Mining Machinery
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Module - 09
Lecture - 50
Aerial Rope Ways

Welcome to we have been discussing about the mine transport. In the mine transport, we have been talking about this surface mining transport and in that we have discussed about the mining trucks we have discussed about the other emerging technologies as well as we have discussed in detail about the conveyor belts.

Now, the another type of transport system is Aerial Rope Ways. You may find that in our present mining industry you may not see this aerial rope ways to that extent. Because it was there of course, in the third or fourth planning commission's time, India also manufactured some of these aerial rope ways it was there in Dhanbad and Jharia coal field and Raniganj coal field they are wire aerial ropeways.

But one thing is there this piece of this transportation means is very very useful in some of the context particularly where a low capital investment transportation system in some of the difficult terrain and if you see that this is being used railway this aerial ropeways is a very good system in Nepal.

It could be in Bhutan, it could be in many of our hilly areas this system could be of much use, but we have not much exploited this system. So, I will be discussing this to give you an idea what this aerial ropeways for bulk material transport is and how it can be used and so, that you can take up some activities. So, you can design and sometimes you can make some innovative applications in the localities particularly in some rural and interior areas of our country where at a very such type of systems could be useful.

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So, coming to that let us see what is this aerial rope way our objective is to just give you an introduction of this transport system how it can be used in mines. You can see that aerial ropeways of course, is a it is being used in a many other forms many other things many of the your hill stations you may see it if you go to Europe.

Wherever there is your ice skating skiing this skiing sites there in whether it is Slovakia, Slovenia or any other country in Europe you will find this is in the hilly regions they are very much used for transportation of man and materials.

And this is basically when we talk about in the mine transport for our coal or rock mass or sand for sand stowing purposes they can be considered as a transport system in which we

have got a special type of carrier which can be suspended from a rope which are just mounted on a trestle as shown in this figure.

So, here this is a aerial rope way. So, you can see here how this, this is a human that is a man carrying ropeways that Doppelmayr you might have heard this company's name Doppelmayr is a very known name in the world wherever these aerial rope way cars are there. You might have used some of these aerial rope ways in when you have gone to Rajgir or in some of the our hilly hill stations.

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Now, after this class you should be able to tell about what are the principles behind, what are the constructional components and then how it will skinned in that your bulk material handling. You can see this figure shows that this system can you not need of any road or

anything you can go in any terrain conditions you construct a tassel and then the ropes and then you can carry the material from one end to the other.

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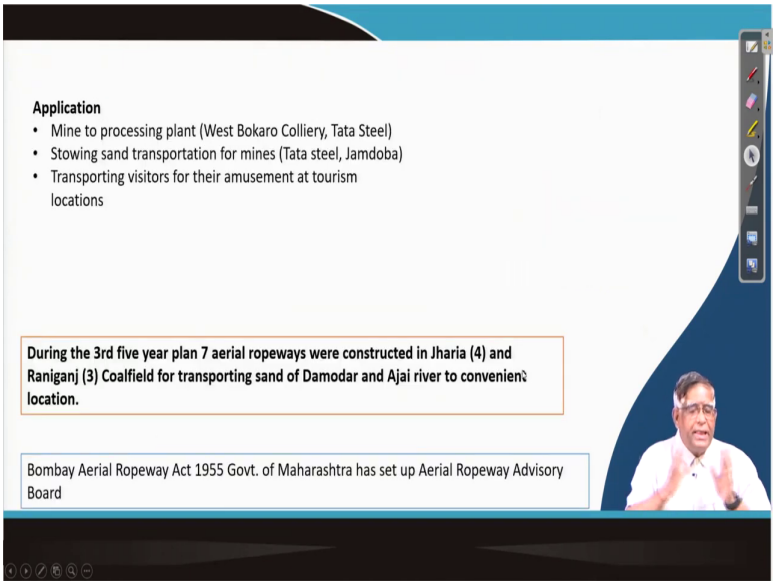

So, this is how that aerial rope way is. So, it is applied in mine to processing plant, in India we have got this in West Bokaro colliery they have got the Tata steel has got an aerial rope way system, then for sand stowing purposes also it was there in Jamdoba Tata steels mines and it is for transporting visitors at amusement and tourism locations you can see in our country also there. During the third 5 year plan, 7 aerial ropeways were constructed in our country.

Then Calcutta based company they were manufacturing and installing this, but of late I do not know if there is any new, but thing is that I think in Gujarat in 2018 also some companies

have started in a aerial rope way constructions and all that in our indigenous companies are there.

So, for that our country has got also that Bombay aerial ropeway act 1955 that Government of Maharashtra. So, you should if you are serious about and there you can explore the business opportunity in this particular type of system introducing in other field other than the mining also, but you need to know about that what are the rules regulations and acts are available.

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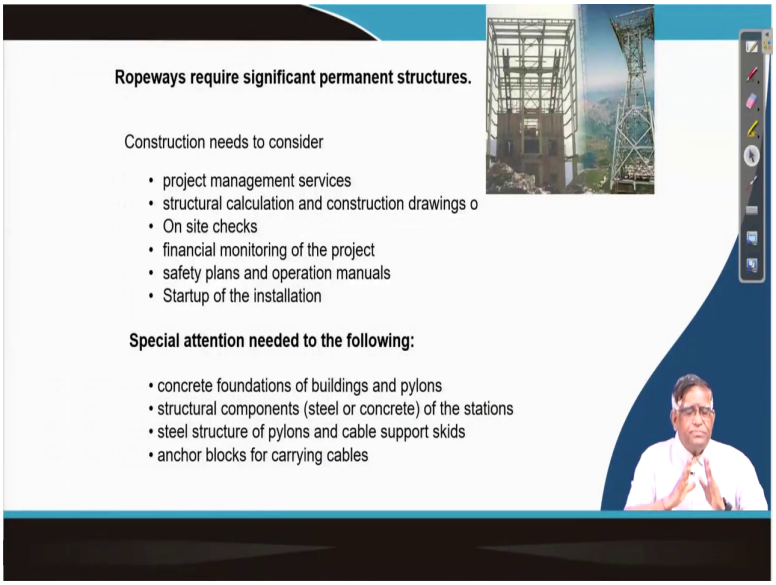

So, this ropeway requires significant permanent structures along the route there will be those trestles will be made and then you will have to have these type of permanent structures will be there.

So, this is a constructions at that time if you are going to manage the things, you need to know that what are the project management services, structural calculations and constructions drawing you will have to understand how it is there how we will be doing the maintenance and checking of this problems and how will be operational troubles how you will manage those are the things also we will have to be knowing.

At the same time what is the cost of transportations and how much exactly maintenance cost, how you will do a total aerial ropeways economics part of it. That is also a management operations you can study separately.

Then there is a financial monitoring of a whole project that what is the life cycle of that (Refer Time: 06:46) total life cycle costing of such type of a proposed project or an existing project you can do it over there then that safety so, that it does not create any problem for there also you have you can get a study and if you have to do as a startup for some places you want to do these installations there also we can study.

