Surface Mining Technology
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Lecture – 29
Transportation in Surface Mines - 2

Let me welcome you to the 29th lecture of NPTEL online certification course, Surface Mining Technology. We are continuing with the transportation system in mines, and in this lecture, our title is transportation using excavator dumper combination. This is the first lecture on this, and we will do some problem tutorials in this lecture.

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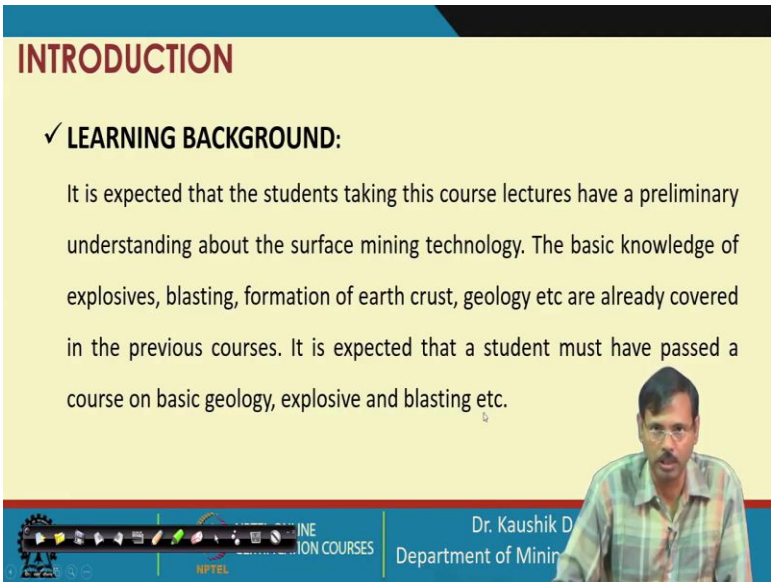

But before that, let us have a look into the learning background required for appearing in this surface mining technology course for NPTEL online certification course.

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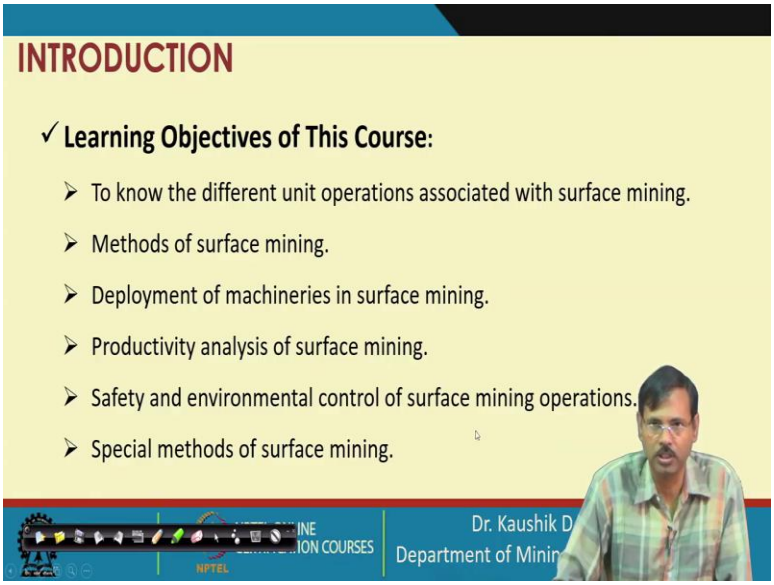

These are the learning objectives set for the Surface Mining technology course.

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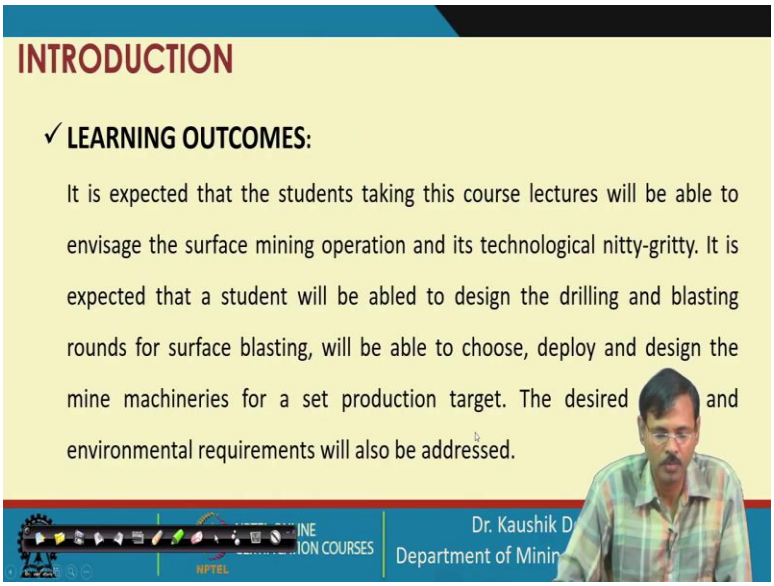

