Mining Machinery
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Module – 03
Lecture – 11
Steel Wire Rope Maintenance

In the last class, we discussed about the wire ropes, Steel Wire Ropes, how they are used in the mining industry and we will be doing more with wire rope when we will be discussing about the rope haulage system and winding system. There we will have to do some of the wire rope calculations, but as a general understanding let us talk about that what type of problems are faced in steel wire ropes and then how they are maintained.

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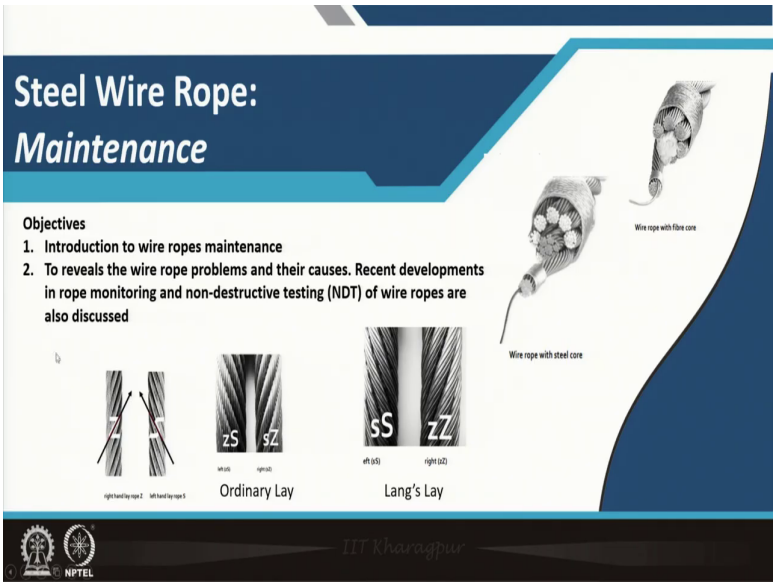

So, our objectives of today's lecture is just to introduce the wire rope maintenance and then to reveal the wire rope problems, their causes and then what are the recent developments in the non-destructive testing of ropes.

So, just to refresh that you have studied already that the wire ropes are constructed with either fiber rope or fiber core rope or steel core rope and also, we know that right hand lay rope and the left hand lay rope depending on this how the wires in the rope and the ropes in the wire are laid, depending on that we have got this ordinary lay and Lang's lay.

These are things we have discussed. Now, this rope when they will be working what is the working conditions in the mining industry? Full of dust, humid and in a very difficult work conditions the wire ropes will be applied. So, what type of problems may arise and then how they will have to be overcoming?

So, one thing is very important that as because these are all made of steel, they will be subjected to the problems normally the steel go that is it can be affected by corrosion, it will be affected by wear and tear, it will be there can be misuse, there could be if the load depending on the load it can break and depending on different type of abuse these wires may be getting damaged or separated, the strength of the rope may get deteriorated and then we will need to test it.

Now whether this what is the strength of it can be tested by destructive testing by making it to break, we can find out the breaking load, but whether the internal conditions are properly working or not that can be found if we do some non-destructive testing. That means, while the rope is in service, we need to do some instrumentations in the wire rope, so that we can know what is the condition of it.

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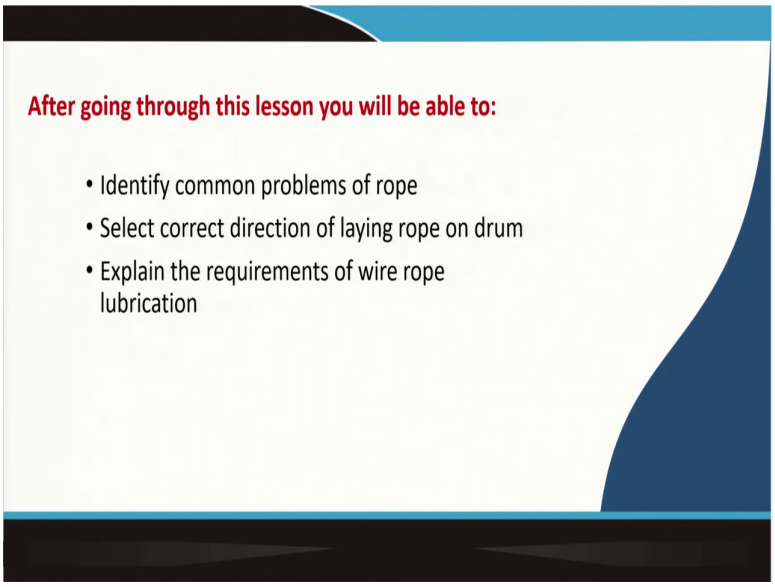

So, we will be addressing these issues, so that after attending this class you will be able to identify some common problems of rope and also, you will be able to select that what will be the how we will have to keep it, so that the problems are less that is how you will be handling the wire rope and also what how will be lubricating whether there is a lubrication why it is necessary; because there is a there will be a movement of the strand to strand wire to strand and that is why a lubrication is necessary in case of wire rope. We will be discussing these issues today.