So, here we will be discussing the basic principles, but from here you can take a clue and then you can become a competent engineer by learning about how to do it over there. So, you can become a important human resource of the country, if you can come out of these things, but this 1 hour lecture it may not be giving you all details, but it will be a learning point for that you can start coming 1 or 2 years you can learn about the system for your benefits.

So, what is exactly special attention for these type of systems? There is exactly as we have said in the figure you can see there is a trestles. So, there should be a very concrete foundations, a lot of civil engineering will be involved over here there will be a lot of structural components. The structural analysis exactly what will be the wind load how it will be coming how it will be exactly having the fatigues due to the repeated load coming over here.

Those type of civil engineering your structural analysis part also need to be known, then there are what are that exactly this your different supporting systems, what type of exactly

components you can keep it over there and how you will be maintaining the tension in the rope, how you will be anchoring it over there those are the things which will be coming as a associated things which you need to know.

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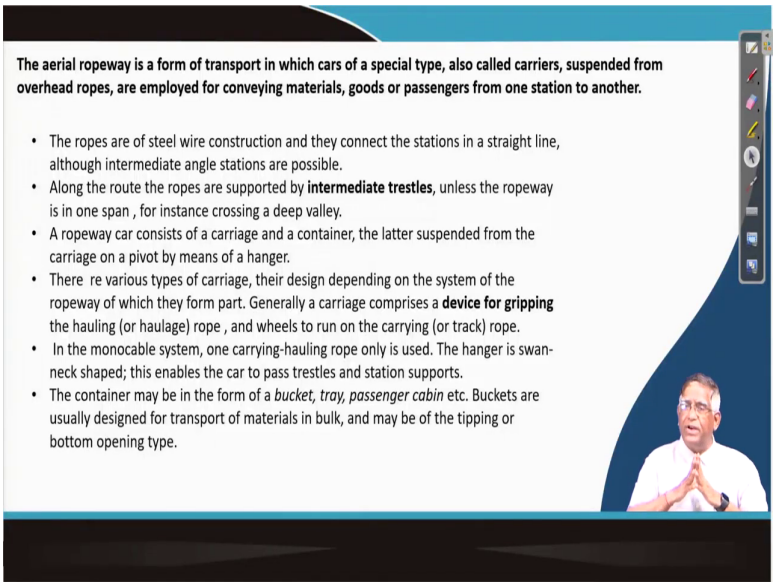

Now, the aerial ropeway is a form of transport in which is as a special type, also it is called a carrier that or somebody say it is a car or a tub whatever it is there, it is suspended from the overhead ropes and they are exactly can be filled you will have to how you will be loading the material.

Say your sand will have to be loaded onto those carrier and then it will have to be again at the stations unloaded. So, that means, basically you are having a overhead rope from here you are hanging a carrier and you are having a stations where it will be loaded and it will be taken over there at the destinations, there will be a unloading systems and then once unloading it

will automatically or by manually by semi manually it will be again put into the system and it will be going.

So, it is exactly the rope it is continuously moving, but the material it is going batch by batch and that is how much will be the production capacity will be depending on how much gap between two carriers are there and at what speed the material is going we will be coming to those things quickly.

Now, the rope wire rope it is already you have studied wire rope in separately that is a steel wire rope, that steel wire rope constructions there could be depending on the type of things we have got mono cable, we have got the bi cable, we have got a carrier cable and that is exactly what type of rope it will be there that is one of the main component of this.

Then it will have to have these trestles. The trestles are also your steel structures then how to design there that is also this special designs is similar to our mine winder design it will be coming over there. When we will be talking about mine winding that winder design also you do some structural design that is basically a truss and columns type of design you will have to know little bit of that. Then this the car consist of a container and it is suspended. So, there is a hanger.

So, how that hanger will be going over there and there will have to be wheel which will be moving over the rope. So, those components need to be designed or as a mining engineer if you are not going to do the detailed mechanical design, but as an engineering analysis, it is very simple because the whatever engineering mechanics you have studied in second year level that is sufficient for going for designing those type of system or any design you can understand easily.

Now, there are various types of carries and then we can we will be discussing about here two types today about mono cable and bi cable and let us see this the in the mono cable system, one carrying and hauling rope is there and the hanger is swan neck shaped that is your just like a gooseneck type of things it will be hanging from there.

And there the this exactly the bucket or that you need to have a hanging a bucket or you need to have a passenger car or with a that is your provisions for sitting and things like that. So, those are exactly the innovative engineering imaginations and planning you can do and we put it.

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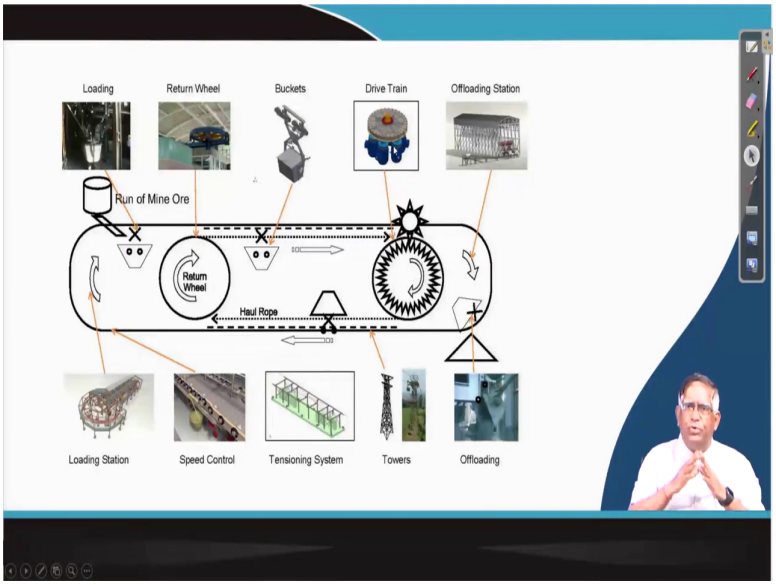

So, basically what that aerial rope way system is, that you are having a continuous endless rope is running over here, this is called your haul rope and then there you are connecting these buckets.

Buckets are connected to that rope and it is carrying over there and there is this wheel it has got a drive to it and there how the material will be exactly when it is tubs will be coming over

here, they will be loaded from a loading stations and then it will be unloaded at a unloading stations.

So, in between there will be some of the control you will have to have, you will have to have a speed control, you will have to have a monitoring all along over there, then there will have to be this rope will have to be under tension.

So, you will have to have a tensioning arrangement the rope will have to be suspended some tower. So, you will be having this trestles on which it will be there and basically these wheels these are the sheave which will be exactly driving the rope, it is just only as a friction drive.

So, driving the wheel there will be separately your motor and gearbox systems and then your the rope is getting power over here. So, how the grooves of the that your sheave and then how the rope will be performing, how you will be monitoring about its life strength and all that whole comes about the engineering of the aerial ropeway system.

