Mining Machinery
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Module - 10
Lecture - 52
Endless Rope Haulage

In our last class, we have discussed about the general introduction of the Rope Haulage, and there we have talked about this Endless Rope Haulage. This which is most commonly used in our Indian coal mines.

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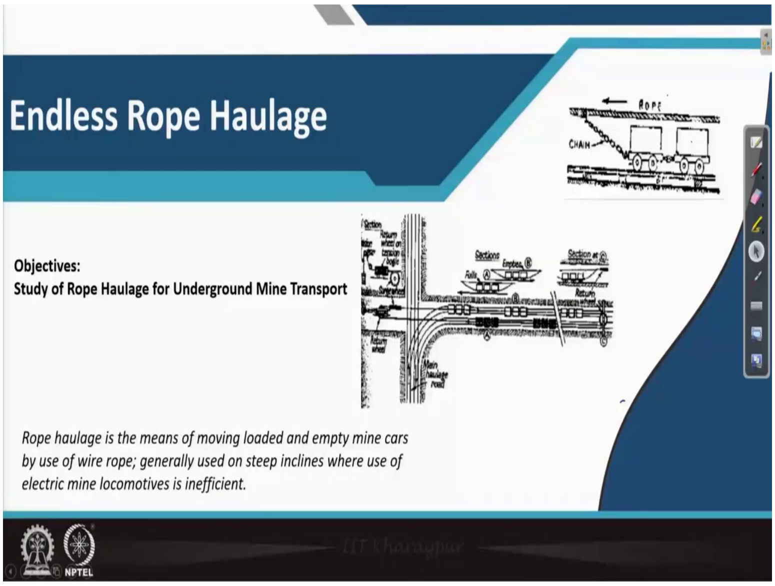

So, let us just go through quickly about what this endless rope haulage is. That one you have already you have studied that rope haulage. In any rope haulage, we are having a rope. Here we are showing an over rope, and in that rope our cars are connected with the help of a chain that is they are couple together, cars, mine cars are couple together running over this rails and then your chain by chain you are connecting it to the wire rope or by some clip or that lashing it is done.

And now this system in an endless rope haulage system this is this rope is exactly connected on a return (Refer Time: 01:36) and then there will a; there will be a drive. So, then you can see here how it is being connected to the main haulage road. There it is bringing and then this rope one is your you can see this is one track, this is the loaded track is coming over here, and here you will be doing all the that is your empty canal shaft could be somewhere here, and then this written these empties will be going down hike like this.

So, you can see in an endless rope haulage these rope system at the end. So, this was connected here and this track is there, so it can be just coming over here, it will get detached from the rope and then you can pull it here. And again it will be attaching to the rope over here. So, that rope is endlessly moving and then your cars are being connected.

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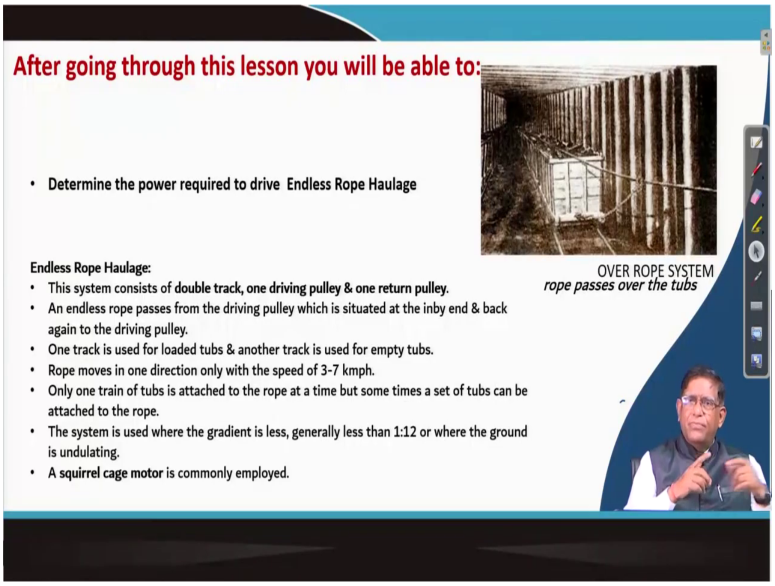

So, your in this system, we will be determining how the power required in a that is our main objectives today to do some calculations on the basis of this. So, this endless rope haulage it is a as we have already discussed it is consists of double track one driving pulley and one return pulley. So, if we somebody ask what are the main components? Very simple double track is required one driving pulley and one return pulley.

And then the driving pulley, it could driving drum whatever the case maybe. Then an endless rope haulage passes from the driving pulley which is situated at the inby end back again to the driving pulley. And then one track is used for loaded one, other track is used for the empty one.

Rope moves in one direction only with a speed of 3 to 7 kilometer per hour. And only one train or tubs is attached to the rope and at one time, and sometimes a set of tubs can be also attached to it. So, the system is used where the gradient is less that is your 1 is to 12 gradient you can use. You can just see that difference with that in the direct rope haulage, you can work with a very steep gradient also.

