Construction Methods and Equipment Management
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Lecture-11
Earth Moving Equipment-Scrapers (Part-1)

Hello everyone, I welcome you all to the lecture 11 of the course construction methods and equipment management. In this lecture on the series of earthmoving equipments, in today's lecture we are going to discuss about the scraper.

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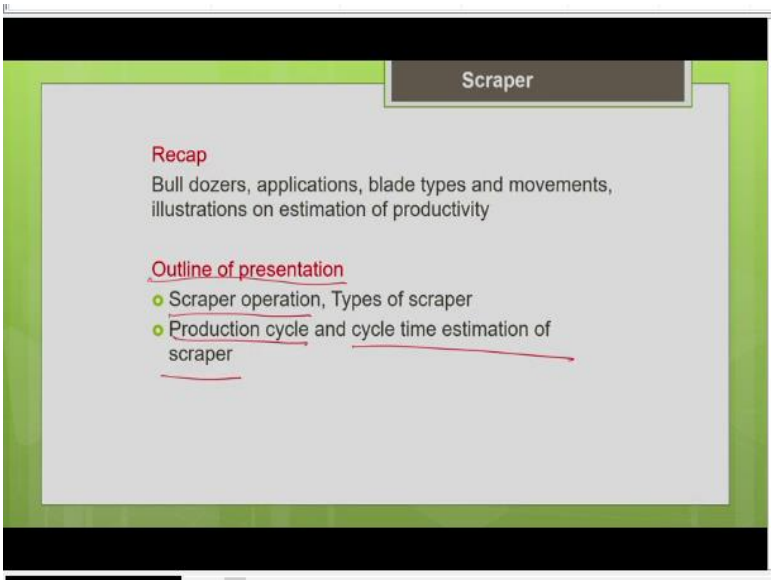

In the previous lecture, we have discussed about the bulldozers, the applications of bulldozers, the blade types and the possible movements of the blade of the bulldozers and how to quantify the performance of the blade and what are the factors which affects the productivity of bulldozers, then we even worked out some illustrations on how to estimate the productivity of the bulldozer?

So, let us see the outline of today's presentation. In today's presentation, we are going to discuss about the operation of scraper. So, what are the basic operating parts of the scraper and what are all the different types of scraper and their applications? So, I will also introduce to you what are all the components of the production cycle of the scraper and how to estimate the cycle time of the scraper? So, these are the things we are going to discuss in the lecture today.

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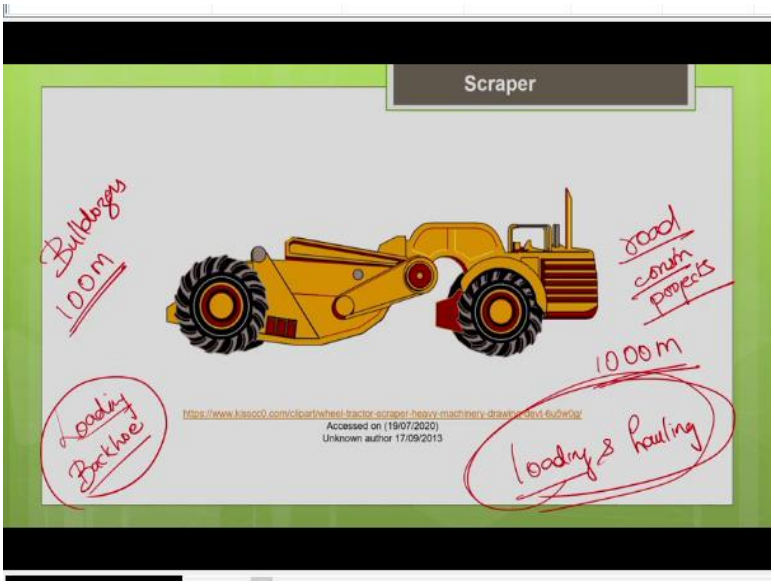

I hope most of you might have seen the scraper. So, this is a picture of the scraper. This scraper basically it is used for medium to long haul distances, say up to 1000 meters you can commonly use the scraper. So, very commonly you can see its application in the road projects, road construction projects, you can see this application of the scraper. Commonly it is used in the foreign countries, but India we cannot very commonly sees this, the scraper.

So, the main advantage of this scraper is it is both good in loading as well as hauling, loading and hauling. So, I hope everyone knows what is loading. It is nothing but cutting the earth and loading a bowl of bucket whatever. So, that operation we called it as loading. There are certain machines which are very good in loading. Say for example, your loaders, your backhoes, excavators. So, they are very good in loading, but their mobility is very much less.

So, that means their economic haul distance for those machines very commonly less than 100 meter. So, for the bulldozer what we discussed in the earlier lecture, the economic haul distance is only up to 100 meter for the bulldozers. So, what I am trying to say here is there are certain machines which are very good in loading, but their mobility is less that means they are not good in hauling. So, they have a haul distance of maybe less than 50 meter or less than 100 meter.