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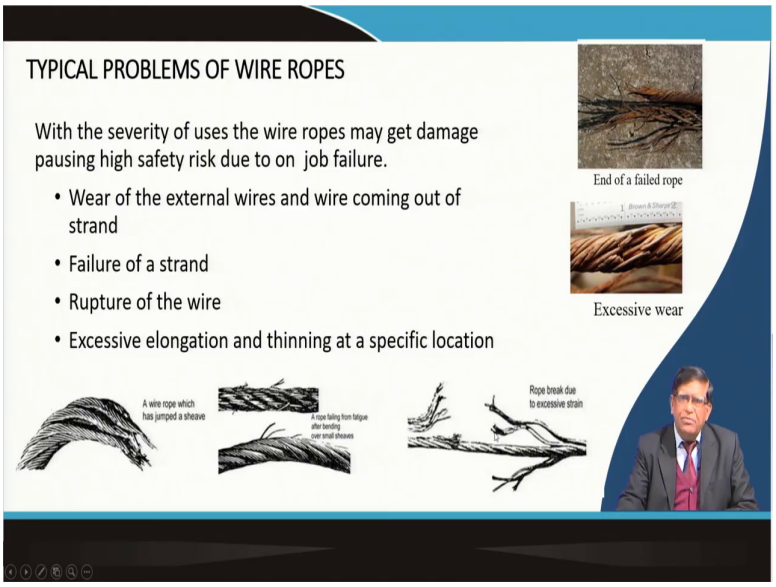

Now what are the typical problem what a wire rope face? It is with the severity of the uses of these wire ropes may get damaged and it may pose a high safety risk due to and then in the job, it can fail and you know that depending if the rope breaks or it fails, then there could be a disaster also.

So, wear of the external wires and wires coming out of strand this is one problem that may takes place because if the wires from a strand get peeled off and then they will be just taking out like that with a number of wires if get cut. That means, the whole rope strand will get reduced and sometimes the whole strand, a particular strand may get damaged, then the thicken that is your the diameter of the rope for a particular portions may get weaken and that becomes a weak point in the wire rope.

So, sometimes the wires may rapture or sometimes there could be additional elongations. So, this type of problem are there in case of in our wire ropes. So, the typical problems of wire ropes that you can find out sometimes there could be as in the figure you can see that the end of the rope failed. They say it raptured and then this your a particular with the all the wires and the strands got separated out. This is a failed rope you can see over there.

Now, this is depending on the type of use. Many a times a wire rope will be subjected to very severe uses. So, the external wires and the wire can come out of the strand. This type of problem is there now the failure of the strand, rupture of the strand and that excessive elongations that may lead to and then you can see in this figure how excessive wire has taken place. So, because of that wire that rope strength has got reduced over here.

So, also that a wire rope can as I just it can be jumping out of the if that there is a breakage in the wire rope when it is running moving over the sheave, it can come out of the sheave and then it will be falling on the side and then, it will get that is rubbed differently and then the wire will get damaged.

Sometimes there will be of course due to repeated use that they undergo fatigue and then over some sheaves if they are not of the proper diameter, then there will be more stress developed in the wire ropes and they may fail. Sometimes the rope breakout due to extensive strain. Because of the strain that they have got elongated and then there is a breakage of the wire rope over there.

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Now such type of problems can also be there say you have got a clock that is your corkscrew type deformation. The rope is getting deformed, then bridge that is a birdcage formation. That means, these strains are coming out of it and they are forming as a cage like things and then these portions will get weaken and then their rope will be ultimately damaged from here.

Then sometimes a protrusion or a deformed core strand that is inside the core is getting damaged. As a result it is getting swelled up and our whole wire rope is getting damaged like this. Sometimes small wires of the strand are coming out and forming small small loops you can see over there that is called looping and sometimes a strand is getting flattened and then by that it is the gap between two strands, they get come out as a result the rope is getting weaken and it can fail.

And sometimes depending on the use you can have a cleanse or tightening of the rope sling formations. This type of formation will be there and then these are that wherever there is this band that it get tensed differently and then you can start getting a issue which can lead to failure of the rope.

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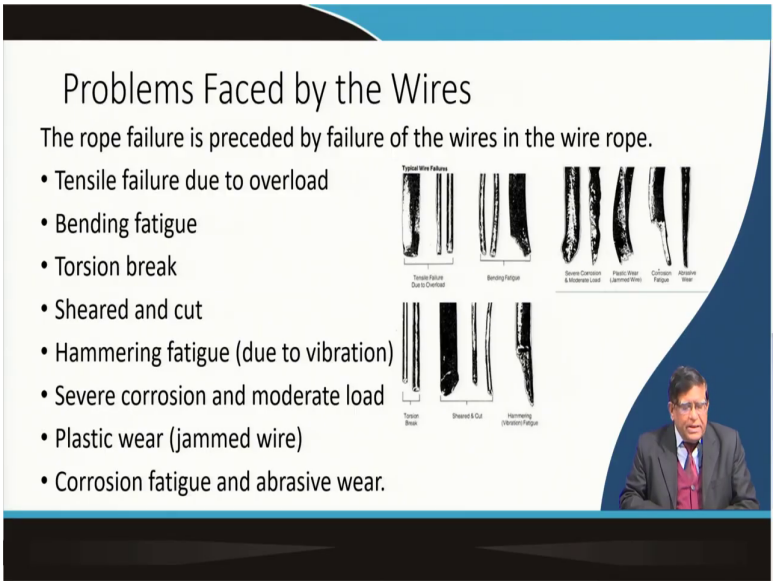

Now, sometimes this is the wires which are forming the strain that you can in the previous diagram you have seen these are problems in the strands, these are the problems in the strands.

Now in that wires which is forming the strand, they may also go undergo different type of failure that is your due to the overload, they may go a tensile failure, sometimes the bending

fatigue because repeatedly the wires are exactly moving over the sheave and the drum there it is repeated banding, it gives a bending fatigue.

