Surface mining Technology
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Lecture 34
Excavation with Surface Miner 4

Let me welcome you to the thirty-fourth lecture of Surface Mining Technology, NPTEL online certification course. In this lecture we will continue with excavation with surface miner. The fourth lecture of the same will be covered in this lecture and in this lecture, we will basically do some tutorial. But as we do in every lecture before start the exact content of this lecture.

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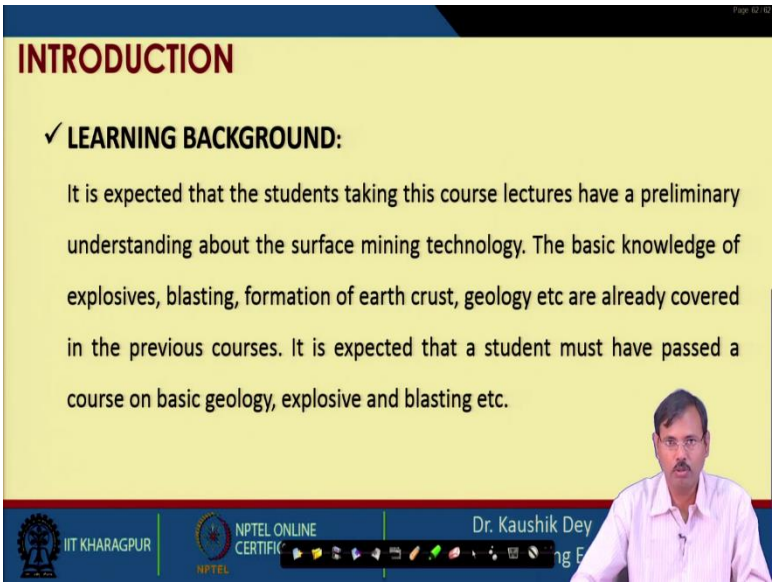

Let us have once look into the learning background required for Surface Mining Technology course.

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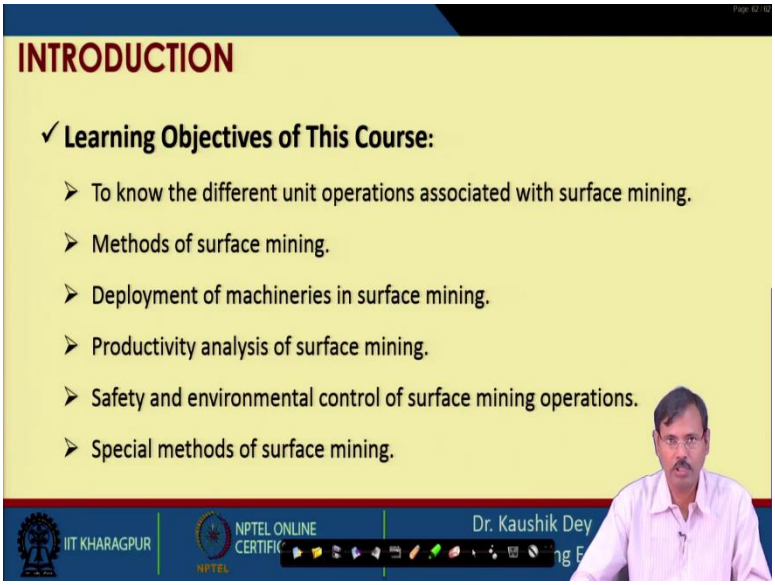

These are the learning objectives of Surface Mining Technology course.

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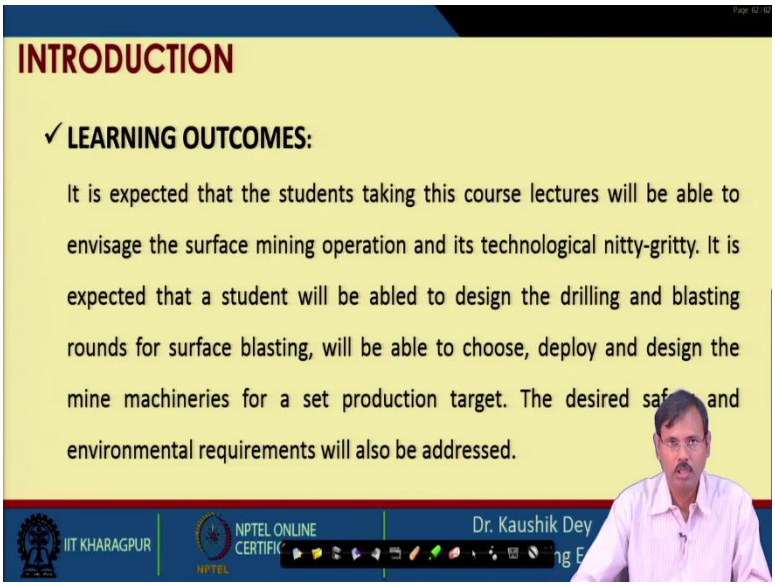

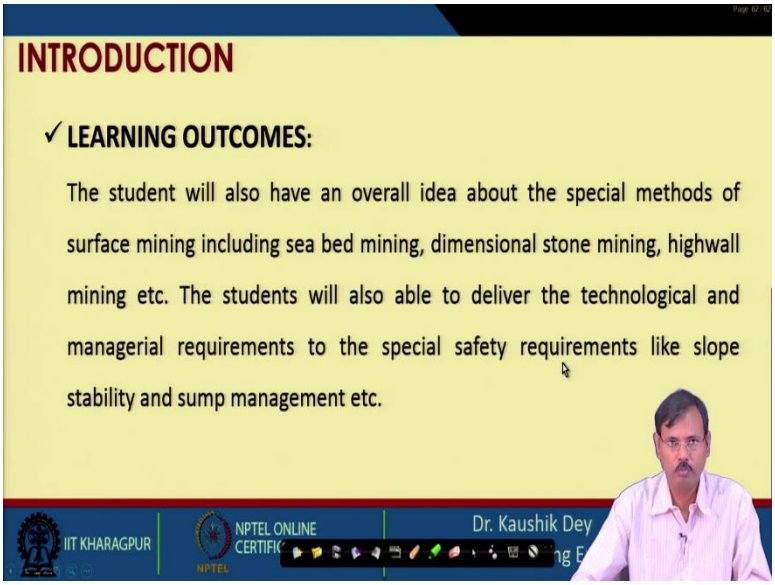

And these are the learning outcomes expected from the participant of the Surface Mining Technology course. These are the learning outcomes.

