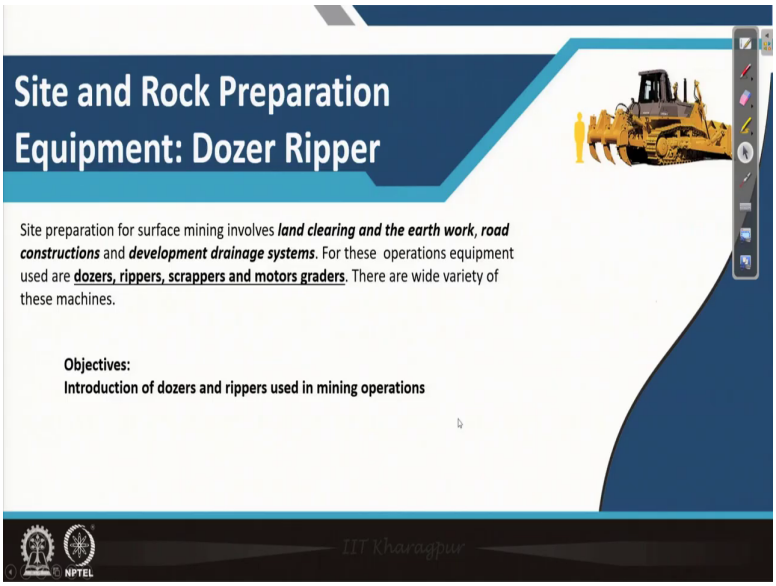
Mining Machinery
Prof. Khanindra Pathak
Department of Mining Engineering
Indian Institute of Technology, Kharagpur

Module – 04
Lecture – 13
Site and Rock Preparation Equipment: Dozer Ripper

(Refer Slide Time: 00:39)



Today, we will be discussing the Site and Rock Preparation Equipment that is in Mining Machinery, for different purposes are different, you know that before starting any mine the site need to be prepared for different operations that is called your site preparation.

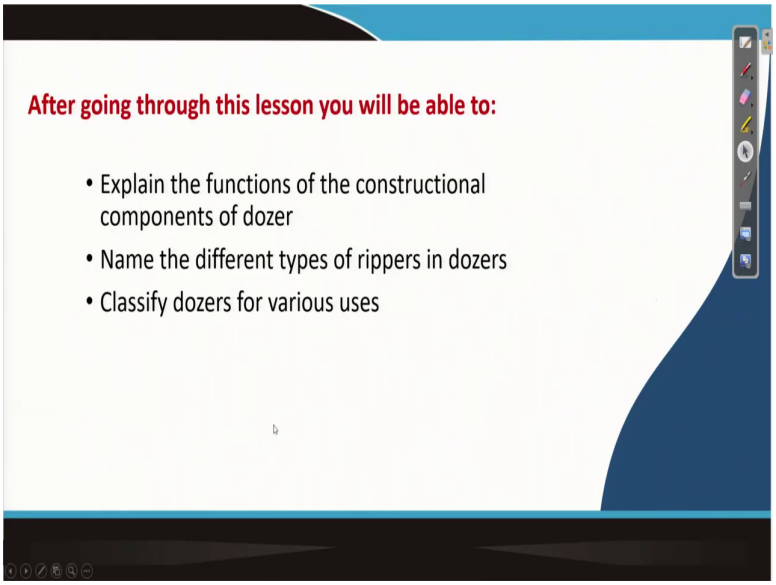
Which is basically cleaning the forests area or adjusting the new area for construction operations, for different premises to be built roads others need to be starting; so, for that some civil construction machinery will be necessary. And, also there is a once the site is prepared

then we will have to do the rock preparation that is the once the surface is ready for doing the surface mining. Then, we will have to prepare the rock for its fragmentation.

So, for that different types of machines are used the first machine which is brought is the Dozer. And, this dozer with a ripping blade as you can see in this photograph of this dozer, there are the rippers at the back of it. So, this Dozer Ripper it is used then other machines like scrappers and motor graders, they are brought for constructing the scrappers for taking out the top soil for preserving.

And, the motor graders for construction of the roads and also there are in the site preparation use sometimes the compactors that road building machines all those civil machines are working. So, today we will be talking about this dozer ripper that how it is used in the mining operations.

(Refer Slide Time: 02:21)



After going through this lesson you should be able to explain, the functions of this constructional components of a dozer. How a dozer is made of, how it functions, what it is there what are the how it is powered and what are its major components, how it is to be selected for different operations?

Those things you will be able to know. And, then forgetting yourself familiar with the machine you must know, what are the name of different components. So, you will be able to tell this components name and also how you classify that different manufacturers are making different types of dozers.

(Refer Slide Time: 02:59)

So, there are different makes; makes this company liebherr, they makes this caterpillar Komacho. Then, also in India we have got this indigenous manufactured dozers that is by

Bharat earth movers limited Bangalore, they have this BML dozers very widely used in Indian mining and construction sites. So, we will be talking about this dozer.

(Refer Slide Time: 03:25)

Now, coming to what is a dozer how will you define? You can see this machine, it can be a crawler mounted or tire mounted. That means, the mounting means that under carriage on which the machine is working that is called on which it travels, that is the travel gear or undercarriage. This travel gear can be a crawler mounted, this is or a track mounted sometimes it is called.

And it is a self propelling; that means, it has got its engine which gives the power to this crawler and, it is a self propelling machine. And it has got a front mounted, this is a front mounted hydraulically operated blade, hydraulically operated means, this blade can be slightly raised lowered or it can be tilted or it can be pushed down these operations can be

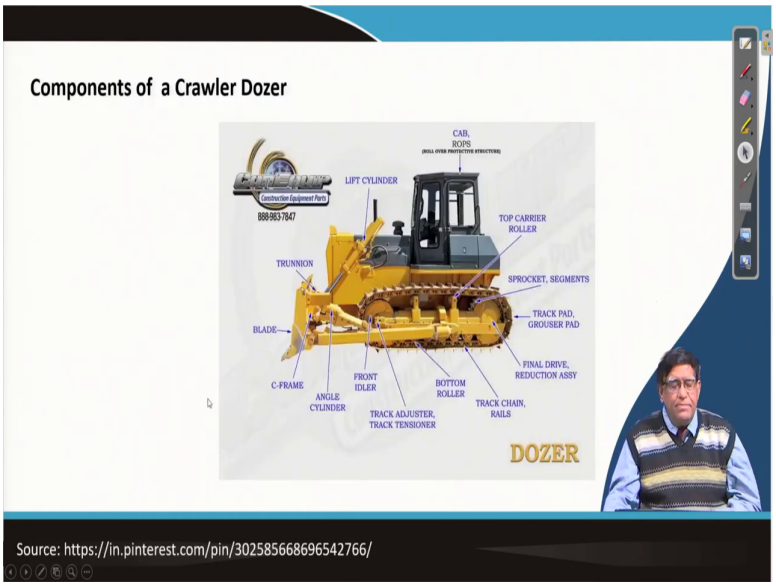
done by hydraulic operations. There were dozers even the there is a fixed type of things, without any movement wereare there in old days.

Now, the hydraulically operated blade, which is connected to a push beam, there is a push beam is there by which it is connected. And, then we can see here how it can do a tilting operations and it is used for cutting and pushing earth material with it. So, it can cut even semi consolidated or loose material depending on that what type of the situation is there.

With these three figures you can find out that this is a real life, those are photographs you can see the operator is sitting inside. It has got a very good operators cabin, which can be your protecting with say noise dust. And, then there is a very good cabin top, if any rocks or anything fall over here you will be protected.

And that engines has got the hydraulic power pack. So, that this hydraulic pump can work and give the sticks to the actuator. And, this blade you can see here how a push arm is there and there is called a pitch arm by which you can just make give some movement to the blade, it can raise lower and things like that. And, in the for cutting forces, which is there it is given by the pushing of this vehicle.

(Refer Slide Time: 05:59)



So, when this move basically will be moving it will give a pushing actions. So, now, coming to the constructional component, you can write it down this names at least, it has got a blade, which is the main functional component. And, then it is a trunnion point above which it can tilt or it can move this point is a just a trunnion point. And, this is called your C frame on the front of which the blade is mounted here.