Sometimes it may undergo torsional break, sometimes there may be a shear and cut, sometimes you can get the due to the vibration, a hammering fatigue may take place because of that vibrations in between that is on the sheave or the wire to that is your wire and the sheave. There will be a hammering action because of the vibrations taking place during this movement of it.

Then there is also a plastic wire that is a when a jammed wires get jammed and that is a plastic deformations in the wires may takes place, then corrosion fatigue and abrasion wire is also there. So, there are different types of the you can see some of the damaged wires figures that is exactly if it is a tensile failure, you can find out that due to the overload there is a thinning part of it. It has got elongated and then failed.

Sometime due to bending fatigue a different type of wires that damage you can see then torsion break, you can see sometimes even you can see when you are taking a small wire and then you to give a twisting and all after sometime it get failed. So, the similar things may happen in your wire ropes also. Shearing and cut, this is under different uses conditions it may get a cut type of things, so that corrosion is also one of the main problem you may find in different application situations.

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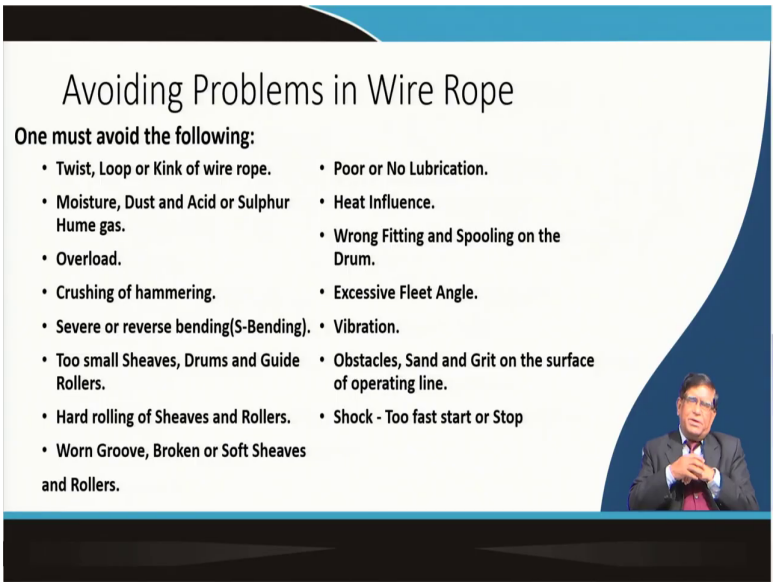

So, what we can do? That means, such type of problems are there in the wires and the strands. So, we will have to be careful in handling the wire ropes and then particularly the clink will be formed when you are taking out of the reel and then fitting it at that time, you need to take extra care. So, twist loop or kink of the wire should be avoided. If you can avoid certain situations, then your the maintenance of wire rope is basically avoiding the problematic situations.

You take utmost care say for example, moisture dust and sulphurous or hume gas conditions depending on the uses. Of course, in mining you get mainly the sometimes the mine water which may be having very low pH value under that conditions the if the wire rope say particularly the haulage wire haulage rope and all if it is running through that type of watery conditions, it may get damaged.

So, you will have to be careful about it and you must not overload when you determine that we will be discussing those while studying the transportations like by rope haulage and all. We will be doing the calculations how to determine the diameter and how to determine the material of the wire. Now, that means every installation there is a specific your prescription that it can be used only in that load conditions, you must not overload. It is clearly understanding.

Similarly the crushing and hammering action should not take place, severe reverse bending should not be there that as bending you must avoid, then the two small sheaves drums, then guide rollers should not be used. If you bend it on a small diameter, then this exactly they it will get more tensed.

So, that is why the diameter of the rope and the diameter of the drum, their ratio as prescribed should be utilized. You avoid using smaller diameter sheaves, hard rolling and rolling of the sheaves and the rollers sometimes on which the rope will be moving, that surface should not be very hard.

So, if it is very hard definitely that will not wire, your rope will get wired out. So, it is better to use certain form of liner that which will be exactly getting worn out and you can change that sheave easily, but then the wires will be protected then because laying of the wire rope and then putting it into service. That is also a tedious and lengthy operation. So, you should increase the life of the wire rope as much as possible.

Then worn grooves, broken soft sheaves and rollers if you are having some worn parts are being used, there can be sharp edges which may cut the wire and that damage may take place. So, that is why while using the wire rope all the components of the wire rope system should be seen that there is no sharp edges are getting entangled with the passes of the wire rope.

Similarly, there is a need of lubrications in the wire rope. If your wire rope is not properly lubricated, then also damage will be there. Now the lubrications of wire rope, it is done during the manufacturing. When you are manufacturing that as I said that there are a fiber

core wire rope or steel wire rope strand as a core; now during the manufacturing itself there is a lubricant is kept over there, but then there is also need of re-lubricating depending on the type of use.

Sometimes you might have seen in some cranes and all they apply this your cadmium compound over the wire rope. You may see a black color material or sometimes even the grease they put it. So, those how they will have to be applied for that also different methods are there which when you are particularly applying, you need to see the ropes should not run very dry.

And then heat influence some you should not avoid that the there should not be the lubrication. One main job is also between the sheave and the wire rope. If it is moving over there, there is a friction and it will generate heat, the lubricant is taking away that heat. So, you should see that there is no point of the passes or path of the wire rope, a heat generation takes place because that will be damaging your wire rope.

