Bulk Material Transport and Handling Systems
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Lecture – 50
Haulage Calculations

You have already studied about this mine transport system in underground mining and we have briefly introduced the basic theory of the basic calculations what you do? Today, we will be doing few examples by which you can practice and then understand the basic haulage calculation.

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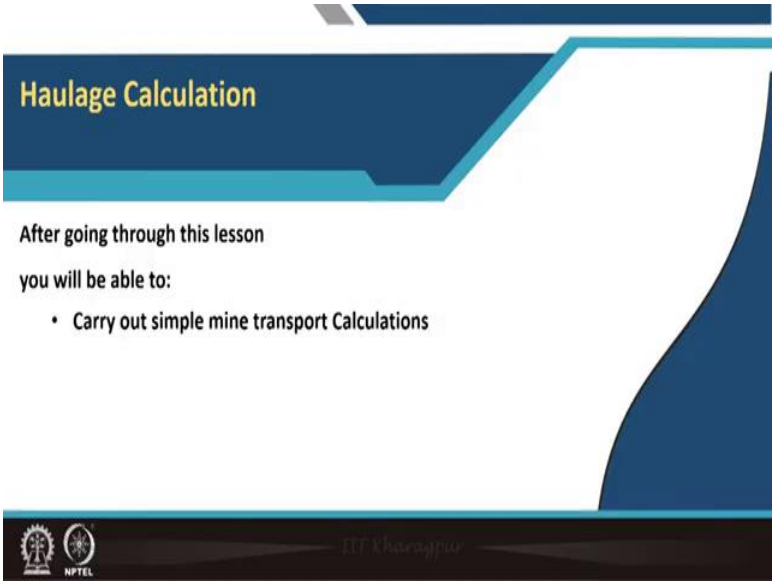

So, our that to carry out simple mind, transport calculation is our objectives today.

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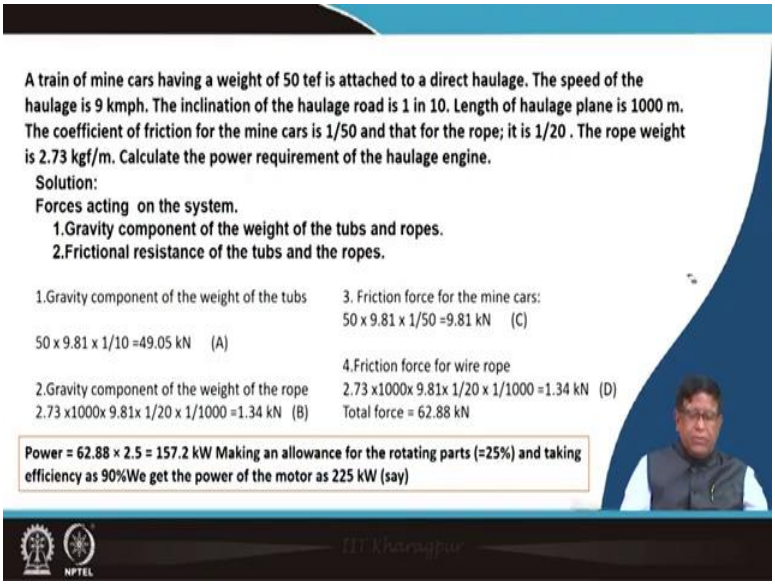

Now let us take a small problem. You can write it down, a train of mine cars having a weight of 50 ton force is attached to a direct haulage. You can know that is a direct rope haulage. Now the speed of the holes is 9 kilometer per hour and the inclination of the haulage is 1 in 10. You know that it can work in such type of things in direct rope haulage they are capable of working in gradient.

Now length of haulage plane is 1000 meter and the coefficient of friction for the mine car is 1 in 50 and that for the rope is 1 by 20. Now the rope weight is given, rope specification that is 2.73 kgf per meter and you need to find out that what will be the power requirement for the haulage engine? Haulage engine means your rope will have to be; rope haulage will have to be, there will be a drum and that drum there will be electric motor.

