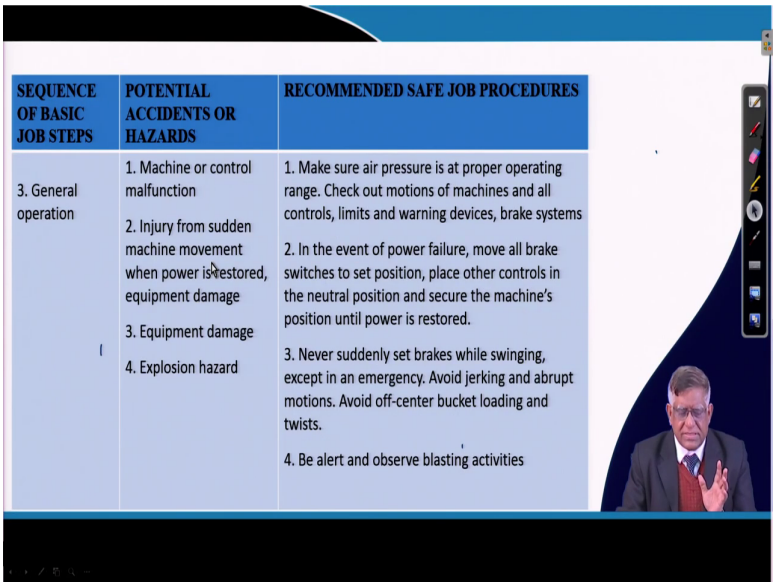

So, this also if you do not do it properly that safety will be getting affected. So, in the general operations also there are potential accidents and hazards. Particularly, if your control system does not work properly, if there is a sudden machine movement takes place or that equipment is already damaged.

And you are working with it or sometimes of course, there could be if a working in a coal mine lot of dusts and all are coming in a small chambers over inside the that and you are not properly cleaning or your ventilation in the that closed area inside the tub and all is not proper there may be explosive. So, there are different possibility which need to be set.

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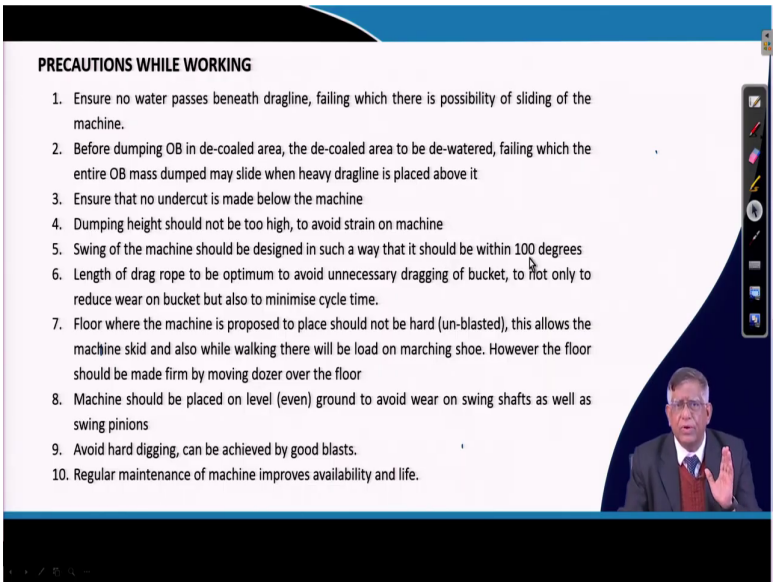

So, you should take proper precautions while working. So that there is no water possess, your tub sitting over there. So, you should not have a water below the tub. Then what will happen? It may slip. And while you are operating with this you should not cut below the tub so that overhang type of cut that it may machine may slide down from the one bench to the another bench. So, that type of things should be avoided.

And then that is a undercut should not be there. And when you are dumping the material on the pit floor the pit floor should not have water or it should not have high inclination. Because otherwise that huge quantity of overburden it may slide down. And you know that type of overburden sliding problem took place in Northern Coalfield.

In the giant coalfield where there is a when the on the road a dumper was going the overburden that all slided and buried the dumper and dump operator could be traced after a

few days by radar, GPR and all that thing had to be brought. So, while dumping the geo local the geometry of the area the conditions that need to be very well seen.

