Surface Mining Technology
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Lecture 21
Excavation By Ripper -1

Let me welcome you to the 21st lecture of Surface Mining Technology. From this lecture, we will start Excavation by Ripper. This is, the ripper is basically special equipment that is utilized for excavating the soft material which is not diggable by the excavators but needs to be first loosened, and that ripper is the machine which is carried out for losing the, loosening the rock mass. So, in another way you can say the ripper is another type of, you can say another type of plough.

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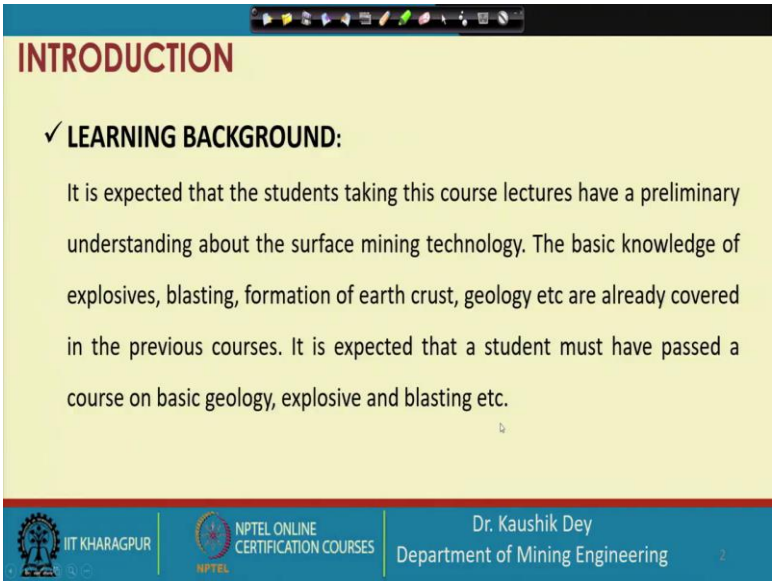

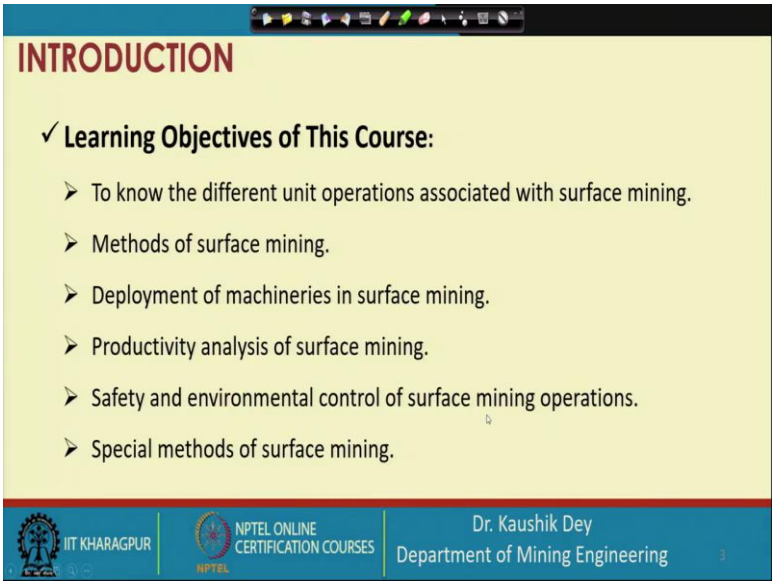

So, as we generally do every time we discuss our learning background required for the surface mining technology participants. This is the learning objective of the Surface Mining technology course.

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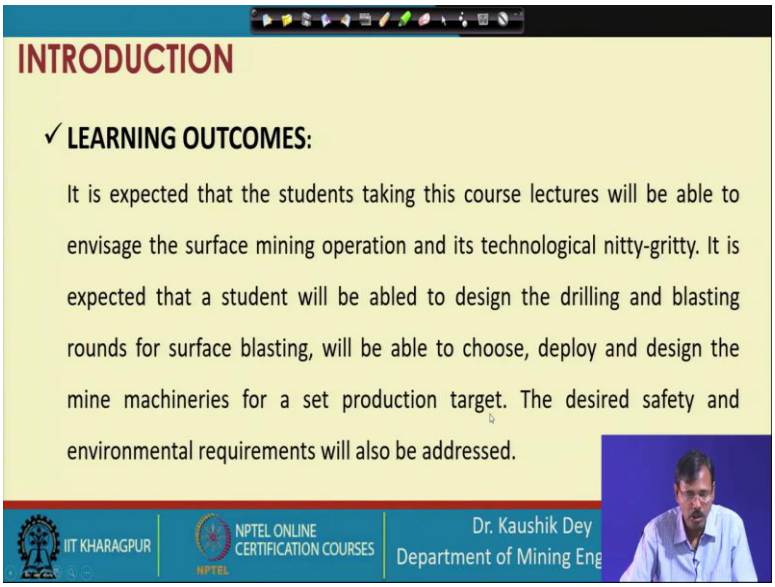

