Construction Methods and Equipment Management
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Lecture-10
Earth Moving Equipment-Bull Dozer

Hello everyone, I welcome you all to the lecture 10 of this course construction methods and equipment management. In this lecture, we are going to discuss about the earthmoving equipments specifically about the bulldozers.

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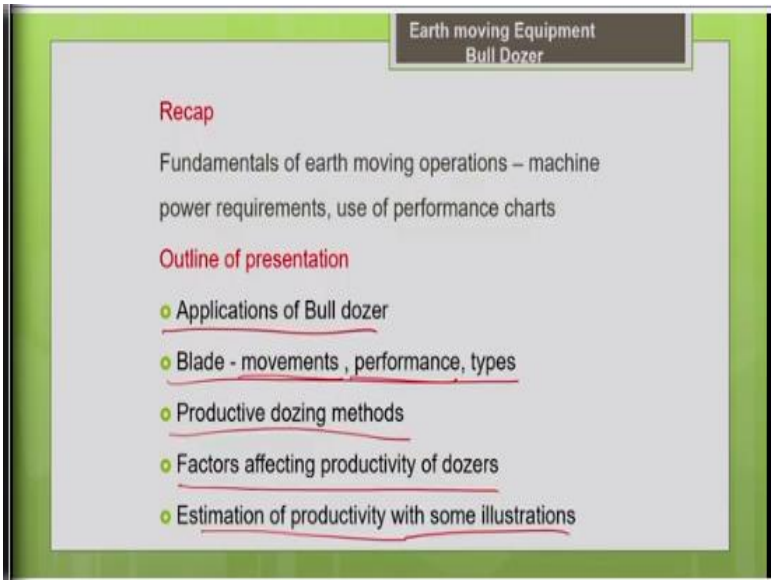

So, in the last lecture, I introduced you to the various fundamental terms related to earthmoving operations, like how to determine the power requirements of the machine and what is the significance of performance chart, how to quantify the payload of the machines? So, all those terminologies related to the earthmoving operations were introduced in the previous lecture.

Now, let us see what is the outline of today's presentation? So, in the today's presentation, we are going to discuss about what are all the applications of the bulldozer. So, there will be some series of lectures on different earthmoving machines. So, in this lecture we are going to discuss about the bulldozer. We will look into what are all the uses of bulldozer and what are all the different types of the earthmoving blade which we use commonly for the bulldozer.

So, what are all the possible blade adjustments and the blade movements with the bulldozer, how to assess the blade performance. Say and what are all the different productive dozing methods which can be adopted to enhance the productivity of the bulldozer. So, the factors which affects the productivity of bulldozer and how to estimate the productivity of the bulldozer with some in illustrations. So, these are the things which are going to discuss in the upcoming slides.

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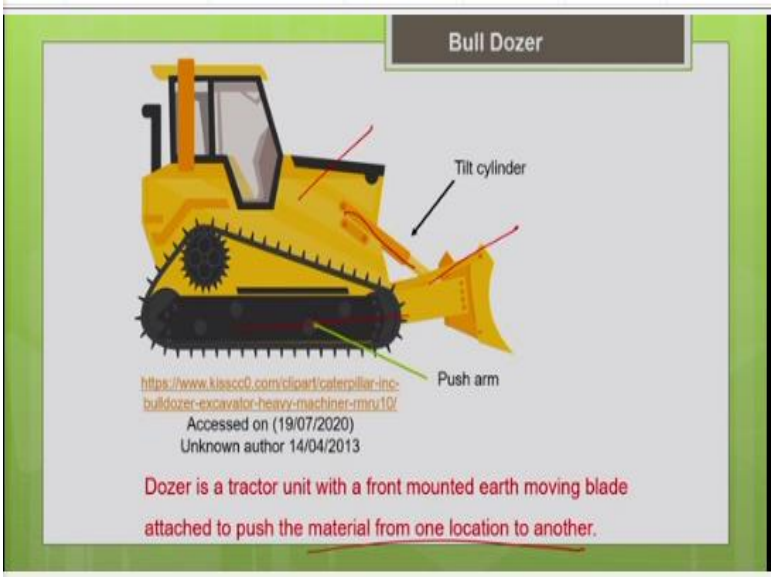

So, most of you might have seen the bulldozer, it is basically a tractor unit connected to your earthmoving blade. So, it is nothing but your tractor unit connected to your blade. So, with the help of this blade, you can push the material from one location to another location. So, you can see that there are possibilities of different types of the connection between this blade and the tractor. So, here you can see a type of connection tilt cylinder and a pusher arm arrangement, so with this you can adjust the blade movement. So, similarly there are also possibilities of different types of connections.