And then if it is a type of motor which is used for driving this endless rope is your squirrel cage induction motors are used.

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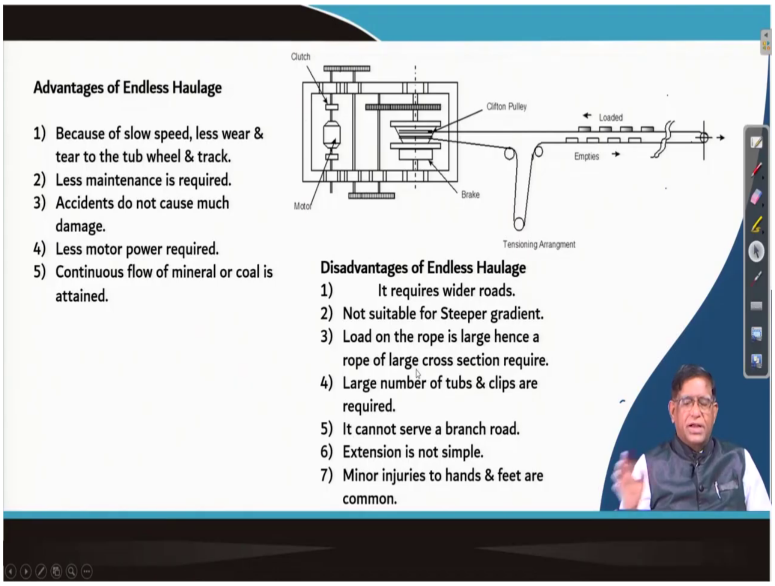

So, we have already discussed in our previous class that advantages and disadvantages of this endless rope haulage system is because of its low speed wear and tear is less. So, maintenance requirement is less, and a accident even if takes place sometimes their damages are not much, then your less motor power is required and a continuous flow of mineral or coal can be getting because all the time the rope is moving, so you are connecting.

So, it is coming, though it is given in a batch we cannot say it is a continuous operation because the material coming at sequence at a different interval, but the rope is running continuously. But the disadvantage is, it requires a wider road and it is not suitable for steeper gradient. So, if someone ask that what type of haulage system rope haulage system will be used if your seam is inclined in say 1 in 7, 1 in 6.

So, in that case your endless rope haulage cannot be (Refer Time: 05:14), direct rope haulage is main and tail rope haulage can be used. Now, load on the rope is large, hence a rope large cross sections is required because there is as you I told you in the previous class that more number of cars can be connected over there at any time.

There will be one loaded train on empty train, and then this because of that the rope will have to take more load and as you and studied in your wire rope calculations, if the more load is to be taken the wire rope diameter will increase. If the rope diameter is increased; that means, more metal is there, its self-weight is increased, more power is required. So, on and the other disadvantages will be coming.

Now, and then it is exactly when the road are branching out at that time you cannot do it very easily. Then, it cannot serve branch road and then extension is possible, but not very simple that is your the rope connecting and other things will be there. Then, because this rope if it is in a under rope, that any time if it is going out of the road where the people are walking by the side and then this rope may sometimes say hit the people and accident take place.

If you study some of the case studies of underground mine accidents, you will find that is a hit by the moving rope is a very common accidents that takes place.

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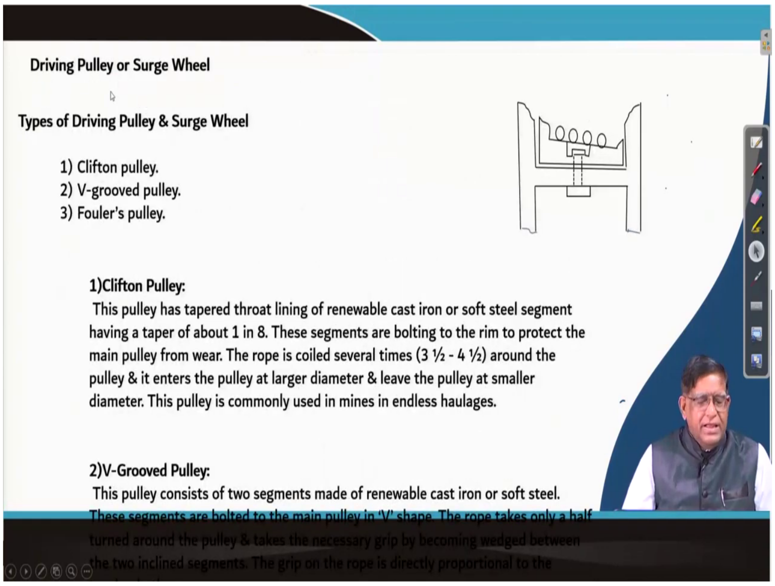

So, what exactly we have said that as you can see here there is a main called Clifton pulley. This is that most important thing for the drive this drive component can be of different types. There are called Clifton pulley, V-grooved pulley, and fouler pulley, that type of different type of pulleys are there.