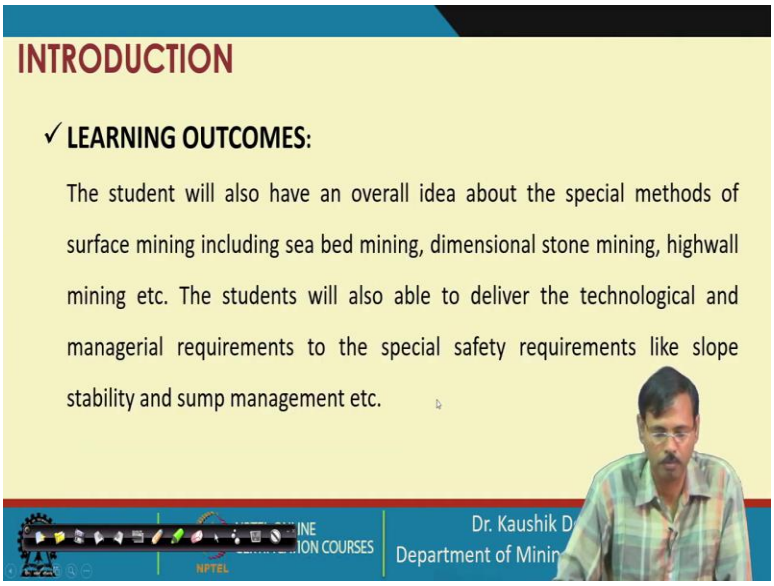

And these are the expected learning outcomes from the participant in the surface mining technology course.

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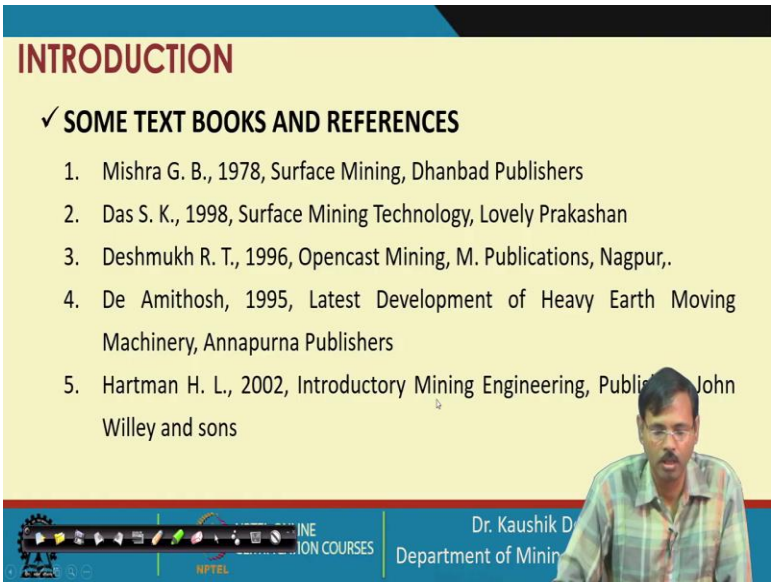

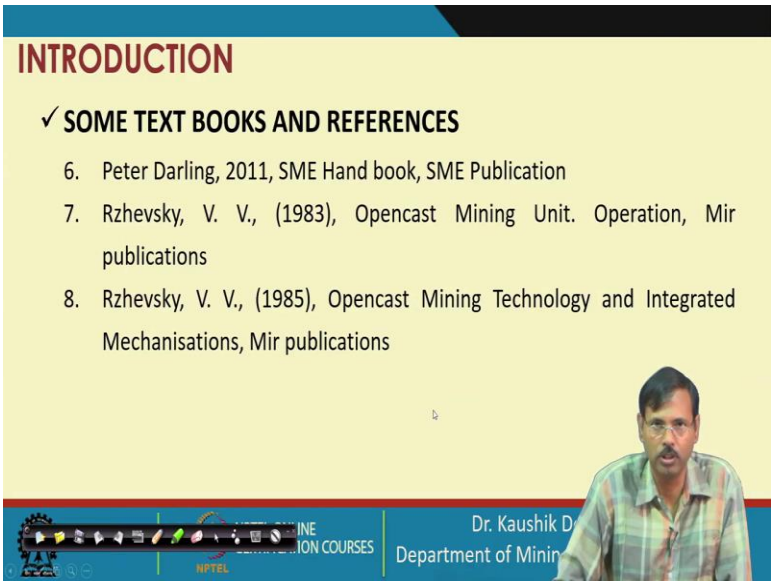

And these are some of the textbooks and references that can be followed during this course work. These are some more references. Apart from that, there are good numbers of YouTube videos are available, Google Photos are available, and web sources are also available there.

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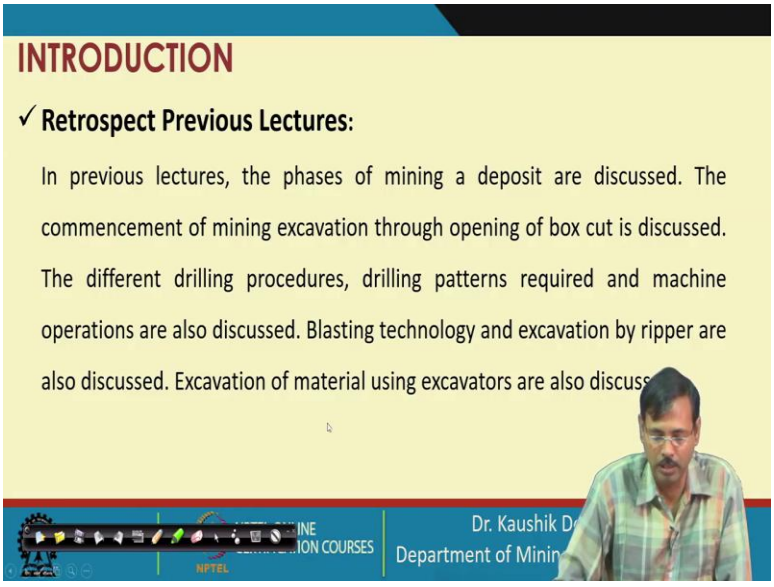

And in this course, we have covered the phases of mining and deposit. We have also covered the commencement of surface mining through the opening of the box cut. And we have also covered different drilling procedures and drilling patterns required for carrying out blasting in the mines. And we have discussed the blasting technology. We have also discussed the excavation by ripper, a blast-free technology.