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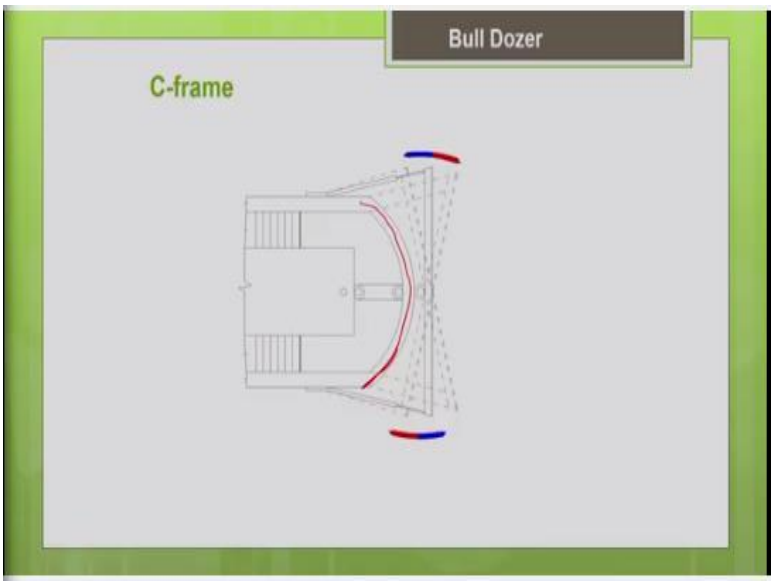

Like say for example, you can have a C frame connection like this, C frame connection between the tractor and the blade. So, with this particular kind of connection, certain types of movements of blade are possible. So, basically the connection between the tractor unit and the blade will decide what are the possible movements or the adjustments for the particular blade. So, we will discuss about the blade movements later.

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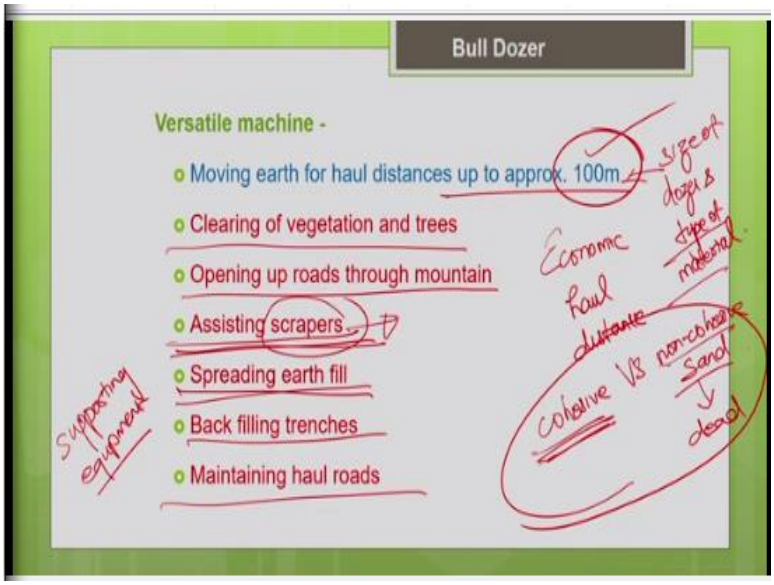

So, this bulldozer is basically a versatile machine. So, it can be used for different types of applications in a construction project site. So, before you select an earthmoving equipment for your particular activity or your particular job, you should know what is the haul distance actually

needed for your actual job, because every earthmoving equipment has it is own economic haul distance**.**

So, every equipment has it is own economic haul distance, this we have discussed earlier also. So, the economic haul distance of a bulldozer, the maximum distance is only 100 meters. So, beyond 100 meter it is not advisable to use this particular machine, you will not get you desired productivity and if you will use it will result in lot of wear and tear for the particular machine**.** So, this machine is designed only for a haul distance of up to 100 meters.

So, the actual distance will design depending upon your size of your machine, your size of your dozer, and the type of the material which you are going to handle, which you are going to push which the bulldozer is going to push. Say if you are going for a bigger tractor, bigger bulldozer, the economic haul distance maybe slightly higher than this. So, the actual distance depends upon the size of the dozer, greater the dozer the economic haul distance will increase.

Similarly, it also depends upon the material which the bulldozer is going to push, say some material are cohesive some material are non cohesive. Say generally the bulldozer can push a cohesive material more easily when compared to non-cohesive material like sand is non-cohesive material. Because a cohesive material can easily roll in front of the blade, so it is easy to push, but your sand it will remain like a dead material, it will not roll easily.

So, the pushing of the sand is little bit difficult with the bulldozer. So, in the case your haul distances get reduced. What is a haul distance possible? Depends upon your size of a bulldozer and it also depends upon the type of the material which you are going to push with the bulldozer. So, commonly you can say the maximum haul distance is up to 100 meters. So, apart from the earthmoving operation, you can use this machine for so many activities.

So, you might have seen bulldozer, used for cutting trees So, it can also be used for clearing the vegetation at the construction site. So, for opening up of roads through mountain, it is a very common supporting machine. So, very commonly it is used as a supporting equipment. Say for

example, for pushing or towing other machines this can be used. Say this scraper; scraper is another earthmoving machine which we are going to discuss in the upcoming lecture.

So, this scraper will also cut the earth, there will be a bowl in the scraper, there will be a blade with the help of the blade you can cut the earth and fill the bowl in the scraper, so this is called as the loading operation. During this particular loading operation, I can take the help of a bulldozer to push the scraper, so that the job of the scraper will be easier. So, that this is used as a supporting machine.

Similarly spreading so you can use the bulldozer for spreading the earth for preparation of your subgrade for your road or whatever for spreading the earth, for filling the trenches for backfilling the trenches, for maintaining the haul roads. So, different applications it is used, that is why we call it as a versatile machine.