Now that is why the you must make a list of the precautions and that how it will be working; that means, it should not swing of the machine should be designed in such a way that it should not be within 100 degree. If you make a very big swinging and then you are operating that is sometimes you may find that you are out of control, you cannot have that is your the operator may not be able to see the both the phases simultaneously number of things like that happens.

Now, the floor where you are working exactly along with the these drag line movement tub movements should be on a smoother. So that means, doozer must be associated with this machine so that before it moves the things are properly the platform is properly leveled. So, we should not do a very hard rock digging, it should not be done. So, like this type of precautions you must take.

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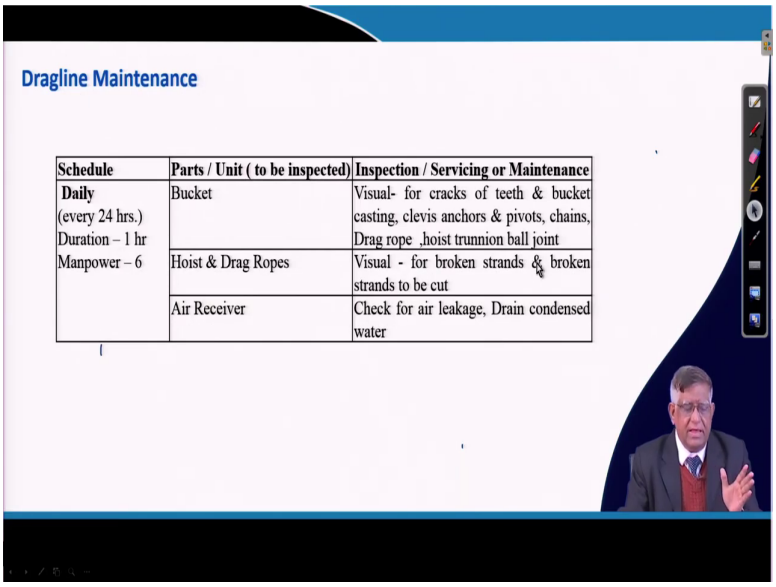

So, as a maintenance its components like your bucket, your hoist and drag ropes, your air receiver this need to be inspect. The operators or the machines manufacturers manual it gives a checklist. So, it is your responsibility to have an idea of how these checklists are prepared. The checklists they give a maintenance schedule some as a daily. You can see that some of the visual inspections and then checking for the leakages and all should be done daily.

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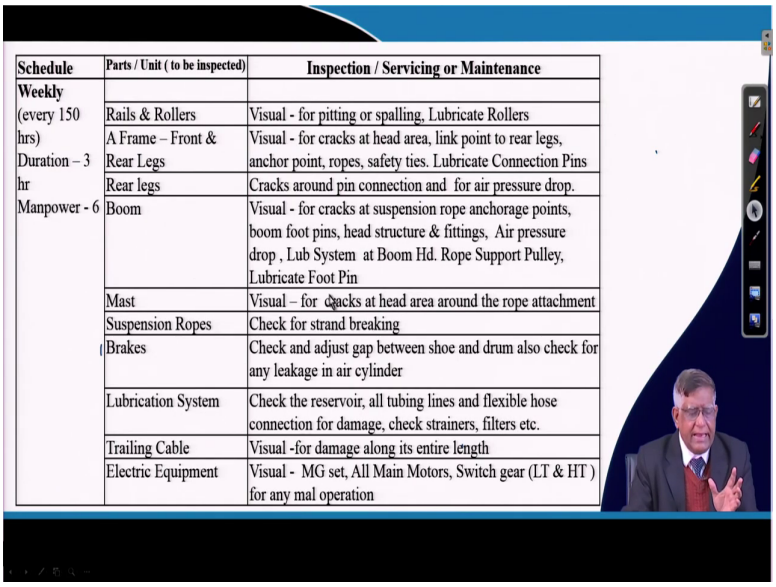

Some of that maintenance will have to be done weekly. So, weekly you will be going and seeing if there is any cracks developed, if there is any things coming out as protruded portions or if any foreign materials is there. If there is any spillage at some places or if that any rope strands, etcetera are not working properly, if something is coming out; those things every week you must see.