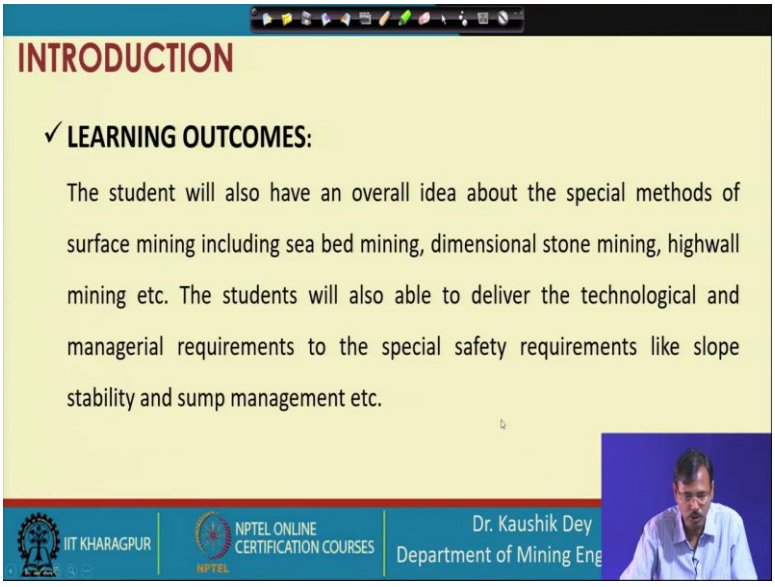

And these is the expected learning outcomes of this from the participants of this surface mining technology course.

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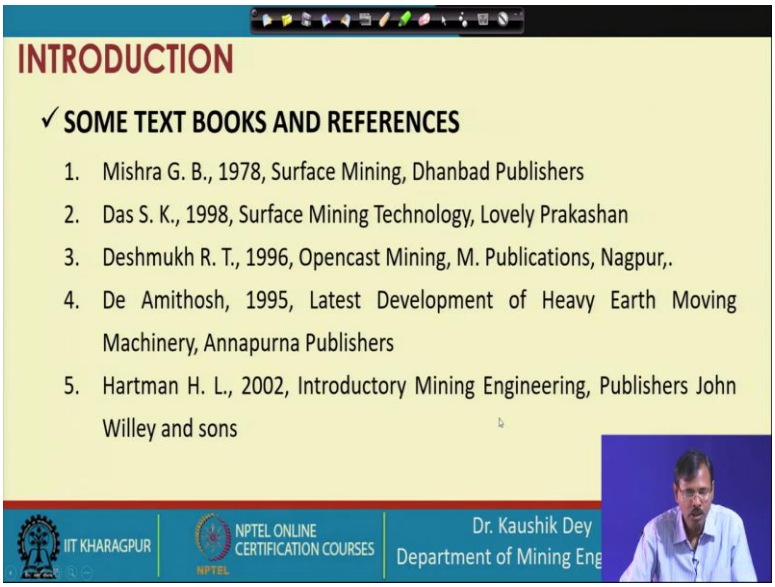

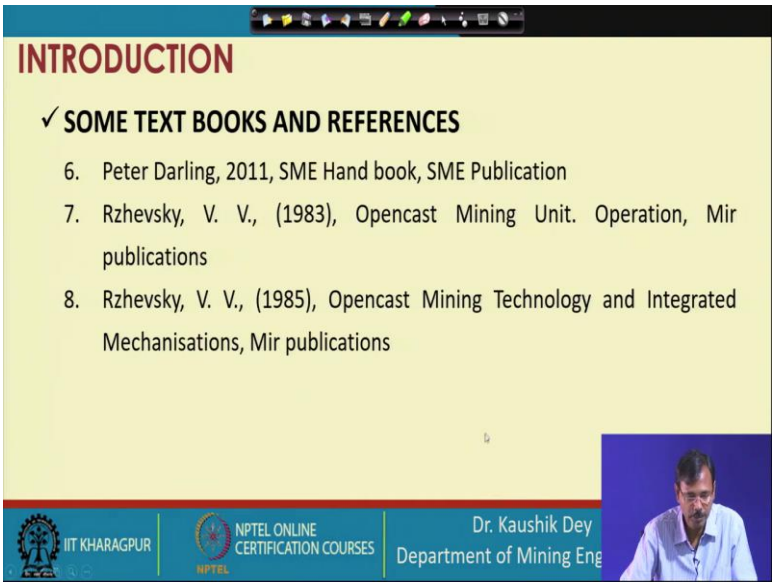

And these are some of the textbooks and reference materials.

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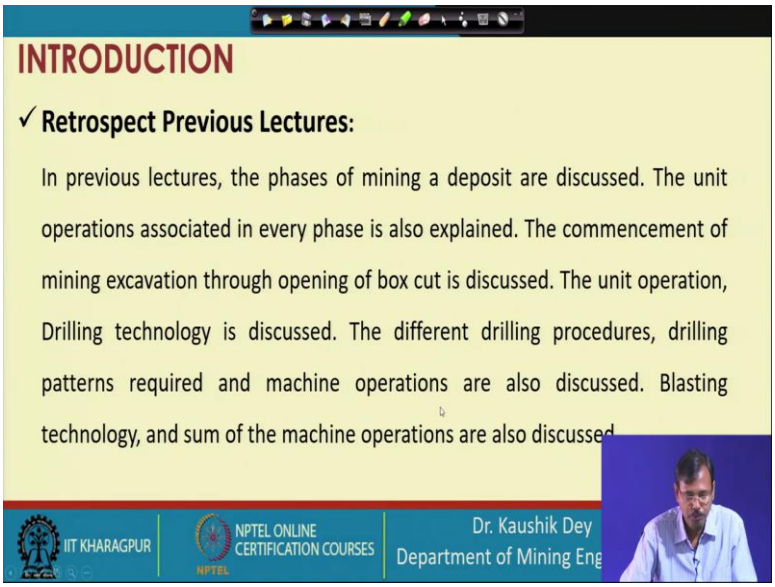

Before this ripper discussion, we have already covered the phases of surface mining, and the unit processing operations associated with the different phases of surface mining—the commencement of surface mining using opening through box cut.

