Mining Machinery
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Module – 04
Lecture – 14
Site and Rock Preparation Equipment: Ripper

Welcome back. In the last class, we introduced you about the dozers and we told that the dozer is one of the most widely used machinery in surface mining or in fact, in any mining operations, the site preparation dozer is indispensable. Now, we also told that dozer comes along with a Ripper.

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In today's class, we will be discussing this ripper dozer. So, this is in a part of our site preparation machinery. Now, the what is the ripper? Ripper is that claw-like device that is used for loosening the dense rock mass and then, it is just given as an attachment.

As I said here, at the backside of a dozer these are the ripper, a claw-like things which are just exactly fixed over there so that it will scratch on the ground surface and it has got the features with a hydraulic power can be given over here. So, that it can dig and then break or loosen the rock mass. So, the objective of this lecture is to introduce this ripping principle and then, how we have different types of rippers used.

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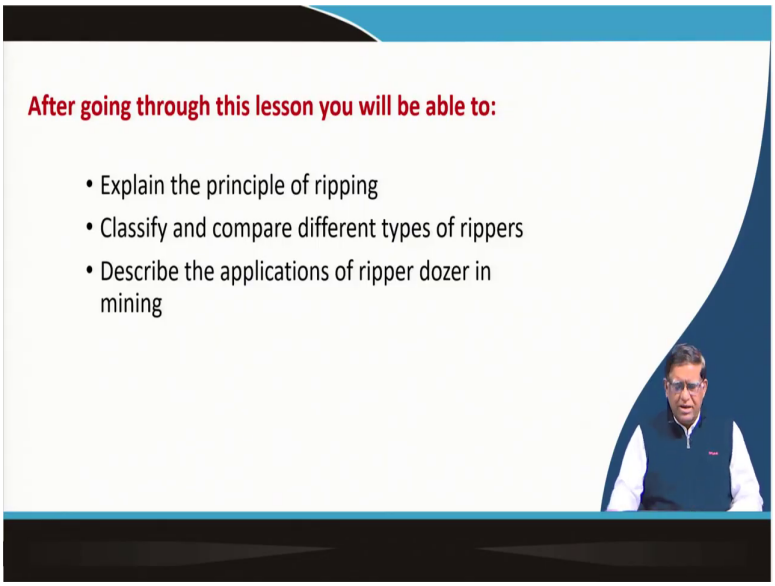

So, after attending this lecture, you should be able to explain the principle of ripping and also, you should be able to classify and compare different type of rippers. And I hope that you will be able to describe the applications of ripper dozer in mining; particularly, in surface mining.

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Now, as I first to get familiar with, you know now what is a dozer and the dozer you have seen at the backside, this ripper is connected. This ripper can be fitted as a single ripper or there could be a ripper with a number of multiple rippers can be here. So, now what is here? This ripping is the horizontal ripping; that means, that on the surface when it is the dozer is moving, at the back you are doing the ripping action.

But there is also a vertical ripping. As you can see in this machine, there is a hydraulic excavators where the front attachment, it is changed with a ripper. This ripper is a Vibro Ripper. It exactly give a lot of vibration energy and also, because of this, your hydraulic

machines, this capability of this boom, it can go down like this, a lowering actions can be done.

By the twisting and lowering, you can give a ripping actions vertically. So, in that way, you can create a bench. You can cut the machines that can be the ripper can be a primary cutting machinery in surface mining. So, that is why the ripper is not only a site preparation equipment, if you use a vibro ripper, it can be a main production machinery. It is used in some very hard and a compact rock mass.

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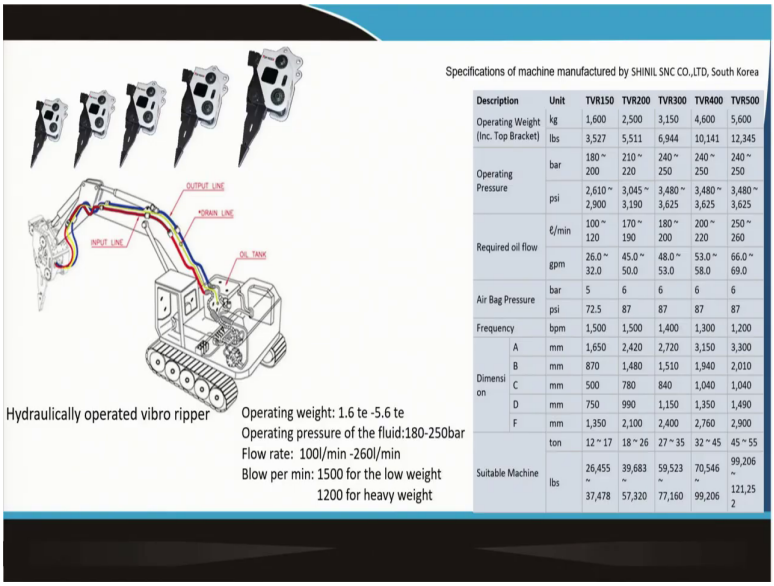

Description		Unit	TVR150	TVR200	TVR300	TVR400	TVR500
Operating Weight (Inc. Top Bracket)		kg	1,600	2,500	3,150	4,600	5,600
		lbs	3,527	5,511	6,944	10,141	12,345
Operating Pressure		bar	180 ~ 200	210 ~ 220	240 ~ 250	240 ~ 250	240 ~ 250
		psi	2,610 ~ 2,900	3,045 ~ 3,190	3,480 ~ 3,625	3,480 ~ 3,625	3,480 ~ 3,625
Required oil flow		ℓ/min	100 ~ 120	170 ~ 190	180 ~ 200	200 ~ 220	250 ~ 260
		gpm	26.0 ~ 32.0	45.0 ~ 50.0	48.0 ~ 53.0	53.0 ~ 58.0	66.0 ~ 69.0
Air Bag Pressure		bar	5	6	6	6	6
		psi	72.5	87	87	87	87
Frequency		bpm	1,500	1,500	1,400	1,300	1,200
Dimension	A	mm	1,650	2,420	2,720	3,150	3,300
	B	mm	870	1,480	1,510	1,940	2,010
	C	mm	500	780	840	1,040	1,040
	D	mm	750	990	1,150	1,350	1,490
	F	mm	1,350	2,100	2,400	2,760	2,900
Suitable Machine		ton	12 ~ 17	18 ~ 26	27 ~ 35	32 ~ 45	45 ~ 55
		lbs	26,455 ~ 37,478	39,683 ~ 57,320	59,523 ~ 77,160	70,546 ~ 99,206	99,206 ~ 121,252

