**Surface Mining Technology**
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**Department of Mining Engineering**
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**Lecture 25**
**Excavation with Shovel – II**

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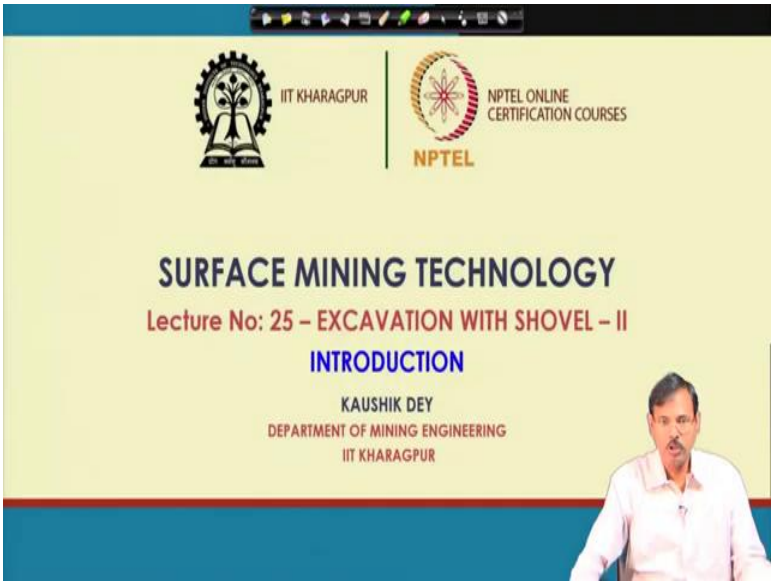


Let me welcome you to the twenty-fifth lecture on surface mining technology; we are continuing with excavation with a shovel; this is the second lecture on that; in our first lecture, we have covered some parts of the excavation with a shovel.

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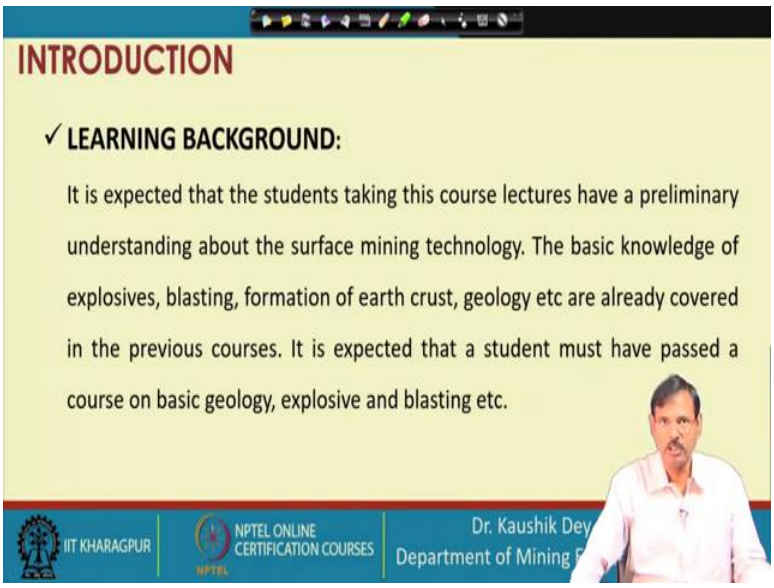

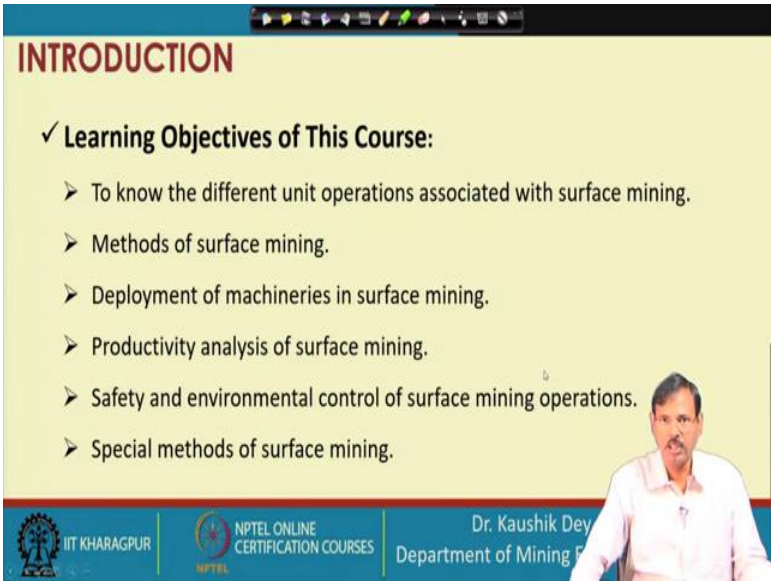


So, like every lecture, let us see the learning background for the surface mining technology course. These are the learning objectives of the surface mining technology course; surface mining technology is a basic course for the basic compulsory course for the graduating mining engineers as well as it is also an important subject for the postgraduate mining engineering in surface mining, mining engineering as well as in rock mechanics, and other surface postgraduate course of mining technology.

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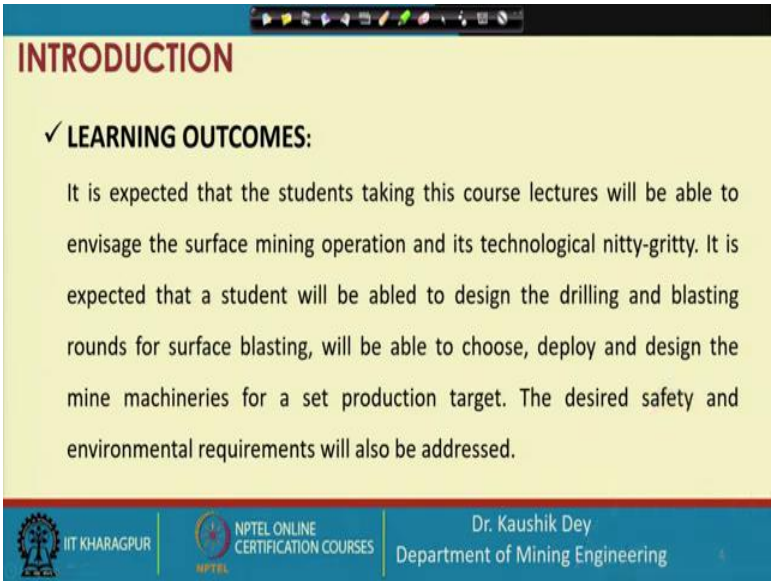

