

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

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.


(Refer Slide Time: 01:31)

Surface Mining Machinery Machinery for Cyclic Excavation: Dragline



Objectives:
Introduction to the construction, operation and applications of Dragline

- Weighing 13,500 metric tons
- 68m (222 feet) high and 46 m (151 feet) wide
- The bucket weight 210.5 te empty. It is 4.3 m high, 8.2 wide and 7m deep. It can hold 295 te of dirt.

Powered by electricity supplied at 13,800 volts via a trailing cable, which had its own transporter/coiling units to move it. The electricity powered the main drives, **eighteen** 1,000 horsepower (**750 kw**) and **ten** 625 horsepower (**466 kw**) dc electric motors. Some systems in big muskie were electro-hydraulic, but the main drives were all electric.



Big Muskie (1969-1999), Ohio



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.

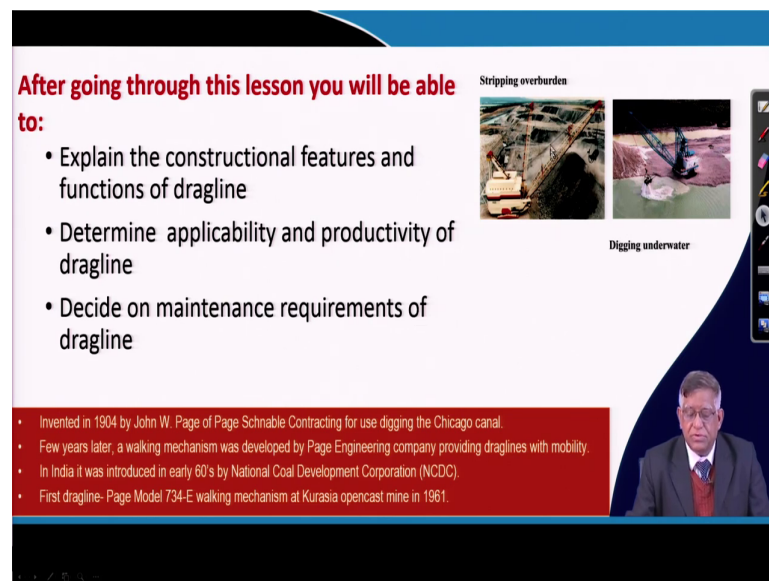
Then it is also the width of the machine is 46 meter, 50 meter; you can imagine your 100 meter track in your field then from there you can imagine that how width wide this one machine is. And then this empty bucket such a huge bucket it is weight itself is 210 ton and it

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.


(Refer Slide Time: 04:16)




After going through this lesson you will be able to:

- Explain the constructional features and functions of dragline
- Determine applicability and productivity of dragline
- Decide on maintenance requirements of dragline

Stripping overburden



Digging underwater



- Invented in 1904 by John W. Page of Page Schnable Contracting for use digging the Chicago canal.
- Few years later, a walking mechanism was developed by Page Engineering company providing draglines with mobility.
- In India it was introduced in early 60's by National Coal Development Corporation (NCDC).
- First dragline- Page Model 734-E walking mechanism at Kurasia opencast mine in 1961.

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.

(Refer Slide Time: 07:43)

Construction


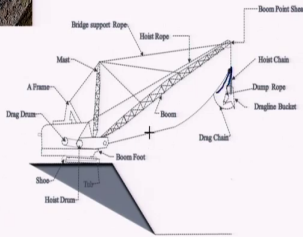


TYPES

- Self Propelled
 - Crawler Mounted
 - Walking Dragline.
- Propelled by external agent.
 - Wagon Mounted
 - Truck Mounted.

Basic Units:

- Base
- Rotating Frame
- Hoist, Drag and Dump Ropes
- Walk Mechanism
- Boom
- Bucket with Bucket Suspension System
- Superstructure



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.

(Refer Slide Time: 11:35)

So far in India, 48 draglines have been installed and few of them were surveyed-off and grounded

History of Dragline in India

- The first walking dragline in India was commissioned in 1961 at Kurasia Open Cast of erstwhile M/s National Coal Development Corporation (NCDC).
- It was Page Model 734E with 11.47m³ bucket capacity.
- Two more machines 6/45 P&H Model 1855 were commissioned at Kurasia and South Balanda.
- Bigger machines of 30m³ bucket capacity Marion Model 7800 were commissioned at Bisrampur opencast mine of NCDC in 1964 and 1967 respectively.
- Earlier draglines were of smaller capacity and smaller reach except the Marion 7800 at Bisrampur.
- Mostly 5/45, 10/70, 15-20/90 were deployed.
- Later on 20/90 and 24/96 draglines were introduced in the mines, of Moher basin in Singrauli CF in the mines of CCL, which formed the present Northern Coalfields Limited.



Walking Dragline 24/88 "Agni" manufactured by HEC, at NCL, Amlohri Project, Singrauli on 28.3.19 Against the order of 15 nos. in 2017

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.

(Refer Slide Time: 13:48)

Table 1. Company wise deployment of Draglines

So far in India, 48 draglines have been installed and few of them were surveyed-off and grounded

History of Dragline in India

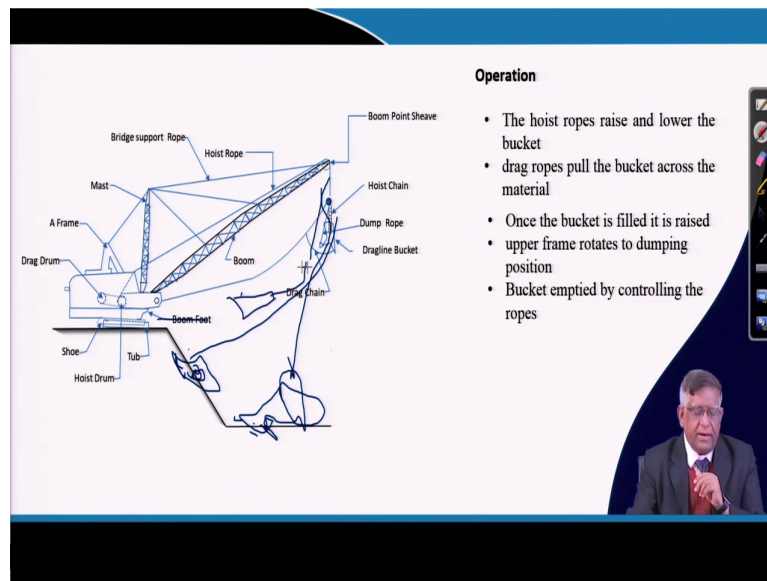
- The first walking dragline in India was commissioned in 1961 at Kurasia Open Cast of erstwhile M/s National Coal Development Corporation (NCDC).
- It was Page Model 734E with 11.47m³ bucket capacity.
- Two more machines 6/45 P&H Model 1855 were commissioned at Kurasia and South Balanda.
- Bigger machines of 30m³ bucket capacity Marion Model 7800 were commissioned at Bisrampur opencast mine of NCDC in 1964 and 1967 respectively.
- Earlier draglines were of smaller capacity and smaller reach except the Marion 7800 at Bisrampur.
- Mostly 5/45, 10/70, 15-20/90 were deployed.
- Later on 20/90 and 24/96 draglines were introduced in the mines, of Moher basin in Singrauli CF in the mines of CCL, which formed the present Northern Coalfields Limited.