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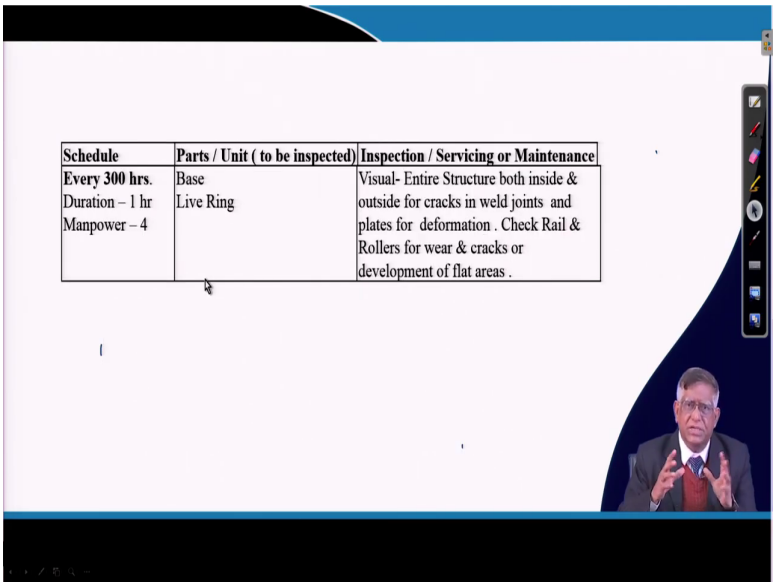

And then some of course, after 300 hours operations you will have to see that how the that is your the base is working, whether there is any wear and tear has taken place, cracks developed. These are the general inspections as a maintenance engineers will be doing. As a manager of the mine you will have to see that whether they are maintaining the logbook of the machine by carrying out all this maintenance.

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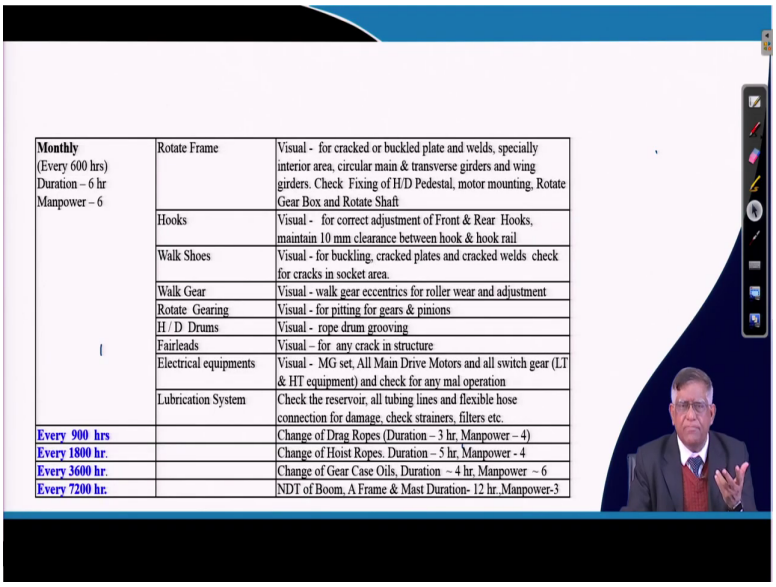

And sometimes periodically you should get a report of the maintenance work done. They can they do some of the monthly then there are also some major repair after some period.

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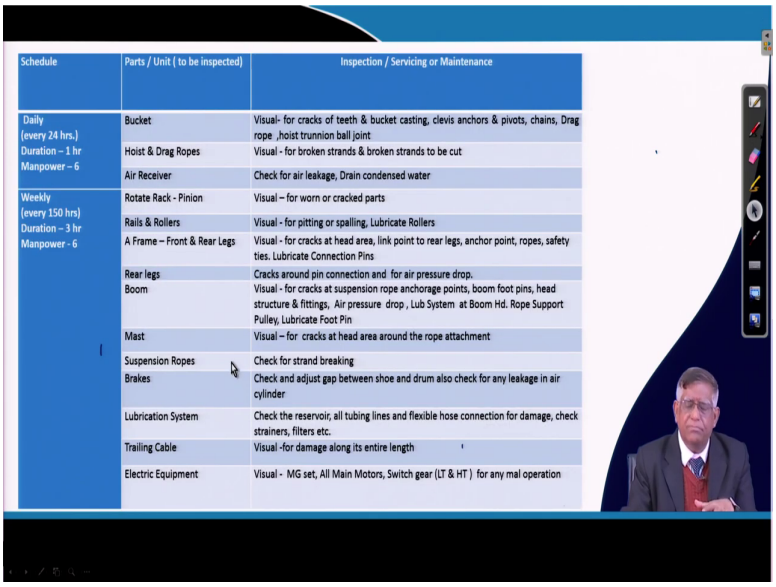