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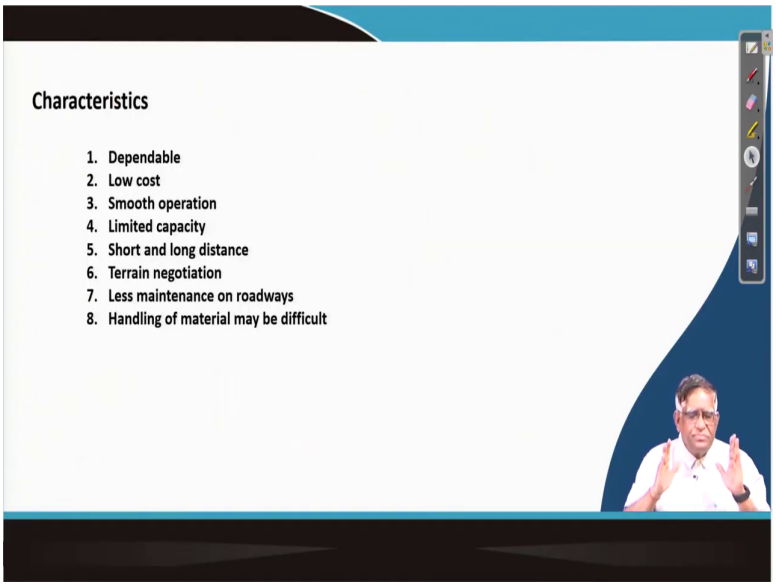

So, I hope you have understood the components. So, what is basically its characteristic? It should be dependable, it should be low cost, operation should be smoother there is of course, this system will be having a limited capacity not like a heavy truck or like your this the conveyor belt where you can go 10,000 tonne 15,000 tonne per hour.

Or they say a truck which will be taking your 500 tonne per that in one truck and you can go over there, but there are many places where your bulk material will have to be transported not that much rate, but in less amount of material also need to be carried. So, you can see here wherever this limited capacity is there.

There you do not go for a very high investment then short and long distance it can be done for any things and it can negotiate the terrain for truck you need to get having a that your road for

aerial at the for your pipe belt conveyor you need to make a total let say layout systems for there you need to a supporting vehicle movements necessary.

But here any terrain you can make you can negotiate it over there and there no maintenance on roadways things will be coming and the handling of the material may be difficult. Sometimes, that you are loading and unloading and if there is a non that is if you are not properly designing the material may get spill over there. So, those are the issues there.

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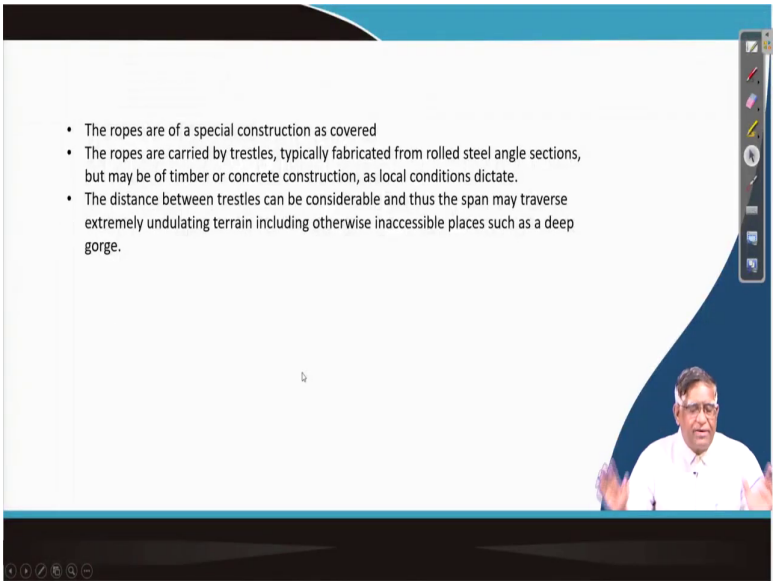

So, here you need to take care of the rope and this the trestles and that your that mainly that what will be the distance between two trestles that will also we will have to be designed. Because if your two trestles are at a very wide then there will be a sag and when that sag will be there will be different type of tensions.

Now, depending on the height of that the at what height you will be keeping up the trestle, your rope will have to be selected that if when it sags down it will not obstruct any movement other than this. So, there are so, many issues need to be considered while designing and constructing.

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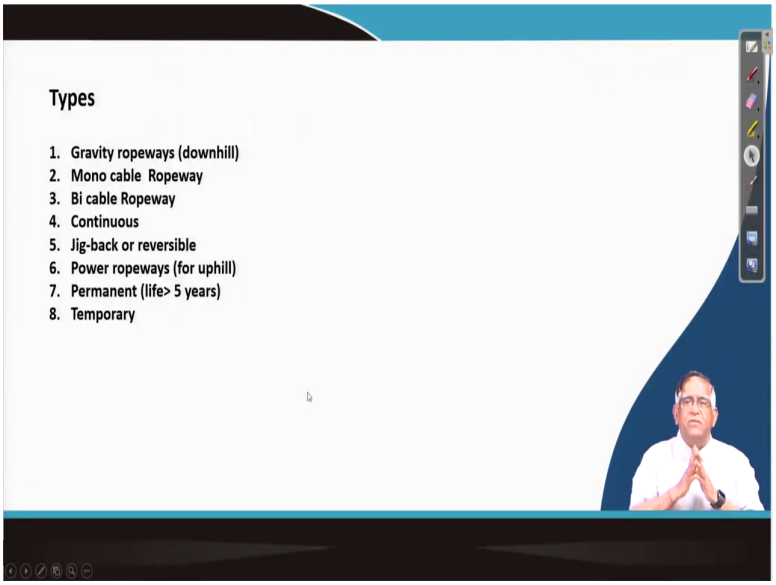

So, there are different types of this your rope way system. A gravity ropeways that is your mono cable bi cable it can be continuous ropeways jig back or reversible one will be going and then same rope will be coming like that that type of things, then there is a uphill. Uphill ropeway means you are exactly giving that power if it is a downhill ropeway then what will happen?

When it will be moving at that time your that sheave it will get because of the load is going over there it is rotating. And you can generate electricity over there. How the regenerative

breaking and all is used that is exactly going in a downhill and then it could be a very small durations.

Sometimes, you are suppose you are doing some construction work at a near a hilly area on the hilltop you need to take up this say materials all the cement brick and everything is to be taken up there. So, there you do not have a road to go up the hill. So, there you can have a very short life.

Maybe the construction period is 5 years you can have that is your one very short durations aerial ropeway can be constructed. So, you can see that it could be temporary or permanent different type of this aerial ropeways could be there. One thing is there all our hilly areas they are very good and there is a lot of opportunity of investment and having a better this aerial rope ways. You might have seen that we are our many of our hill area they do not have a proper bridge over the rivers and all.

But only thing is there while constructing them, it is very essential to see that stability and then this exactly the soil condition and the foundations not that all places may not be suitable because of that other geotechnical factors also will have to be seen. So, that is why it is a technology which is very easy to install and it can easy to operate, moreover it will not give a very heavy load. So, that is why the with a proper geotechnical considerations it can be negotiated with any terrain.