What will be the power of that electrometer to do this job? So, I think this is a very simple mechanics problem. You can solve it very easily. Only you will have to find out what are the forces that will be acting on the system. In this particular one as you can see here, there will be the gravity component of the weight of the tubs and the rope. And there will be the frictional resistance on the tubs.

So, that means when you are doing this transportation. That means you can think of the whole. There will be a inclined part you have given that it is your 1 in 20 and then you know that there is a mine car which is a number of them, will be having a train. A train number of mine cars are connected together and they are exactly taking their travelling by this rope, it will be putting and that rope will be connected to a drum over here.

Now, at that time there is a gradient. This total weight is coming over. Here we are having this one in ten gradient is given. Now, this weight will be having a component in this direction and the frictional resistance will be coming and then your that main driving force will be here. So, under this force condition how exactly your the power will be required? Now basic things you know, that in any such problem, the power required is equal to.

That is your what is the total tension or the total force for overcoming the resistances and after overcoming that resistances? If you were to move with a particular speed. That means that force into speed is the power if you know that how much Newton force is coming and that what is the meter per second Newton per second will be giving you the what? So that is the very basic principle.

So, in this one, what is given? Your gravity component of the weight of the tubs is given. Because what will be coming, your one is your 50 ton force. That means your 50 multiplied by the gravity and then you take the gradient. So, that means your foot multiplying this one you will be finding out. This is an example that you can check it. That is 49.05 kilo Newton is coming as the gravity component.

And then this is for the tub, but the rope which is carrying you are having a 1000 meter length of the wire rope and you know that wire rope, what is the perimeter weight is given? That is 2.73 kgf. That means 2.73 into 9.81 that much that your force is being applied and that is going all along this 1000 and there is a frictional resistance that is your 1 in 20 and from this one you can calculate that what will be the total?

That is your that Newton, you are dividing by 1000 you can get the kilo Newton. You are putting into kilo Newton so, that your power calculations will be coming into your kilowatt. Now, once you have got this two component, what else is there? There will be the friction forces of the mine car, as it is said, the mine current friction is 1 in 50 that is 1 by 50. So, that much force how much coming you can easily calculate for each of that car?

That is your 9.81 kilo Newton is coming for the that your this, then your total frictional force of the wire rope you can calculate here because there the resistance is given 1 in 20. So, from here you are again converting into kilo Newton you are finding. Now that main 4 components

of the forces you have got. That means, if you have that forces there, you can just simply they are in the same direction.

So, you can add it with getting total force coming 62.88 kilo Newton. After that, will you be able to calculate now the power requirement? What will be the power? Because, once you have found out the total resistances, after finding out the resistances, you know that velocity is given. That is your whatever the total, your speed coming up with that, when you will be multiplying, then you will be finding out the total power required.

And then there will be that your efficiency of the motor, if you divide by that that will be giving your the total power.

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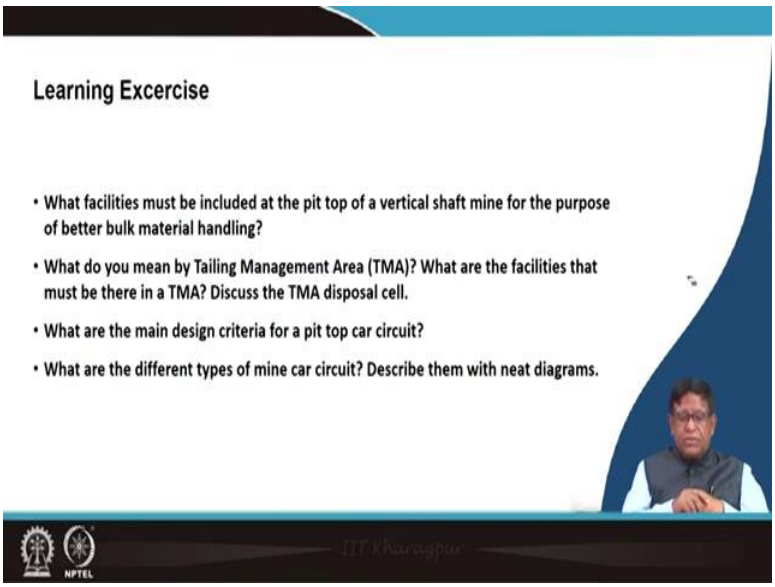

