Surfacing Mining Technology
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Lecture 27
Excavation with Shovel - IV

Let me welcome to the 27th lecture of surface mining technology. We are continuing with excavation with shovel, this is the fourth lecture in this series. And in this lecture, we will discuss the pit layout. And we will discuss the cost analysis pertaining to the surface pertaining to the excavation with shovel.

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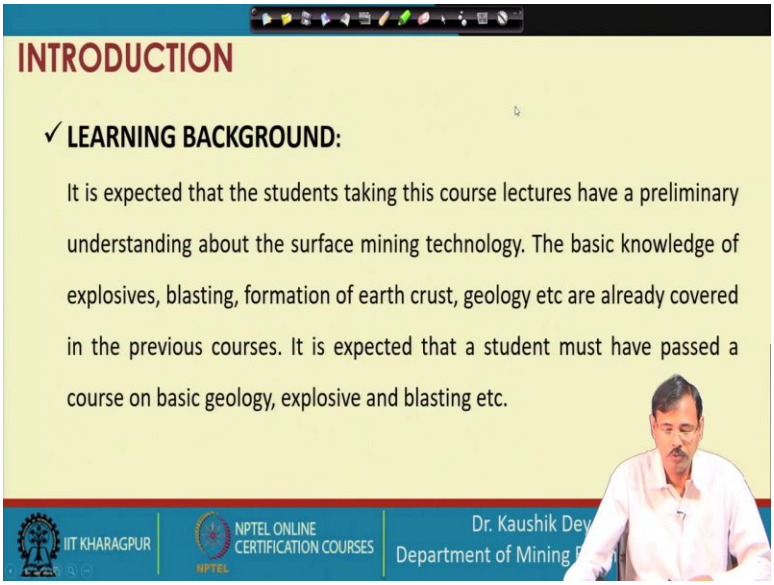

And let us have a glimpse of the learning background required for surface mining technology course.

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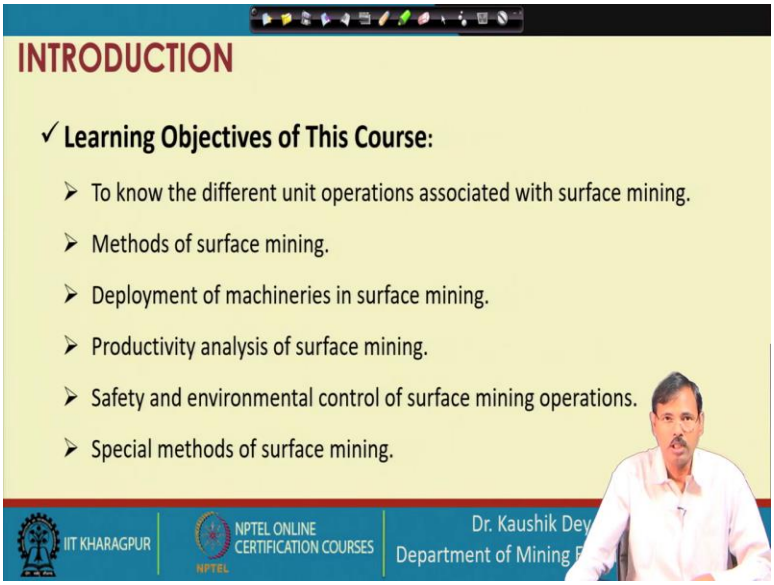

Learning objective of surface mining technology course.

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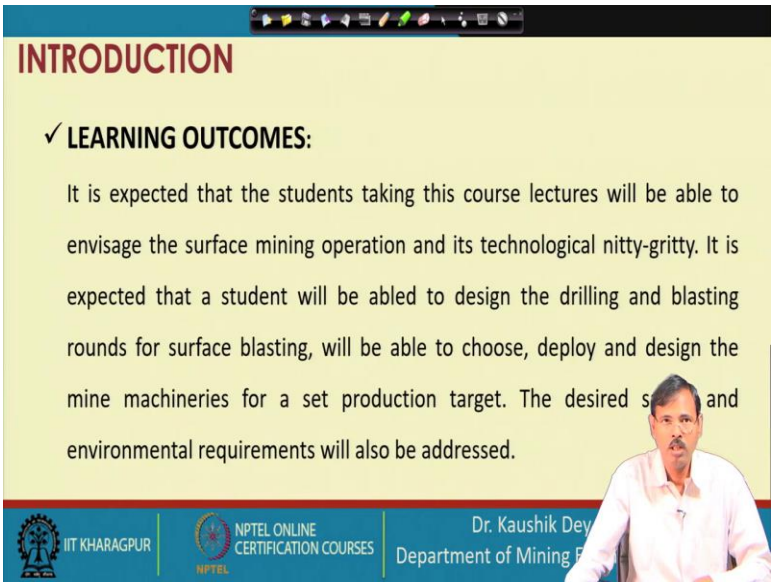

Learning outcomes expected from the participants of the surface mining technology course.

