Surface Mining Technology
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Lecture 33
Excavation with Surface Miner - III

Let me welcome to the 33rd lecture of Surface Mining Technology, this is the third lecture on Excavation with Surface Miner and we will continue with operation of surface miner in this lecture also.

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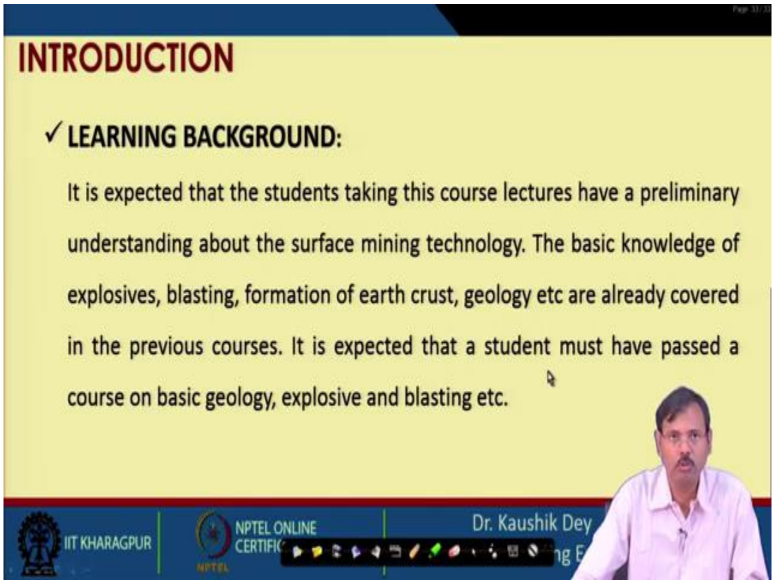

And as we do before the starting of the lecture, let us have a glimpse of the learning background required for surface mining technology.

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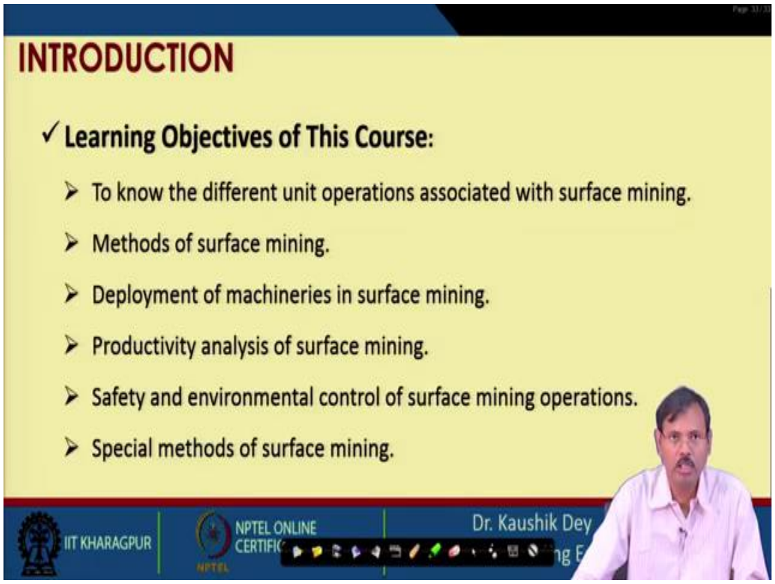

This are the learning objectives of the course surface mining technology.

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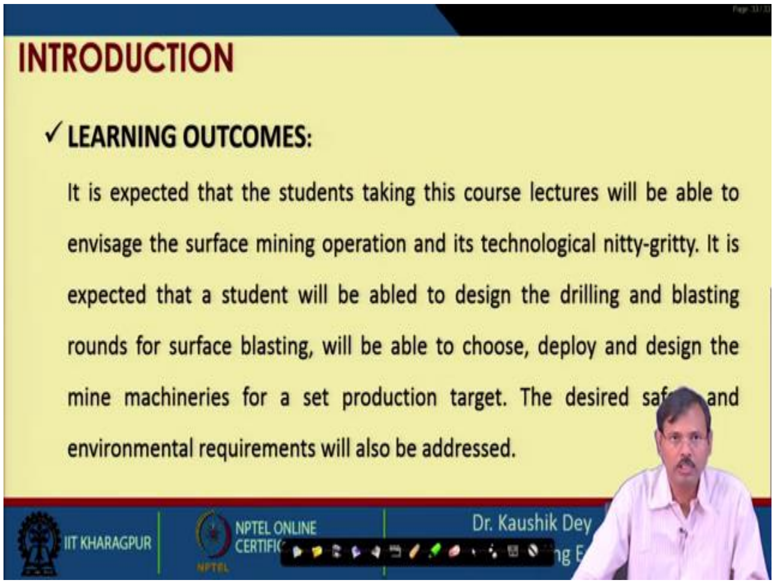

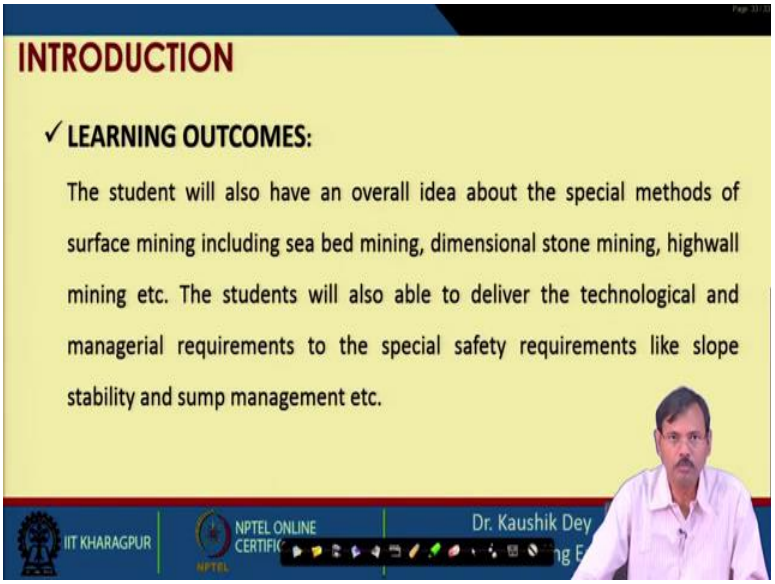

And these are the expected learning outcomes for this course: surface mining technology.

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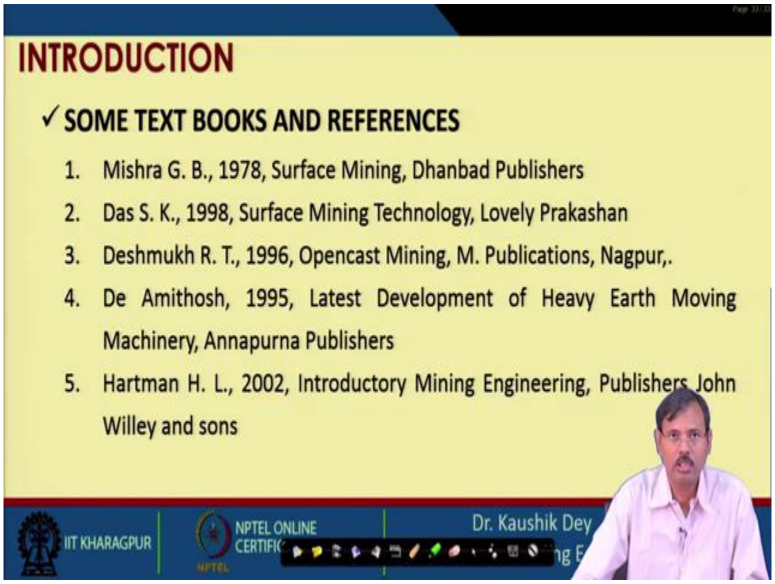