So, you can take some learning exercise that what facilities must be included in the pit top of a vertical shaft mine for the purpose of better bulk material handling. And what do you mean by tailing management in a mine? This type of activities you can take up and then what are the main design criteria for the pit top car circuit and what are the different types of mine car circuits are there? You can find out.

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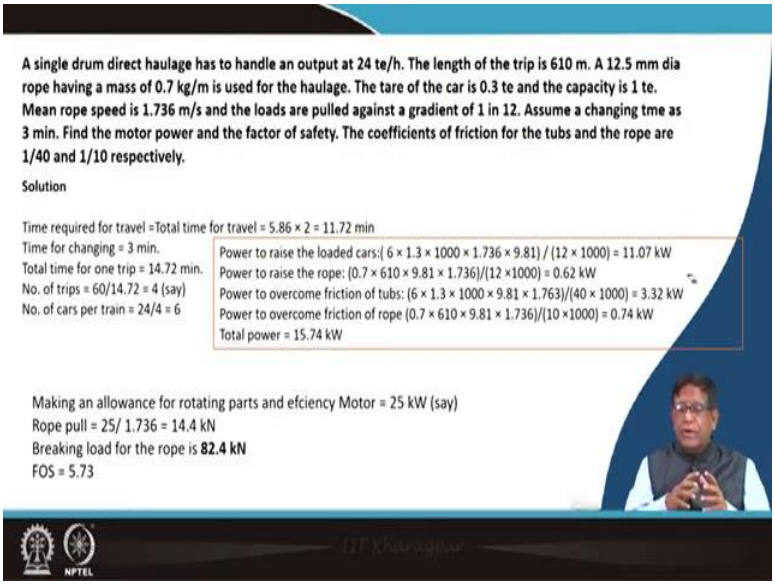

And then you can do this some more numerical over here. Now in this numerical you write it down, a single drum direct haulage, has to handle an output of 24 ton per hour. The length of the trip is 610 meter. A 12.5 millimeter diameter rope having a mass of 0.7 kg per meter is used for the haulage. So, this just a some figure randomly given. The tare of the car is 0.3 ton that means the cars own weight is 0.3 ton and the capacity is 1 ton.

That means you know now gross will be 1.3 ton that the min rope speed is 1.73736 meter per second that is go while converting from feet to meter. This figure is coming, you can take any value for your practices and the loads are pulled against a gradient of 1 in 12. Now you assume a changing time as 3 minute. That is your when you are doing at the end something will be there.

So, find the motor power and the factor of safety, the coefficient of friction for the tub and the rope are given as 1 in 14 by 1 in 10. So, how will you resolve it that? What are the given the time required for the travel that is that will be the total time required. It will be from the given time you can find it out and changing time is given. So, you can find out the total time and then how many number of trips will be there in a hour?

So, that you can find out that it will be around 4 trips, it will make and then number of cars per train that you can calculate out. So, from here you can find out what will be the power required to raise the loaded car. You can multiply this number of cars. Your this 1.3 ton is the your capacity then your the speed is given. So, by taking the resistances and it is coming to the power to raise the material that is coming as an 11.01 kilowatt.

You check the calculation, then your the rope that is also from that bottom it is moving its a continuously. If you take there, the total length of the rope that is 610 meter and you are having this 0.7 is the rope specification per meter weight. So, again applying the same thing, you can find out the total power required to raise the rope. Next component is the how you overcome the friction of the tub?