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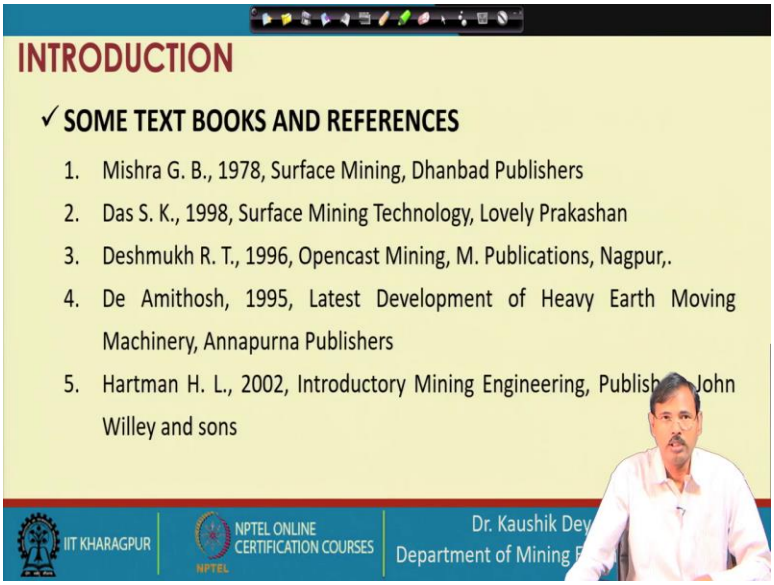

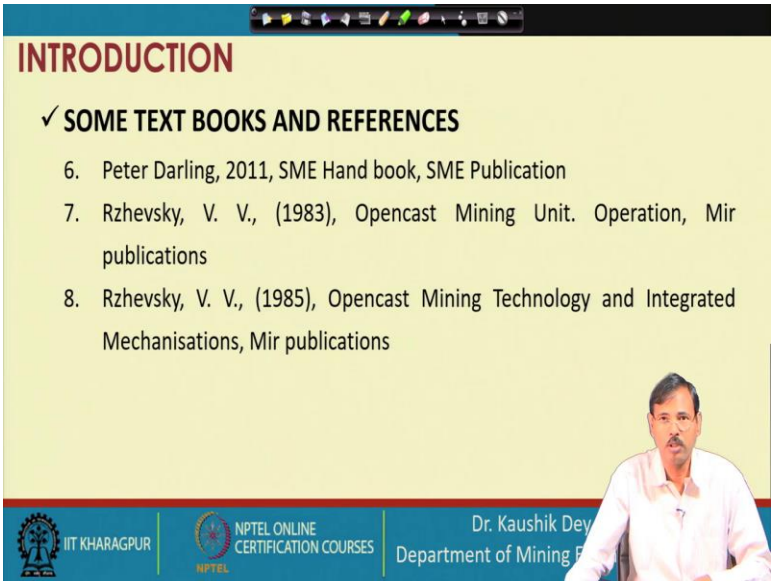

And these are some of the textbooks and references of surface mining technology course, apart from that, also, a number of videos are available in YouTube's web sources are also there. Please go through those things.

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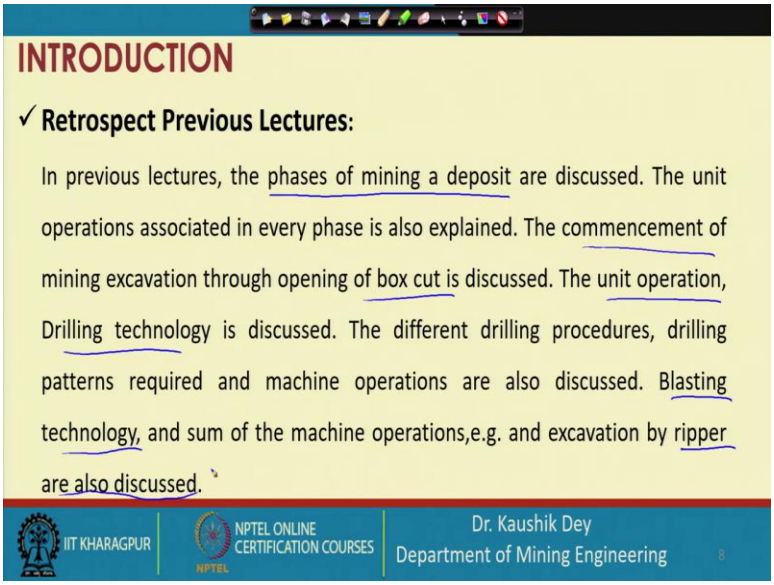

And let us retrospect of the previous lectures so far we have covered the phases of mining a deposit and we have also discussed the unit operations pertaining to those phases and how the decision will be made after each phase on whether the mining will be carried out or not. We have also discussed the commencement of surface mining using a box cut, and we have discussed the unit operations like drilling and blasting.

And we have also discussed the blast tree technology where the rock mass will be fragmented, and this is understood that the insitu rock mass which has to be mined has to be reduced in sight. So that the material can be excavatable and material can be taken out by the excavator or transported the where to the plant where it will be used. So, for all this drilling blasting, loading and transportation is carried out. So, basically, these are the sizing technique and material transportation technique which is practiced.

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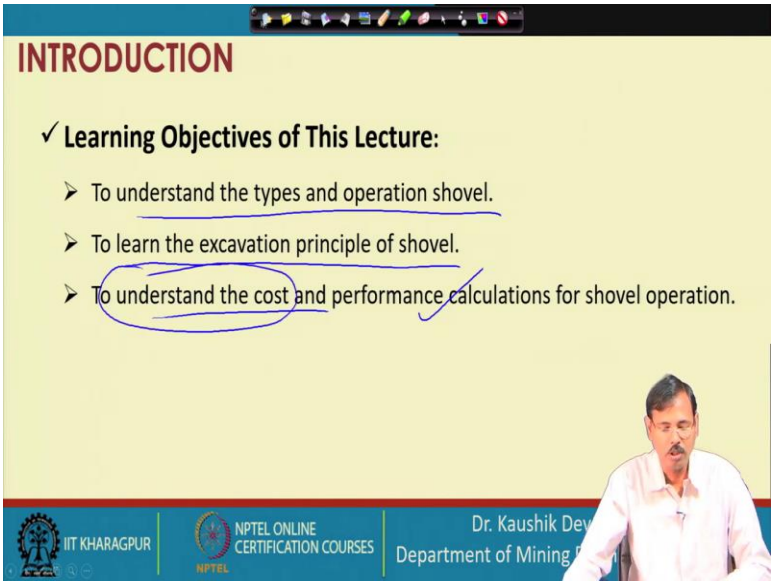

We are discussing the excavation by shovel. In this lecture series, our objectives are understanding the shovel's type and operation, excavation principles of the shovels, and the cost and performance calculation. So, we will understand the cost analysis of the shovel operations and the performance calculations we carried out in the previous lecture in this lecture.