Then, it has got a lift cylinder by which this blade can be moved up and down. There is a angle cylinder by, which a angling action that build can be giving an angle up and down, that motion can be given by this hydraulic push. Sometimes, there are some manual angling blade in which there will be groups, you can manually connect it to give at a particular angle.

And, then it will be a whole operations it will be doing at a particular angle of the blade. So, there are boards that angling can be done manually or by hydraulically. And there is a, this is the crawler track or chain, the track chain which is between two idlers or sprockets are here.

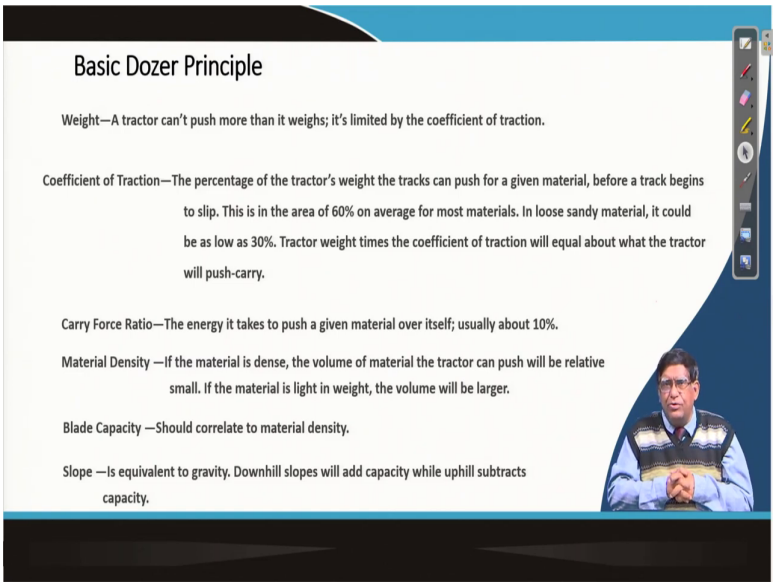
This is your driving sprocket and this is your idler sprocket that which it has got the power is given to the driving sprocket.

And, then the this is your idler front idler it is saidit is just because of that chain is getting the by friction the motion is coming and that chain will be moving. You have whatever in the chain drive you have studied the same principle works here. Now, this chain is supported on this you have got the carrier top carrier roller, and you can see that there are bottom rollers.

So, these bottom rollers and carrier roller in between this this chain moves. And, then these chain can be there is a arrangement for tensioning, sometimes it this this idler can be this the distance between these two idler can be increased and lowered depending on that we can mention, that you can maintain a particular toughness or tension in this chain.

And, then you have got this your that your roll over protection structure, roll over protection structure is the, that where that cabin is there the operator is protected if any rock from the slopes fall down on it will not break. So, that sufficient strength is given over there.

(Refer Slide Time: 08:31)



So, you can see that the different functions of these operations, their basic principle you should know, that a tractor cannot push more than its weight it is limited by its coefficient of traction. So that means, whenever you are going to select a dozer that is we will have to know. How much material, how much load you want to push depending on that what will be the weight of your this system that you can find it out?.

Then, the coefficient of traction it is the percentage of the tractors weight. The track can push for a given material before a track begins to slip, because if there is a more load is coming. Then, that your roller will not be able to move over there and then slip is will take place.

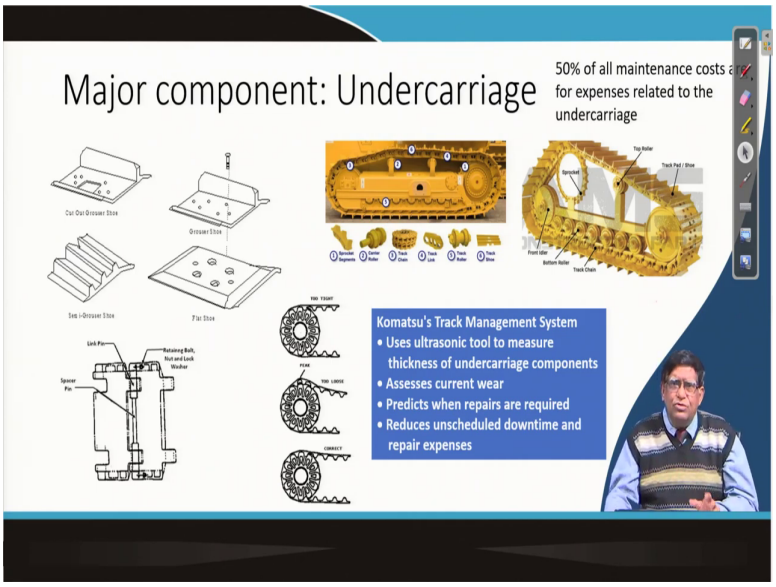
This is the area of 60 percent of average for most materials; in loose sandy material it could be low as 30 percent. Because, it cannot give it push that is that this coefficient of traction this concept is you should be very careful about using this while selecting dozers.

Then, tractor weight times the coefficient fractions will equal about what the tractor will push carry. So, how much material it can carry can be determined from that. Then, there is a carry force ratio the energy, it takes to push given material over itself usually 10 percent of material it can push, that is how much total amount of material it can work.

Then, material density makes a very important contribution. If the density is more then, definitely the weight will be more and that is why the you will be able to less volume can be pushed. And that material that which get in front of the dozer blade, how much material get piled up that is called your dragging prism, that is how much material it has come and then it will be able to push it over here.

Then, the blade capacity shell correlate to material density that is, how much material it can carry that will be because the resistance to motion it will be providing on the basis of that the whole the capacity of the dozer will be depending. And, then also it is the slope is important, whether you are dosing down the slope or you are dosing up the slope, depending on that also the capacity will vary.

(Refer Slide Time: 10:54)



So, these are the basic principles we need to remember while working with a dozer. Now, coming to this that what is the major component is the undercarriage. Under carriage can be a different type of this is also, here the driving sprocket is here and these two are the idler rollers. In one case here this is the driving sprocket; there you can see the differences.

And, now the main components is you have got these are the your the sprocket on which you are giving a driving sprocket over here, then you have got these rollers on which it is this step of carrier rollers are there. And, then this is the track chain at the top, there is a track chain. This track chain is made of number of this pads, it can be different type of you can see here. These are dozers crawler chain has got this grouser type of so, like that a grouser portion is there.

And, then because of this grouser portion when it moves on a gradient, it will be gripping it will not slip down. And in case of your shovel or other machines, you may have a flat surface. Now, these two pads are like that then you can have see this is a partition next item can come and it can be just putting over here.

So, you can in between these two there is a pin by which it is connected, you can think of this crawler chain is nothing, but just like you may have seen some of the steel chain of your watch. It is similar to that exactly number of this pads they make this chain. And this chain is rolling over this your sprockets.

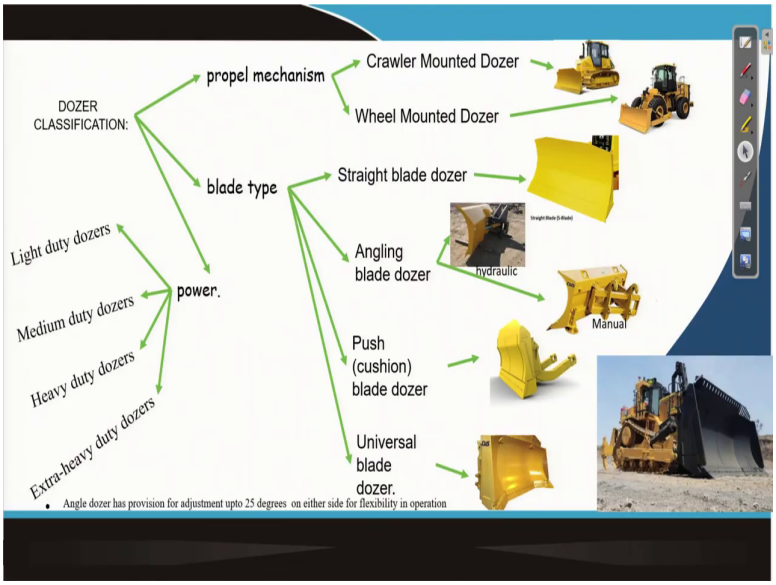
So, now, the this is a very important that while you are you should not keep this track too tight or too loose, it should be a correct tension should be maintained. If it is not there will be a breakage of the pin by which thesetwo pads are connected. And, then what will happen the whole machines with this chain will be coming out. And, there will be a lot of problem for refittingit. And that all the maintenance work in a dozer is to be done, on this crawler track which is called your in under carriage.

