Surface Mining Technology
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Lecture 24
Excavation with Shovel - I

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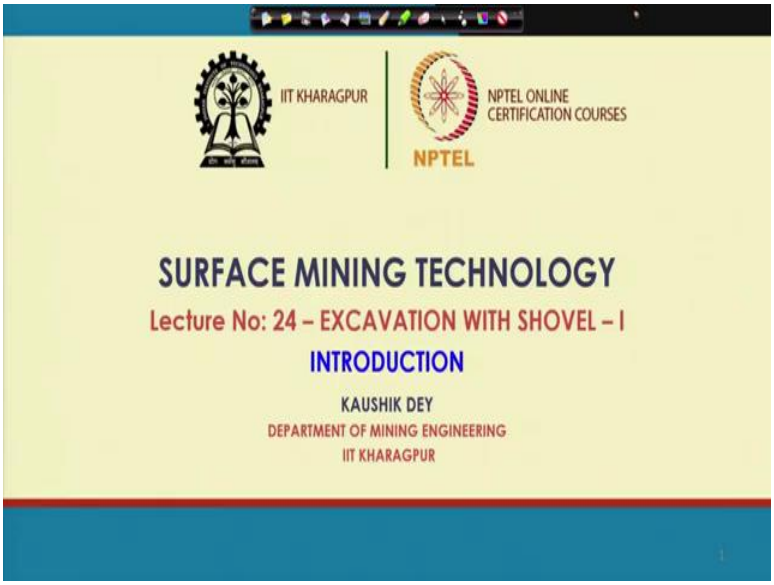

Let me welcome you to the twenty-fourth lecture of surface mining technology course, in this lecture we will start our excavation technology with shovel, which is basically the after blasting the mock pile, how that is being excavated, that is that will be discussed here. Apart from that shovel is also used for excavating the in situ rock also, if it is very, very weak in that condition, shovel is utilized to excavate the in situ rock material.

So, you have seen that loose soil during the box cut excavation those are being excavated by the shovel. And we have also discussed that while we have studied the ripper, we have also shown you the excavatability index, where an excavator can be used for direct in situ excavation of the rock material.

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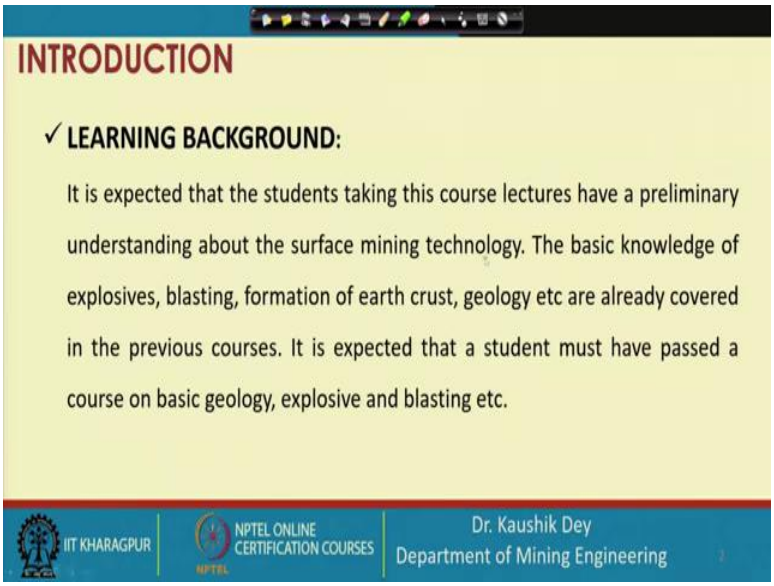
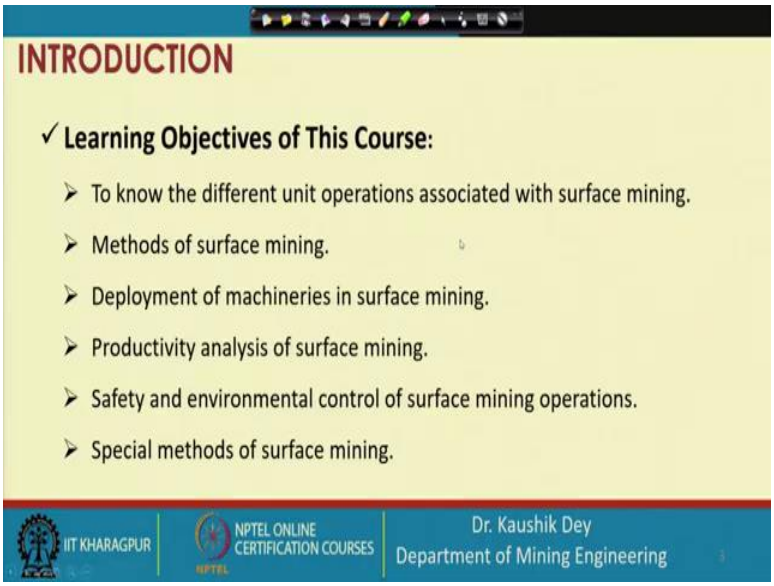