Company	Mine	30/93	30/67	24/96	20/90	15/90	10/70	10/60	6/45	5/45	6.9/70
NCL	Amidori			1							
	Bina			2			2				
	Dudhichau			4							
	Jayant			3		1					
	Khadia			2	2						
	Migahi			2	2						
				12	4	1	2				
SECL	Bisrampur		2								
	Chimiri						1				
	Dhanpuri				1		1				
	Jamuna						1			1	
	Kurasia						1				
	Rainagar						1				
			2		1		5			1	
MCL	Belpahar						1				
	Bharatpur				1						
	Jajkora						1	1			
	Jamshedpur										1
							3	1			5
WCL	Shyams			1							1
	South										1
	Umer				1						1
	SUB									1	3
				1	1						1
BCL	Block-II			1							1
	S.Tipa							1			1
				1				1			2
ECL	Sonpur										1
	Basani			1							
SCLL	Ramagundam-1			1							1
	Ramagundam-2										1
	am-3			1							2
		1		1							2
INDIA		1	2	16	7	1	10	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.

(Refer Slide Time: 14:26)



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

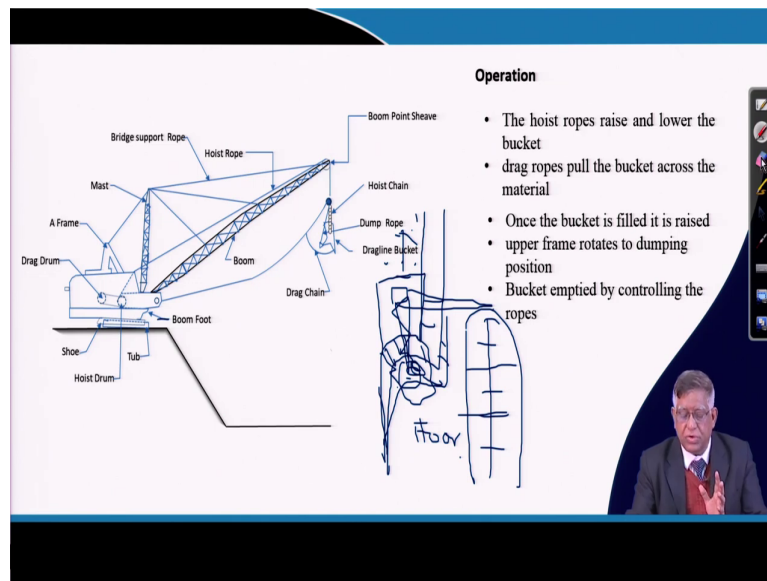
dig. And then this rope is released with that dig part your this drag rope it drags the bucket along this floor and then the slope.

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.

(Refer Slide Time: 17:15)



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 hump like this exactly the overburden 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.

(Refer Slide Time: 19:17)

Factors necessary for operation of Dragline:

1. Gradients flatter than 1 in 6
2. Seams should be free of faults & other geological disturbances
3. Deposits with Major Strike length
4. Thick seams with more than 25m thick are not suitable
5. A hilly property is not suitable

Disadvantages of a dragline:

- Constraints on dig depth and dump height,
- Relatively inflexible,
- Requires detailed planning,
- High capital cost.

The slide also features a hand-drawn diagram of a dragline bucket and a small video inset of a man in a suit in the bottom right corner.

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

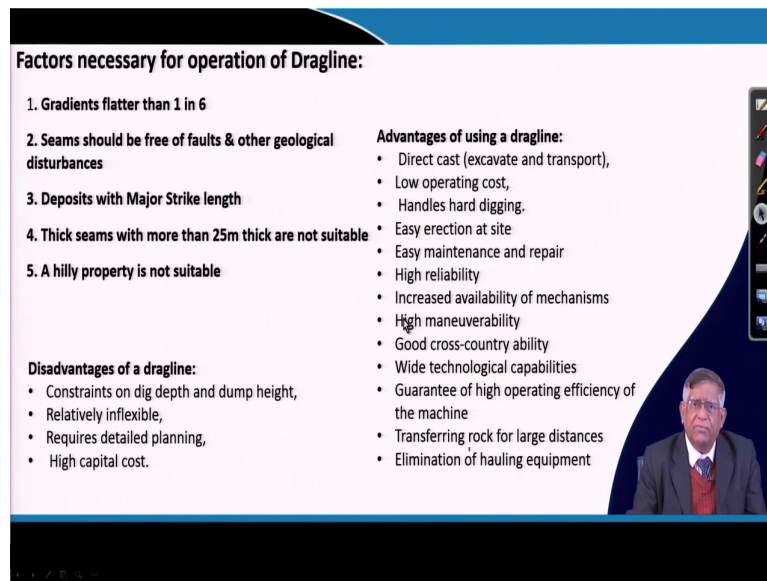
line work that is it should be the gradient should not be more than 1 in 6. Then seam should be free from false.

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.

(Refer Slide Time: 22:09)



Factors necessary for operation of Dragline:

1. Gradients flatter than 1 in 6
2. Seams should be free of faults & other geological disturbances
3. Deposits with Major Strike length
4. Thick seams with more than 25m thick are not suitable
5. A hilly property is not suitable

Disadvantages of a dragline:

- Constraints on dig depth and dump height,
- Relatively inflexible,
- Requires detailed planning,
- High capital cost.

Advantages of using a dragline:

- Direct cast (excavate and transport),
- Low operating cost,
- Handles hard digging.
- Easy erection at site
- Easy maintenance and repair
- High reliability
- Increased availability of mechanisms
- High maneuverability
- Good cross-country ability
- Wide technological capabilities
- Guarantee of high operating efficiency of the machine
- Transferring rock for large distances
- Elimination of hauling equipment

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


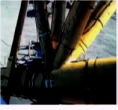
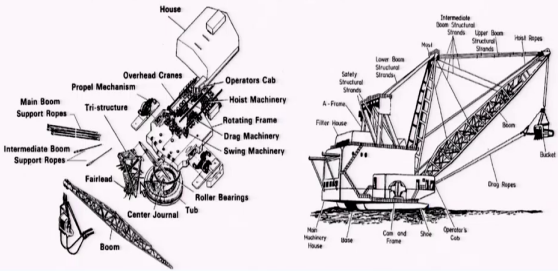
been operating in a very successfully. And it can work in that mining terrain no problem and it has got a lot of use.

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.

(Refer Slide Time: 23:53)

Design Features

- The boom is a triangular tubular space truss. The top chord is pre-compressed with force exceeding the working tension. This considerably increases fatigue resistance of the structure, its reliability and service lifetime;
- Truck frame and turntable consist of sections connected with high-strength bolts. This reduces erection labor intensity and shortens erection time;
- Hydraulic dragline walking mechanism provides for smooth machine movement and high maneuverability. Depending on dragline model, the walking mechanism may feature three- or four-point design;
- The smallest dragline model features four-bar crank-hinge walking mechanism with a DC electric motor;



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 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.

(Refer Slide Time: 27:32)

Design Features

- Depending on the model, the turning mechanism may feature different numbers of planetary or parallel-shaft reduction gear units;
- Dragline models with high unit power feature gearless turning mechanism drive with four, six or eight low-speed motors;
- Rotary support with taper rollers and forged rails;

A walking dragline had mounted to the frame of the upper works and utilized an eccentric trunnion to impart a walking motion to a shoe on either side of the dragline. The trunnion was *operated by a rotating shaft*, and as the shaft turned the shoes, and the front of the dragline itself, were alternately lifted up and forward and then lowered gently to the ground, thus propelling the machine forward. When digging, the shoes were left in the raised position, and the machine's base, called the tub after its tub-like appearance, bore the dragline's weight and spread it more widely than could a set of crawlers.

In a later improved design, mounting the shoes to the trunnion was with cams instead of suspending them from it by chains

- Two operator's cabs permit both right-hand and left-hand control to suit the particular conditions of the excavation area. Cabs comply with the latest ergonomic requirements and provide for state-of-the-art comfort degree.
- Automatic centralized lubrication system ensures longer service life time of dragline mechanisms and units with minimal friction power losses while saving lubrication material.
- Main units are driven from DC electric motors designed as generator-motor systems with excitation of electric units from static SCRs. The control system is based on solid state elements.