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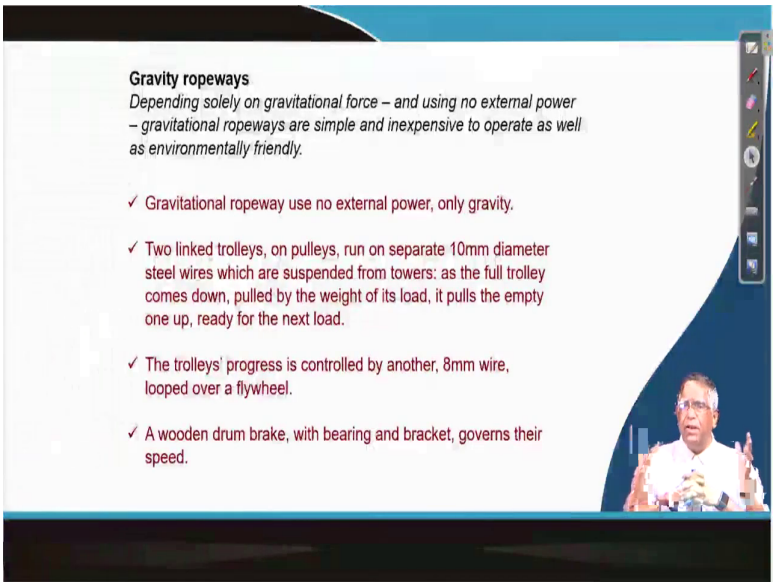

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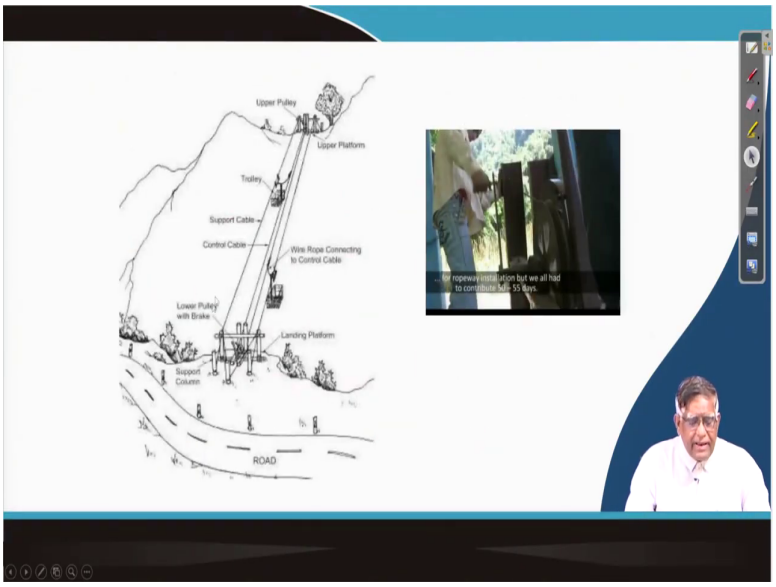

So, now coming to the first type of that gravity ropeways which is there exactly in the Nepal, it has used in some of the hilly areas in Nepal, this gravity ropeways have created a very good boon to the common people there. You can see here in a hill top here that the people living some villages are there they need to go and come very close to the road for going other places and all they had to walk down and all this area with their heavy loads.

Now, for coming over there, they can use this ropeway for even for transport and then carrying out their these agricultural products and all to over here. It is a very simple system they have operated with a manually because they are taking the gravity load and they are the type of material which they are moving with that they can take it over there with the jigging system when something is going down then the that other things can go up, when your materials are being carried down.

Then some of the people who wants to come up they can go over there such type of systems are there in Nepal.

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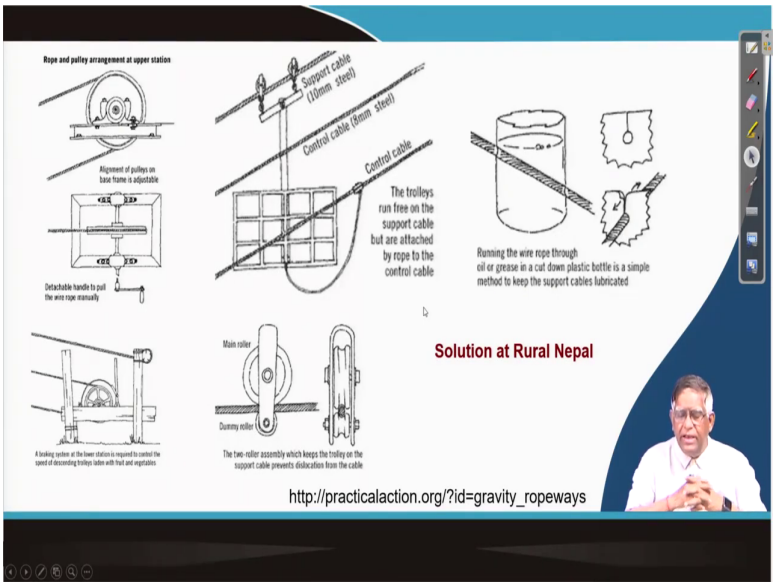

And now in that exactly the in a rural Nepal how they have used you can go to the website and see, it is a very simple low cost mechanism their local people they have in a village people they have made this system and the beauty of the things, they have taken some of the plastic bottles.

In that plastic bottles they have cut and then inside that they have put the lubricating oil and the rope is passing through that. So, that oil is that is the whole lubrication is done. So, that on the sheave there is no more wear and tear of the rope and then it is exactly the life is taken care off.

So, there are exactly where there is a problem and if you think an innovative ways the things are done. So, it is basically how you have engineered the things that is most important thing. So, you can learn from these applications in Nepal that how this type of systems can be done.

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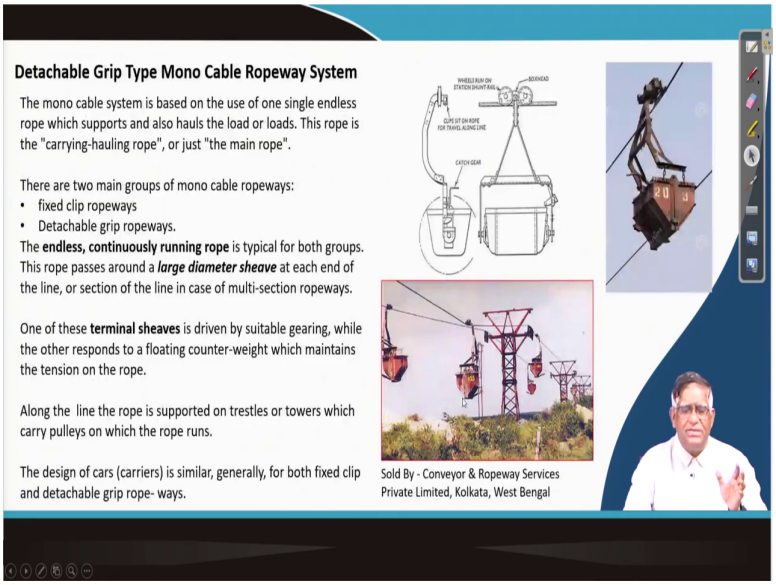

So, the other thing is we are telling about this monocable ropeway. In a monocable ropeway you can see that there is only one rope is there going over here on this rope you can see that this your that bucket or the container there is a your catch gear by which it is kept and then it has got the wheelchair wire which is having a grip.