Just like the previous example, you calculate the friction of the tub and then also the power required to friction of the rope. So, you are everywhere what you are doing? You are getting the force and then you are multiplying by the velocity. So, that way you are calculating this at a go. So, if you want to do you can separately one by one, you first calculate the forces and after the trading the forces also you can do it over there.

So, once you know this total power, our objective is to find out that is your, what will be the alliance? Now, your the for rotating parts of the and the efficiency of the motor you will have to take this total power required will be some more. So, you have given this you, consider it will be requiring about 25 kilowatt. So, then how much will be the if you are having a 25 kilowatt motor, giving some allowances from that 15.74.

That means now you can safely drive with the help of a 25 kilowatt. Then your rope pull that will be giving your 14.4 kilo Newton. Then the breaking load of the rope is given 82.4 because of your the factor of safety. You have taken 5.73, it comes that is factor of safety is your breaking load divided by your rope pull. So, this is the way how exactly you verify different type of calculation part.

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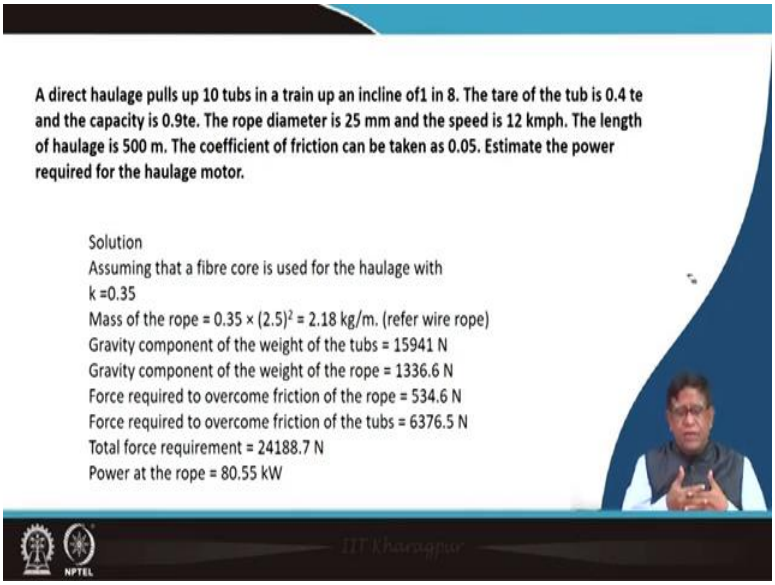

Now there could be another type of numerical you may face. A direct haulage pulls up to 10 tubs in a train up an incline of 1 in 8. The tare of the tub is 0.4 ton and the capacity is 0.9 ton. The rope diameter it is given 25 millimeter and the speed is given 12 kilometer per hour and this is length of the haulage is 500 meter. The coefficient of friction can be taken as point 0 5. Here again, you will have to calculate the power of the haulage motor.

Here also, the solution is given here. You note it down that is you can practice it that if you know the matter note down the questions and very simple direct calculation. That is your what that certain data are given from the design data book you collect, there is a different type of that is your the fiber core rope they have got this factor k is equal to 0.35 when a mass of the rope, it is given exactly your that your diameter in centimeter square, multiplied by this mass factor.

That gives your what is the mass per unit meter? This is as a from the design book you can find out this relationship that is a depending on the different type of rope, may be having different type of mass factor. And this is a thumb rule coming that that factor multiplied by the square of that is your k the square is the that is your mass of the rope and then gravity component of the tub you can find out.

This is the total force coming and the gravity component of the weight of the rope that you calculate and then the force required to overcome the friction of the rope that you can calculate. And the force required to overcome the friction of the tub you can calculate using the numerical value given and that is why you can find out what is the total force? If you

know the total force, then you can find out the power of the rope by force into your velocity that will be giving you the power.