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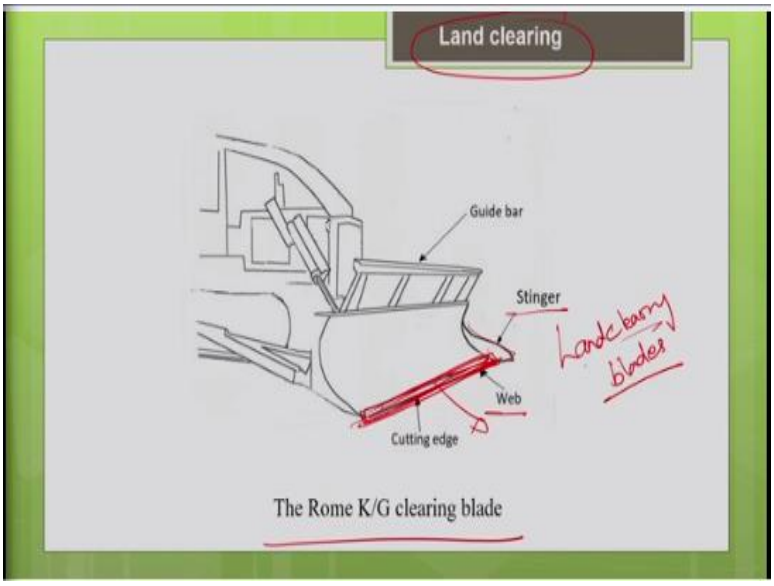

So, let us see some examples. Now you can see this bulldozer can be used for land clearing, so it is used for cutting the trees clearing your site. So, these are special bulldozers, for this purpose, we should not use a earthmoving blade, there are special land clearing blades. One such land clearing blade is Rome K bar G clearing blade, it is a very powerful blade, manufactured by Rome company.

So, this blade you can see it as a vertical knife called as stinger and the horizontal knife called as web. So, it has both the vertical knife and the horizontal knife, so with this, you can easily cut the trees. So, generally for cutting the trees, you need more tractive effort, more power is needed, so you have to use the very big bulldozer. So, you have to choose a very big tractor unit, so that you will be able to deliver more power.

And one more important thing you need to note is there is cutting edge at the bottom of every blade. So, generally when you use the blade frequently, the one which gets worn out very fast is the cutting edge. So, we do not replace blades very often, we replace the cutting edge only. The cutting edge is just bolted; it is just bolted at the bottom of the blade. So, once it gets worn out, you can just replace it with a new cutting edge. So, generally we do not replace blades frequently, but we replace only the cutting edge at the bottom of the blade.

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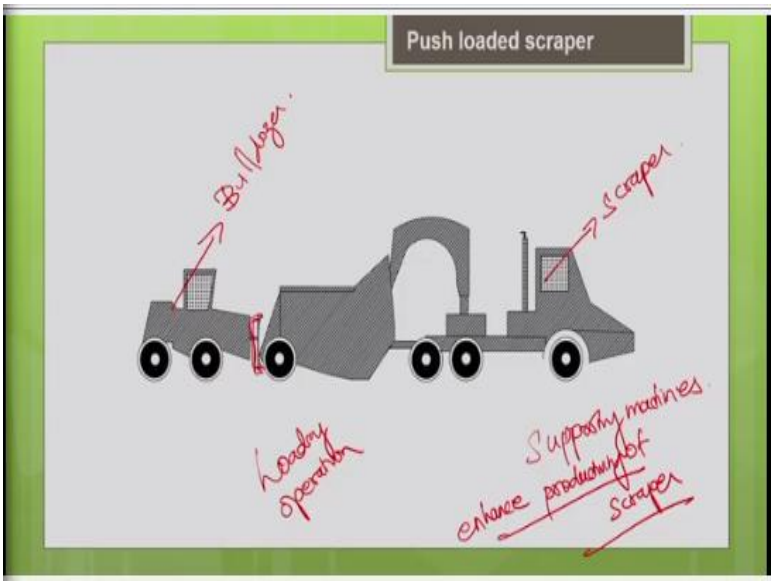

So, this is what I told you earlier, the bulldozer is used for assisting other machines, so it is supporting the other machines. So, this is your bulldozer, so this is a schematic sketch, so the leading one is your scraper. As I told you the scraper has to cut the earth and fill its bowl. So, during that loading operation, your bulldozer will push, you can see it has a special type of blade just for pushing it that blade is called as cushion blade.

I will explain you later when we discuss about the type of blade. So, this bulldozer will push the scraper during the loading operation of the scraper. So, by that process you can enhance the productivity of your scraper. So, this is one application of the bulldozer.

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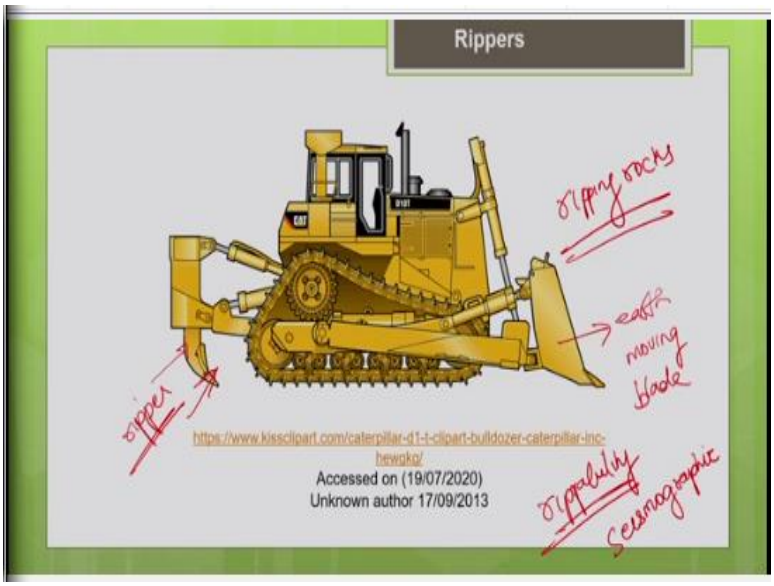