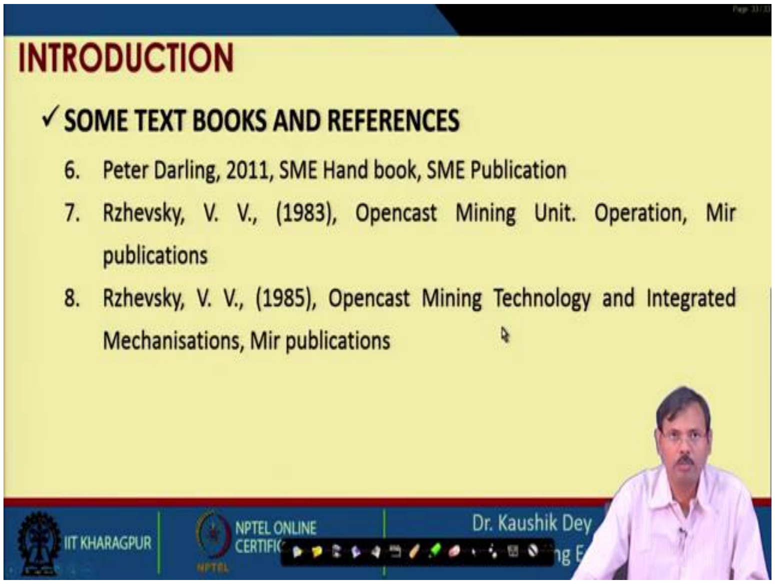

These are some of the text books and references advised for the participants.

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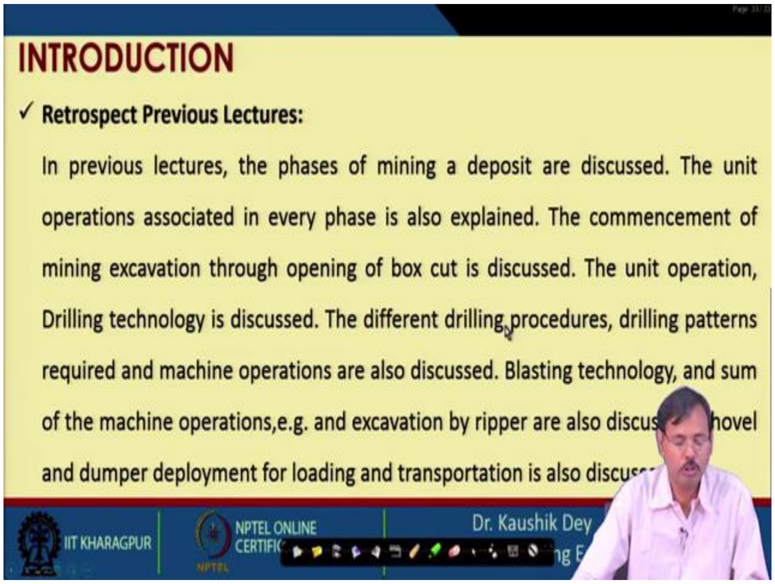

And let us retrospect the previous lectures, which we have covered in this course. We have covered the phases of mining a deposit; we have covered the commencement of surface mining using the box cut. We have covered the unit operations like drilling technology and blasting of benches. We have covered the blast free excavation technology that is excavation of loose material, loose rock mass using reaper.

And we have covered the material handling technology using excavator and dumper combinations in shovel dumper combination system for the fragmented blasted rock mass and we are continuing now with excavation with surface miner which is also a blast free mining technology. So, we have covered already two lectures on this and we are continuing with the third lecture; there will be two more lecture after this on the surface minor technology. In surface miner, excavation with surface miner we have so far covered the introductions and we have covered a part of the operations and performance of surface miner. So, we are continuing with the second part now.

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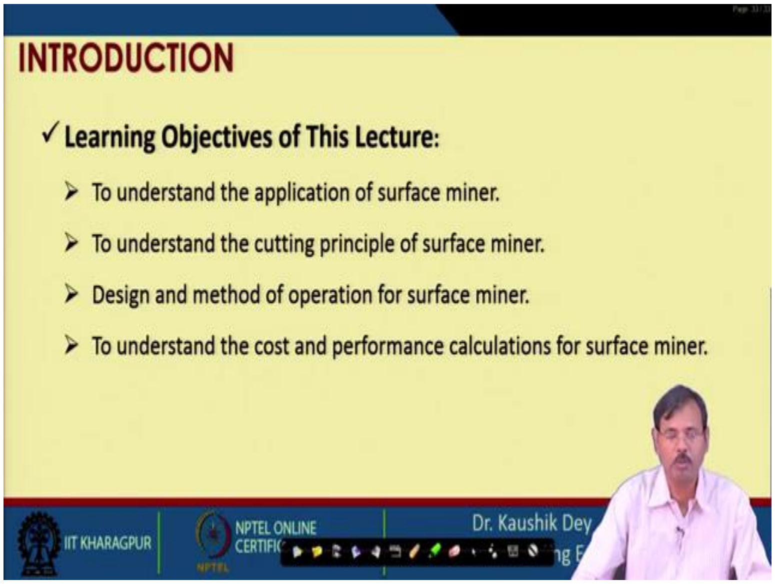

The learning objective of this excavation with surface miner is to understand the application of surface miner; to understand the cutting principle of surface miner, design and method of operation for surface miner and to understand the constant performance calculation for surface miner.

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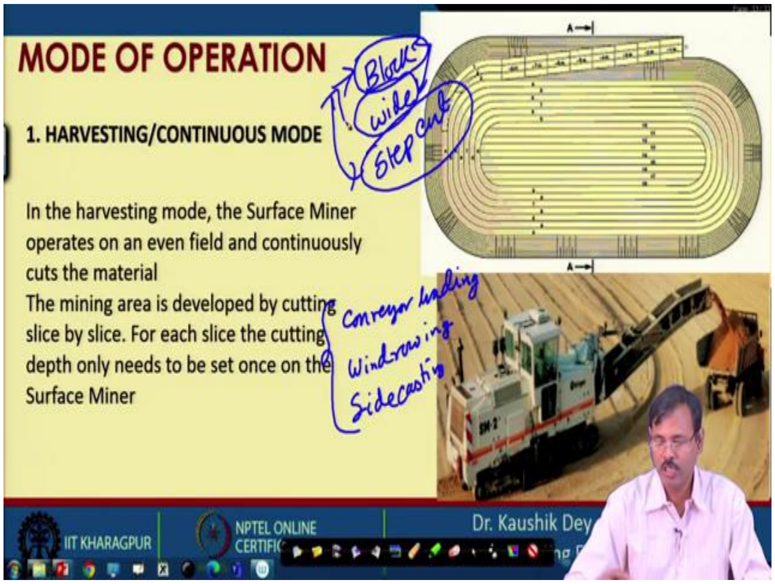

So, in last class we have seen that we are having options to use surface miner either as conveyor loading mode or we can go for windrowing mode and we have found another type of windrowing is possible that is called site casting where the conveyor is used for casting or windrowing the material and we have seen for our pit we can have the block mining system, we can have wide face system and we can have step cut system which is basically the combination of the block mining and wide mining is basically called step cut system.

Where some portions of some blocks are taken differently and in block, blocks are considered of having different grades; sit is homogeneous and in block cut we are excavating the grades separately; in step cut we are allowing the blending of the grades. So, that is basically opted for this technology. Now, we are moving into another way of operation where we allow the movement of surface miner inside the pit. And basically, we need to design the pit based on the same. It is called as the mode of operation which we will discuss now.