We have also discussed the drilling technology required for surface blasting, we have discussed the different drilling procedures, we have also carried out tutorials related to drill performance associated with the costing of drilling, we have discussed the surface blasting technology especially the bench blasting technology, we have discussed, and some of the machine operations are also discussed previously.

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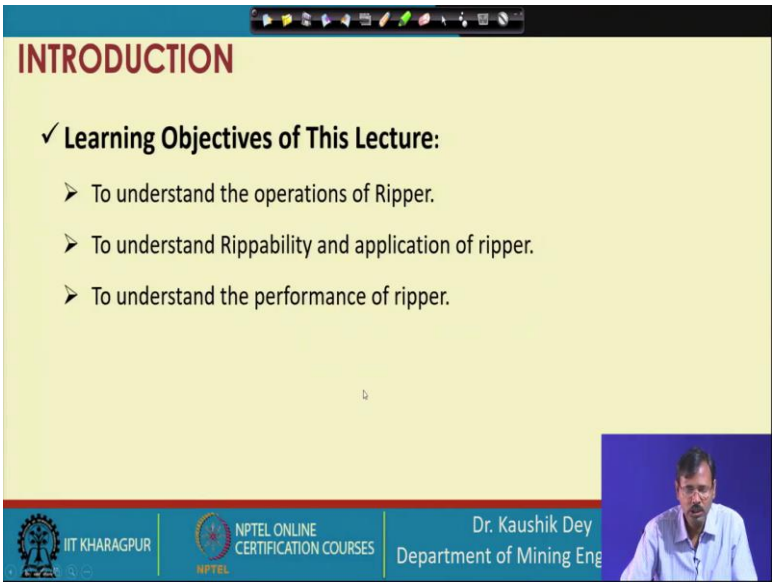

So, in this lecture, our objective is to understand the operation of the ripper to understand the rippability and applications and understand the performance of the ripper. So, we will continuously have these lectures in this lecture series. We will take this lecture 21 and 22 that way. So, in this first lecture, our main objective is to understand the ripper, which we are telling that it is a special type of rock loosening machine.

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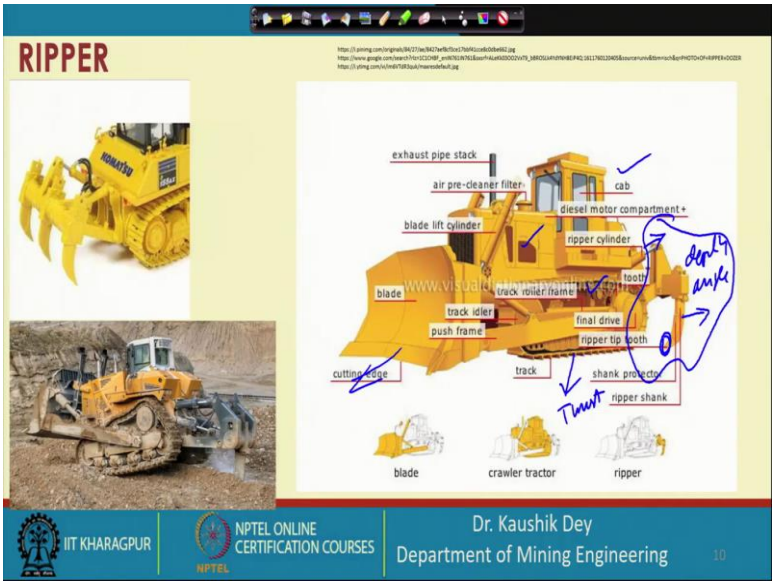

So, this is the photograph of the ripper. You can see the in generally use the term ripper dozer the reason is, the ripper, in general, is fitted in the back side of the dozer blade, when the machine is there in front side, it has a dozer blade, in the backside, it has a ripper. So, this one here is termed as a ripper shank, and you can see there may be multiple ripper shanks available; here, you can see a single ripper shank is available. Their connections and operations may be different from this to this.

And if you look into the different assemblies of a ripper, you can see this is the operator's cab. This is basically the engine; this is the crawler track; this crawler track provides the thrust. This is the main source of the thrust to the ripper, or tractive force is basically provided by this crawler. This is the blade part. Let us not to be discussed whether this is carried out after, say loosening to boost the material using this one. This is the ripper shank, this is the two teeth of the ripper, and this ripper is, in general cell-penetrating type.

Now, these are the ripper control cylinders that control the depth, which controls the angle of ripping. So, these are the basic control system of a ripper. Nowadays, rippers are also available where the hammering actions are generated in the ripper. So, that type of ripper is also currently available.

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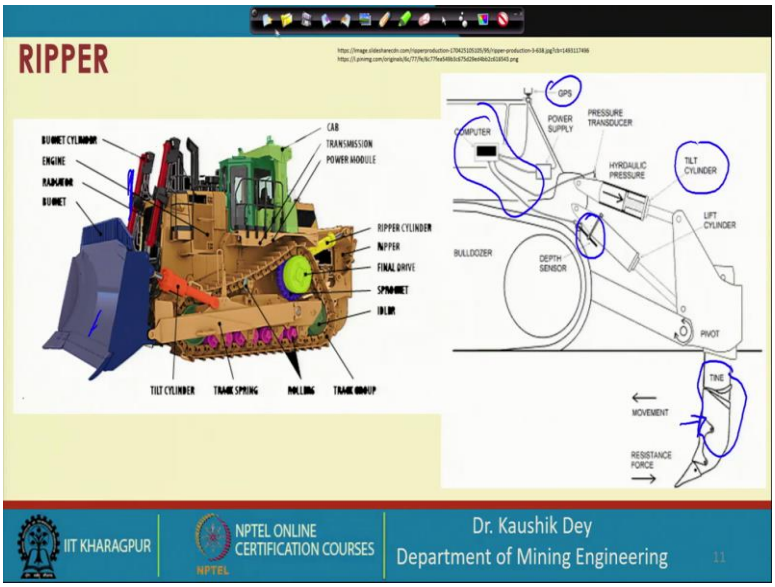