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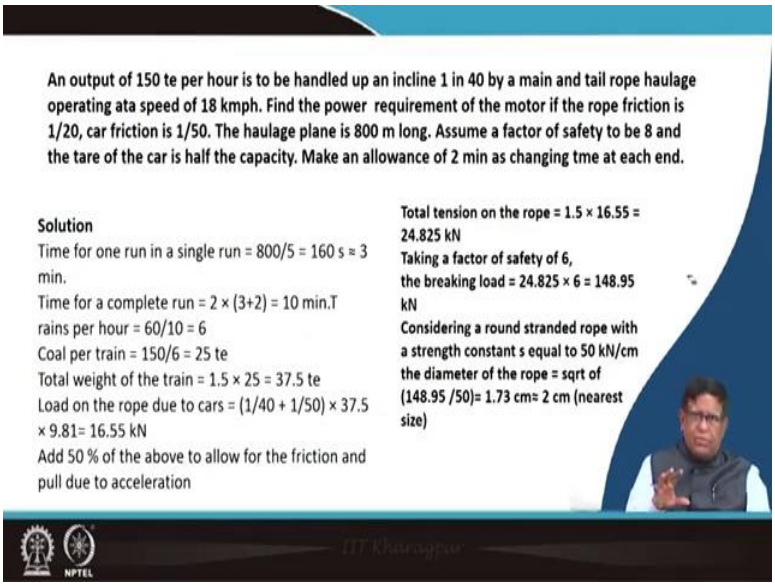

So, that I have just given you the hinge from that hinge, you should calculate. So, right another problem, an output of 150 ton per hour, is to be handled up an incline 1 in 40 by a main and tail rope. Polish, you remember that our we discussed main and telephotos, then operating at a speed of 18 kilometer per hour. Find the power requirement of the motor if the rope friction is 1 in 20 car friction is 1 in 50.

The haulage plane is 800 meter long. Assume, a factor of safety to be 8 and the tare of the car is half the capacity. Make an allowance of 2 minute as changing time at each end. If this is the data, given you can now easily that plan it. The problem think a little bit you can resolve the hints are given here. That is time for one run in a single run, is you can find out from the given distance.

And then you can find out that time of day complete run adding the time at the end that is given and then that is your trains per hour. How many, how much train per hour it will be coming? How many tubs exactly making in the train it can go? And then it each train will be having how much total coal you can find out. The total weight of the train that is your total tub and its full weight how much it is coming?

And from there, when you find out again, you find out the load because of the rope and then you can do some of this additional frictions of 50% to allow friction and pull due to the

acceleration and all. By doing that, you can find out that what will be the total tension of the rope and then you take a factor of safety. You are taking here 6. Then you can find out the breaking load.

So, that is your total load that means your why you are taking a breaking load? That means you want to select a rope that will be what the dimension? So, once you find out, then you can give the strength constant. That is the formula again it is given. That is your with the square root of this product that will be giving you a that is your how you will be selecting a diameter.? This is rope selections.

So, this type of problems you should practice so, that you can learn it and to do some more practices. You can read that **(())(18:34)**book or that Norman books book that mechanics of bulk material handling that will be giving you more solution.

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This problem further, you can do that the mass per unit length is known. That is a mass factor here we have taken again the fiber per rope. That is why we have taken the k value as 0.35 and the mass of the total rope you can find out the gravity of gravity effect of the rope that is also ending up and the pull on the rope due to friction is taken. Then total static pull you can calculate then the power on the rope you can find it out by multiplying by the velocity.

So, once you know that thing, then, by dividing this by efficiency of the motor that will give you the total power requirement.