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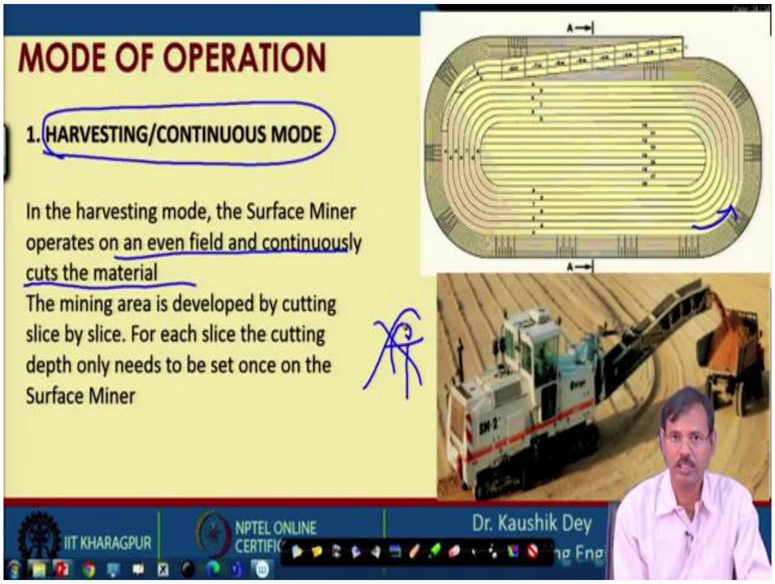

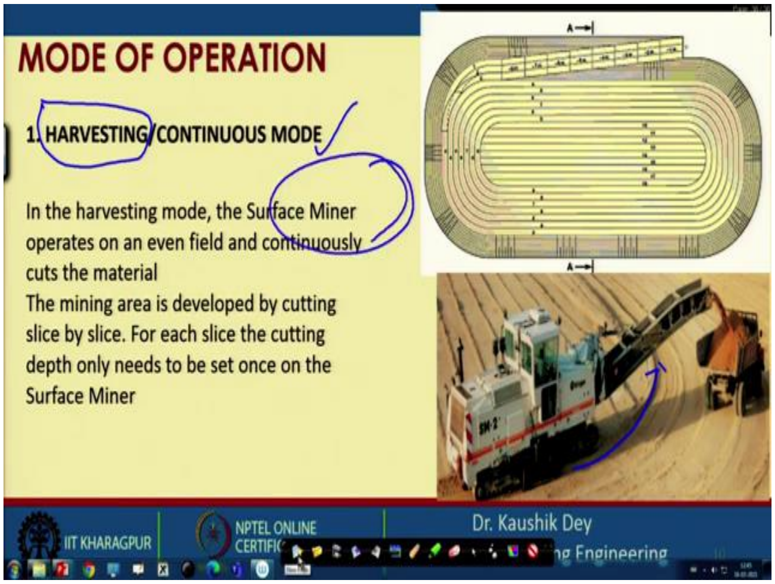

The first mode of operation is considered as the harvesting mode or continuous mode. What we do in this case, we allow our surface miner to cut continuously and there should not be any change of operation from this. Only the surface miner is allowed to cut continuously that means when the surface miner is turning that time also, we are allowing surface miner to cut.

So, in one of the previous videos in the previous lecture we have seen the surface miner was allowed to turn back and again that was allowed to cut. So, in this case there is no question of turning, so that turning was found non-productive hours because the turning time was there which was not the cutting is carried out. So, here the turning is allowed along with the cutting, so that is why it is called continuous mode of operation where we are not allowing the surface miner to turn.

Surface miner is turning here along with the cutting that is why it is called continuous mode of operation. So, you can see here the surface miner is cutting the material and along with the cutting it is turning also and during turning it is also dumping to the dumper or filling the dumper. So, this type of operation is called continuous mode of operation or also called harvesting mode of operation. Probably one can recall a tractor is allowed to plough like this in a field, so that is why it is called harvesting mode of operation or continuous mode of operation.

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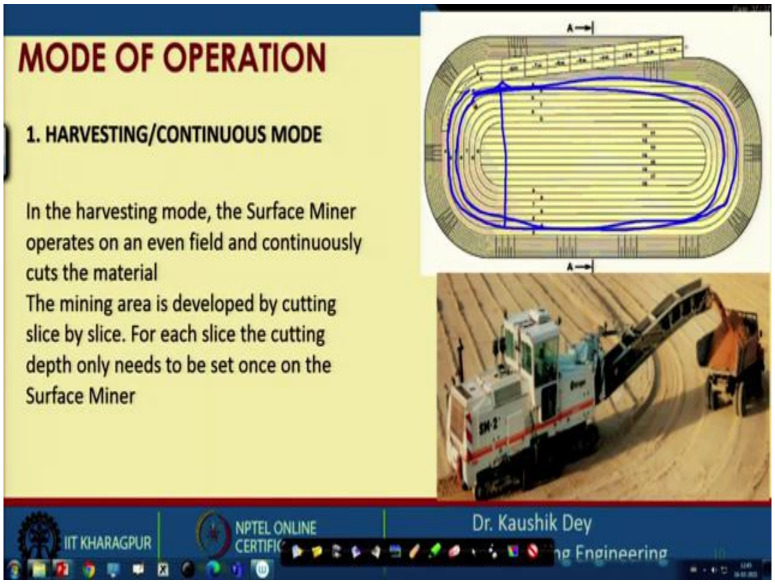

So, in this case one can see the slices of the complete thickness is taken with a number of operations, so this is one slice taken then the second slice is taken, so like that way it is taken, this figure is taken from the manual of WIRTGEN GMBH.

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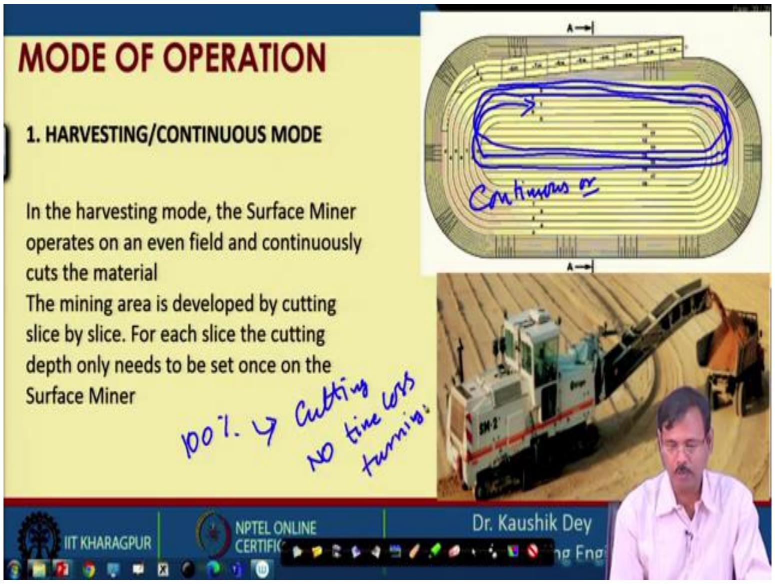

But there are some modifications possible with this; in this case if the first slice is is taken like this, the second slice can be taken like this, the third slice can be taken like this. So, there will be little bit overlap with the system but that is also another modification of the continuous or harvesting mode of operation that is also possible with this system. So, in this case we are carrying out cutting only, so 100 percent time is utilized, available time is utilized for cutting only and there is no time loss for turning the machine.

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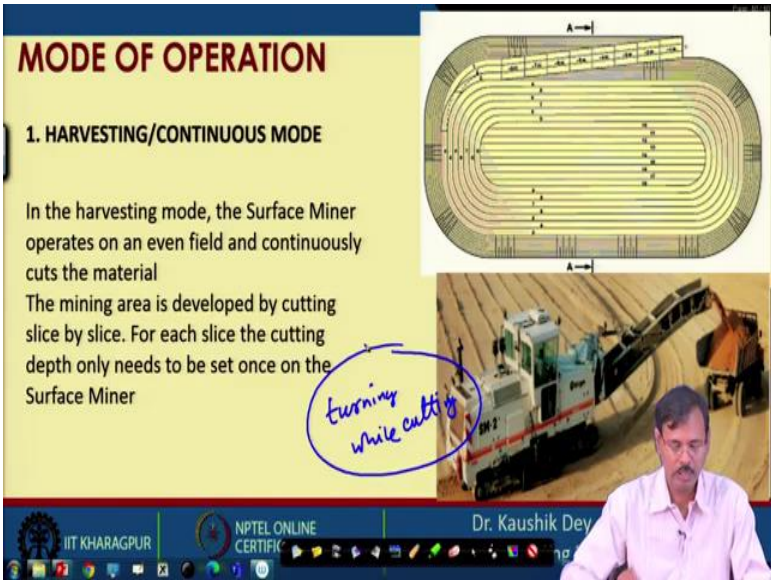

So, here the essential part is that the turning while cutting. So, the turning is carried out with the cutting only that is the characteristics of the continuous or harvesting mode of operations we will come to the advantage disadvantages at a later part.