So, most of the part is covered in this lecture, we are mainly eyeing the understanding of the cost of the cost analysis of the surface mining operations, but before that, let us discuss something related to the pit layout what could be the possible pit layout where the Surface Mining has to be carried out the best way it can be carried out.

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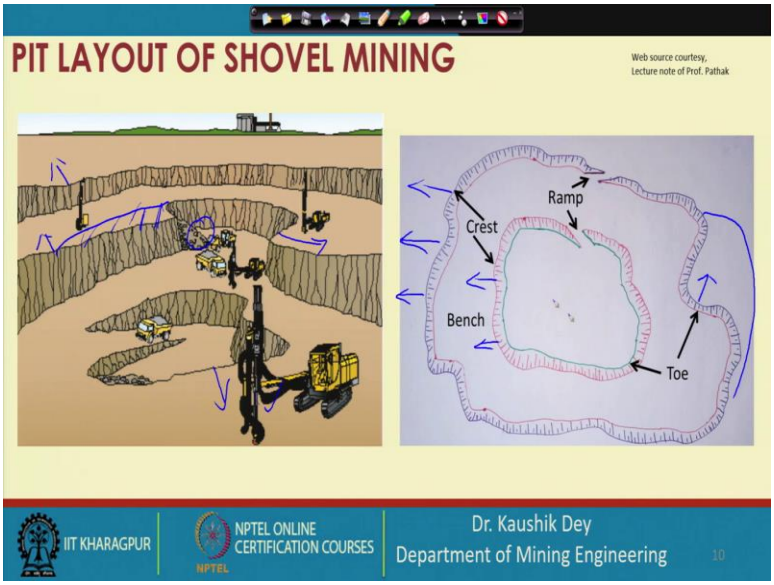

So, this is an example pit available; these are taken from the web sources I have taken from the lecture notes of Professor Pathak. So, you can see where the shovels are under operations, and this is the drilling is carried out this is the shovel that is taking out the material. So, basically, this excavation is in progress like this. So, this excavation this portion of material will be excavated, and the pit will be extended.

So, the peat is being extended in this direction, this is also grown in this direction, and in this direction you can see the extension is carried out in this direction. So, generally, the pit extension is carried out, and accordingly, our shovels are being deployed for the extending of the same. So obviously, if we consider a circular pit, these circular pits will be gradually extended in these directions. And this will also be gradually extended in this direction.

So, this is the gradual extension this will be extended in this direction so that in future, this can be made like this. So, this is how we are extending our pit, and as we are extending our pit, we are also changing the layout of the pit, and for that, our operation of the shovel is required. And for the benefit of the best operations of the shovel, we are designing our pit in such a way that that excavation can be made easily.

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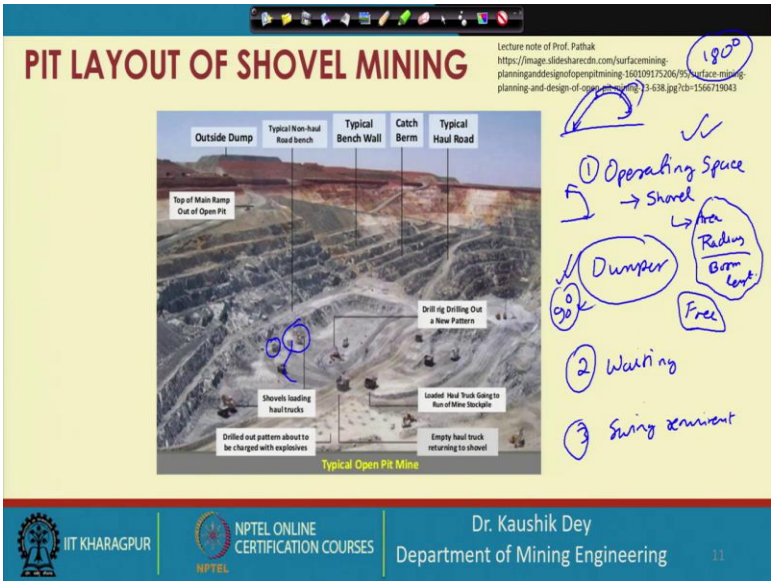

Now, a few things are essentially controlled while designing a layout. First is the operating space; the space required, suppose in this case the shovel is loading at this position. So, as this position is kept for the operation of the shovel, we have to provide sufficient space, so this dumper is taking the material and coming in this way. And this is the next tamper that is waiting to take the material.

So, these are important aspects of how the machine and its other supporting machines will operate in that particular space. So, the operating space has to be provided first for the shovel operation for shovel operations; we have to give the room as the area to be provided depending on the dimension of the shovel, including the term including the radius considering the boom length.

So, whatever area is available, considering the boom length as the radius that must be free and no machine, nothing will be placed manpower will be placed there. So that they will not pose any safety hazard in the operations of the shovel. Only the dumper which the excavator is loading has to be placed in this rest. All other machineries has to be placed outside this operating space.