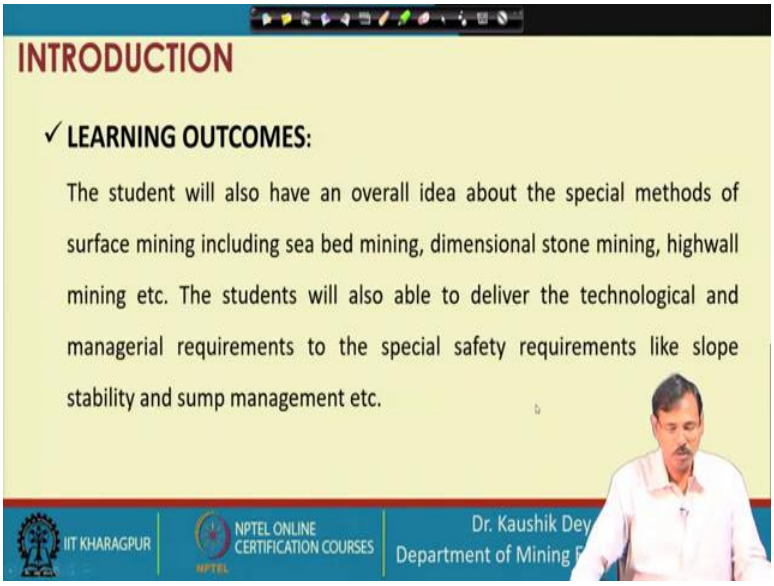


These are the expected learning outcomes from the participant of this course; these participants may be from, maybe an industrial people, a B. Tech graduate, or maybe postgraduates.

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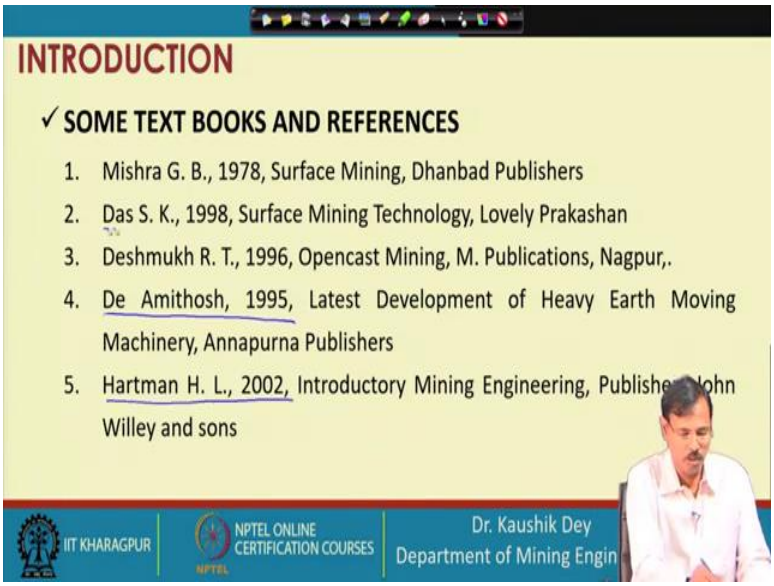

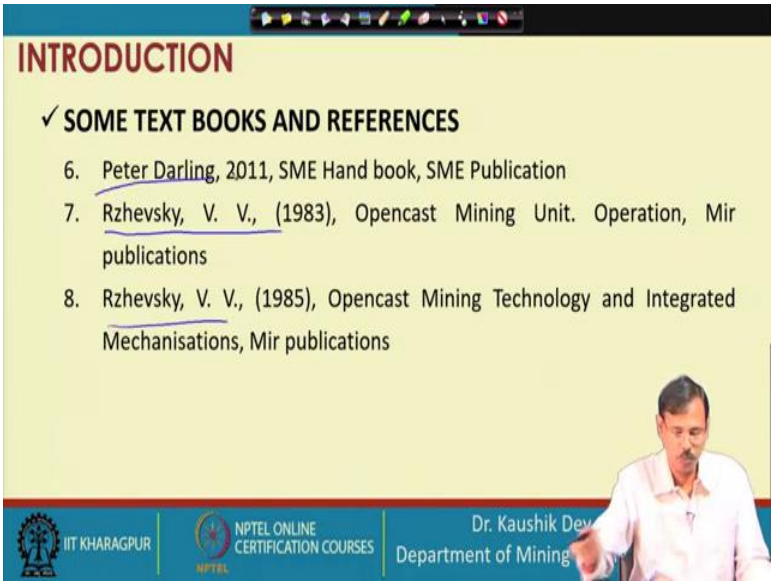


And these are some of the textbooks and references, it is expected that the participant will follow this one and for these particular lectures, I also request you to look into this, this book may be this book also, this book and as well as these are some of the books, which can be followed and this is the SME handbook.

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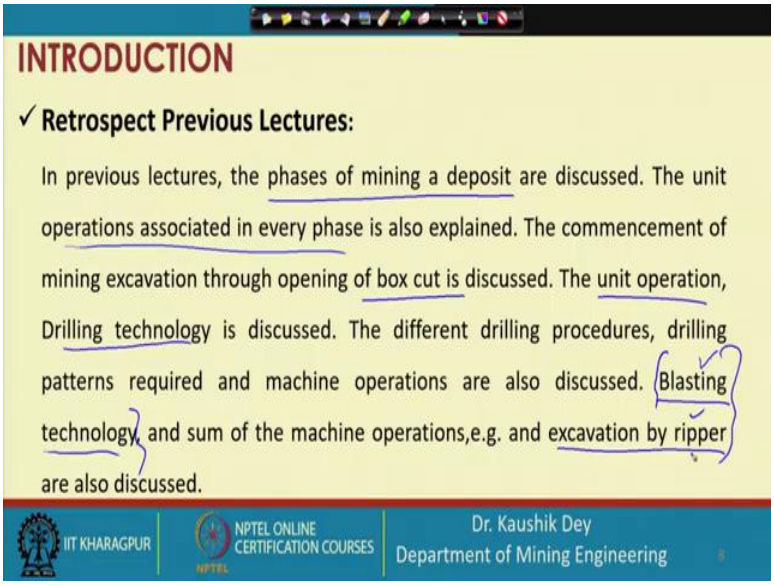


Now, let us look into the previous lectures; previously, we have covered the phases of; we have covered the phases of surface mining deposits. Then the unit operations associated with every phase, we have also discussed in detail the excavation, starting of excavation of, in surface mines

through box cut. We have also discussed the unit operations like drilling and blasting, which are considered in details blast designing and are also given in detail.