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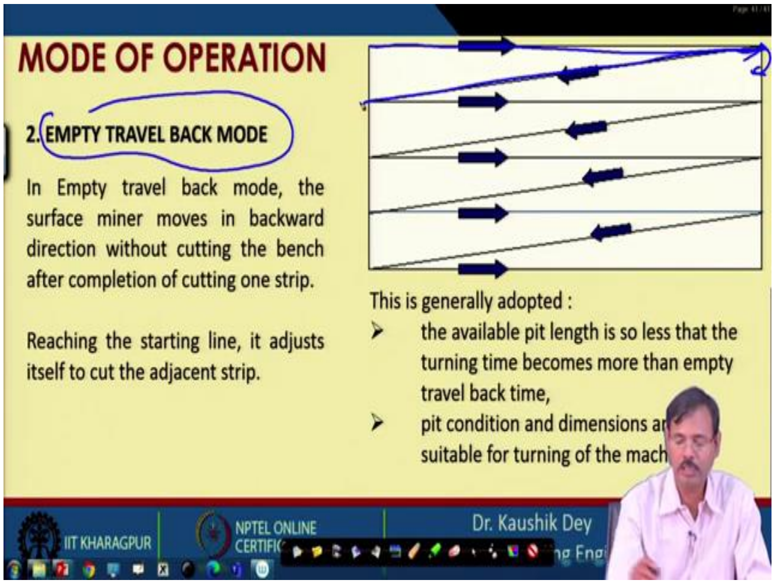

Now, second one is the empty travel back mode, in empty travel back mode we allow the surface miner to cut like this, then the surface miner instead of turning at this position the surface miner is allowed to return back in a back gear without cutting up to the initial point and then it takes the second part.

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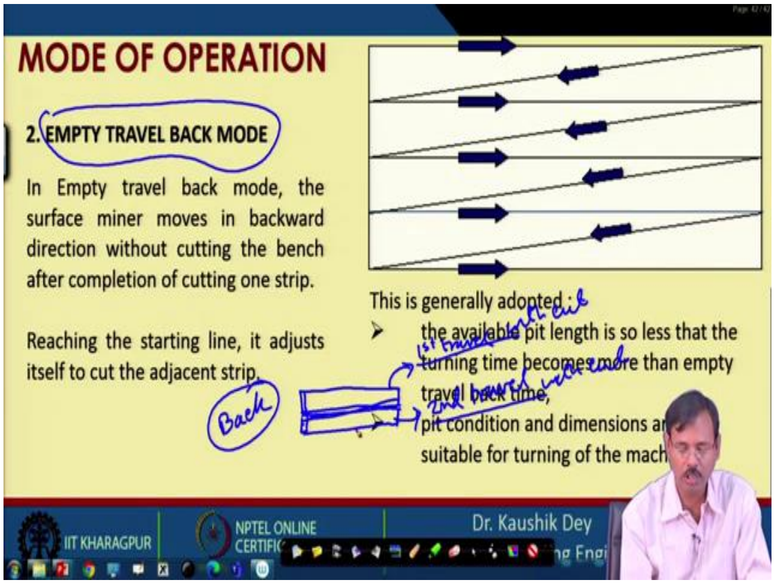

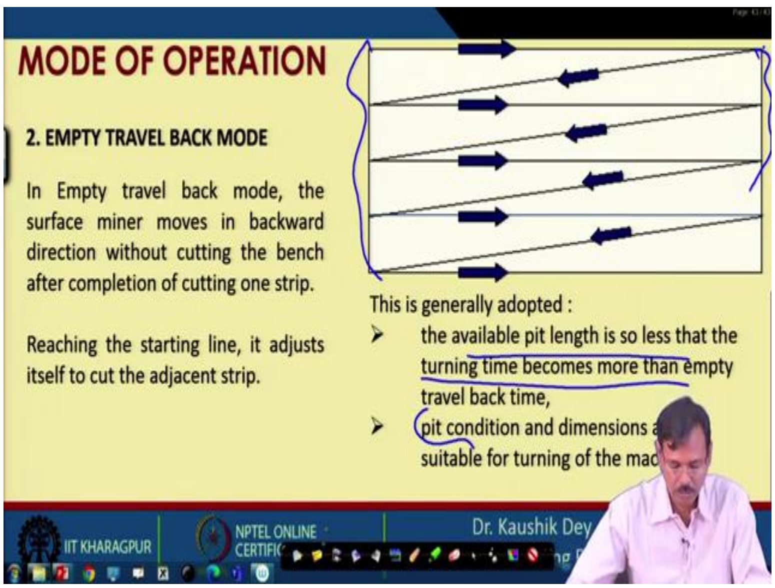

So, if we are considering in the first case the surface miner, this much width is being cut by the surface miner. So, the surface miner in first travel it cut up to this, so this area is cut by the first travel and then the surface miner is allowed to return back and take the second position at this and it cut the this is the second travel. So, this between the first travel and second travel with cut there is a movement of surface miner in a back gear without cutting.

So, that is why it is empty travel back, so it is traveling back in a back gear without cutting that is why it is called empty travel back system. So, this is in general adopted if the pit length is too less so that the turning time becomes more than the empty travel back time or the pit condition at the side, at this end or maybe at this end such that the dimensions are not suitable for turning, not the condition may be suitable for turning, it may be possible in this place; there is a very slushy condition, there muds are there in those cases, there is a chance that more wear and tear to the system may occur or maybe there is some unsafe condition; in those cases you can allow the empty travel back of the machine.

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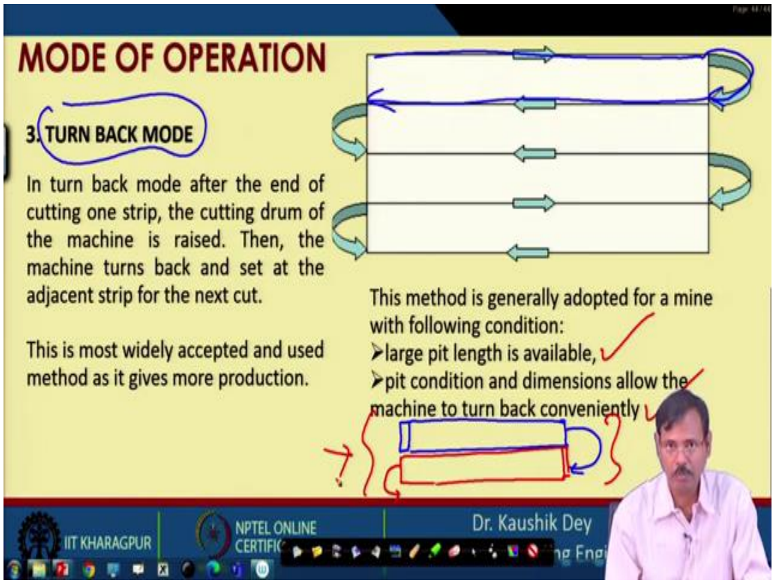

Similarly, this is not a very popular method of operation; the most popular method of operation is turn back method. In turn back method, the first slice is taken then the material turns back and take the second slice. So, this is something like that if you are considering the width this is linearly shown, so this is the width of the machine so the machine is taking the first slice.