And now that is exactly there is a clip which is sitting onto the rope and there is a sheave over here this is exactly running on that rope and then you can see here that these wheels they run on that shunt rail that is at the time of that loading and unloading these 2 wheels will be going on to the shunt rails and they do the your unloading operations, that is at the when there will

be unloading this lever it will hit on proportions and this will be tilting and the material will be unloaded by a (Refer Time: 20:12).

So, this is a very simple mechanism and such type of systems were used in our west Bokaro and in Jamdoba mines, this aerial ropeways and there this there are conveyor and ropeway services private limited a Kolkata based company, they exactly manufactured few 30 years, 40 years ago in our country.

So, this exactly there is a sometimes we have got that grip that is a detachable grip, it can be detached from there or otherwise it could be as a permanent grip will be there and it will be moving But the rope will be moving and then you are not exactly detaching over there that these 2 types of that is a fixed clip ropeways and detachable grip ropeways 2 type of ropeways are there. The endless continuously running rope is typically for both the groups that is your you can have the detachable or detection.

Now the how it is run as we have said in the figure this figure we have shown here, that is this wheel that is exactly around which this rope goes at the end stations when it is coming to the end stations, this this ropeways it will be going at the end there is a terminal sheave. So, basically now on the road you can see like that, but there are 2 3 stations where this whole technique is there.

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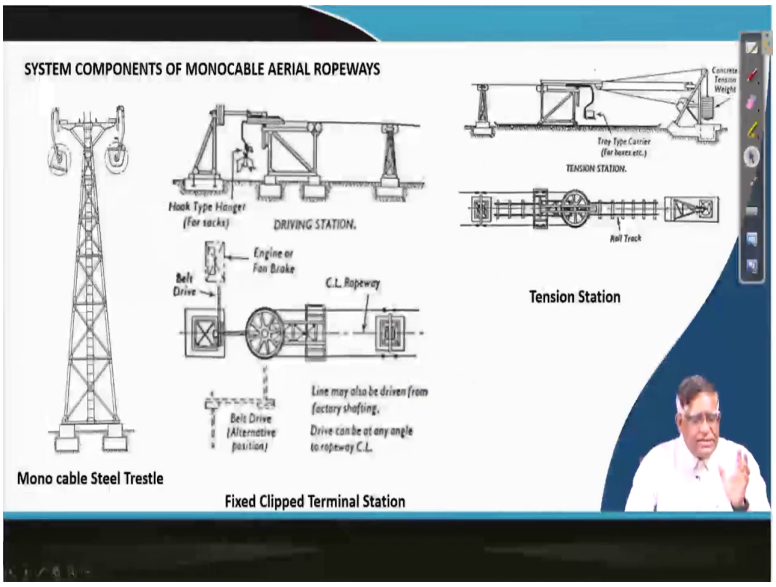

If you see here this is a trestle on which this rope will be going one for you are going say towards the from the upward and the another is going downward or one is for carrying side, one is for your return side. This is the loaded one will be going from here and you can see that empty that is a reversed one it is coming this way.

So, there are 2 ropes and now there are terminal stations one is your a driving stations where your main power is given and another your tension stations where the rope is given tension. So, you can see this is the sectional view and this is the plan view. Now this is again here you can see this is your the that in a your how that your this is the sheave that we are telling this sheave which you can see from the on the plan view you are looking it higher like that because it is there you can see on a horizontal.

So, on a vertical axis it is rotating so, that this rope it will be going over there and the same rope the other side it is returning. So, the loaded things which are coming over here they will be getting unloaded and then it will be going as a unloaded one. So, this is how this drive to that will it can be given a drive systems where we have got an engine.

It may be a diesel engine from there it can give a belt or chain or gearbox drive and then this drive is given to the wheel that your wheel will be rotated, here exactly with a belt drive also you can make it rotate. So, after that you are having this whole line will be played over there you can see that this trestle this is the trestle on the plane view, this is showing over here. So, this is the there is a carrier these 2 points that you are saying the carrier. So, this is how a system will be there.

Now in the tensioning side the other side there is also a sheave. Now this sheave here there is a platform on which there is a rail you can see that this rail on the plane view we can see this is the rail, on which this is your this sheave which is mounted on this is a trolley.

Now, this trolley is now connected with a wire rope and then there is a another sheave with a rope and pulley system we are having a weight is loaded over here. So; that means, because of this weight that whenever there is a an elongation of the rope this will be coming towards these directions and that rope will be always in a tight and at a particular tension.

So, if there is a that chug and all that thing will be taken care of over here. So, I hope you have understood that in a ropeway aerial ropeway we are having these systems of a terminal stations one for driving another for tensioning.

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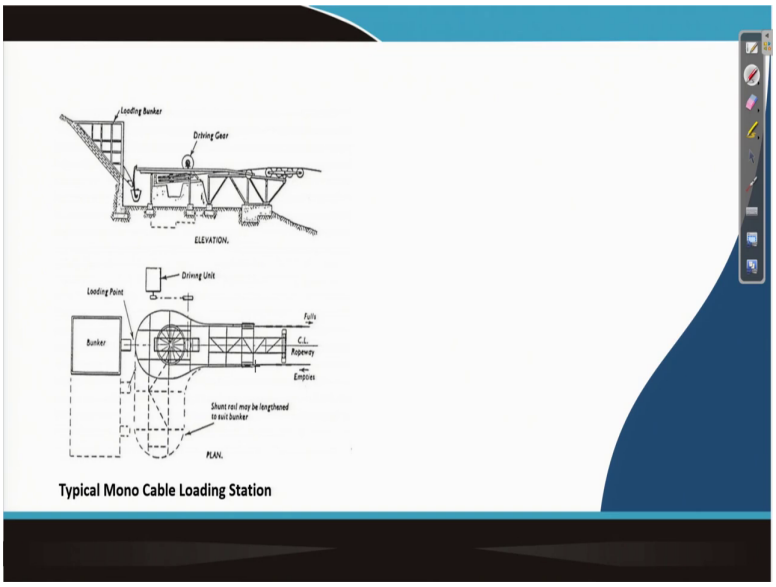

And then in the loading that is in the one terminal at your driving stations or at your that if it is a loading, the material will be brought by truck or anything and they have got a bunker. From that bunker it will be operating with a gate is open and the material as soon as the bucket will be coming over here this gate will open material will get filled.

And then this will be staying only that much it is continuously running it will be having or we are having a shunt rail system by which this will be loaded and then it will be pushed and it will go into the rope.

That is how exactly if you have gone to Rajgir and all you might have seen that when you enter into the aerial ropeway after that some person will be pushing or you will be going over

there and it will get connected to the that your wire rope or because of then when it is coming over there it get detached from the wire rope you get up and then it goes again.

So, this type of system is also there in this. Here you can see from the bunker, this is the bunker on a plan view you can see here it is coming and then loaded and then this is the sheave and then up to here it was a rope is coming over here. Now from here when this is the your there empties which are coming to the loading stations after they come over here from there they do not they get detached from the rope.