So that the participants can follow those lectures and after the blasting, it is expected that the material blasted material has to be taken out using an excavator. So, we are continuing with this part that we have also covered; if we are not doing the excavation by blasting, because of some problems, etcetera, we can go for adopting blast-free technology, which is in which the ripper is a possible technology, in which we can loosen the rock mass.

So, the blasted rock mass has to be excavated after blasting or ripping. So, for this, we need the excavator. That is the objective of this lecture; we are trying to understand how the excavator is working.

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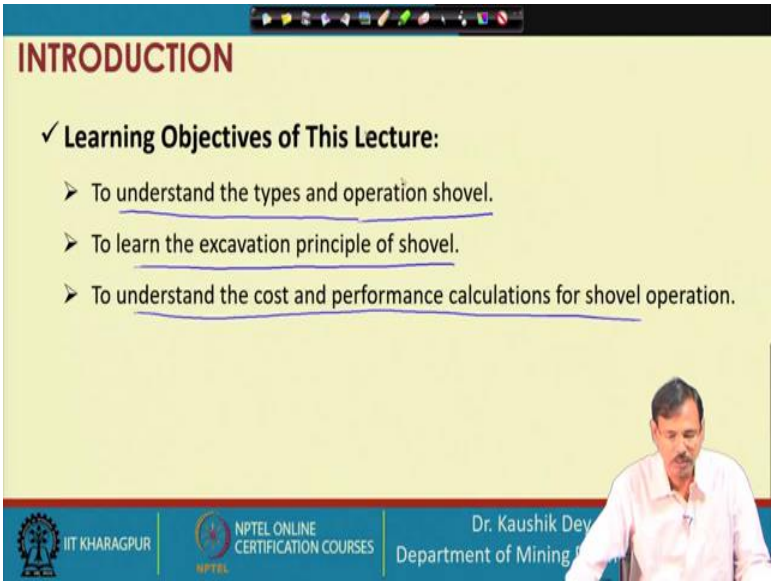


So, we are continuing with this excavation by shovel, the shovel is nothing but an excavator, and we are in the first part, which is understanding the types and operation of the shovels. So, there are different types of shovels; their operations are a little bit different from each other.

So, we are in this part; we will also learn the principle of shovel operations and understand its cost and performance calculation; this will be carried out in future lectures. So, these are the basic objectives of the lecture series related to excavation by shovel.

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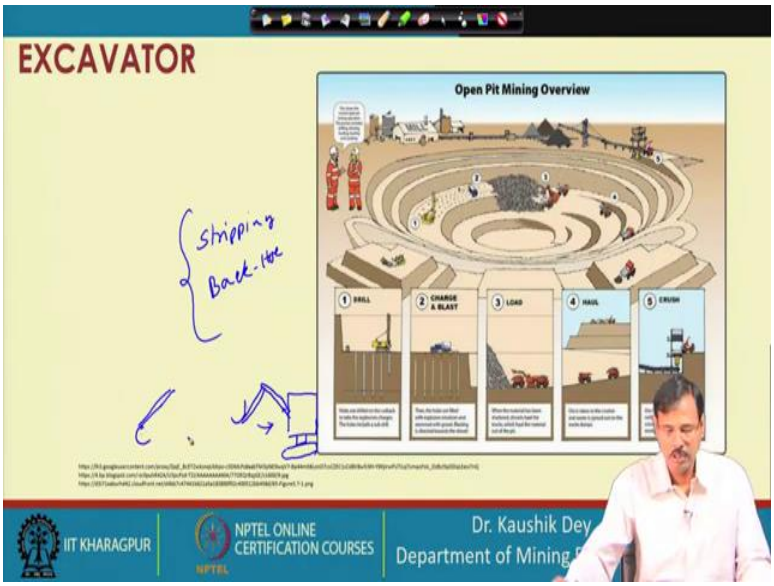


So, we now understand the types and operation of the shovel; in the last class, we have seen; in the previous class, we have seen that shovels are of three types. It is a dipper shovel, it is a stripping shovel, and it is a backhoe.

So, in this class dipper shovel is already discussed, so in this class, we will discuss these two types of shovels. You have understood that the basic difference between the dipper shovel and backhoe is that, in the dipper shovel, the bucket position of the bucket, is on the opposite side, is in the opposite side of the machine. In the case of the backhoe, it is towards the side of the machine.

So, that is the main difference between the backhoe and dipper shovel, and the stripping shovel is a special type of dipper shovel with a long boom so that it can dump the material directly onto the overburden dump which is why it is called a stripping shovel.

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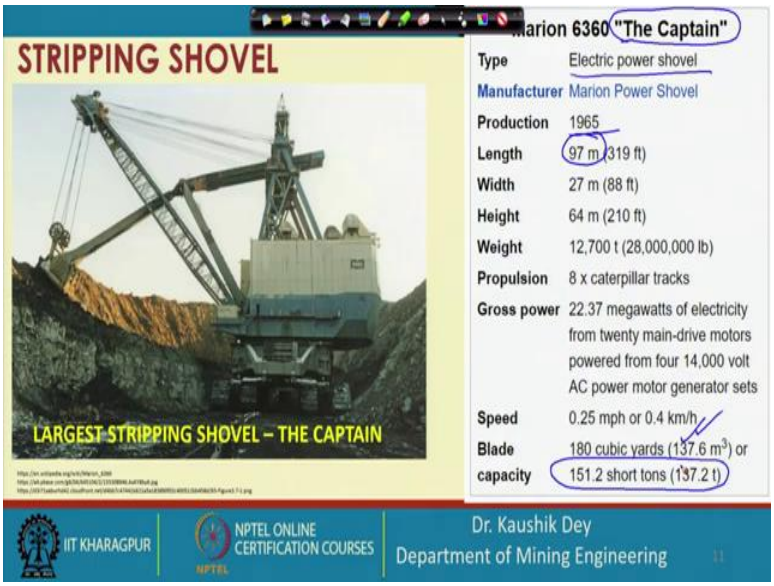


So, we are continuing with this; let us start our stripping shovel; this is the largest stripping shovel available in the world; this is an electric power shovel 1965 made, boom length is 97 meters, and this has a capacity of 151 short ton, and you can see this is the capacity of the bucket. So, this is the largest, this is the largest stripping shovel, this is the photograph of this one, and this was under working up to 1990s after that it is no more under use.