Then the machine is allowed to turn here and the second slice is taken like this and the next turning is carried out here. So, this is the way turn back mode is being operated, this is most common one, sufficient pit length is there so the turning time is significantly less than the empty travel back time and these are allowing the turning and now obviously it is found that this is very good but the problem is when you will choose the continuous or harvesting mode of operation and when you will choose the turn back mode? So, for that let us once look back into the harvesting mode of operation.

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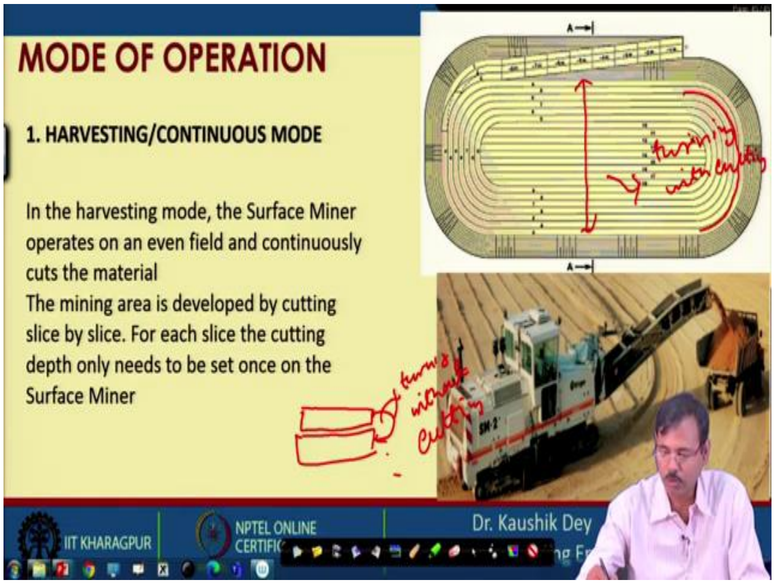

So, you can see in this harvesting mode of operation you need to have a very wide face because whenever you are turning at this position for this cut and this turning is not taking a very large turning radius because you are turning without cutting, so this is turning without cutting.

But in this case, it is turning with cutting so turning radius required here is much-much lesser and your machine is having the facility, it can move forward it can come backward so like that way the crawler has to adjust and turn back. We have seen in the last class one video related to this turning where the machine is turned again reverse back and come to the back side of this one. So, this is the benefit we have seen. Similarly, here we have to turn with cutting that is why we need a very large timing radius.

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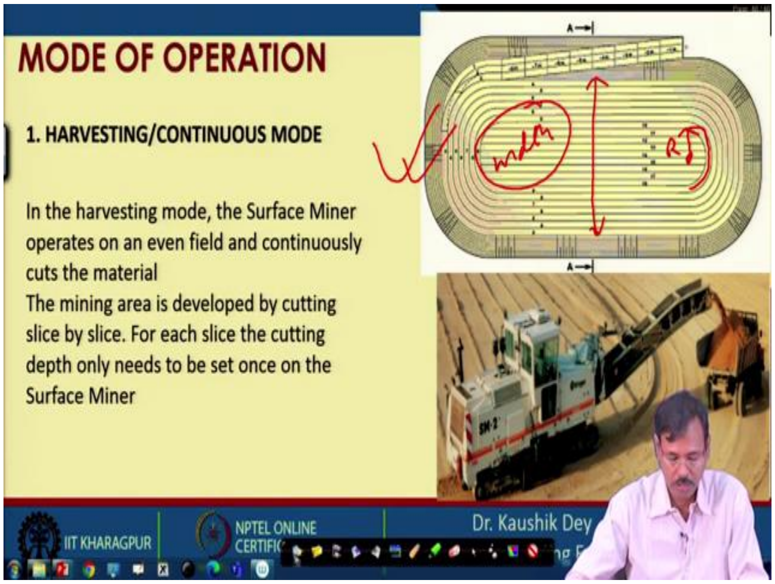

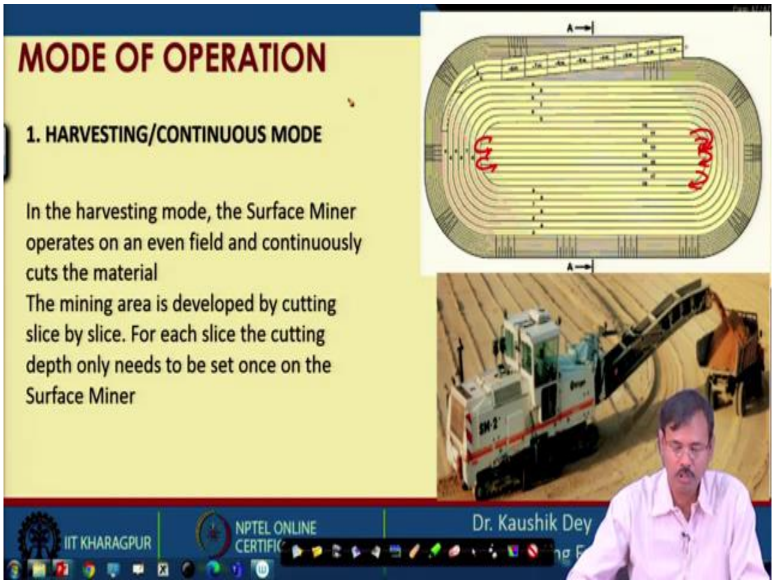

So, the minimum turning radius which can be seen here with cutting is this much, so this is the minimum turning radius required, this is the minimum turning radius required for the turning of the surface miner with cutting. So, this is huge length so that means the continuous or harvesting mode of operation is required the width of the bench should be significantly high in this case then only harvesting mode of operation can be carried out.

So, that is the main drawback of this one; otherwise this is always much-much higher productive than the turn back method and often if the radius is restricted in that case you have to go for turn back method of operation in the central part of this one. The central slices can be taken on turn back mode of operation while the harvesting mode of operation is practiced.

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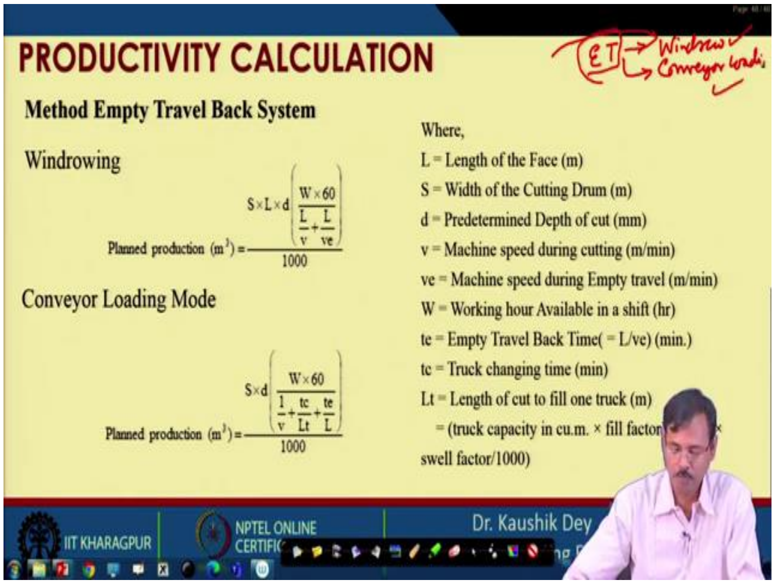

So, that is why if now we are considering the operations let us have the table. We are having empty travel back, empty travel back that operation that can be combined with windrowing that can be converted and that can be carried out with conveyor loading. We are considering side casting is associated with windrowing because conveyor loading additionally, we are having the truck filling time waiting time for the trucks which are not there in windrowing and side casting also. So, side casting can be considered as similar to the windrowing case. So, we are having empty travel back operation system along with windrowing conveyor loading.