But there are certain machines which are very good hauling like a trucks, but they are not good at loading, but the advantage of this machine is it is good in both loading and hauling. So, it is something between loading and hauling that means, so, I cannot compare the loading efficiency of a scraper with an excavator. So, when you compare it with an excavator, the scraper loading efficiency is less.

Similarly, I cannot compare the hauling efficiency of a scraper with a truck. In that case, the hauling efficiency of a scraper is going to be lesser than the truck. But it is something in between the loading machines and the hauling machines but it is good at both loading and hauling. So, that is the advantage of this machine that makes it more versatile for so many applications. Because it is good both in loading as well as in hauling.

Say for example in your project site, if there is a temporary breakdown of a loading machine. So, but if you have a scraper, then in that case your entire work will not come to a standstill. Similarly, if there is a breakdown of your hauling machine. So, if you have a scraper, it would not stop the entire work. Your work will keep progressing because this machine can take care of both loading as well as hauling.

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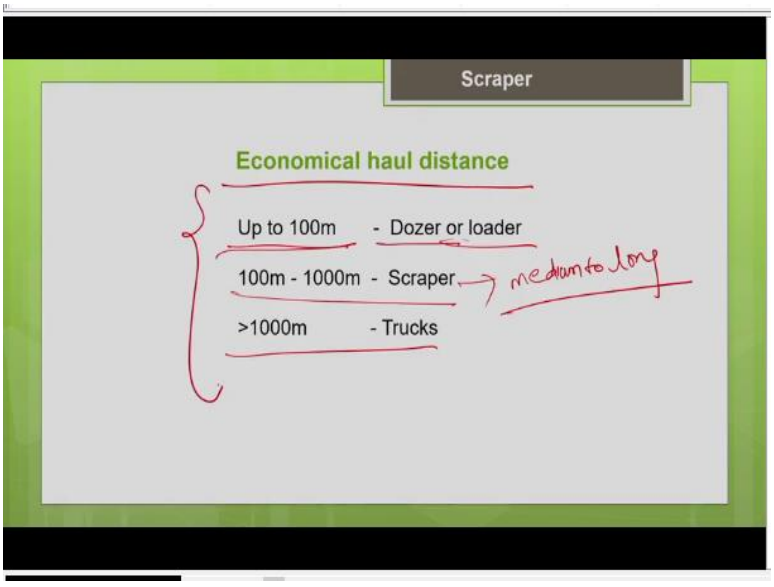

So, when we select the earthmoving machines, we are very much concerned about the economic haul distance of the machine that is a very important parameter. So, based upon that only we have

to select the earthmoving machine. Say the bulldozers what we discussed earlier, it has a hauling distance up to 100 meter. So, beyond 100 meters, it is not economically feasible to use this machine.

Similarly, front end loader, if it is going to be crawler mounted and we can have a haul distance up to 100 meter, if it is going to be wheel mounted, it can be even slightly more than 100 meters. Say it can go up to 200 meter, but not more than that. But your scraper you can see the haul distance is a 1000 meter. So, it can be used for medium to long haul distance I can say.

Obviously trucks can have any long haul distance greater than 1000 meter. So, based upon this haul distance only we have to select the earthmoving machine. So, that depends upon your project requirement. Say for example a dam project or a road project where the haul distance requirement is more, your scraper will perform well. So, that will be the right application for this scraper.

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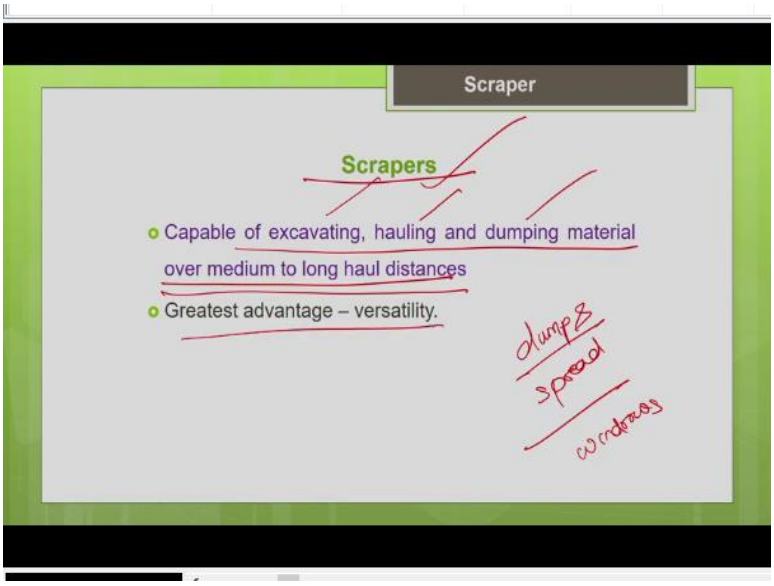

So, the scraper is capable of excavating hauling and dumping material over medium to long haul distances. So, it can excavate, haul as well as dump. So, it can dump and spread the material in continuous operation that is one advantage, it can uniformly dump and spread the material same windrows. So, you can have a uniform spreading of material to required thickness. So, very much suitable for the preparation of subgrade of the roads.