And, because of that nowadays we have got your maintenance tool or the Komatsu; they have given a track management system. In which they uses ultrasonic tool to measure thickness of the undercarriage components, because if the pins which are there if they wear out if the blades, if they wear out or if the teeth of the sprocket, if they wear out after uses. Then, there will be problem the chain will become loose, then your total power will not be consumed, there will be wastage of energy.

All these things can be measured or can be known by measuring the wear of it. That it assesses the current wear whatever the wear is there. And, then after some operations it can predict that when that exactly should be repaired or when it should be stopped. And, then it can make it so, that you this is a principle of condition based maintenance system, by developing such type of surveillance system in the machinery you can do it.

So, nowadayseverywhere this all the data, which will be collected, from that data you will be developing your software to predict when the maintenance will be done. That is the way how modern mining machinery are being managed.

(Refer Slide Time: 14:27)



So, now this dozer, how you classify? The dozer you have seen a this type of dozer with a back side there is a ripper blade. Now, these dozers can be classified on the basis of the propel mechanism; propel means, how it travels it can be travel either on the basis of the on the supporting on a crawler. It is called crawler mounted dozer or it can be on tire it could is called wheel dozer or wheel mounted dozer.

And, then it is also classified with the type of blades, you should remember that this dozers blades can be a straight blade dozer. There is a straight there is a that only it will be pushing down the material and then it will go, or it can be a angling dozer in which that exactly it can

as you have said by pushing it hydraulically, the blade can be in front of the blade can be pushed in one side.

So, it become an angle in one way it can cut other way, it can be just it can tilt only one corner will be cutting. So, particularly when you are making a road. The road surface need to be having a crown.

So, in the side you need to make that [vocalized-noise] ah dozer blade can be made an angle. So, that it will give a side cut over there. So, there is also a push cushion type of blade, there is it is not a cutting blade sometimes in your surface mining class you might have studied that, how the scraper machines are pushed sometimes in a dozer will be pushing the scraper.

So, let us say when a scraper is worked with the help of a dozer, that scraper need to be pushed. So, a push block or a cushion blade will be given this is not for cutting the rock or it is for just pushing a scraper the dozer is used. Then, also universal blade dozer that straight dozer you can see there is no side, but here a side blade is also there. So, the material can be retained over here, and then more material can be pushed.

So, this is how you can see a universal blade there is a straight blade is there and on the side we have got this blade. So, that and then here this is a dozer used for pushing coal; coal has got less density that is why the blade size is more.

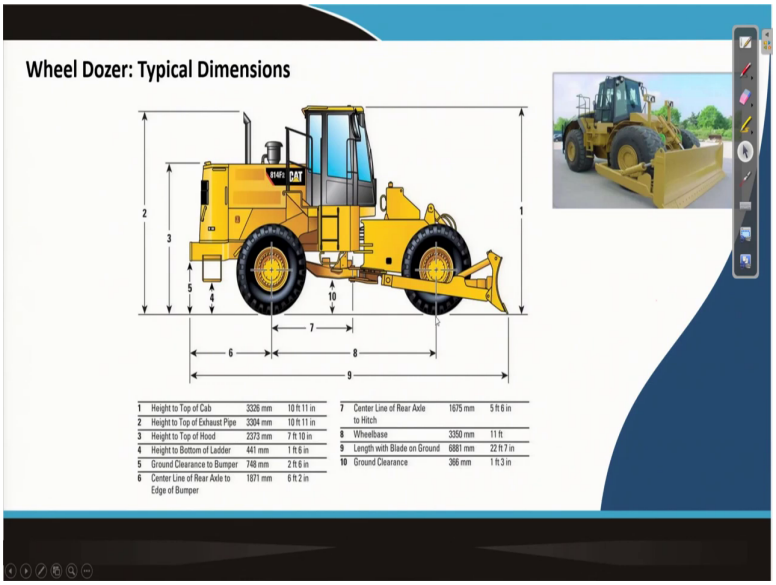
So, with the same dozer power engine, power it can take more volume that is why, the blade is of specialdesign. So that means, depending on the type of material you use depending of the job you use, you can use different type of blades and the dozers can be said as a straight blade dozer, angle dozer push button dozer or universal dozer.

Other than that, you can also classify on the basis of the power, that can be a light duty dozer, medium duty dozer, heavy duty dozer or extra heavy duty dozer. Now, particularly in some dozer where with a ripper, they use as a primary mining machinery particularly if you go to

the bauxite mines of NALCO at Panchpatmali. There, you will find the dozers are exactly doing without drilling and blasting with the dozer you cut the rock mass.

And, then you make it to be loaded by shovel on the truck to take it away. So, in that thing you have got a very heavy duty, your very high horsepower engines are placed over here. So, this is and then when you are using this angle dozer we can give a 25 degree on either side it can tilt or move.

(Refer Slide Time: 18:02)



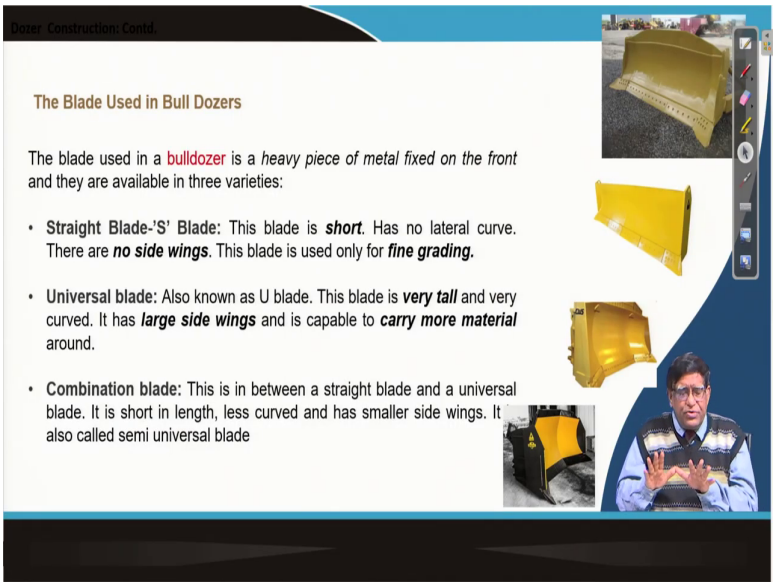
So, this other than that we have got this wheel dozer, in the wheel dozer you can see that the dimensions matters. So, here in this we can see a height of the top cab can be your just 3.326 meter. So, and then what is the height of the exhaust pipe here it is going. So, that is your giving this total height becomes your 3.34 meter. So, that is your the total height coming over

here, and you can see this your, the total length of the machine. The total length of the machine, it goes about your 6.8 meter.

So, that dimensionally your, this machine, why it is important depending on your mining site your what is the benchheight and then how you are operating this dimensions need to be taken care of.

So, whenever you are selecting or specifying a machine specifications for a particular operations, you should know that what should be this height and what should be the ground clearance. And, then what should be the blade height this all items are given then the manufacturers can find out that what will be your matching type.

(Refer Slide Time: 19:15)



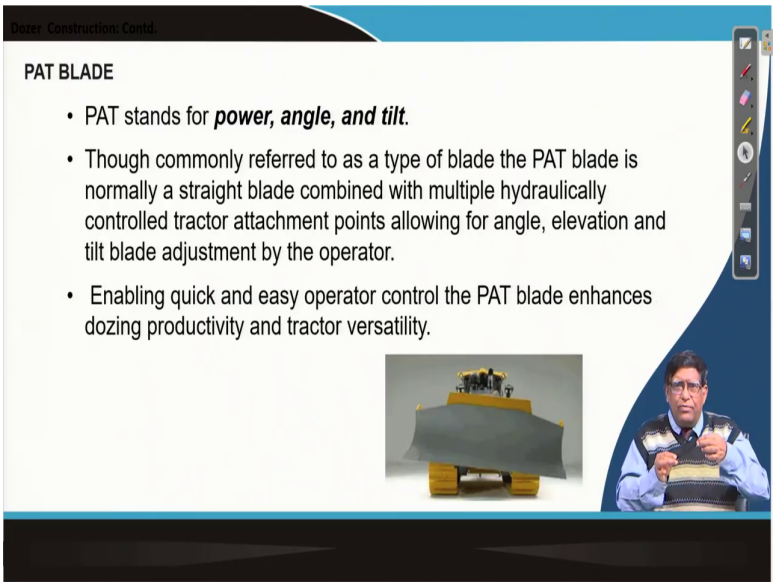
So, this blades already I have said that there is a classic blades of the dozer, it is the main operating member or the main functional element. And all your energy from your engine it is going to come over here, how the energy from the engine is exactly giving your hydraulic motor the hydraulic power pack is there in the dozer.