Schedule	Parts / Unit (to be inspected)	Inspection / Servicing or Maintenance
Daily (every 24 hrs.) Duration – 1 hr Manpower – 6	Bucket	Visual- for cracks of teeth & bucket casting, clevis anchors & pivots, chains, Drag rope ,hoist trunnion ball joint
	Hoist & Drag Ropes	Visual - for broken strands & broken strands to be cut
	Air Receiver	Check for air leakage, Drain condensed water
Weekly (every 150 hrs) Duration – 3 hr Manpower - 6	Rotate Rack - Pinion	Visual – for worn or cracked parts
	Rails & Rollers	Visual - for pitting or spalling, Lubricate Rollers
	A Frame – Front & Rear Legs	Visual - for cracks at head area, link point to rear legs, anchor point, ropes, safety ties. Lubricate Connection Pins
	Rear legs	Cracks around pin connection and for air pressure drop.
	Boom	Visual - for cracks at suspension rope anchorage points, boom foot pins, head structure & fittings, Air pressure drop , Lub System at Boom Hd. Rope Support Pulley, Lubricate Foot Pin
	Mast	Visual – for cracks at head area around the rope attachment
	Suspension Ropes	Check for strand breaking
	Brakes	Check and adjust gap between shoe and drum also check for any leakage in air cylinder
	Lubrication System	Check the reservoir, all tubing lines and flexible hose connection for damage, check strainers, filters etc.
	Trailing Cable	Visual -for damage along its entire length
	Electric Equipment	Visual - MG set, All Main Motors, Switch gear (LT & HT) for any mal operation

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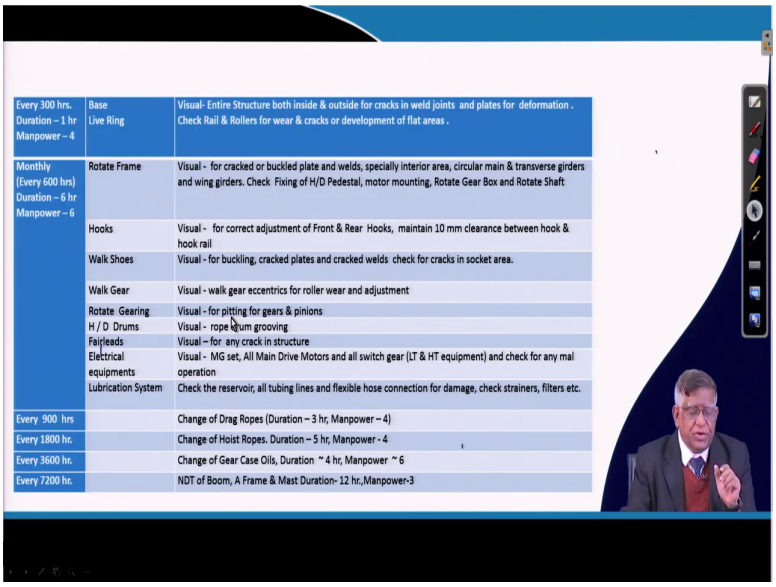