So, other application you can see it can be used as a ripper. So, for this tractor you can see a front end you have this blade earthmoving blade, this is the earthmoving blade, so at the rear end, you have this ripper. So, this is similar to plough what we use in farming. So, basically when we discuss about the earthmoving operations, the steps involved in the moving operations, I told you like the first step is we should loosen the earth before digging it.

So, when you loosen the earth before digging it, the digging becomes easier that will enhance the productivity of the digging job. So, that is my first say for example particularly for the hard terrain, if it is going to be a consolidated clay terrain. In that case first use the ripper, then loosens the earth with the help of the ripper. Once after you loosen it, then use the earthmoving blade and push the earth.

So, we can follow the sequence, so that you can enhance the productivity of the job. Similarly, even before using scraper, scraper is also earthmoving machine. Before using the scraper, I can use a bulldozer with a ripper attachment, loosen the earth first, then use a scraper for loading,

thereby you can enhance the productivity of the scraper. So, this ripper is basically to loosen this material, you can also use this for ripping the rocks, so this can also be used for ripping rocks.

So, you know that the commonly adopted method for excavating the rock is drilling and blasting method, so that is always a costlier method. So, if you are able to use ripper for ripping the rock, you can have a huge saving in the cost. So, first before that you have to check the rippability of rock for that there are some special methods like seismographic methods, we are not going to discuss that in this particular lecture.

There are some seismographic techniques, sound seismographic techniques based upon that you can check whether the rock rippable or not. Once you know that the rock is rippable, you can use this technique for ripping it that will result in huge saving in the cost. Similarly, you can use it also for ripping an old pavement. So, it can have different applications accordingly.

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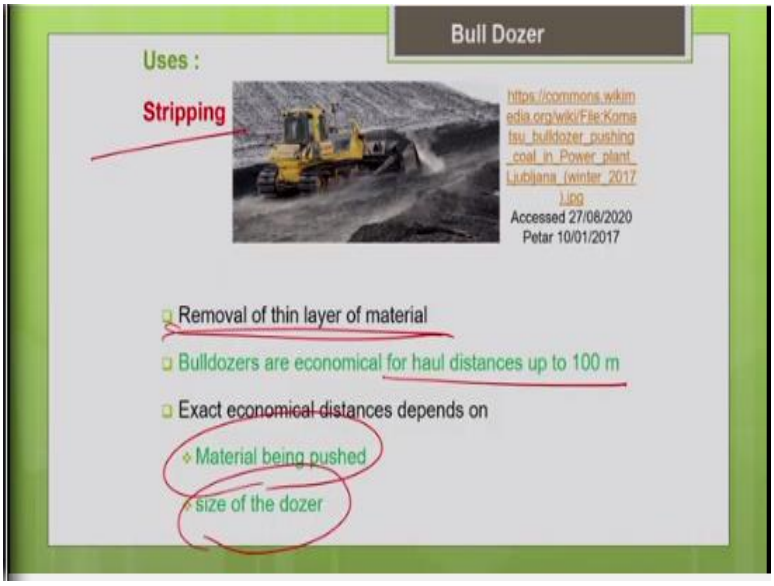

Then stripping, stripping is a very common operation in the construction project site. So, you know that stripping is nothing but removal of the top layer of the soil. So, if the top layer of the soil is weaker one with lot of vegetation, so you have to remove the top layer of the soil. So, depending upon a depth to which the vegetation is available in your soil accordingly you have to remove the top layer, so that is what is stripping.

So, bulldozer you can see very commonly used for stripping the top layer. So, as I told you, the bulldozer is economical only for the haul distance of 100 meters. The actual distance depends upon your size of a dozer and also the material which you are pushing. So, if you are pushing a cohesive material, it is easier for a bulldozer to push, so you can have a little bit greater the haul distance.

But if you are going to push the sand which is non-cohesive, in that case your haul distance is still going to be reduced. It depends upon the type of materials which you are going to encounter in your project site.

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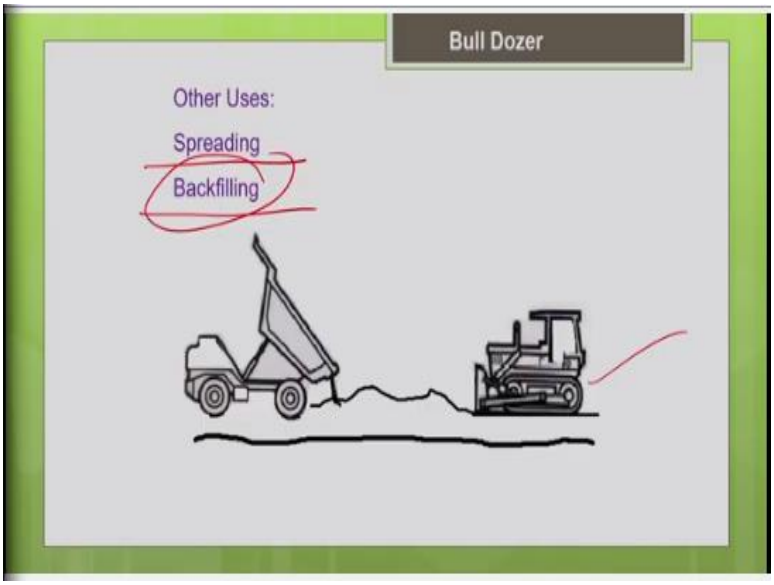

