Surface Mining Technology
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Lecture No. 42
Excavation with Bucket Wheel Excavator – I

Let me welcome you to the forty second lecture of NPTEL online certification course surface mining technology. From this lecture we will start excavation with bucket wheel excavator. There will be three lectures on this bucket wheel excavator, and this is the first lecture in this; title of this lecture is Introduction to Bucket Wheel Excavator. So, as we do in every class.

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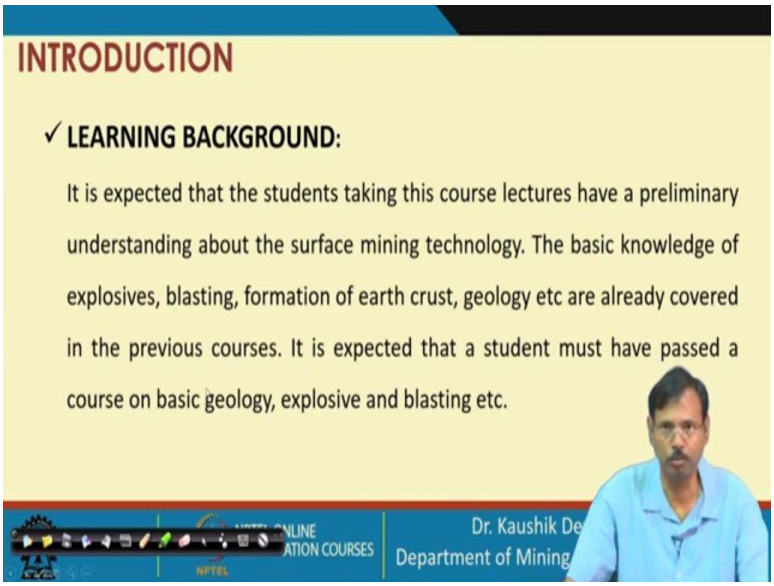