And after that, we discussed how the excavated materials could be loaded into the transporting system in which we discussed the excavators like a shovel, and we are continuing with the transportation system.

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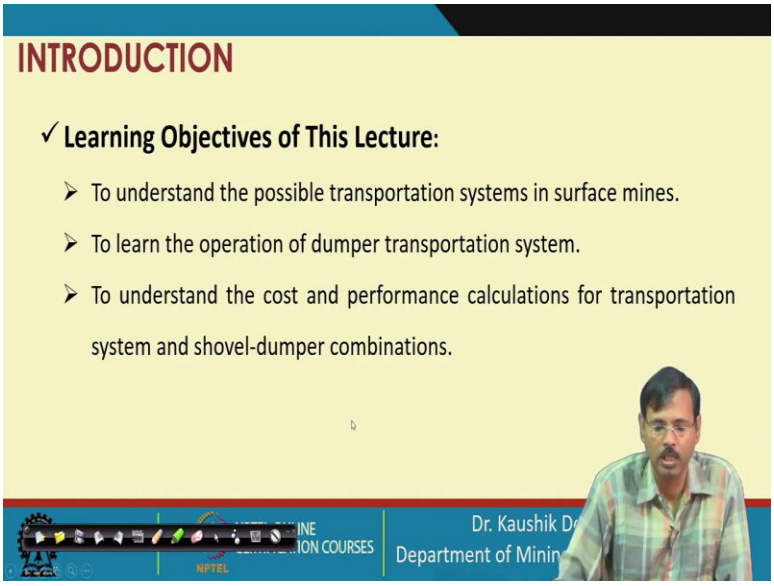

There are three lectures set for this transportation system in surface mines. In these three lectures, our objectives are to understand the possible transportation systems in surface mines, to learn the operation of the dumper transportation system, and to understand the cost and performance calculation for the transportation system and shovel dumper combinations. So, in this lecture we have already before this lecture, we have already covered the different types of the transportation system in surface mines. And this lecture will give more emphasis to the shovel dumper combinations and this transportation system.

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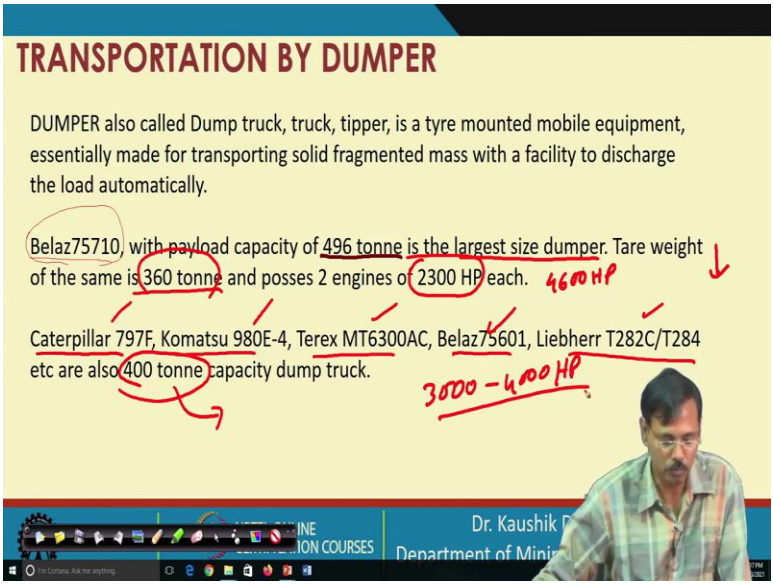

So, transportation system when it is carried out by dumper then dumper is also called dump truck, tipper or only truck and dumper is a tire mounted Mobile Equipment essentially made for transporting solid fragmented mass with the facility to discharge the load automatically. So, dumper and it is essentially assumed that a dumper should have an automatic dumping facility though the loading has to be carried out there by some loading equipment.

And if you look into the current scenario, earlier small-sized dumpers were used. Still, in the present scenario, we have the largest dumper, which is made of the Belaz 75710 model, and this has the capacity to take a 496-tonne load. It is considered the largest available dumper in the current scenario in the market. The tare weight of this dumper is 360 tonne, and it has two engines of 2300 HP so, you can consider it is being run by 4600 HP engine.

And below these are a series of manufacturers with dumpers of 4000-tonne capacity. So, these are Caterpillar 797 F, Komatsu 980 E-4, Terex MT 6300 AC, Belaz 75601, Liebherr T282C T2824. These are the models available which have a carrying capacity of 4000 tonnes of material. And they also have almost equivalent tare weights to the dumpers, and most of these dumpers are using engines ranging from 3000 to 4000 HP engines are being used by these trucks.