So, another thing is very commonly you can use a scraper and you can see its application for top layers stripping of the soil or the cutting and filling. So, we cut the soil in one place and carry it and fill it in the other place very commonly you can see many construction projects like road projects, cut and fill earthmoving operation. So, this is a very common equipment use for those operations particularly for medium to long haul distances. The advantage of both loading and hauling makes it more versatile for many applications.

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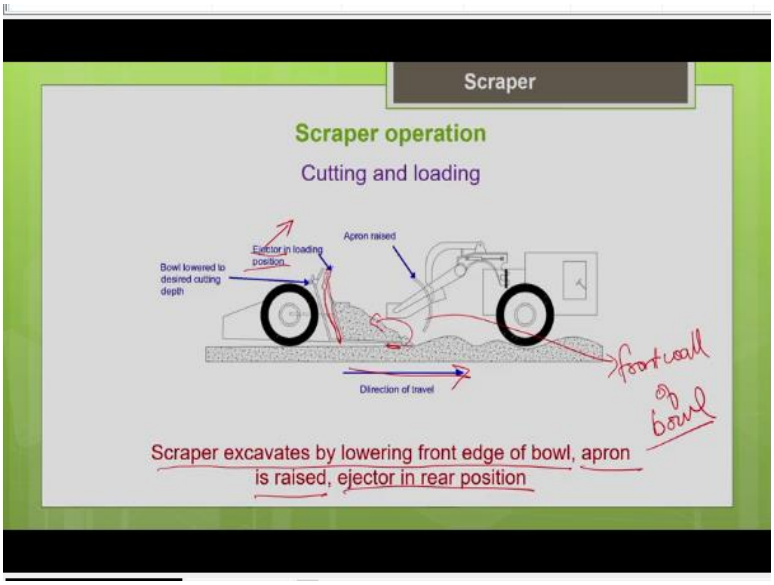

Now, let us see the basic operation of the scraper. So, first of all, we should know what are all the operating parts of the scraper? The scraper has a bowl. So, this is the bowl of the scraper you can see the bowl. So, at the bottom end of the bowl, the frame bottom end of the bowl, this is the direction of travel. At the front bottom end of the bowl, you have the cutting edge. So, cutting edge across the width of the bowl.

So, when you want to do the cutting and loading operation, you are supposed to lower the bowl, lower the bowl, so that the cutting edge is in contact with the ground, once it makes a contact with the ground, it will start cutting the soil and the soil will start entering your bowl. So, to facilitating the entry of material to the bowl, you have to raise this apron, apron is acts like the front wall of the bowl.

So, you can either raise your apron or lower the apron. So, when you want the material in flow, you have to raise the apron. Similarly, when you are dumping it, to facilitate the outflow, you have to raise the apron and now for the loading operation and need to raise the apron. So, as the material can enter into the bowl and there is one more important part called is ejector. So, this ejector is in the rear end of the bowl, you can see this is in the rear end of the bowl, it can either move forward or backward.

So, when you are doing the loading operation, it has to be at the rear end of the bowl. So, the scraper excavates by lowering the front edge of the bowl, that is a cutting edge apron is raised and the ejector should be in the rear position. As the name indicates ejector means it helps in ejecting the material out of the bowl. So, we are going to move this ejector forward when you want to dump your material.

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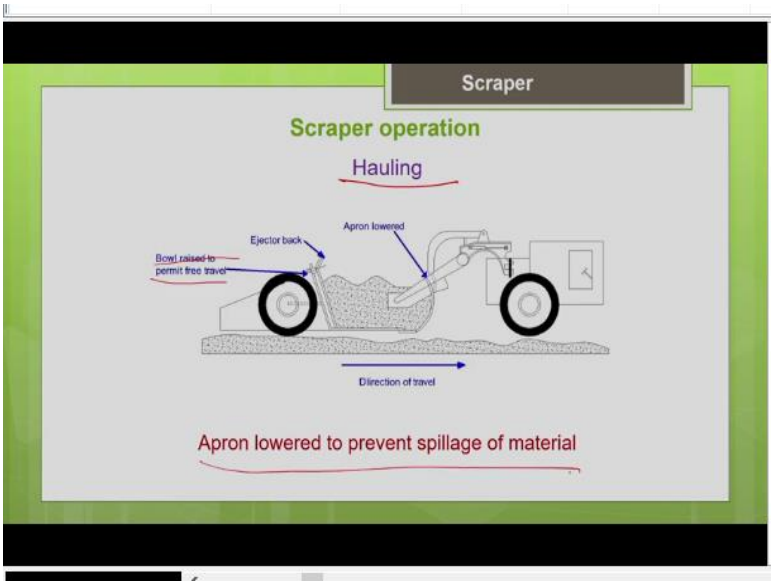

So next is hauling, once your bowl full, so now you can just raise your bowl and you have to just carry the material in the bowl. You are going to haul it. So, the bowl is raised, so that you can permit free travel of your machine. So, now also you can see the ejector is in the rear end only. Now you are lowering your apron. So, why should we lower the apron so that we can avoid the spillage of the material out of your bowl. So, the apron is lowered to prevent the spillage of materials during the hauling operation.