In this case, you can see that the ripper shank is termed as tine here; you can also tell the ripper as a plough. So, these are the different control systems, GPS may be there, depth sensors may be there, tilt cylinder is there, and tilt sensor is also there. So, all these are the control system nowadays. Computerized control are possible with the modern equipment. And similarly, you can have a bucket lifting arrangement for this, of say blade lifting performance all these are available with the ripper also.

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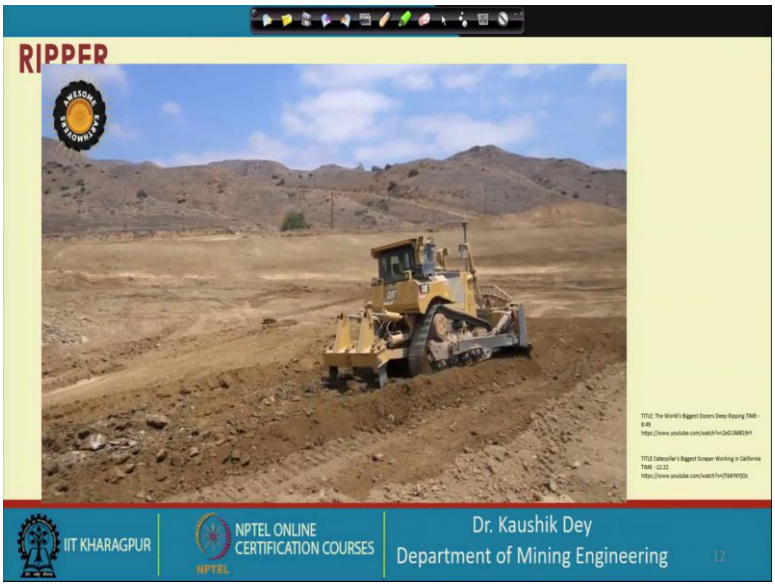

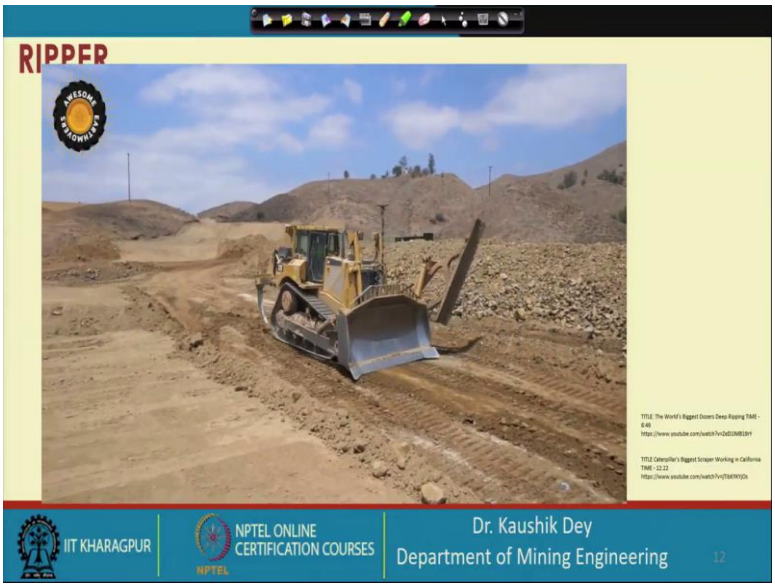

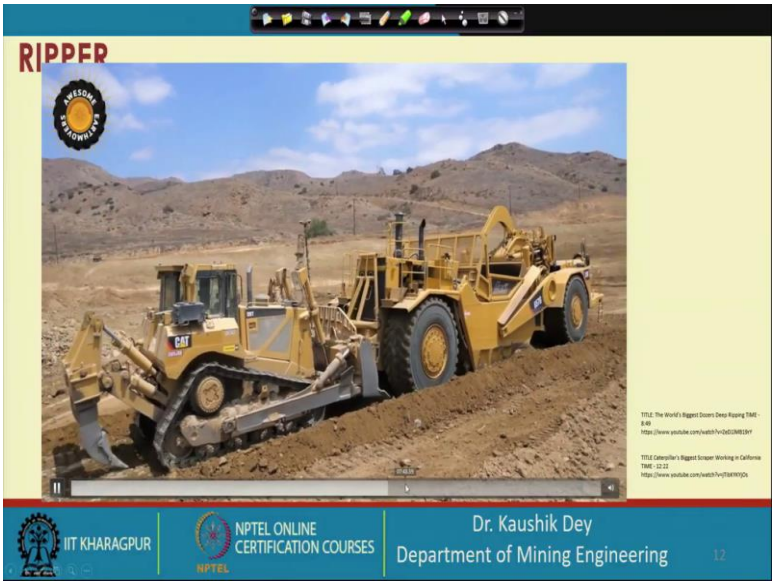

But to understand the operation of the ripper, let us see the video which is carried out taken from the YouTube; the links are shown here. This machine is called a scrapper, which takes after ripping whatever loose material is available in the ground, which this is taking the loose material in its bucket by from a using a scraper blade you can see the scraper blade is provided here, the mouth of the crapper blade is kept open the loose material is allowed to insert into the inside the chamber. The loose material is taken at this position.