So, that means, in a nutshell, we can understand say nowadays dumpers are available of very large size and these are very popularly used in the mines. We also understand the use is that it gives high flexibility.

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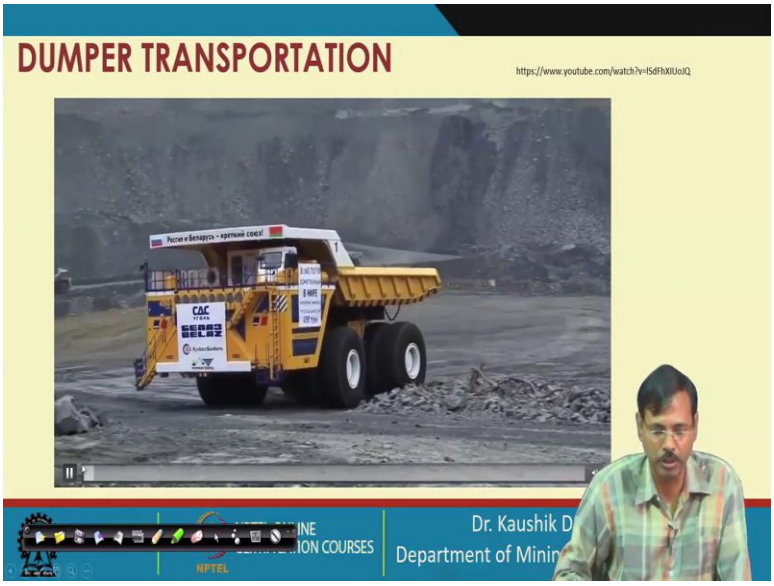

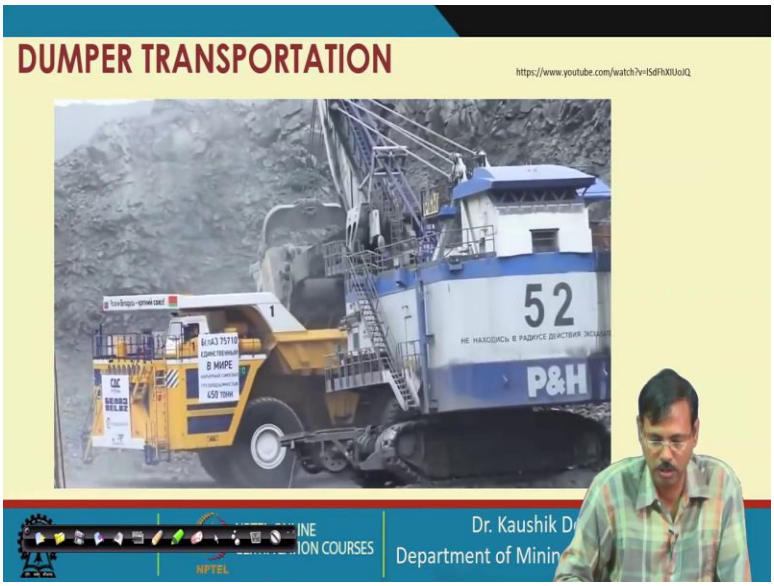

Now, let us look into the operation of the largest dumper in the world. So, the YouTube citation is given here, this is the largest dumper which can have a carrying capacity of 496 tonnes, and it is in general rated that this dumper is used for 450 tonnes of material can be handled at one time and did not consider some of that this dumper is used. See, you can see other dumpers are also available in a close range of 400 tonnes, and this is a huge shovel used for loading the dumper.

This is the dumper 450-tonne material rated to be taken from this though its actual capacity is 496 tonnes. Now, the number is being placed in front of the shovel. So, this is a huge dumper, and the shovel is also a very big shovel, substantial shovel; it has a very high cutting efficiency.

So, if the first bucket load is given to the dumper, this is the second bucket load, or maybe more loads are given.

In general, we allow 4 to 6 bucket loads to a dumper so that we can have some control over the loading time. Also, we will come to these details at a later stage. So, the dumper is full, and the dumper is allowed to move. So, this dumper is closely taking 450 tonnes of material.

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So, we have already discussed that dumpers have a dumping system, either it is a rear dumping system, or it is a side damping system, or it is a bottom discharge type dumper. The damper we have seen in the larger, as the largest dumper which can take 496 ton of material at one go that can, that is having a rear dumping system in the, in that dump.

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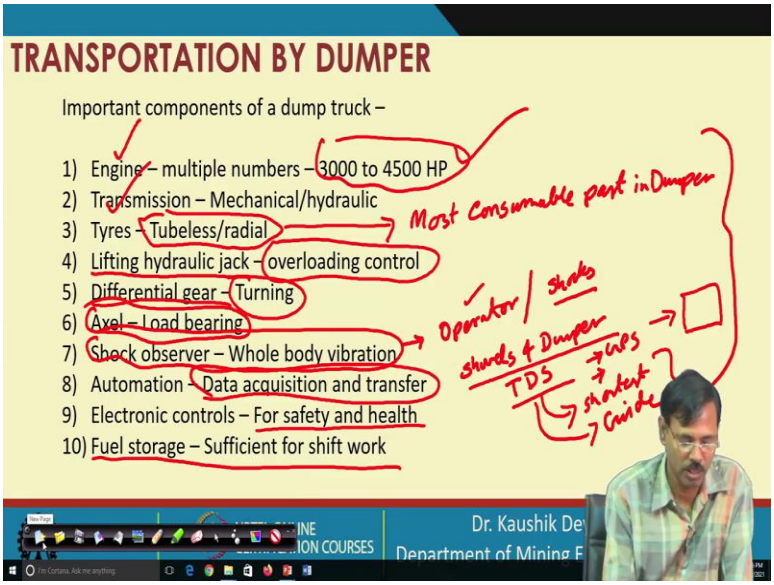

