Surface Mining Technology
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Lecture No. 44
Excavation with Bucket Wheel Excavator - 3

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Let me welcome you to the forty fourth lecture of NPTEL Online Certification Course - Surface Mining Technology. We are continuing with Excavation with Bucket Wheel Excavator. This is the third and final lecture of this excavation with Bucket Wheel Excavator. In this class, we will calculate the performance of bucket wheel excavator.

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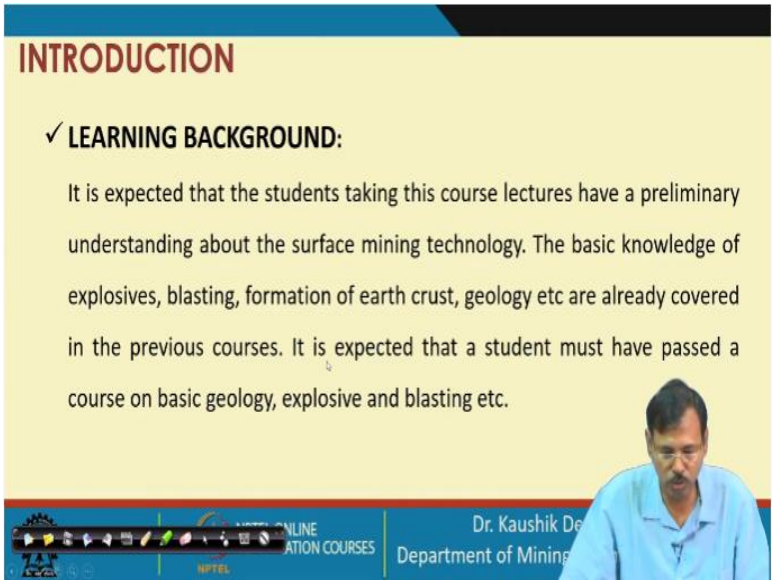

But as we do in every class, let us look once again the learning background required for surface mining technology course.

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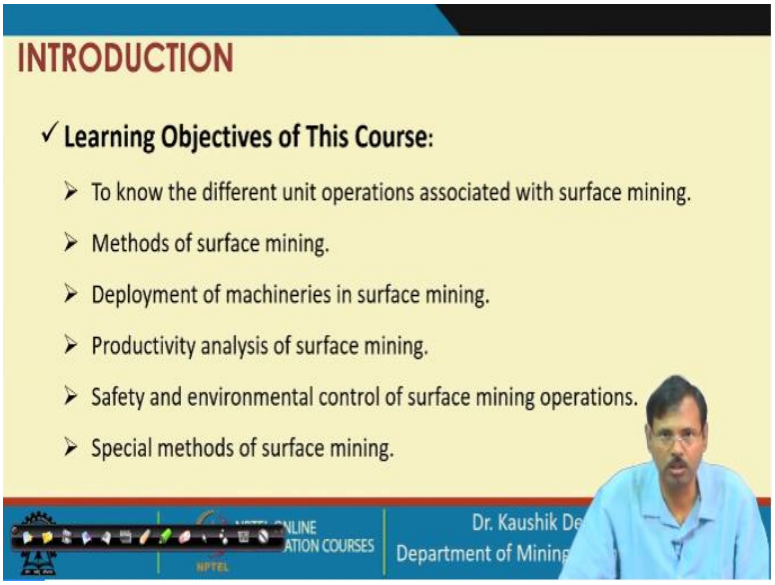

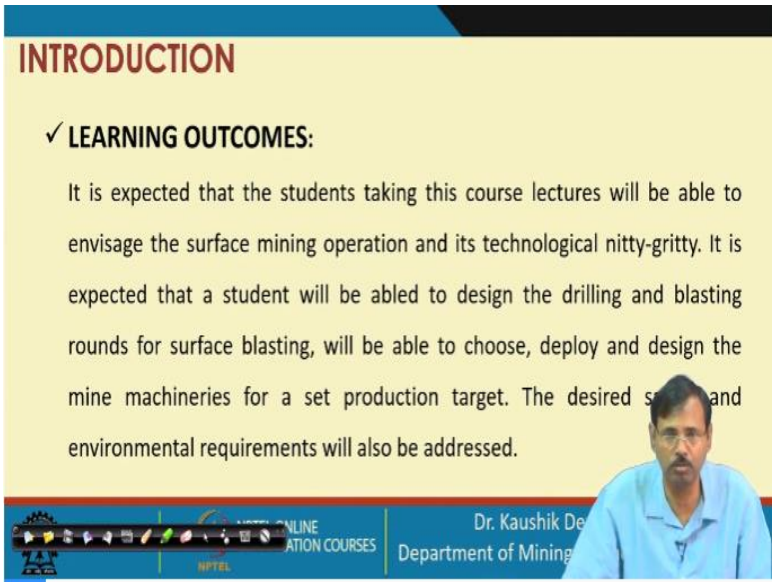

The set objectives of surface mining Technology course in this NPTEL Online Certification Course. These are the expected learning outcomes from the participant of this surface mining technology course.