Now, as you said that this in a vibro ripper, you may have this ripper (Refer Time: 04:01) that ripper part, it is an attachment in which the vibratory motion is imparted by the hydraulic pressure. So, you can see here that in a hydraulic excavator or the main machine which is a

crawler mounted machine and in that, we are having the hydraulic power pack that hydraulic fluid is passing through.

And then, it gives to the vibrate ripper, where the rotary and percussive motions are imparted and by which this vibro riper can work and this machine, it has got an operating weight in the range of 1.6 ton to 5.6 ton.

That means, this part is that heavy, if you are having very hard rock, very compressive strength is very high, there also with this heavy heavy loaded machines, it can work and this the pressure at which this hydraulic power pack will have to generate, it can be your 180 to 250 bar. And also, the fluid which will be there flowing, it can be 100 liter per minute to 260 liter per minute the fluid will flow.

So, depending on that, the size vary one to use this machine, you will have to the dimension of the machines will get changed. That means, you will have to have a bigger capacity engine bigger capacity Tank bigger capacity of that or at that whole hosepipes through which it will be fluid will be flowing will have to be designed for high pressure so that it does not burst out of the heavy pressure, it is working with.

Then, the main performance that how it will be breaking the rock, it will be depending on the blow per minute how much you are giving, you can get 1500 blow per minute for a low weight machines and then, if it is a very heavy weight machines, you can get at a 1200 blow per minute. You can know that we need every blow how much momentum is imparted and that energy it will be it will be above the cutting resistance or breaking resistance of the rock mass and the rock mass will get fragmented.

So, this is exactly there are different makes of such type of machines you can see for a that a South Korean machine, their specifications are here. Please make it an habit of studying the internet, finding out different manufacturer of such matching machines and you try to develop a competitive table and you can see what is the present range of development in this particular equipment.

So, that will help you in identifying for your minds or any particular operation, what type of operations or what type of machines will be more suitable, that operating range which you are saying, you can see from this table, we can find it out.

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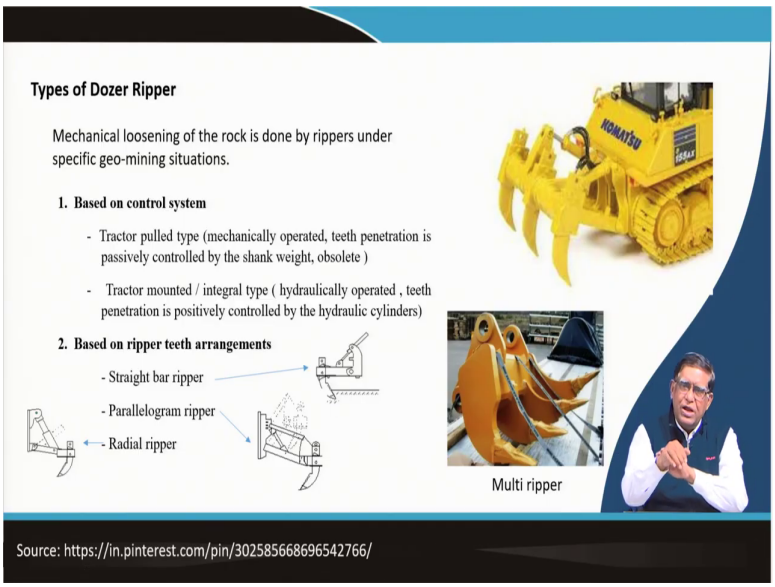

Now, when we talk of this ripper, there could be wide varieties of. This is where that engineering is a things of designing. As an engineer, you must think as an engineer and your job is to know the things and then, customize for your applications. Now, to customize these applications, the people they find out they define a new requirements and when a new requirements is incorporated, a new form of, new class of, new design of machines emerges.

So, in case of our ripper which is has got number of different types exactly what type of features or characteristics incorporated, depending on that, we have got different type of ripper. Basic job is that mechanical loosening of rock. We are not doing the drilling and

blasting, we are break breaking the rock with the help of this. At the time of site preparations, if you have got a hard rock, hard mass is coming, you can do it or in the main production phase also, you can use this ripper.

Now, these are exactly how the ripper is controlled, depending on that we have got a tractor pulled type or you can have a tractor mounted type. In the tractor pulled type, it is exactly a mechanically operated teeth penetration is passively controlled by the shank weight and obsolete. This shank there exactly weight will be giving over there and you can put it and sometimes, it is a tractor mounted, where it is hydraulically operated.

You can see here in this machine, it is hydraulically operated and then, that means, you can just rigidly fix it over here that is a tractor pulled type or you are giving additional force here by a hydraulic features given over here. So, that it may that is what is called your a rigid type or we are having a controllable type of ripper.

Now, then the ripper can be based on the ripper teeth arrangements, the teeth can be as you can see in this figure that is your straight bar ripper. This is a straight bar ripper and the there is a parallelogram ripper and there is a radial ripper. Now, these rippers have got their different type of behaviour.

This is a straight bar ripper. It will be fixed directly mounted on it, that is it will be a tractor pulled type of ripper you can have this straight bar. Now, in case of your that no this is your you can have a hinge point over here, by giving a hinge point you are exactly this tip, the tip can be giving a rotations like this because it is a hinge. But if you are having a parallelogram type, this is rigidly fixed at the tractor.