So, what are the other uses? The bulldozer can be used for spreading, backfilling. So, here you can see the example of spreading your truck. Very commonly you can see this in a road construction, the hauling equipment that is a truck, so it will dump the material and your bulldozer is used for uniformly spreading it and it will compact it to the regular thickness, so it helps in spreading the material.

Then backfilling, so when you excavate a trench, say for example, for pipe laying your excavating the trench with the help of the bulldozer, push the material into the trench there is you can backfill the trench. So, there are different applications in a project site.

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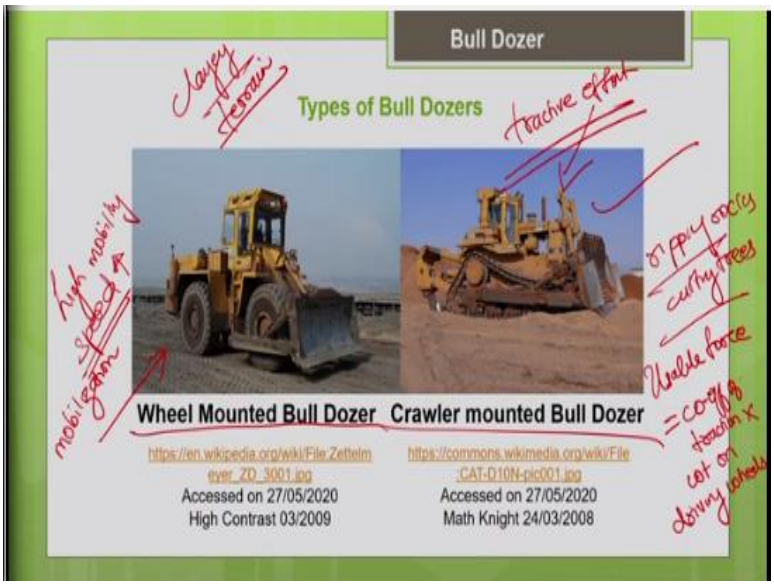

So, now let us look into what are all the different types of bulldozers based upon the mounting. So, there are obviously you know that there are 2 possible mounting one is your wheel mounted bulldozer other one is your crawler. Crawler is nothing but track; you can see the track mounted. So, crawler is nothing but your track mounted, you can see the chain type of track.

So, now let us compare what are the merits and demerits of these both the cases. If you go for wheel mounted bulldozer obviously the main advantage will be it is mobility. So, this one will have very high mobility, this has very high mobility. I mean the speed will be very high with the wheel mounted machines. But with the crawler mounted machine, so there is a restriction on the speed, you will not be able to realize the speed the similar speed what we realized with the tire mounted machines.

Another important thing is you can easily mobilize this machine wheel mounted, mobilization is easier, mobilization to the project site is easier. You can even take it on the highways without damaging the highways to the project site. But in the case of crawler mounted, you need another equipment to mobilize this machine to the project site. So, we cannot use it on the highways, it will damage the highways, so this mobilization is a little bit difficult.

But when you look into the tractive effort**.** So, which one will deliver more power, you know that obviously the crawler mounted will deliver more power, because this track motor has broader

contact area, so the traction develop is more. So, this develops more tractive effort that is why for most of the tough conditions, say for example, ripping the rocks, cutting trees all these are tough jobs.

For that we generally go for only crawler mounted, because that will be able to deliver more tractive effort. We know that already how to estimate the usable force. The usable force is nothing but your coefficient of traction multiplied by weight of driving wheels. Compare 2 cases, 2 different types of bulldozers you have with 2 different mountings, say one is wheel mounted other one is crawler mounted.

Say assumes that both are of same weight, the gross weight of both the machines are same. So, you are going to operate this machine on a clayey terrain. So, obviously which one will have better coefficient of traction? When compared to the tire mounted on a clayey terrain definitely your crawler mounted will have better coefficient of traction. So, there will be proper grip between the track and the haul route.

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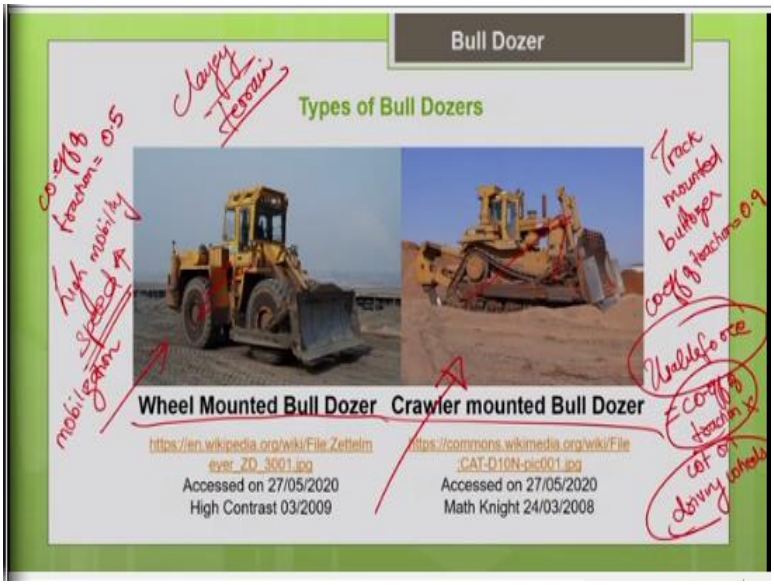