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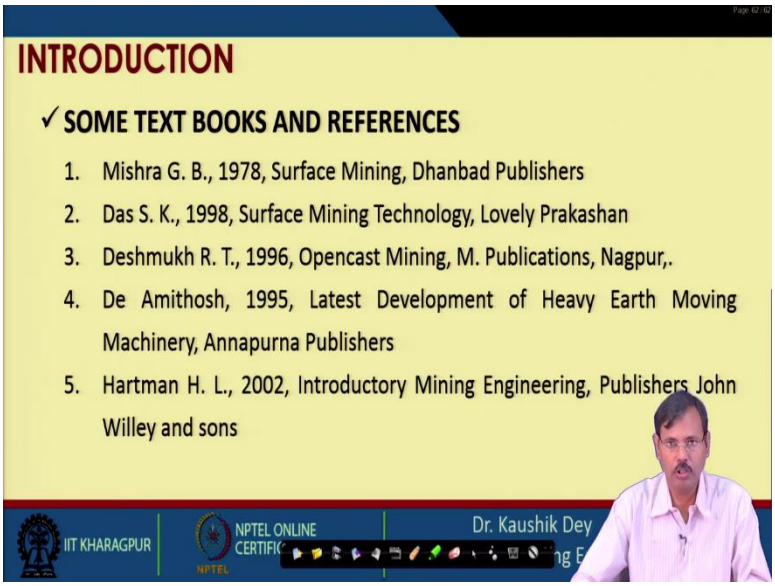

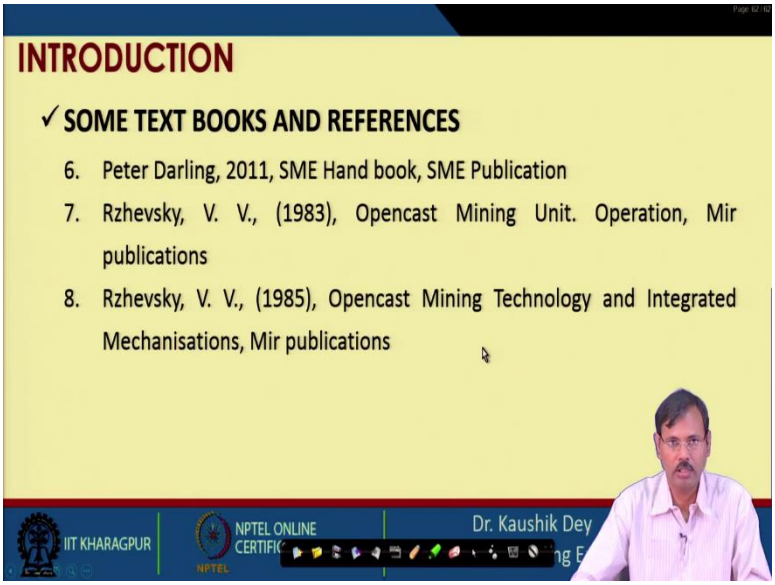

And these are some of the textbooks and references, advised to the participants, they can follow these books for the better inputs. These are a few more books.

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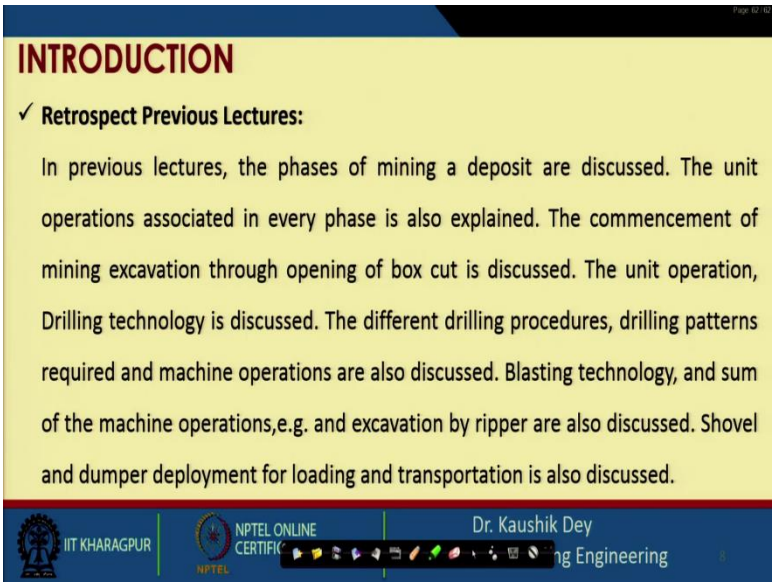

And as we do, let us retrospect so far whatever we have covered. So, before starting the surface miner lectures, we have covered the phases of a mining deposits. We have covered the different unit operations of those phases of this, phases of mining a deposit. We have covered the commencement of surface mining using box cut, we have covered the drilling technology, blasting technology.

We have covered the dipper technology for excavation of the soft material without blasting. And we have covered the excavators. How the excavators are utilized to excavate the fragmented rock material either by blasting or by ripper, and to load them onto the transporting system truck transport system, and the combinations of the shovel and dumpers are also discussed before the commencement of this lecture pertaining to surface miner. In excavation with surface miner, so far, we have covered introduction to the machine, we have covered the different operations and the productivity formula and mode of operations, cutting principles, those are covered for excavation with surface miners.