So, if any movement is there up and down, it will go directly down and while at a particular point it is fixed this penetration, this tip will not go fetching. So, as a result, such type of ripper will be giving you higher productivity. So, then there is also as a multi ripper, it as a as you can see here a number of ripper teeth, we take your radial type of things you can see with that curvature, it is fixed over here at 1 mount, there are 4.

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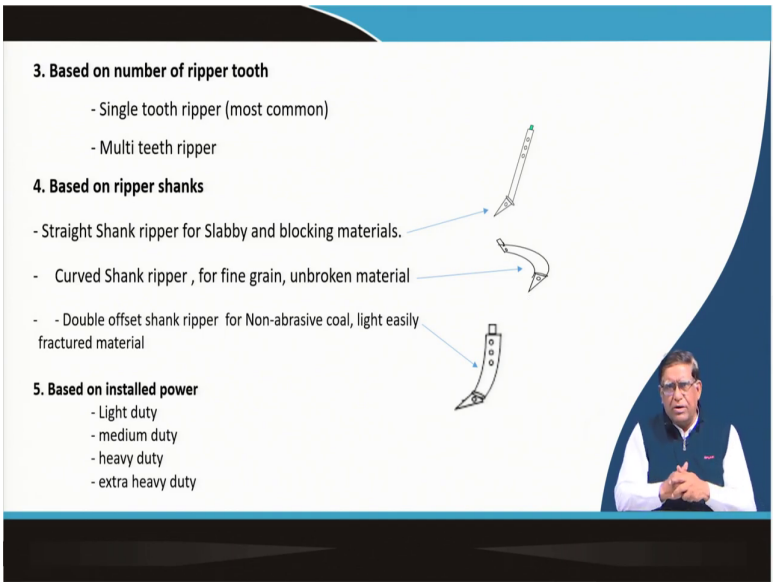

So, there are different types of ripper can be there. So, number of ripper tooth can be a single one, that is a single ripper or a multi teeth ripper, it can be on the shank that is this shank is a straight shank and there is a curved shank or there could be a double offset; here also an offset, here also an offset.

So, that is a different type of configurations can be designed depending on yours your mining conditions, depending on the type of rock you are getting whether you are going to do it in a bauxite mine or you are going to do it in an overburden of coal mines, depending on that you will have to design.

Not only the shape of it, the type of this your cutting tool that what type of material you will be using that basicallyyou may have is tungsten carbide because of its the very hardness. And

also, sometimes you may be using some bracing and all that thing to so that the abrasivity of the rock will be affecting it very less.

So, that is engineering of designing these things are also involved. While your work, you have got an opportunity that if you think and you can find out a new model, new design can be arranged. Similarly, the install power that is your it can be a light duty, medium duty, heavy duty, extra heavy duty depending on how much pressure of how much bar.

If it is coming as a 250 bar, pressure is generated and then, you are going to give about this 1200 blow per minute and then, you are say making about 150 liter of oil is flowing per minute. Such a heavy duty that the those are on which it will be mounted, that will also have to have a high-capacity engine. So, that type of on the basis of install power also, you can calculate.

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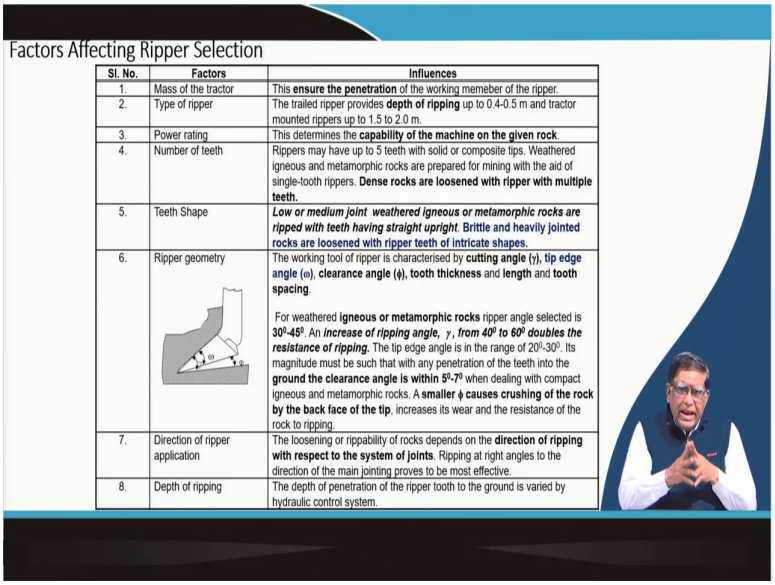

Now, we need to select a dozer or a ripper for a particular mines. Suppose, you have goneto a bauxite mine and in that bauxite mine, maybe in between there are some intrusions of some hard rock, maybe a quad jets or a bended quad jets magnetite or anything intrusion is there, very hard there you, but they are coming in a patches.

So, you can think of having a ripper there. Now, how will you use that ripper? The factor which will have to be calculated or which will have to be considered while selecting, you should note it carefully that is the mass of the tractor.

So, that means, your how much it is there; that means, you will have to how much you will have to ensure a penetration of the working member. So, that it will be depending on that say if you are having a very light weight, that say ripper, you are leading into work there, it may not go a deeper. It will not penetrate into the rock. So, there you may have to have a hydraulic pressures or pressure to be given.

So, instead of that you can have this ripper tractors. Heavy tractor can have a give you a better penetration capacity because it can exactly give more drawbar pull or more rimpull will be available for doing it. We will be coming over rimpull. Then, the type of ripper that is your if it is a depth of ripping, it can be 0.4 meter 0.5 meter or it can be in a deeper shank of 1.5 meter.

So, depending on that type of ripper, you can select because accordingly, your engine and other will have to be selected. You will have to do the power rating because that how much power will be necessary that engine capacity will be requirement, then how many number of teeth you will be having. So, if you are having a dense rock, then we may have it a more number of teeth at a time you can give.

But you remember that whenever you are putting more number of teeth, the cutting resistance will be coming more and at that time the dozers to propel, you will have to have a heavy engines on that dozer. So, those are the things will have to be looked into. Similarly, the teeth

shape if you are having a low or medium joint weathered igneous or metamorphic rock, you can have a straight upright ripper blades.