And nowadays, this type of big machine is not generally produced because the surface mining is going deeper and deeper, which is why the land acquisition is becoming a problem.

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## STRIPPING SHOVEL

https://www.youtube.com/watch?v=g7i8R6ZbJio

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So, let us look into one first video of a stripping shovel and how a stripping shovel works. So, you can see this is the stripping shovel, which is taking the material from this bench, and then in the opposite direction, the overburden dump is there. It is dumping the material onto the overburden dump. So, it is taking the blasted material from this side and dumping it on the other side.

So, this is a very, very big machine, the height of the machine is almost equivalent to a 12-storage building, and you can see this is a very long boom length and this is a wire rope shovel, wire rope dipper shovel, and you can now understand how big it is. The benefit of this stripping shovel is that you can very easily understand it is dumping the material precisely at the position it is intended for.

So, that is the main benefit of this stripping shovel, that it is dumping the material at the point for which it is basically intended. So, this is the benefit you can see the movement of this stripping shovel, and how it is being moved.

So, these are the benefit of this machine, this is the A-frame, and this is a look from the operator's cabin, how the operator is looking at the machine, and these are the different systems, gear system inside the machine you can see these are the wire ropes, and this is the propelling system of the devices, it is a four-crawler operated system, you can see this one crawler, this is one crawler this side in the opposite side also, it is having the similar crawlers. And this is how one can move to the top of the boom and inspect the thing.

So, these views are interesting to see from the top of the boom; you can see it is moving up to this to go for any maintenance work. That requirement is not there for the stick because you can lower the bar to the bottom and inspect there, but this part cannot be lowered up to the floor level. So, that is why that movement is essentially required.

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This is another video of this stripping shovel, actually, I am emphasizing you to look at this stripping shovel because in India, we do not have any stripping shovel under operation. So, having a clear view of this in the actual field is impossible.

So, only videos are available to the students of this country to see the operation of the stripping shovel; you can see how the stripping shovel is working, this is another rope shovel, which is not a stripping shovel but a dipper shovel is being used for loading the machines. Here a dodger is working. You can see the dodger size in comparison to the stripping shovel size is too less.

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Now, you can see the stripping shovel is starting loading its bucket, you can see the bucket movement, the stick, stick arm are now pushing the bucket, stick arm is pushed, and the hoisting arm that is the boom is being moved towards an upward direction. So, the bucket is being loaded, and now the bucket loading is complete, the stripping shovel is rotating for dumping into the dump.

So, the right side of the machine dump is there, and it is now dumping the material exactly at the position as it is boom mounted. So, better control over the bucket is possible. So, that is why the dumping is made at the position where the operator intends to dump. So, that facility is not available for wire suspended buckets, like dragline, etcetera.

So, the stripping shovel has a little benefit over this, and these are the electrical cables used, which is supplying the current to the stripping shovel. And this is the more or less; I believe you have understood the operation of the stripping shovel.

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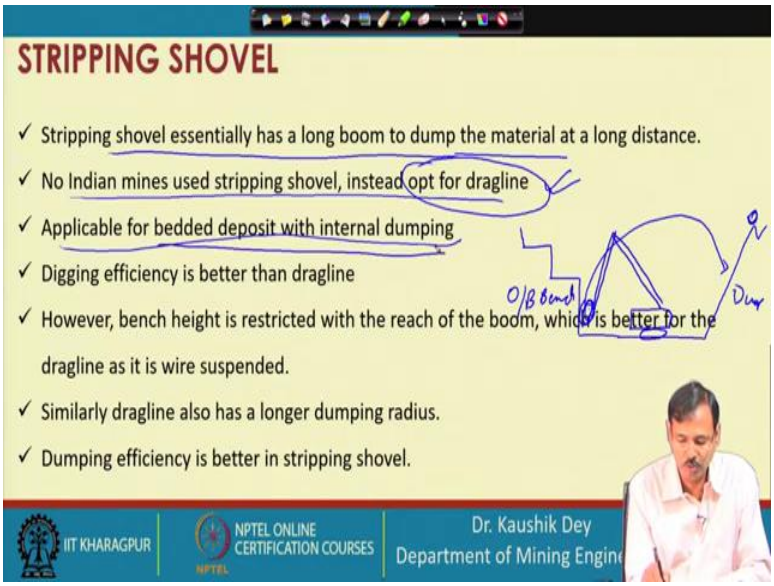


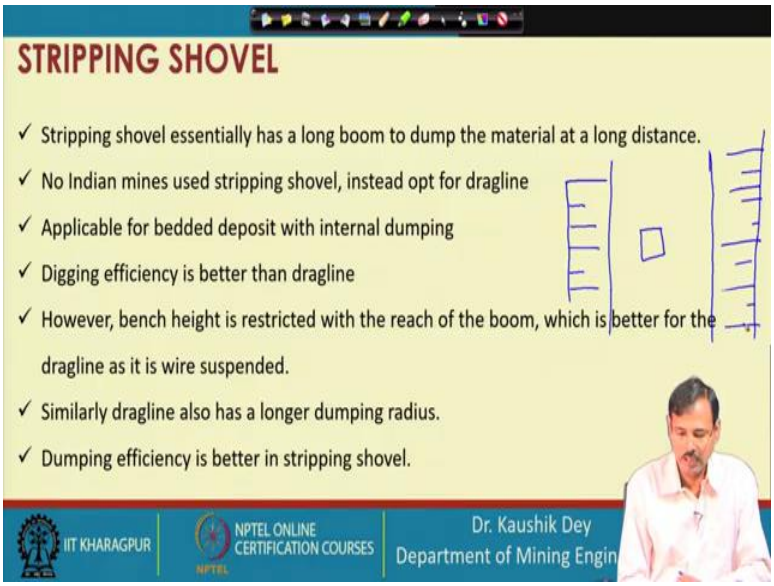


Now, let us look into the benefits of the stripping shovel, or you can say characteristics of the stripping shovel. A stripping shovel essentially has a long boom to dump the material at a long distance. Unfortunately we do not have any stripping shovel, but in most of the Indian mines intended for the dragline, we will discuss the dragline, and we will discuss why dragline opts in most of the mines.

Applicable for bedded deposits with internal dumping system, because the material is, if you are looking at these benches, you have seen, these are the operating benches, and these are the overburdened dumps. So, a stripping shovel is operating at this position, it is basically taking the

material from this position and dumping this material at this position and that is why it is having a long boom, it is having a long boom.