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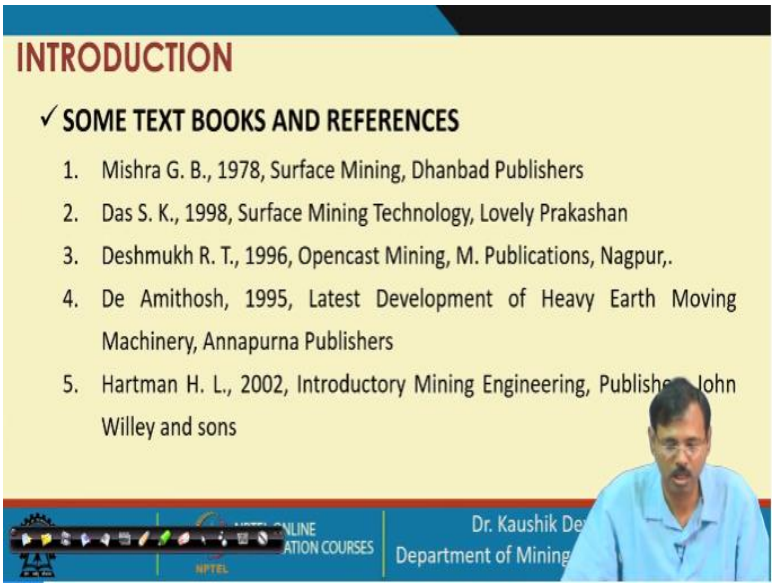

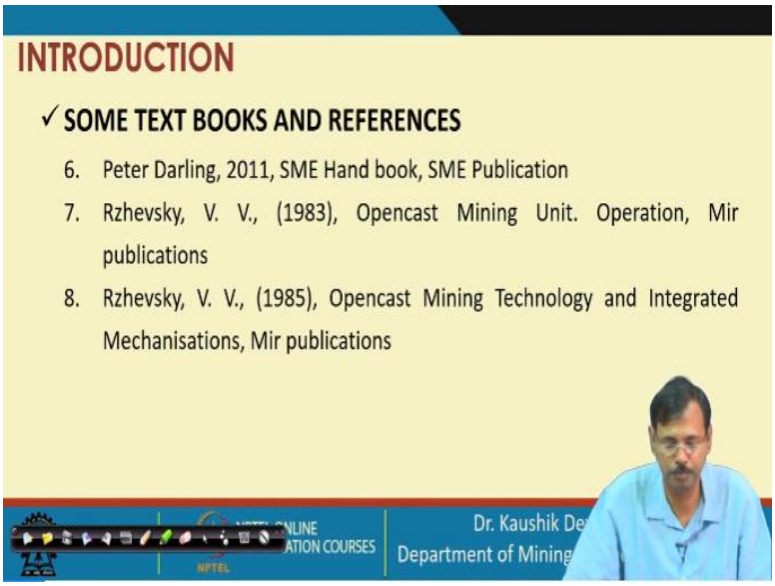

And these are some of the text and reference.

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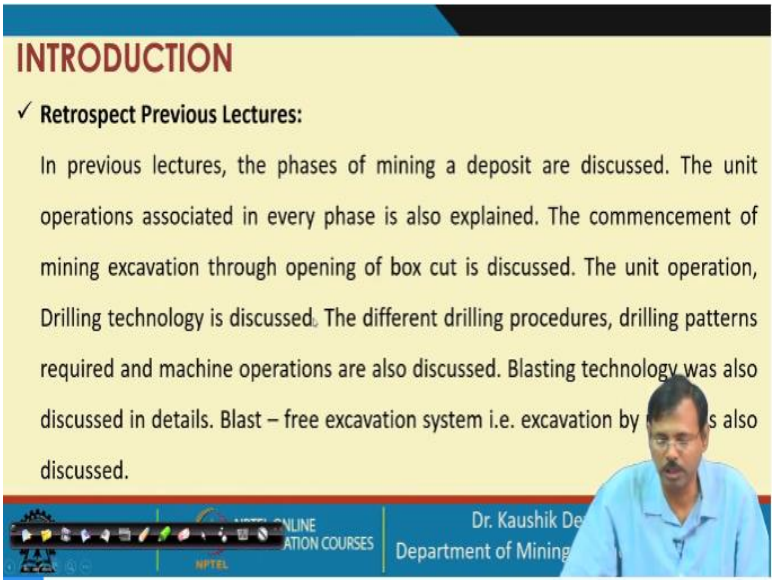

And as we retrospect whatever we have covered so far, here we have covered so far the phases of mining a deposit we have covered opening of surface mining through box cut, we have covered the drilling technology, we have covered blasting technology, we have covered plus three excavation of rock using ripper, we have covered the handling of fragmented rock mass by shovel and transporting the same with the dumper and other transportation system.

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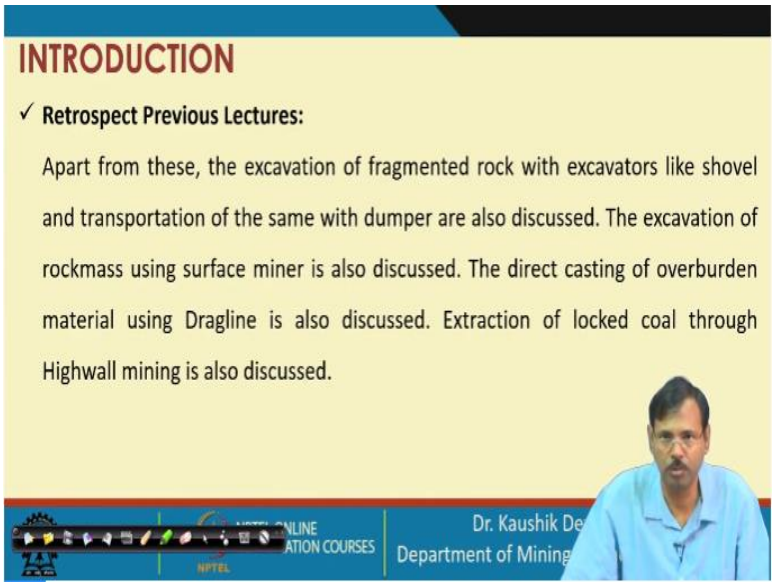

We have covered the excavation of rock mass using surface miner, we have covered the direct crusting of the overburden rock material by drug line. We have covered a high wall mining operations in which the locked coal under the high wall is excavated and we have already covered two lectures related to bucket wheel excavator in which we are introduced

with the bucket field excavation system and we have seen the different types of excavation possible with the bucket feel excavator, how that drop cut and terrace cutter made, how the full block method and hub block method are carried the types of bucket Feel excavator crowded type, crowd less type. These are already discussed in the previous two lectures.