1913 design of walking dragline

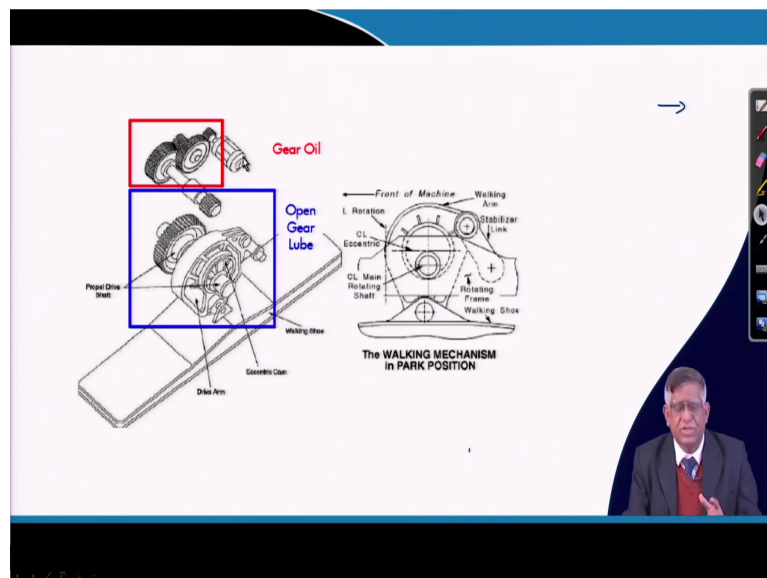
So, these are designed in such a way. You can see that 1913 design of walking drag line. You can see one eccentric here. Now, when it will be rotating this part at one time it will be giving a pressure over here that is your it will be giving a pressure over here and at that time this machine part will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

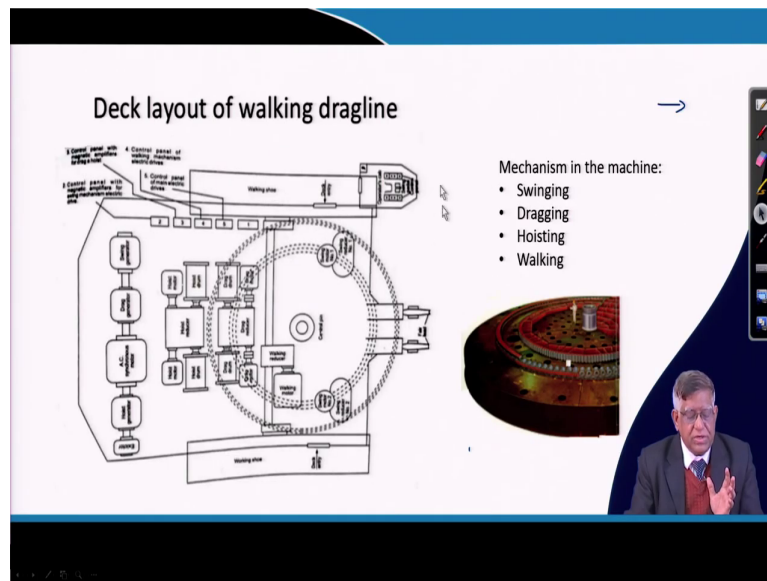
Now, there is a here the whole operation it can be it is also having a lot of moving part; the drums, then your the gears of the sun gear and then even the rope moving on the strips everything some they need lubrications. So, that is why this machine has got a centralized lubrication system so that it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

(Refer Slide Time: 28:57)



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.

(Refer Slide Time: 29:14)



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.

(Refer Slide Time: 30:28)

Bucket and Bucket Suspension

- Bucket design depends on the type of operation and digging conditions.
- Usually of rectangular section with an opening on one side.
- Available with different internal and external curves.
- Bucket is suspended from the boom sheave by attaching to hoist rope and drag rope.

1. HOIST SCKET
2. DRAG SCKET
3. CLAMP SCKET
4. DRAG HOIST CHAIN
5. DRAG HOIST CHAIN
6. DRAG HOIST CHAIN
7. DRAG HOIST CHAIN
8. DRAG HOIST CHAIN
9. DRAG HOIST CHAIN
10. DRAG HOIST CHAIN
11. DRAG HOIST CHAIN
12. DRAG HOIST CHAIN
13. DRAG HOIST CHAIN
14. DRAG HOIST CHAIN
15. DRAG HOIST CHAIN
16. DRAG HOIST CHAIN
17. DRAG HOIST CHAIN
18. DRAG HOIST CHAIN
19. DRAG HOIST CHAIN
20. DRAG HOIST CHAIN

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.

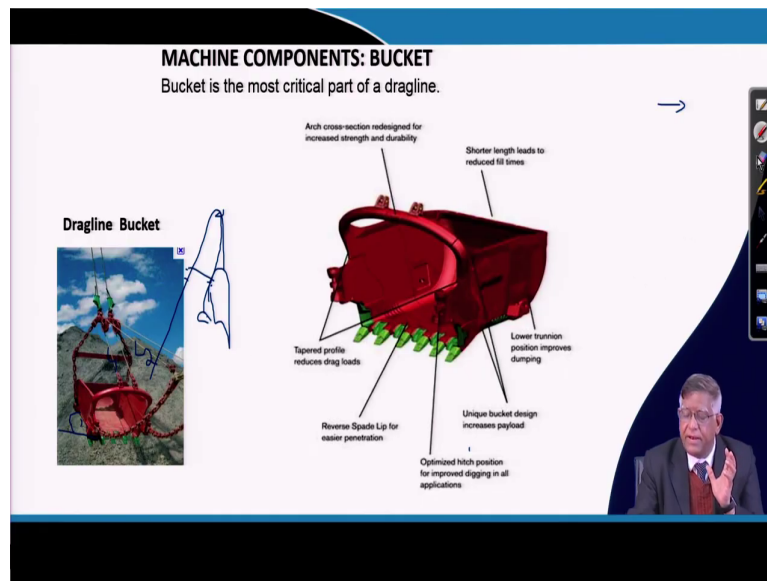
And then there is the upper hoist chain which is going to a hoist coupler one which we are having a shave where one rope from this arm of this bucket this rope called dump rope it is connected to a yoke or which is also called a coupler. On this coupler or the yoke there is one

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.

(Refer Slide Time: 32:26)



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.

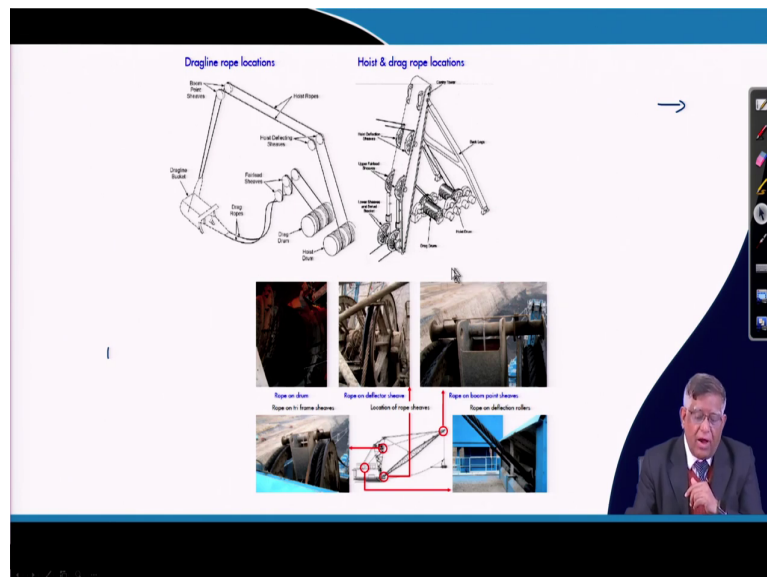
Say this is this rope l_1 and l_2 as I said by their ratio you can make it that bucket is totally upside down, which will be at that position of dumping it will go. So, controlling this angle is

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.