So, what happens if you go for say when you consider your track mounted or crawler mounted bulldozer. Here the coefficient of traction says it may be approximately 0.9 on a clayey terrain. So, here for the wheel mounted the coefficient of traction maybe only say 0.5. So, for the same weight of the machine since the coefficient of traction is very high obviously you can see with the usable

force which is generated by this crawler mounted is going to be very much high when compared to the wheel mounted bulldozer.

So, that is why I told you for very tough job conditions you have to go only for the crawler mounted. And similarly, for poor underfoot conditions as I told you for clayey terrain, muddy terrain or rocky terrain, because in the rocky terrain you cannot use your tyres that will damage your tyres. So, you have to go for this crawler mounted. Similarly, if you want to climb a very steep terrain, it will be more easier to use a crawler mounted machine when compared to wheel mounted machine on steeper slopes. So, all these things you should note it when you are select a machine.

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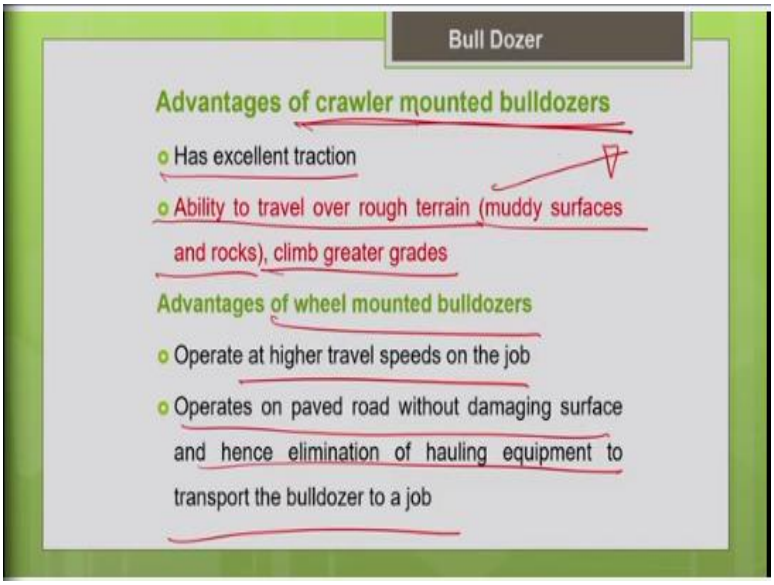

So, let us now summarize what are all advantages of the crawler mounted dozers and wheel mounted dozers. It has excellent traction, crawler mounted has excellent tractions as you know. So, it has the ability to move over rough terrain, your muddy surfaces or rocks or steeper grades everything can be handled by the crawler mounted machines**.** But a wheel mounted machines, the main advantage is it can operate at a high speed and it is mobilization is very easier.

It can be operated on paved road without damaging the surface. Hence there is an elimination of hauling equipment to transport the bulldozer to the job site. So, it can be used on the paved highways and it can be easily mobilized to the project site. But here you need a separate hauling

equipment to carry this crawler mounted bulldozer to the project site, because this crawler track may damage a highway, it cannot be taken on the public highways. So, now, let us look into the blade adjustments.

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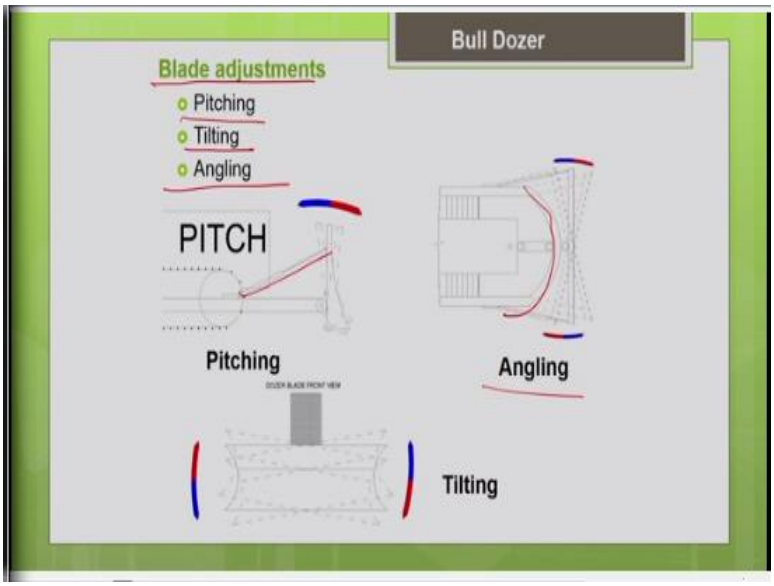

So, what are all the possible blade movements with the bulldozer blade? As I mentioned earlier, the movements which are possible depends upon the connection between the tractor and the bulldozer blade. In some bulldozers you can see this kind of C frame connection between the tractor and the blade. So, those tractors will facilitate certain kind of movements like angling.