So, this is the shovel's operating space that must be placed there while we are designing the pit. The second is the waiting dumpers; the next dumper must take the load. If the one dumper is underloading, that dumper's waiting space must be provided in that particular case. So, this is the second thing, and we have to minimize the swing requirement.

Because more angle swinging if a shovel is swinging this angle, and again returning this angle, this is the time required for swinging, but instead of that, if the shovel is swinging only this much, then the swing requirement is less if this is swinging this much. So, swinging must be close to 90 degrees is assumed. But it can be up to 180 degrees also. So, 180 degrees means we are going for the additional unwanted swinging; we can also restrict it to 90-degree swinging. So, we will try to make it as close to as 90 degrees swinging, that is also the third objective. So, these are the objectives of designing a pit layout.

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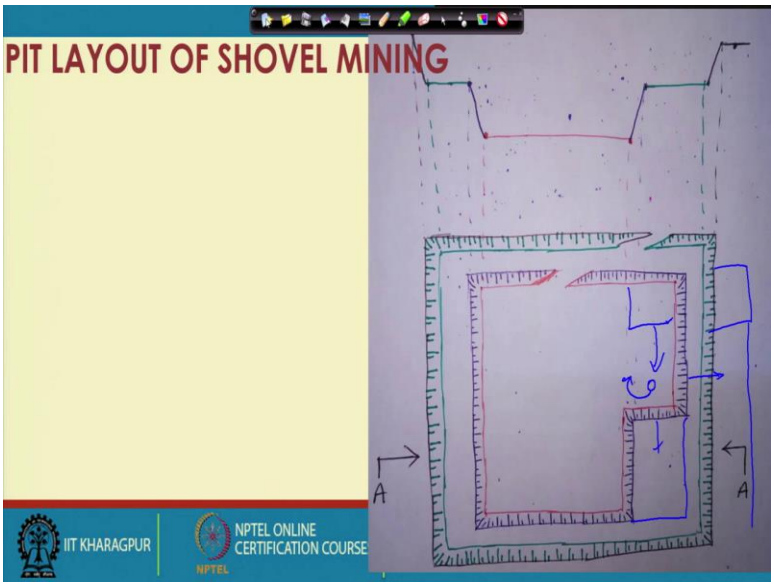

So, this is a rectangular pit; you can see if the pit is moving; if a pit is moving this way, the pit has to move in this way; we provide an excavation at this position, then gradually throw this one at this. So, what is the benefit? The benefit is that our shovel has to swing only 90 degrees in this case. That is the benefit in this way. So, when it reaches this, we will do the same thing at this position. And we will extend this gradually at this in this direction. So, this is how we carry out our pit extension.

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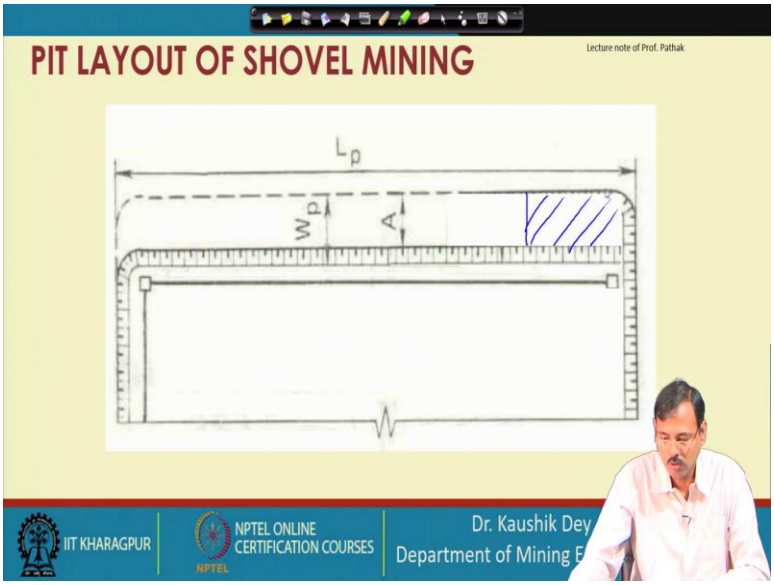