Now, in general, if we are looking at this, the important components of a dump truck can be considered as the engine is very important. In general, this is the capacity of the engine we use for large-size dumpers. Transmission is very, very important, tyres are also important because this is one of the most consumable parts in the dumper and that is why this tyre life, tyre price is very very important on the selection of dumper.

And these are nowadays most of the tyres are tubeless or radial and lifting jack this is also a very important part this should have an overloading control so, that the capacity of the jack can be maintained well, the number of jacks may be increased also. This is differential gear is important for turning. Axel is the load-bearing component and nowadays shock observer is very very important.

And most of the cases it is in general either hydro-pneumatic or pneumatic or hydraulic systems are used for this case and that is taking care of the most of the vibration and allowing the dumper operator a hassle-free not the significant whole-body vibration level and not only this vibration level it is also absorbing the sudden shocks which in general come to the dumper if the shovel is not properly loading the dumper if it shovel is dropping the material from a height then the jerk will come to the operator.

So, a good shock observer has essentially required as well as a good sitting arrangement. Often these dumpers are also having a shock observing system or shock observing suspension system

for the seats also. Automation is very very important, data acquisition and transfer of the same nowadays almost all the shovels and dumpers or equipped with automated tedious truck dispatch system and in this system these are fitted with the GPS and all the electronic components automated data acquisition systems are placed with the dumper system.

So, if there are four axles all the axles or load coming onto those axles are automatically recorded at the speed when the dumper is moving at what speed what is the hydraulic status, what is the diesel status, what is the speed limit what is the jerk it is receiving? All these are basically noted with this system and this data are can be stored centrally in a mine and this is not only that, but it is also communicating with all the systems.

So automatically, this system, this truck dispatch system can find out the shortest route, can find out the ideal shovel conditions, ideal dumpers conditions and accordingly it can guide the destination of the dumpers, guide the destination of the dumpers very easily. So, these systems are very very important along with that, electronic components are available for the safety and health like muffling of the cabins, then the airbag systems, all these anti-skid systems all these are available and sufficient fuel storage must be provided.

So, a dumper can work for the whole shift because these dumpers are having large engine power and because of this large engine power, it is consuming a huge quantity of fuel during the work. So, that is why sufficient fuel storage must be given to the dumper.

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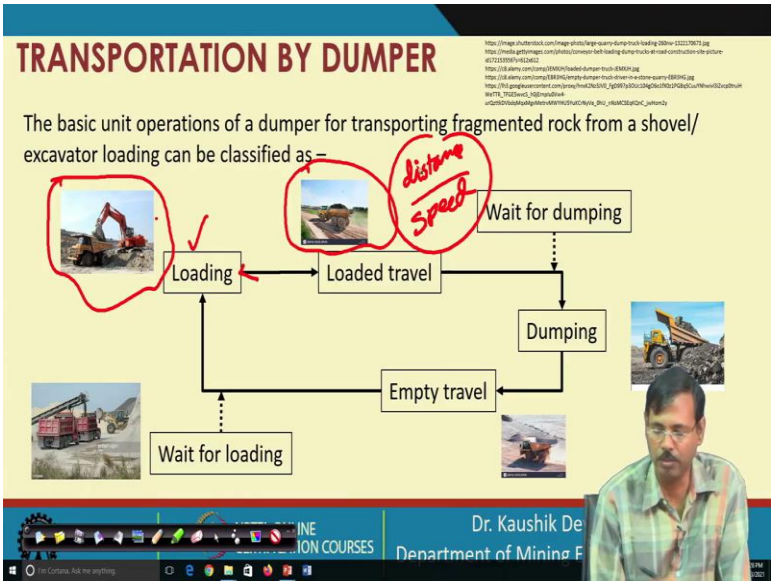

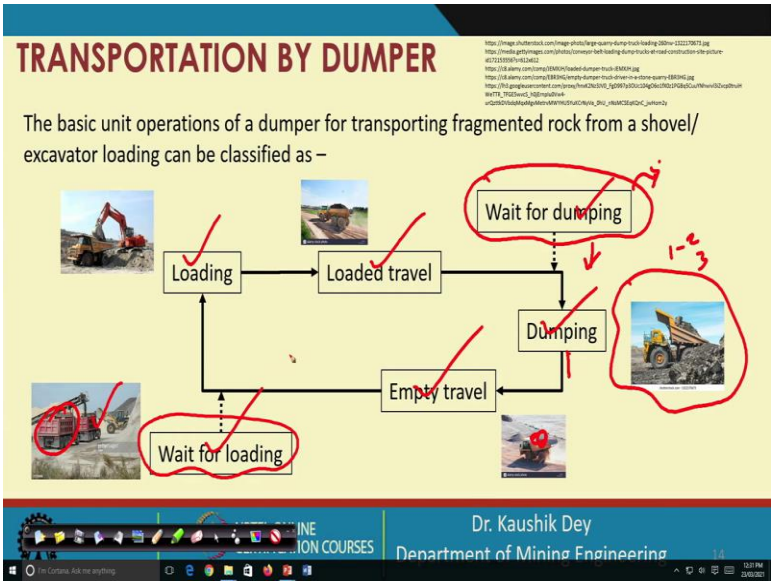

Now, if we are looking at the unit operations to be carried out by the dumper, then we can see dumpers are basically operating like this, first, it has to take the load from the shovel. So, the dumper has to come report to the shovel, shovel will load into this dumper. Now, for loading a dumper, we have seen in the video shovel has to give a number of bucket-filled material to the dumper. So, for loading each bucket it is taking some time.