And, it is running a hydraulic motor which is there to drive the, your this driving sprocket. And, then when the machine propels, then it gives through the push arm it can give a load andthen it can work. Similarly, for steering also you can just in dozer steering, is it has got this two crawlers. Now, if one crawler is stopped the other crawler is that is your will be rotating, then it will giving a turn. Similarly, if this one is moving and this is stopping, then it will be giving a turn.

So, that is, your if you are moving you are driving this right hand, then it will be giving a turn towards left. If you are driving the left, it will be giving a turn to the right, that is the way by disengaging the drive to one of the crawlers they stop.

That means, that it shows that the total power transmission in a dozer goes from the engine through that your hydraulic motor. It is given independently to the two crawlers, which each one of them you can individually just stop it. And from that that is the way how the steering is done. So, when you study this different blades and then how energy is going over there you can see.

(Refer Slide Time: 21:01)

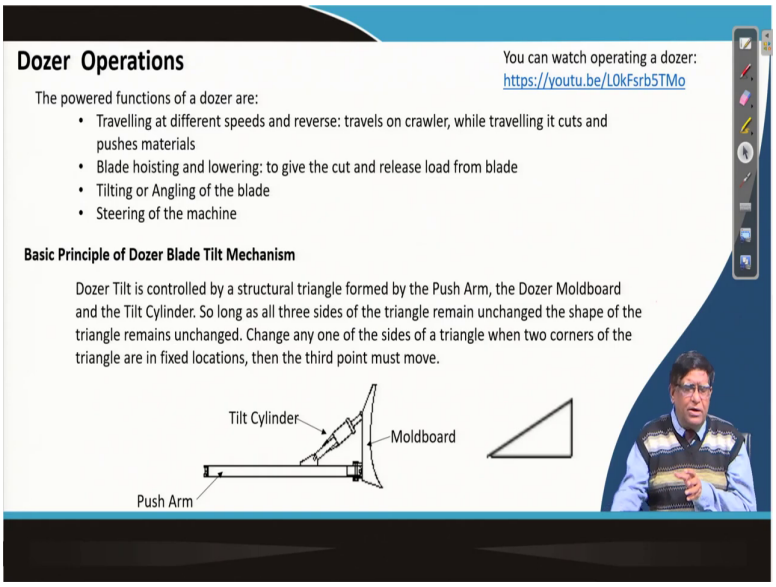


Then, another thing is you have got a patblade that is your power angle and tilt. There are the, these pat blades, they have got the all are hydraulically operated, you can see how this particular of this blade is not parallel to the ground surface. That means, it has got an angling operations and it can tilt; that means, if the blade is like this you can raise the blade you can lower the blade, you can give a and tilt over here and also you can make it rise like that.

So, all the 3 dimensional movement at the back of it done by hydraulically and that is why it is called a pat blade power angle and tilt. So, it can give a extra push to the material by that hydraulic or it can give a extra cut, that is how deep it will penetrate this blade depending on the productivity will be there.

In your surface mining you normally study, that how it will be deployed in the site. That means, how much exactly it will penetrate into the ground depending on that your what will be the advance or the how much how the your mining rate will be coming that is determined.

(Refer Slide Time: 22:14)



And this dozer operations are basically, it will be travelling at different speeds and it can reverse. So; that means, the dozer operations you have got just like in a gear, you can change the gear at different speeds, but the speeds that which gear you will be selecting it will be depending on how much total load is coming up.

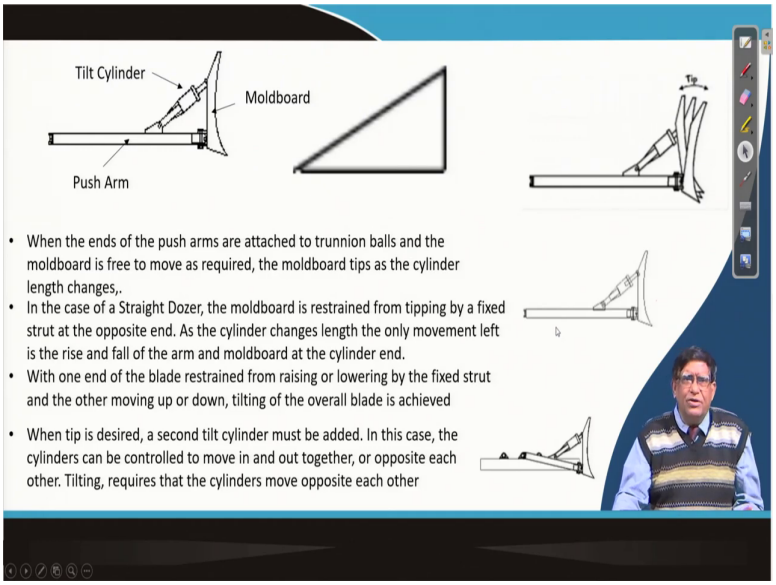
And, then there is also the blade hosting and lowering operations is done, tilting operation is done and the steering machine. So, these are the powered functions as I said there is a in any machines you need to know what are the powered functions.

So, this requires your, the power and then you can study that what will be the control over there. So, you can control the speed by that controlling the drive of the driving hydraulic

motor. So, those controls are there in the operators cabin through his lever, he just controls the flow of fluid and then he controls the, that its speed its directions and all.

Then, the basic principle of the dozer blade tilt mechanism, that you can see, there is a tilt cylinder. And the push arm is there and then in front of that mold board on which the blade is there.

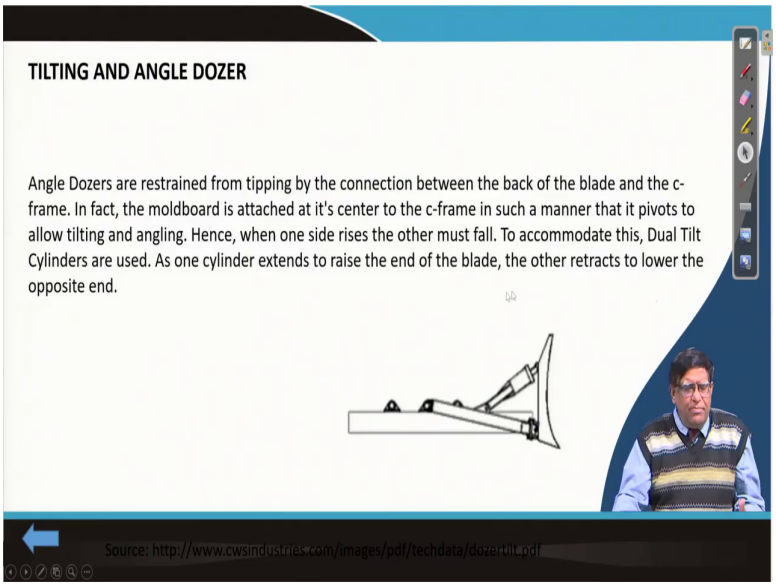
(Refer Slide Time: 23:39)



So, by giving a different combinations of this how much you push here and how much you do there on the basis of that you can tilt. You can see here; that means, by taking out this hydraulic cylinder, this piston movement will be giving the tip of the blade will be going forward or backward or doing like this. So, similarly this whole thing the blade movement is done by hydraulic systems. As you have studied in our pneumatic and hydraulic power, how different speed that actuator works that basic thing is there.