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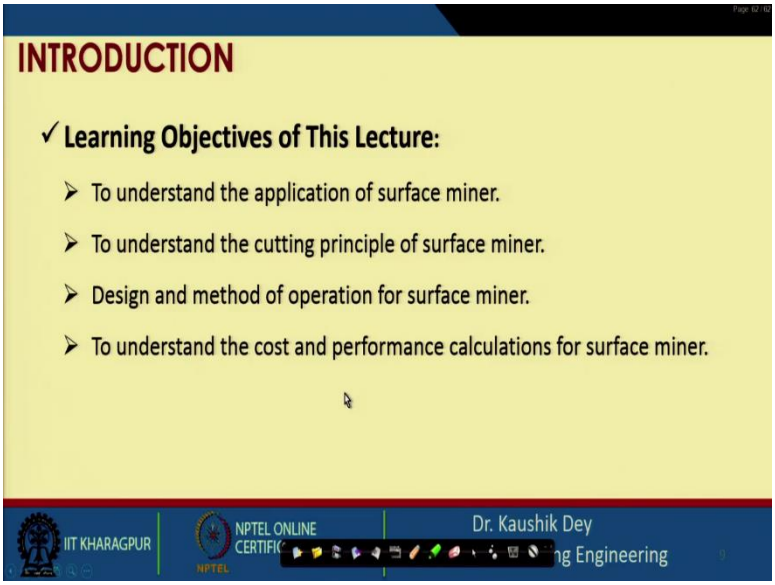

And in this lecture, we will carry on some tutorials, these are the learning objectives of the excavation with surface miner. So, learning objectives are to understand the application of surface miner, which is covered. To understand the cutting principle of surface miner that is also covered and design and method of operation for surface miners is also covered and will now go for cost and performance calculation of the surface miner.

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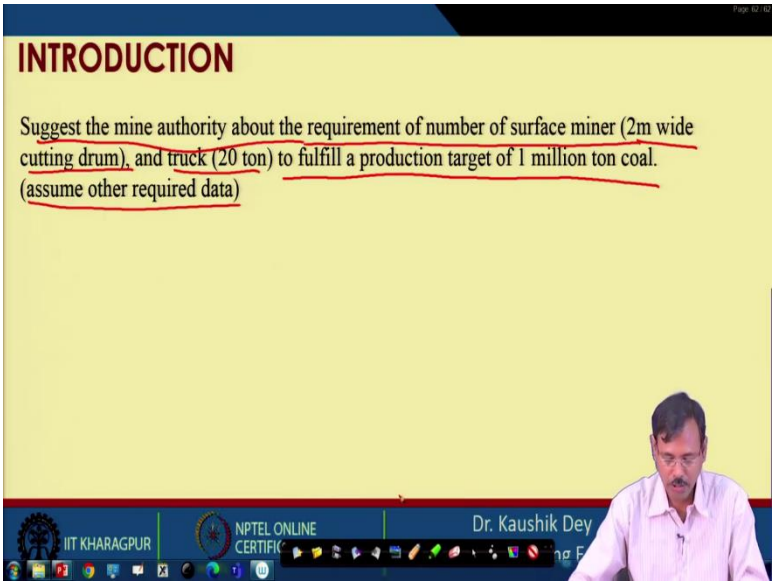

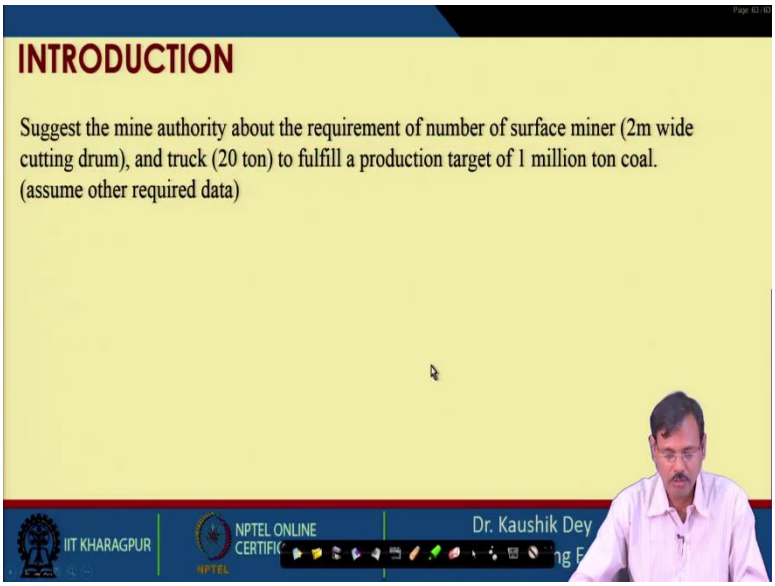

So, say our problem is that we have to suggest the mine authority about the requirement of number of surface miner, two-meter-wide cutting drum and 20-ton dumpers to fulfil the production target of 1-million-ton coal and no other data is available with us. This is a very beginning condition for a mine and we do not know after procuring of this one to reach to the 1 million tonnes target, we do not know what are the mode of operation.

Whether we will go for harvesting mode of operation, whether that pit dimension is available there or not. Whether we will go for the empty travel back mode or whether we will go for windrowing or conveyor loading, all these details are not with us. So, we have to think of all those conditions and based on that we have to suggest so that the mine authority can come out with its procurement of 1 surface miner through which they can or number of those

surface miners through is they can fulfil the production target of 1 million ton. So, before we will assume the data pertaining to that. Once again, look back to this formula.