INTRODUCTION

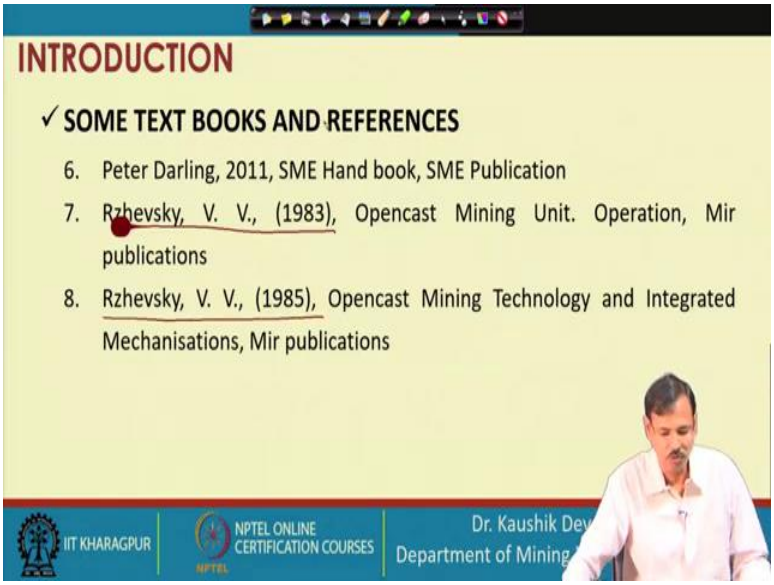
✓ **LEARNING OUTCOMES:**

It is expected that the students taking this course lectures will be able to envisage the surface mining operation and its technological nitty-gritty. It is expected that a student will be abled to design the drilling and blasting rounds for surface blasting, will be able to choose, deploy and design the mine machineries for a set production target. The desired safety and environmental requirements will also be addressed.

INTRODUCTION

✓ **SOME TEXT BOOKS AND REFERENCES**

1. Mishra G. B., 1978, Surface Mining, Dhanbad Publishers
2. Das S. K., 1998, Surface Mining Technology, Lovely Prakashan
3. Deshmukh R. T., 1996, Opencast Mining, M. Publications, Nagpur,.
4. De Amithosh, 1995, Latest Development of Heavy Earth Moving Machinery, Annapurna Publishers
5. Hartman H. L., 2002, Introductory Mining Engineering, Publishers John Willey and sons



So, let us continue with the twenty-fourth lecture; this is the introductory lecture. So, before that, let us looks once again, look once again at the learning background required for the surface mining technology course. And the learning objectives of the surface mining technology course. And expected learning outcomes from a participant in a surface mining technology course.

And these are some of the textbooks and references which can be followed during this course. And for this particular lecture, I would like to draw your attention to the books of that Amithosh De; for this lecture related to the excavator, you can follow this book, as well as you can follow these two books also, you can follow these two books also for this particular lectures.

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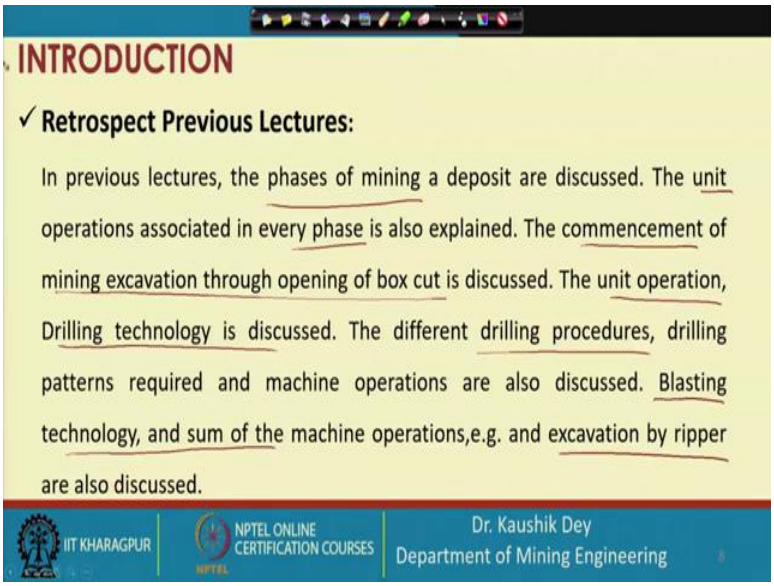

But several things have been taken in this lecture from the web sources; videos are taken from the YouTube's photos are taken from the Google photo. So, let us retrospect previously on what we have covered; we have covered the phases of surface mining, and we have also covered the unit operations particular pertaining to each phase.