So, this is a Clifton pulley which is as a tapered throat lining, and then there is a very soft segments. As you can see here also that you are a taper that is a where the loaded one where it is coming over there empty one going like this, but there is a tapered pulley that type of pulley is call your Clifton pulley.

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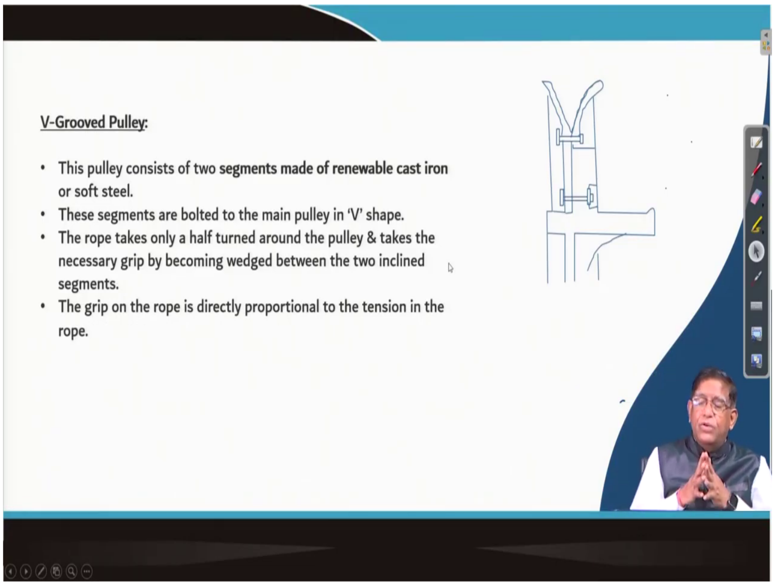

Similarly, a V-grooved pulley, a in a V-grooved pulley our there is a as the load is there that rope can be accommodated over here. So, this is a type of pulley which is used. And that there exactly two segments are there, and they are bolted together that is a bolted together and connected like this. So, that is the grip exactly if that more tension is there they will be just gripping it tightly. So, that is how a how it works.

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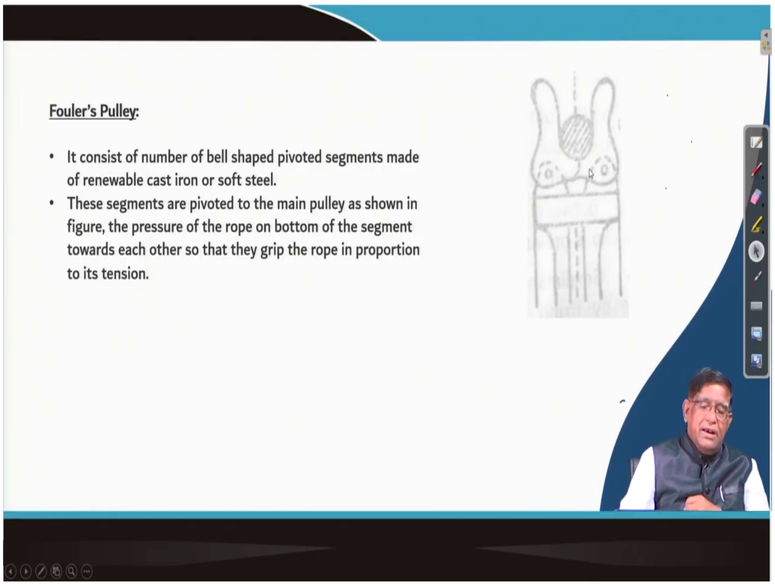

So, now there is a fouler pulley in which number of this is a bell shaped pulleys are there and they are just exactly connected to the that is your on your the main part you are just connecting this bell shaped one. Now, why it is a separable? If any wear and tear take place it will take place of the this portions, you take it out and connected another one and you can go on using.

But if you are having the only one sheave on which this rope will be moving, then what will happen? Because of this friction between the rope and that sheave then sheave will have to be replaced. So, now here only this your the upper portion it will be replaced, so that main thing, that main shaft and is a main pulley it does not get replaced. So, this type of different type of systems are there.

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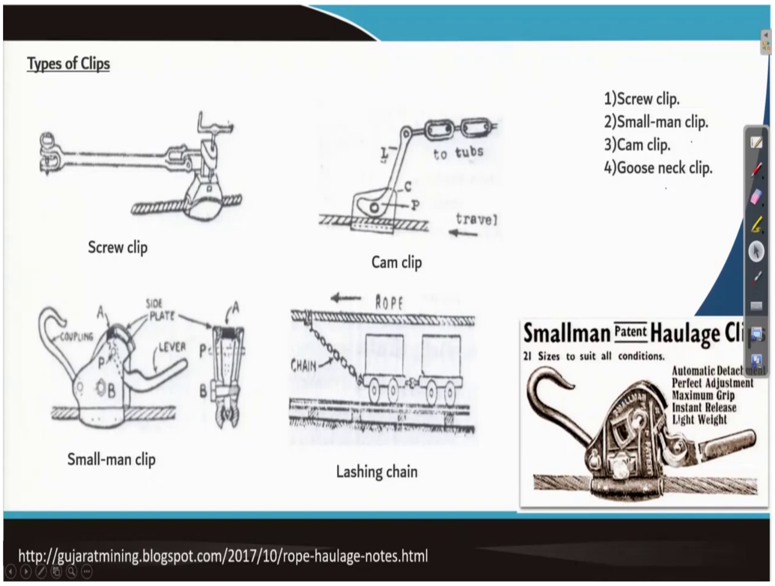