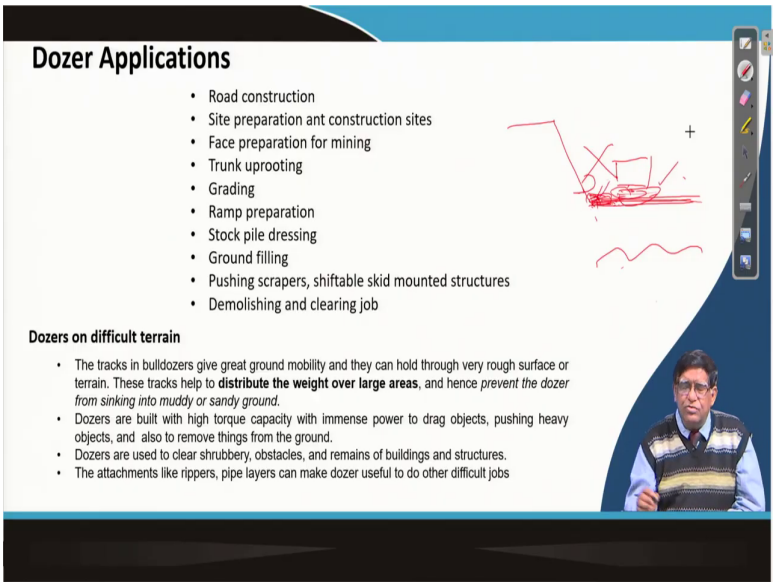
So, while maintaining the, operate that dozers, you will have to know the hydraulic circuit which is exactly responsible for giving over here. Your this oil which is being used how they are flowing and then there will be number of hose pipes and this valves. So, that your hose pipes and valves should be in a properly maintained conditions then, you will get the trouble free operations.

(Refer Slide Time: 24:33)



Similarly, in the tilting we have got a, another the cylinder, this keeps by pushing it over there you can tilt the blade.

(Refer Slide Time: 24:44)

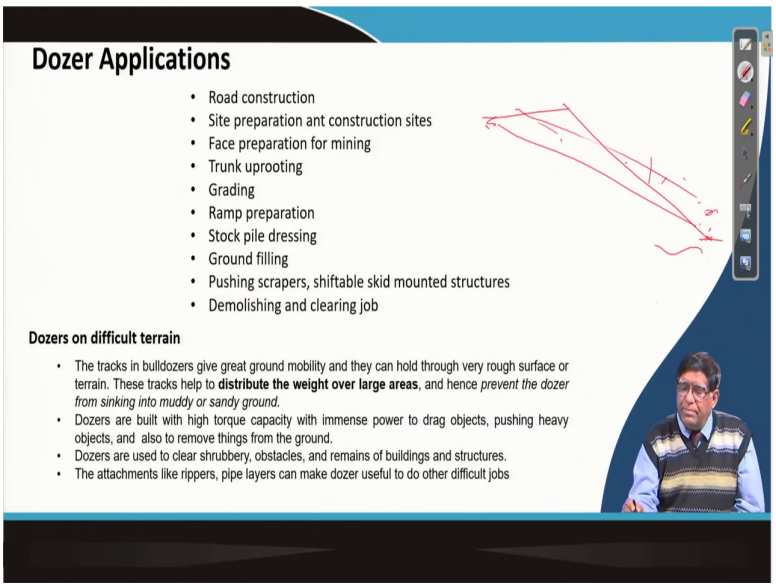


So, these operations exactly are used in this dozer, then how you apply it. You can apply it for road constructions you can apply for site preparation on the construction sites, you can have a in a mining you have got the facepreparation job; that means, when you are working with a shovel or in the while working with shovel. You can see here that when a mine, if your shovel is working over here. That shovel is a crawler mounted machines. So, you are having a bucket which is taking this material.

Now, when a crawler mounted machine is working over here, this should be all the time and then properly maintained, that the gradient should be it should not be a undulated surface. Because, on an undulated surface if this crawler mounted shovel, it moves it will be giving operational difficulty, crawlers may fail and also the productivity that is the production rate will be decreased.

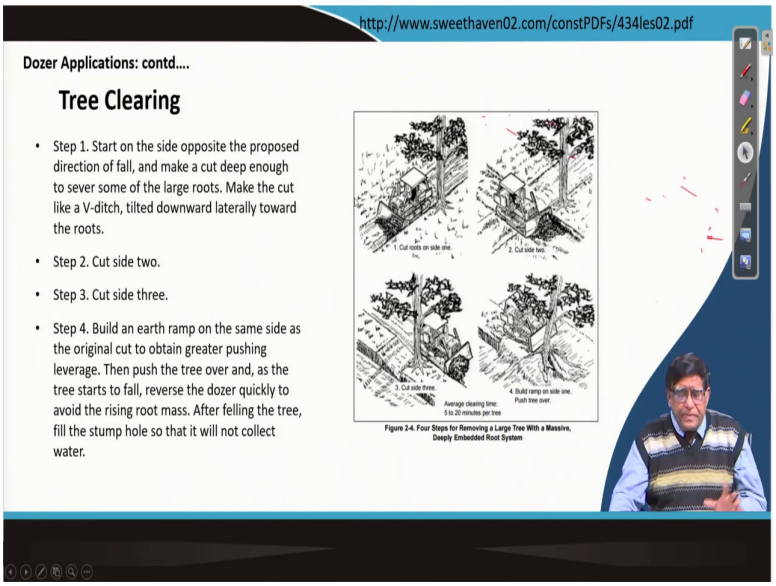
So, what is done? This a dozer is normally working in combination with so, that it dries the things it brings the material over here. So, that that shovel gets a easy way to take your material out. So, then sometimes what happens? Whenever your, you have got this.

(Refer Slide Time: 26:04)



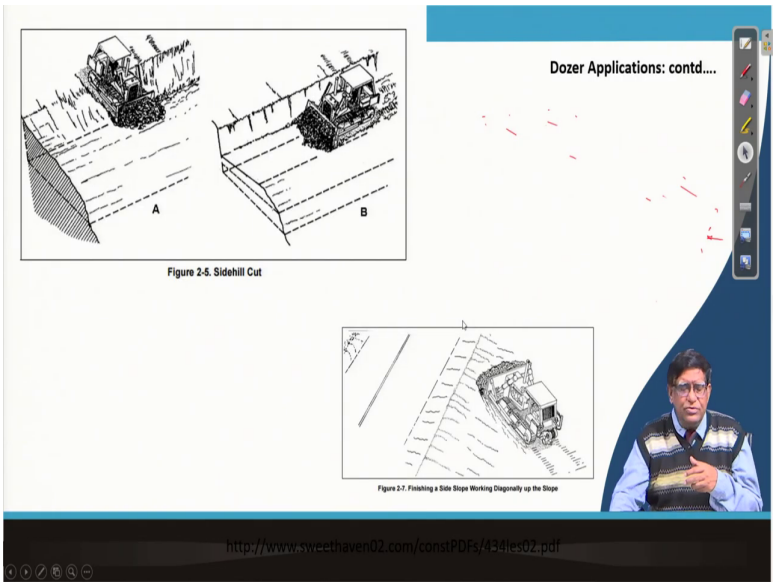
From here if you need to go up to here, you will have to give create a ramp. So, that you can a vehicle and all go up here. So, this type of ramp creations also can be done by dozers. Similarly, dozers can operate in different difficult terrain. Because, where no machines work, there the dozer can easily work, because it has got that grouser crawler it can go at a high gradient also, and it is a very high horsepower engines are there. So, it has got a robustness in this machine that is why in the mining the dozer is indispensable.

(Refer Slide Time: 26:45)



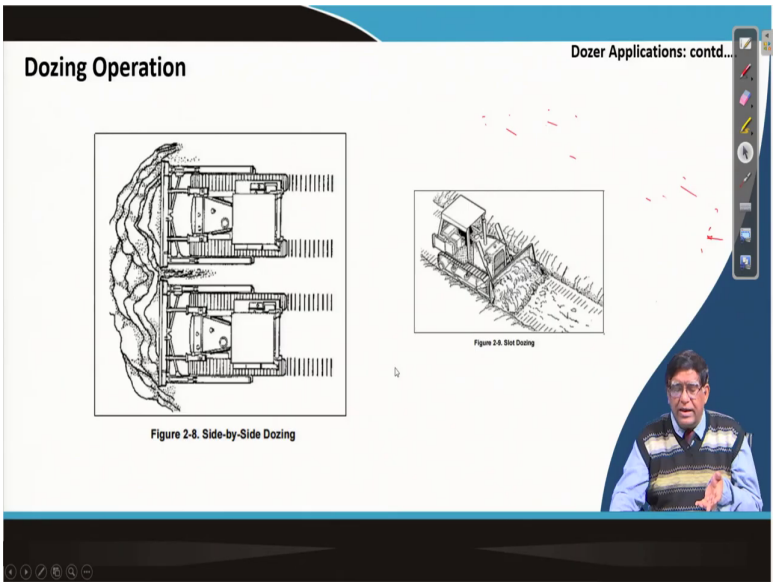
And also it is initially for site preparation purposes that uprooting of the trees. It is necessary and dozers are used for uprooting the tree, and then you can push it over there. Then, sometimes if the trees are cut, then the stumpis there for the stumpremoval these dozers are used.