And we have studied the commencement of surface mining using the box cut, unit operations like drilling technology are discussed, and different drilling procedures and blasting procedures are discussed. And along with that, we have also covered the excavation by ripper in the last few classes. So far we have covered up to this.

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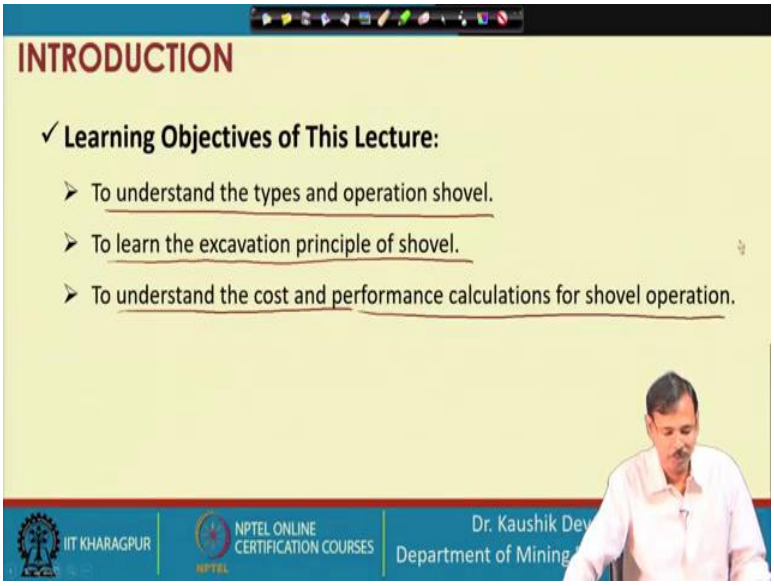

And the objective of this lecture series is related to the excavation by shovel, or in which we will mostly discuss the excavator part. So, in these lectures, we have the objectives to understand them, to understand the types and operation of shovels. We will learn the excavation principle of the shovel, and we will understand the cost and performance calculation for shovel operation. So, these are the three main objectives we will cover in these lectures. So, in the first lecture, we will understand the different types of shovel operations.

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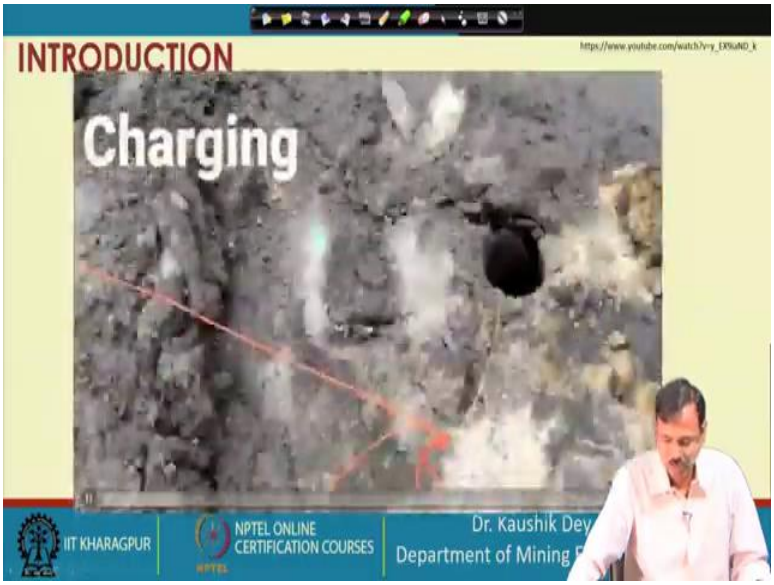

But, before that, let us have a look at the different unit operations carried out in the surface mince from this video, which is taken from YouTube. So, this machine is called a dragline, you can see in which wire suspended bucket is utilized to excavate the loose material blasted rock mass and to dump that at a long distance.

So this is the drill machine which is utilized to create a hole inside the rock mass. So that the explosive can be placed in that hole and the blasting may be carried out. So, you can see this is the drilling operation, using this drilling machine. So, this drilling machine is utilized to create a hole, and you can see while the drilling is carried out, the machine is allowed to stand on a strong surface. This is the drill hole is created, and explosives are placed these are the surface connections using the nonel, and this is the bulk explosive truck is used to place the explosive inside the hole.

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So, explosives are placed inside the hole; connections are made, and you can see now the stemming is carried out that is the sand rock mass is placed, and now they are going to blast it. So, you can see blasting is carried out, this is the detonating fuse part and you can see actual blasting is carried out on this bench.

So, this operation, I termed it very unsafe operation because this people they are not standing in the shelter, they must stand under a strong roof area so, that any fly rocks should not damage them. So, this is another blasting you can see; the material is blasted. And this is the coal bench blasted.