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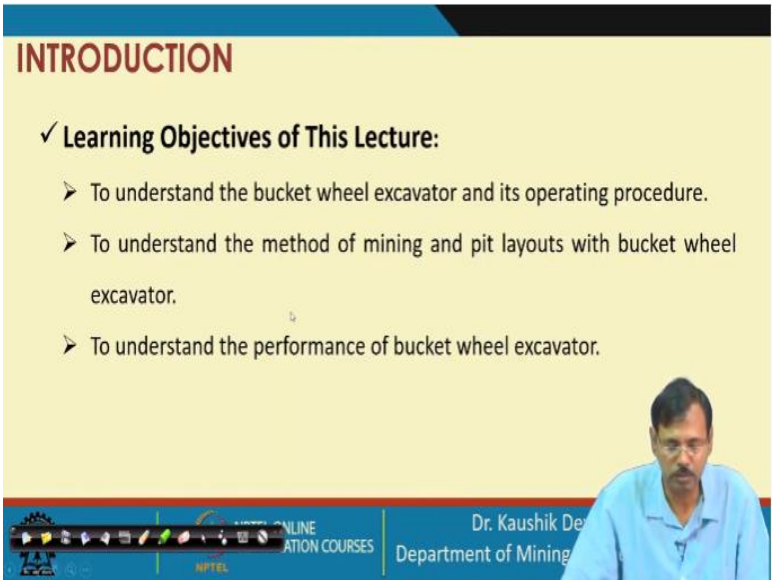

And these are the objectives of these three lectures. We have already understood the bucket wheel excavator and its operating procedure. We have covered and understood the method of mining and pit layouts with bucket wheel excavator and the performance of bucket wheel excavator.

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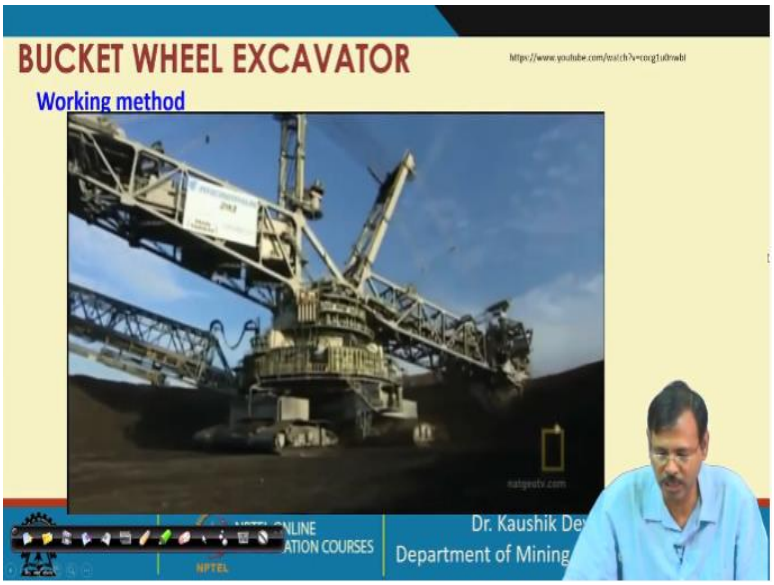

So, in this class we will calculate the performance of bucket wheel excavator, but before that let us look once again how the bucket wheel excavator works. Then it is easier for us, you can see the bucket wheel excavator is having a number of buckets fitted with these buckets are these buckets are cutting the material and as it is cutting it is allowing the material to coming to the conveyor of the cutting boom.

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This conveyor is taking the material and allowing that material to come to the discharge boom and discharge boom is discharging the material to a shiftable belt conveyor and the shiftable belt conveyor is transferring that material.

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So this is in a nutshell, the bucket will excavator is working and as the bucket is trucking with the face wall, as the bucket is trucking with the phase wall, the rock is basically coming into the or ill being filled disclosed and filled the bucket of the bucket wheel excavator and after entering the material into the bucket wheel excavator, the material is discharged to the conveyor of the discharge cutting boom.

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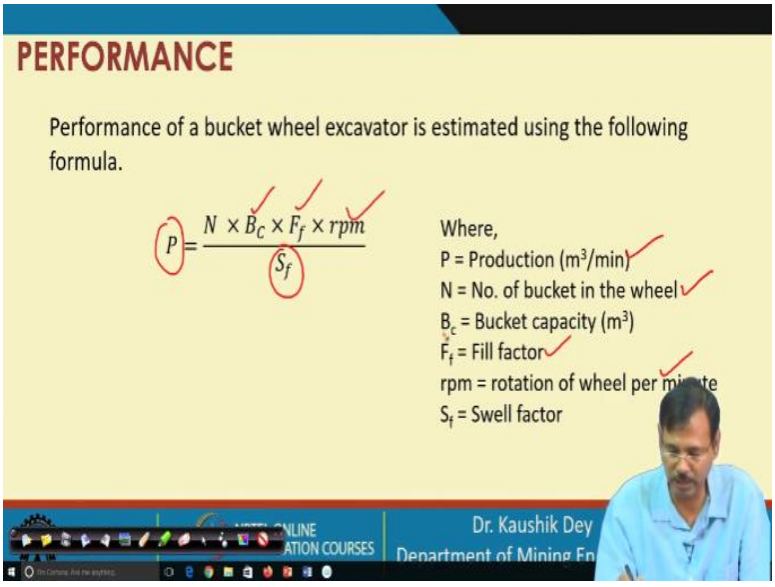

So, this is in a nutshell the excavator is bucket excavator is working. Now let us look how we can expect the performance of the bucket excavator as the bucket wheel excavator is fitted with a number of bucket, the performance can be estimated like this, if the number of buckets N is the number of buckets in the well, P is the performance production meter cube per

minute, B_c is the capacity of the each bucket. F_f is the fill factor of the bucket, rpm is the rotation per minute of the bucket and S_f is the Swell factor.