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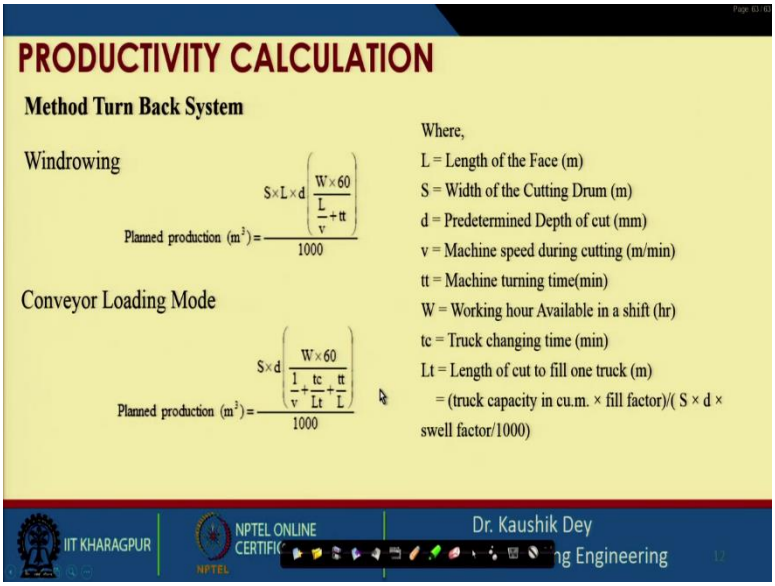

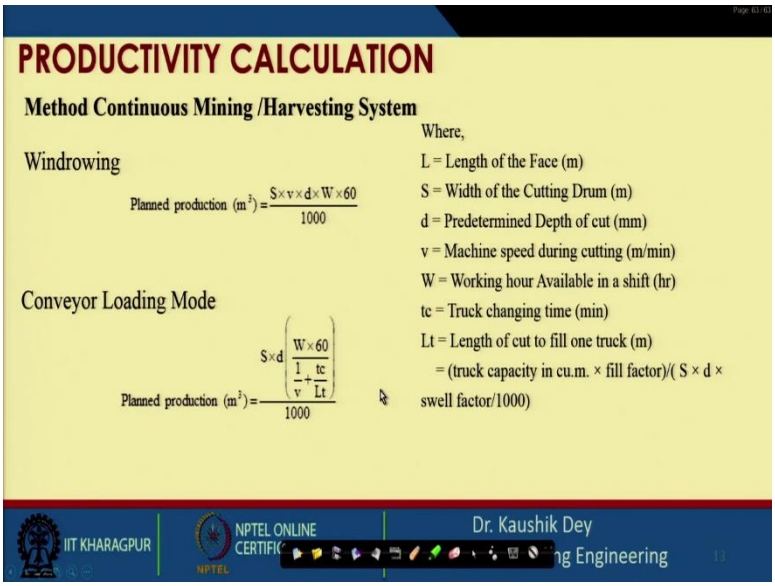

These are the formula.

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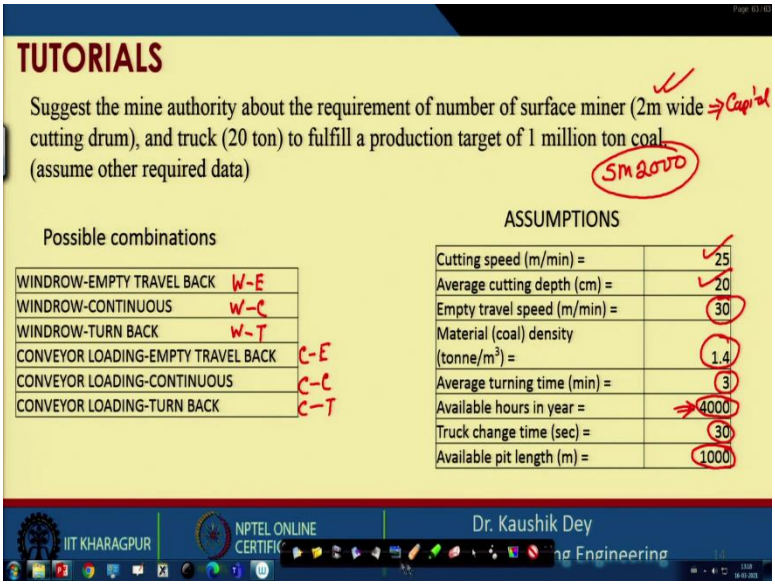

And we will carry on now the exercise. So, let us assume different data, we are having the possible combinations, either go for windrowing empty travel back mode, we will mark it as W-E or we will go for windowing harvesting mode. So, this is W-C or we will go for windowing turnback mode, this is W-T, then alternate to that we are having conveyor loading system.

So, conveyor loading system can be combinations with the empty travel back mode. So, this is C-E, we can have conveyor loading with continuous mode C-C and conveyor loading with turn back mode C-T. Now, let us assume the different conditions say for a particular machine as we have considered the surface miners of two-meter-wide cutting drum and basically these considerations are made as per the capital requirement.

So, the capital available with us is suitable for this. So, that is why we are opting for this one. So, for this let us assume some conditions which are pertaining to SM2000 model. So, we are assuming that we are having the cutting speed of 25 meter per minute, empty travel speed is considered as 30 meter per minute cutting, depth is considered at 20-centimetre, density of coal is considered as 1.4 tonne per meter cube and we have considered our operators can give us turning time of 3 minute.

This is the yearly available working hours we have considered which is very, very highly optimistic hours and truck change time we have considered the 30 second, we can change the truck while the conveyor loading is practiced and the available pit length with us is 1000 meter. So, with this assumption let us go for calculation of this one. In next slide calculated

values are given but the for better understanding let us use the different productivity formula for this.