This rope is this once as you can see here the your that rope is going from here this is the rope coming like that then the material will get detached and it will go to this, this is the shunt rail, on that rail it will be moving and then it will be coming over there. Now, you can see here that is after these portions this will be coming to this and then it will get it loaded and then after that the shunt rail it will come and there it will get connected to the wire rope system. So, this is the way how your loading and unloading takes place over here.

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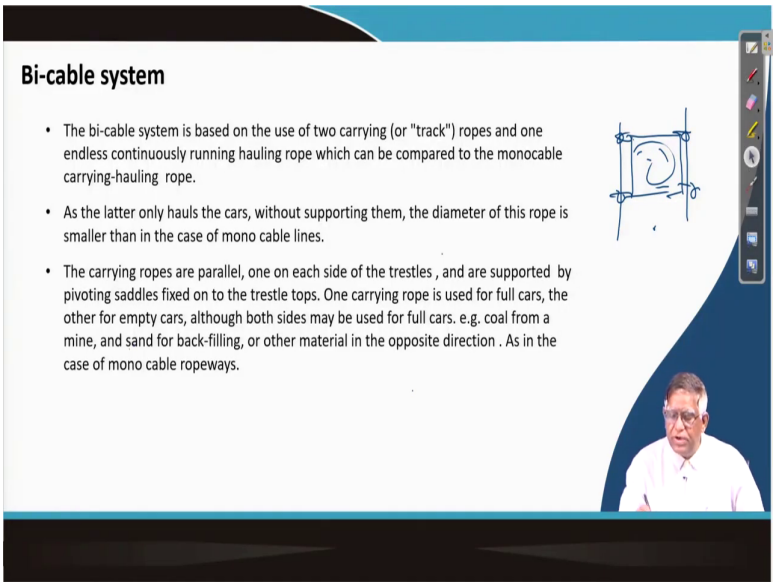

Now, if you see that in a bi cable system there are of course, the 2 cables. Now on that 2 cable there are systems sometimes you have got the 2 cables like that and you may have a 2 cables on this even a trolley like this we can have on a 4 wheels it can go over here the material will be loaded in this bucket.

So, this type of systems are also there in which Bokaro or sometimes this bi cable is your based on how that your that you can see the drawing over here which will tell you how exactly a bi cable system is working.

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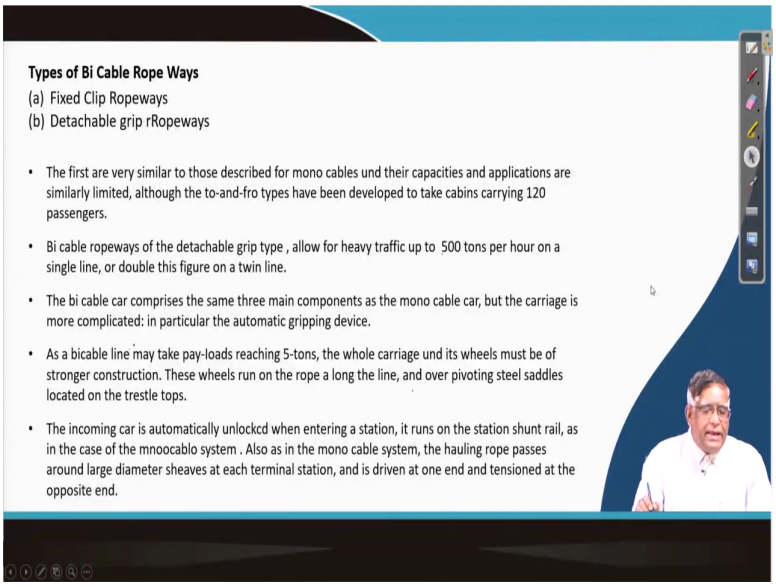

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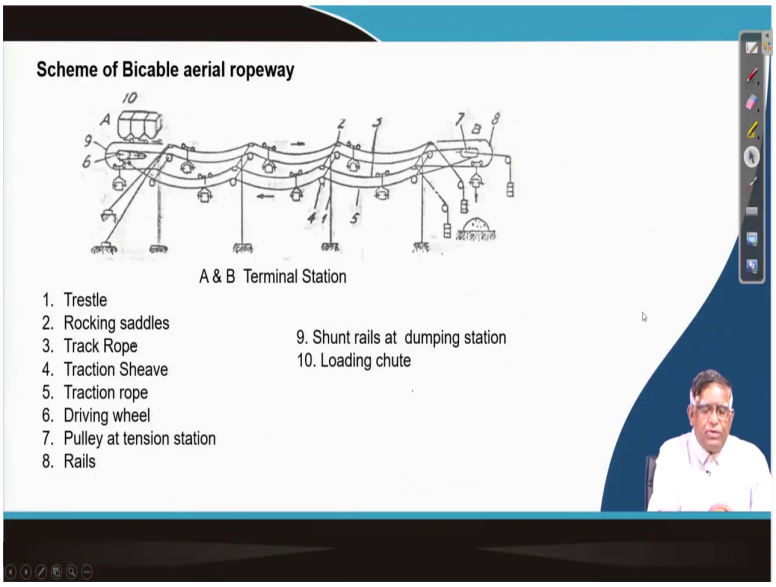

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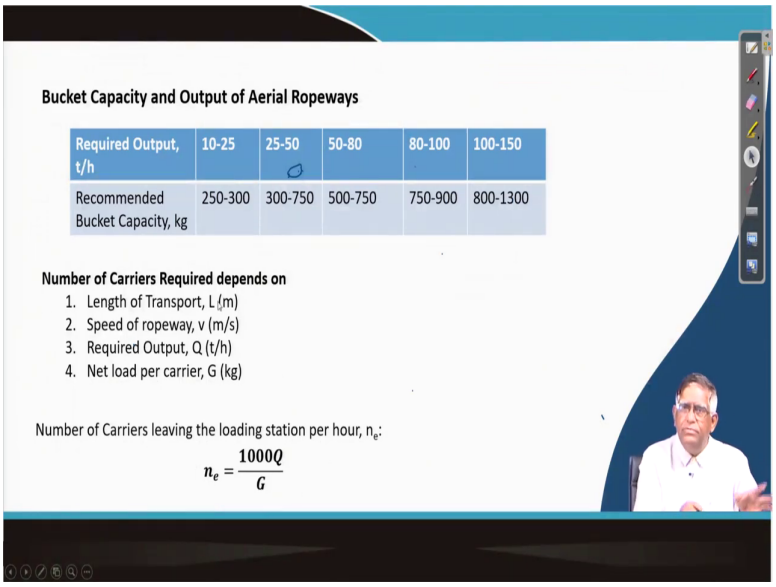

Just I will see there also that your fixed type and things. You can see here a bi cable system there are 2 cables one is hauling another is your carrying; that means, they this there are 2 cables here you can see this the carrier, it is a mounted on your that is a if you see here this your this is your carrier is on this rope and there is a one small diameter rope which is exactly connecting and it is hauling the things. So, that you can see that this is just like a track, on that track it is moving.