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And these are the excavators. So, now excavators are allowed, see these excavators are taking out the material and dumping that material onto the dumper. So, this is the transporting medium dumper, which takes the material from the shovels. So, the shovel is loading the dumper. The first dumper has left, and the second damper has come.

So, this loading of material blasted material is carried out by the shovel. So, this is a standard excavation machine used in mining, and in this series of lectures, we will do these things. So, this is electrically operated. You can see the trailing cable of the shovel.

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Now, this is the hydraulic excavator, which is the diesel power and the movement of this rock, it is this boom etcetera, these were in where rope shovel, that was controlled by the mechanical system here it is a hydraulic system used you can see, these hydraulic cylinders are there which is controlling the movement of the boom and bucket.

So, that is the procedure of operation of the hydraulic shovel. The hydraulic shovel is also used for excavation purposes, and this machine is called a front-end loader or wheel loader; a wheel loader is another type of machine. But wheel loader, in general, is termed as the loading machine because its loading efficiency is very high, but the excavation efficiency is low.

So, this excavation efficiency is called backhoe, which is also one kind of shovel or excavator. So, the loading efficiency of the excavator is poor than the loaders, but the excavation efficiency is higher.

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And this is the dumper, which is taking that loaded material and going to the dumping station; if it is an overburden, it is being dumped to the overburdened dump or in the backfield dump. And if it is a coal or mineral, it is dumped either in the crusher plant or in the stockyard.

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So, the material is sent to the particular destination and this is a coal handling plant; if it is coal, then the coal is dumped at this and you can say, this is a crusher. The coal is dumped into the crusher, the crusher is size the coal into regular size, and blasted mass is in general we have seen in the blasting results, it is generally not of uniform size, but the sizing is carried out in this place.

So, this is more or less the production unit operations associated with the mining system; apart from that, there are other requirements like environmental control, safety control, those are auxiliary works are also there that maintenance of the whole road, maintenance of the drainage system, some pit maintenance, water management, these are also there, which are also basically controlled in the different unit operations, but those are the auxiliary operations.

So, you can see that the crusher is crushing the material at a regular size. So, this is the dumping system in the crusher, how the dump is coming and dropping the material into the crusher. So, this is the crusher; the material is fed in this. So, there is the general unit operations which are practiced in a mine.

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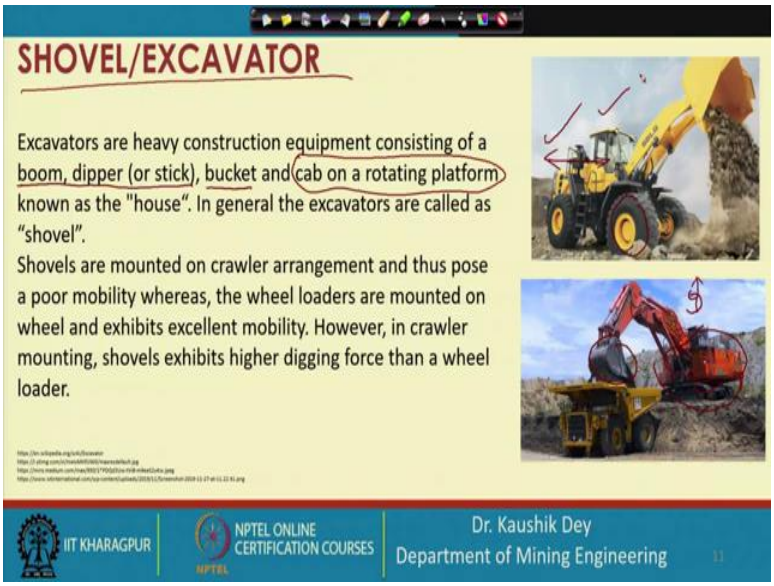

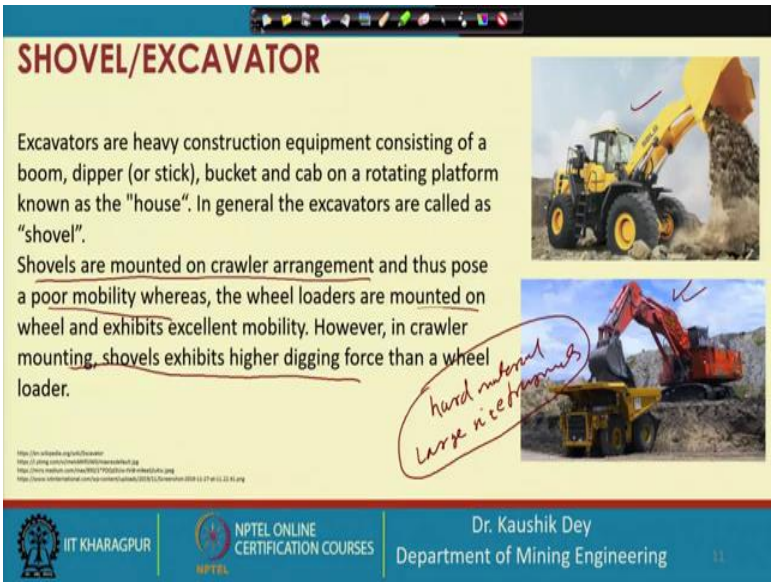

Now, let us look into the excavator shovel or excavators are the heavy construction equipment, consisting of a boom, a dipper, and a bucket and cab are placed on a rotating platform; that is the generalized constructional features of an excavator. So, you can see this is the boom; this is the stick, this is the bucket, and this is the cab, which is placed on a rotating platform that can move, or rotate, which can rotate 360 degrees along with the crawler.