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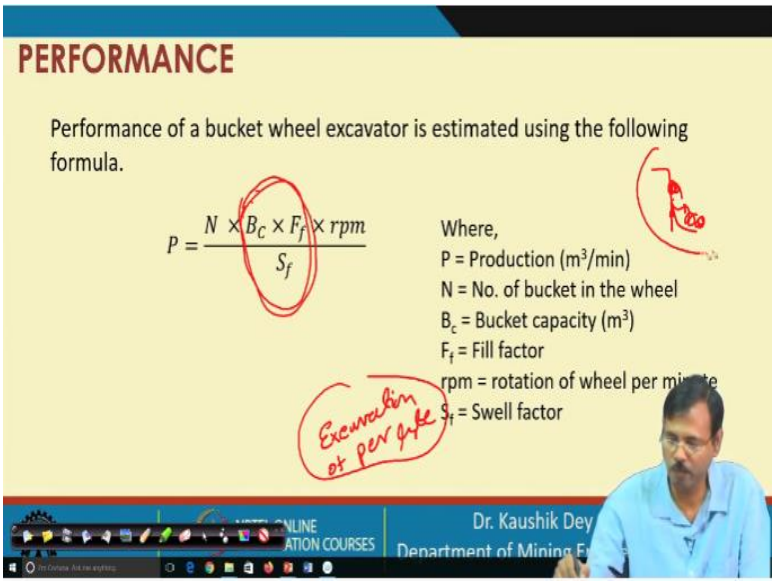

Now if the bucket is not, say, cell less type or semi cell less type, then bucket capacity calculation is difficult. So basically, we can consider this part, this B_c into F_f into is basically the excavation of power byte. So, this is the excavation, when a bucket is trucking the face is trucking the face the material dislodged and coming into this the quantity of that material is basically this one.

So, this material if we do not have that B_c also, then also this bucket bite excavation material is basically considered here as the excavated material coming out per bite. So, the production is basically the P, now N is basically the number of bucket means the number of bit and rpm is the rotation of the wheel per minute. That is basically giving us the performance of the machine.

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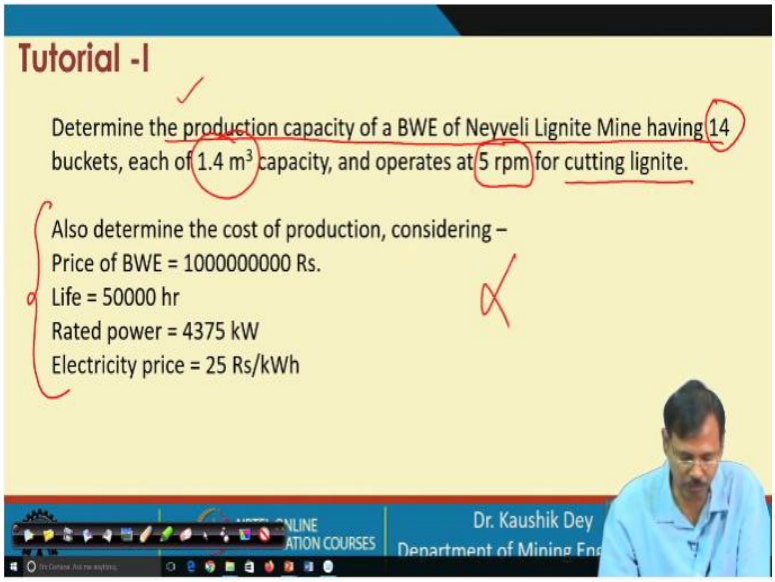

So, now let us go for solving some problem related to this. So, our first problem is that determine the production capacity of a bucket wheel excavator of Neyveli Lignite Mine fitted with a 14 number of buckets as the capacity of each bucket is 1.4 meter cube and it is having the rpm of 5, while cutting the lignite. Rest part we are not considering at this, currently we have to find out the production capacity.

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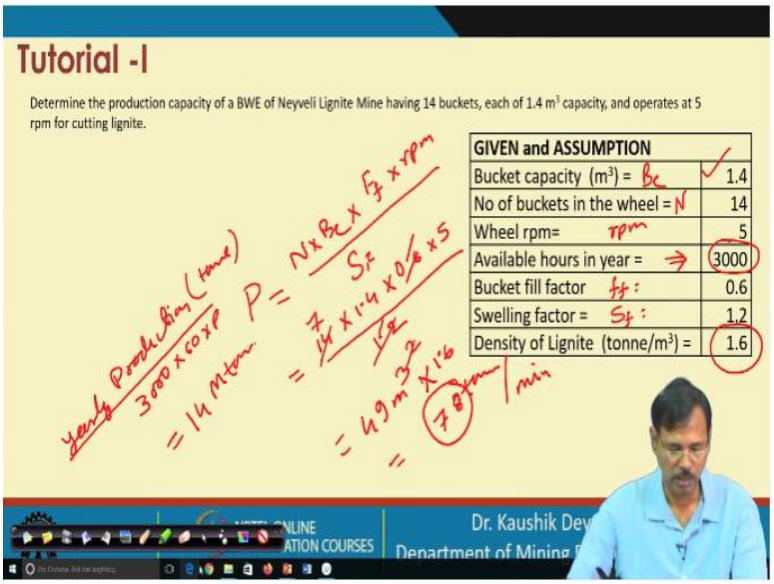

So, for this let us find out we are already given the bucket capacity is given. So, B_c is given number of when buckets in the wheel is given, so N is given, rpm is given, 5. We have assumed this is the available hours in the year. Bucket fill factor is given. Swelling factor is given and we have assumed the density of the lignite is 1.6 per meter cube. So, the production

capacity P is the meter cube per minute is equal to 14 is equal to N into B_c in to F_f into rpm by S_f. So, N is 14, B_c is 1.4, Ff is 0.6, rpm is 5, S_f is 1.2. So if this is given so this is coming 2 and this is coming 7. So, this is understood this is 49 meters.