(Refer Slide Time: 34:37)



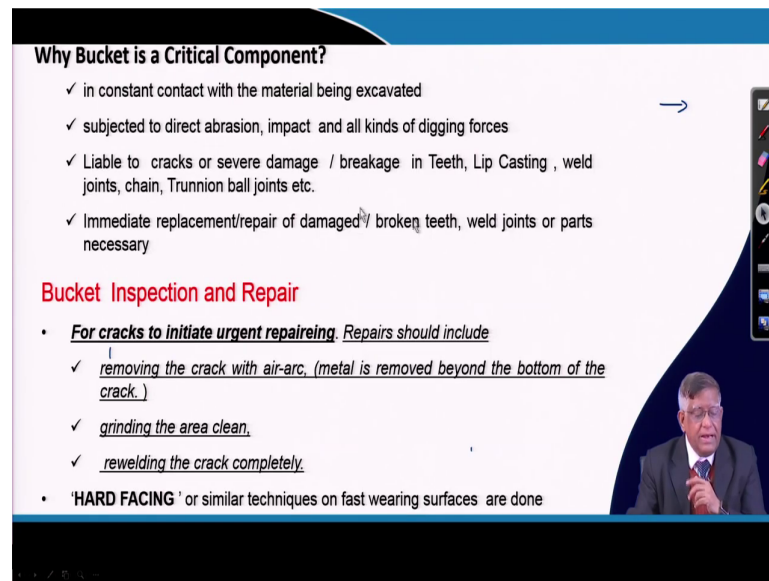
And then next is how the rope is reeved. You can see that in a drag drum and this is the hoist drum that hoist rope is connected to the bucket and drag rope is connected to the that is your with the drag chain. Now, this drag ropes they are coming through a your fair lid.

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.

(Refer Slide Time: 36:13)



Why Bucket is a Critical Component?

- ✓ in constant contact with the material being excavated
- ✓ subjected to direct abrasion, impact and all kinds of digging forces
- ✓ Liable to cracks or severe damage / breakage in Teeth, Lip Casting, weld joints, chain, Trunnion ball joints etc.
- ✓ Immediate replacement/repair of damaged / broken teeth, weld joints or parts necessary

Bucket Inspection and Repair


- **For cracks to initiate urgent repairing.** *Repairs should include*
 - ✓ removing the crack with air-arc. (metal is removed beyond the bottom of the crack.)
 - ✓ grinding the area clean.
 - ✓ rewelding the crack completely.
- 'HARD FACING' or similar techniques on fast wearing surfaces are done

So, similarly this bucket is a very critical component because if there is any problem with it 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.

(Refer Slide Time: 36:29)

Bucket Inspection and Repair

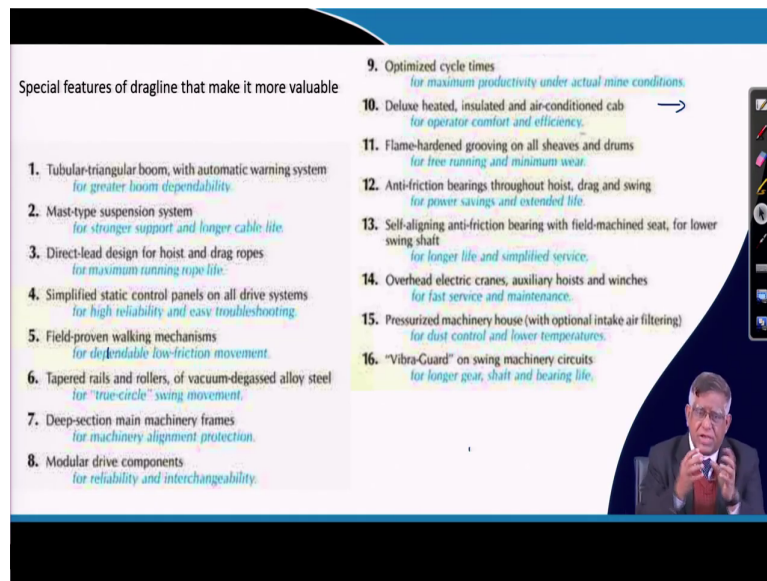
- Welding should be done with proper / recommended electrodes as per recommended welding procedures by approved welder
- **A New Bucket should not be hard faced before it is put to work.** It should be allowed to polish up so that it load and dump well.
- **Heavy Wear Plating or Hard Facing inhibit loading & dumping.** A new bucket should be operated for at least 3 to 4 weeks to allow the exact wear area to show up and allow stresses created during fabrication to be relieved. The recommended delay in wear plating can save money and dead weight since wear protection can be applied only where needed. The additional weight of liners to be kept within the capacity of the machine.
- **TOOTH POINTS AND BASE** are heat treated for maximum hardness and wear resistance. **Rebuilding or hard facing of these parts is seldom an economical alternative to replace worn parts.** In fact, this practice may lead to premature failure of the part. However, if these parts are to be hard faced, it should be of the dot type with preheat and post heat.



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.

(Refer Slide Time: 37:15)



Special features of dragline that make it more valuable

1. Tubular-triangular boom, with automatic warning system
for greater boom dependability.
2. Mast-type suspension system
for stronger support and longer cable life.
3. Direct-lead design for hoist and drag ropes
for maximum running rope life.
4. Simplified static control panels on all drive systems
for high reliability and easy troubleshooting.
5. Field-proven walking mechanisms
for dependable low-friction movement.
6. Tapered rails and rollers, of vacuum-degassed alloy steel
for "true-circle" swing movement.
7. Deep-section main machinery frames
for machinery alignment protection.
8. Modular drive components
for reliability and interchangeability.
9. Optimized cycle times
for maximum productivity under actual mine conditions.
10. Deluxe heated, insulated and air-conditioned cab
for operator comfort and efficiency.
11. Flame-hardened grooving on all sheaves and drums
for free running and minimum wear.
12. Anti-friction bearings throughout hoist, drag and swing
for power savings and extended life.
13. Self-aligning anti-friction bearing with field-machined seat, for lower swing shaft
for longer life and simplified service.
14. Overhead electric cranes, auxiliary hoists and winches
for fast service and maintenance.
15. Pressurized machinery house (with optional intake air filtering)
for dust control and lower temperatures.
16. "Vibra-Guard" on swing machinery circuits
for longer gear, shaft and bearing life.

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 mast 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 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.

(Refer Slide Time: 39:33)

APPLICATIONS

Basic tasks

- Excavating a trench
- Sloping an embankment
- Digging underwater

Methods of Dragline Stripping

The stripping cycle of dragline involves *positioning, dragging and dumping*:

- trench being cut which is generally called key cut by the Dragline.
- Dig out length is the distance between the previous key cut position to the new key cut position.
- Proper planning of the key cut is important as it is made to maintain the panel width with and uniform highwall.
- With each subsequent dig out the panel width get narrow if there is no key cut.

- On completion of the key cut, the dragline is moved to the new position to complete the dig out excavation which is called production cut.
- In production cut the material is dumped on top of the key cut spoil.
- After completion of the dig out the dragline is moved to the next position to begin the next stripping cycle.