But if it is a brittle and heavily jointed rock, you can repertit with a intricate, different shapes can be there we can give a curve. And in if you are going to work in a mines, where there is a ripper you can vary you can do a research find out what is that exactly effect of the ripper curvatures on the cutting resistance. And that that type of research can be found out and you can optimize the shape of the ripper by which you can save your fuel or energy consumptions.

Then, the ripper geometry, you can see that this is a very important figure you have drawn in our dozer studies that in any cutting member, you have got these three angles that is your the clearance angle, your there is a tip angle and then, your there is that tip edge angle, clearance angle and cutting angle.

Now, these if your clearance angle is very less, then what will happen? This back portion will be touching this ground; that means, more resistance will be there, so that exactly your wear and tear of the teeth will be more and then, you may not get the proper fun proper performance of that equipment.

So, you will have to optimize this, depending on what is the properties of this rock and that not only the properties of the rock, but in which directions you are using, if that rock was there as a particular joints and then, the their features are having some directions of which that the layering. Then, accordingly, you will have to find out in which directions if you cut, it will give a maximum or better use of this equipment.

So, the direction of ripper application should be respect to the system of joints. Ripping at right angles to the direction of the jointing proves to be most effective. What is this? That means, if you are having a joint surfaces. Suppose, this is the joints or cracks are there. Now, if you rip like this or you will be ripping like this, if you rip like this, then what will happen? When you are ripping here, this small three portions will be getting separated.

But if you start ripping like this, then your big boulder and all that thing will be coming. So, that is where how the direction of ripping is to be decided depending on that in which way the joints and features are there or what is that exactly; if it is a sedimentary type of rock, how the layering has taken place that need to be seen. So, this is a depth of ripping that is your how the tooth is getting penetrated, on that basis you will have to see.

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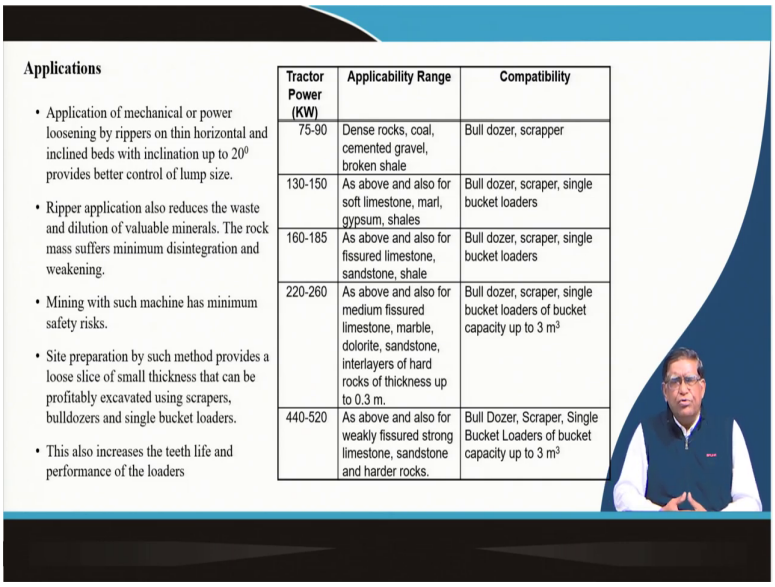

So, there is a requirement of selecting a dozer, all these factors need to be properly understood and then, you will have to tabulate it on the site, specify the conditions of the site and then, you can do it. And the applications of mechanical power in loosening of the rippers on thin horizontal and inclined beds with inclination up to 20 degree provides better control of the lump size.

So, how when you apply, your applications need to be seen very carefully because you want to do a you want to reduce the big lump size, exactly in the mines. You should make as much as fragmentation possible because that is the best optimal use of your energy.

If you are getting a bigger block or boulders, then it will have to be sent to the crusher and that crushers, another energy will be consumed over there. So, that is why the ripper will have to be properly selected and applied and this will also reduce the waste and dilution of valuable minerals. The rock must suffers minimum disintegrations in weakening.

If you when you do blasting, at that time lot of disintegration takes place, where there will be the more dilutions may be coming up. But this will be helping you sometimes, the waste can be separated easily and then, it has got less safety problem. You know in while you are doing a blasting, the fly rocks, it can go and kill a person's at a distance.

Moreover, when you will have to carry these explosives means there will be more manpower will be used and then, for their bringing in all, more number of vehicles will be running in the mines. So, that means, more moving stock and there will be more probability of failure and more accidents may take place.

So, when you are reducing the equipment, reducing manpower, you are getting better economics and as the same time, you are improving the safety. Then, there your site preparation by this methods will provide a loose slice of small thickness that can be very easily excavated.

That is you are; by doing this ripping, you are exactly giving better life to your shovelby which you will be loading because now it is a better fragmentations. There will be less wear and tear of the bucket teeth and its productivity also will increase.

So, that means, these machines when it is made compatible with the shovel, we can get a better performance right. So, your this machine ripper, when it is used for loosening and then, you use the other shovels to work with it. So, that is where your compatible machine.

So, that means, you can use the tractor power at different ranges depending on your site requirement. You can see that it can be applied to dense rock, coal, cement and gravel, broken shale, a smaller machine and there will be bulldozer and scraper will be there with this machine, it can work.

Similarly, if your that is a high capacity, your you can use in weakly fissured strong limestone, sandstone, harder rocks in overburden, it can be used. And then you will have to along with that, you can have a single bucket loaders like a shovel, hydraulic shovel or electric shovel, they can work along with this.

So, a bucket capacity of 3 meter cube because one thing is there as a disadvantage you can say, that when you are doing a primary mining operations by a ripper dozer, you cannot go for a very high volume of productions at a time. So, for that exactly if the volume of production is not very high, you will not be investing on a very high-capacity shovel.