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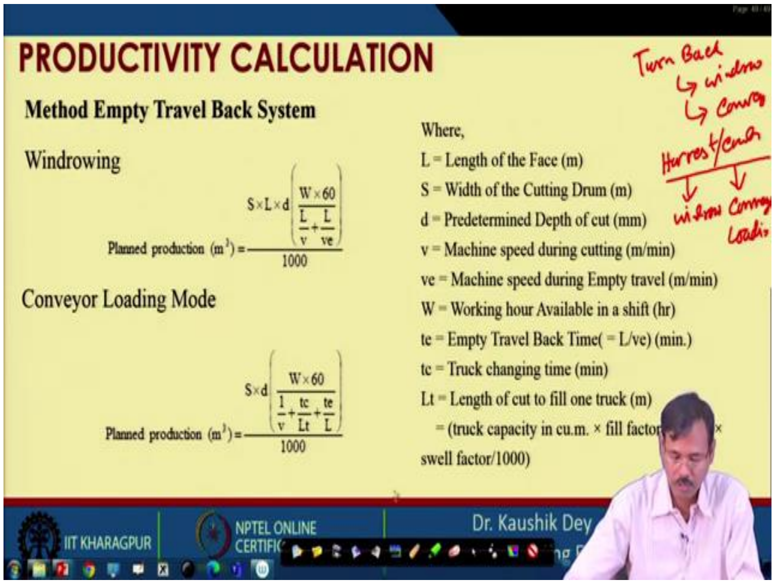

Similarly, we can have turn back method with windrowing, with conveyor loading and similarly we are having harvesting or continuous mode in that case also we can either go for windowing or we can go for or we can go for conveyor loading. So, these are the different combinations of operations possible with this, but let us understand how we can calculate the production rate for each type of application.

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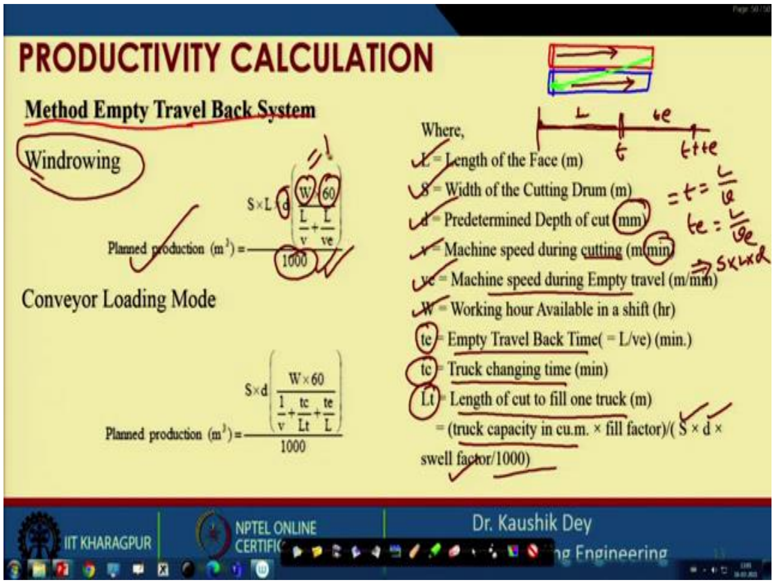

So, this is a simple one so let us look into the first one empty travel back method and this method is easily understood. So, what is the requirement? First the material is cut from this direction to this direction then there is a empty travel from this to this and then again there is a cutting from this direction to this direction.

So, if L is our length of face, S is our width of the cutting drum, d is the predetermined depth of cut, v is the speed of the machine during cutting, v is the empty travel speed, W is the working hour so available for in a shift or whatever for which we are interested in calculation, t_e is the empty travel back time, t_c is the truck change time when we are filling the material in conveyor loading, L_t is the length of cut to fill one truck so that means truck capacity into fill factor divided by this is the width of the drum this is the depth of the cut swelling factor then divided by 1000 to make it millimeter to meter.

So, now if you are looking at this first-time cycle let us look into the time cycle here. So, first we start cut at this position, so it is cutting for windrowing and leaving the material up to a time t where t is equal to L/v. Then it has to empty travel back so then there will be time t_e, so this is t so that is this point is t+t that, is the empty travel back time, so this is L/v_e and in during this total time, then again it will start this.

So, in this total time what is the production? The production is $S \times L \times d$ is the production, so from this we can calculate, if considering the windrowing, our production in w working hour can be estimated using this formula $S \times L \times d$ that is the production and for this the time required is $l/v + l/v_e$ so that is the time required, so this is the production per unit time and the time available with us $w \times 60$.

If we are considering that the production in w hours, so if W is equal to L then production in 1 hour. So, 60 is made because we have considered all this in minute that is why we are considering this 60, this 1000 is kept here because we have taken the d in millimeter so d is kept in millimeter so 1000 is placed here.

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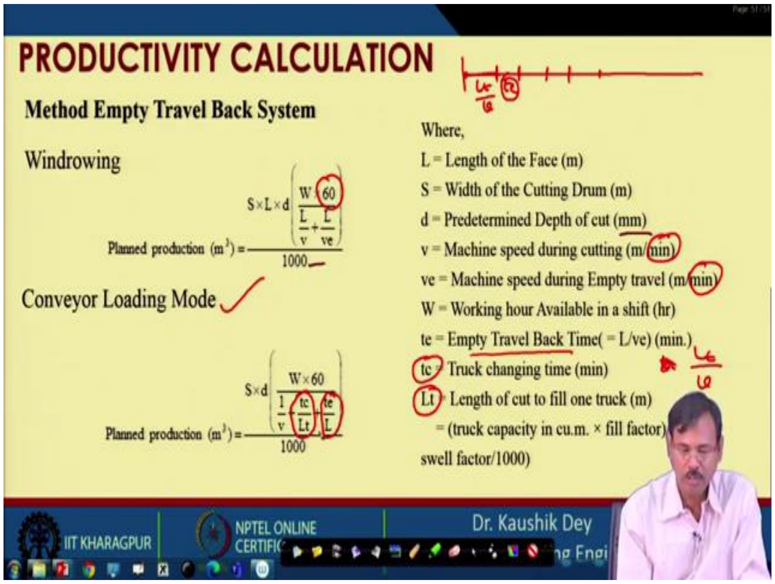

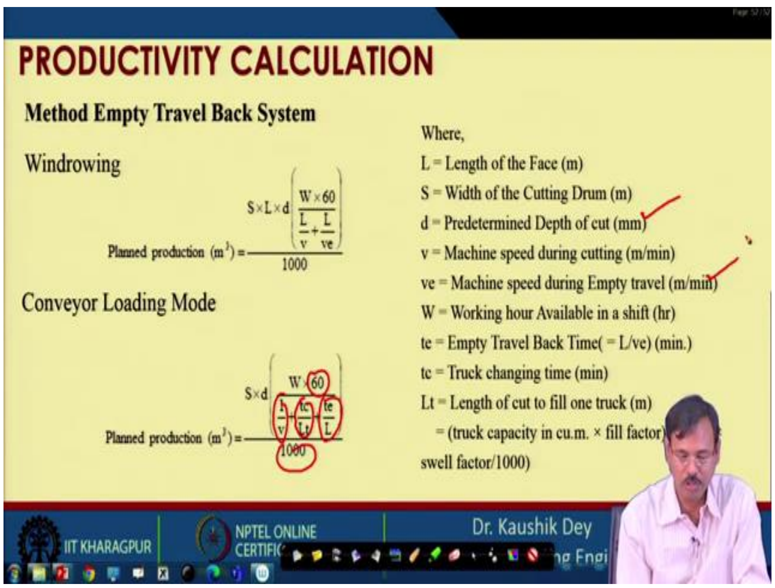

So, whenever you are using this formula be careful about this point because millimeter is there and 60 minute is there okay so that is why these are important part. So, the same thing when we are trying to calculate for the conveyor loading mode so what is the time cycle let us look into this. So first we start cutting so we have started cutting up to this one, what is this? This is the L_t; this is the L_t length to fill the t_c truck. So, after cutting this L_t length, our time required for this is L_t/p so that is the time required so we cut this L_t/v time at this position then with there we need a t_c time.