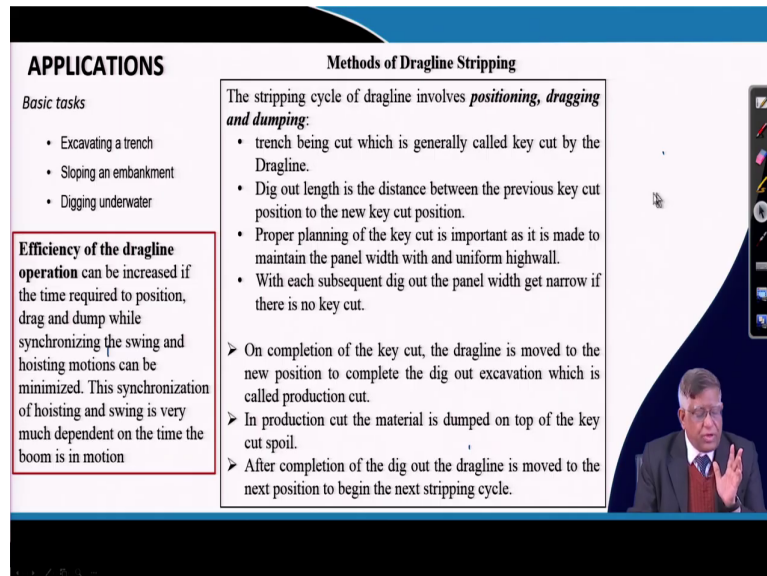
Now, one thing is the whole application it can be there for excavating of trends, sometimes you can do a smaller machine for civil work. You will be doing for the sloping of the embankment. You can raise the embankment in a mine then also digging in the underwater. These are the civil applications other 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.

(Refer Slide Time: 40:58)



APPLICATIONS

Basic tasks

- Excavating a trench
- Sloping an embankment
- Digging underwater

Efficiency of the dragline operation can be increased if the time required to position, drag and dump while synchronizing the swing and hoisting motions can be minimized. This synchronization of hoisting and swing is very much dependent on the time the boom is in motion

Methods of Dragline Stripping

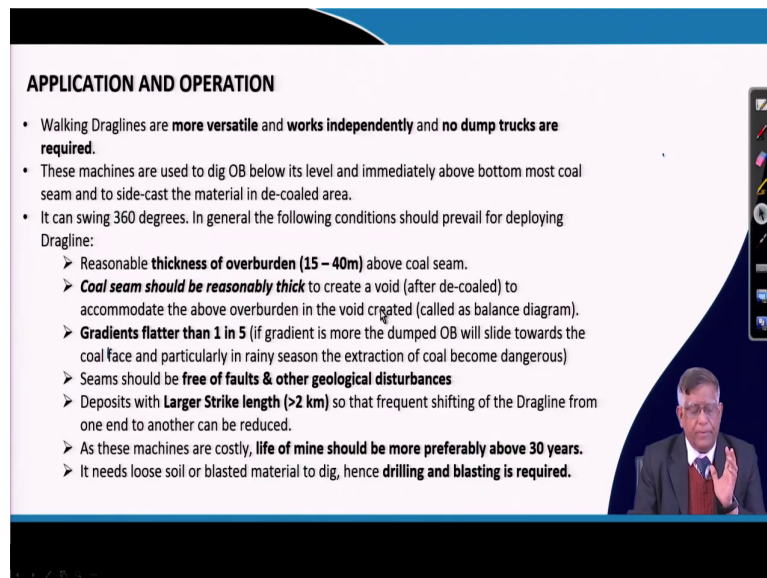
The stripping cycle of dragline involves *positioning, dragging and dumping*:

- trench being cut which is generally called key cut by the Dragline.
- Dig out length is the distance between the previous key cut position to the new key cut position.
- Proper planning of the key cut is important as it is made to maintain the panel width with and uniform highwall.
- With each subsequent dig out the panel width get narrow if there is no key cut.

- On completion of the key cut, the dragline is moved to the new position to complete the dig out excavation which is called production cut.
- In production cut the material is dumped on top of the key cut spoil.
- After completion of the dig out the dragline is moved to the next position to begin the next stripping cycle.

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.

(Refer Slide Time: 41:10)



APPLICATION AND OPERATION

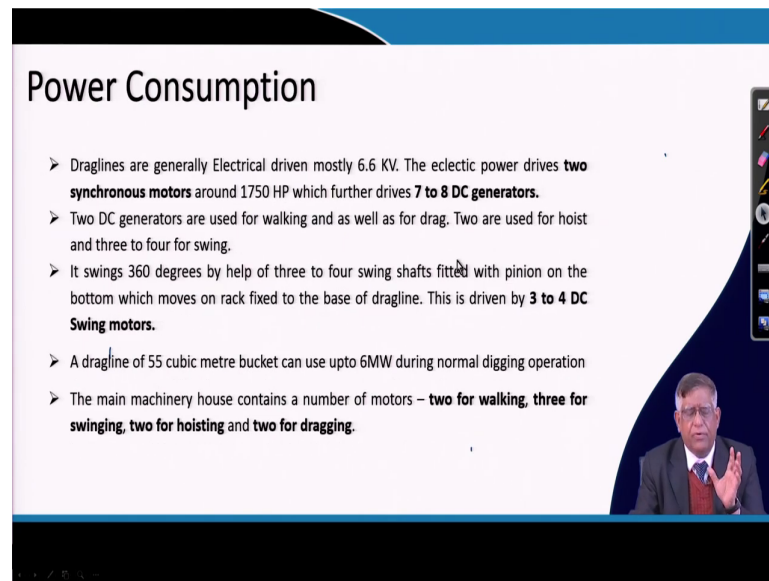
- Walking Draglines are **more versatile** and **works independently** and **no dump trucks are required**.
- These machines are used to dig OB below its level and immediately above bottom most coal seam and to side-cast the material in de-coaled area.
- It can swing 360 degrees. In general the following conditions should prevail for deploying Dragline:
 - Reasonable **thickness of overburden (15 – 40m)** above coal seam.
 - **Coal seam should be reasonably thick** to create a void (after de-coaled) to accommodate the above overburden in the void created (called as balance diagram).
 - **Gradients flatter than 1 in 5** (if gradient is more the dumped OB will slide towards the coal face and particularly in rainy season the extraction of coal become dangerous)
 - Seams should be **free of faults & other geological disturbances**
 - Deposits with **Larger Strike length (>2 km)** so that frequent shifting of the Dragline from one end to another can be reduced.
 - As these machines are costly, **life of mine should be more preferably above 30 years**.
 - It needs loose soil or blasted material to dig, hence **drilling and blasting is required**.

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.

(Refer Slide Time: 42:02)



Power Consumption

- Draglines are generally Electrical driven mostly 6.6 KV. The eclectic power drives **two synchronous motors** around 1750 HP which further drives **7 to 8 DC generators**.
- Two DC generators are used for walking and as well as for drag. Two are used for hoist and three to four for swing.
- It swings 360 degrees by help of three to four swing shafts fitted with pinion on the bottom which moves on rack fixed to the base of dragline. This is driven by **3 to 4 DC Swing motors**.
- A dragline of 55 cubic metre bucket can use upto 6MW during normal digging operation
- The main machinery house contains a number of motors – **two for walking, three for swinging, two for hoisting and two for dragging**.

42 / 42

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.

(Refer Slide Time: 42:23)

Limitations

- Boom height and boom depth
- Digging depth
- Digging above its working level is inefficient
- Extremely high capital cost
- High power consumption

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.

(Refer Slide Time: 42:38)

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.