Now if we are multiplying it with 1.6, this is coming to tonne. So it is coming something around I think 78 ton or something like that that can be precisely carried out on multiplication. So, this is the production per minute, we have seen the available hours for cutting because the in bucket wheel excavator the downtime that is non-productive times are significant as occasionally the shiftable conveyor has to move that time.

The bucket wheel excavator has to stand alone. These are carried out very frequently and moving acceptable conveyor means it is almost for one shift time is required for shifting the shiftable conveyor. Sometimes the main conveyor has to be extended so as the benches are moving.

So, the down times are non-productive times, are also significant. But we are expecting that 3000 hours are available for bucket wheel excavator to cut continuously. And in considerations with that our production, yearly production in tonne will be 3000 into 60 into this whatever is coming that P, so this is ours 3000 hours. So, we have carried out and it can be seen. It is 14 million tonnes found as the production from this case. So, let us look into this in the detail calculation.

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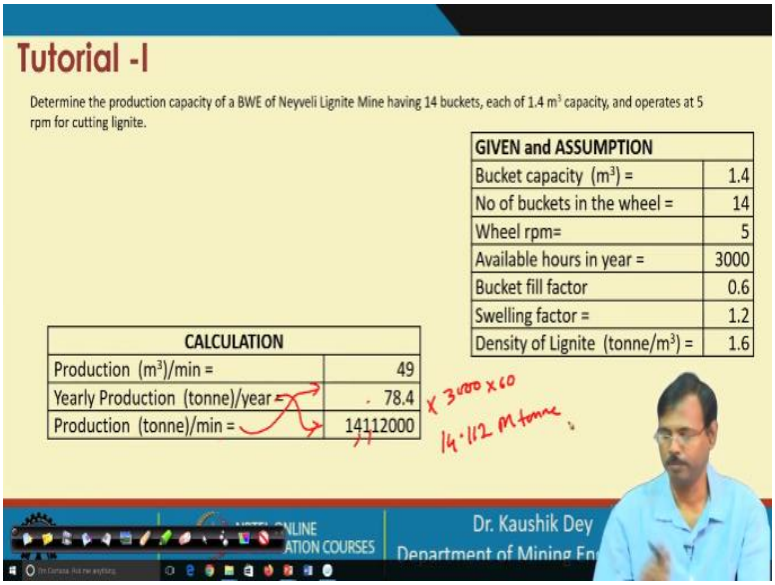

So, the production 49 meters cube per minute. So, on multiplying this with 1.6 we have found this is 78.4 tonne, this is not here, this is per minute. Actually, there is a problem, so this is

here, this is here. So, this is production in tonne per minute. So, yearly production, you have to multiply this with 3000 and 60. So, it is coming 14 million tonne, 14,000,001 lakh. 1 crore 41 lakh 12 thousand tonne. So, that is the production or you can say this is 14.112 million tonnes can be produced by this bucket wheel excavator. So, this is the first problem from where you can see this is the huge production you can achieve from one bucket wheel excavator.

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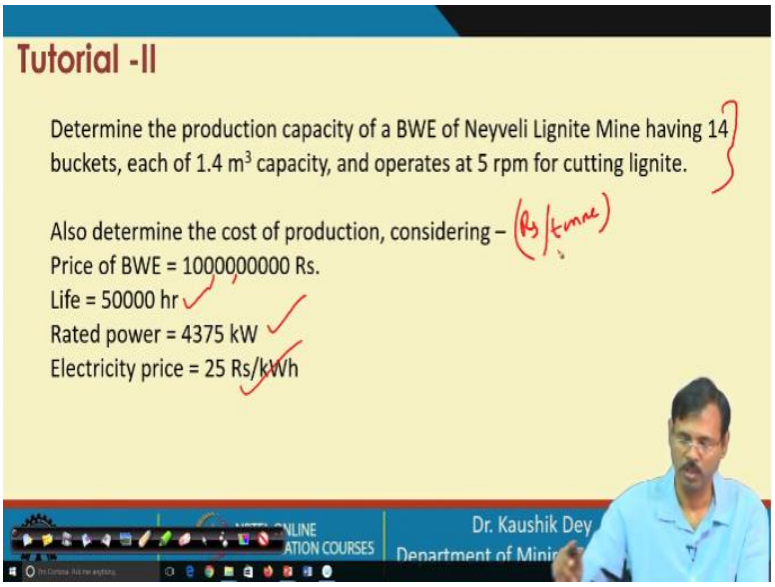

So, let us continue for the second problem, so second problem is the same. If you are considering this excavator the price of discuss excavator is 100 crore rupees. Then the expected life is 50,000 hours. The power required for this bucket wheel excavator is 4375 kilowatt and the electricity price is 25 rupees per kilowatt hour. Then the cost of production, we need to find out cost of production of lignite in terms of rupees per tonne. If we are considering this, then we have to assume some more data also.