So, this t_c time is required so the truck can be changed at this position okay. Then again there will be L_t there will be t_c and till we are reaching at the end at this position. So, actually t_c is basically the delay hours and which whose frequency is basically the L_t length. So, this t_c by L_t is basically the delay component and t_e is the truck empty travel back time and the frequency of the delay is L.

So, we use this in this formula where S X d and this is the consideration and this is considering L/v is the velocity cutting time, these are the delay time, these are the cutting time and this frequency are utilized here for this production calculation mode and again this 60 and this 1000 is for millimeter and minute and that is utilized here.

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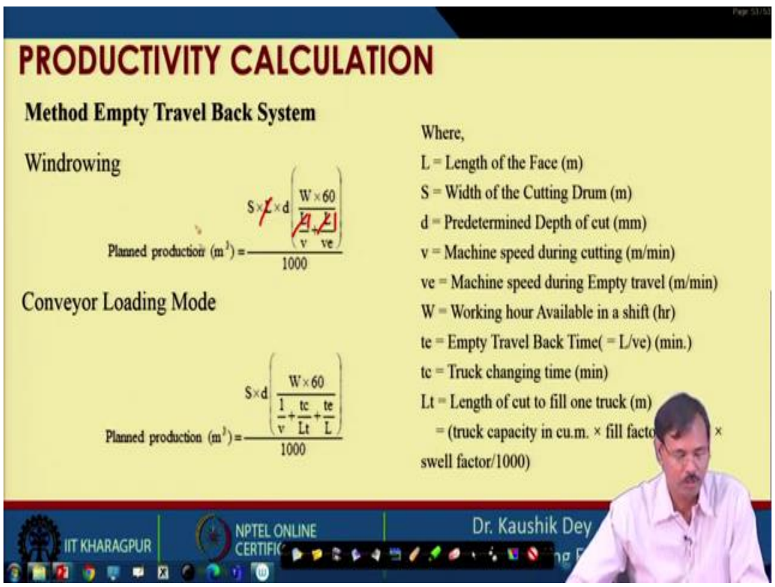

So, in a nutshell our formula became:

$$\frac{S \times L \times D \times \left(\dfrac{W \times 60}{\dfrac{L}{v} + \dfrac{L}{v_t}}\right)}{1000}$$

You remember one thing in this case actually this was becoming L/v if you are cancelling this; L from the numerator and denominator, then this will come to L/v and L/v_e. So, same thing we are applying here also basically this L is replaced we divide this and finally it is coming into L/v formula and that is now replaced with this formula. So, this is the formula for method of empty travel back with windrowing and with conveyor loading system.

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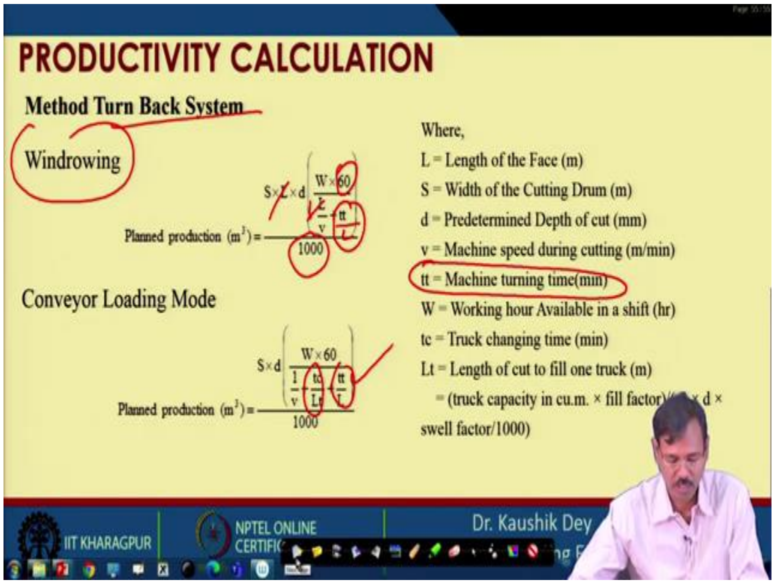

Now, what will be the system for the turn back mode of operation? In turn back mode of operation for windrowing we have to consider the machine turning time so again we are considering (S X L X d) L/v + t_t or in other word you can remove this and you can consider t_t/L because the frequency of this is that turning time is after complete completion of one length of cut. And again, this one and this one is utilized for the millimeter and second. So, the same thing is considered at this place L is considered here this is for the frequency of the truck exchange this is the frequency of the turning with respect to the length.

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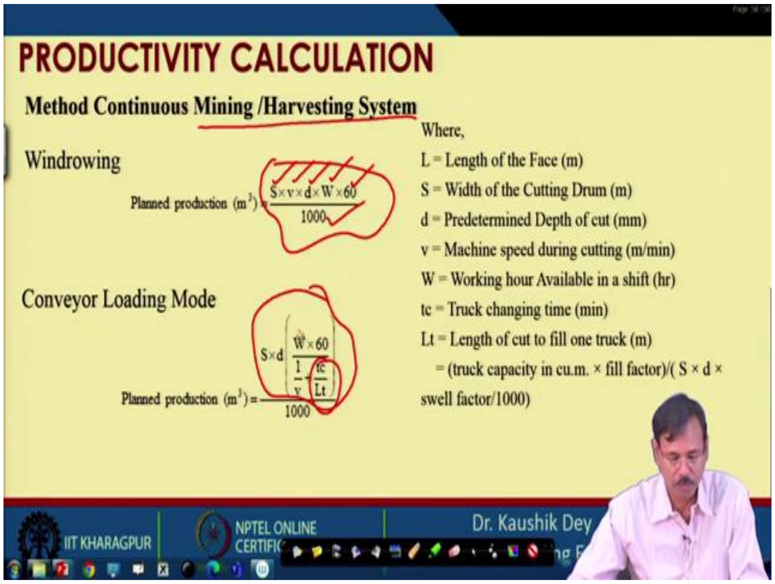

And this is the case of harvesting mode of operation where there is no question of turning. So, there is no question of delay hours, so this is S x v x d x working hours x 60 per minute and 1000 for d so that is the S x d x v is basically the production formula for the windrowing method and in conveyor loading method, we need to consider the delay time with respect to the truck exchange time after filling of each truck. So, that is the production formula for the harvesting or continuous mode of operation.

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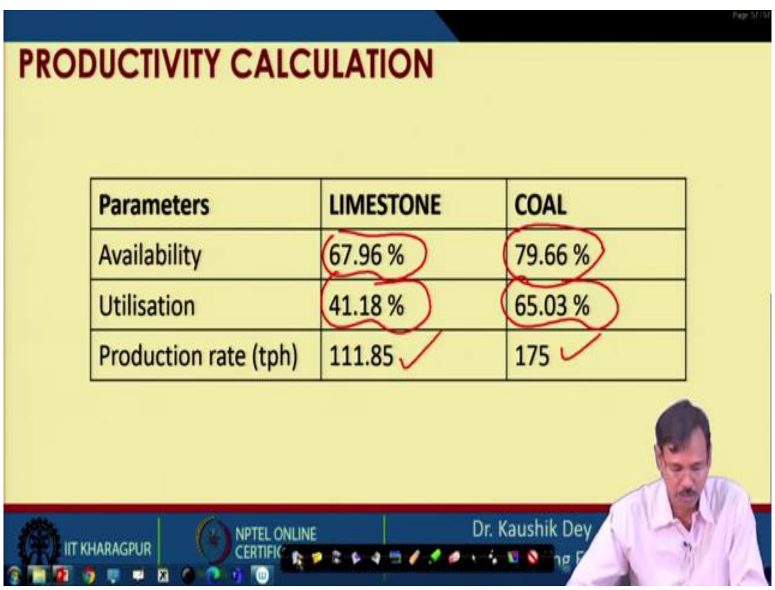

Parameters	LIMESTONE	COAL
Availability	67.96 %	79.66 %
Utilisation	41.18 %	65.03 %
Production rate (tph)	111.85	175

Let us just have a one small exercise here; this is one calculation if you are looking it into this if it can be seen for a particular case the availability and utilization of the surface miners for coal and limestones for Indian cases are considered here and these are the ton of production for coal and limestone.