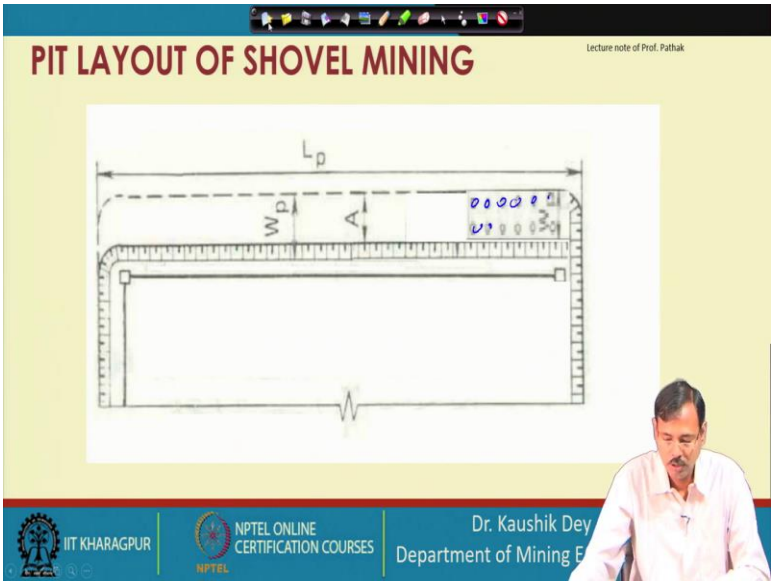

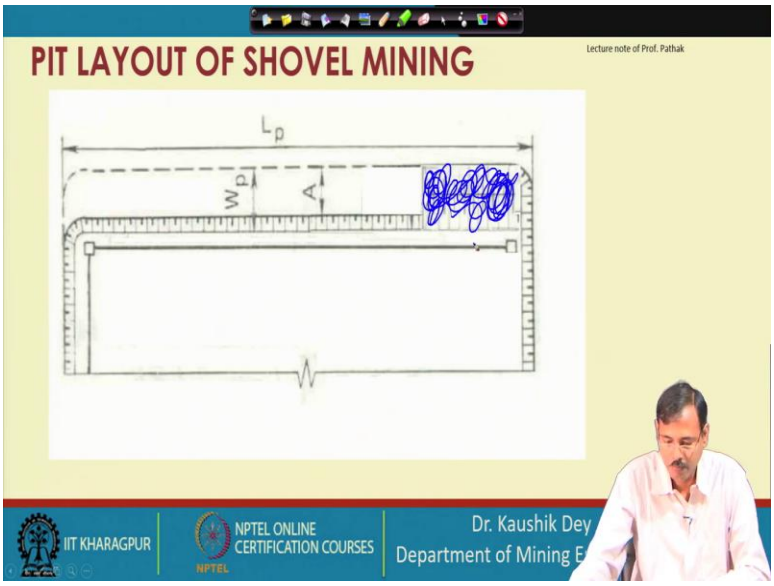

See, this is one by one in detail; suppose this is the pit where the excavation is met. We have to extend this, so what we will do, we will try to excavate this part. We will try to excavate this part first. And to excavate this one, what do we need to do? We have to carry out our drilling. So, these are the drill holes; we have carried out drilling at this position, then we go for blasting this one. So, after drilling, we have blasted this one. So, this is basically the blasted drachmas. This is shown as the ramp but this is the blasted rock mass. So, you have provided the blasted rock mass here.

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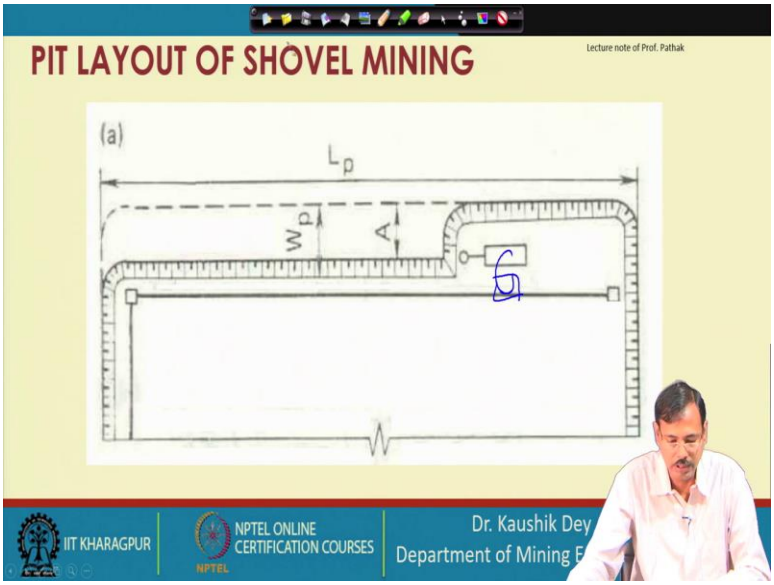

And after blasting this one, we deployed our excavator to take that material. So, now the excavator is working here, and we are taking the material. We allow our dumper to stand on this, and the material is loaded onto the dumper. So, gradually dumpers are taking the material and moving out from this.

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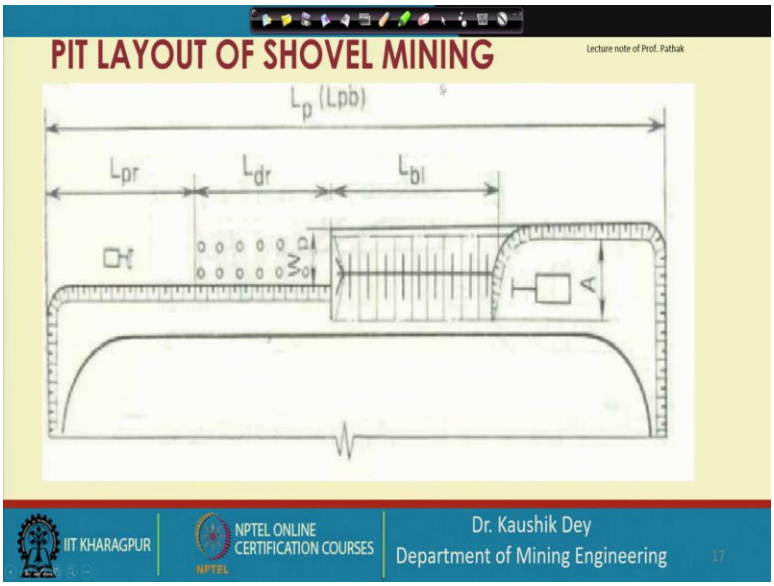

This is the ramp it is provided at this position. So, excavation is carried out here, and the material is taken out from this ramp from this to this direction. So, this is the way we are moving with our layout.