So, now you can see that the dozer blade is utilized to give the force, tractive force from the backside from the tendon. It is basically providing the force to the scrapper; the scrapper does not have a very good force because it is a wheel mounted. So, the grip between the wheel and the rock may not be that much tight, which is available with the Dozer. So, it is basically, so you can see how the scraper is coming and the scraper is being pushed by the Dozer. So that it can take this much material through its proper blade.

Now, we can see how the scrapper blood is basically, this part is in general carried out; this part, in general, carried out after the ripping is conducted. Then only the scrapper is allowed to take the loose material. You can see that the scrapper is full, and the scrapper is allowed to move.

So, now, you can see the Dozer is trying to level the ground using its blade. So, Dozer is now leveling the ground using its blade. Now again, it is allowing the scrapper to take the remaining material. So, it allows the scrapper to take the remaining material and give a better feeling of the scrapper bucket. It is basically pushing the scrapper from the back.

We gradually will see how the ripper is also cutting. So, this ripper scraper combination is considered a good combination because the time cycle can be maintained easily. So this is one example of this one. That is why we are watching this complete video; this video is also available on the YouTube. So, the scrapper bucket is now full. So, the Dozer is allowing the scraper to move and now the Dozer will return to go for a new fresh ripper cart.

So, this Dozer has two tines you can see, now, this two tine is allowed to penetrate, and now it is ripping the complete ground, and as it is cutting these two sides, the middle part will also now be removed, possible to remove. We will, that ripper will take another middle slice in the next time. So, the ripper is coming out again, returning back, and now it is started to take you can see now it is slightly moved and take the middle part which was not earlier ripped is now being ripped.

Now this complete material is now loosen such that if the new scrapper will come that will. So, the scrapper which is coming that will be able to take this one. So, now the ripper is returning back. Now ripper is returning back and now it is allowing the scrapper, now it is allowing the scrapper to come to take the material. So, that, that new scraper which is there now it is coming, empty scraper. Now, this empty scraper is coming to take the ripped material from the ground.

And now the Dozer will start to push this new, this scrapper from the back. See it is now, so now it is understood how the ripper is ripping, this is two tine ripper there may be single tine there may be multiple tine rippers are also available. So, depending on the type of application the right ripper has to be chosen and that can be utilized in the mine.

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RIPPER

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So, this is another compilation of different applications of the ripper. This is the heavy ripper you can see this completely very deep cut is made in this mine.

And this is possible in this mine with a deep cut using this one. This is another in the soil the ripping is carried out, this is also in the soil. This is very hard ripping condition you can see these are the different ripping applications in hardened, sometimes in hard, sometimes in soil. So different ripping applications you can see in this video.

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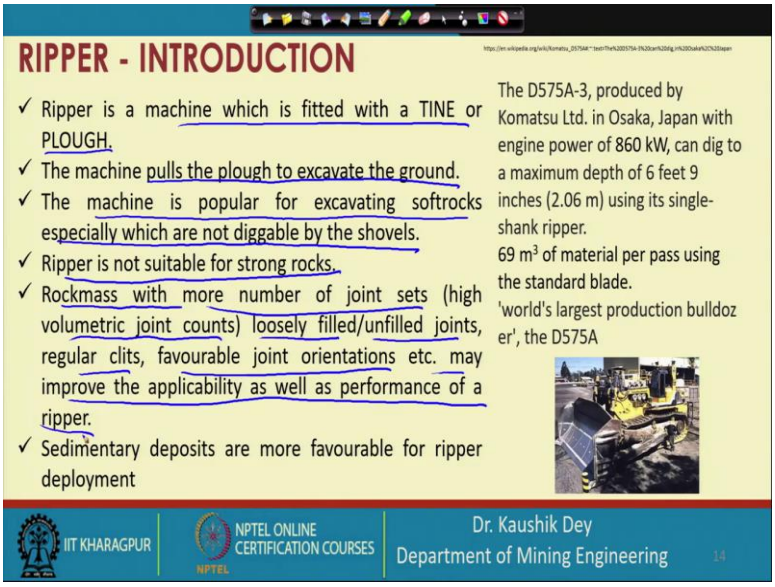