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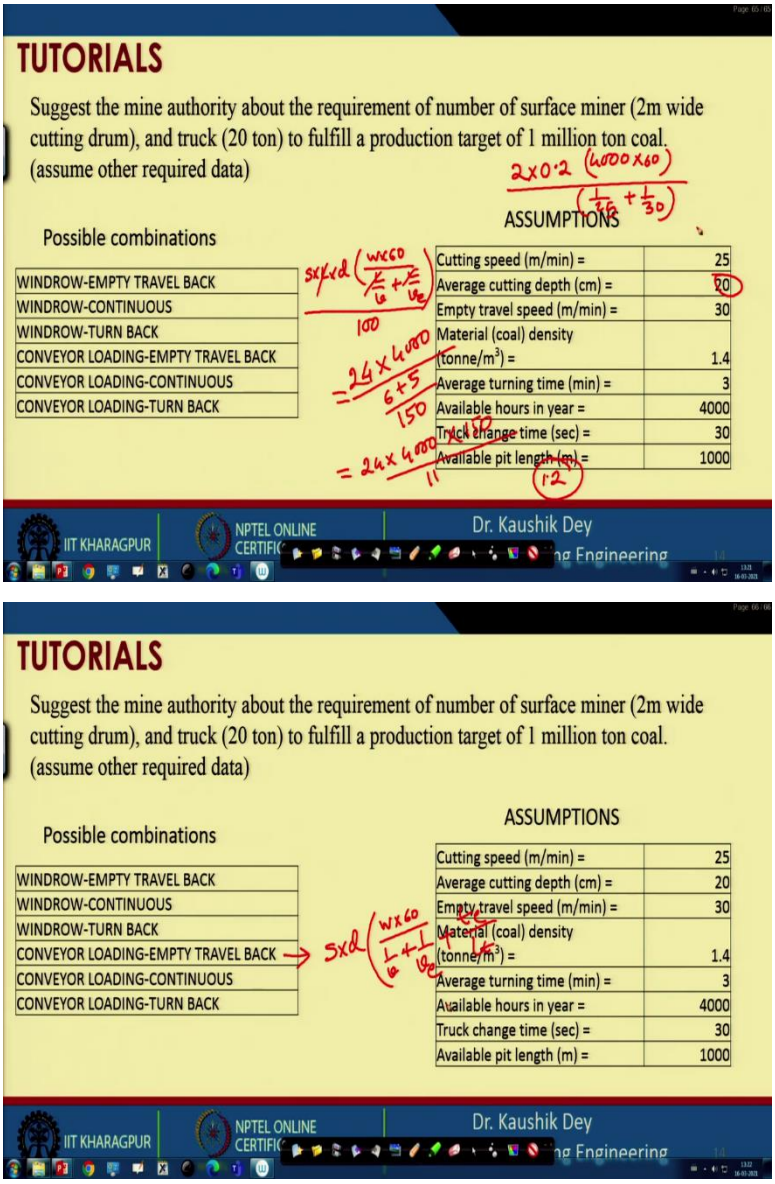

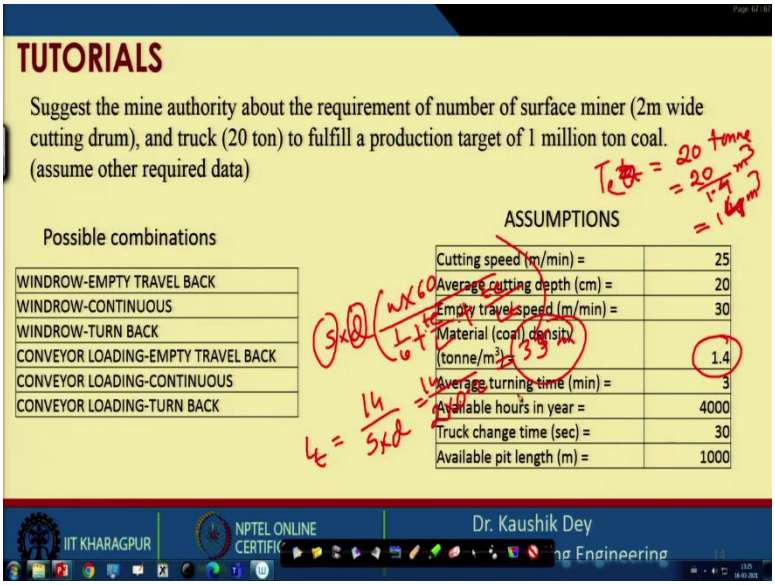

Say, for the first case, what is our production? Possibly that is windrowing with empty travel back system. So, we are having formula.

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

So, in this case as we have taken it in centimetre. So, we replace this 1000 with 100. So, that means L can be cancelled. So, this is coming; S is 2-meter, depth is d/100; let us consider that 0.2-meter, w is 4000, 60 is 60 and we are having 1/25 + 1/30.

So, on calculation of this, we will get 6 24 x 6, 4 x 24 x 4000 and this is divided by 6 + 5 and this is 150 x 4000 x 150 divided by 11. So, this is the production expected from this. So, if you are considering 2 it is 30 then probably 1.2 million ton. So, this is almost 1.2 million tonne is achieved using this machine. So, you can say the 1 machine is sufficient for this application.

Similarly, if you do it for the con conveyor loading empty travel back mode, then our formula will remain as:

$$\frac{S \times L \times D \times \left(\frac{W \times 60}{\frac{L}{v} + \frac{t_e}{L} + \frac{t_c}{L_t}} \right)}{1000}$$

Now, we have to find out L_t here L_t is given us 20 tonnes. Now, let us see these 20 tonnes means how much in situ coal quality.

So, 20 tonne means how much in situ coal quality, so, in situ coal quality, coal quantity. So, in situ coal is having a density of 1.4. So, in situ coal volume required to fill this truck is $20/1.4 m^3$. So, this is coming some value say close to probably close to 1.4 itself. So, 1.4 x 1.4 is 196 and 19.6. So, that is probably it is coming sorry 14, 14-meter cube. So, this is coming around close to 14-meter cube.

So, the exact calculation we will do later on. So, this is coming to this. So, this is not L_t, this is actually truck capacity we are considering about. So, the truck capacity is 14-meter cube of coal, 14-meter cube of coal can fill this 20-tonne truck. Now, if this quantity is this, then the length required to cut, this is the S is the drum width, d is the cutting depth.