So, if the n number of buckets are to be given to the one dumper, so the n number of times the shovel has to load the fill the bucket and unload that bucket to the number so, that much time is considered as the loading time then, after loading the dumper has to start moving and it has to

take the load and it has to reach to the destination where the material has to be dumped. So, this is called loaded travel.

So, in loaded travel dumper has to take the material that loaded material along with that dumper, will travel and dumper will reach its destination. So, the time after the running time of the dumper after loading and reaching up to the dumping point is considered as the loaded travel time and this is basically depending on the distance and the speed at which the dumper is moving.

So, this is these are the two important parameters based on that, this time is depending on. Often, we may, we can see the dumper has to wait at the dumping point before dumping because of the condition of the traffic, or maybe the site is not prepared. So, for that dumper, men need to stand there for a while and that is considered as the wait for dumping. But then generally this is unwanted, but occasionally it occurs. So, this is sometimes available, but it is may not be true for all the cases.

Then dumper has to dump the material for doing that dumper has to come to the spot, then turn back and come to the point then it has to lift its pan, and then the pan has to be unloaded in the place. So, the time is required some time is required for that maybe sometimes 1 to 2 minutes, sometimes up to 3 minutes also it can take for dumping the material.

So, that is considered the dumping then after dumping the dumper has to again report back to it is loading point for taking the next load. So, now this dumper is moving without taking any material in its pan. So, it is an empty travel run by the dumper and the dumper has to report to the shovel. Now dumper has to report to the shovel, but it may be possible during that time the shovel is engaged in loading another truck or another dumper.

So, the dumper may need to wait so, you can see this dumper has already arrived. But as the first dumper is underloading, the second dumper has to stand for waiting. So, often you can see some waiting time is also there prior to loading the dumper has to wait. So, this is the waiting time. So, a dumper in his cycle is a time cycle it is facing the loading phase status, loaded travel phase, wait for dumping phase, dumping phase, empty travel running phase, and wait for a loading phase.

So, these are the different phases a dumper will face during its operation. Now among these waiting times are unproductive times. And that is why these are unwanted and these are that is why these are shown is as a dotted line this waiting time for dumping and waiting time for loading. These are unwanted but these are unavoidable.

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So, now you can see one first operation which is the loading operation of one dumper. So, this is the loading person, this is one of the iron ore mines, this is the shovel, this shovel is taking the load and it is rotating and dumping the material on the dumper. So, see already the second dumper has come from where this camera is basically recording this one. So, the second dumper has already come, but this is under waiting now.

So, this is the second bucket being taken by the dumper. So, this is the third bucket taken by the dumper. So, you can consider that this is around 2 minutes time taken by this excavator to load this dumper.

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So, this is the loaded time now, we can see the unloading, this is the dumping time you can see the dumper is moving back then it is lifting it is seen now, hydraulically the jack is lifting the pan. So, you can see there are two hydraulic jacks, those are pushing this one. Now, the material is being unloaded. But, sometimes materials are sticky, they stick on this so, dumper has to move a little bit so, that the complete material can dump. So, now almost the dumping is complete now, and it is again returning back to its original. So, almost 1 minute is taken for dumping the material by this dumper.

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TRANSPORTATION BY DUMPER

Courtesy: Satyabrata Behera

Dr. Kaushik D

Department of Mini

TRANSPORTATION BY DUMPER

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Dr. Kaushik D

Department of Mini

And this is one empty travel return after dumping the dumper. So, after dumping the dumper is returned to the shovel. So, this is depending on the distance and the speed at which the dumper is moving. Generally, most of the dumpers are having high speeds close to 50 to 60 kilometers per hour. But in general, the mining roads are haul roads are made of loose materials.

Generally, dumpers run at a speed of 20 to 30 or sometimes up to 30 up to 40 kilometers per hour speed. So, that gives better control and that is also not generating very much dust in the road. So, now this dumper is moving, it is the empty travel after the dumping, and going to report the shovel we just saw earlier where the loading was carried out. So, the dumper is now close to the shovel, and the shovel is now under the ideal conditions.

So, there is, there will be no waiting time for the dumper, the dumper can directly engage itself for the loading. But if in the earlier case we have seen as one dumper is was underloading, so the dumper has to wait for loading.