So, that it can take care of this bench as well as it can dump the material at this particular point also. So, this is the benefit of this stripping shovel, it is operating on the bench floor at this position, which one side is the dump, another side is the overburden bench. So, that is why stripping shovel is applicable for the bedded deposit, which is following the internal dumping only.

So, if you are looking at the plan view of this one, this is probably the bench, the shovel is under operation at this position, and its right side is the overburdened bench. So, this is the general plan view for a mine, where the stripping shovel is operating.

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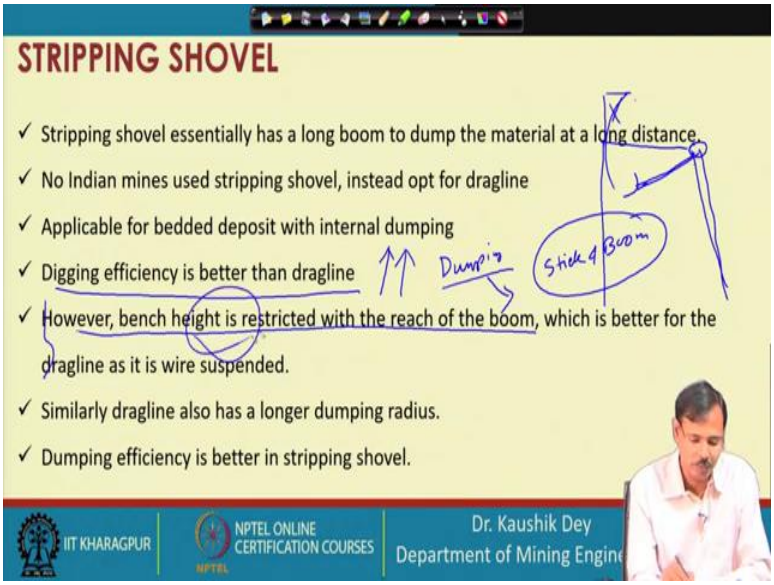


Digging efficiency is better for the stripping shovel, because its bucket is controlled by the stick and boom, which are the solid iron part, not like dragline, dragline the wire rope controls the bucket. So, its digging efficiency is very high very, very high. And the dumping efficiency is also very high, as the boom controls the bucket position. So, dumping can be made accurately at the particular face.

However, bench height is restricted by the reach of the boom. So, you can carry out excavation up to this boom height. So, that your bucket can dig, above that the bucket will create the overhang, which is not allowed, so it is restricted up to this height only, that is up to which your

boom height. So, up to which you can carry out your bench height for the digging by the stripping shovel.

But, in dragline, as the dragline is standing on the top and with the suspended bucket. So, the bench height is not that much restricted; bench height is restricted by the control of the wire rope given in the dragline system. So, that is a benefit in the dragline, but it is a problem with the stripping shovel at this position.

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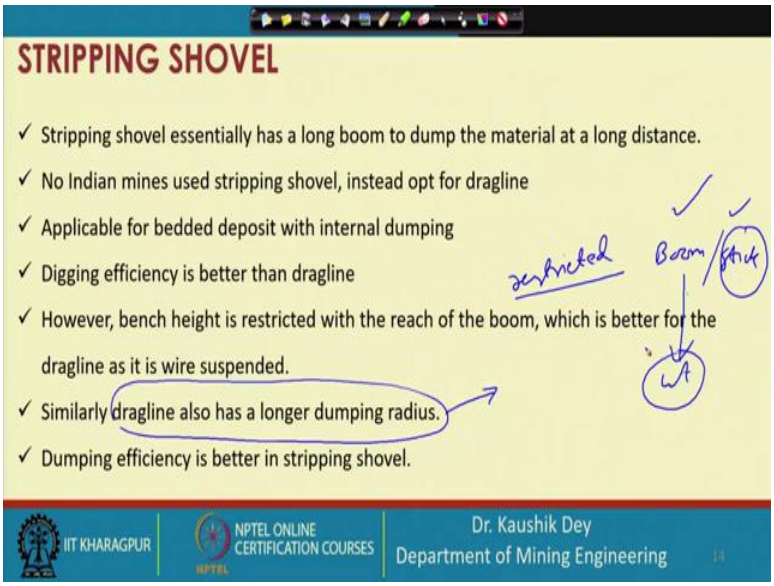


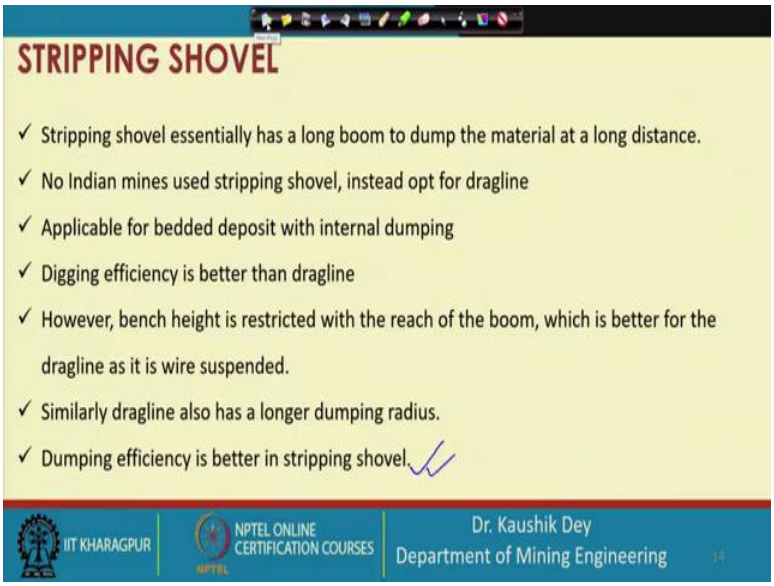


And dragline is having, in general having a longer dumping radius than the stripping shovels, stripping shovel dumping radius is also restricted, because as it is a control system using a boom

and stick. So, if anyone is willing to increase this dumping radius, then they have to increase this boom length and stick length, which is basically increasing because of the stick actually; the stick is not available with the dragline.

So, the stick is the main culprit; as you are increasing the stick length. In that case, the weight of the machine has to be improved. So, that is creating disturbances, which is why stripping shovel has some restrictions of overall increased boom length and stick length. But, dumping efficiency, which we have also discussed earlier is better in the case of a stripping shovel than the dragline because in the dragline, it is where suspended, and in a stripping shovel, it is a stick suspended bucket system is provided.