Similarly, you should be do the proper fitting the groves in when your rope will be moving on a drum, you can see wire rope used on the winch or wire rope in a drum or in you might have seen in mind winder when there will be winding drum and then there will be a sheave. Now from the in the winding drum that your rope will be moving say this is in your in case of your winding drum.

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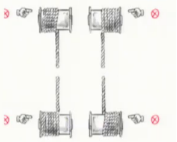
DIRECTION Of lay

- The choice of the correct direction of lay is essential for the proper functioning of a reeving system. A wrong direction of lay leads to torque build-up, spooling problems and structural changes

One layer spooling: For drums with one layer, the following applies***: right hand drum – left hand rope, left hand drum – right hand rope***
Multiple layer spooling: With multiple layer spooling, the direction of spooling changes from layer to layer. So the direction of lay of the rope would also have to be changed from layer to layer. Here, the direction of lay should be chosen for the layer which is working the most: ***right hand layer – left hand rope, left hand layer – right hand rope***
Multiple part reeving: In a multiple part reeving system, the influence of the fleet angles between the sheaves is often greater than the influence of the drum. In this case, the direction of lay of the rope should be chosen depending on the direction of the reeving: **right hand reeving – left hand lay rope left hand reeving – right hand lay rope**

right hand drum -
left hand lay rope
If you move your finger clockwise, the drum (reeving system) is right hand, and needs a left hand lay rope.



left hand drum -
right hand lay rope
If you move your finger counter-clockwise, drum (reeving system) is left hand, and nee right hand lay rope.

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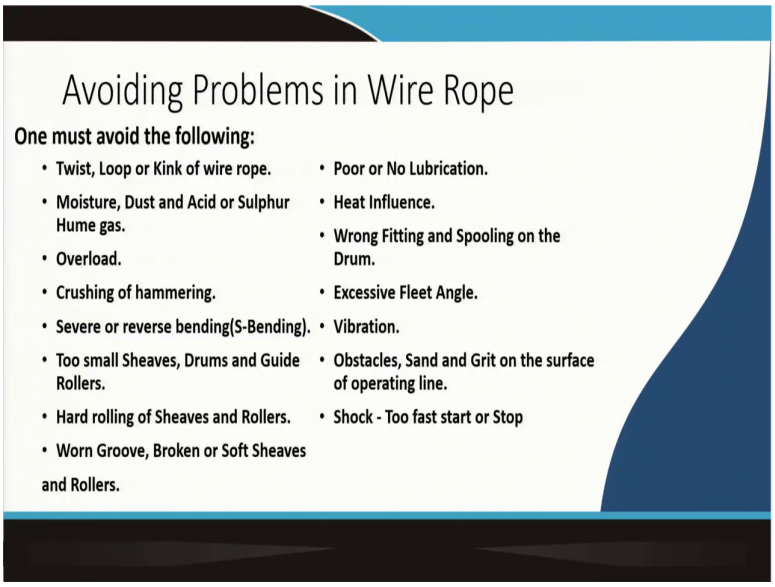

You will find that in case of your using a winder drum and then the sheave depending on the location of the drum and the sheave.

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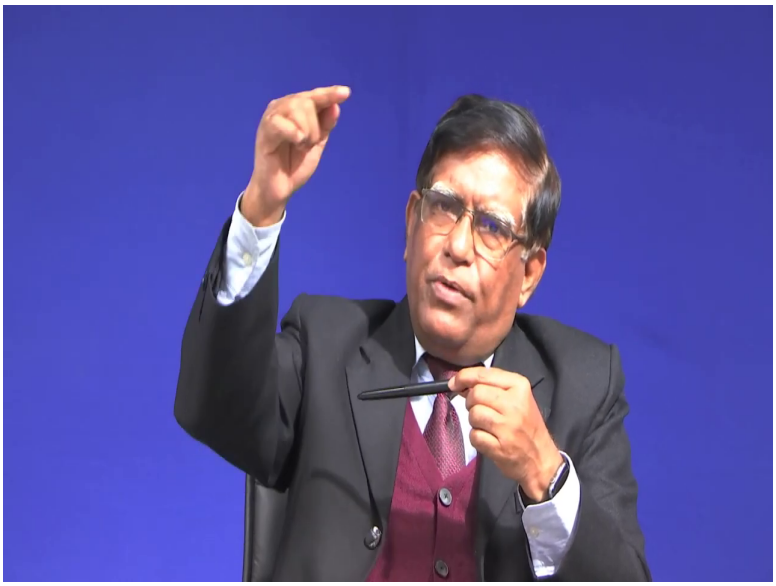

Suppose you are having this drum and then we have got a sheave over here. So, now this wire rope will be going from the drum and to the sheave. So, there is an angle that is from the sheave to the edge of the wire rope which is called a fleet angle and then, the in the groove where the wire rope will be there, there is also a groove angle.

Now, if these are not properly matched and when the rope will be going from the drum to the sheave, at that time on the groove edge it may that give a rubbing actions. So, that is why what should be the fleet angle and the group angle and the drum length these things are to be matched.

So, those are studied when you are going to select a particular applications of the wire rope, at that time we need to see that the location of the drum, location of the sheave and then the groove it is made in such a way that in the passes of the wire rope, it is not the not interfering and you are not going to damage the wire rope

So, for that this fleet angle should not be too large. There is a that is why there are international standards by which you will be selecting the fleet angle. Similarly in your there should not be vibrations.