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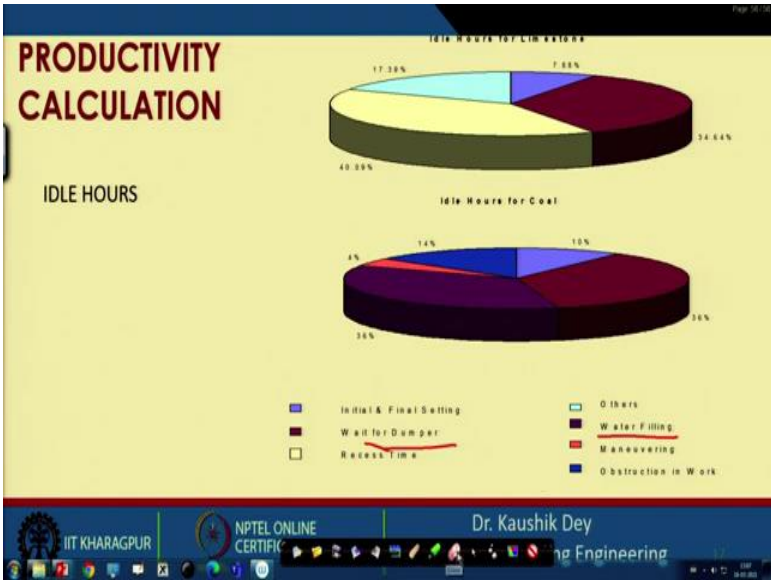

And if you look into the idle hours, these are the idle hours. For coal, it can be seen that the water wait for dumper is a significant idle hour and sometimes it has been found that the water filling is also significant idle hours occurred because of the machine operations.

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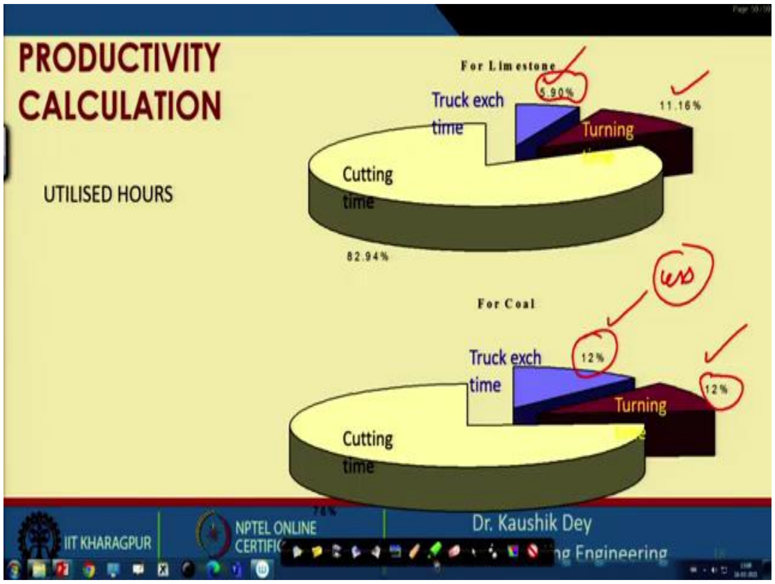

But the interesting part is that the utilized hours, if it can be seen, that the 12 percent utilized hours are taken for truck exchange and turning in coal whereas in limestone it is 5 percent for truck exchange and turning time is significantly close to each other. So, that is truck exchange time is significantly higher in coal than the limestone that is the because this truck capacity was less so the frequent truck exchange occurred here; that is the first reason. Second reason is that here the large size dumpers are used so the frequency is less and frequency of trucks change is less as well as these trucks are operated by the educated operators. So, they place it more safely and that is why the truck exchange times are significantly lower in this case.

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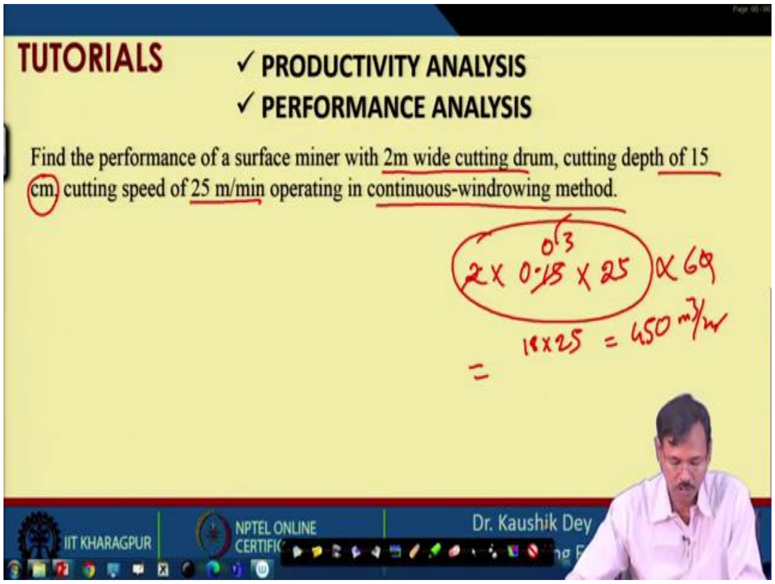

So, this is a small example; if a surface miner is working with 2-meter-wide cutting drum 15 centimeter is the c. I have changed the unit to centimeter here ok and cutting speed is 25 meter per minute then continuous windrowing method how much it will produce? So, obviously we know it is 2 x 0.15 we have made it meter so we need not to use any more the thousand.

And the cutting velocity is 25 meter per minute so this is the production in 1 minute and if we are multiplying with 60, we will get the production. So, the production will come, so this is 18x25; 0.3 x60; 18 x25 so that means it is 250; 250 + 200, so 450 cube per hour.

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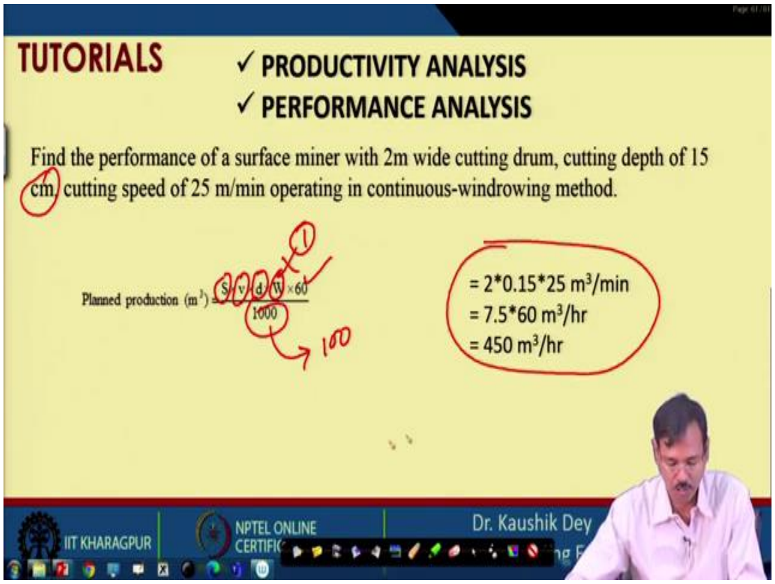

So, now let us look into the solution; so, we have used this formula S x v x d. W is replaced with L and 60 is minute; 1000 is no more applicable because here we have considered in centimeter so thousand will be changed to hundred, so it is calculated here for 50-meter cube per hour is the calculated results. So, this is a small example and we have and we have covered the productivity formula. So, we will go for more and more tutorials in the next two classes. Thank you.