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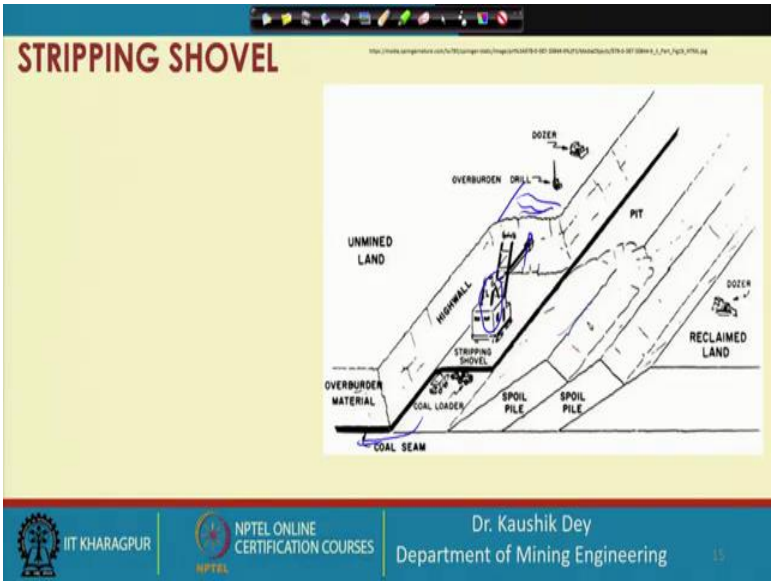


And this is the plan view; you can understand the stripping shovel, this is the stripping shovel, which is under operation, this is the loading coal bench in which the loading is carried out, and this is the whole road through, which the operation is going on. This is the overburdened rock, and this burden part, this part, is being blasted.

So, this blasted material is taken by this stripping shovel and dumping at this position. This is the overburdened dump bench, which is why it is easily understood how this control is carried out. So, this is the general stripping shovel layout of the stripping shovel, where the shovel operates.

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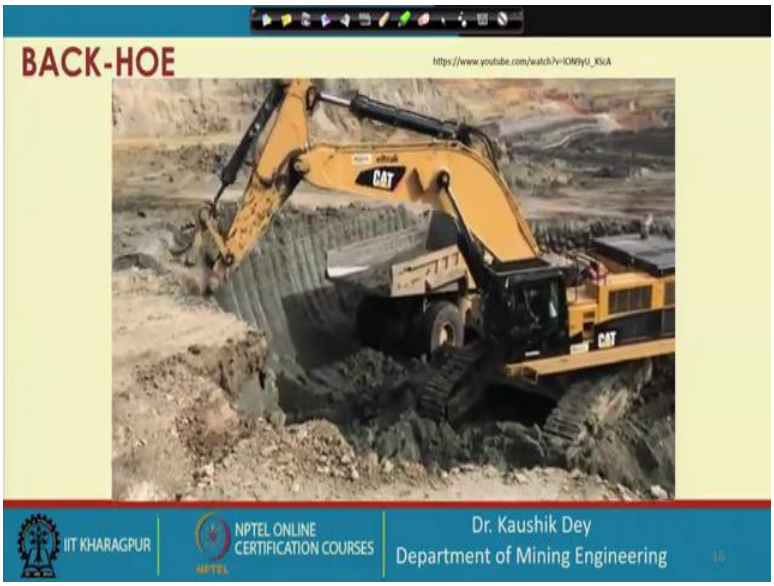



Now, our next type of excavator system, we have already discussed that is called backhoe, before discussing the details of this, let us have one view of this video, how the backhoe is operating. So, this is the dumper is being placed in front of the, in front of the backhoe. Now, backhoe is basically dumping the material, now see the backhoe is digging the material, it is basically loosening the material, or dropping the material from the bench to the down, then you can see the backhoe is standing on a heap of material.

So, it is first created the heap, then allow the heap to become its platform, on which it will work, then it is taking the material bottom of his heap, see its datum level is high, it is taking the

material from its below level and now it is taking the material and dumping the material onto the dumper for its loading. So, this is in general a backhoe is operating, so the backhoe has the tendency to operate, tending to work at a level which is below then its standing level so, that it can have a good efficiency of the loading of the bucket.

But that does not mean that it will not be able to dig the material from the above part of its level, it can dig the material. Still, for loading it has to stand on a heap, because as its bucket is in the opposite direction from a upper level, then its datum level, from this level it cannot load the material, material can be loaded only if the bucket position is below than its crawler level then only the loading can be made to the backhoe.

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So, in the other side also this is the second dumper, which is placed and here it is very easily visible how the loading is made to the inside the bucket. Now, the bucket is released by rotating the bucket in the upward, opposite direction. So, in the dipper shovel, you are having a door, which is released behind the bucket from which the material is allowed to discharge, but in this case your bucket material is discharged from the mouth of the bucket itself.

So, the bucket is rotating in the upward Z direction and allowed the gravitate, material is gravitated down from the mouth of the bucket for its loading. So, what is happening in this case, the benefit is that the oversized boulder are also able to be handled by this excavators, because those boulders need not to be allowed to dump, need not to be allowed to dump from the bottom part of the boulder by opening the door.

So, it can take a oversized boulder in its mouth and gravitate that, gravitate down that boulder to the dumpers pan, that is easily possible with the backhoe, which facility is not available with the normal dipping shovel, or stripping shovel. So, that is the benefit of the backhoe and this is the operation is shown using the backhoe.

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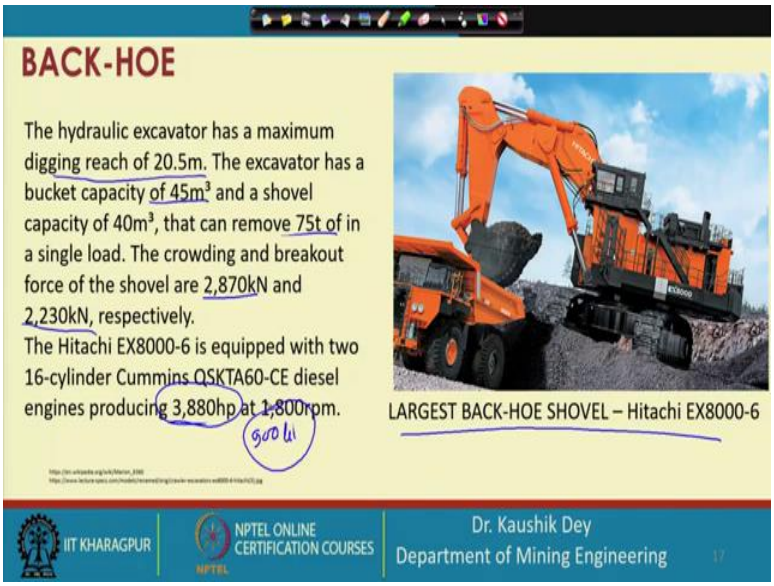


Now, this is the largest backhoe shovel, as per the internet source achieved Hitachi 8000 EX. So, this is having a reach of 20-meter, bucket capacity is 45-meter cube, it can take 75 ton in a single load, or this is the crowding force and this is the breakout force given by this shovel and this is having almost 4000 hp motor, almost 4000 hp motor is used. So, you can imagine that 4000 hp means per hour, it is almost consuming 900 liter of hst, for its operation.