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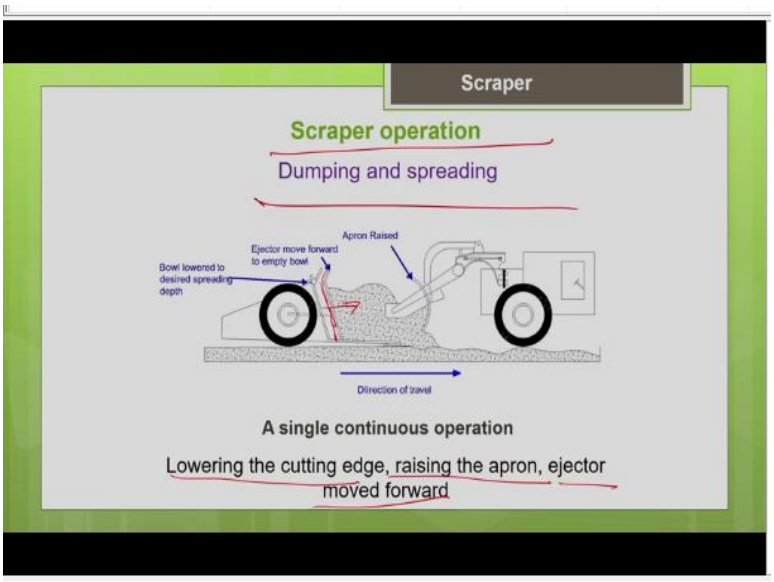

So, after hauling once you reach a dumping place your filling place, now you have to dump the material. So, now you again raise an apron to facilitate the outflow of the material. Again, lower the cutting edge, lower the bowl, now raise the apron, you are going to facilitate the outflow of the material, you have to move your ejector forward. So, this is an ejector, you move it this ejector, you have to move it forward as you slowly move it forward you can eject the material out of the bowl.

So, that you can do the dumping and spreading in one operation, one step I can do it. I can uniformly spread the material in windrows or spread it in uniform layers of required thickness, that is one advantage of this scraper. Dumping and spreading can be done in one step. So, you are going to lower the cutting edge, raise the apron and ejector is moved forward. So, that you can facilitate the out flow of the material out of the bowl. So, this is about the scraper operation.

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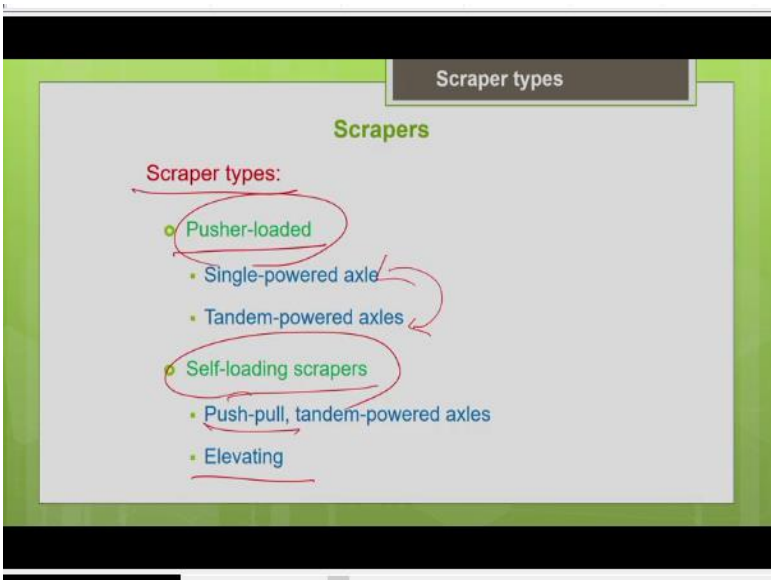

Now let us discuss about the types of the scraper. So, there are different types of scrapers. So, in this we have classified based on whether the scraper needs assistance from the other machines during its loading operation or not based upon that we have done this classification. Pusher loaded means that scraper needs the assistance of a pusher or a tractor or a bulldozer during its loading operation, those scrapers are called as pusher loaded scrapers.