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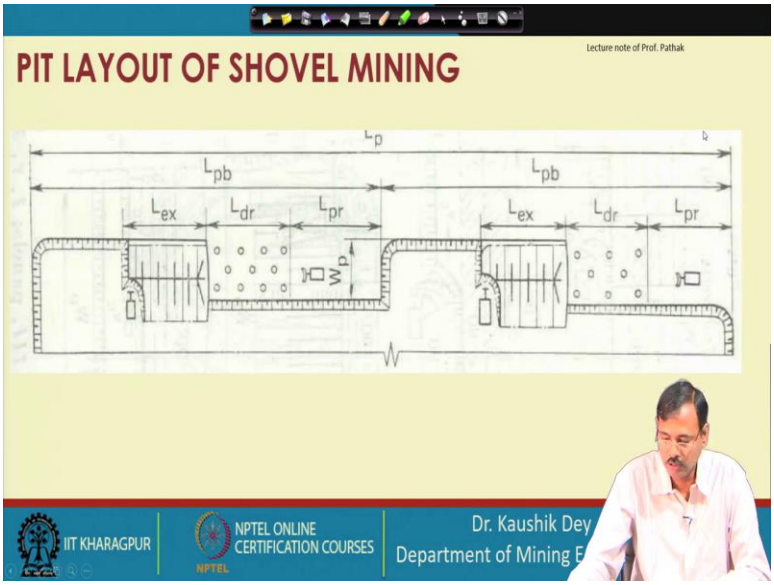

This is when the two shovels are working.

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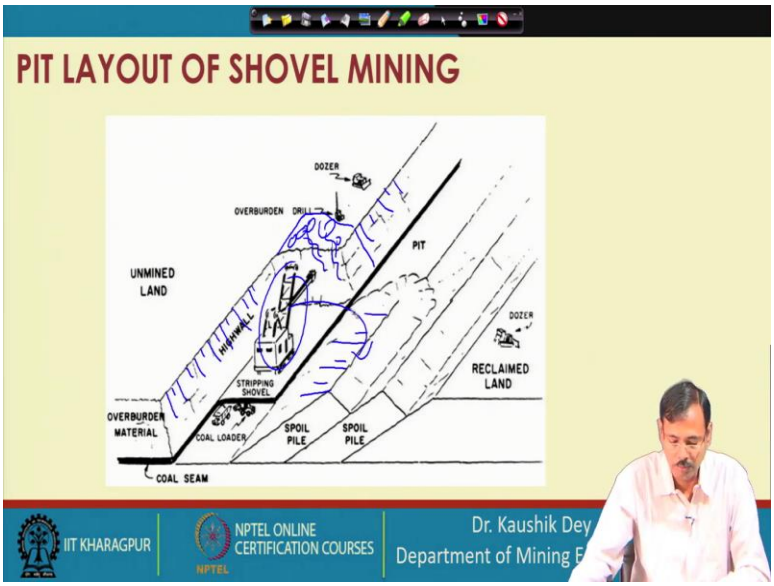

And this is the typical layout we have already seen, which is possible in case the stripping shovels are working at this position; it is swinging and dumping the material in this dump pit at this position. So, this is the operation of stripping shovel you can see this is the pit layouts.

So, the plan views these are the slope, high wall slope, and the blasting portion. So, this is the loose blasted rock mass, and this is the future drilling carried out at this position. So, consider this the pit one and the wisdom pit, which is being dumped by the stripping shovel in this case.

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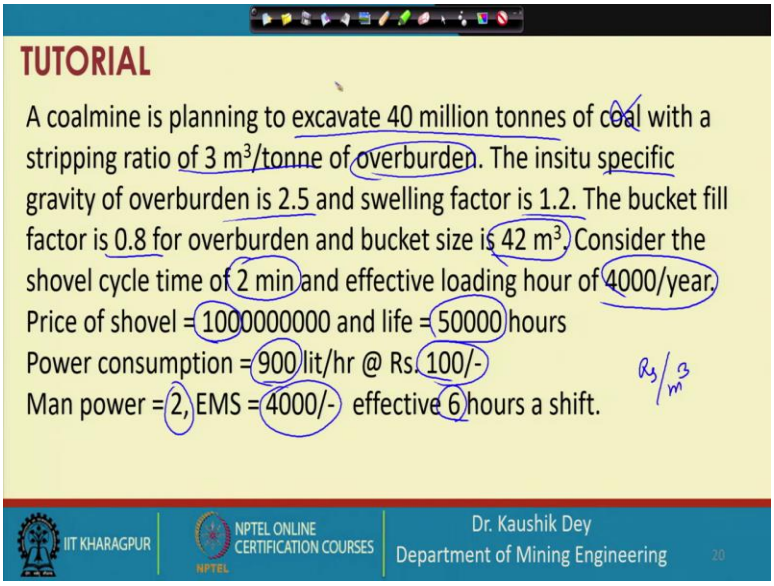

Now, let us go for the calculation of cost. This system calculation of cost system is more or less the same as we have practiced in the case of a drilling machine. So, you know, first let us look into the problem. Say this is the same problem we have carried out the performance analysis. So, this is a coal mine planning to excavate 40 million tons of coal with a stripping ratio of 3-meter cube per tonne insitu specific gravity is 2.5, 1.2 swelling factor for overburden we are only considering overburden we are not considering coal in this case.

So, an overburden-specific remedy is given swelling factor is given, a bucket fill factor is given, and an overburdened shovel bucket capacity is also given. This shovel cycle time is considered 2 minutes, and the available loading hour is regarded as 4000 hours per year. The price of the shovel is considered 100 crores rupees.

So, you can say it is 1000 million rupees, and life is considered 50,000 hours diesel consumption is considered as 900 liters per hour and diesel prices considered 100 rupees two manpower is required with EMS of earning per man safety is this one and effective 6 hours are available in the shift. And these are the considerations given here, and we have to find out the cost of excavation in rupees per meter cube. So, this is the consideration.