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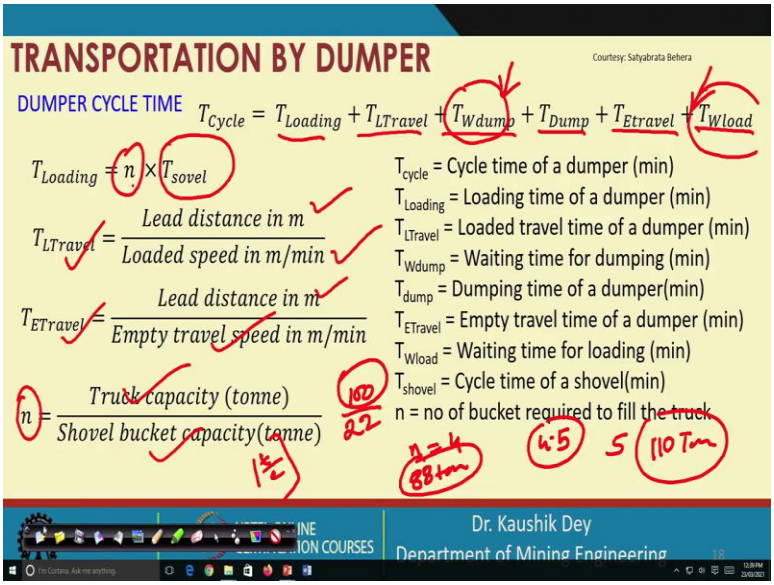

So, now we can describe the time cycle of a dumper as the loading time, loaded travel time, wait for dumping, dumping time, empty travel time, and wait for loading time, among this wait for dumping and wait for loading are unwanted and that is why those are not considered as the in the time cycle. Because our optimization requirement is that we would like to reduce this to as minimum as possible.

So, let us see what formula we should adopt for the loading time: the shovel cycle time and the number of buckets required to fill the dumper. So, that depends on that, so, if we multiply that, you will get the loading time. The number of dumpers is obtained from the truck capacity and the one bucket load if the truck capacity is said 100 tonnes and one bucket load is said 22 ton, then this can n should be equal to 4 though it is 4.5.

But we should not consider that it is five because, if we give five bucket load, it will become 110 tonnes which is overloading. So, we have to give four buckets, then it will be 88 tonnes, then the dumper 100-tonne dumper will carry this 88 tonne that is allowed this overloading is not allowed. So, that is why this is mod of this truck capacity by the shovel bucket load.

So, by this, we can come out with the number of buckets required to fill the truck. Loaded travel time is the lead distance divided by the loaded speed and empty travel time is just similar to that lead distance by the empty travel speed. Occasionally this may be the same, or this may be

different loaded travel speed may be less and if we add this, then we will get the truck cycle, and dumper cycle time in this formula.

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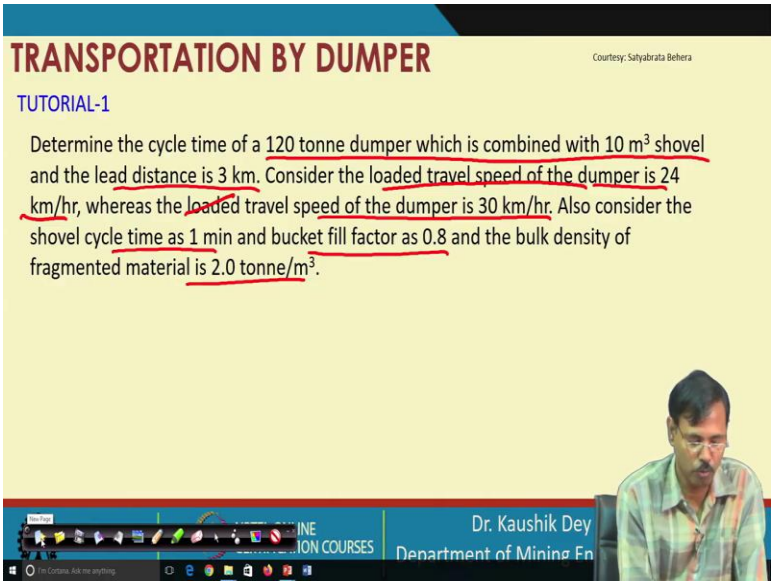

So, we can have one tutorial on this to determine the cycle time of a 120 tonne dumper combined with a 10 meter cube shovel and the lead distance is 3 kilometers. Consider that the loaded travel speed of the dumper is 24 kilometer per hour, which is an empty travel speed. So, this empty table speed of the dumper is 30 kilometers per hour, and also considered the shovel cycle time is 1 minute, bucket fill factor 0.8, bulk density of the fragmented rock mass is 2 tonne per meter cube. So, with these considerations, we have first to find out how many numba er of buckets have to be there so, that we can get the loading time.

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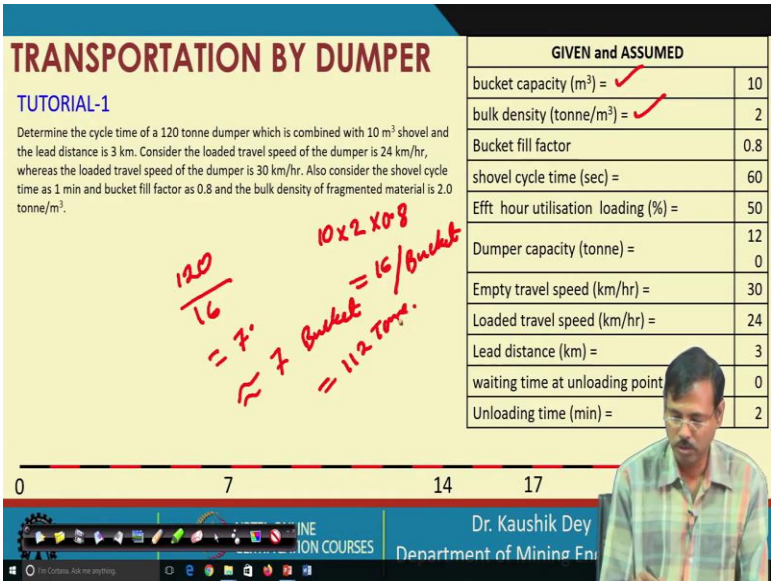