So, there are certain scrapers which are self loading in nature. That means it does not need the assistance of other machines during its loading operation. That is why they are called as self loading. So, we can classify the pusher loader into single power axle and tandem power axle, we are going to discuss that in the upcoming slides. Similarly, self loading also there are different types, push-pull and elevating. So, we are going to discuss all these types of scrapers in detail in the upcoming slides.

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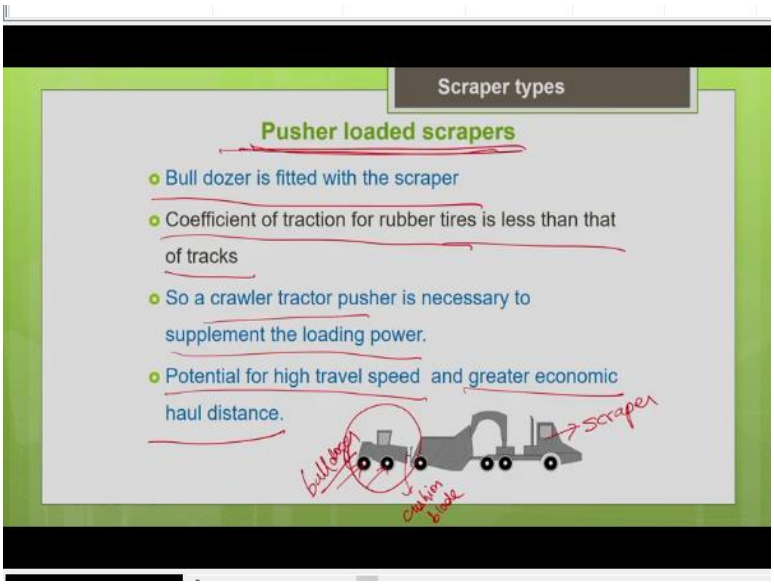

So, now first let us see what are pusher loaded scrapers? So, I have shown the schematic sketch earlier, this is your scraper machine which is leading. The trailing one is your bulldozer. So, hope you remember what type of blade you will fix for assisting other machines. So, you are using a cushion blade, C blade, C blade is attached to the bulldozer just for pushing or assisting the other machines.

So, you know that the scrapers are tyre mounted, normally wheel mounted machines. So, for the wheel mounted machines, the tractive effort generated will be lesser when compared to the crawler or track mounted machines. So, the coefficient of traction will be poor. So, the amount of tractive effort generated will be less for the wheel mounted machines, to supplement the loading power of this wheel mounted scraper you can take the help of a crawler mounted or track mounted bulldozer.

In this picture I have shown you the wheel mounted bulldozer you can still go for crawler mounted bulldozer, so that it can still increase the loading power of the scraper. So, the main thing is fitting the scraper with the bulldozer here, you know that the coefficient of traction for the rubber tyre is less than that of tracks. So, we are taking the help of the crawler tractor pusher to supplement the loading power of the scraper.

So only when the scraper is cutting the earth and filling its bowl that is during the loading operation I need the help of the pusher. Once a bowl is completely filled, your pusher can be detached from

the scraper and the scraper can haul the material by itself. So, we need the assistance of the machine only during the loading operation, but taking the help of the pusher I am able to reduce the cycle time of the scraper because the loading time gets reduced and also I can increase the productivity of the scraper.

So, basically all conventional scrapers are pusher loaded scraper. So, they have the potential for high travel speed because power is supplemented with the help of the pusher and also the economic haul distance is also higher relatively higher for this kind of pusher loaded scraper.

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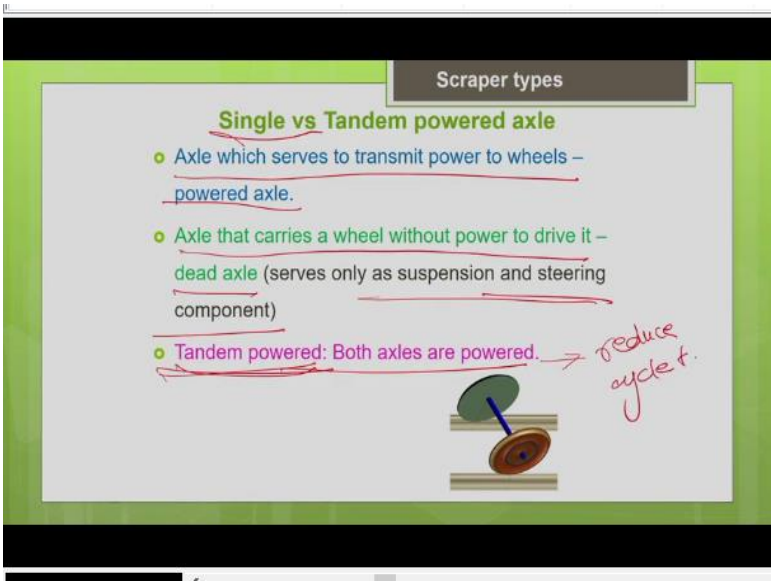

So, now let us see what are these are single versus tandem powered axle scrapers? So, axle basically how do you classify the axle into powered axle and dead axle? See in our common vehicle say for example car, so you know that it may not be the case like all the axles are powered. So, maybe we only one axle may be powered the other axle we just dead ok powered in the sense the powered axle will transfer the power to the wheel those wheels are called driving wheels.