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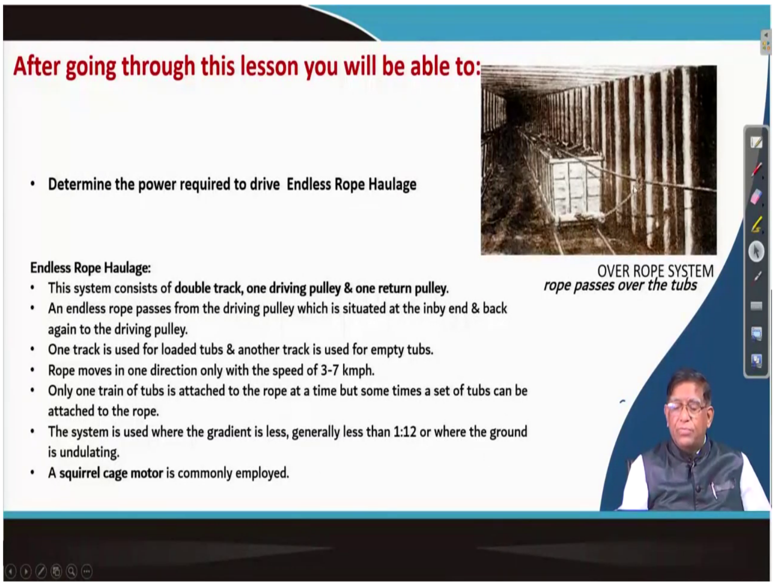

Now, the second thing is as you have seen in the previous diagram as a here this ropes it will have to be connected say this is your over rope, now this chain which is connected to the tub here and then it is connected to the rope here. Now, this connections is done by different types of your this clips. This is the rope where there is a screw type of clip is there, you can see that there is a two part in between you just turn this one it will tightly grip over here. You open you take it out. So, this is a screw clip.

There is a cam clip by which exactly a cam management is there and then it get when because of this movement whenever the load will be coming through this it will be pulling in these directions and it will get tightly gripped over here. So, when this rope is moving like this and then your this tub which is being pulled, so that load of this it will make these cam portions will give a tightly connected to this.

And then the detaching is very simple. If you make it move it in the opposite direction if you will just pull it this directions it will come over here, the grip will be released, so you can take out of that. So, you just appreciate the engineering involved over here. There is a simple mechanical engineering, simple machine principles are used and the things make it and that work in shape.

So, now, there is another that is a clip which is call your small-man clip, which is having this your liver system by which exactly that when your you will be coupling to on that the tub or car will be connected to this one and then automatically this side plates will be giving a grip onto this rope and that is the how the small-man clips are there. So, a lashing chain, so this chain will be connected to this, that is a lashing chain type of connections are there.

So, there are this cam, lashing chain, screw clip, small-man clips, these are the very much used over here. And that you can see that small-man clip inside that how it is there, with that help of this liver exactly this portions whenever the load will be connected over there they will be giving a grip to the rope.

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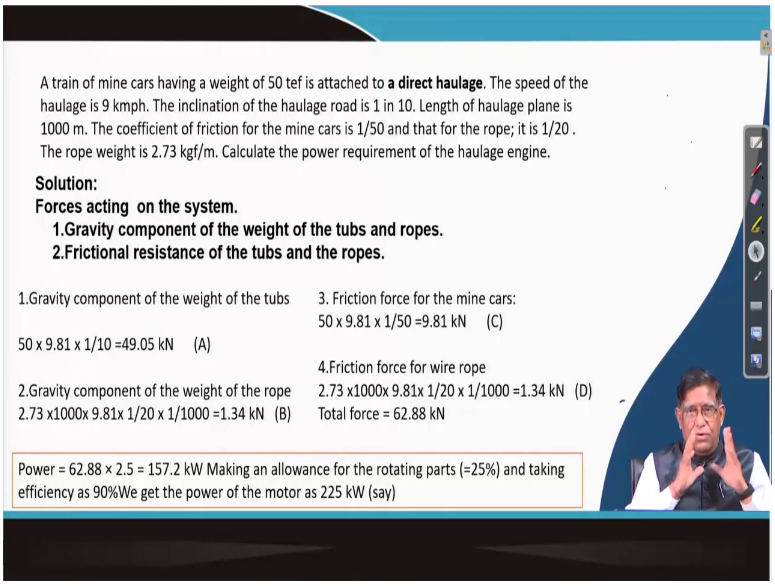

So, now I think you can do that whatever the basic principles you have learned on that you can take up a small numerical say a train of mine cars having a weight of 50 ton force is attached to a direct haulage. The speed of the haulage is 9 kilometer per hour given, and the inclination of the haulage road is given 1 in 10.