So, that is the facility of the excavator, unlike the loader. The loader is mounted on a steering system, where the loader has to move, but it is a wheel-mounted one. In contrast, it is a crawler-mounted one; the mobility is high in the case of a loader. Still, mobility is low in the case of an

excavator, but simultaneously loader is having very inferior, or you can say the low digging capacity.

But it is loading efficiency is very high, because its propelling speed is more here the this is, in general, it is called mobile equipment, but this is stationary equipment it is standing on this, it is allowed the transporting medium to stand in front of this, and the machine is rotating around its own axis, and around its own axis and take the material from all side to dump onto this machine.

So, this is excavator cum loader, where it is mainly the loader only. So, shovels are mounted on crawler arrangement, poor mobility, wheel loaders mounted on wheel exhibits excellent mobility. Still, the crawler being the crawler-mounted shovel exhibits higher digging force than the wheel loader.

And that is why the bucket capacity, etcetera for a wheel loader, is higher in most cases kept higher than these excavators. Still, these have very, very poor digging efficiency, which is why shovel the digging efficiency is very good, these are that is why applicable for the hard material, large size, large-sized fragments. So, for this, these are basically the equipment chosen over the loader; however, for the soft material like coal, etcetera, you can also have post-blast direct loading using the wheel loader.

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In general, the excavator is classified in three ways depending on its bucket position and your purpose of excavation. So, these are the three purposes you can see in this case: this bucket has

the opening in the upward direction, this bucket has the opening in the upward direction, or you can say, in another way, it is on the opposite side of the cabin.

So, from the boom, or you can say from the stick, this is the direction of the cabin, but the direction of the opening of the bucket is on the opposite side. So, the bucket opening is opposite the machine side. So this type of shovel is called a dipper shovel.

Stripper shovel is a type of dipper shovel, but its boom length is very, very long, and it is in a multiple of 10 meters, 20 meters, 30 meters, sometimes more than that also. And this is in general; this is the type of dipper shovel that is used for stripping purposes. What is the meaning of stripping purpose? Stripping purpose means directly taking the blasted rock mass and dumping that rock mass into the overburdened dump is called stripping.

So, these shovels are utilized for stripping purposes, which is why this is called stripping shovel. So, this is a type of dipper shovel that is used for stripping. And backhoe is the excavator, where the bucket position is opposite the dipper shovel. So, in this case, you can see that the bucket opening is on the opposite side of the machine, but this is called backhoe, where the bucket position is open towards the direction of the machine.

So, that is why you can understand that these machines are good at digging towards the upward direction from the datum level on which, the datum level on which the machine is standing from this level this machine explores well towards the upward trend. So, whenever some bench is there, these excavators stand in the lower bench and dig the upper bench.

So, that is the characteristic for the deeper shovel, whereas for the backhoe, the machine is standing, if this is the case, the machine is standing on this, and the machine is basically digging from the upward point to the lower point. So, it is basically digging towards the below its datum level, then its loading efficiency becomes more.

So, the machine is standing on this platform and taking from a level lower than this. So, this is the difference between the backhoe and the dipper shovel, and both have some benefits and drawbacks also. Still, very, very both the machines are very, very popular in mining and civil excavation work.

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Apart from that, because of the motive power, actually not motive power, you can say it is the transmission power; based on the transmission power, it is classified into two groups: the electric shovel and this is the hydraulic shovel. It is not that, the electric and diesel are the electric and diesel, these are the motive powers used hydraulic shovel can also be an electric shovel, a there is no problem in this.

And similarly, the rope shovel can also be a diesel-operated shovel. Still, the difference is that in rope shovel, these operations you can see in this rope shovel, these operations are mechanically driven. So, there is a rake and pinion arrangement that allows the movement of this in this direction. Then this is the rope wheel, which allows lifting the bucket.

So, this is the benefit of that; similarly, this movement of this one in this direction is also being controlled using this rope. So, these are mechanically driven exercises. So, that is why this basically rope shovel is a mechanically driven one. Still, hydraulic shovels, and hydraulic cylinders are used. You can see this is a bucket cylinder, a stick cylinder, and a boom cylinder.