(Refer Slide Time: 27:04)



Then, there also in a side hill cut they can cut these things in a side hill, they can make the layer by layer, they can cut and create a slope over here.

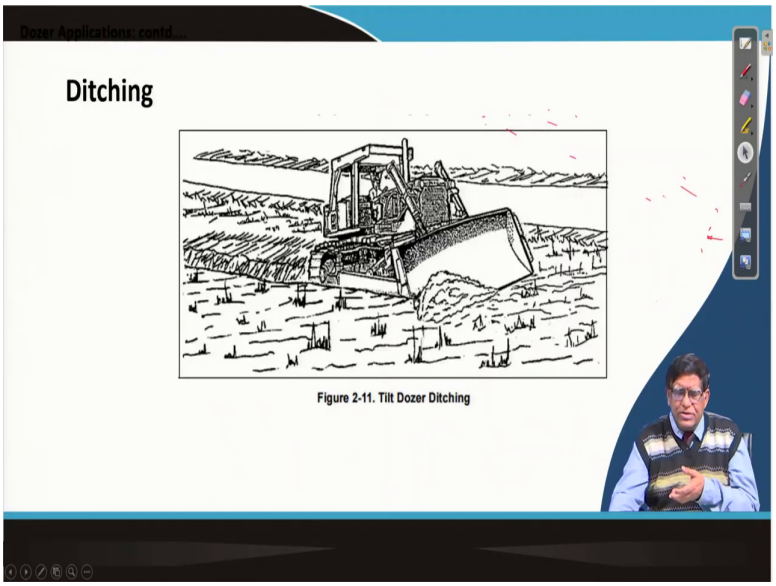
(Refer Slide Time: 27:18)



And, then the mining exactly can start initially. Sometime the dosing operations are done in the mining that is the material by using two dozers, simultaneously they can push the material. And, then they can expose say the overburden can be removed like this, and then the minerals can be collected over there. That I was telling the dragging prism this amount of material which is getting in front of the blade that is called a dragging prism.

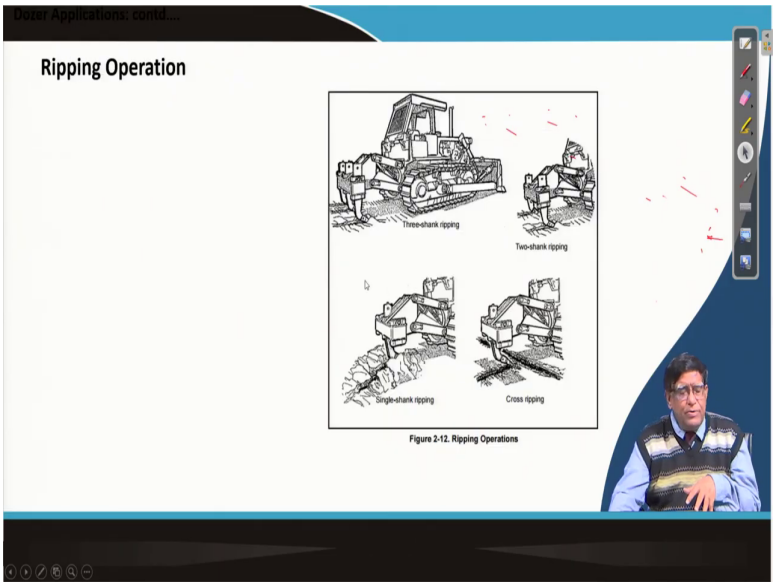
Now, the productivity of this dozer, it will be depending on how much material is exactly getting accumulated in front of the blade and how it is being moved. So, if we know the total volume of this material. And, if you know at what speed it is giving that volume into the speed that will be giving exactly the production that rate by multiplying withthe density, we can find out what is the tone per hour it can move.

(Refer Slide Time: 28:12)



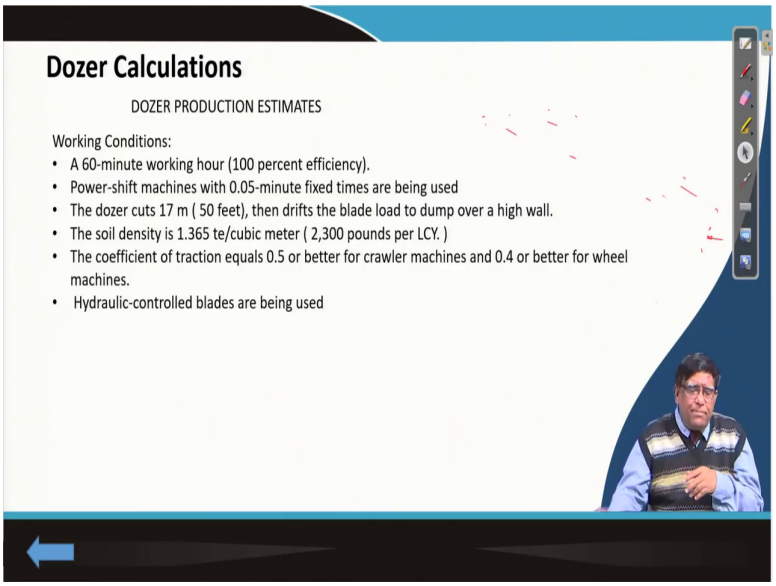
So, this will be having a then sometimes, you want to do a ditch cut that is you might have seen many civil constructions, where they are constructing ditches with the help of dozer. Here this is by till dozer, a portion one corner is tilted and then the material from this is getting taken it over.

(Refer Slide Time: 28:31)



So, then the rippers are exactly the ripping blade or the shank blade, here is a single ripper, here is a tree rippers, here are two rippers at the back side of the dozer is there. So, that it will be cutting that just like a plough it will be that making the rock loose, by which after that from the front it can push that material out like that the dozer operates.

(Refer Slide Time: 28:54)

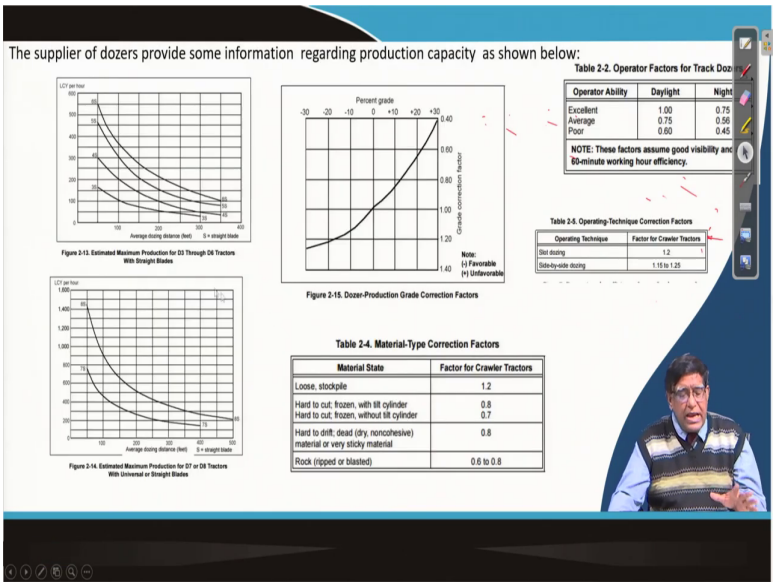


Now, well calculations of the dozer involve basically, depending on the it will have to get under what working conditions, how it will be working. You can do a dozer calculations to determine, what should be the height of the blade, what should be the length of the blade for a given operations?

Normally, one example you can see here that if you are having 60 minute working hour for 100 percent efficiency you assume that in power shift machines, about 0.5 minute fixed times are being used, and that dozer cuts say about 17 meter.