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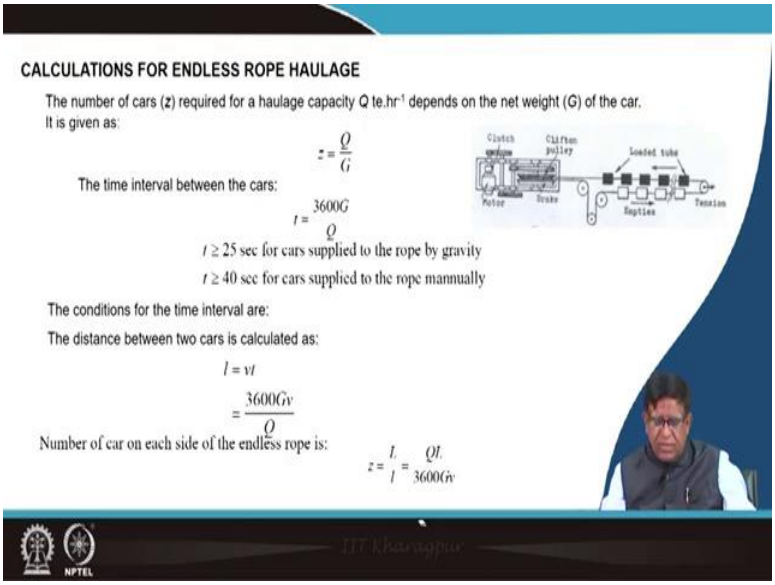

So, this is just an example of how different type of problem can be solved and, in case of your endless rope haulage. This also, we discussed some theory that a number of cars required to for a haulage capacity of Q per hour depends on the net weight of the car. So, this is given that is how many number of cars will be attached to a endless rope haulage. It is given by this two parameter.

That is what is the net weight of the that your car and then what is your total capacity? From there you get this number of thing and the time interval between two cars in endless rope haulage. Because one is connected to the rope then next time the next car is connected to the rope. So, between connecting these two that how many you can find out that is your time will be the 3600 G by Q will be giving you this.

Now this time between these two car, it should be greater than 25 second for cars supplied to a rope by gravity or when you are having a manually you are doing it. Then you can be this t can be greater than 40 second. The conditions for the time interval that you can use it the distance between two car. You can calculate by that is your if that you are connecting two cars on the rope the time is t. During the time the rope is moving with its v.

So, the distance between two cars is l is a v t and, as you can see that the t is given by the your the net weight and capacity. So, the distance between two cars on an endless rope haulage, it is determined by that what is the net weight of the material and what is the capacity of your haulage system and the velocity with which it is coming. So, that is you find out that.

And then number of cars on each side of the endless rope haulage you know it is going over here that loaded is coming and the empties are going out. So, both sides, you can have equal number and that number will be divided by that is your total length on which this exactly the cars will be there. If that is l and then you know between two curves, whatever is the length. So, l by l will be giving you the total number of this mine curves.

As in this figure, you can see how many loaded cars will be there in this set and how many empty curves will be this set. That number z is calculated by this now only the main point is to calculate this l.

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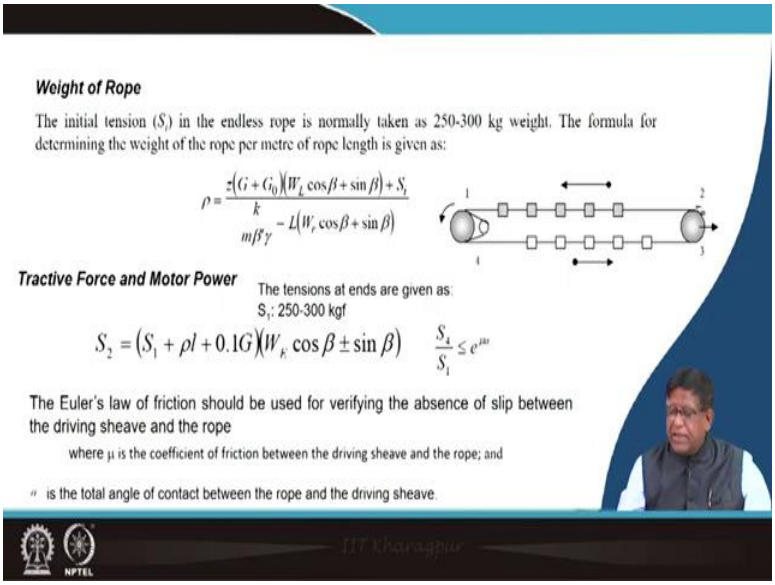