Similarly, some of the bulldozers, they have this kind of tilt cylinders and pusher arm arrangement. So, in those bulldozers, some other movements are possible. So, we will discuss what are all the possible movements in detail in the upcoming slides? So, basically pitching, tilting and angling 3 types of the blade movements which are commonly seen in the bulldozer blades.

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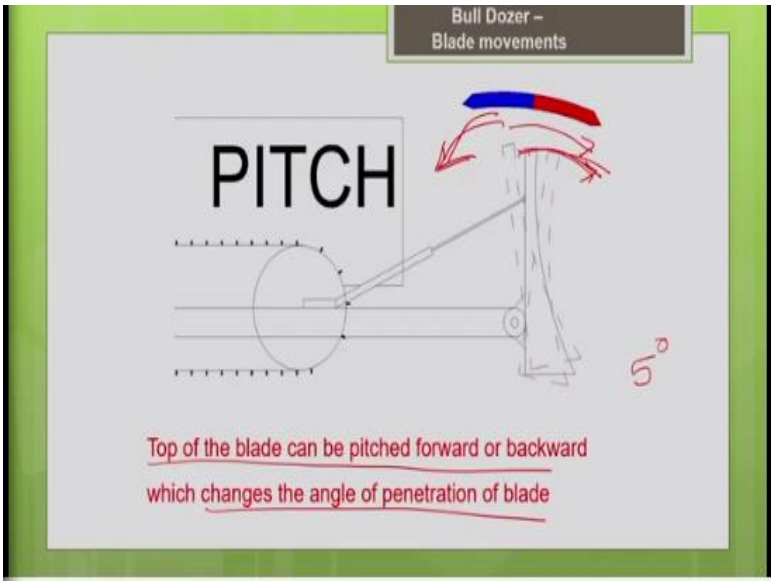

So, what is this pitching? Pitching means, the top of the blade is pitched forward or backward. That means you are moving the top end of the blade either forward or backward. So, this top end of the blade is moved forward or backward. So, why should we move it forward or backward? So, accordingly you can change your angle of cutting, accordingly you can change the depth of penetration of your blade.

Say for example, if you move the blade the top end of the blade forward, it means what happens. So, when you move the top end of the blade forward, it will decrease the penetration of the blade into the soil. So, similarly if we move the top end of the blade backward, it will increase the penetration of the blade into the soil. So, by pitching it forward or backward, either I can increase or decrease the depth of penetration of the blade into the soil.

So, generally when we do the earthmoving operation, you can see that the bulldozer will be cutting the earth for some distance. Once the blade is full after that it will not cut because the blade is already full then you have to just push the loaded earth to the required dumping place that is it. So, when you just want to push the material, so you can reduce the depth of penetration of the blade into the soil.

So, in that case you can pitch the blade forward**,** so that you can reduce the penetration of the blade into the soil, so that is the purpose of pitching. By pitching it forward or backward, so you can

change the angle of attack or the depth of penetration of the blade into the soil. So, how much is the pitch possible for the particular blade is defined by the manufacturer. So, in the specifications given by the manufacturer, you can see say for example, if it may be mentioned 5 degree, so that means the maximum pitch possible with this grade is 5 degree.

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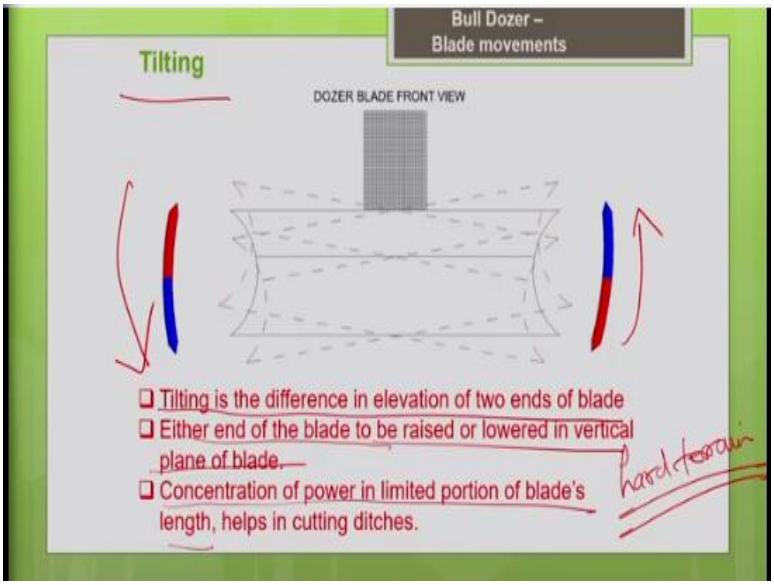

Now coming to tilting, tilting is the next type of movement. So, basically this is a movement in the vertical plane. So, you can raise one end of the blade and lower the other end. So, tilting is a difference in the elevation of the 2 ends of the blades; it is a movement in the vertical plane, why should we tilt the blade?

So, basically when we encounter a tough terrain like very hard soil or consolidated clay, in a very tough terrain, we need more concentration of power. So, if you raise one end of the blade only the remaining portion is in contact with the ground. So, only some portion of the blade is now in contact with the ground. So, the concentration of power will be more in the limited portion of the blade, so it will be very easy to cut the hard terrain.