So, that up to 3 meter cube or at the most say maybe 6 meter cube, shovel can very easily work depending on of course, the rock mass. So, that means, the asa medium up to medium type of mines, where the rocks are this compatible for doing the ripping and dozing and scrapping, your by using this low cost machinery, you can do a productions.

And I think that pro producing about that is your 4-5 million ton in a year from a mines by using this machines can be easily planned. Now, here is a point that you can plan and design and then, you do the cost calculations.

And by that, but only thing is that the conventional systems of your shovel dumper and that other things which is being practiced everywhere. But sometimes you need to apply your mind that if you can do this by a different set of combination of machinery, then if it is done

can be done in a cheaper way, why do not you try for it? Only if it is a as a conventions people have selected, do not go by that selections maybe this type of machines in some of the operations can be done.

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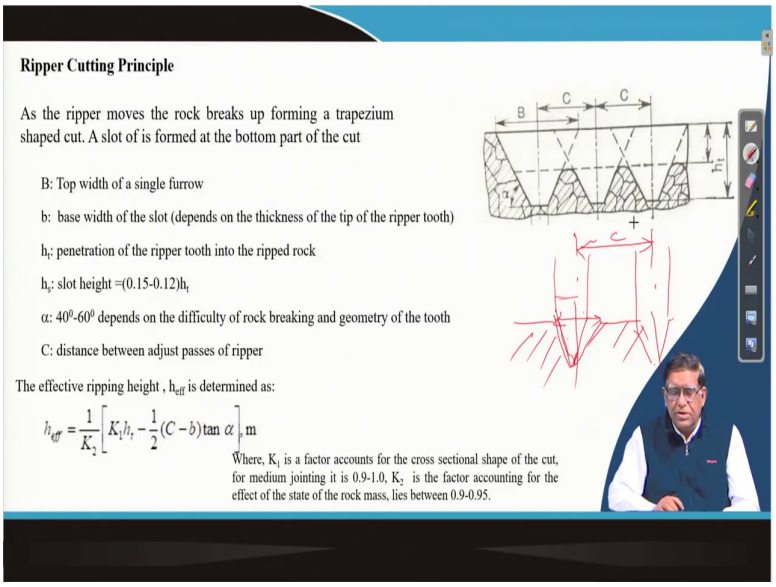

Now, we will be very briefly telling you about what is the main cutting principle of this ripper. Now, you know I have seen that ripper has got these shanks now, when the shanks will be put inside it will give a it will cut. Now, let us briefly discuss about the ripper cutting principle.

Now, what is exactly the ripper does? In a ripper, we are having the this your the tooth is there and now this tooth will be penetrating over here. Say this is a ripper shank, we are just sticking over there, now if this is your rock mass, now when it is penetrating that exactly it will be forming a slot.

So, this one is shown in your this figure, you can see that where you are seeing over here this is a slot formed. So, that means, depending on how much it has got over here that is that B. Now, you may have another your tooth will be there, this is also. So, now, that means, there are two there is a your shank. So, in distance between them is C. So, now, seeing this one, you can exactly use to find out that what should be the productivity, what should be the cutting thickness, this need to be determined.

So, main parameter when you are just exactly breaking this rock by ripper, your the top width of the they are creating this furrow. Now, that top width of that furrow, we are telling it as a B and then, the base weight here this is your small b, this small portions here. And then, there is a penetration of the tooth is going this h t and then, it has created a slot height, this is your slot height which is above this.

So, that means, between these two teeth, there is a small portions of this rocks will be there. Now, that your this angle depending on the type of your shank or the type of ripper teeth is there, this angle, it can be 40 to 60 degree and then, this is the distance between two ripper.

Now, you can note it down that the effective ripping height that is though it has got this much penetrations; but effectively, the ripping will not be taking up to this h t. That is the effective ripping height, it depends on a number of factors that is the one is your that what type of jointing and features are cut joints are there in that rock mass. And that factor, it can be taking as a K 2 and there is a that your what type of cross sectional shape of the cut on that factor is K 1.

Now, these values of these factors exactly that is your the state of the rock mass that K 2, it depends on 0.9 to 0.95 and then, this your that based on the shape of the cut, it can be having this 0.9 to 1.0. So, these two factors they affect and then, this depending on this angle, you can get this is the effective height. So, whenever you have to calculate the productivity; that means, when it is penetrated, what is that effective height or effective layers of rock will be removed by this the ripper. This formula is necessary.

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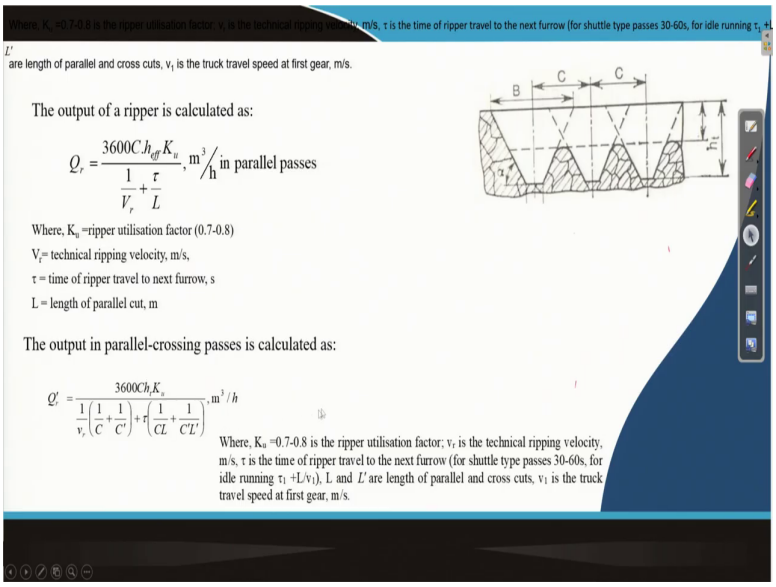

Similarly, when you want to know the output of this, in that case the output is calculated depending on what is the ripper utilization factor the ripper. The when it is there, the utilization factor is depending on how many effective working hours that is in a shift, you may not use the machine for continuously all these things.