So, then this, how you will be this is again an endless rope haulage is there, weight of the rope it will be depending on the initial tension. That is exactly the rope is kept under tension. If that tension is s one and it is normally taken as a 250 to 300 kg weight and then the formula for determining the weight of the rope per meter of the rope length is given by this. you can note down this.

You can try to derive this equation, then it will be good for you to do an exercise, but this the weight of the rope per meter, how much it is coming per meter? It is depending on the tare weight that net weight and the total weight given over there and then you will be finding out that in the gradient at which it is working? The maximum tensions density of the material total length and with that you can find out.

And attractive force on the motor power, this is also that, on the tensions we have in the other class, we derived this equations also and then once you know this, then the you know that the time tension at this taught side and that slack side. That is the famous Eulers equation that is your S 4 by S 1 is equal to e to the power Mu alpha. Alpha is that angle of rep. So, this will be giving you that your what forces could be there?

That means your tension at S 2 S 3 S 4 S 1. You can find it out and that will be giving the design of your end drop.

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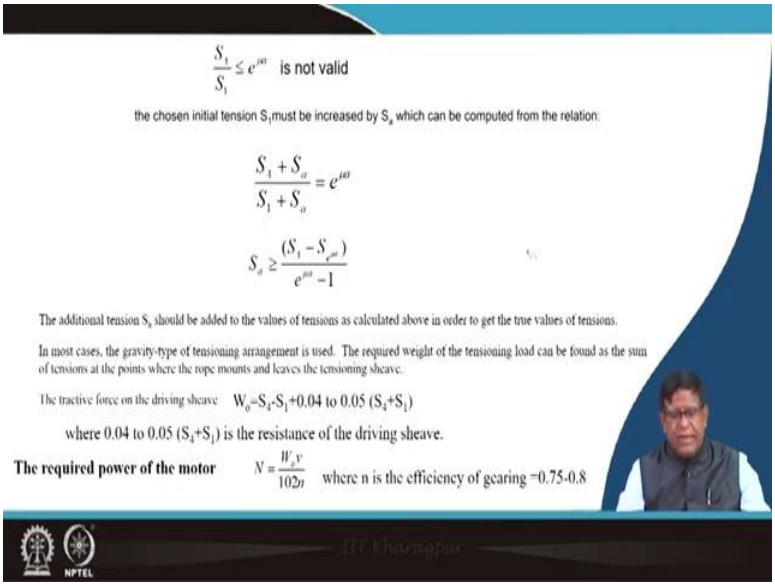

So, this once you know, if it is less than then it is not valid, it should be always greater than equal to. The chosen initial tension must be increased by an amount which can be computed from this that what should be this essay. So, that it can become at least equal to if it become less a, then you have to what that essay that additional tension you have to given on the rope you can calculate it out by this method.

So, the additional tension should be added to the value of tensions calculated above in order to get the true value of the tension. So, that your this additional tension is given over here. So, that this rope remains in tensions and you can drive this well. So, that essay is a very, very important, then in most cases the gravity type tensioning arrangement. The tensioning can be we have discussed earlier attention, boogie can be there or a gravity type you put it over there and dig a hole and on that you suspend a weight.

Now the tractive force on the driving shift that also you can calculate out by this equations. And then the, once you know the total tensions you can find out that what will be the motor power required. This is also your just normally you can take this efficiency up to 0.7528 efficiency and from there you can find out the motor power calculation. So, these are some of the type of calculations you can do.