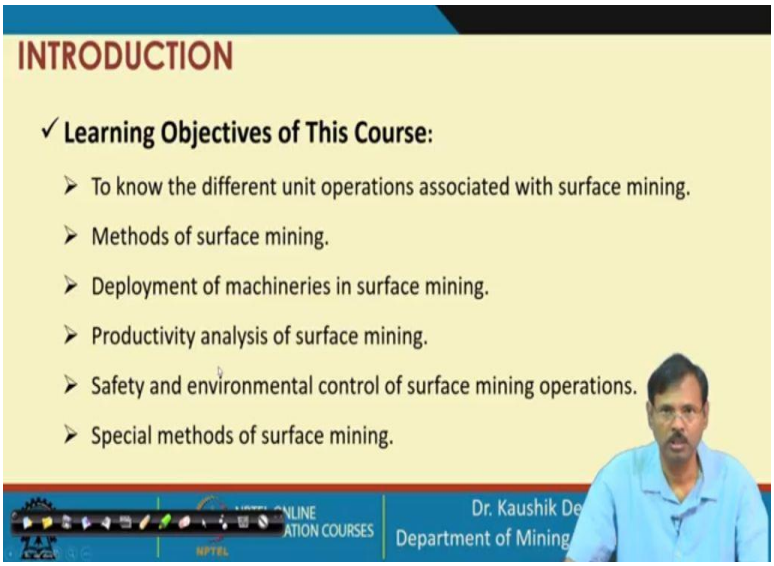

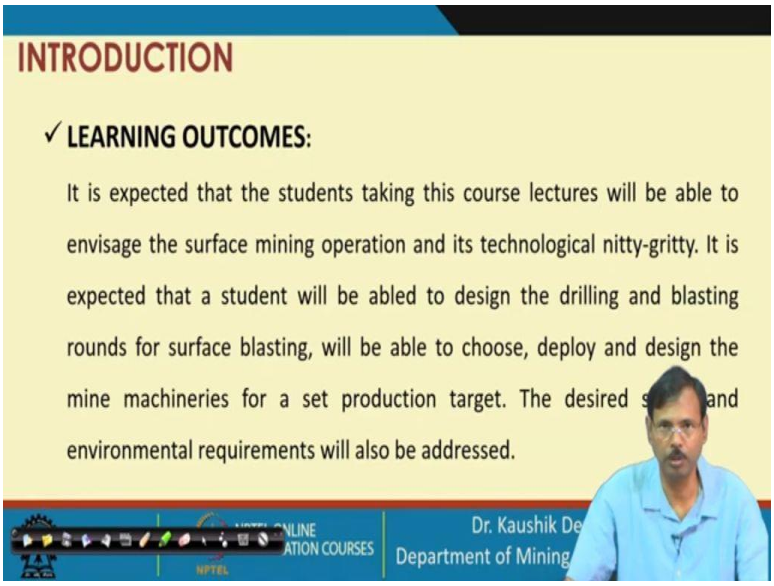

Let us looks once into the learning background expected from the participants. They should have this learning background before appearing for this surface mining technology course. These are the learning objectives set for the surface mining technology course. And these are the expected learning outcomes from the participants of the surface mining technology course.

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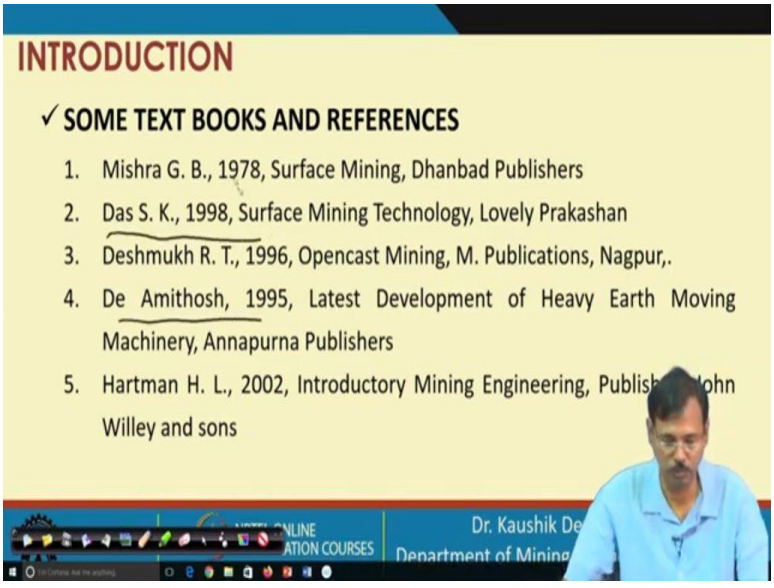

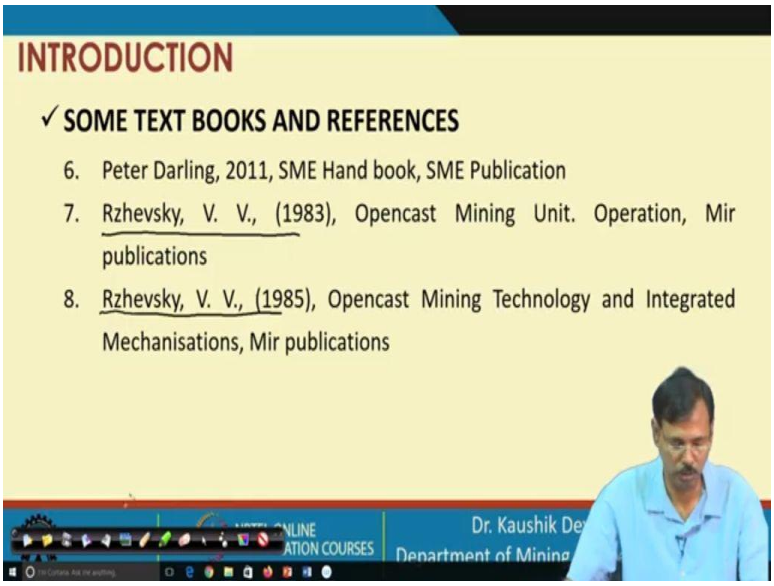

And these are some of the textbooks and references. In this, I would like to particularly draw your attention in these two books in connection with the bucket wheel excavator and its performance. These two books are good, and should be followed. Apart from that, this book is also having a good material for studying the bucket wheel excavator part. Apart from that there are in website, a number of information's are available.