Now, the length of the haulage plane is given 1000 meter and the coefficient of friction of the mine car is given as a 1 is to 50 and that your that of the rope it is 1 is to 20. Now, the rope weight 2.73 kgf per meter. So, that is the weight of the rope per meter. Now, you will have to calculate the power requirement of the haulage engine. These apply your school day physics and you can find it out.

So, what are there? The what are the forces acting on the system you will need to separately calculate out, one force is your gravity component that is the weight of the tubs and the rope that will have to be overcome by the your; what are that is exactly, one basic principle is you need to find out the tractive effort. That is say what is the total tensions or whatever the tractive effort coming over here.

And if you know that is in kgf or Newton that whatever the total kgf or Newton is coming and then if you multiply by the meter per second at speed Newton meter per second is Watt. So, you can find out that will be the required power. Now, that required power the motor we will have to give.

But for that the motor efficiency could be that something showed that what will have to do if the motor is efficient say 90 percent, then by whatever that what you are getting divided by 0.9, you will find that what should be exactly the minimum rating of the motor or the power you will have to use. Because if you use less then that then this motor will not be able to draw your system. So, that is there.

So, from the given things you have got a 50 ton force. That means, how much Newton? And then it is working inclination is there, so you are getting the total this much kilo Newton it is coming and then your gravity component of the wire rope it is working which is a coefficient of friction is working over here. So, you can overcoming the total, you are getting this much Newton that is your gravity component.

And then the friction force on the mine car that is separately you calculate and the friction forces on the wire rope you calculate. So, what is the total force coming you are getting that. So, the total force and then the velocity you multiply you get that total power which you are getting.

So, and then once you are getting this much you give some allowance because some additional things will have to be there because of the efficiency of the motor and then you can suggest a power. So, that means, that some of the assumptions you will have make here you have given an additional 25 percent you can say the motor power, you can say as a 70 percent or you can say 80 percent depending on that you can do it.

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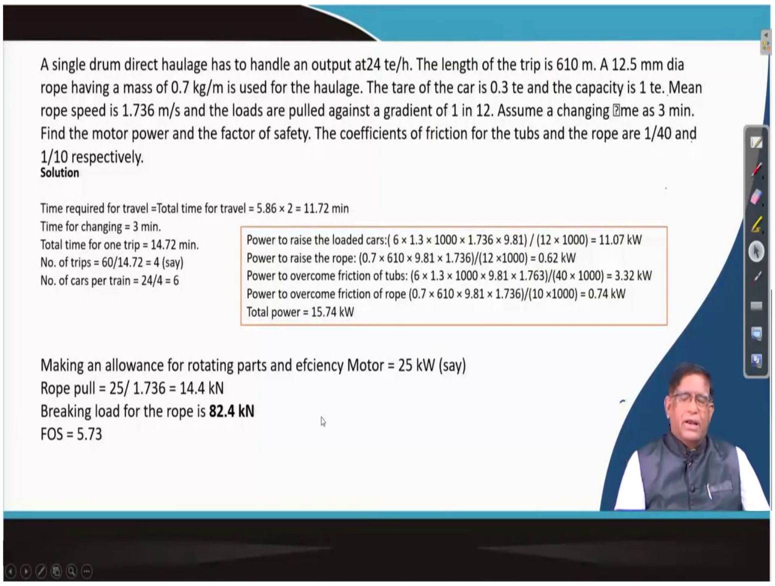

Another problem you can just say a single drum direct haulage has to handle an output of say 24 ton per hour. The length of the trip is 610 meter, 12.5 millimeter diameter rope having a mass of 0.7 kg per meter is used for the haulage. The tear of the wear car that is 0.3 ton, 0.3 ton weight car and the capacity is 1 ton. Mean rope speed is 1.736 meter per second, and the loads are pulled against the gradient of 1 in 12.

Assuming a changing time of say 30 meter. Find the motor power and factor of safety. The coefficient of frictions are given. So, if this data is given you can easily find out first find out what is the total time of travel, then you find out what is the total time for changing, and the total time mean one trip will be calculated out once you know the time; and the number of trips how many will have to be there in 1 hour. So, number of car per train how much. These are the basic informations you determine.

Now, for the power to raise the loaded car you can total resistance and the speed multiplications will be giving you the power to raise the rope, how much is the level differences it is coming from there you can find that. And a power to overcome the friction tub that also you find out. And then power to overcome the friction of the rope if you find the total power can be calculated.

So, this is just simply just like your in convert calculations is also we did, that is what is the running for the empty, running for the mass, running and raising for the this a mass that will be giving the total power.

And once you know that you can find out that if the motor power is one how much pull will be coming on to the rope, and then what will be the breaking strength of the rope, from there you can find out the factor of safety. So, this is how the rope calculations are made.