(Refer Slide Time: 42:38)

ENSURING SAFETY IN DRAGLINE DEPLOYMENT

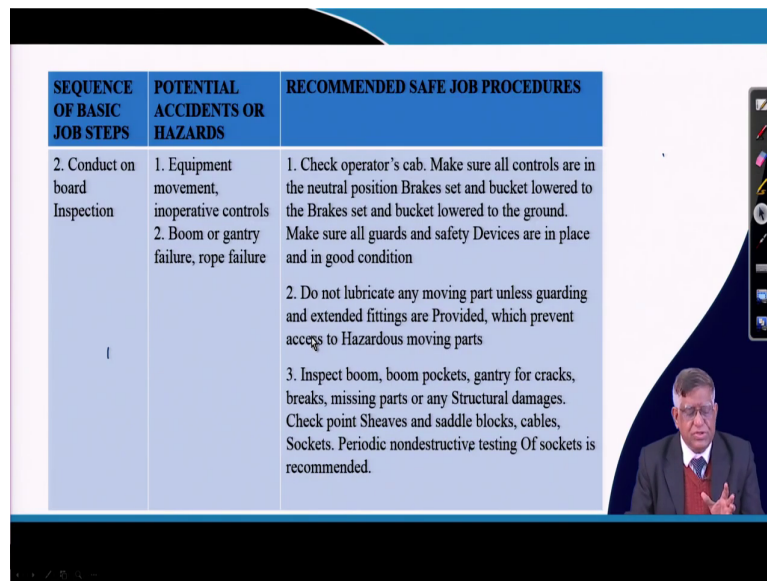
Hard hat, safety shoes, safety glasses with side shields, gloves, snug fitting clothing appropriate for weather conditions, hearing protection where needed

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
1. Conduct walk around Inspection of dragline and work area	1. Personal injury, unsafe equipment or work area. 2. Fall of material or overturning machine. 3. Equipment damage or malfunction 4. Slips and fall	1. Visually inspect machine and work location And report to supervisor and correct the defects. 2. Inspect highwall, spoil and pit conditions Be sure dragline is on solid ground and area is as level as possible 3. Check for oil leaks, gear wear or damaged rollers or crawlers, tub cable hooks, lubrication of gears and rollers, signal devices. Inspect bucket, drag ropes Sockets drag chain, sheaves boom cables boom structure for any damage or unusual wear. 4. Slip resistant flooring is recommended in walkway zones.

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.

(Refer Slide Time: 43:31)

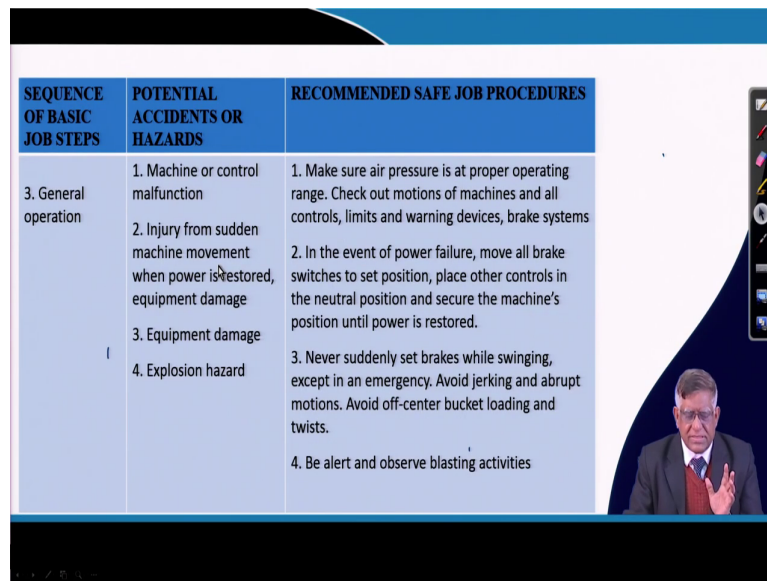


SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
2. Conduct on board Inspection	1. Equipment movement, inoperative controls 2. Boom or gantry failure, rope failure	1. Check operator's cab. Make sure all controls are in the neutral position Brakes set and bucket lowered to the ground. Make sure all guards and safety Devices are in place and in good condition 2. Do not lubricate any moving part unless guarding and extended fittings are Provided, which prevent access to Hazardous moving parts 3. Inspect boom, boom pockets, gantry for cracks, breaks, missing parts or any Structural damages. Check point Sheaves and saddle blocks, cables, Sockets. Periodic nondestructive testing Of sockets is recommended.

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.

(Refer Slide Time: 44:13)

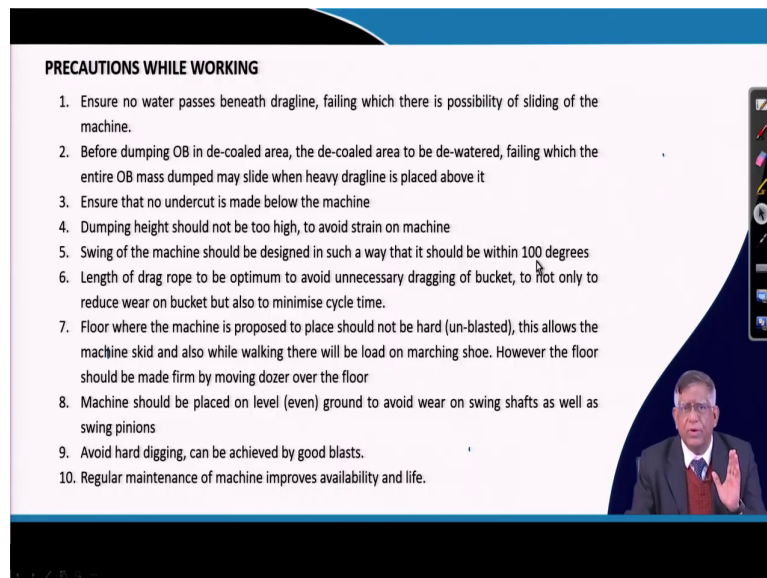


SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
3. General operation	<ol style="list-style-type: none">1. Machine or control malfunction2. Injury from sudden machine movement when power is restored, equipment damage3. Equipment damage4. Explosion hazard	<ol style="list-style-type: none">1. Make sure air pressure is at proper operating range. Check out motions of machines and all controls, limits and warning devices, brake systems2. In the event of power failure, move all brake switches to set position, place other controls in the neutral position and secure the machine's position until power is restored.3. Never suddenly set brakes while swinging, except in an emergency. Avoid jerking and abrupt motions. Avoid off-center bucket loading and twists.4. Be alert and observe blasting activities

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.

(Refer Slide Time: 44:54)



PRECAUTIONS WHILE WORKING

1. Ensure no water passes beneath dragline, failing which there is possibility of sliding of the machine.
2. Before dumping OB in de-coaled area, the de-coaled area to be de-watered, failing which the entire OB mass dumped may slide when heavy dragline is placed above it
3. Ensure that no undercut is made below the machine
4. Dumping height should not be too high, to avoid strain on machine
5. Swing of the machine should be designed in such a way that it should be within 100 degrees
6. Length of drag rope to be optimum to avoid unnecessary dragging of bucket, to float only to reduce wear on bucket but also to minimise cycle time.
7. Floor where the machine is proposed to place should not be hard (un-blasted), this allows the machine skid and also while walking there will be load on marching shoe. However the floor should be made firm by moving dozer over the floor
8. Machine should be placed on level (even) ground to avoid wear on swing shafts as well as swing pinions
9. Avoid hard digging, can be achieved by good blasts.
10. Regular maintenance of machine improves availability and life.

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.