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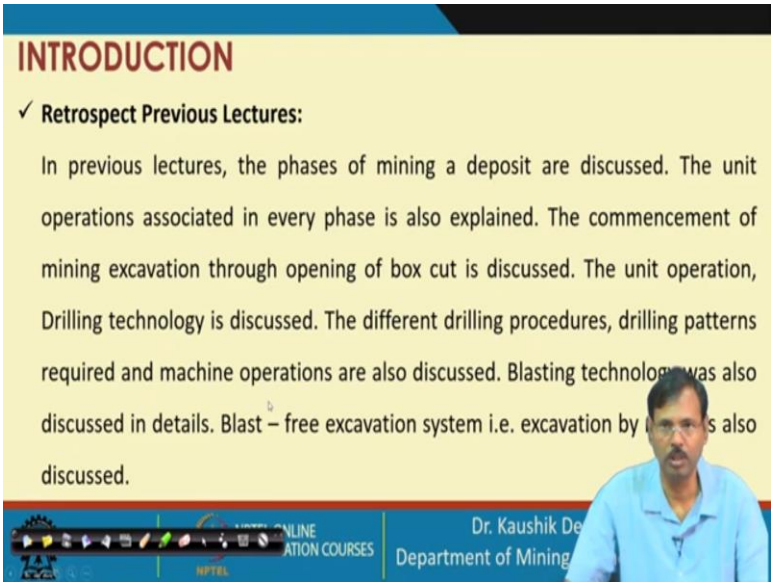

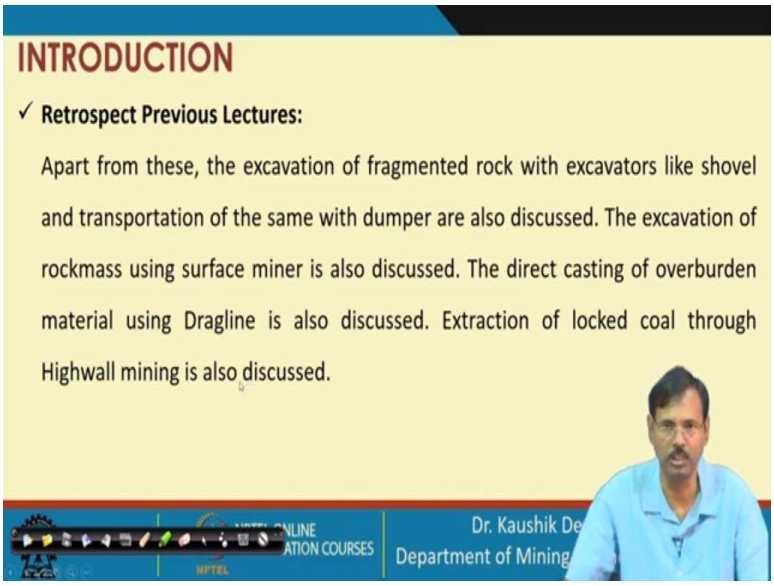

Now, let us retrospect so far what we have covered in this surface mining technology course. We have started with the status, current status of the surface mining in the worldwide. And after that we have covered the phases of mining a deposit and what are the operations associated with these phases. After that, we have covered the commencement of surface mining through excavation of box cut.

Then we have covered the unit operations like drilling technology and we have discussed different drilling pattern. We have discussed the blasting technology, which is most commonly used for fragmenting the rock mass. After that, we have covered blast free excavation technology, which is adopted for soft material, that is, ripper. And the excavated material how that can be that fragmented material how that can be excavated by the excavator, or loading that to the transporting system that is discussed.

And we have discussed the transporting system, with special emphasis to the shovel dumper combinations. We have discussed the excavation by surface miner, and we have discussed the excavation and direct casting of the material using dragline. And we have discussed the excavation using the highwall mining system for the locked coal, especially the coal seams, which are locked under the highwall, how that can be mined with the highwall mining system.