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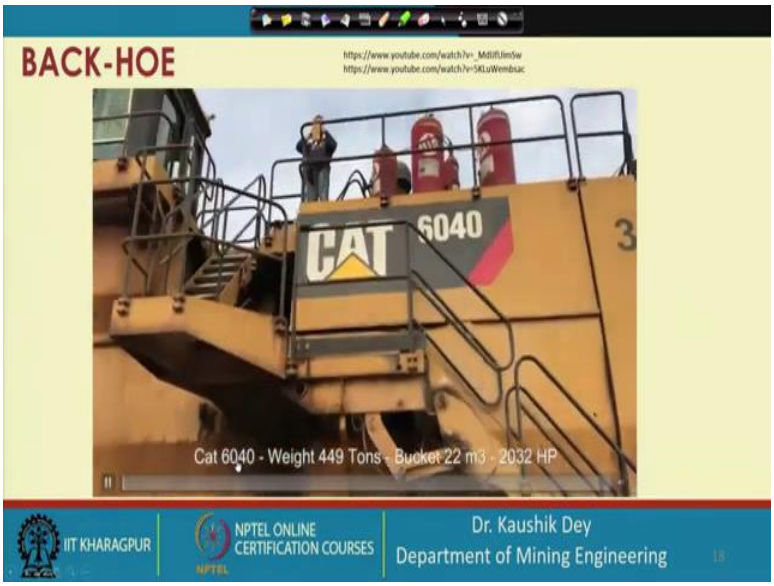


BACK-HOE
https://www.youtube.com/watch?v=_MdIIfUim5w
https://www.youtube.com/watch?v=5KLuWembsac
Cat 6040 - Weight 449 Tons - Bucket 22 m3 - 2032 HP
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BACK-HOE
https://www.youtube.com/watch?v=_MdIIfUim5w
https://www.youtube.com/watch?v=5KLuWembsac
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So, this is another operation of this one, you can see CAT 6040, 22-meter cube bucket is used, which is having 2000 hp mod the engine, and this is having a very good look, because this video is taken from the operator's cabin.

So, you can see the look of the operator, while it is digging the look of the operator, how it is looking at the bucket and the visibility of the operator can be easily seen, see the operator is able to see completely, how the bucket is being loaded, you can see only two stick can control all the operation, this two stick in two hand can control all the operations, except the movement of the crawlers, that is in the front direction, back direction, that is given in the leg, in the in the foot except just like a car.

But except that all the operations, movement of all the three cylinders, movement of the swinging of the platform all these are basically given in the two that joystick to the operator. So, not only this with the reverse of that one, means front direction if it is the movement of the stick in the front the backward movement of the stick is also given.

So, all those eight operations are given in the two joystick of the operator and that can be easily controlled. So, it is very easy and acceleration is given as a handle bar, so the once the bar is given, it is having the full throttle and then that can operate very easily, you can see how hard digging is there, because of this lateritic soil and that is being digged by this operation. Hydraulic shovels are very good because in overloading case the mains pairs can be kept in safeguard in overloading case also by releasing the hydraulics.

So, that is the benefit of this hydraulic system, however the loss of hydraulic and wear and tear may often become more. So, as this excavator is working at a backhoe excavator is working at a level, which is higher than its digging level, as well as often the dumpers are also placed at a lower level.

So, the filling of the dumper is also becoming very, very efficient, because operator can easily see the position of the filling rock inside the dumper. So, that is why the filling efficiency of the transporting systems are also becoming more in case of backhoe excavators, as they are working from a height.

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So, you can see this is the how hard digging lateritic soils are made by these excavators and it is basically by this way provide a smooth floor, as well as it is provide a smooth, or uniform bench slope at the face almost there is no loose material available in this case, it is completely dig the toe part of the bench also. So, that is the benefit of the use of backhoe in the mine, you can see the full video in the YouTube also.

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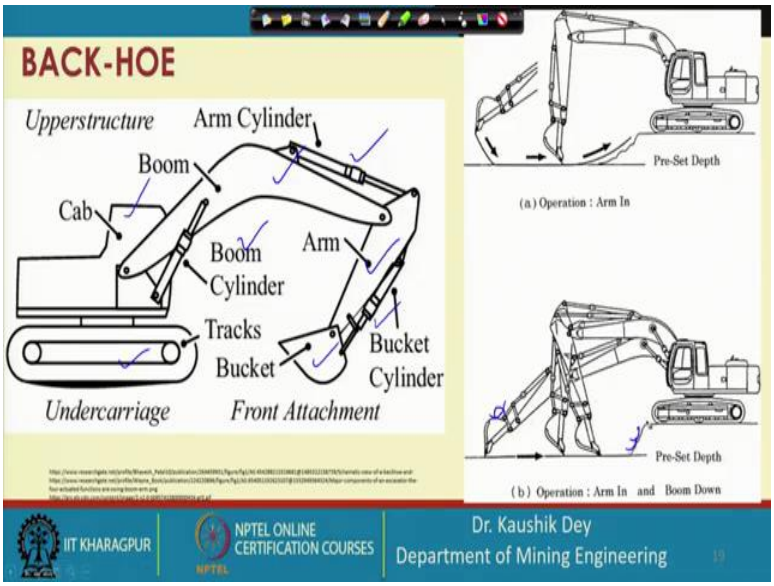


And this is the different terminology of the backhoe, this is the arm, or stick, this is boom, these are the different cylinders, we have already discussed bucket cylinder, arm cylinder, and boom cylinder, this is the average, this is the crawler system, this is bucket, this is the angle of digging how the material is being digged, how the rotation of this angles, these rotations are controlled from this, this rotation is given more angle to this bucket for the better filling.