(Refer Slide Time: 47:05)

Dragline Maintenance

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

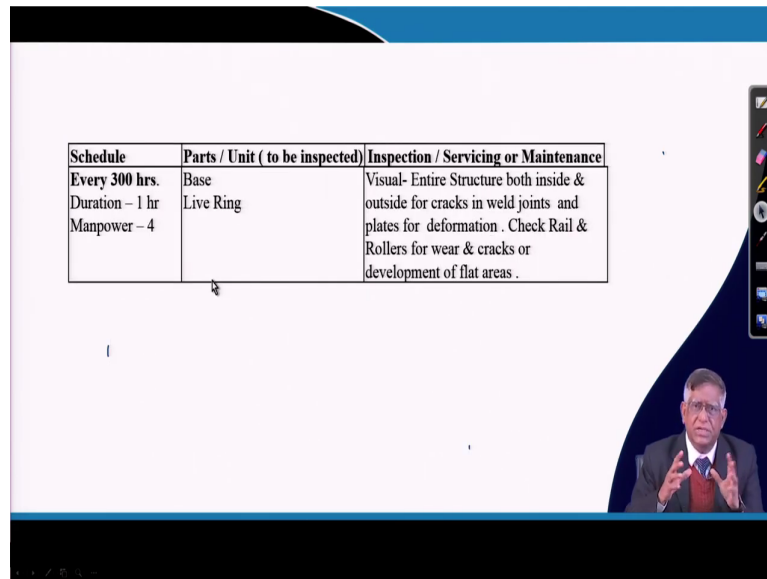
So, as a maintenance its components like your bucket, your hoist and drag ropes, your air receiver this need to be inspect. The operators or the machines manufacturers manual it gives a checklist. So, it is your responsibility to have an idea of how these checklists are prepared. The checklists they 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.

(Refer Slide Time: 47:39)

Schedule	Parts / Unit (to be inspected)	Inspection / Servicing or Maintenance
Weekly (every 150 hrs) Duration - 3 hr Manpower - 6	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

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.

(Refer Slide Time: 48:07)



Schedule	Parts / Unit (to be inspected)	Inspection / Servicing or Maintenance
Every 300 hrs.	Base	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 .
Duration - 1 hr	Live Ring	
Manpower - 4		

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.

(Refer Slide Time: 48:35)

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

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.

(Refer Slide Time: 48:44)

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	

(Refer Slide Time: 48:47)

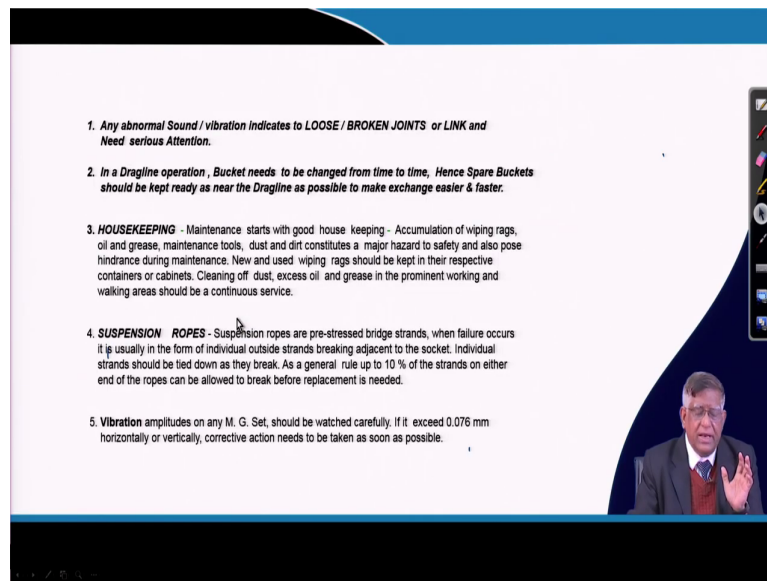
Every 300 hrs. Duration – 1 hr Manpower – 4	Base Live Ring	Visual- Entire Structure both inside & outside for cracks in weld joints and plates for deformation . Check Rail & Rollers for wear & cracks or development of flat areas .
Monthly (Every 600 hrs) Duration – 6 hr Manpower – 6	Rotate Frame	Visual - 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
	Faj/leads	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

(Refer Slide Time: 48:49)

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
	Faj/leads	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

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.

(Refer Slide Time: 48:49)



1. *Any abnormal Sound / vibration indicates to LOOSE / BROKEN JOINTS or LINK and Need serious Attention.*

2. *In a Dragline operation , Bucket needs to be changed from time to time, Hence Spare Buckets should be kept ready as near the Dragline as possible to make exchange easier & faster.*

3. **HOUSEKEEPING** - Maintenance starts with good house keeping - Accumulation of wiping rags, oil and grease, maintenance tools, dust and dirt constitutes a major hazard to safety and also pose hindrance during maintenance. New and used wiping rags should be kept in their respective containers or cabinets. Cleaning off dust, excess oil and grease in the prominent working and walking areas should be a continuous service.

4. **SUSPENSION ROPES** - Suspension ropes are pre-stressed bridge strands, when failure occurs it is usually in the form of individual outside strands breaking adjacent to the socket. Individual strands should be tied down as they break. As a general rule up to 10 % of the strands on either end of the ropes can be allowed to break before replacement is needed.

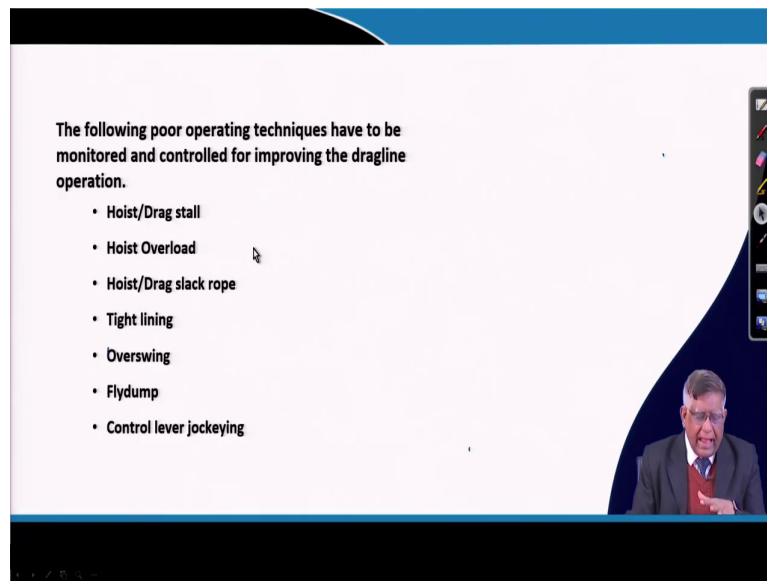
5. **Vibration** amplitudes on any M. G. Set, should be watched carefully. If it exceed 0.076 mm horizontally or vertically, corrective action needs to be taken as soon as possible.

The slide also features a small video inset in the bottom right corner showing a man in a suit and glasses speaking, and a vertical toolbar on the right side of the slide.

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.

(Refer Slide Time: 49:37)



The following poor operating techniques have to be monitored and controlled for improving the dragline operation.

- Hoist/Drag stall
- Hoist Overload
- Hoist/Drag slack rope
- Tight lining
- Overswing
- Flydump
- Control lever jockeying

Now for that as an 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.

(Refer Slide Time: 50:26)

ESTIMATING THE BUCKET SIZE:

Estimated on the basis of maximum allowable suspended load to the machine.

- Let *loose density of the material* to be stripped = 1.602 t/m^3
- Approximate *tare weight of heavy duty buckets* including rigging, teeth and wear plates = 1.335 t/m^3 of bucket capacity.
- Approximate *tare weight of light duty buckets* including rigging, teeth and wear plates = 1.246 t/m^3 of bucket capacity.
- Total weight of material and tare weight* of heavy duty buckets including rigging etc. = $a + b = 2.937 \text{ m}^3$ of bucket capacity.
- Total weight of material and tare weight of light duty buckets including rigging etc. = $a + b = 2.848 \text{ m}^3$ of bucket capacity.
- Assuming that **maximum allowable load** on the dragline (**sas from specification**) equals 181.44 t at 30° boom angle.

Therefore,

- The **rated capacity of heavy duty bucket** = $f/d = 181.44 \text{ t} = 2.937 \text{ t/m}^3$ of bucket capacity or 62 m^3 .
- The **rated capacity of light duty bucket** = $f/e = 181.44 \text{ t} = 2.848 \text{ t/m}^3$ of bucket capacity or 64.4 m^3 .