So, to achieve 14-meter cube the length has to cut is this much. So, whatever is coming this this is 14 divided by this is 2 x 0.2. So, this is coming close to say this is 0.4, so, 2 and a half times so, that means it is maybe coming around 33 or 35 meter or something so. So, this is the L_t value which is coming here. So, we have to use these values here in calculating this.

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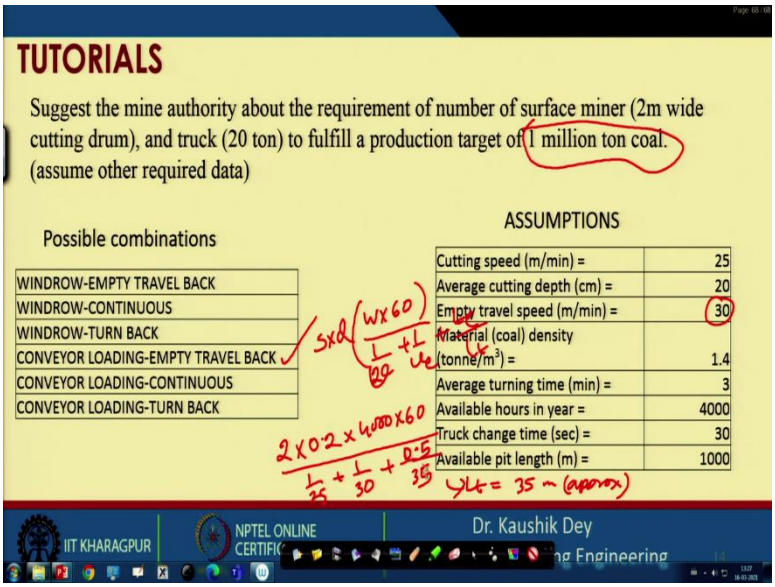

So, whatever is the L_t value, we have to consider this much at this position, this is close approx. Exact calculation, I will show you in the next slide. So, this is the value now we can utilize, so this is:

$$\frac{S \times L \times D \times \left(\frac{W \times 60}{\frac{L}{v} + \frac{L}{v_e} + \frac{t_c}{L_t}} \right)}{1000}$$

So, it is coming 2 x0.2 x 4000 x 60, 1/25 + 1/30; tc is 0.5, 30 seconds. So, you have to convert it into minute so, 0.5 divided by 35. What is the value of L_t? So, you have to calculate this, then whatever you will get if you divide it 1 million tonne you will get the number of machines required for conveyor loading turn back mode. So, that has to be calculated and considered in this case.

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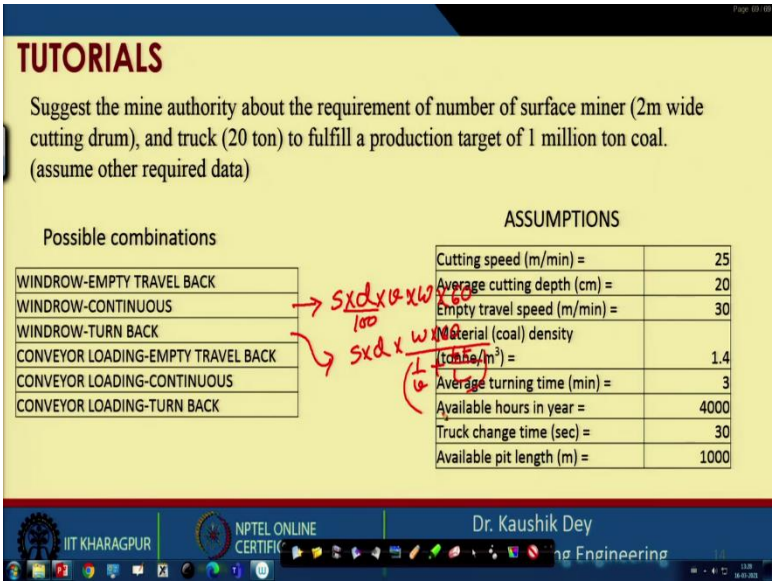

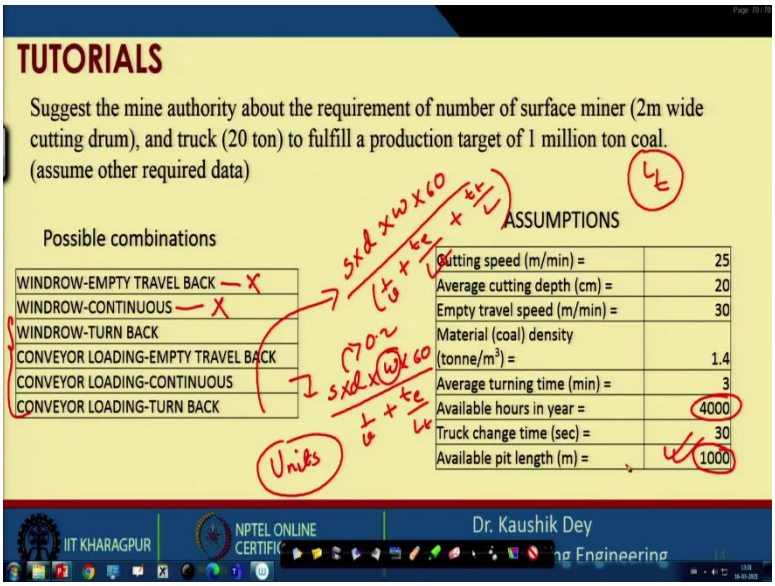

Now, similarly one need to do it for the other methods. This is windrowing continuous mode so, that is.

$$\frac{S \times L \times D \times \left(\frac{W \times 60}{\frac{L}{v} + \frac{t_t}{L_t}} \right)}{100}$$

This is for this one and similarly, the formula needs to be adopted for all these cases, the L_t is there, that calculated L_t which is 35 or something has to be used.