Every 300 hrs. Duration – 1 hr Manpower – 4	Base Live Ring	Visual- Entire Structure both inside & outside for cracks in weld joints and plates for deformation . Check Rail & Rollers for wear & cracks or development of flat areas .
Monthly (Every 600 hrs) Duration – 6 hr Manpower – 6	Rotate Frame	Visual - for cracked or buckled plate and welds, specially interior area, circular main & transverse girders and wing girders. Check Fixing of H/D Pedestal, motor mounting, Rotate Gear Box and Rotate Shaft
	Hooks	Visual - for correct adjustment of Front & Rear Hooks, maintain 10 mm clearance between hook & hook rail
	Walk Shoes	Visual - for buckling, cracked plates and cracked welds check for cracks in socket area.
	Walk Gear	Visual - walk gear eccentrics for roller wear and adjustment
	Rotate Gearing	Visual - for pitting for gears & pinions
	H / D Drums	Visual - rope drum grooving
	Fairleads	Visual – for any crack in structure
	Electrical equipments	Visual - MG set, All Main Drive Motors and all switch gear (LT & HT equipment) and check for any mal operation
	Lubrication System	Check the reservoir, all tubing lines and flexible hose connection for damage, check strainers, filters etc.
Every 900 hrs		Change of Drag Ropes (Duration – 3 hr, Manpower – 4)
Every 1800 hr.		Change of Hoist Ropes. Duration – 5 hr, Manpower - 4
Every 3600 hr.		Change of Gear Case Oils, Duration ~ 4 hr, Manpower ~ 6
Every 7200 hr.		NDT of Boom, A Frame & Mast Duration- 12 hr.,Manpower-3

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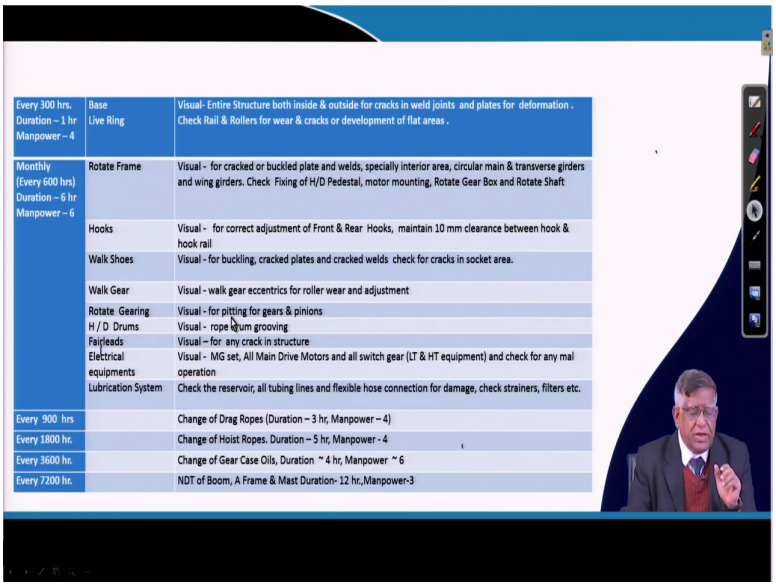

So, this is a schedule maintenance is a important thing. You must look into it while studying and then make a comprehensive idea, what are the things of this machines need to be maintained.

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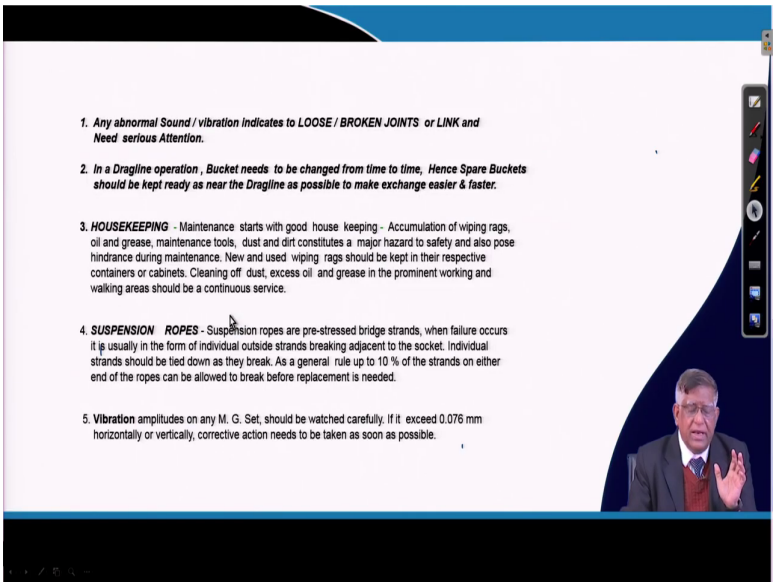

But one important thing your proper housekeeping; that means, maintaining the proper cleanliness and then proper that is your you should feel free that there is no vibration, no noise additional noise and all these are coming. So, you should have a feeling of the machine how it is working by seeing by touching that what is the temperature of a motor or a gearbox should be there.