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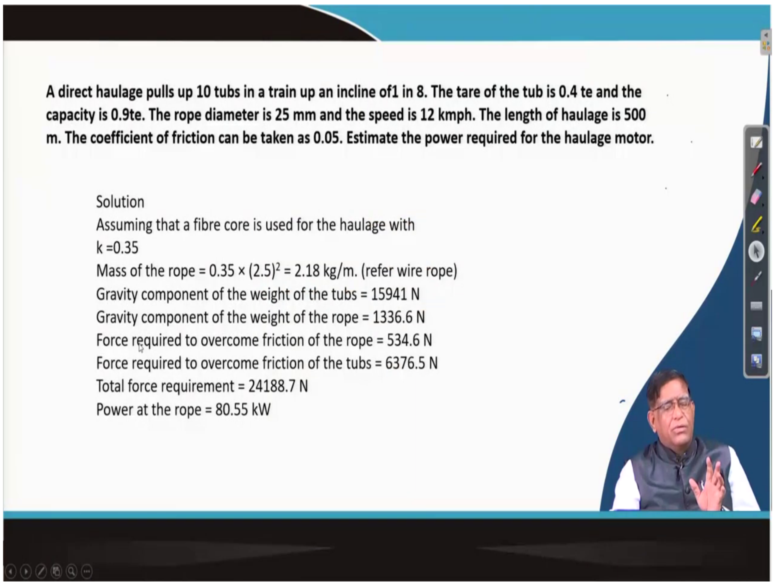

So, you practice some of these questions like, a direct rope haulage pulls about say 10 tubs in a train up and incline in 1 in 8. The data are given. Populate the data do the calculations. Practice such type of problem it will be good for you.

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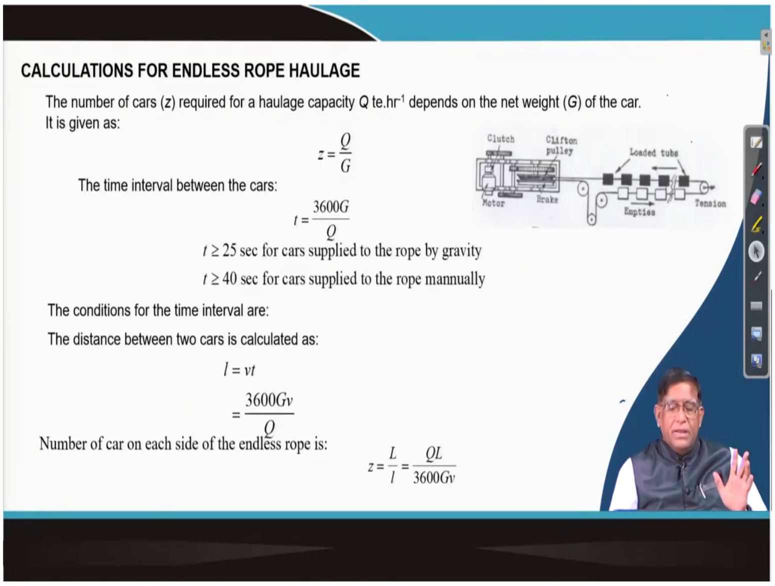

Now, if you see that is a little bit of you can apply this physics develop a generalized equation. So, what exactly you will be working mainly that if you are asked that you develop a simple excel or a simple small program to do a rope calculations. So, how can you develop a small app to the mining engineer to do the rope calculations? All that principles you can derive, and then you can easily convert it to a small program or in a small app you can make it.

So, exactly if you are how many number of cars is required? Very simple. If you know the total capacity and if you know what is a total weight it can carry, so from there you can calculate the number of tubs. And then what will be the time interval between the cars? So, that means, see when a car is coming to that is you are connecting the tubs at different time.

Now, when it is coming and then the rope is going continuously. At the time where you are taking out the loaded tub for your loading to the case, that when you are taking it out after that this you will have to put it over there the second will have to come, whether the one persons can do their job or you will have to keep two persons will depend on at what interval they are connected.

So, that connection interval you can find out from their exactly how many time you will have to require and then from there you can find out this the distance between two cars. It will be depending on that what is the speed by which it is coming, and then what is the total time interval between the cars. If you know that you can find out this distance between these two, and then you can calculate out what will be the total number of cars along the whole length can be connected.

So, your; that means, from your one point to the end point the total how many number of cars at a time you can connect also be calculated. So, this is here in endless rope haulage you did not connect this as all as a train some time, you can just individually you connect it and it will go, unlike your in main and tail ropes.