So, this is a

$$\frac{S \times L \times D \times \left(\frac{W \times 60}{\frac{L}{v} + \frac{t_c}{L_t}} \right)}{100}$$

In this case you need to find out the formula

$$S \times L \times D \times \left(\frac{W \times 60}{\frac{L}{v} + \frac{t_c}{L_t} + \frac{t_t}{L}} \right)$$

Now, in all the cases, I have removed 1000 because I have taken d is in meter that is 0.2 and you have to calculate for all these cases.

So, be very very careful about units, you need to careful about this; w value also for it is considered as 4000 here, it may be in different variations, it may be given maybe in power, in the percentage of utilization or in other way it can be given. So, those things have to be considered in this case and then the calculations should be made based on that. Now, see this available pit length is not considered in case of this one.

This is not considered in pit length because it is not dependent on the pit length and this is also not dependent on the pit length. So, for these two cases bit length is not affecting a lot. But in other cases, pit length is affecting significantly. So, pit length is also having significant effect on the performance and that should be considered and that can be considered and that options are also there for how the things are changing based on that. Now, let us look into the values.

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TUTORIALS

GIVEN		CALCULATION	
Drum width (m) =	2	Length of cut to fill a truck (m) =	35.71
Truck capacity (tonne) =	20	Time required to fill a truck (min) =	1.43
Production target (tonne) =	1000000	hourly production (tonne) =	51.02
ASSUMPTION		**PRODUCTION (TONNE/HR)**	
		Windrow-Empty Travel Back	458.18
Cutting speed (m/min) =	25	Windrow-Continuous	840
Average cutting depth (cm) =	20	Windrow-Turn Back	781.40
Empty travel speed (m/min) =	30	Conveyor Loading-Empty Travel Back	384.73
Material (coal) density (tonne/m^3) =	1.4	Conveyor Loading-Continuous	622.22
Average turning time (min) =	3	Conveyor Loading-Turn Back	589.47
Available hours in year =	4000		
Truck change time (sec) =	30	No Of Surface Miner (W-E)	0.55
Available pit length (m) =	1000	No Of Surface Miner (W-C)	0.30
		No Of Surface Miner (W-T)	0.32
		No Of Surface Miner (C-E)	0.65
		No Of Surface Miner (C-C)	0.40
		No Of Surface Miner (C-T)	0.42

truck m^3 in-situ coal

100 %

35 %

TUTORIALS

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		No Of Surface Miner (C-T)	0.42

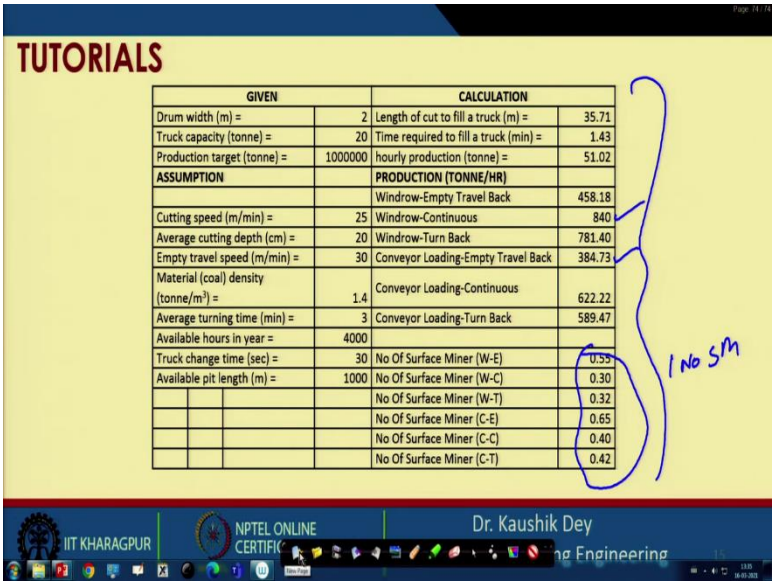
Highest

Lowest

3 min

1000/30

30 min



So, in this case, you can see given this one truck capacity, production target and our assumptions, we have considered this one, this one, this one, this one, this one and this one. So, these are the assumptions we have made. Now, first we need to calculate the L_t. So, see these calculations we have already shown you, you have to convert the truck capacity, truck capacity that is 20 tonnes.

This one x m^3 you have to convert the same in situ coal meter cube and then from there you are calculating, you have found it as 35.71, length is required to cut and fill the truck. Now, often it may be possible we are not able to utilize the complete 100 percent of the truck capacity. So, in that case we can reduce it to 35 also and based on that we can calculate.

So, all these considerations are there that can be taken that may not be taken. So, in fact, if a practical mindset is carried out, then it is better to consider a percentage of the truck is filled and rest part is not filled because all these requires operators' efficiency and in any case no calculation can be made based on the overloading condition because overloading is not allowed.

So, now it can be seen, this is the particular case, it is considered and the production tonne per hour in windrowing empty travel back mode, windrowing continuous mode, empty travel back mode, continuous mode all are expressed in tonnes per hour. This is for turn back mode, this is conveyor loading turn back mode, this is conveyor loading continuous mode and this is conveyor loading turn back mode.

So, I draw your attention on this one. So, windrowing continuous mode always gives the highest production and empty travel back conveyor loading is the lowest one. In this case, the

only one thing has to be considered that conveyor loading is the minimum one that is understood, but whether it will be this one or this one that is depending on the empty travel back time and turn back time.

So, as we have considered turn back time is 3 minutes, here and empty travel back that is 1 kilometre divided by this empty travel speed is 30. So, it is taking around 30 minutes for empty travel back. So that is why a significant difference that is why it is showing this one. But if this empty travel back time is less than this one. So, it will become the lowest production.