But for driving you can see that the another small rope which is here this rope is under tensions and then it is exactly driving over here. So, there are the bins from which it get loaded and then it is getting unloaded at the other end. And now for this rope that main there are 2 rope system the rope on which the carrier is moving this has got a separate tensioning arrangement, the rope which is hauling it is having a separate tensioning arrangement.

So, you can see in a bi cable ropeway, a trestle, rocking saddle you can see this item that is your we are having a traction sheaves are there then we have got this traction rope this is the traction rope and then there is a driving wheel will be there this is a driving wheel and then there is a pulley for tension arrangement, this is a tensioning arrangement is done and at end we have got the rails on which this comes over here for unloading purposes on this rails which is called your shunt rail.

So, then you have got this the bucket capacity and output of this aerial ropeway, it is exactly depending on. That is your if you were to have a 25 tonne per hour that your recommended bucket capacity will have to have about 250 to 300 kg. Similarly, if you want to get about 100 tonne per hour, then your bucket capacity will have to take about 800 to 1300 kg it must take.

So, that is a number of carriers required for a let us say aerial ropeway, you will find if the length is L. Your speed of the ropeway is v and required output quantity is your Q, then net load per that carrier is G, then you can find that number of carriers required is 1000 Q by G very simple logical calculations.

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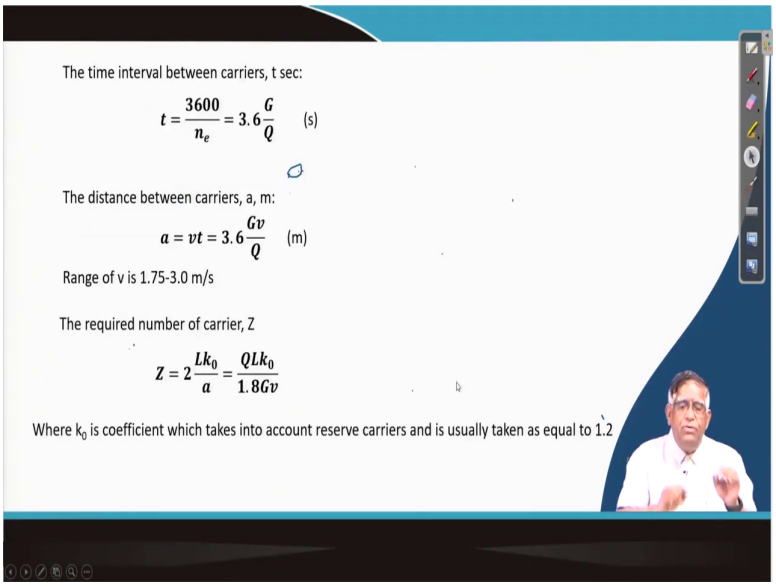

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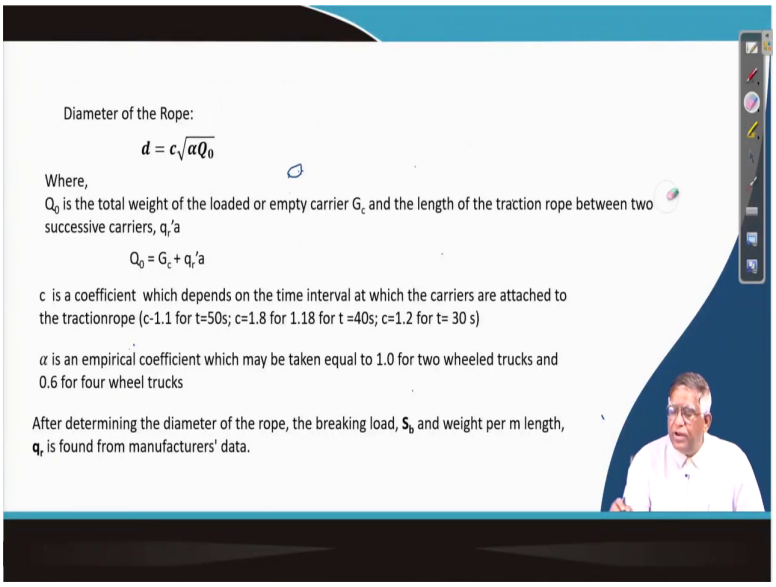

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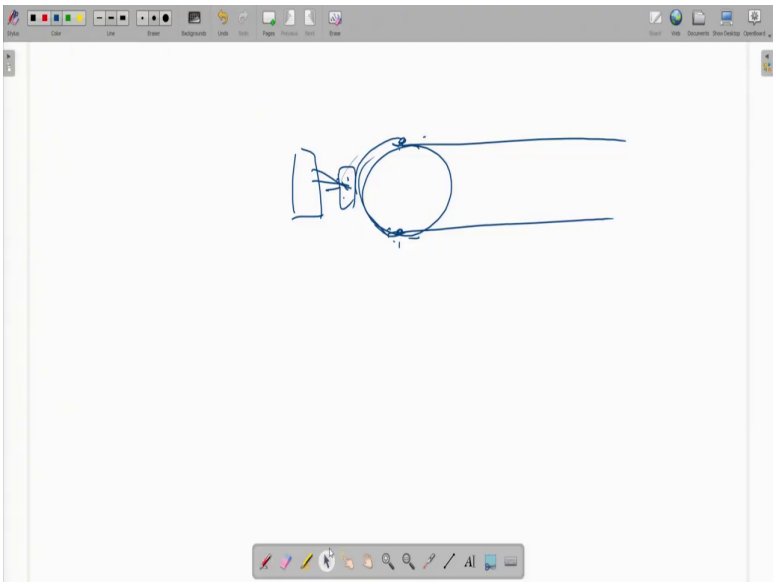

Then you can find what is the time interval between the carriers. That means, when you are going to a one end sections sorry that is when you are coming to the when you are coming to the end section if you are having this is your terminal stations here, from the terminal stations if your carrier is going over here it is your loading stations here your bucket is getting loaded.

Now, from here to here; that means, it will get connected. So, after it goes then only the next one will be coming. So, therefore, there should be a time gap that is your how that time will have to be managed over here. So, that is where you need to find out the time interval between the carriers, it will be depending on your this parameter as you have said that is your net load per carrier this exactly affect it and then what is your rate that coming over here then you can find out.

That means, you will what speed of the rope you will be designing that will be depending over there. So, then what will be the distance between two carrier that is given by these equations you can find out and then this velocity range is normally within 1.75 to 3 meter per second from there you can find out what will be the required number of carriers for a given capacity. So, from these equations you can easily calculate out.

And now here one coefficient k naught is given which is exactly how many reserve carrier you should have sometimes you may have to get little bit overload and all. So, that is why a 1.2 you multiply that is 20 percent more number of carriers you normally provide this is how exactly the system works. And for that what type of wire rope you will be selecting?

Their size of the wire rope it will be depending on exactly that what is the total weight of the all the loads loaded your loaded tubs, how it is coming over there that your wire rope diameter should be such that it will not break. So, that the diameter of the rope is depending on the what is the total load coming over here.