If it is getting overheated; that means, somewhere a problem. So, as an engineer when you are deploying a machine you should have an idea that this will not be working.

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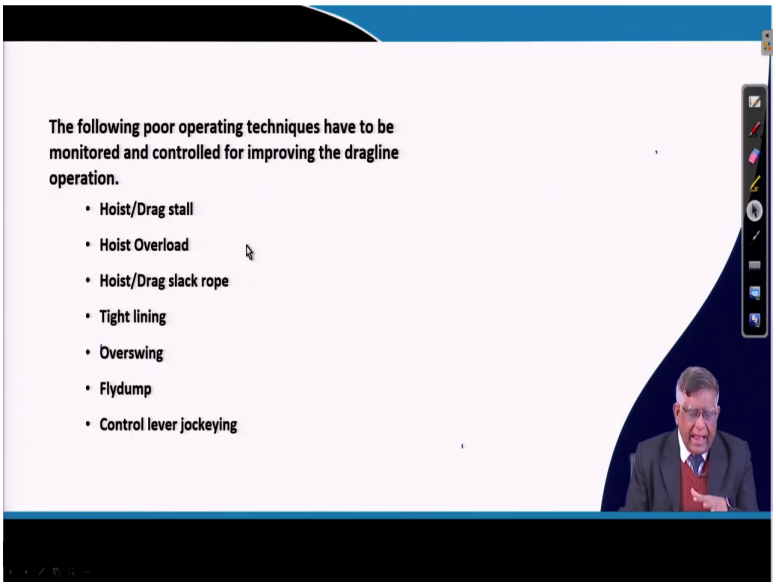

Now for that as a engineering student you will have to find out also that what is an improper operation. So that means, if in the field you go and see that machine is having a stall; somewhere it is not working, the motor is not giving the motion or if there is any overload every motor has got some overload protection system, you need to see that the operator and others they have not bypassed that protection system.

You should see that there is a slack of the ropes should not be there, rope should be always in a proper tension. Then it should be it should not go swinging more than necessary then you should see that the dumps should be placed in a proper manner. Then all these your control lever should be working smoothly, such type of things you need to observe.

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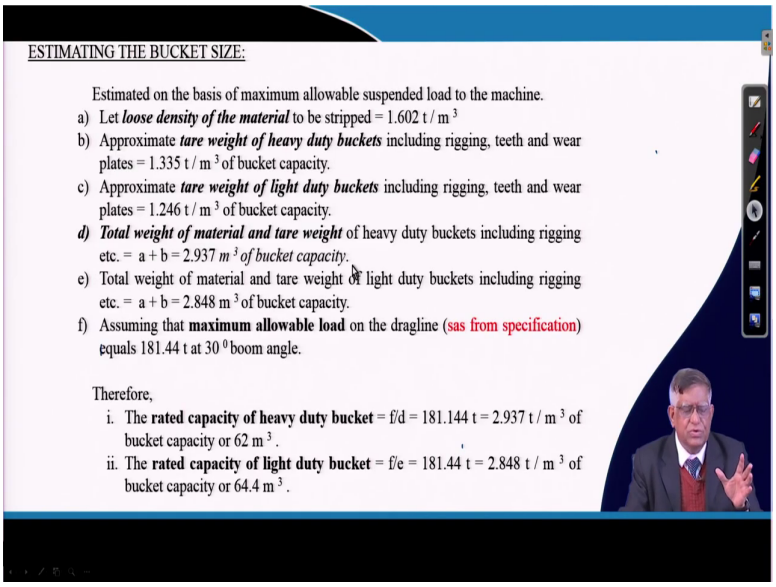

Now to coming to this, that how will you estimate the bucket size. Now, estimated on the basis of the maximum allowable suspended load under the machine. So, now, you just take in an example. Let loose density of the material, you are giving say a particular density is given 1.6 ton per meter cube.