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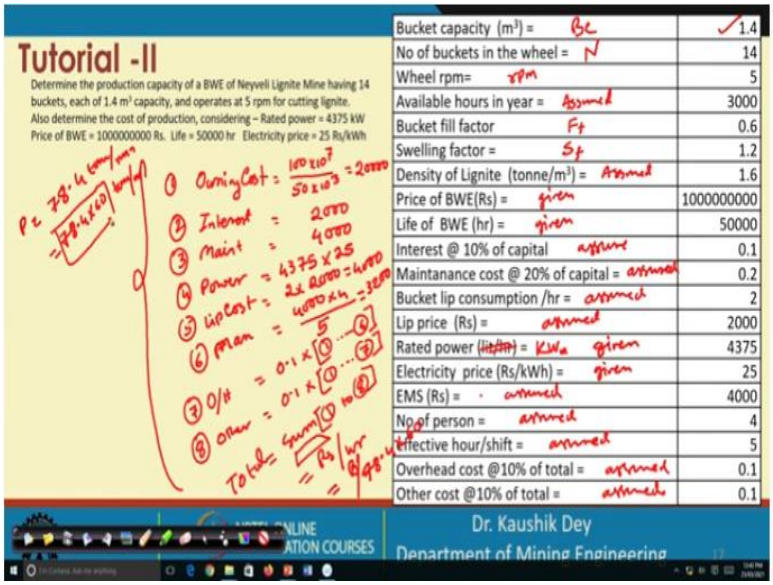

Now let us look into the assume data. So, in this case you can see the bucket wheel excavator capacity is given this is busy. The number of buckets is given 14 rpm here. Available hours assumed. This is assumed bucket fill factor given selling factor. Given density assumed price of the bucket, given life, we assume 10 percent capital interest, maintenance assumed 20 percent of the capital, bucket lip consumption we have also considered here bucket tip.

So, this is assumed lip price is also assumed that is 2000 rupees rated power. Actually, this is kilowatt hour, this is given kilowatt power, given this is electricity price given this is EMS assumed, we always assume it is 4000 rupees number of persons required is 4, that is also we have assumed and effective hour perceived is also assumed as the 5 hour overhead cost assumed 10 percent and other cost also assumed 10 percent in this case.

So, with this assumption and given data, we have to find out the cost of a person. So, let us consider it, first we have to calculate the owning cost. So, this is price by life, so price is 100 crores, 100 into 10 to the power 7 and life is 50 into 10 to the power 3. So, that means it is 2, then 10 to the power 4, so 1111. So, 20,000 rupees is the owning cost. Now let us consider the interest, interest is 10 percent of the owning cost. So, it is 2000 rupees. Then we have considered the maintenance cost is 20 percent. So, that is 2000 into 2. So, this is 4000.

Now next our power cost, so power cost is rated capacity 4375 and power price is 25 rupees per kilowatt hour. So, whatever is coming this is the electric power cost and then the lip is consumed. Two lips are consumed every hour, so the lip price is 2 into 2000. And so that is 4000 rupees. And then EMS manpower man power. EMS is 4000 rupees, we are deploying 4 person, so this is the cost in one shift. So, our lip cost is this much. So, this is coming 3200.

And after that we are considering if we are making it 1, 2, 3, 4, 5 and 6, then our overhead cost. 0.1 into 1 to 6 and other cost 0.1 into 1 to 7. So, these are the cost and if we are calculating this one we will get the cost, total cost is the sum of 1 to 8. And this is expressed in terms of rupees per hour. So, this is the cost of bucket wheel excavator is capital in per hour when it is under operation.

Now we have to see what is the hourly production. So, if you are considering the hourly production, we have seen the production per minute is 78.4 tonne per minute. So, hourly production is 78.4 into 60 tonne per hour. And if now whatever we are obtaining at this position, then to convert it into rupees per tonne, we have to make it 78.4 into 60, we have to divide whatever value we are getting here, we have to divide that value with this value. Then we will get the price in rupees per tonne.

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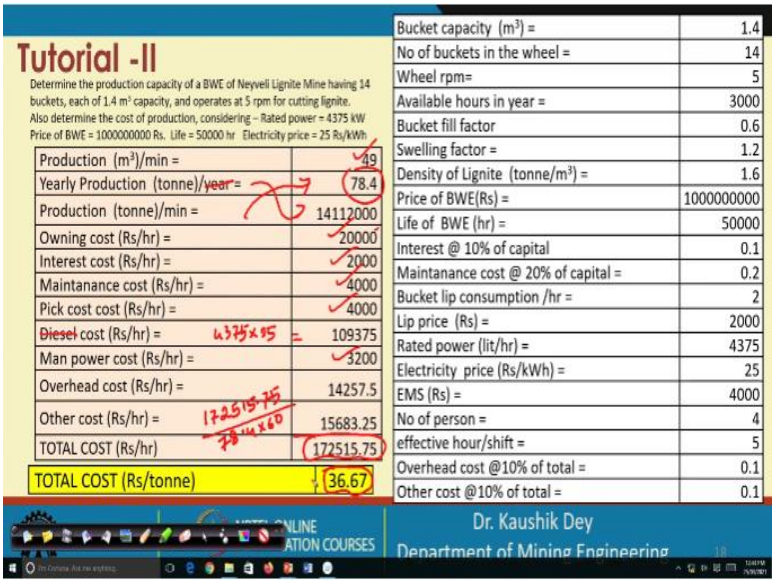

So, now let us look into the calculation part. Now this is the calculated values, production 49 meters cube. Then it is again reverse, so this is here and this is here. So, owning cost we have found 20000 rupees per hour, so interest cost is 10 percent of that one 2000 rupees maintenance cost 4000 rupees, 20 percent of this one. Then the pick cost 4000 rupees is two into 2000.