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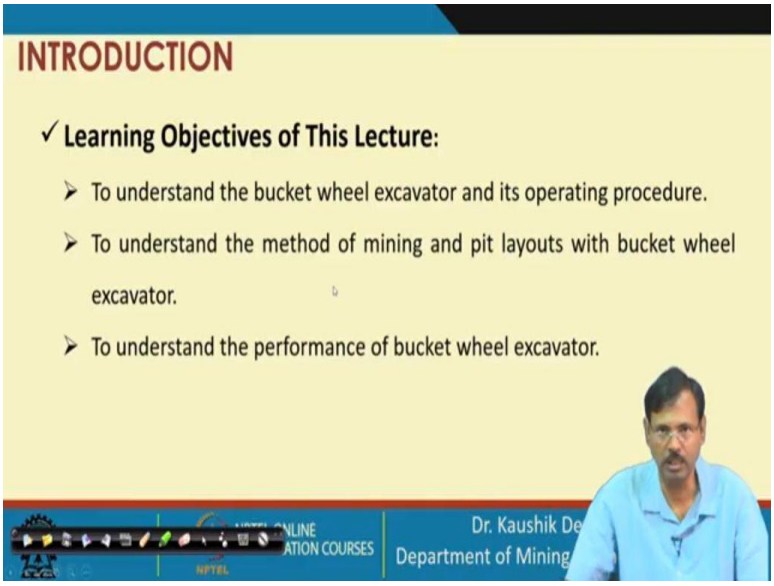

And in this lecture we will discuss the excavation by bucket wheel excavator. The learning objective set for these three lectures on bucket wheel excavator is like this. To understand the bucket wheel excavator and its operating procedure, to understand the method of mining and pit layouts with bucket wheel excavator, and to understand the performance of bucket wheel excavator. These are the objective set for this lectures.

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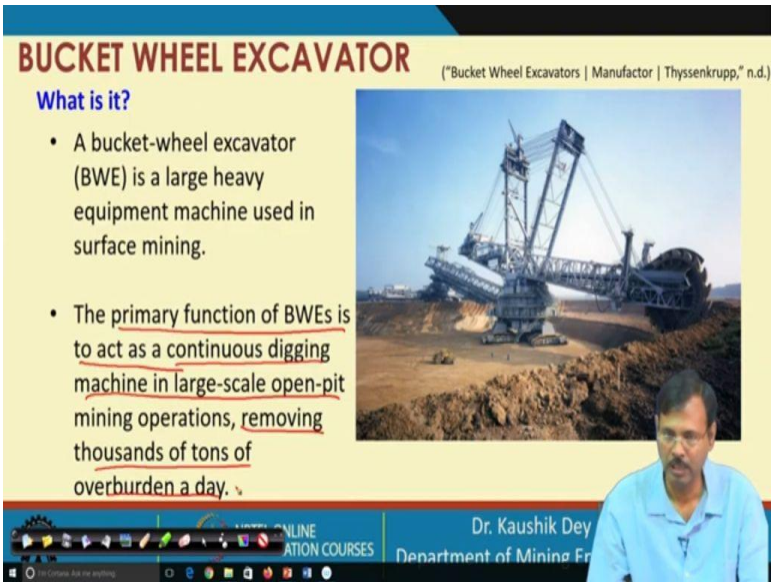

Now, let us try to understand, what is bucket wheel excavator? Basically, bucket wheel is comprising a large wheel; you can see in this figure, this is the large wheel. And in this large

wheel, a number of buckets are enclosed with. So, when the wheel is basically rotating that time this buckets are striking with the wall, and it is excavating the rock. So, that is why this is called a bucket wheel excavator is a large heavy equipment machine used in surface mining. In fact, the largest mobile equipment on this earth is bucket wheel excavator; we will come to that at a later stage.

The primary function of bucket wheel excavator is to act as a continuous digging machine in large scale surface mines, and remove thousands of tons of overburden or coal material in one day. Basically, this is a wheel, which is comprising a number of buckets; these buckets are filling the material, and discharging that onto a continuous transporting system; then the production is achieved through this. So, bucket wheel excavator is a very highly productive machine.