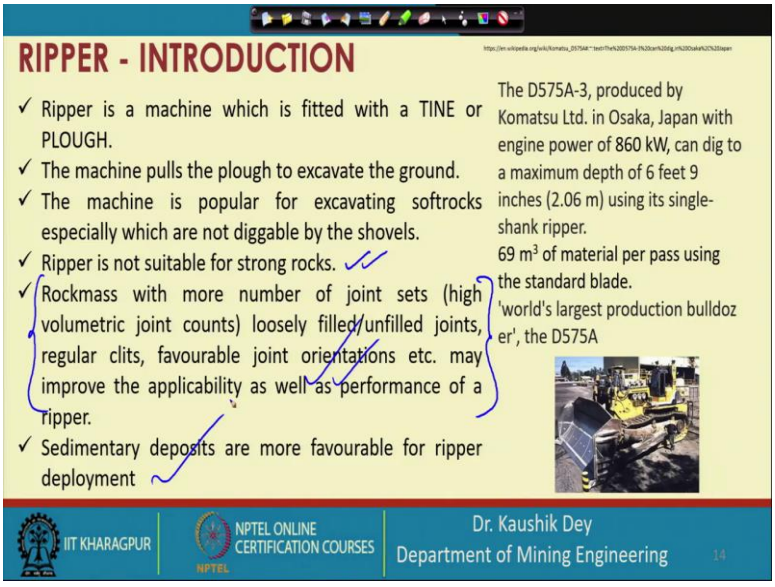

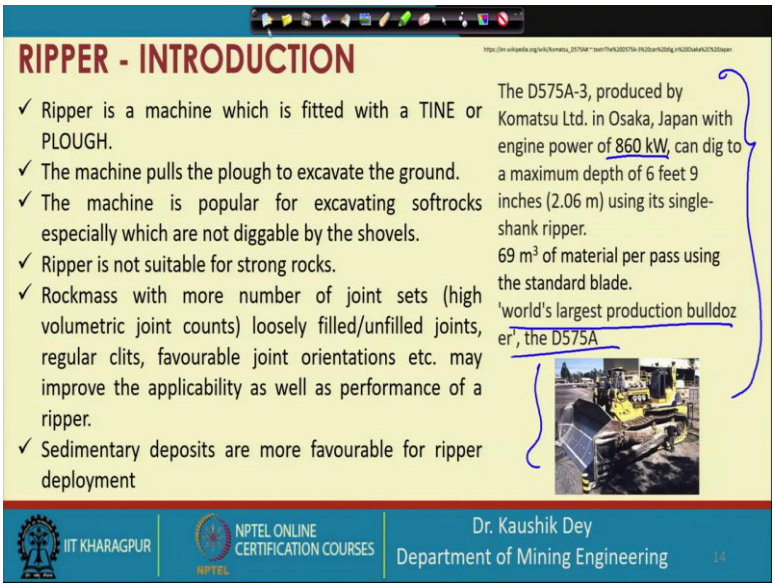

So now you can see ripper is a machine fitted with a tine or plough. The machine pulls the plough to excavate the ground. The machine is popular for excavating soft rocks, especially those not diggable by the shovel. Ripper is not suitable for the strong rock. So we will see the applicability of the ripper in our next class not in this class. Rock mass with more number of joint sets, that is having high volumetric joint counts, loosely filled unfilled joints, regular clits, favorable joint orientation etc., may improve the applicability and performance of a ripper.

So, that means all these discontinuities, these are basically the discontinuities. So, if a strong rock, rock may be strong, but if the rock has discontinuities sets, the overall rock mass strength will decrease. So in that case, the ripper may be applicable in those cases, sedimentary deposits are in general soft and maybe favourable for ripper deployment and this is the one of the very, very powerful largest production bulldozer is available as shown in this figure, which is 860 kilowatt motor power.

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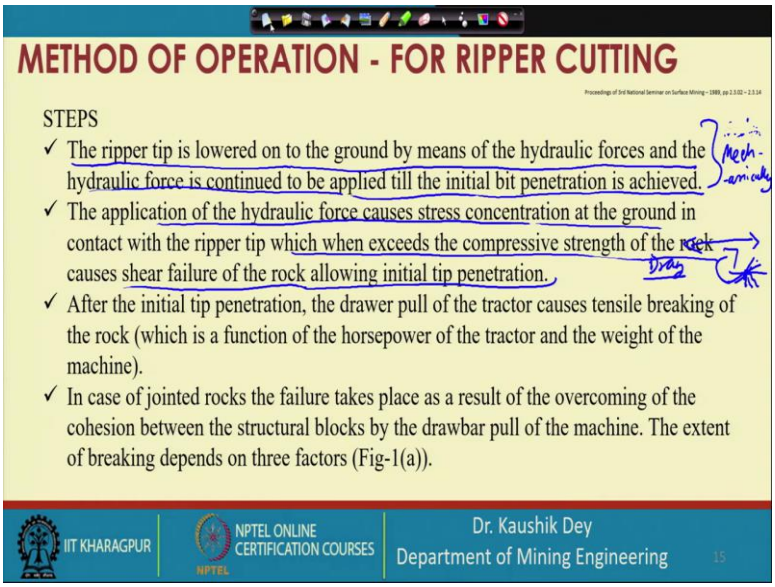

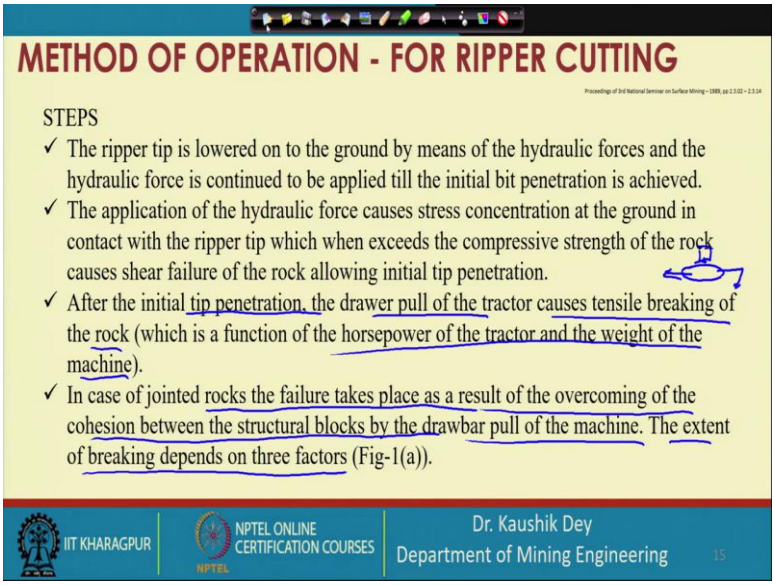

Now, if you see the steps taken by the ripper for cutting, the first job is that the ripper tip is lowered onto the ground through a hydraulic force, and the hydraulic forces continue to be applied until the initial bit penetration is achieved. If hydraulic force is not there, then you can use any mechanical force either hydraulically or mechanically, hydraulically or mechanically.