So, these three cylinders are used, the bucket cylinder is for rotation of the bucket, the stick cylinder is for rotation of the arm, and the boom cylinder is for the rotation of the boom. So, these are the three cylinders used, you can see in actual photograph, this is the bucket cylinder, this is the stick cylinder and there is a boom cylinder, you cannot see which is at a lower part here.

So, these are the three cylinders, which are utilized in this hydraulic shovel. So, that is why this is basically a mechanical driven shovel, this is a basically mechanically ropes and gears driven shovel, here the hydraulic shovel is basically movements are driven by the hydraulic cylinders.

So, that is the difference in these two, there are some mechanical advantages and disadvantages for both the cases and this is in that case, this that is why these are having different applications like these are having overloading, good overloading capacities, these are having poor overloading capacities, but operations are easier in this, wear and tear is more in hydraulic shovel. So, these are some main benefits and drawbacks associated with each system of excavator.

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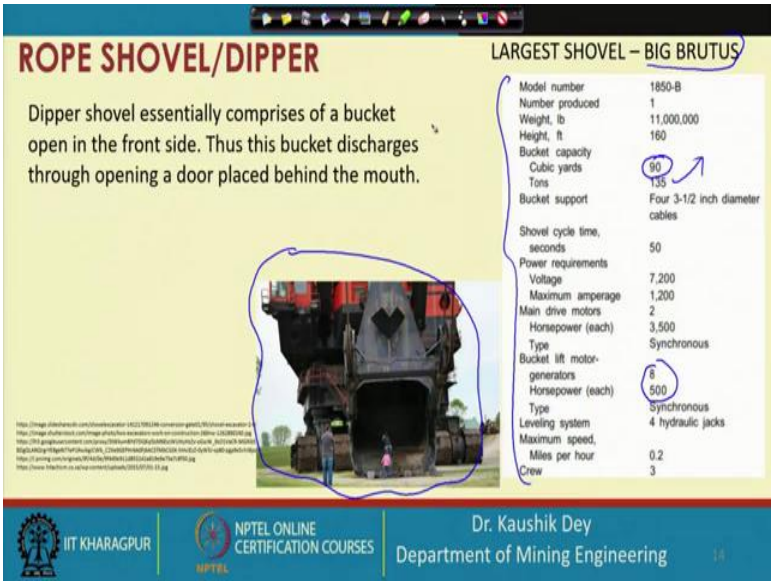

Now, let us look in this lecture about the rope shovels, rope shovels are most of the rope shovels are very, very big, in fact this is the largest rope shovel called Big Brutus its name, and you can see this is the 8 motors of 500 HP are there and you can see this, this is the capacity 90 cubic yard is the capacity of this machine, which can take 135 ton load at one time. And this is the largest excavator, or largest shovel made in, I think in 1960. So, this is the very big, this is the very big rope shovel, or dipper shovel.

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Now, you can see the operation of a rope shovel, you can see how see this rack and pinion system is allowing this movement in the front direction and this wire is being pulled to lift this bucket in the upward direction. Now, the bottom pan of this will be released and the material is released into the dumper. Now, again it is going towards the lower part and the bottom pan will be again, now this is fitted, bottom plate is fitted, now again see this is moving.

So, this one is going being lifted this was is moving in the upward downward direction with the rake and pinion system and this one is taking the material to load into this. So, you can see the loading efficiency of this excavator is very high and it is almost digging a very, very solid rock

mass, a very, very solid rock mass it is excavating. And this is also allowing the controlling of the very good bench floor. So, you can see the angle at which this excavator is operating. So, this is the loading system, using this rope shovel, we have already seen this one.

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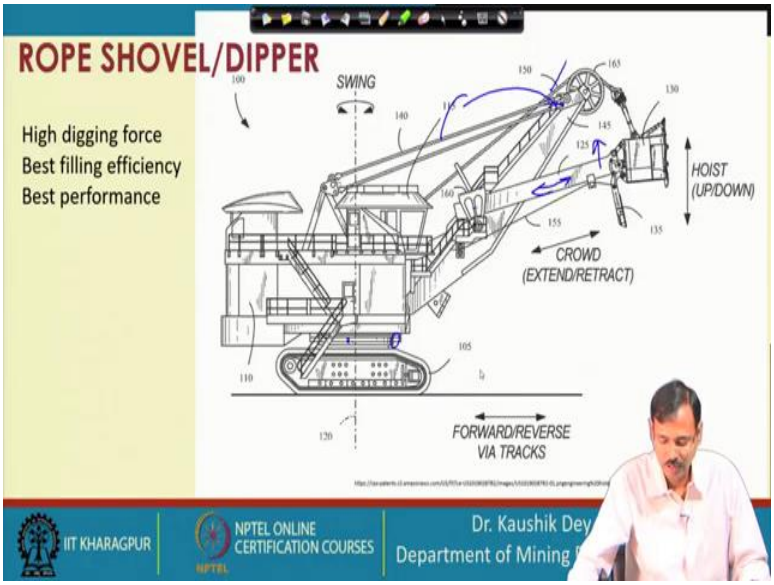

So, these are the different parts, this is the axis at which it is swinging. So, there is a gear system on this and this is the operating on that gear. So, this is allowing the rotation of the machine, this wire is basically allowing the lifting of this stick and this rake and pinion system, or sometimes it is a gear system, which is allowing the movement of this one. And this boom, this lifting of this boom, or position of this boom is being controlled by this wire system.