Say may be in a shift of 8 hours, your machine is effectively working say 5.5 hours because it will have to have a maintenance hours, there may be some small breakdown and all that things. So, effectively, it is working 5.5 hours.

Now, that means, that5.5 hours is out of what is the planned hour. It is not that say for example the whole day that 24 hours is not the whole days, that is in a year out of the 365

days, you may be having some 30 days or so as a holiday. So, separate it out, then that maintenance other things you separate it out.

So, you may plan maybe that effectively say 300 days in a year will be working. So, in the 300 days of working hour, you have got some scheduled maintenance and all, that also you subtract then the remaining whatever the hour is left is that is your exactly the available hours.

So, effective working hours divided by the available hours that will give you the utilization factor and then, technical ripping velocity at what velocity you are going to cut, that depending on the type of resistances you are getting, your equipment be moving with a different velocity. That technical ripping velocity is to be given, that will affect your total productivity.

And the time of ripper travel for the next furrow because the ripper will be moving over here, then after that it will take a turn and again do the next a furrow like that when you will be going on cutting, so this, what is the time of that parallel cut that is given and also how much exactly the total length of the site, where you are using it. Considering all these things, you can use this formula for calculating the hourly productingproduction capacity of the ripper.

So, this if you are having a parallel cut like that you give and then, you rip also like that a cross. So, sometimes that whole surface can be given a parallel cut like this by the ripper and then, given a cross cut. So, depending that, you can have a different formula for cutting.

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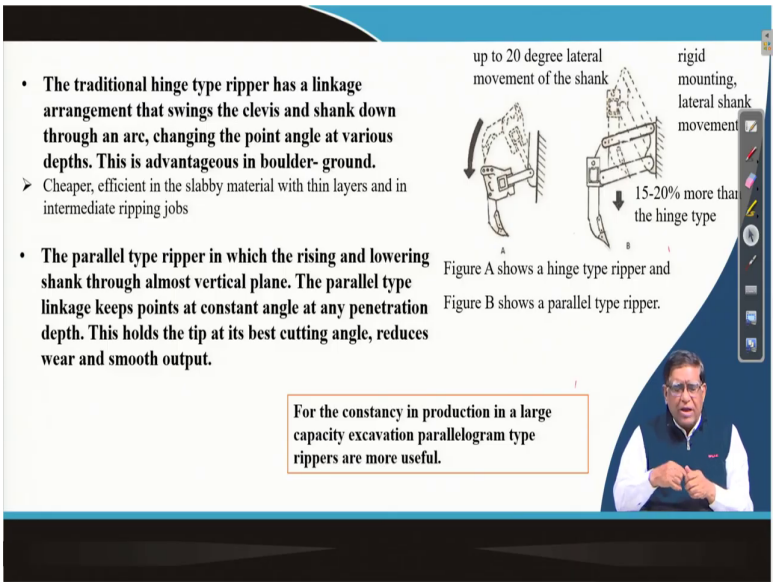

So, that is the way how you can use this ripper. So, these calculations when you do, you can find out that productivity or the production capacity will vary with the type of design of the machines. So, as I said, that your when you are having a hinge type or you are having a fixed type.

In a hinge type of ripper, it will be moving with a 20 degree lateral movement is possible and in case of your this mounted type, it will not give any lateral movement and that is why it will be just cutting and then, ripping. It a give about more than 15-20 percent, more productions it can give. So, in a large applications, you always use this type of rippers.

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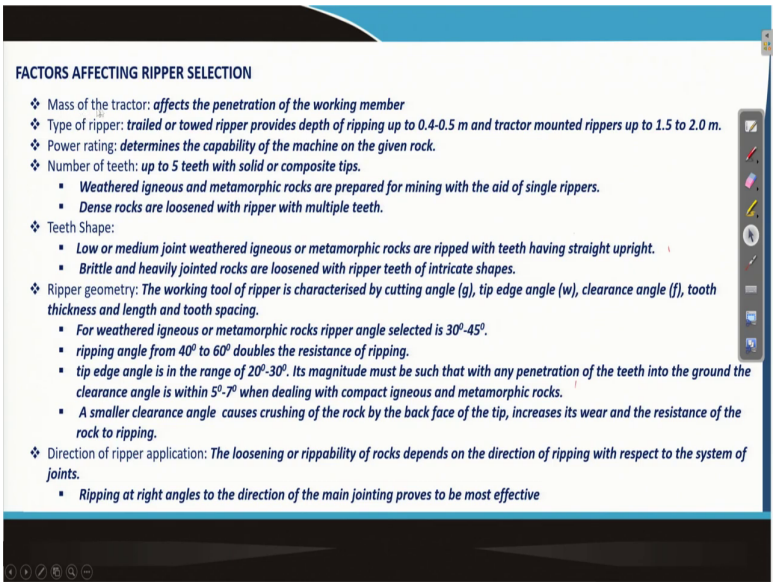

Then, there are different factor as it affects, I have already told you that they (Refer Time: 30:57) mass of that tractor, type of the ripper, power rating, number of teeth, teeth shape, ripper geometry and direction of ripper applications will be affecting this.

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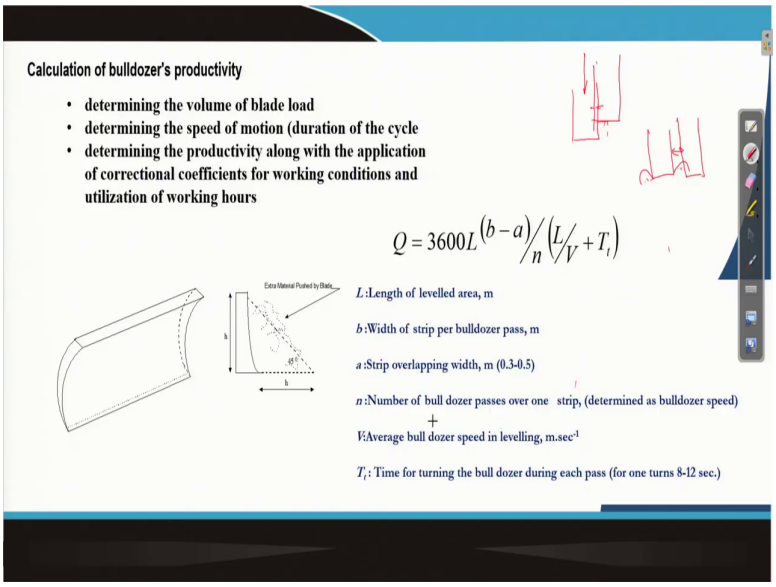

Now, when the dozer which will be working, their productivity is also important, you can calculate that by knowing what is this. Exactly this in front of the dozer blade, where there will be some mass of material which is getting accumulated that is called the dragging prism. Now, these dragging prism, now the blade can be of different shape.