The application of the hydraulic forces causes stress concentration at the ground. Which exceeds the compressive strength of the rock, shear failure occurs the shear failure occurs to the rock allowing the initial tip penetration, so when the tip is acting at this position, the cracks are generated here, and from these cracks, the tip penetrates through this cracks then the sheer ring of this remaining rock portion occurs.

And for this the, for this the drag force, drag force is provided by the crawler to the tip. After the initial tip penetration, drawer pull the tractor causes tensile breaking of the rock and the weight of the machine is in this case very, very important because if the weight of the machine is more, then the crawler on which this weight is acting and if the drawer pull is given here, then the drag force acting on the tine is working fine.

In the case of jointed rocks failure occurs as a result of overcoming the cohesion between the structural blocks, and by the drawbar pull up the machine, the extent of the breaking depends on the three factors as shown in the figures here.

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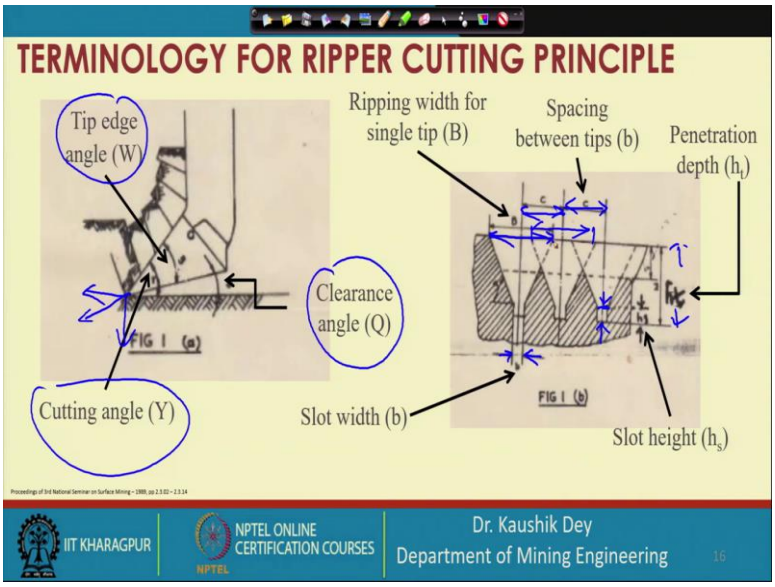

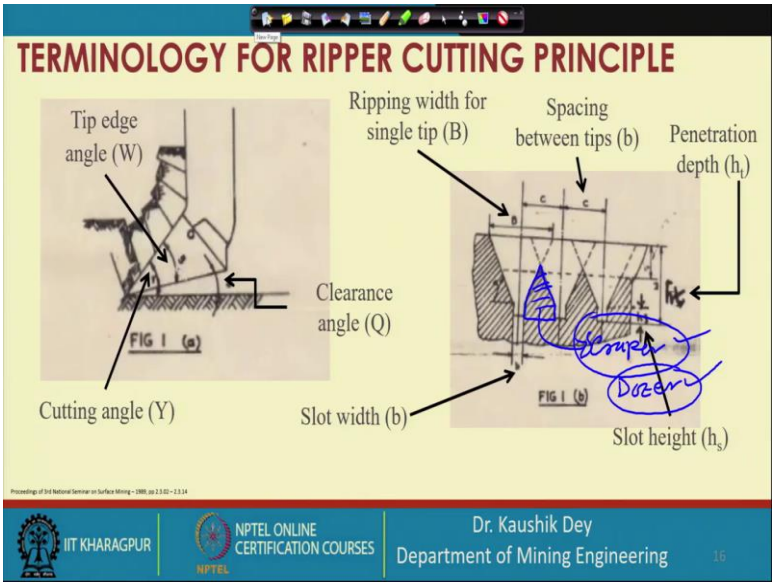

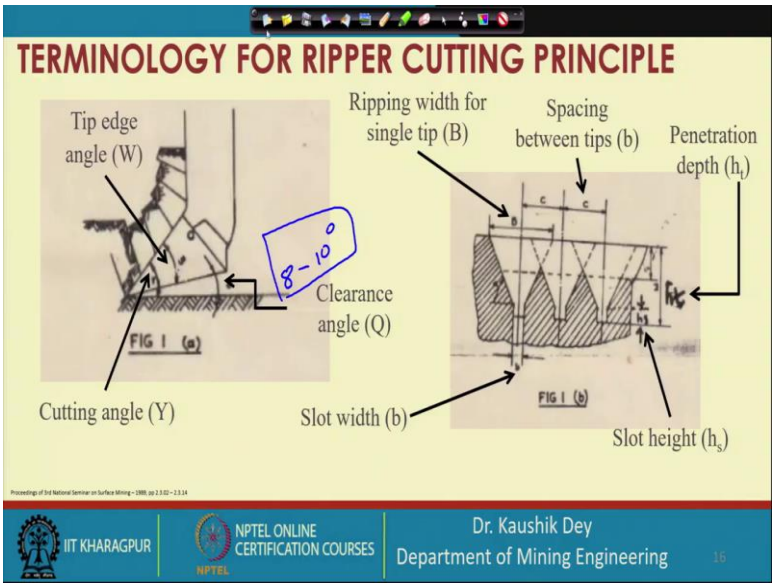

So, you can see in this figure that the factors are the factors clearance angle, cutting angle, and tip edge angle, these are basically allowing this is the cutting force to act on this. So this is the normal component force, and this is the drag force acting at this position. And this is the if you have three tine. This is the consideration of the tine. This is the tip, tip position. This is the tip width. This is the spacing between two, spacing between two tips or two tines you can say; this is the penetration depth. This is the slot height. That is the tip how much that is penetrating, that is this one that additional one.