So, you can control this one the angle of this one, or you can see the boom. So, that is the way so this is called crowding system, this is hoisting system. So, that is maintained, and this crawler system is there, allowing the movement of the excavator in both directions.

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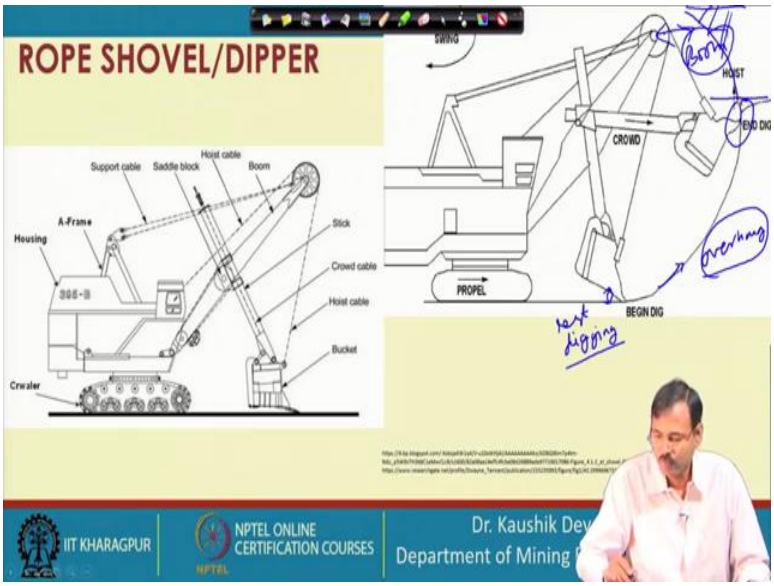

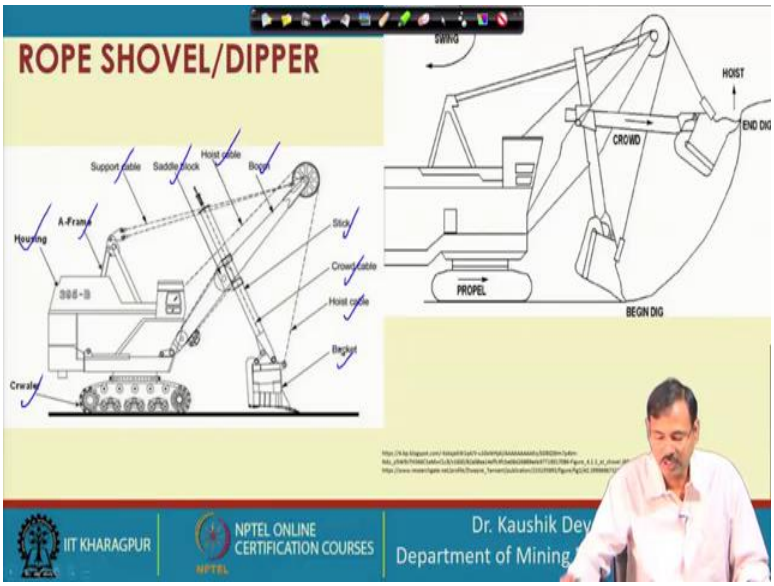

So, you can say this is the beginning of the digging at this position and these angles are being controlled for the best digging, best digging performance, these angles are controlled and this is the excavation angle and no way this portion is allowed to overhang. So, this is never allowed, that means this is not, this is not allowed because otherwise this portion will become overhang.

So, that is why, the excavation height is restricted from the height of this boom. So, the boom height is set such a way, so that there should not be any overhang and based on that the excavation height is controlled. So, this is the general terminology, you can see this is crawler,

housing, frame, support cable, saddle block, hoist cable, boom, stick, crowding cable, hoist cable, bucket, these are the different components of the rope shovel.