Whenever you are using a wire rope system, there the vibration must be arrested say for example when your cage in a mine will be moving up and down, at that time your the cage must not oscillate for that exactly we are having the guide rope, so that it will be holding properly and this particular arrangements are necessary.

Similarly, your if there is a in a mining conditions, there may be sand grit and all type of that materials are there, they should not come in contact with this and sometimes if your a you are having a loose rope where rope is loose, then suddenly you give a jerk that at that time that cling formations may be there and the wire rope may be damaged.

So, that means that is your you should not give a sudden jerk or a sudden load. You should gradually make it, so that rope does not get a shock load. So, these type of things are to be there by avoiding that you can increase the life of the wire rope.

And also the while we are doing the operational arrangement how you lay the wire rope that is on the drum in which directions your drum is rotating and your this rope is getting wound and unwound, they are also playing a big role in proper maintenance of the wire rope. Exactly there are three types of systems there, we may have a one layer spooling in a one layer spooling your right hand drum and left hand drum, so that you can use with the left hand drum, you will have to use a right hand rope.

So, that means your that which lay of rope will be getting wound and unwound by which directional drum that place. Sometimes we have got a multiple layer spooling. With multiple layer spooling, the direction of spooling changes from layer to layer because there will be and then the rope to loop actions will be frictions will be there.

So, for that time also you must meet with the right hand layer, you will be using a left hand rope and with left hand layer you will be using a right hand rope. By that the exactly they will be sitting properly groups to groups and in the rope to rope and that the frictional loss or the damage of the wire will be reduced.

And then the reeving also that is your in a multiple part reeving system, the influence of the fleet angles between the sheaves and is offended. That is what I was telling about that this drum when it is going, this rope will be going to a sheave. So, from there that is where how it is going to the sheave from this end to the sheave location, there will be an angle that fleet angles plays a very important role.

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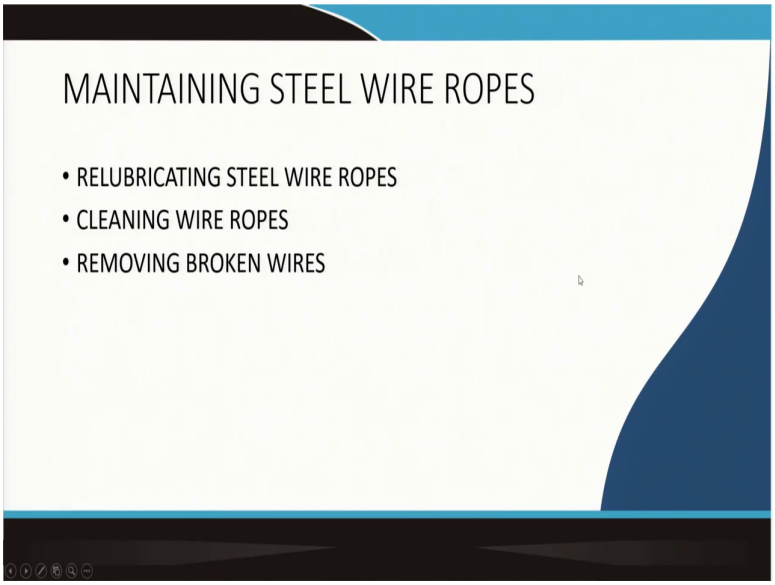

So, what in maintaining the steel wire rope? You need to see that the re-lubricating of the steel wire rope is necessary. As I said already the wire ropes are manufactured. During

manufacturing the lubrication is given particularly if it is a fiber core wire rope, then the fiber it keeps absorbed all the lubricant and while using it get squished out and then it lubricate the internal strands and the wires.

Now, this while you are using after sometime you will have to apply this other lubricant. You may see that it can do a greasing over there, you can put sometimes that whenever the rope is taking a turn you can make a lubricant submerged over here and then this will be passing through the lubricant and that rope will be getting all the time lubricated.

Now, then other another thing is for maintaining wire ropes. You must keep it clean. Cleaning of the wire rope is very very necessary because if it is not clean, the one of the most important thing in maintaining is the visual observation.

The visual observation will get obstructed if there is a dart or other layers are coming over there and then you do not know whether a particular wire is cutting or not and then you will have to if you find that one or two wires are coming out, you should take care of that. Those extruding wires should get nipped or cut in such a way that it does not get obstructed with another one and get peeled off.

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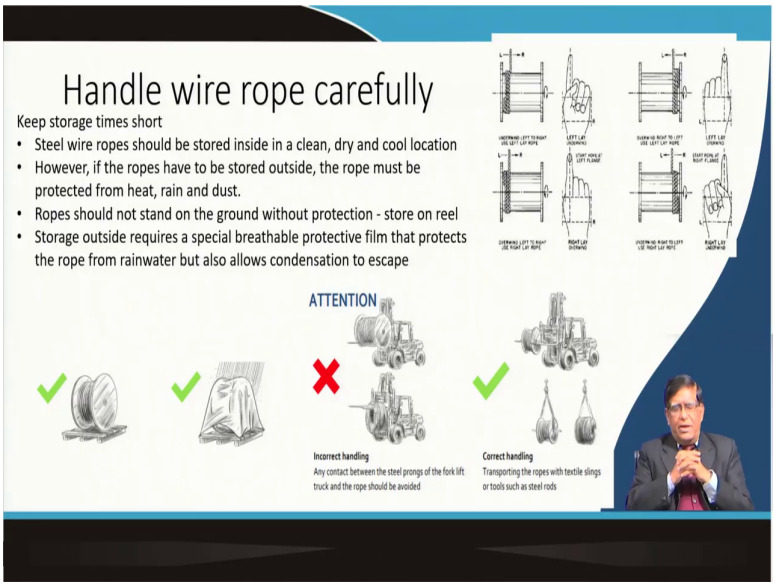

So, this type of general maintenance you must follow and then the in a handling it should be very careful. As I said that your laying whether your left lay and then your that left hand right hand drum, these two are to be followed in handling, but at the same time when you are carrying the wire rope drum see here you can see in this figure.