So, the other axle will be just dead axle which would not transfer the power to the wheel, it will just act like a steering component. So, the axle which serves to transmit the power to the wheel is called a powered axle, the axle that carries a wheel without power to drive it, it is called as it dead axle, they are just acting like a suspension steering component. So, in the construction equipment

you can say for the machines which are operated in very tough underfoot conditions where the rolling resistance is very high.

Say very rocky terrain or muddy terrain. So, very hardened clay terrain or very steep grade where the grade resistance is very high, steeper slopes. In those cases, we have to go for tandem powered that means all the axle should be powered. So, that the power generator will be more. So, tandem power in the sense all the axles are powered, single power means only one axle is powered.

So, how do you make the choice of machine for a project? If your project conditions are very severe, extreme working conditions, poor underfoot conditions, where the resistance is going to be very high in terms of rolling resistance and grade resistance. In that case, you have to go for tandem power machines where all the axles are power which can generate more power to overcome all this rolling resistance. So, that will help a lot to reduce your cycle time and increase your productivity. So, it will reduce your cycle time or increase the speed of your machine.

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So, this is tandem powered axles. So, they have this twin-engine arrangement. So, twin engine arrangement in the sense that they have 2 engines. So, that it can produce this extra power for you. So, this kind of arrangement produces extra power. So, that we can overcome the rolling resistance and high grade resistance. But obviously, because of the twin engine arrangement, its cost is going

to be higher than your single power axle at least 25% the cost is going to be more than your single power axle.

But even though the cost is high it is going to be economical for you for tougher underfoot conditions. Because in your tough underfoot conditions, you can increase your speed of your machine thereby it increases the productivity and reduces your unit production cost. So, that is why I say tandem power is economical for tough underfoot conditions. So, based upon project conditions, you have to make the right choice of your machine.

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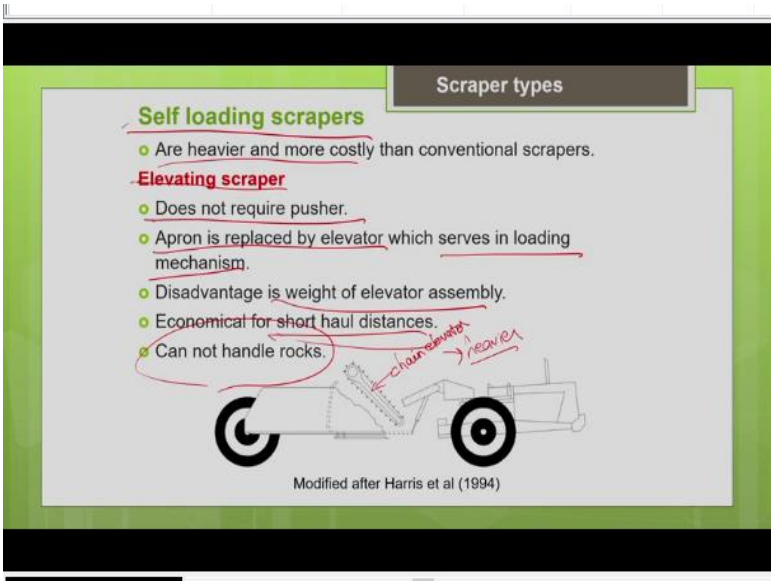

So, next is your self-loading scraper. So, far, we have discussed about the pusher loaded scraper where it needs the assistance of a pusher during its loading operation. In the scrapers it is self loading, that means it can load on its own, it does not need the assistance of another machine during its loading operation. So, but basically these machines are heavier and costlier when compared to a conventional pusher loaded scrapers that is one limitation of this machine.

So, under the self loading, there are different types. So, one such type is elevating scraper. So, elevating scraper, you can see a chain elevator. So, this is your chain elevator assembly, just like the elevator, you can see series of flights kind of steps arranged the elevator chain. So, instead of apron you have this chain elevator, it will facilitate the entry of your material into the bowl. So, as usual you have an ejector, which will help you to dump the material when the dumping is needed.

So, basically this does not require the help of pusher that is why it called it as self loading scraper. Here the apron is replaced by an elevator which helps you to load, but the disadvantage is this chain elevator is heavier, it increases the self weight of your machine. So, this machine is economical only for short haul distances. So, we cannot use it for a very long haul distance like the other type of scrapers.

So, you can use it only for a very short haul distance. And one more thing from material perspective, you have to be very careful this cannot handle rocks, because the bigger size rocks can jam, it can create jam in the chain elevator assembly. So, that is why you should not handle the rocks with this machine, it cannot use the rocky terrain, it cannot be used for handling the rocks.