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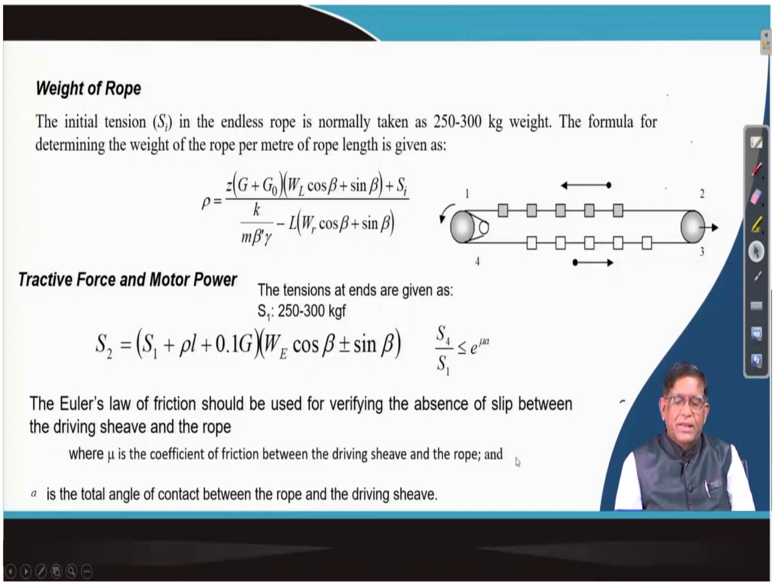

So, then how you select the weight that is your weight of the rope, that is your selection of this density as I said in the previous class that same way you can calculate out the tractive force and motor power by knowing how much will be the this your total load coming onto the system.

So, that exactly here in a wire rope just like your conveyer calculations, that total tensions that rope will have to be maintained at say this ratio the maximum tension at the point 1 and the tension at that is your slack side tension at 4 their ratio is that your e to the power mu a, where a your angle of rap that is how this rope is connected over here. Now, sometimes this rope is giving a turnover here, so that your this angle is increase, so that this tension can be maintained over here.

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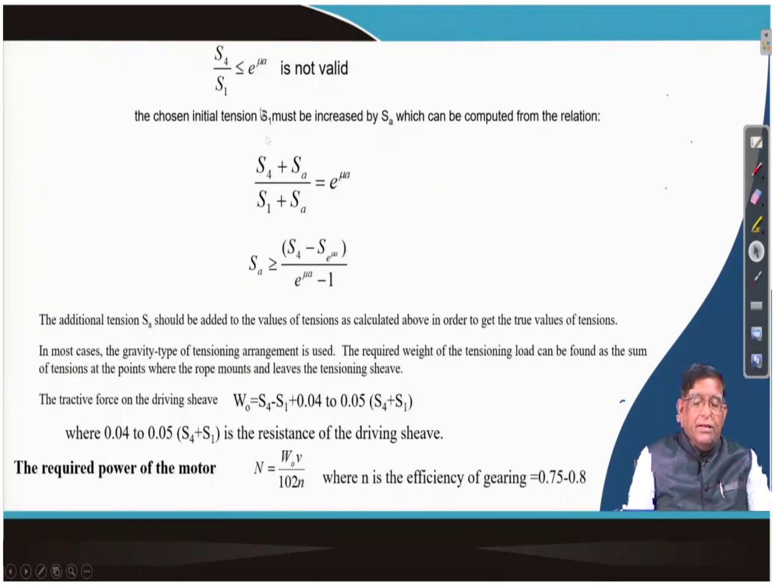

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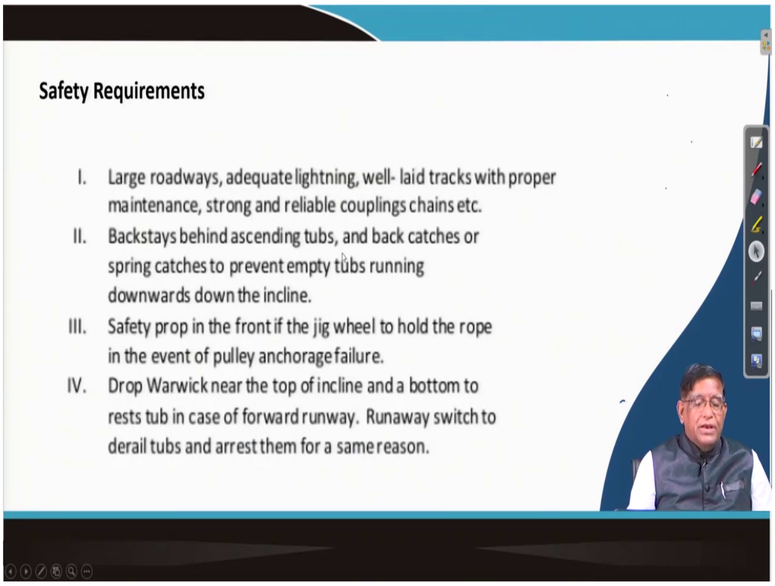

So, this if this chosen tension you will have to collect that to say exactly the different tension when you are connecting over there that is your this conditions which will have to be maintained for the wire rope to be working smoothly and the power to be transferred, so that it can do the work without any trouble. So, this connection is there.

So, the tractive force on the sheave what will be coming it can be calculated by using this formula and then your required power of the motor can be calculated. Once you know that motor power, then your exactly whole you can prescribe that what will be what type of motor and all will be connected. So, that is a basic endless rope calculations simple one. And then a safety requirement is a very very important thing. So, you will have to maintain the gallery.

So, that the main problem is the people who will be working and then travelling around they should not be getting affected. Now, there are some devices called backstays. So, that is exactly if a number of cars are going over there at the backside there will be a rod, so that if it is sliding down the a gradient it will be stopping over there. Then there will be the safety props.