So, that is why this is highest, this is lowest and all rest all are in between. So, considering that if we are trying to find out the number of surface miners, we can find out the number of surface miners required for all the cases are less than one. So, one number of surface miner if procured, that is satisfying in all the conditions so that is adopted very easily. So, you will suggest mine authority that you purchase one surface miner.

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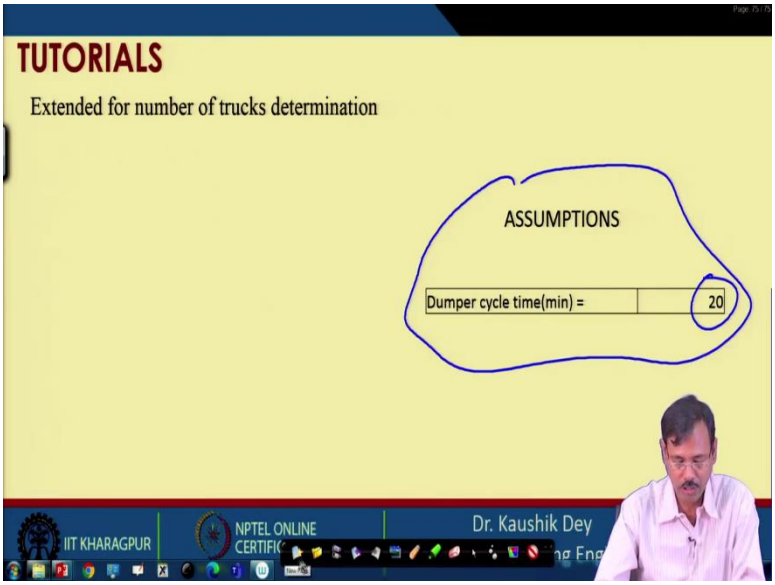

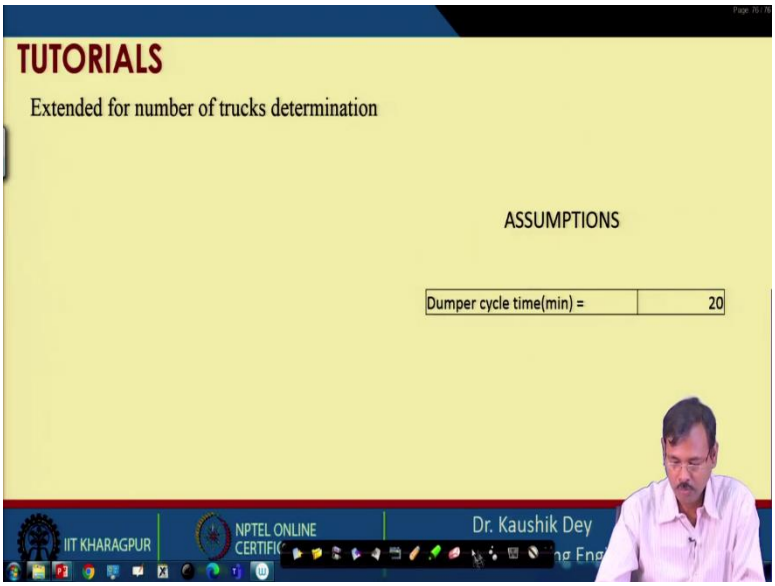

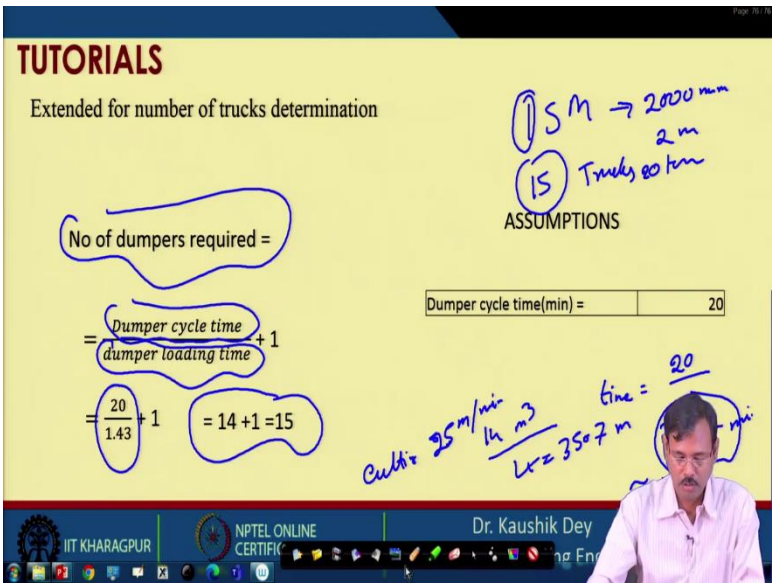

Now, you need to calculate how many numbers of dumpers you have to provide for the surface miner. Now, for this you have to assume; so you assume that what is the cycle time of the dumper. So, we have assumed dumper cycle time is 20 minutes, you can assume anything and we have to find out what is the filling time of dumper because we have already covered the similar calculation for for the shovel also.

So, we have to find out the number of dumpers is basically the dumper cycle time divided by the dumper loading time plus 1. So, dumper loading time we have found; it is the dumper loading time is basically the truck capacity and you have to find out the dumper loading time is how much so, that for 14-meter cube, you have found your L_t is 35.7 meter, your cutting speed is 25 meter per minute.

So, 35.7 meter to run this surface miner need this much of time, so, this is the minute so, it is coming close to 1.4 minute, so, 1.4 minute is the dumper loading time by the surface miner. So, we have added 1 additional dumper for this case. So, we can identify we need to procure 15 number of trucks to combine this with the surface miner.

So, with this our suggestion to the mine authority, 1 surface miner of 200 mm drum width, 2000 mm rhomboids or 2-meter drum width and for along with that we must procure 15 number of trucks of 20 tonne capacity. So, that is the solution for this problem. So, let us close at this position. We will continue the last class of the surface miner that is the cost calculation in the next class. Thank you.