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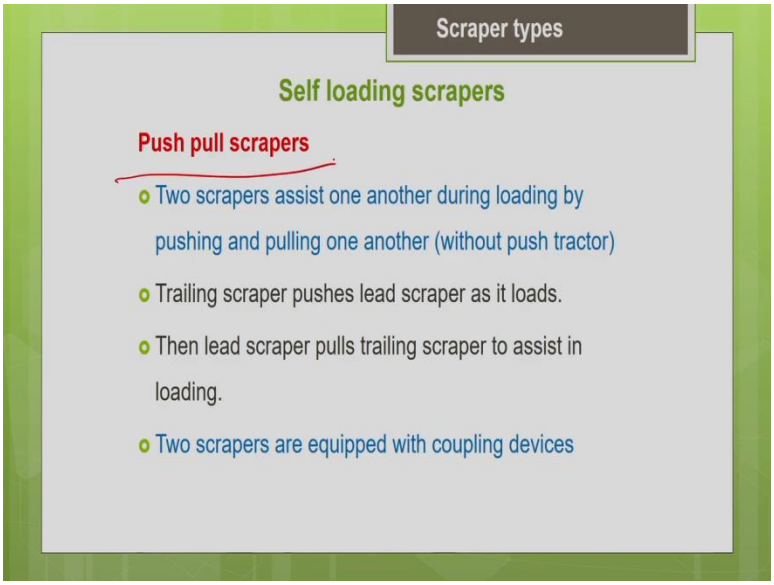

The another type of to self loading scrapers is your push pull scrapers. Here, these machines are not going to take the help of other machine like a pusher. But let us say for example, the scrapers which are employed in a project site. So, they will do a teamwork. Teamwork in the sense if there are 2 scrapers, one is in the leading position, the other one is in the trailing position. See, the one which is in the leading position. So, it will pull the trailing for the scraper when the trailing scraper is doing the loading operation.

Similarly, the trailing scraper will push the leading scraper when the leading scraper is doing the loading operation. So, these 2 scrapers are connected to each other with a coupling device. So, that the scrapers can help each other during the loading operation. So, this is a kind of teamwork, with the help of teamwork, we can get the job done. So, this is basically the mechanism of the push pull scrapers. So, the 2 scrapers are assisting one another during loading by pushing and pulling one another without the help of push tractor.

The trailing scraper which is in the rear end pushes the lead scraper as it loads, it will push it, when the leading scraper is loaded. Then the lead scraper pulls the trailing scraper when the trailing scraper is loading, that is how they help each other. So, that the productivity of the scraper can be enhanced to facilitate this the scrapers are equipped with coupling devices.

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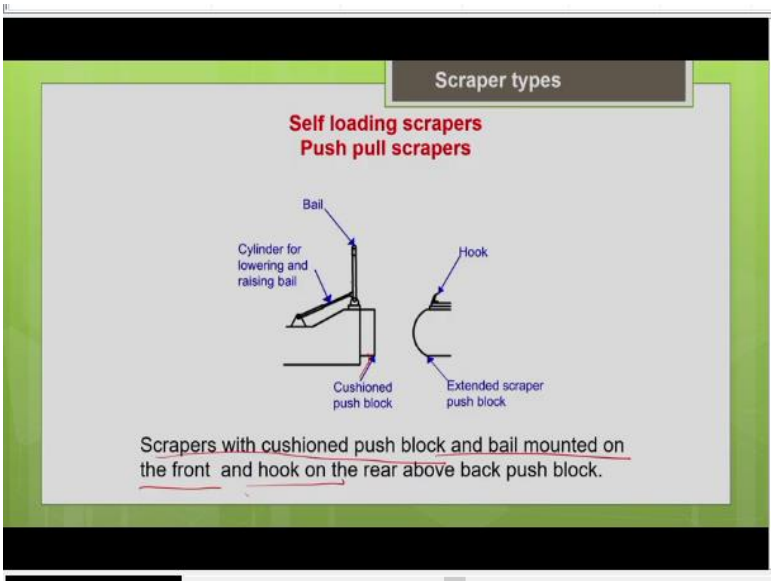

So, you can see the picture. This is a kind of coupling device like the scrapers will be having a cushioned push block, you can see the push block. So, this is also another scraper push block. So, the scraper has this hook and the bail arrangement. Hook and bail arrangement so that you can easily connect one scraper to the other scraper and also this push blocks will facilitate while pushing the when the scrapers are pushing each other.

So, the scrapers are provided with cushion push block and a bail mounted on the front each scraper will have a bail mounted on the front and there will be a hook on the rear end. So, that it can

facilitate coupling of scrapers. So, this hook and bail mechanism can easily facilitate the coupling of 2 scrapers. So, every scraper will have a bail mounted on the front and a hook on the rear end. So, which will facilitate its connection with another scraper.