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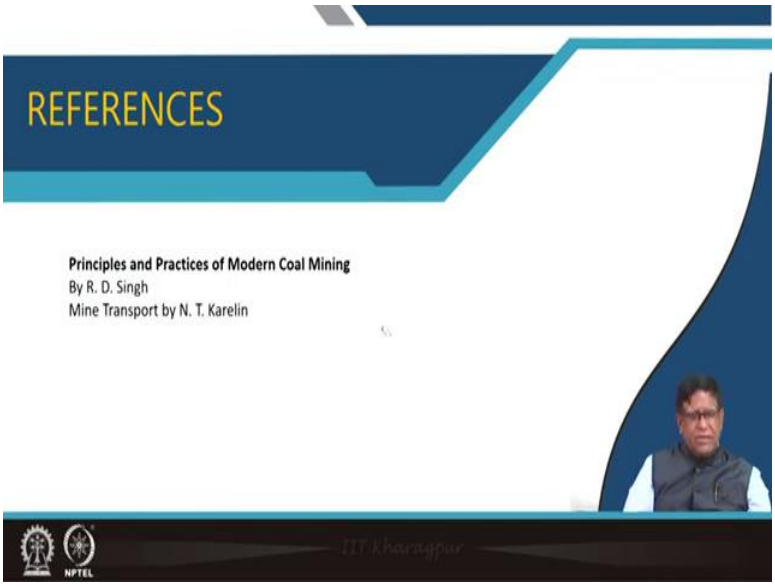

And here again these two books I referred earlier also that will be giving and the Norman book that book gives a lot of numericals and they you need to do some of the creating some problems and try to derive an equations and solve it.

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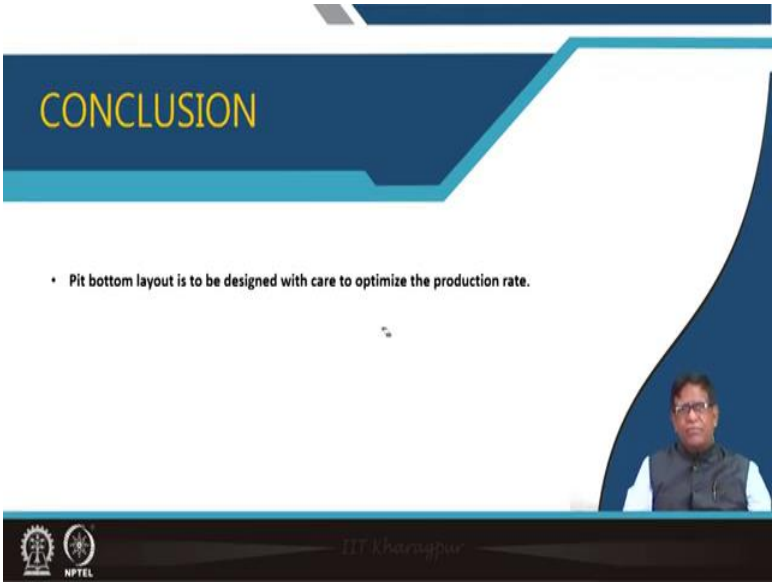

So, we have discussed the pit bottom layout. We have discussed this calculations and I hope that you will be able to take up this transportation problem in underground mining. That is

whenever the situation comes, but what I request you please try to derive the calculation formally and do few small numerical equations draw different circuits. Try to understand that what are the factors that are considered in the design?

And then how they will have to be taken care of in while operating and when you will see you will be able to get a that is what type of retrofitting in this system is necessary and how you can improve. Now, the other things which you need to know in the whole transportation system. How will be maintaining it? What type of failure will be coming? That is another important area of understanding the mine transport system.

But in the next class we may be requiring we may discuss briefly. What are those two type of the vertical transportation system? That is the case, transportation and skip transportations, we will be discussing in our coming class. Thank you very much.