Your that other value which is required for calculating the capacity is what is the tare weight of the heavy duty buckets. Then what is the your total weight of the material and tare weight then your total weight of the material and then the maximum allowable load.

These are the things if it is known then the rated capacity of the bucket can be calculated depending on this information. Similarly, if it is a heavy duty bucket then you can find out the capacity. So, that is why a bucket size and capacity is determined.

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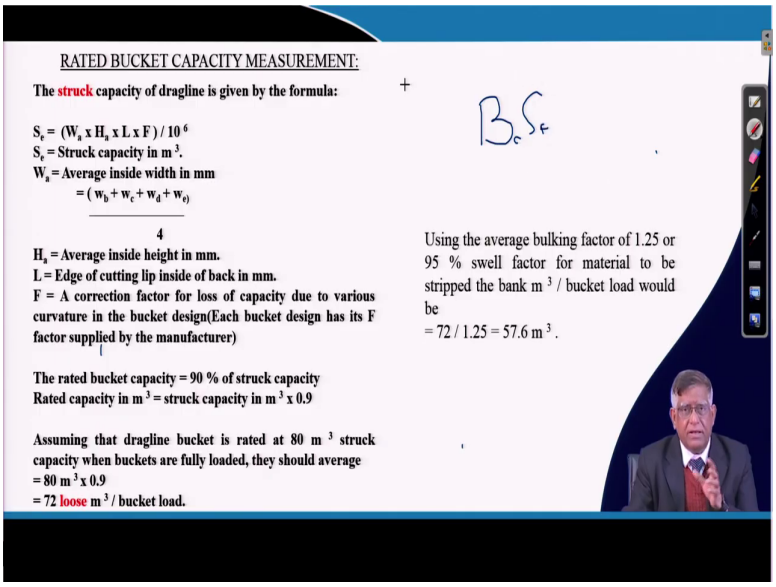

Now, the rated bucket capacity measurement it is it depends on the what is the average inside the height of the bucket. Then what is the edge of the cutting lip inside the bucket and the a correction factor is given depending on the different site that a correcting factor is also used.

So, that after you know that things then you know what is the average width of the bucket can be calculated by knowing different size because the bucket will be coming of different dimensions. Different manufacturers gives a different type of bucket. From there you need to find out that how the basic the dimensions to calculate the volume is taken.

So, ultimately you just calculate out the total volume how much it is coming then you can find out that is a it should be multiplied by the swell factors that is how much the material. So

that means, if you know the bucket capacity that is your if the bucket is having a particular capacity you have found and then if you know the swell factor.

That means, that you can find out that if your swell factor is your whatever the bank volume hard volume were there when it has got fragmented its volume has increased. So, when you will be putting in the bucket that is your the material which is there it is having more than the bank capacity.

So, from the capacity of the bucket you know the volume which is the lose volume is coming. So, from there you can calculate exactly how much the phase is advanced; that means, how much bank volume has been cut. So, that is why how the bucket capacity is estimated.

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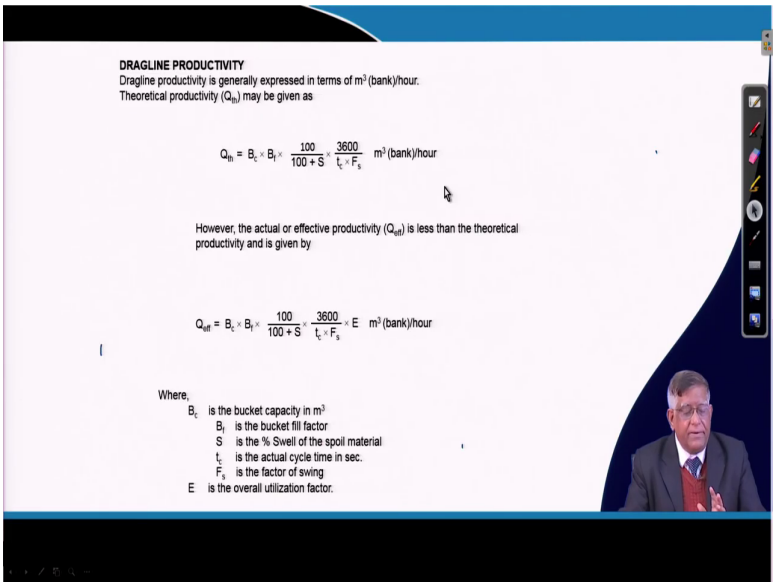