Now this is the power cost, power cost is 4375 into 25. So, this is coming this much, so this is something 109375, man power cost is 3200 overhead cost 10 percent of all this is coming 14000 rupees other cost is 10 percent of all these will 15,000 rupees. So, altogether production per total cost is 172,515 is the rupees per hour and whenever we are dividing it, so

this is 172515.75 divided by 78.4 into 60. So, this is coming 36 rupees 67 paise that is rupees per tonne.

So, the total if you are considering the bucket wheel excavator excavating lignite, so that excavation cost using bucket field excavator for lignite is coming 36 rupees only per tonne of lignite. So, this is the cost of excavation for lignite and then this is considered with a highly high considerations of that the price is 100 crores. And we have also considered the rated capacities of the power is fully taken with the price of 25 rupees per unit.

So, with this consideration, it is found that the price is coming in and around 36 rupees for per tonne of excavation of so this is just estimation. We need to consider the other components depreciation, etcetera. All these components are also there, so those are not considered in this case, but this is a similar type. All these options and the realistic some values can be taken for having some cost calculation for this purpose.

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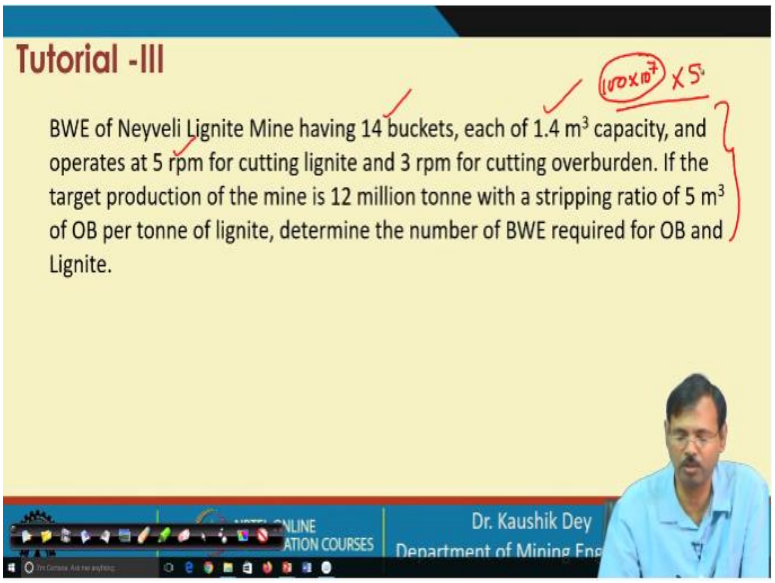

Now let us look into the third topic, that is, what is the capital requirement for opening a mine? Suppose we are operating or we try to open a mine like Neyveli Lignite mine and we would like to have the same model of bucket wheel excavator, which is having a 14 buckets, 1.4 meter bucket capacity, 5 rpm cutting in the lignite.

Now we want to know how many number of machines are required because this machine price is 100 crore rupees. This is the machine price. If we have to procure 5 machines, then we have the capital requirement of this one, so that is why what is the capital requirement?

We want to know that one. For this, we have to find out how many number of bucket wheel excavator are to procure.

Now, for calculating this, we are trying to identify what is our requirement and it is found that our production target is 12 million tonne, We want to produce 12 million tonne of lignite every year and the lignite is situating at depth and that is giving us a overburden handling of 5 meter cube of over burden for per tonne of Lignite has to be considered. So, with this consideration, we have to find out how many number of bucket wheel excavator are required for overburden and how many for the line.

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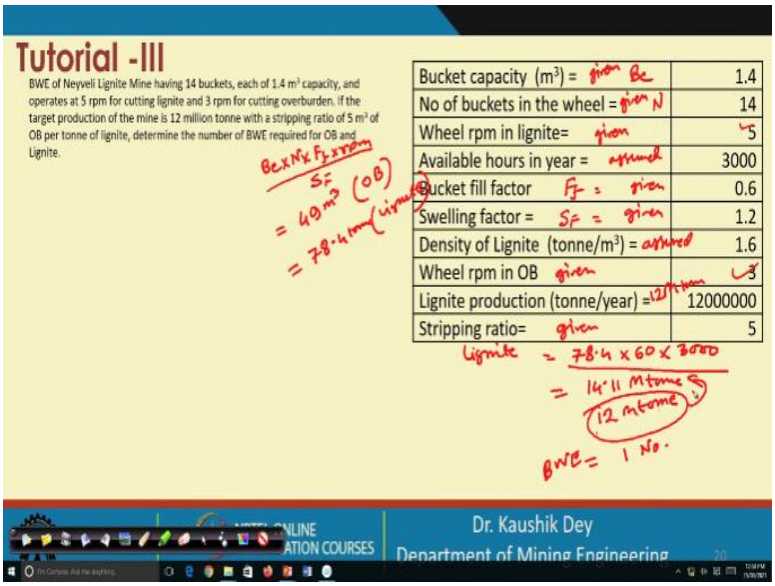