If the blade can be like this or the blade can be totally curved, depending on that, there will be a different type of material will be moving. And then, the coefficient of friction of this blade on the rock here or that coefficient of friction of this material with this blade material, this will be affecting how it will move.

So, normally, this formula is used for calculating what is the hourly production capacity, where this L is your length of the levelled area on which you are using the dozer. And then,

the width of the strip per dozer blade that is depending on the strip and then, that is what is the strip overlapping? Strip overlapping is because if your dozer is cutting like that it is gone.

But the next time, you do not put it totally away exactly when your overlapping is when you are going by cutting the dozer say this strip is gone, this is the first move. In the second move, you may move these things from here exactly because when your one move will be made, the blade by the side there will be some material lying over there.

Now, if you want to make the next pass, then you can give you can keep some bit space over here because these are already loose. But always there is a inter, there is a overlap is given. So, that overlap is b. So, then number of bulldozers pass per 1 strip, how many time it is going?

That for if this is the area you are cutting, you are going over here and then, coming over here like that your number of passes. So, those things in real life will affect the productivity of the dozer. Similarly, you can think of calculating the dozer's the production capacity.

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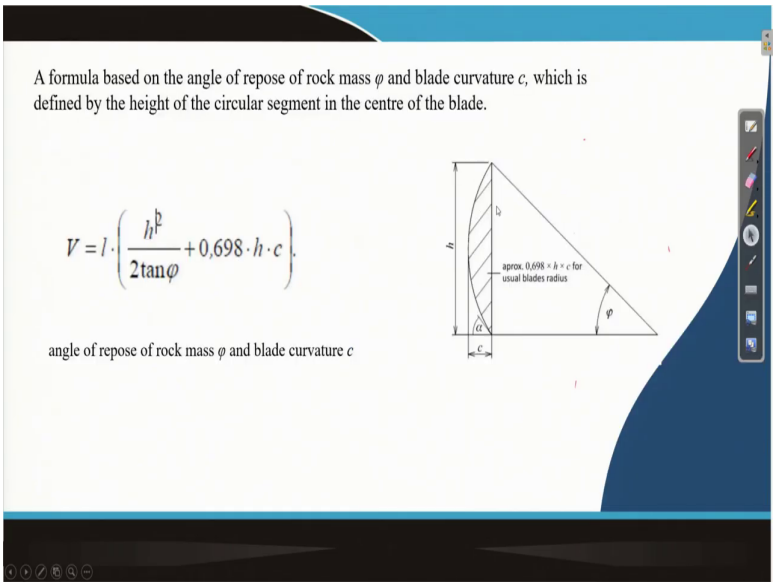

As well as you can calculate the how that material if the blade shape is different, then your the total amount of material which can be retained in the dragging prisms will be different. So, you will have to know about what is this volume which is coming and if you know that how much volume can be dragged, on that basis only you can calculate the what will be the velocity of it.

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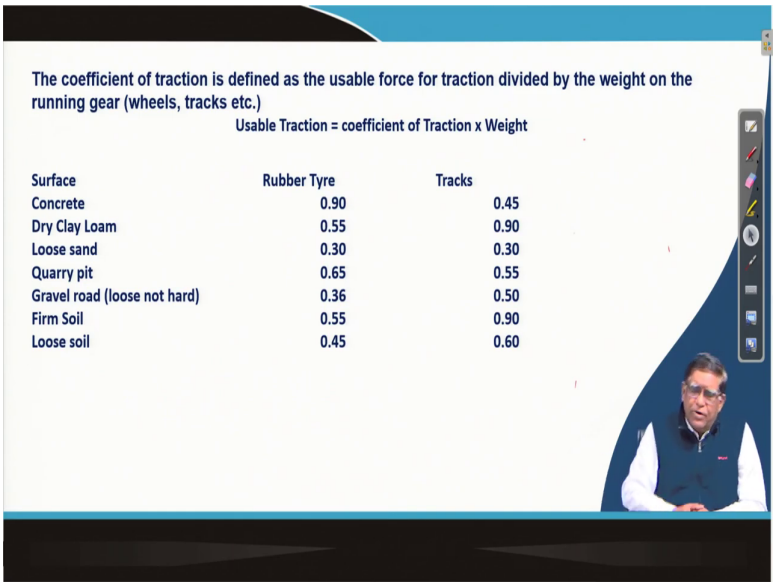

So, now, the most thing is that when the dozer will be moving, how much tractions force it will be coming that exactly how much force will be available to push, how much force will be available for moving, this will be depending on the different type of material. So, they say exactly that coefficient of traction, then and at weight of the material that your dozer that exactly give you the usable traction. This coefficient of traction which vary with subject to material to material.