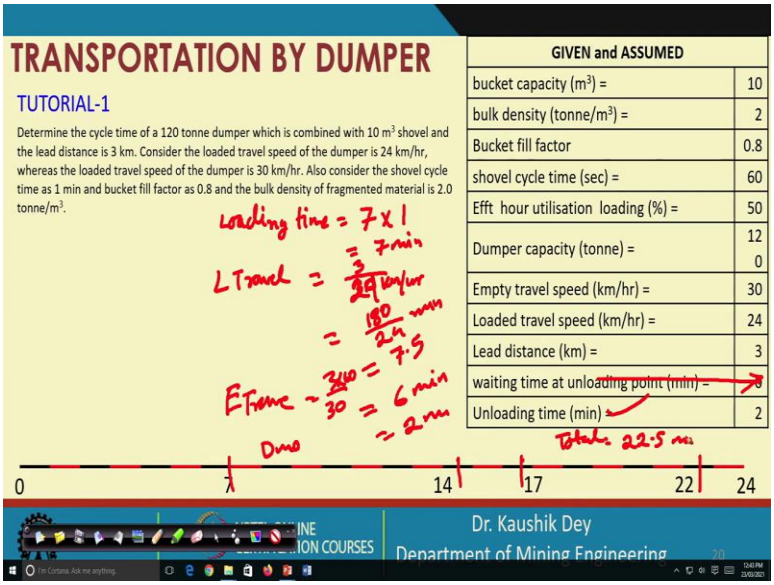

So, this is the data given, or we assume this: bucket capacity is provided, and bulk density is given. So, that means one bucket load is ten into 2; this is the tonne, bucket fill factor is 0.8. So, 16 tons is the load we obtained from one bucket, and our truck capacity is 120 tons. So, 120 by 16. So, that means it is coming 7 point something, so we have to truncate it. So, that means the 7 bucket can be given to the dumper and these 7 bucket will give a load of 112 tonnes.

So, this 120-tonne dumper is now getting 112 tonnes. Now, we have the empty travel speed of 3 kilometers. So, loading time is for 7 bucket, loading time is, this is we have to give 7 bucket, cycle time of each bucket 1 minute. So, that is coming to 7 minute. Now, loaded travel time, lead

distance is 3 kilometer, speed is 30 kilometers sorry, loaded travel speed is 24 kilometer, 24 kilometers per hour. So, for 3 kilometers it will take 180 by 24 Minute.

So, it is coming around say 7 point something, 7.5 minute. Now, empty travel, speed is 30 kilometer. So, this is 180 by 30 so, empty travel time is 6 minute, dumping time is considered as 2 minute, unloading time is considered as 2 minute and waiting time at dumping point is considered as 0. So, the total cycle time comes as 7 plus 7.5 plus 2 so, that is 16.5 plus 6 then 22.5. So, the total cycle time is coming now, adding this 22.5 minute. So, now, let us look into the data now.

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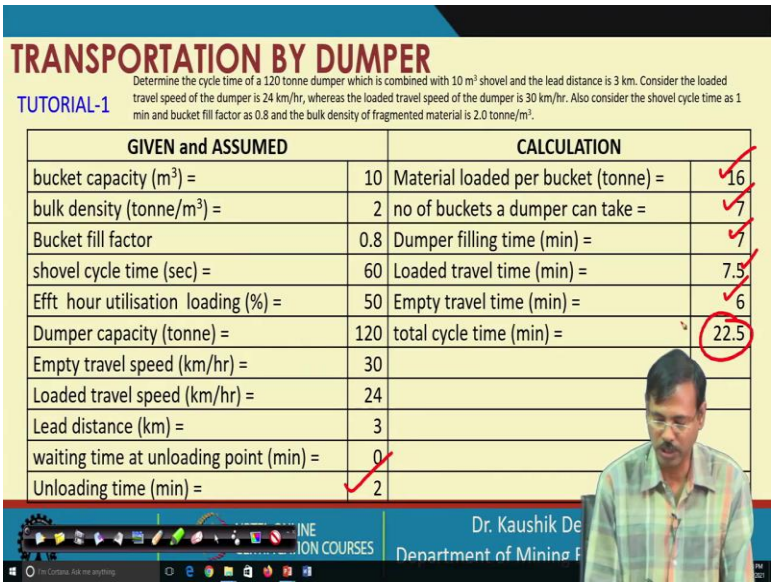

So, we can see the material load per bucket is this one. So, the number of buckets required is 7, filling time 7, loaded travel time 7.5, and empty travel time 6 minutes. So, dumping time is given 2 minutes; adding this two, we are getting the total time cycle time is coming 22.5 minutes. So, we will continue with the shovel dumper combinations with more tutorial in the next class. Thank you.