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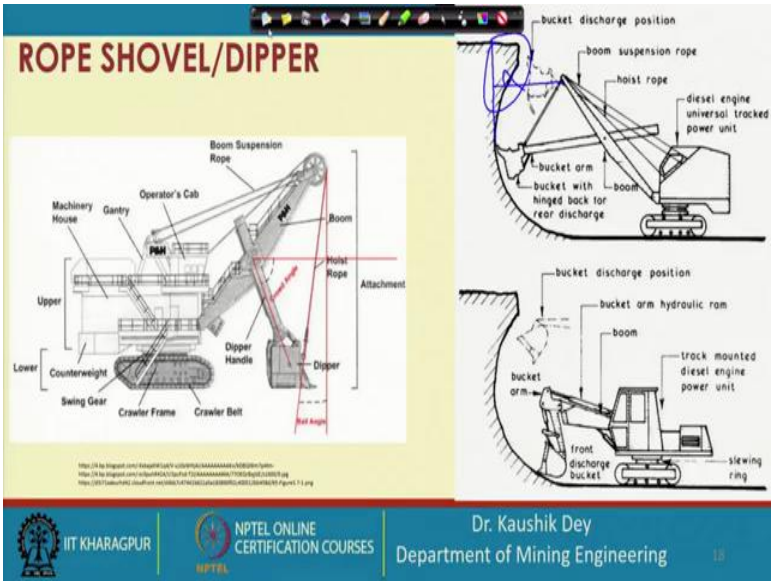

And this is also available, this portion it is shown that, this part will become overhang and that is why this is not allowed. So, that is why this is one must be very, very careful, if it is excavating over this reach of the boom, that is not allowed this can be a this can create a dangerous situation. So, that is not allowed. So, it is no matter whether a diesel engine or electric motor is used for the operations. Still, rope shovels are, mechanically driven operations, which are practiced in the mine.

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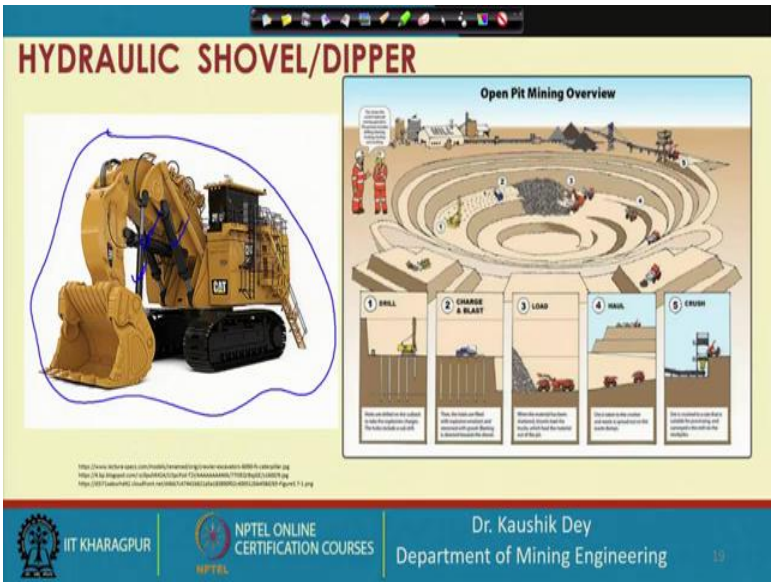

So, as a rope shovel is a dipper shovel, you can also have the hydraulic shovel. So, this is hydraulic, this is the hydraulic dipper shovel, you can see this is the boom cylinder, this is stick cylinder, and this is sorry, this is bucket cylinder, this is stick cylinder, this is boom cylinder, which is used in this and this is a schematic diagram of the caterpillar.

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And you can see one operation of this hydraulic shovel, the hydraulic dipper shovel, here, this is also taken from YouTube. So, you can see how the excavator is, and the dumper is coming back towards the shovel. So, a shovel is a stationary piece of equipment, it stands the transport medium has to go to within its cloximity. So that it can dump the material onto the transporting system.

So, the transport system has come, so it is dumping the material. So, now the door is open, bucket in the bucket cylinder is open, allowing the bucket to move. Currently, the door is closed again, and it is taking the material. So, in this figure, this machine is working on the loose material, which is being dodged. So, this is loose overburden material, which is being dodged the from the upper bench by a dodgers.

So, it is only working as the loading machine and at ,this position and you can see the boom is lowered, now the stick is expanded and the bucket is also being rotated, see the bucket is being rotated. So, that the filling efficiency can be increased, you can see the bucket is almost completely filled, in fact you can say it is over filled in this case.

And now it is rotating after rotation it is placing its bucket using this boom, the stick cylinder, you see the stick cylinder is expanded to properly load the dumper. The hydraulic excavators the easiest part is that a single hydraulic pump is used with a number of actuators, allowing the movement of the fluid for differential way into the different cylinders and that is why it is

something like that you can consider the pump is similar to the heart of the human being, and it is controlling the pressure in the all cylinder.

So, that is why the operation is very easy, only the operator has to control those valves. So, the fluid can flow in that particular cylinder for its expansion or return to the pump. So, in that way cylinder is expanded, and the cylinder is also closed. So, this is the way this machine is operating. So, this is one video. You can have the full video in this given link; this is the way the hydraulic excavators or hydraulic dipper shovels are basically working. So, we will continue with the other types of shovel in the next class. Thank you.