This drum with the wire rope, they have been lifted on the that our fork lift blade it is just that means the metal and the wire contact is there, but instead of that when is the correct form you can see that there is the reel has got a central shaft. So, you use a special type of your there is fork lift in which it will that your a rock is going inside and it is getting lifted.

So, there is no metal to metal contact over here. Similarly, sometimes in a wrong method these wire ropes a reel of wire ropes are being carried by putting it onto the metal forks. So, this should not be should be avoided and you do a correct handling. By doing this type of handling, you exactly do a lot of life increased.

Another thing is when you store, you should store it in a proper place, so that do not keep the wire rope just lying on a ground and then getting contact with the moistures and other things. This is a proper way of storing the wire rope or you should keep it covered, so that rain and other dew do not get any damaged over here. So, that means the maintaining the wire rope you need to see that exactly how you are handling it, how you are storing it. That is also very very important.

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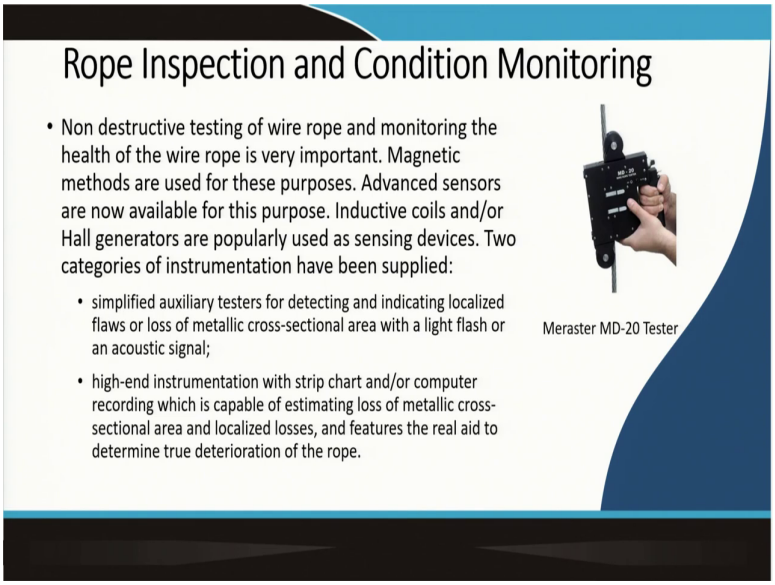

Now next thing is how you inspect the rope? There are many way many companies they have given instruments like that Meraster MD 20 Tester is a non-destructive testing. That means whenever a rope is moving, at that time you can keep this handle equipment by which you can exactly measure that the wire rope is in a proper condition or not.

The one way of doing it exactly the principle is very simple because if you are keeping a wire rope moving and here if you create an magnetic flux here that if you are having a magnet, then what will happen that field will get disturbed if there is a wire is coming out that same principle is used and then you can get a detection that is if any wire is coming out.

So, this principle are used and then there is a number of different non-destructive testing's by which we can find out if a wire rope wire is getting tensile that is which is elongated. If the rope get elongated you know that then the diameter will get reduced. So, if you can keep a sensor by which when the rope is moving if any particular portion you find that this diameter is changing, then you can detect that the rope.

So, this is an area where you can make a lot of even small instrument by yourself to do the testing knowing that thing that if there is any physical deterioration is taking place in the wire rope. So, that is why the condition monitoring it can be done for monitoring even if there is a crack in the wire or there is any breakage in the rope in any strand is there, it can be detected. That is why number of instrumentations can be thought of.

So, if you see some what are the sensors used in mechatronics, so those things can be applied over here. So, there could be a high end instrumentation. There are the strip chart and the computer recording exactly whenever you will be using an instrument from there.

Nowadays the technology is available, you just sense it that signal it can be transmitted anywhere you can put your that say it is a distance no matter wherever is there, you keep it in your office and then the ultimately all the signal will be coming to you.

By seeing the signal you can find out that is what was the normal signature and that how that normal signature had got changed or varied. Sometimes you may have even near the sheave and where the rope is moving, at that time you can keep a simple acoustic sensors by which we can get the noise signal.

Now if there is a groove is getting that is your wire out and then there will be play of the wire and then the noise emanated will be different and from there you will be finding that yes your condition has got deteriorated. That is the main principle of condition based maintenance system and which can be used in wire rope.