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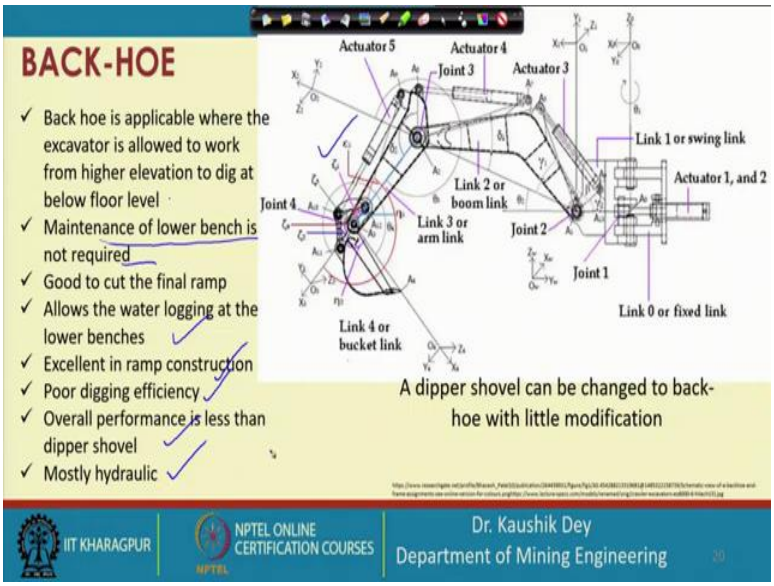


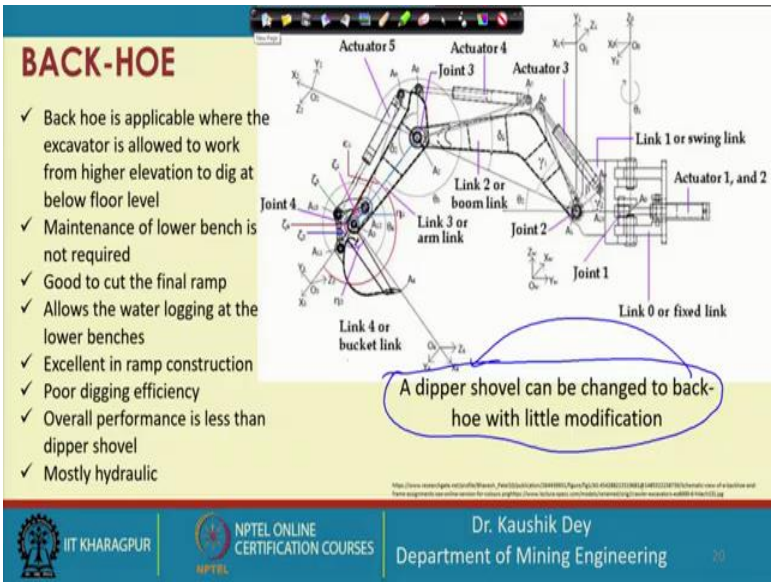


This is another photo, which is showing the different, showing the different parts, all the actuators, these are shown here. So, backhoe is applicable, where the excavator is allowed to work from the higher elevation to dig at below floor level. So, excavator is working to dig at below floor level. So, this is giving the advantage that maintenance of lower bench is not required.

So, it is very good to cut the final ramp and allows the water logging in the lower benches. So, in rainy season also, if the water logging occurs in the lower bench, you can operate still the lower

bench from the upper bench, because this excavator can work from a level higher than the working level.

So, this is good for the ramp construction, it is having a little bit poor digging efficiency of the solid rock, because it is working that below level from the top level. So, that is why it is digging efficiency is little bit poor than the deeper shovel, overall performance is less than the dipper shovel. And it is found this is hydraulic shovels only, so far I do not have any knowledge of the backhoe of wire rope made backhoe only the hydraulic backhoes are also available and seen popularly in the manufacturing area.

So, this is the benefit of the backhoe, but a dipper shovel can be changed to the backhoe with little modification and the vice versa also a backhoe can be changed to a dipper shovel with a very little modification in the works of itself, works of the mind itself it can be carry out. So, the modification requirement is not very significant with few lacks expenses that modification can be made very easily.

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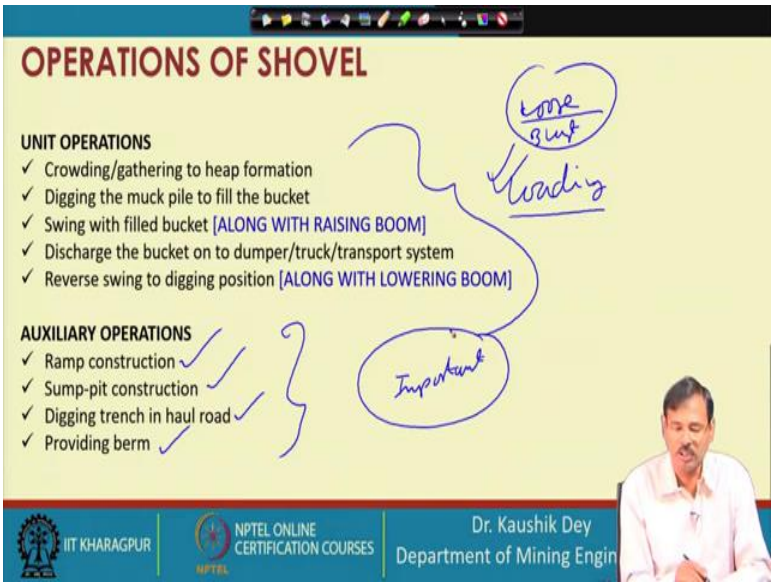


So, in a nutshell the different unit operations can be carried out by a shovel is the, this part is the for loading of the equipment and these are the. So, this is for loading of the, loading of the transporting system by a loose rock, loose, fragmented rock, or blast fragmented rock. So, this can be carried out, basically as the loading purpose, apart from that excavator can be used for

ramp construction, sump-pit construction, and digging trench in the haul roads so that the drainage can be made.

It is also used for providing the berm in the haul road. So, all these operations, along with the loading or excavation operations, can be carried out by a shovel. So, the shovel is a very important and self-sustained machine; a shovel can operate without any other device and start its work in a barren land; it is also for removing the trees.

So, all these operations can be carried out using a shovel, and it can work without the help of any other machines associated with it. So, that is the benefit of the shovel; we will continue the discussion related to the shovel in the next class also. Thank you.