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.

(Refer Slide Time: 51:31)

RATED BUCKET CAPACITY MEASUREMENT:

The **struck** capacity of dragline is given by the formula:

$$S_s = (W_a \times H_a \times L \times F) / 10^6$$

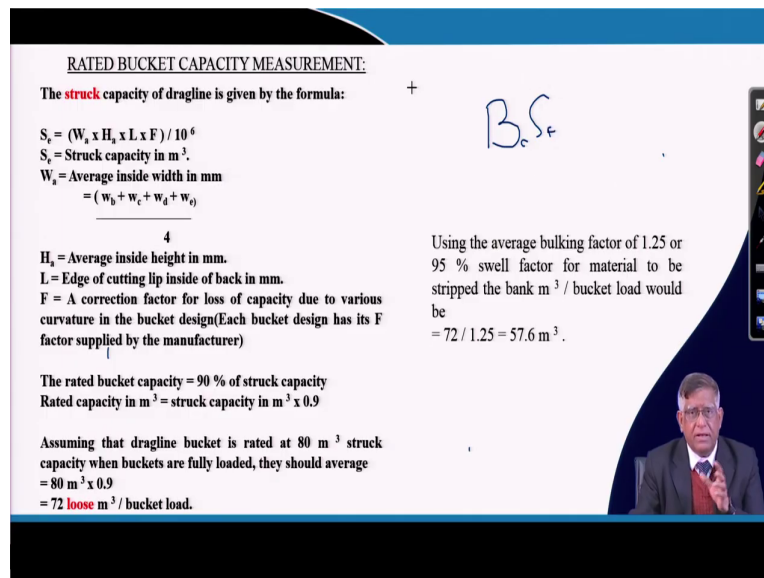
S_s = Struck capacity in m^3 .
 W_a = Average inside width in mm
 $= (w_b + w_c + w_d + w_e) / 4$
 H_a = Average inside height in mm.
 L = Edge of cutting lip inside of back in mm.
 F = A correction factor for loss of capacity due to various curvature in the bucket design (Each bucket design has its F factor supplied by the manufacturer)

The rated bucket capacity = 90 % of struck capacity
Rated capacity in m^3 = struck capacity in $m^3 \times 0.9$

Assuming that dragline bucket is rated at $80 m^3$ struck capacity when buckets are fully loaded, they should average
 $= 80 m^3 \times 0.9$
 $= 72 \text{ loose } m^3 / \text{ bucket load.}$

Using the average bulking factor of 1.25 or 95 % swell factor for material to be stripped the bank m^3 / bucket load would be
 $= 72 / 1.25 = 57.6 m^3$.

BSF



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 loose 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.

(Refer Slide Time: 53:26)

DRAGLINE PRODUCTIVITY
Dragline productivity is generally expressed in terms of m³ (bank)/hour.
Theoretical productivity (Q_{th}) may be given as

$$Q_{th} = B_c \times B_f \times \frac{100}{100 + S} \times \frac{3600}{t_c \times F_s} \text{ m}^3 \text{ (bank)/hour}$$

However, the actual or effective productivity (Q_{eff}) is less than the theoretical productivity and is given by

$$Q_{eff} = B_c \times B_f \times \frac{100}{100 + S} \times \frac{3600}{t_c \times F_s} \times E \text{ m}^3 \text{ (bank)/hour}$$

Where,

- B_c is the bucket capacity in m³
- B_f is the bucket fill factor
- S is the % Swell of the spoil material
- t_c is the actual cycle time in sec.
- F_s is the factor of swing
- E is the overall utilization factor.

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.

(Refer Slide Time: 53:58)

When the material in bank is directly excavated without prior blasting, **bucket fill factor** (B_f) becomes a function of the material characteristics. But in case of excavation of blasted rock, B_f primarily depends on the dragline bucket size and the average lump sizes of the broken material. As the ratio of the bucket size to the average lump size increases, B_f also increases. In practical situations B_f generally has a value between 0.75 and 0.85.

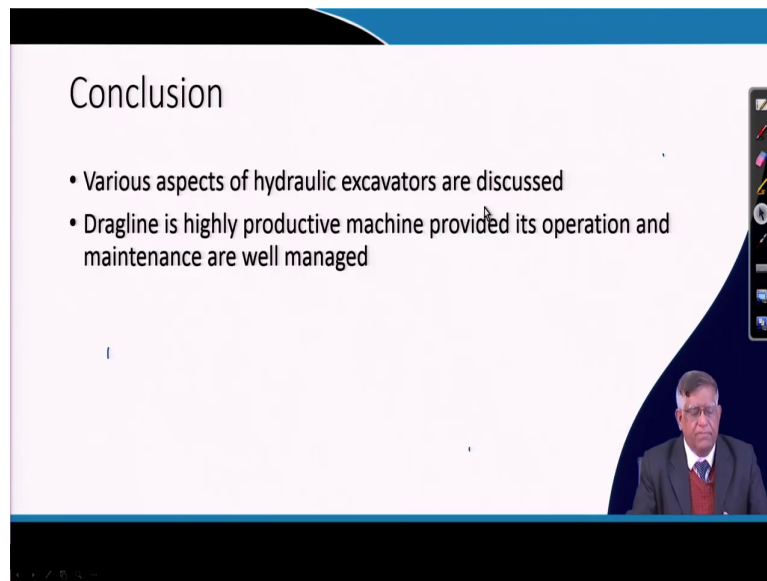
Percentage swell (S) is primarily a function of material characteristics, but this is also influenced by the degree of fragmentation in case of blasted rock. Higher the degree of fragmentation (i.e. Lower the average fragment size), S will be more, limited to a maximum value that is dependent on the material characteristics. Generally for coal measure rocks S has a value around 20.

Factor of swing (F_s) is a cycle time correction factor to take into account the angle of swing that the dragline has to make for the given method of working.

The **overall utilization factor** (E) is the ratio of the actual working hours to the scheduled shift hours (= actual working hours + maintenance hours + idle hours). So, it depends on the maintenance hours required and the idle hours corresponding to particular working hours. In India, the average value of E is about 0.7 for wheel loaders.

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

(Refer Slide Time: 54:02)

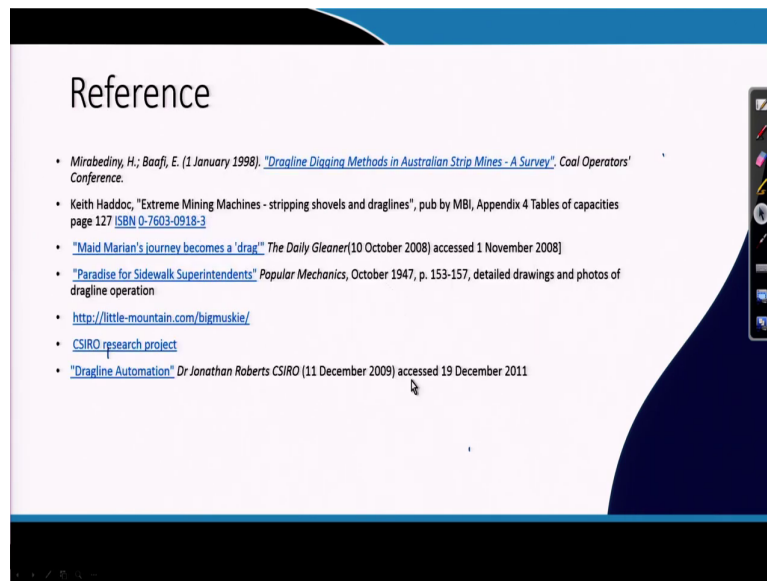


Conclusion

- Various aspects of hydraulic excavators are discussed
- Dragline is highly productive machine provided its operation and maintenance are well managed

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.

(Refer Slide Time: 54:25)



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.