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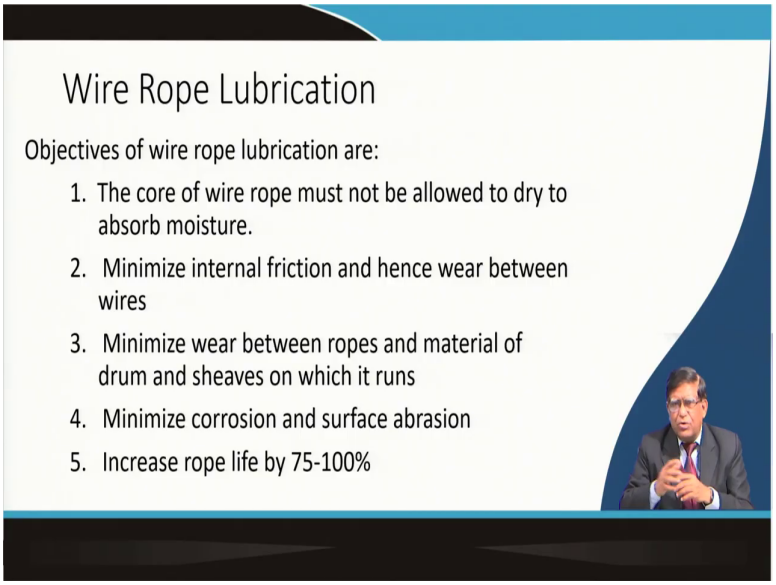

Similarly, for the wire rope lubrications I have already told that is your the objective of the rope lubrication is that the core of the wire rope must not be allowed to dry or absorb moisture because if it becomes dry, it will be absorbing moisture and that will deteriorate it will get because if a fiber core, then with a moisture it can get easily damaged and if the core is damaged, then the rope will get damaged because it will get a kink then minimum internal friction and hence, wear between the wires will take place, that is why we will have to keep the loop rope lubricated.

And then lubrication will keep the wear minimum and the it will not also it will also keep the your wear of the drum or the sheave minimum and then there will be less the surface will get exposed to corrosive atmosphere. That is why by properly lubricating the wire rope, you are also preventing the corrosion, so that there is a corrosive material do not come in contact. So, the rope life can be increased 70 to 100 percent by using a proper lubrications.

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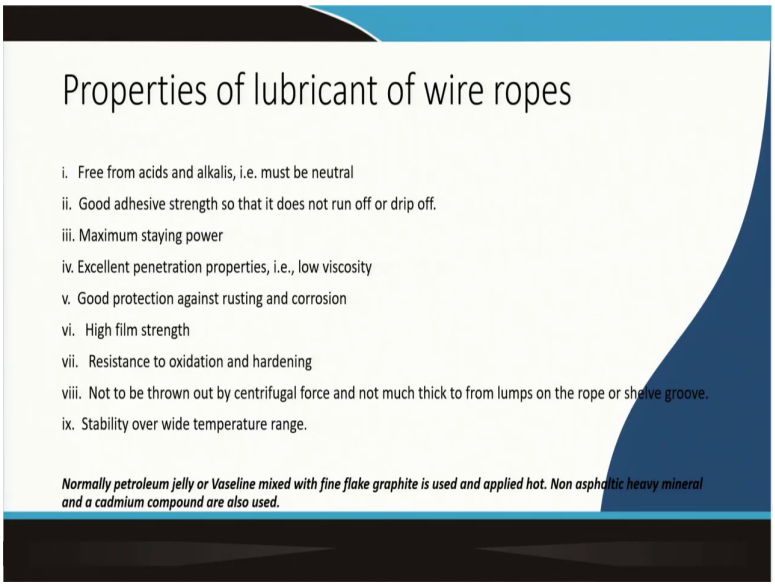

Now, the properties of lubrications of wire rope it is that what type of material or what type of lubricant you will be using. It is always said that you must use a neutral type of lubricant will have to be used; some this lubricant must have a good adhesive strength, so that it does not come out of it. It should get it could stick to the wire rope and it should be staying there for a maximum period and then it has got should be having a penetration property.

That means, between the wires and the strands it should go penetration. So, the wire that the lubricant should have a low viscosity, then it should be protecting against the rust and the corrosion and then also it should have a high film strength that whatever the film formed over here when it is moving over the sheave, it should not get raptured that film strength is very very important property.

And then it should not get oxidized or it should not get hardened because of the conditions of the uses and also, it should not be it is when you are moving over the sheave, then you should be having a centrifugal force under that force the it should not get splashed out. That is also a it should sticking to the wire rope that should be the property of the wire rope.

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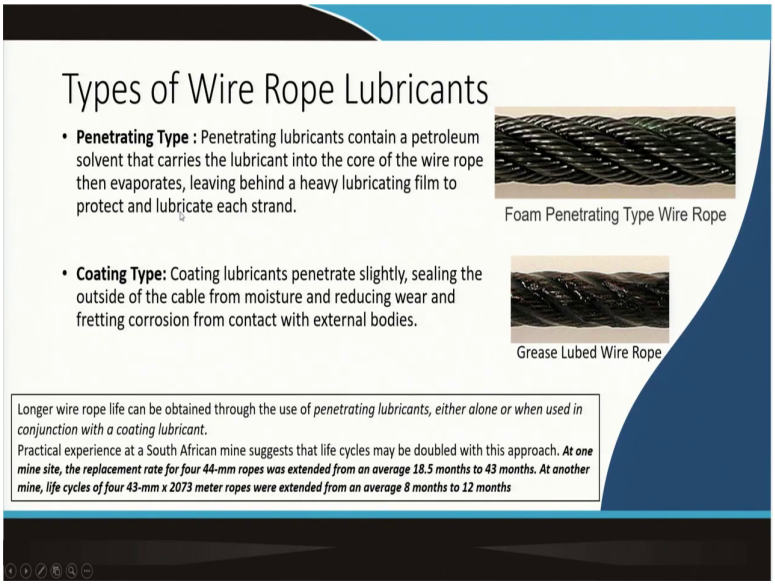

So, normally petroleum jelly is used. The different type of wire rope lubricants are used basically this penetrating type and the coating type.