And this is the, from each tip, the surface is an excavation you are achieving in general. So, there is this overlapping of surfaces excavation from two consecutive. So, this is the overlapping of two consecutive tips. So, that smooth excavation is possible. This portion which is observed as unbraked and not broken, this is taken out when the scrapper is, when the scrapper is moving, scrapper is moving or if the Dozer is working, either the scrapper or the Dozer.

So, this much of small portion of rock ridge that the Dozer or the scrapper can take out during the excavation. So, this is the general understanding this part is very, very important. In general, 8 to 10-degree clearance angle are required for, in general, that is maintained to have the best results. So these are discussed in the following slides.

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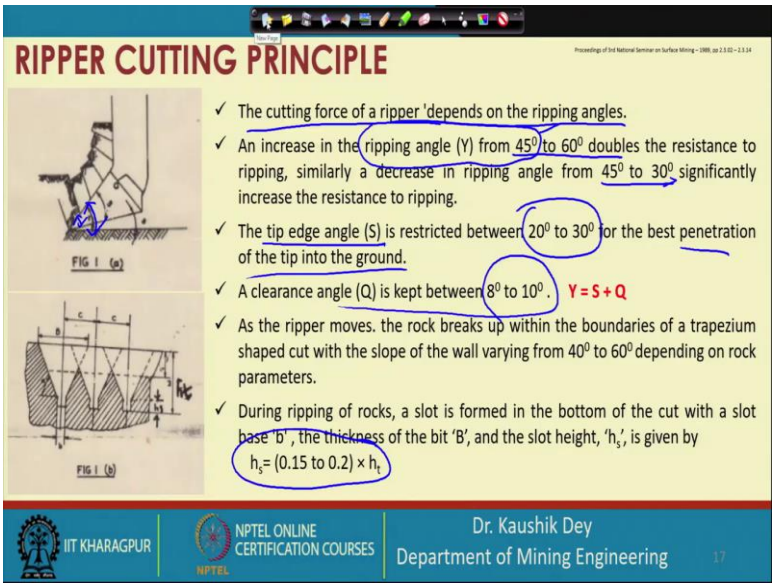

So, can see the cutting force of a ripper depends on the ripping angles and increasing the ripping angle 45 degree to 60 degree double the resistance of the ripping. So, generally ripping angle is kept in and around 45 degrees, so ripping angle is kept, so this ripping angle is kept in and around 45 degree and decrease of that is also increasing the resistance. So, that is why it is kept in general 45 degree.

The tip edge angle is S, so this tip edge angle S is restricted between 20 to 30 degrees for the best penetration of the tip. The clearance angle is kept between 8 to 10 degrees for the best performance. And this is the in general, we keep the slot height and penetration depth relationship when slot height is kept around 10 to 15 to 20 percent of the penetration depth so that the proper excavation can be the best excavation that can be obtained.

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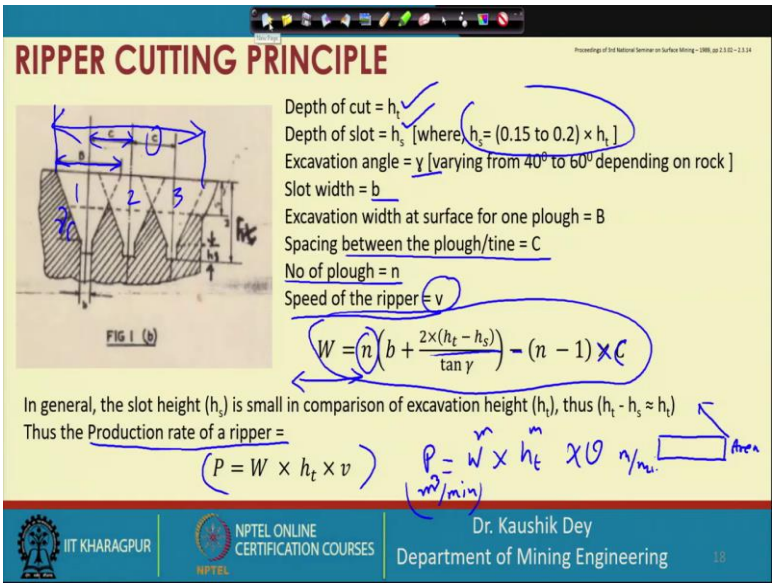

Now the calculation can be made based on this the depth of cut if ht and depth of slot is hs then the considering this relationships excavation angle gamma slot width beta, this is the gamma excavation angle and excavation width at that surface from one plough is b. Spacing between two plough or tines is C. Number of plough n, so in this case, you can see 1, 2, 3 so there is our three plough and speed of the ripper v, then the W that is the width, that is the width of penetration.

So, that means for 3, if we are considering 3. So, this is the width of penetration. So, W is equal to n into b plus 2 into ht minus hs by tan gamma minus n minus 1 into C. So, this is the spacing then this is the width of excavation you can calculate, and the production rate of a ripper then can be calculated as P is equal to the width of excavation into ht is the depth of excavation and velocity.

So, width and depth is basically creating the area and speed is basically dictating the performance of the machine, so this is meter per minute. So, this is the P will become the meter cube per minute will be the, so this is meter, this is meter. So this is the performance calculated for a ripper. Thank you.