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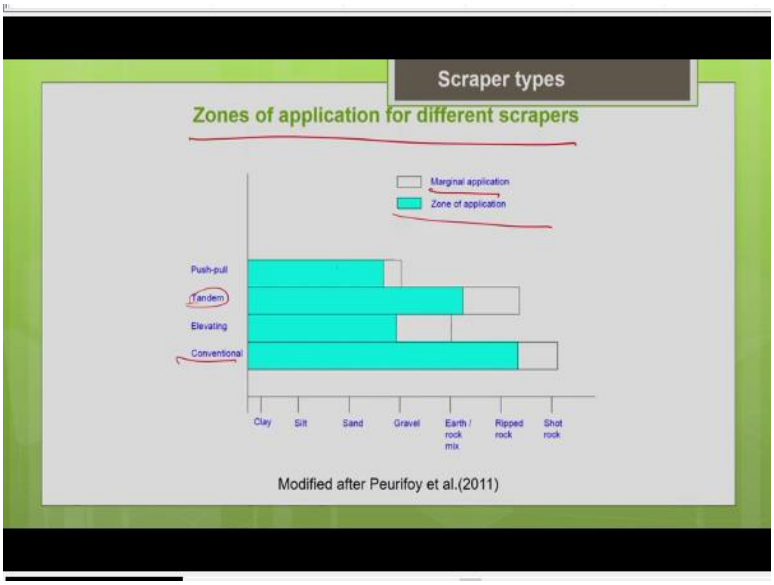

Now, let us see what are all the zones of application of the different scrapers? So, you have to select a scraper based on the type of material in your project site. So, by looking into this picture, you can see this blue color indicates the zone of application and white indicates the marginal application of this particular scraper. So, by looking at a picture, we can see this convention there is a pusher loaded scraper is having a wider zone of application with respect to material type.

So, it can easily handle most of the material you can see, but marginally it can handle the short rock but it has a wider zone of application with respect to material type when compared to other types of scraper. Say this elevating scraper you cannot use it comfortably when handling rocks, you can see that. So, comfortably you can handle when we till gravel even the push pull scrapers it cannot easily handle the rock.

So, when we go for tender over we can generate more power, you can see this slightly, the performance is better when compared to the other 2 types, but among all the type of scrapers your pusher loader scraper is showing the best performance with respect to the range of material you

can see, it can handle most of the materials comfortably because of the supplemental loading power obtained with the help of the pusher.

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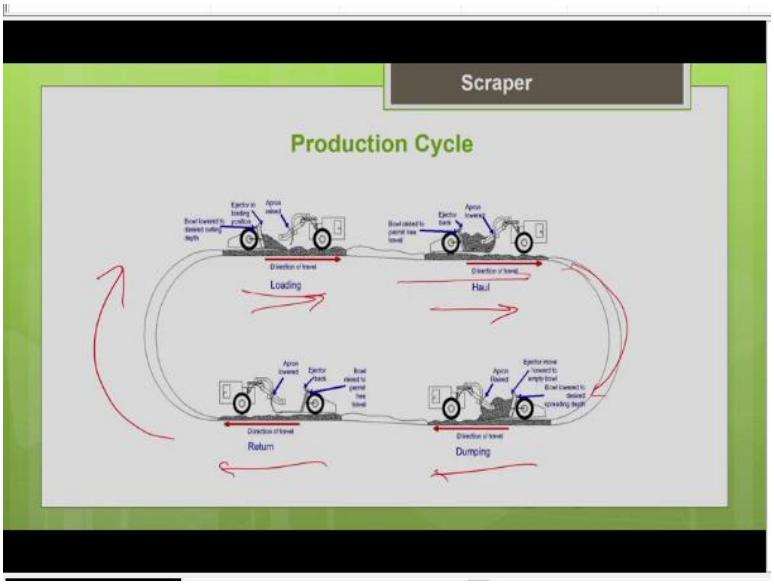

Now, let us see what is it a production cycle what are all the components of the production cycle of a scraper? So, you can see the scraper has to first do the loading operation first, cut the earth and fill the bowl. Once the bowl is completely filled, you will just raise the bowl and haul the material, haul it till it reaches the dumping site. So, in this, picture it will show it is turning first, it is turning then it is dumping it varies from project to project in some cases it has to dump and then make a turn it depends upon your project site constraints.

Then here it is turning then it is dumping. The dump area or the fill area and spreading it to the required thickness as needed. Then, when the bowl is empty, it is just returning return a haul in the unloaded condition. Now again, turning, so I am getting ready for the next cycle. So, in this production cycle, you can see there are 2 turnings involved. So, depending on your project site there can be even more number of tunings than this, everything depends upon your project site. So, basically loading, hauling, your turning, dumping, returning again turning and get ready for the next cycle. So, these are the components which makes up the production cycle of a scraper.

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