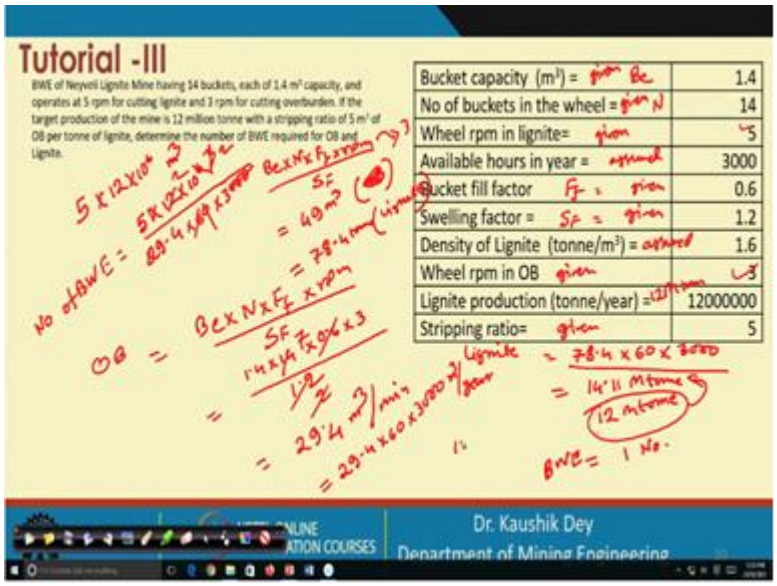

So, this calculation has to be made and to calculate this, we have to assume some of the data so it is given to us that bucket capacity it is given, number of bucket given for lignite is given

for overburden is also given. So, for over burden is 3 and for lignite it is 5. We have assumed the available hours in the year bucket field factor is swelling factor is also given. Density of lignite is assumed. We need not to assume the density of over burden because we can consider it directly the volume it is tonne conversion is not required. Stripping ratio is also given which is 5 meter cube per tonne of lignite. So, we have to calculate the number first.

In first phase we are considering the capacity of the bucket and you know using the formula B_c into N into F_f into rpm by S_f. So using this formula we have already calculated our bucket capacity is 49 meters cube, that is the Nc meter cube. So, we will consider this for over burden and we will multiply it with the density for the lignite and it is found that it is 78.4 for lignite. Now we check what would be its yearly production capacity.

So, for lignite whenever we are considering we are multiplied this 78.4 with our available to make it our we multiplied it 60 and our available hour is 3000. So, this is the total capacity and we have seen it has found 14.11 million tonnes. So, that is the production found from one bucket wheel excavator. So, this indicates our production target is 12 million tonne, this is nothing but 12 million tonne.

So, that means you have to produce 12 million tonne, we have to produce 12 million tonne. So, 14 million tonne is produced by one machine. So, 12 million ton is less than that. So, obviously our number of bucket wheel excavator required for lignite excavation is one number and that is satisfied to produce this 12 million tonne. So, this is for the lignite.

Now let us look how many number of bucket wheel excavator is required for OB, as in OB this rpm is reduced to 3. So, for OB the production requirement is Bc into N into F_f into rpm by Sf, so it is coming 1.4 into 14 into 0.6 into rpm is 3 and Sf is 1.2. So, this is 2, this is 7. So, this is 21 into 1.4, so that is coming. So, this is coming around 29.4 meters cube. So, we need not to change it to the tonne. This is the insitu centimetre cube. This much OB is handled in 1 minute, so you need to multiply with 63 hundred. You will get 29.4 into 60 into 3000. This is the meter cube per year can be handled by the bucket, one bucket wheel excavator.

So, what is the requirement? Our requirement of excavation of overburden is 5 into 12 into 10 power 6, this is the meter cube of material to be handled by the mine every year. So the number of excavator required, 5 into 12 into 10 power 6 divided by 29.4 into 60 into 3000. So, if we are doing this, so whatever is coming, this is that is the number is required. So, I think this is coming around 10 or something like that. So, let us look into the detailed calculation in the next slide which is provided.

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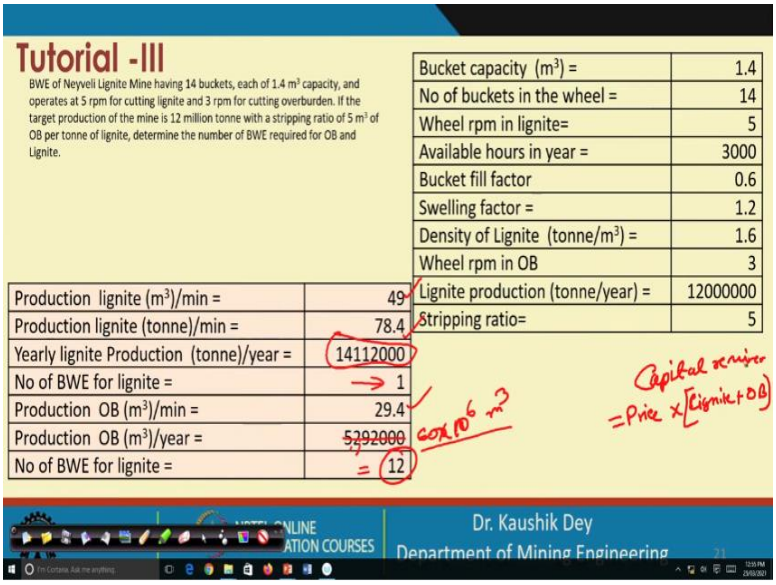

So, you can see the production for lignite is 49 meters cube, which is coming 78.4 tonne. So, this is the production achieved from one bucket wheel excavator, which gives the number of bucket wheel excavator required for lignite is 1, production requirement in OB production we are obtaining from OB is in meter cube, 29.4 meters cube per minute. OB required to be handled 5 into 12, so that is coming around, I think there is some problem with this.

So, 5 into 12 it is coming around, say 660 into 10 to the power 6 meter cube and if we are dividing it with this, so whatever value is coming, I think this value is a little bit wrong here. So, whatever value is coming, that will be the number of bucket wheel excavator required for overburden handling. So, that is why you have to find out the capital requirement: is the price of each bucket wheel excavator multiplication required. The number for lignite plus OB is the capital requirement.

So, this is the in a nut cell, this is more or less about the production performance, determination of the number of machines and determination of the number of machines, determination of capital requirement and production target cost of excavation. These are calculated in this case and these are more or less all about the excavation with bucket wheel excavator. We will continue with the next topic in the next class. Thank you.