And, then it takes the blade to the loop in the front sides and the soil density is given. Then, normally the, that your loose cubic yard that is what that usedas a pound per loose cubic year, there this is the density expressed over here. The coefficient of tractions equals to 0.5 hydraulic control blades are being used if these given conditions.

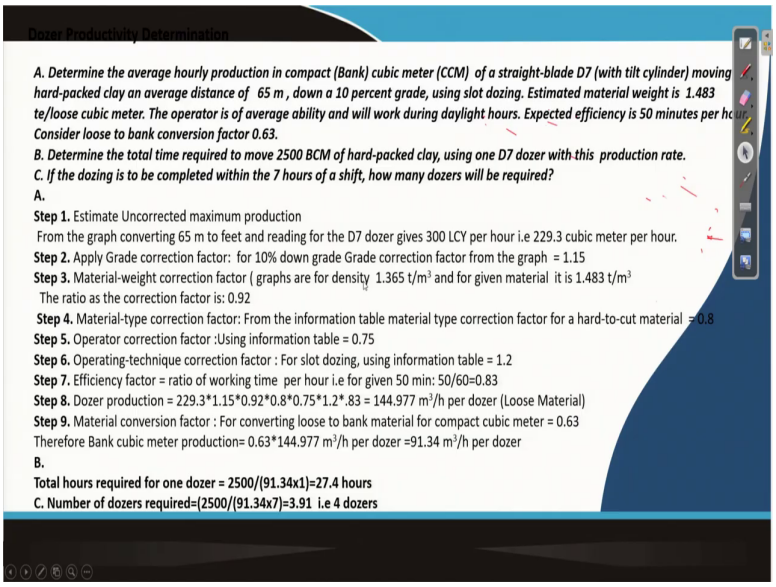
(Refer Slide Time: 29:55)



Then, you need to see that dozer operators that dozer manufacturer, they give some standard chart. The standard charts are exactly for different type of dozer, whether it is a that D 7 dozer or D 8 dozer their various dozing distance.

And, then how much loose cubic yard, they are taking these are all in the FPS system that disperse material is being. If it is say for example, a dozing distance is say 200 meter in a 7, this 7 D dozer D 7 dozer, they will be taking about 300 loose cubic yardper hour. It can produce that is the productivity you assess from there.

(Refer Slide Time: 30:44)



Similarly, in a different gradient of the soil, how it will be done. The this type of tables are used for solving a problem, you may be having a problem say like. You may be asked determine the total time required to move a bank cubic meter of 2500 bank cubic meter means, the hard rock soil and then loose cubic meter means loose.

So, that if you are using such type of dozer how we will determine that. So, there are step by step you can work, from estimate the uncorrected maximum productions. Then, from the graph you convert them and then you find out that how much cubic meter per hour it is taking. Then, the different correction factors are placed. And, then ultimately you can calculate the dozer production rate.

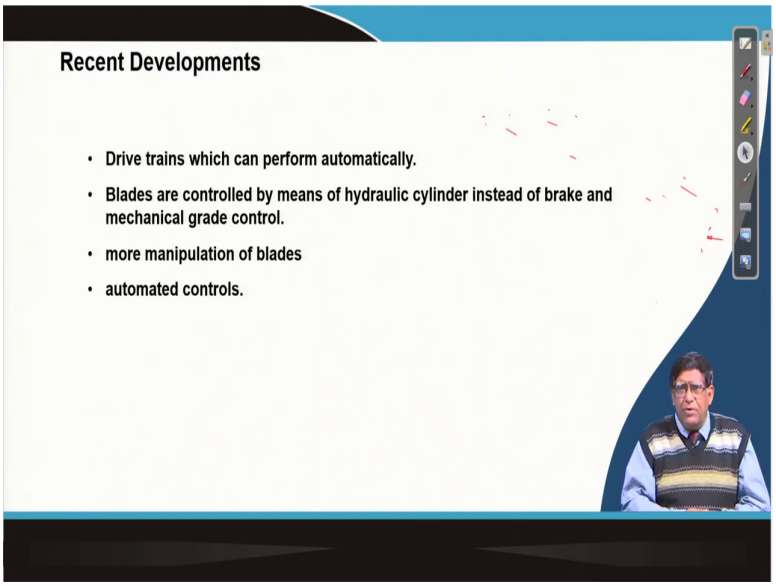
So, this is the way that step by step the calculations are there, as you will have to practice as a practical to work with these things. In the next assignment class, some assignments will be

given which is solve problems. And, then you will be doing some unsolved problems will be given to you, by which this experiment this testyou can conduct.

(Refer Slide Time: 31:53)

So, the selection of dozer will be basically, for you have to optimize the fuel saving, higher productivity, less wear tearon the tractor and better finish product, how you get that one, it will be depending on the site conditions. So, the whole dozer selection problem is basically matching with site conditions and your machine specifications.

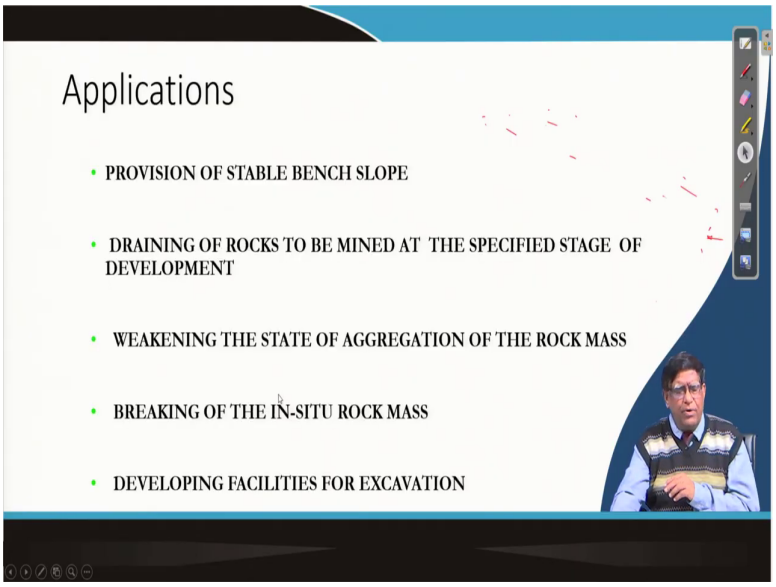
(Refer Slide Time: 32:22)



Then only you can get a productive machine. And modern dozers have got lot of electronic gadgets are coming up with their and their, they have got the advanced technology being used. So, as I said that there will be the track management system, there will be that, your blade monitoring system. There will be automated control; that means, you want to give a how much tilt and things like that, it can be programmed and that machines can work.

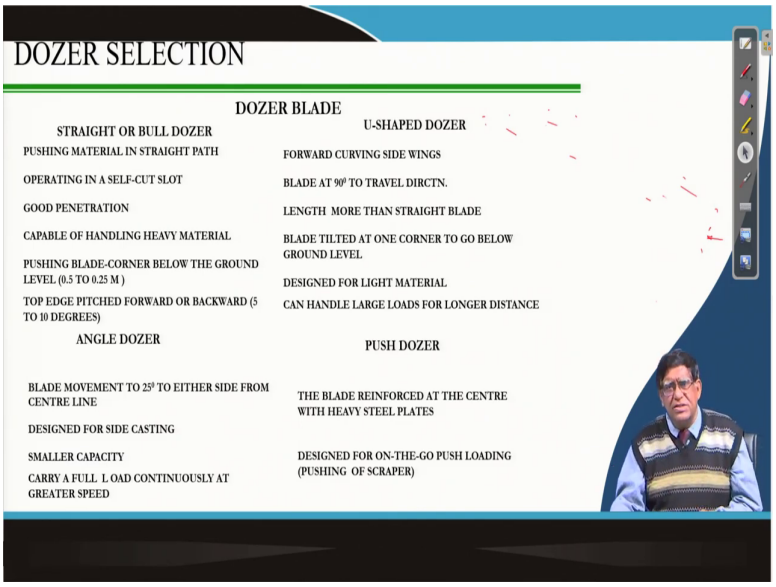
And the other thing is the dozers are now remotely operated particularly, when you are working on a dangerous slope of overburden dump. The operator need not be there on the dozer, it can be operated remotely from here.

(Refer Slide Time: 33:08)



And, that is why this their applications are in a different area, already I have said that it can be for site preparations.