Then another system called drop Warwick that is how it will have to if that any train a number of in a direct rope haulage say, a number of trains are coming down then there will have to be a safety device, so that it will stop over there. So, in your coal mining methods you will be studying about those things.

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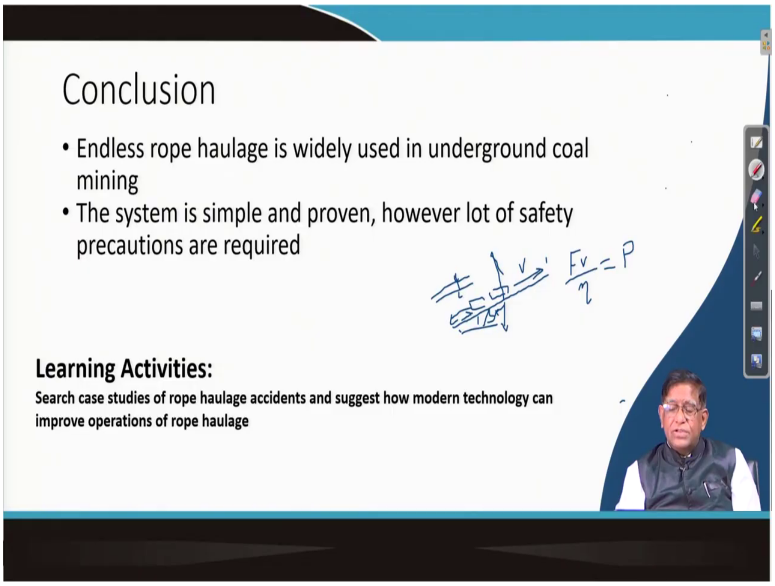

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So, basically your endless rope haulage system is a widely used in underground coal mining and this system is very simple and proven. And then mainly you will have to just maintain at safety. So, as a though it is a very simple system you can think of some of the monitoring depending on the situation.

So, a learning activity here is such case studies of rope haulage accidents, and suggest how modern technology can improve operations of rope haulage. The modern technology means, how exactly you can do a monitoring and then how you can exactly improve. Say for example, that is the rope requires changing or not, that is the rope ok.

So, you can have some testing devices on the roadsides it will be scanning and finding out if there is any damage of the rope is taking place. Then, your there are that exactly wherever there is a guide roles are there is the rope coming out of the guide role near to the guide role from the top you can have a scanning systems by which that will be telling and giving an informations that there is a exactly the it is not properly going or the guide route has got worn out.

When the sheave is on that you are you are having say for example, in at that pulley there is a liner, on that liner if it get damaged then sometimes the pulley will have to be damaged. So, that conditions can be monitored. So, like that there could be number of things.

So, what are the basic things you need to do is say in any these inclinations whenever you are having this mine cars will be moving, then you need to find out that exactly depending on this angle your how much exactly the force is getting into these directions and then how much is your this normal reactions, and then how much this pulling force will be coming up over there because of there is a resistance to motions in these directions, and then your weight is in this directions.

So, all the component you separately calculate it out and then you can find out what is your exactly basically the tractive effort or the force by which you will have to be applied into the motor. And then if you know that velocity then you can just find out that this is your that Newton meter per second, and then if you can find out the efficiency of your motor you can get the motor power.

So, that means, once you know this motor power then you can find out what will be the that is if that much force this will give also that rope that what should be the diameter of this rope and your selection.

So, this is the basic calculation part. And then after that it should operate trouble free. There you can think of your innovative way, so that the stoppages of the system due to the, that operational trouble you will have to find out by the mining history and then you develop a new device and that can be used.

Now, you can also suggest that what should be the that is your house keeping how that the whole thing can be arranged in underground mine, that will exactly if you see some mines in the field you will be able to prescribe and that is what is expected from the new generation of mining engineers. That is the working conditions and quality of life in underground will have to be improved and there you should feel a sophisticated operating condition.

For that at presence wherever you can see that the people working by the site should feel that that is nothing will happen. So, that means, in underground that is while by the operation of the rope itself can it be changed that is you can think of on that some innovative ideas which are always welcome.

And then for that you read some of this, and then particularly these references where all the numerical practices you can do it number of; I have taken the numericals in that from that. But what I found those numericals are somebody has put it over there it was a Norman Brooks, a very old is book is there The Mechanics of Bulk Solid Handling.

In that book of Norman Brook, he has given the theory very simple and simplistic manner which is a very good for becoming a become an engineer. And to look into the problems from the engineering perspectives you should read that Norman Brooks book which is of course, nowadays I think it is an obsolete book you may not find but what I found those website link which I have given here, they have exactly all that material which are there in that book the numerical and all, somebody has very nicely put it over there.

So, I suggest you please go through that, and then start thinking of producing your own that is what I have said as a how can we improve this our 100 years old technology of rope haulage by applying modern technology, particularly for the monitoring and for the trouble free operations, so that no mining accidents can take place.

Thank you very much.