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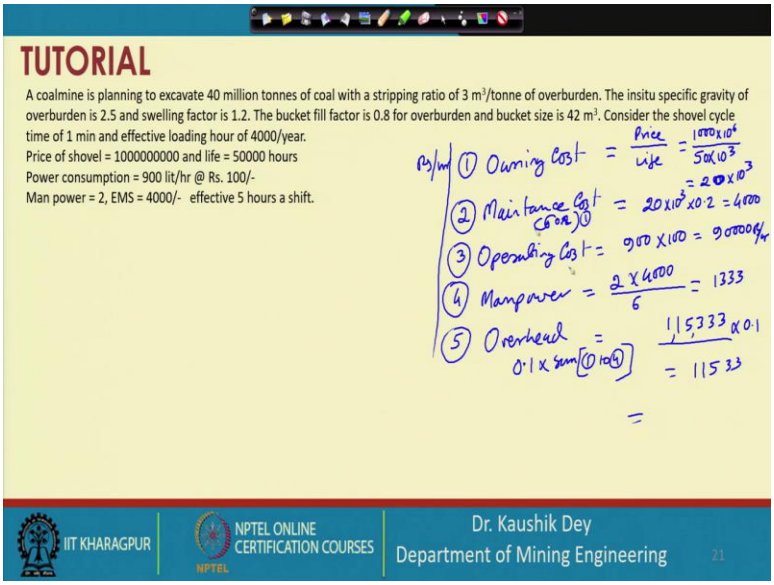

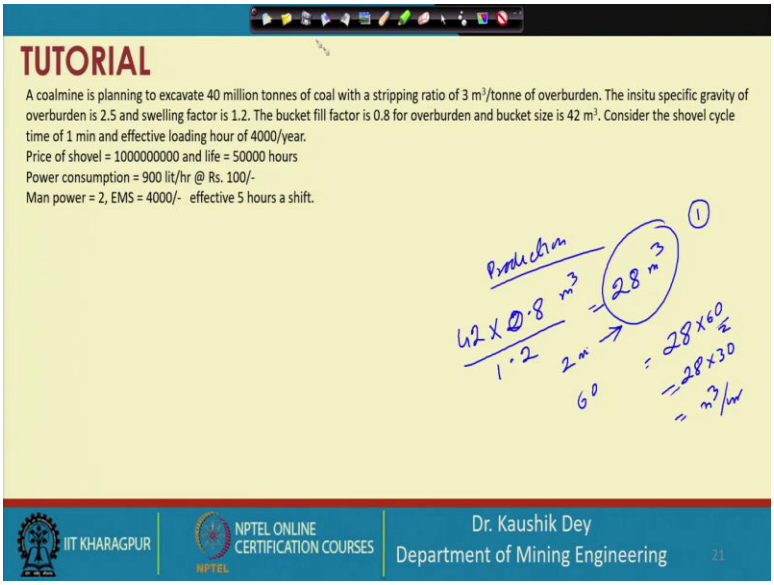

Now, as per the requirement, we have to find out the first one is the owning cost. The second one is the maintenance cost, the third one is the operating cost, the fourth is the manpower cost, and the fifth is the overhead cost. Now, we have simplified a lot to solve this problem; we are not considering most other requirements like depreciation interest. All these components are not considered here to make it simplified.

So, let us consider the simple way of considering the owning costs. Owning cost is the price of the life we have considered here the simplest way. So, this is 1000 into 20 power 6 rupees divided by life is five into 20 power 3 hours. So, that means it is coming close to rupees 2 lakhs.

Sorry, it is not this one. So, this is 20,000 rupees this 50,000. 15 to 20 power 3 So, this is coming to 20,000 rupees per hour.

So, this is all in rupees per hour. Now, maintenance cost, let us again simplify it and consider this is 20 percent of 1, so that is 20 into 20 power three into 2.2. So, it is coming for 1000 rupees. Now, operating costs so, we are not considering any extensive consumables. The shovel bucket teeth are frequently consumable in a shovel operation and the case of hydraulic shovels, etc. Generally, hydraulics is considered separately because hydraulic consumption is becoming more lubricant and the operating cost.

But let us ignore all those things for this calculation; we can have that in actual practice, but for this calculation tutorial, let us ignore those things; let us consider only the diesel consumption. It is seen that diesel consumption is 900 liter per hour, and the price is 100 rupees. So, this is 900, so; this is rupees per hour is the operating cost. So, 90,000 I think it is 90,000, 1 2 3 4, 90,000 rupees per hour.

And the manpower cost we also have some manpower cost here we have seen that two into 4000 is the earning per man shift and it is considered that the in a shift 6 hour is the operating hours. So, our manpower cost let us consider 4000 into two divided by six whatever is coming that is considered as the manpower cost. So, 1333 rupees per hour, all are rupees per hour, and the overall cost is the sum of all this. So, the sum of is considered as the 0.1 multiplied by the sum of one to four.

So, the sum of one to four is 20,000 plus 4000, 24,000 plus 90,000. So, that is 11, so, this is 3 3 3 is already there. So, this is four plus 1, 5 and 9 plus 2 11. So, this is the 1,15,333, the 10 percent of this, which is at the rate of 0.1. So, that is 11,533 is the overhead costs. So, altogether it is coming. I think we may have some calculation mistakes here also. So, this is 11,000 something it is coming that is rupees per hour.

Now, let us look into the production per hour our production is that 42 meter cube shovel it is having production of 42 meter cube into I think bucket fill factor is 0.8. So, this is the meter cube filled by one bucket and our insitu volume is being swelled by 1.2 times. So, if we are considering the meter cube, then the actual meter cube being handled by this insitu is divided by this.