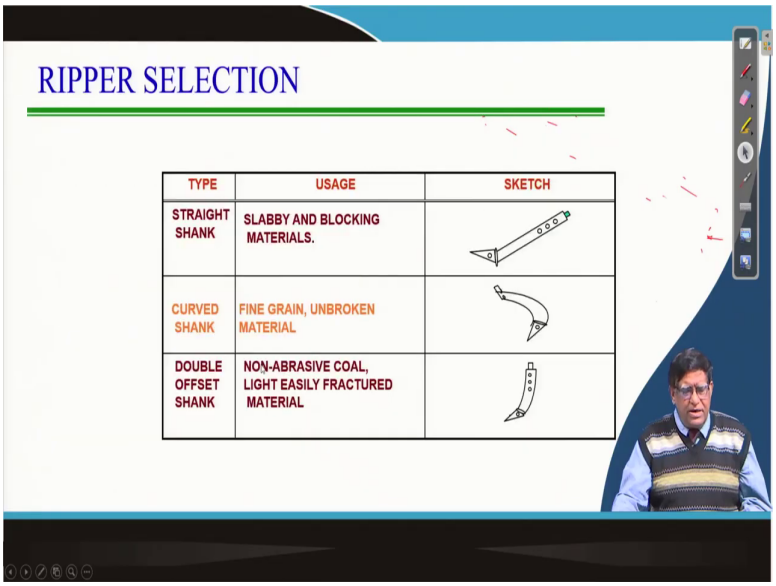
(Refer Slide Time: 33:18)



And, it can be for pushing these things and as we said that there are different types of dozer like straight bulldozer, or U shaped dozers, or angle dozer, or push dozer. Push dozer are used for the scraper pushing U, shaped dozers are for forward curving and then at a blades are at a 90 degree travel directions.

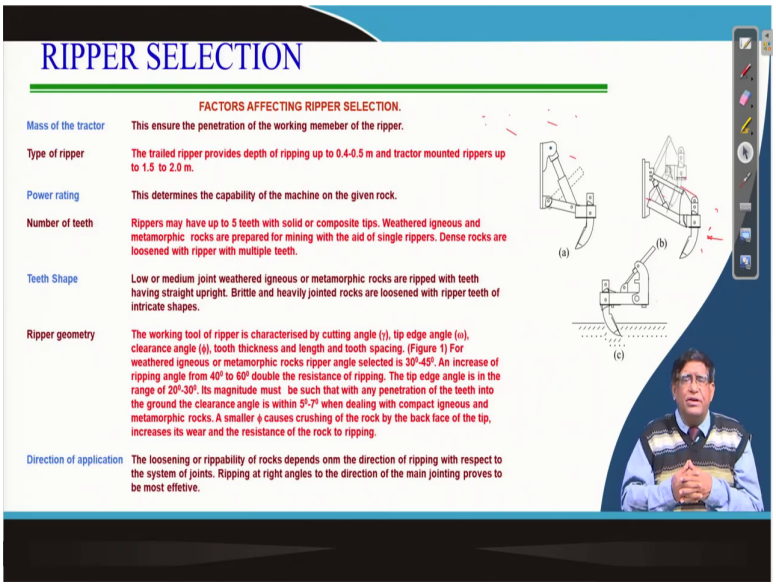
This is a straight bulldozers, it can give a very good penetrations, then your angled dozers it can do the side cutting for that crown. So, like that your different type of dozers are working at a different jobs. So, what you will have to do? As an assignment write down that, what are the differences in different types of dozer, and what are their applicability?

(Refer Slide Time: 34:07)



Lot of materials are available you should see that and, then the ripper. Ripper is basically that what type of ripping blades you are using, just like a plough you have got a curved shank, you have got straight shank and you have got double offset shank.

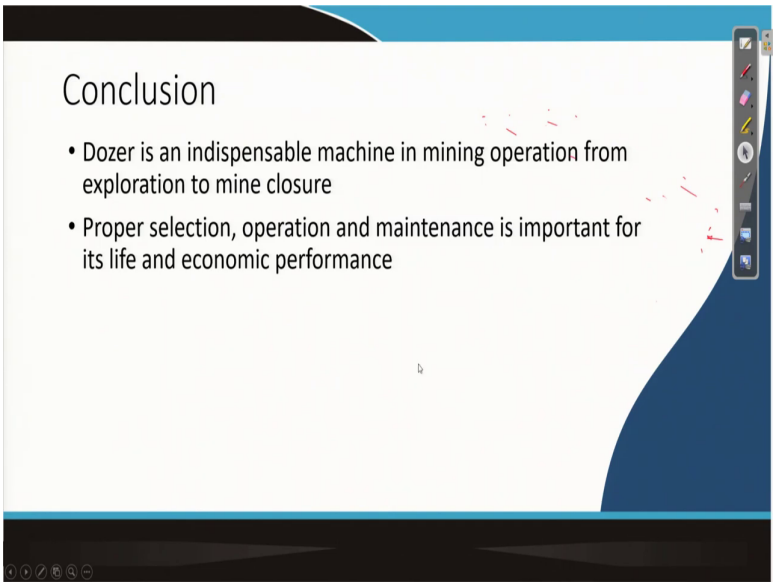
(Refer Slide Time: 34:30)



Now, these are fitted at the back side of the dozers, which can be a hydraulically controlled this shanks or it can be your rigidly fixed. Now, when this ripper backside how you fix, it has got number of parameters like that what is the type of ripper you will be using, that is your whether you have the fixed, or hydraulically operated. And what will be the teeth shape, and the what is the geometry of the ripper say? Here the geometry can be changed, here the geometry is fixed.

And, then in a which directions you are doing that is your the during the forward movement you are cutting. So, that the in your how exactly you are loosening the material.

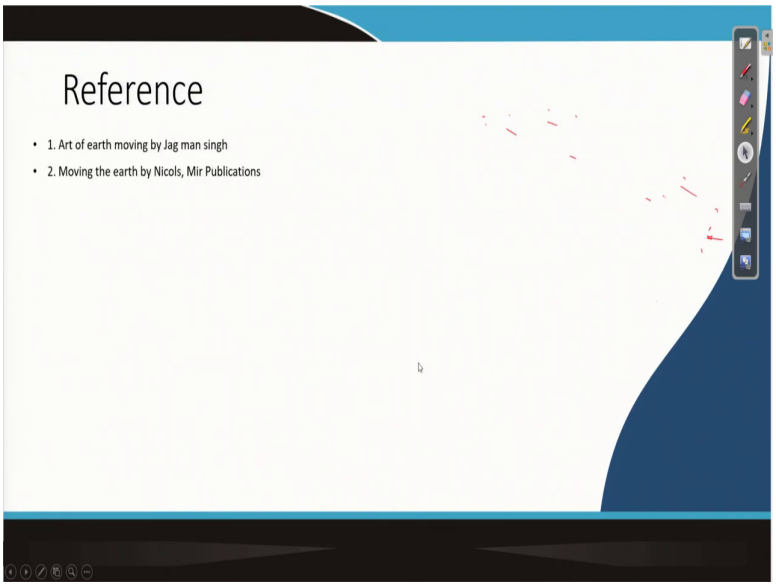
(Refer Slide Time: 35:22)



So, the ripper main purpose is to loosen the material so, that the dozer can push it. So, dozer is indispensable in mining operations, and then it is used during the explorations time to make the roads in the jungles, road in the un inaccessible areas. And, it is also during the, that when you are making your first camp, to construct the buildings, construct the drains. Then, clearing of the roads making the or accessing over climbing a slope. The dozer is the first machine which is used over there.

So, proper selection of operation and maintenance is very important for this. So, today of course, just I have introduced over here, I will be giving you the tutorial sheets, in which there will be some solved problems. As well as you can get some of the, that your assignments, which you can do by yourself studies.

(Refer Slide Time: 36:22)



But, main thing you can read the books of this art of earth moving by Jag Man Singh or the moving the earth by Nicols, these old books they give a very good description of your how dozer operates. So, I wish that you develop a little interest about this machines make from the internet search about the different make.

And study the specifications and develop an understanding of what is the present trend of this machinery. How the modernization of this machinery is taking place, with different advance of hydraulic systems, different advancements on the control systems are being incorporated in this machines.

Thank you very much.