So, particularly to cut the hard terrain, you have to tilt the blade, so that I can increase the concentration of the power in the available portion of the blade. So, basically either end of the blade is raised or lowered in the vertical plane. The concentration of the power in the limited

portion of the blade's length, it helps him cutting the ditches. So, it helps in the cutting the soil in a very hard terrain.

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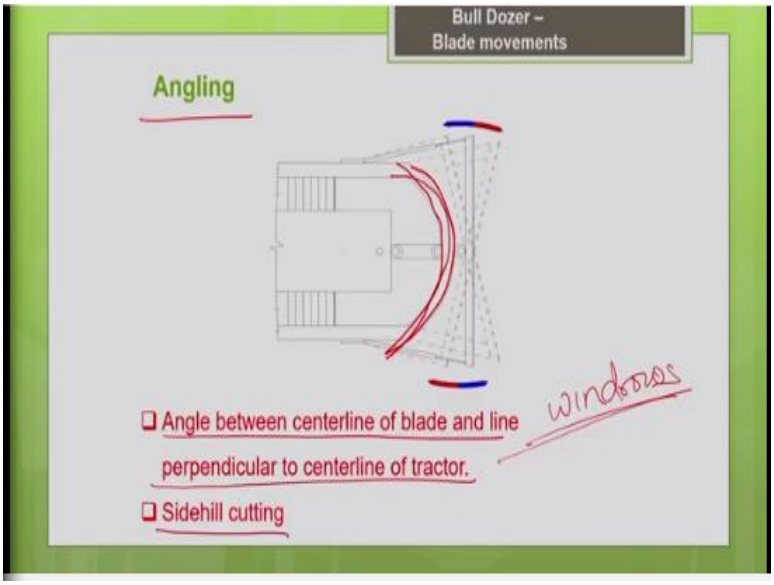

So, next we shall see what is this angling? This angling is possible only if there is a C frame connection between the tractor and the blade. So, basically you can see most of the tractors, the blades are fixed perpendicular to the direction of motion. You cannot angle the blade either to left or to the right in conventional bulldozers what you see. But in some dozers, where you have this kind of C frame connection between the tractor and the blade there is possibility to angle the blade either to the left or to the right, to maximum say 25 degree angle the blade.

Basically, the angle refers to the angle between the centerline of the blade and the line perpendicular to the centerline of the tractor. So, if you are going to work on one side of a road, say for example you are doing some pipe laying, you need to backfill the trench. So, you are working on one side of the road, in that case you can easily angle the blade and backfill the trench.

Similarly, for side hill cutting, and when you are working in narrow constraints, narrow space constraints**.** In that particular places angling will be very easier, so you can just strip the soil and deposit the soil in windrows, windrows of soil. So, using this angle blade it is very easier to do. But basically, angle blade is not considered a highly productive blade with respect to earthmoving

operation, it is not very good in cutting and pushing the earth. I will be discussing that in detail when we discuss about the types of blades.

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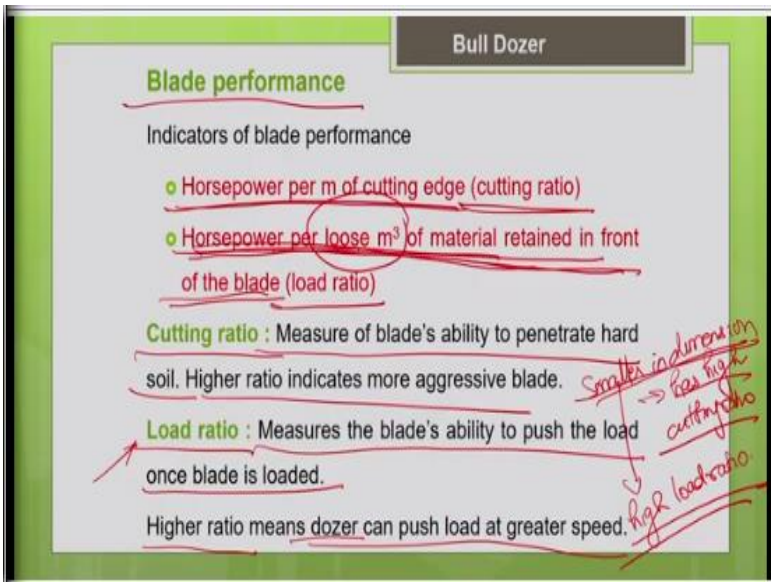

So, we have discussed about the 3 types of movements, one is pitching the other one is tilting and angling. There are different types of blades which we are going to discuss in upcoming slides. You need to note that like for every type of blade, only 2 movements are possible. Either you can go for angling and tilting or you can go for the pitching and tilting. So, these are the 2 options for every blade only to movements are possible.

Blade performance now let us see how to assess the performance of the blade. So, there are some indicators of blade performance. There are some parameters which quantify the performance of the blade. Say, one is cutting ratio, other one is the load ratio, the cutting ratio indicates what is the cutting ability of the blade. So, what is the cutting ability of the blade? I can know it from the cutting ratio.

So, it is defined as horsepower per meter of the cutting edge of the blade. So, first of all we need to know what is cutting edge of the blade. So, generally when we look into the bulldozers I have shown this picture earlier to you.

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