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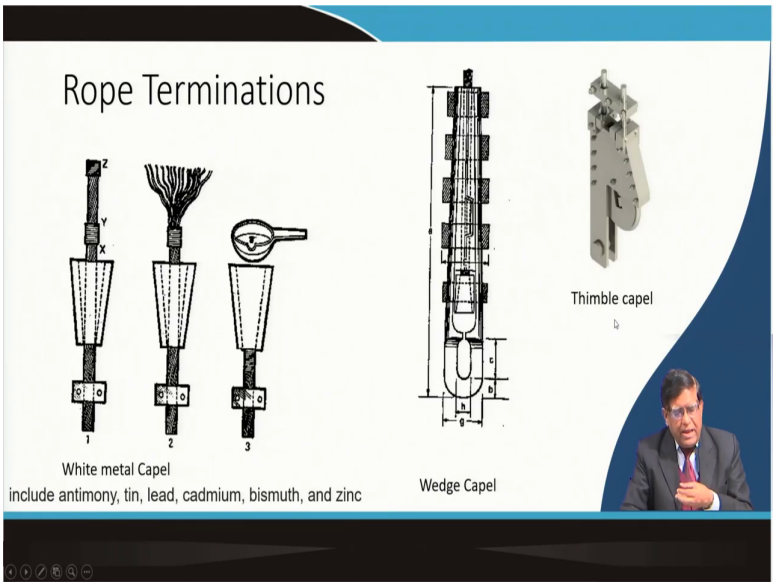

And then the rope must be terminated at the end by giving white metal capel, wedge capel or thimble capel. These capel how they are formed, how they are maintained, we will be discussing when we will be talking about the winder and winding inclusions.

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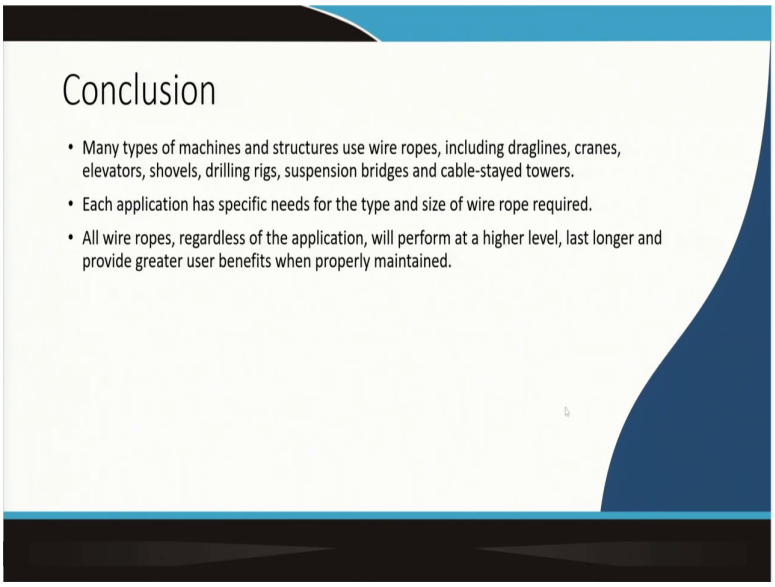

So, many types of machines they use exactly as we said in the previous class the drag line for your cranes and everywhere ropes are there. So, each application there is a special type of maintenance that to be followed and then, you will have to perform very high level of cleanliness and then the high level of lubrications and by doing that you can get a better life.

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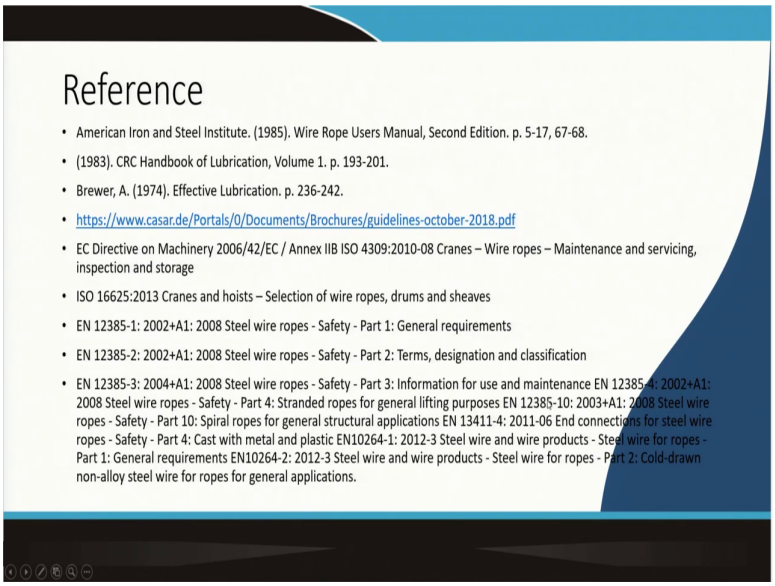

So, this is how you can see that there are lot of references are there because in the mining industry, the wire ropes is a very very important one and that must be maintained, so that you get longer economic life. So, we will be discussing this while studying the machines once again, but I hope you have got now what is a wire rope and how it will have to be used in the mining industry.

Thank you very much.