And then your the whole productivity you can calculate by these things. If you know the bucket capacity, if you know the bucket fill factor because the whole bucket does not get filled fully. So, after knowing the bucket fill factor then how much is the swell and then what is the cycle time.

By knowing that you can find out that theoretically what is the hourly output of the bank material; that means, which is before blasting how much material how the bank geometry has changed.

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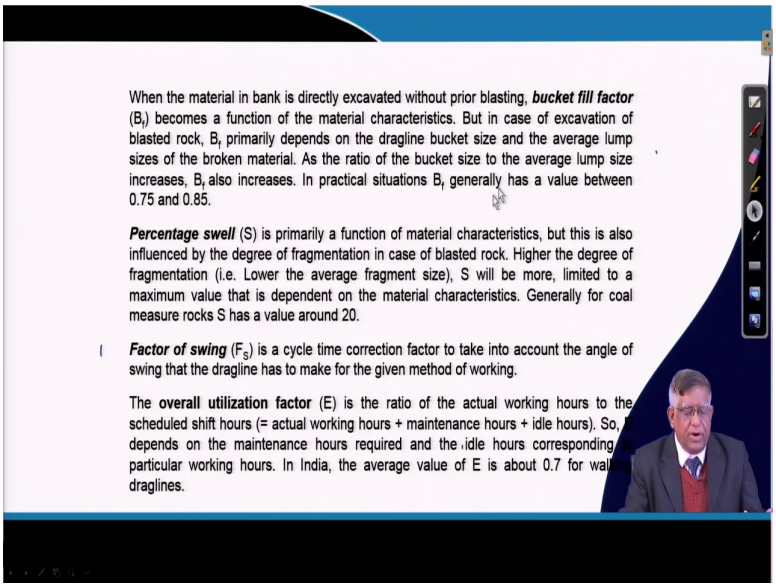

So, these productivity calculations depends on this your percentage of swell and pack bucket fill factor.

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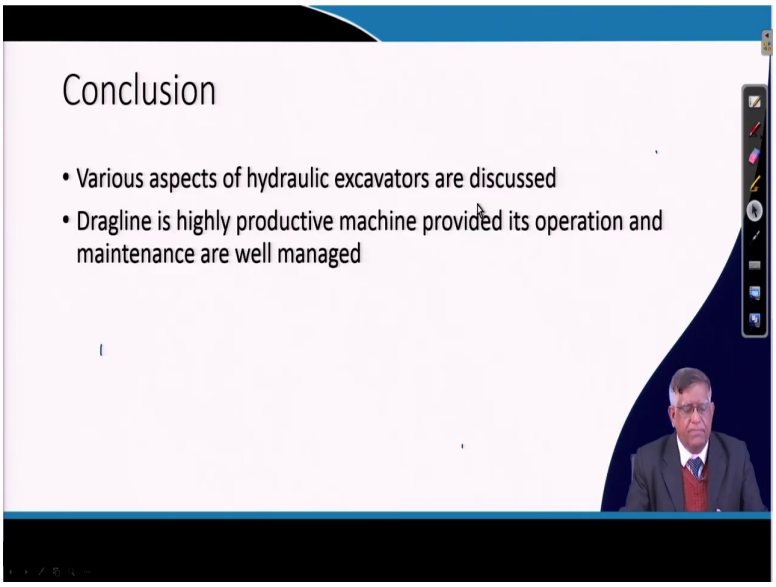

So, in this way the today we have just introduced to you a overall what is a drag line and how it is deployed in the mining sector, but it is as I said it is just the beginning. We have brought out different information's on it.

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I wish that you will be giving some time to study different relevant materials and this slides you will be looking into so that you can make yourself a beginning to study dragline and its application in coal mining purposes.

Thank you very much.