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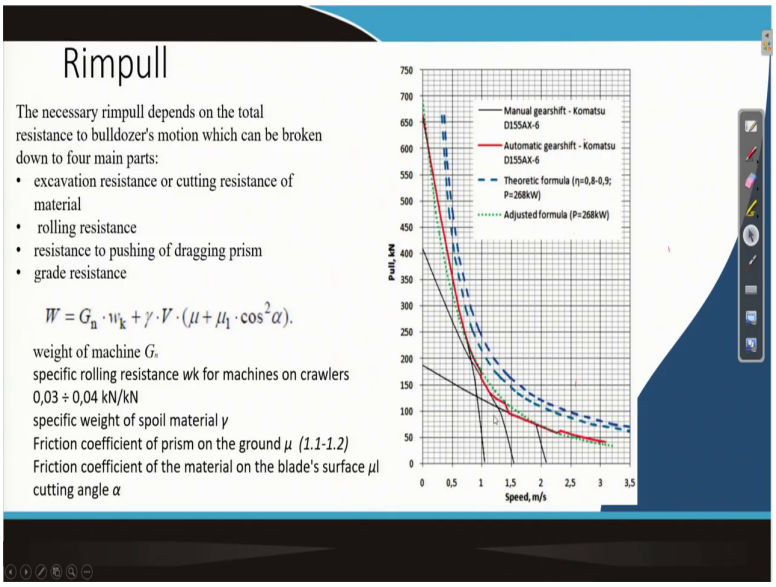

And on that basis, you can also know what is that rimpull. That rimpull is the necessary for how much exactly it will be getting force; how much kilo Newton force will be available in the dozer or and with a ripper. It will be depending on that at what speed that your main dozer is moving and that speed depends on which gear you have selected in that machine.

So, that is where the manufacturer give a that is their speed and pull, a rimpull diagrams are given. From there, you will have to select that exactly for a given dozer or given dozer ripper, if you run it say for example, it at speed of 1 meter per second, you can get a rimpull of this the in a about 210 or like that kilo Newton, if you are using this red one is your a Komatsu machines.

But in a different make, this is a these are D155AX-6, this dozer can be giving like that. So, now, this whenever this rimpull is to be calculated, it will be exactly theoretically calculated

by considering that what is the weight of the machine and what is the rolling resistance of the material and what is your specific weight of the spoil material; what is the friction coefficient of the ground and friction coefficient with the blade. If you know that, then you can calculate what will be the your total rimpull coming over here.

Now, see here these factors we need to in a we should have India should have a nation-wide, the characterization of our material. Many a time, we just assume some value and we do this calculations and there, maybe if we do not really do the experiment and find it out, maybe the engine which we have pushed put in the dozer that may be consuming a lot of diesel, but which is not required.

So, that is why a analytic and theoretical calculation is also required. You should always do that type of research in the industry to find out whether the dozers or any machines that in engine installed is really necessary or there is a some wastage of energy is being carried out.

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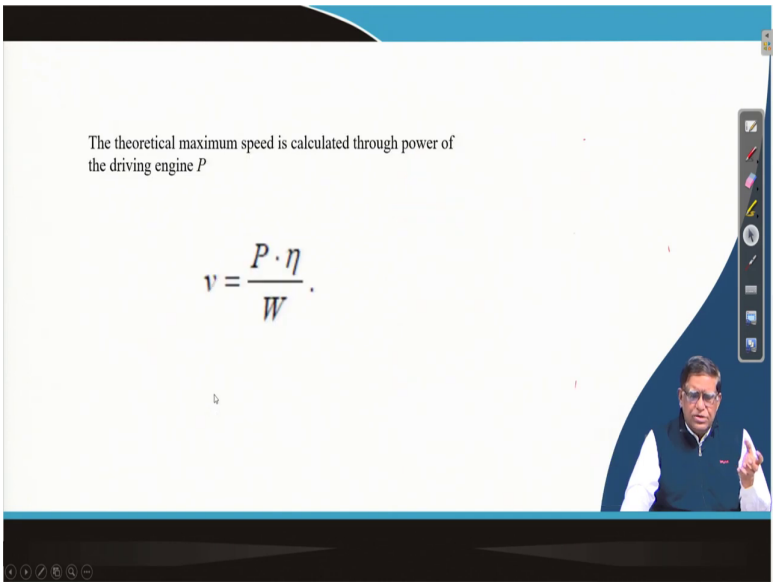

Now, this is a the at what speed your machine will be running, that also you can find out if you know the engine power and then, you know this rimpull, then for a particular efficiency, you can find out what will be the velocity. And then, your while operations, you should maintain the proper logbook with these values, then, you can find out whether you are exactly running or managing a mines very effectively or not.

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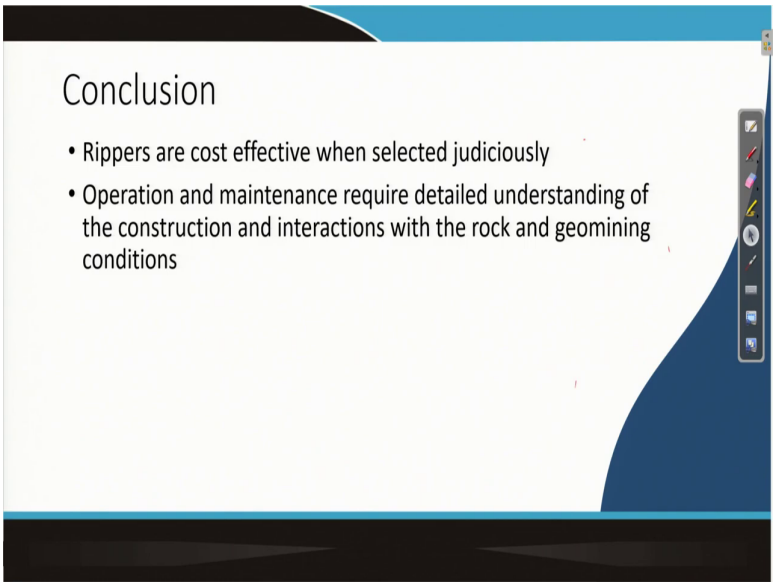

So, that is why you will have to learn the mining machinery. It is intricate things over there to become a better manager; without knowing the machines, without knowing the rock mass, you cannot be a deciding manager. So, with this, I conclude and I tell that you please go through the YouTube videos on the operations of this dozer ripper so that you can have a feel. And from there, you can find out that where we are exactly lacking in our analysis and in optimal selection of equipment for mining operations.

Thank you very much.