So, it is coming around 28 meter cube insitu meter cube which is coming insitu meter cube 28 meter cube that is coming in one bucket. And we have considered this is being handled in 2 minute. So, in 60 minutes, we have to multiply 28 into 60 by 2 that is 30. So, 28 into 30 is the excavation. So, whichever is coming that is the meter cube per hour is the excavation. So, we have already calculated the cost.

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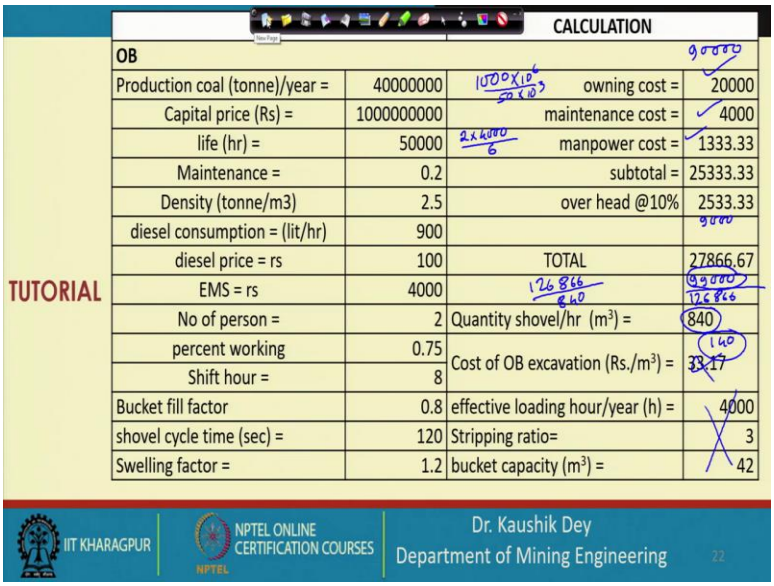

So, let us to avoid any calculation mistake here let us find out the values at this position. So, you can see the owning cost is coming 20,000 as we have found that is 1000 into 20 power 6 divided by 50 to 20 power 3, so, that is coming this is 20 percent of this one. So, that is 4000 manpower cost is calculated let us saw it here 2 into 4000 this is for 8 hours, this is for 6 hours divided by 6. So, this is coming to this, so, subtotal is this one or I think we have missed here the fuel cost is missed probably.

So, you have to add fuel cost at this position. So, that is 90,000 has to be added here. So, this is 90,000 which is missed here. So, again that 10 percent of that is 9000 missed here. So, this will come this will become plus 99,000. So, all together, it will be 866 plus. So, 127,000 you can say so, shovel is handling 840-meter cube, as we have found 28 into I think 30. So, 28 into 30 is coming 840-meter cube, so, 126866 divided by 840.

So, this amount has to become so, there are some calculation mistakes. So, let us overcome this. So, it is coming around close to you can say 140 rupees. So, 140 rupees per meter cube will be

the handling cost for this you can see the main component is basically coming for the fuel. So, the full price is almost coming around 100 rupees per tonne for this operation of this 42-meter cube shovel. So, this is the way you can carry out cost calculations.

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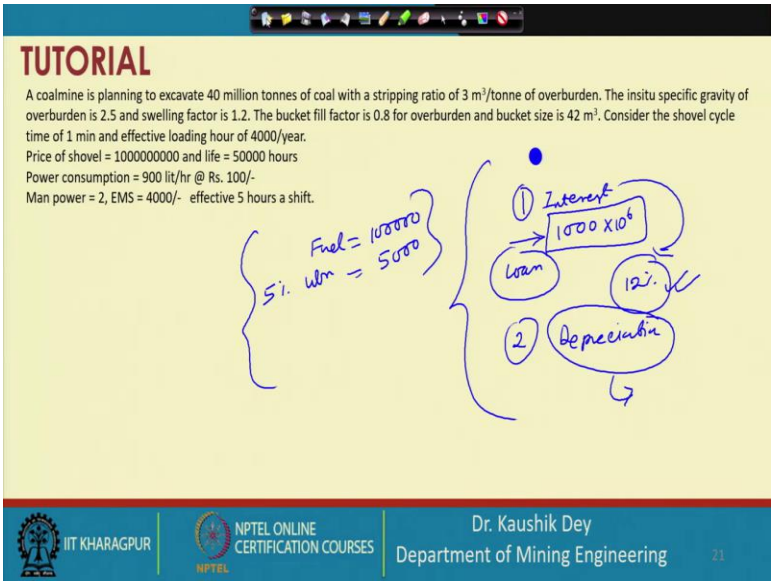

There are other components required to be incorporated in this calculation that is interest part. The reason is that if the shovel price is 10 to power 6, the investors must take the loan from this, which is why interest has to be paid. And in this case, most of the cases, this interest rate is close to 12 percent or so. So, this is significant amount has to be incorporated there.

And second is that the machine's depreciation also needs to be considered because that component must be added at this position. So, these two are part of the owning cost that must be incorporated. Second is that we have seen the main component is the fuel which is coming around 100,000 rupees and in general, the 5 percent of the fuel cost is considered as the lubricant cost. So, that is also a significant one so, 5000 rupees have to be added for that.

So, these are the significant amount that has to be added in the case of the actual cost calculation part. And so, the cost will be very high for using these high-power machines; their operating costs and owning costs are also very high. So, this is the way the cost calculation can be carried out for the shovel operations. And we will continue the transport systems shovel operation and transportation system combinations with the following classes. Thank you.