So, this total weight that will be depending on what is the weight of that carrier and the rope. If the if your the traction rope their weight also taken into considerations and the time interval on that speed how much dynamic load is coming over here and there is a one coefficient is taken whether you are having a 2 wheel truck or a 4 wheel trucks that what type of how the rope is being used considering these things you are exactly you determine the what is the total load coming on that.

Now, once you find out the diameter, then you will have to know what will be the breaking load for that diameter. You can find out the manufacturer decisions from there you can find out what is the per meter what is the length of it and once you find it that is the way how iteratively you design.

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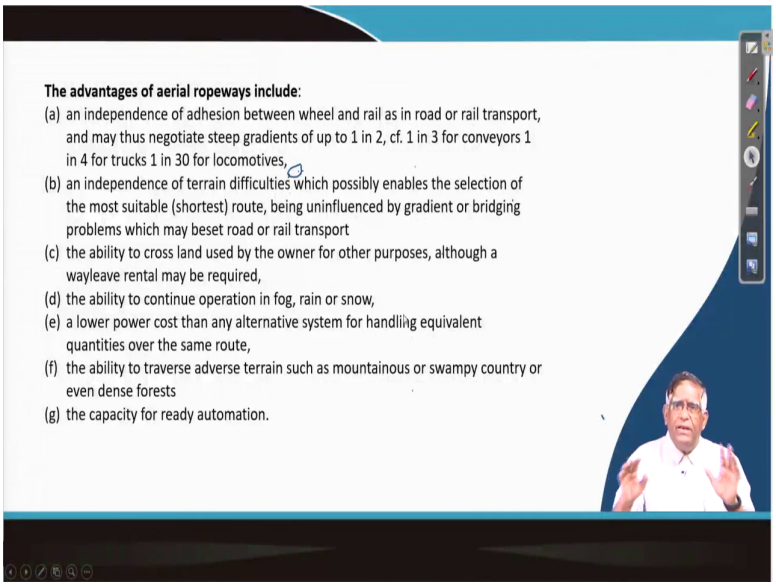

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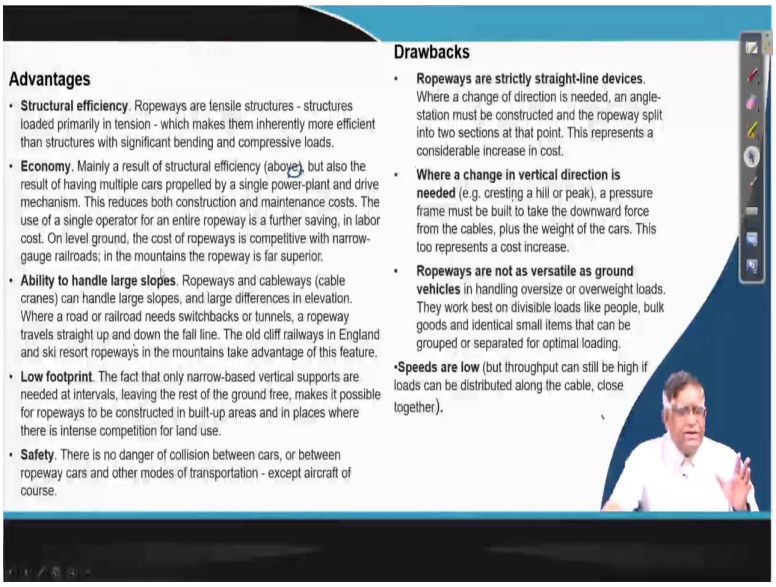

So, only thing is there are many advantage of this aerial ropeways these advantages basically it is a very simple to operate and its structural efficiency its economy its ability to handle large slopes low footprint it does not have a many environmental damage. So, this is a green way of transporting and it is very safe also, but it is exactly you need to do a straight line only for managing the angle taking a turn and going in a different way there need to make a more arrangement at the trestles.

So, this angle stations are a little bit tricky to make it then there is a the you if you were to gave a vertical undulations also sometimes when it has got to be engineered out, and it is a it cannot take a very high load of high rate of transportation you cannot make and you cannot make it to move very fast like conveyor will be moving at 5.6 meter per second, but here it will go only on 3 meter per second and that also there is a gap between two you will have to

maintain that gap between two carriers. So, which cannot be and that way the production rate is less.

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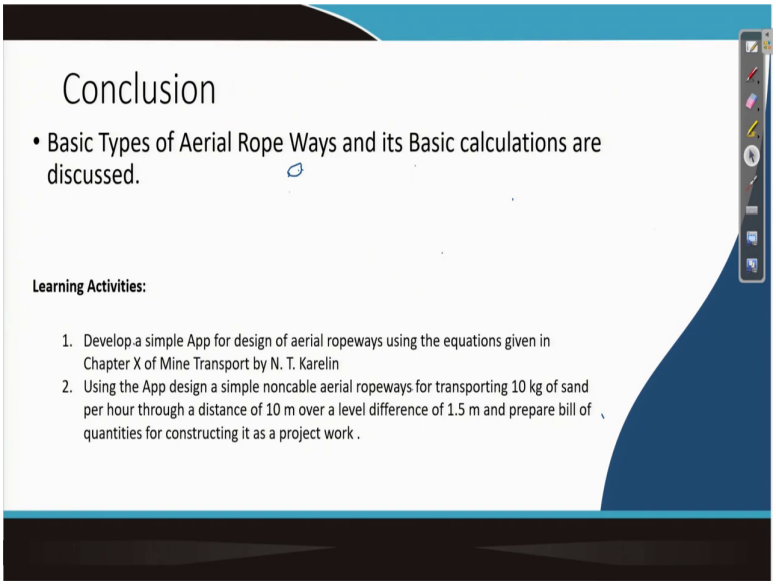

So, these are the drawbacks and there are what I have just introduced you about what is this aerial ropeways and how you can start exactly thinking engineering calculations with this, but there are I have given you a learning activity here please take it up. Develop a simple app that is a it can be a mobile based app to design aerial ropeway using the equations given in the chapter 10 of mine transport book written by professor N.T Karelin.

So, N.T. Karelin's that book mine transport you open it up go to the chapter 10 you will find that exactly the mechanisms are also explained and how the different power calculations what should be the power of the electric motor to drive this also is given over there.

Take those equations first try to develop a that is your simple coding so that you can give the things and you can do it over there and can it be a mobile app to know it or if it is not a mobile app you do it just in excel based calculations then using that app the you design a aerial ropeway for transporting 10 kg of sand per hour through a distance of 10 meter over a level difference of 1.5 meter and prepare a bill of quantities. Now, you should know now you are almost going to be engineer.

You are in a third year level and every engineer they need to do a project. Project is a part of engineers work if you are do not have project you will not become an engineer as a competent engineer and for that engineer must do a project means what are the requirements for that project that is to be designed as a bill of quantity. Learn, what is the meaning of bill of quantity and you prepare it for this particular one if you can do that then it will be just you will having the experience of this.

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So, with this we conclude on this particular module of our surface mining transport.

Thank you very much.