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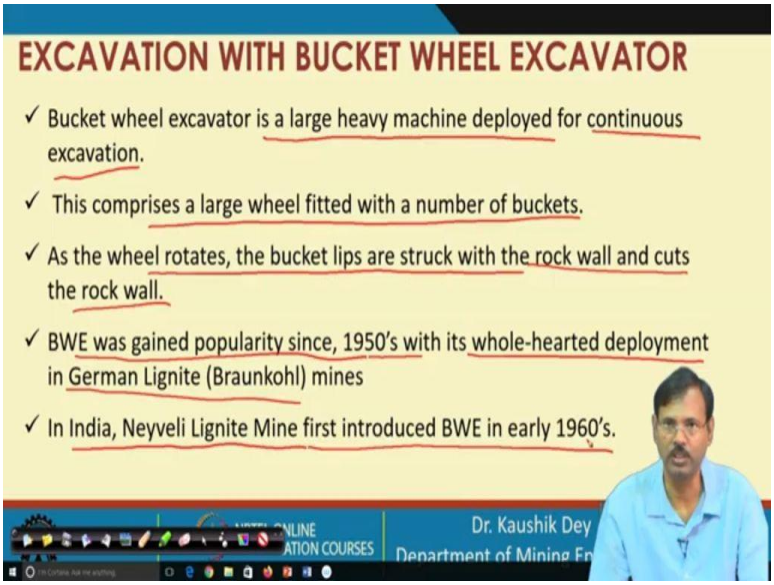

And with its efficiency of the cutting, it is deployed in the soft rock material for the excavation purpose. So, we can say it is a large heavy machine deployed for the continuous excavation, as continuously the wheel is rotating. Buckets are continuously struck onto the wall face, and it is digging the wall; it comprises a large wheel fitted with a number of buckets. As the wheel rotates, bucket lifts are stuck with the rock wall and cut the rock wall.

Bucket wheel excavator gains popularity in 1950s onward, and whole-hearted its deployment occurred in the Braunkohl coal mines, or lignite mines in Germany. And in India the first bucket wheel excavator was introduced in a Neyveli lignite mine, which was opened in the year 1956

onwards. And in early 1960, the bucket wheel excavator was deployed in the mine on the consultation of the German people, along with their experience in Germany.

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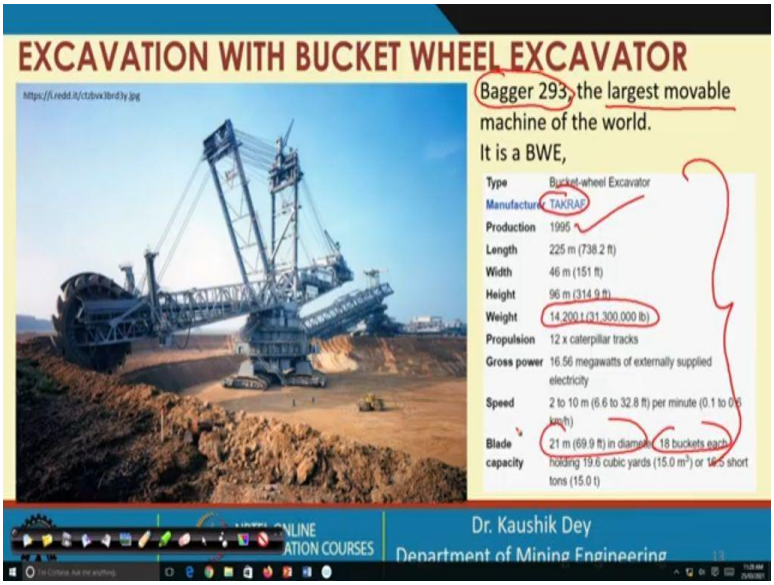

So this is the largest movable equipment in the world, which is Bagger 293 bucket wheel excavator, manufactured by TAKRAF; and it is produced in 1995. Its weight is 14,200 ton, and which makes it the largest movable machine in the world. And these are the other specifications of the machine, approximate I think 17 buckets or 18 buckets are attached with this. Diameter is 21 meter, and it can handle huge quantity of material in one pass; so, this is the largest machine.

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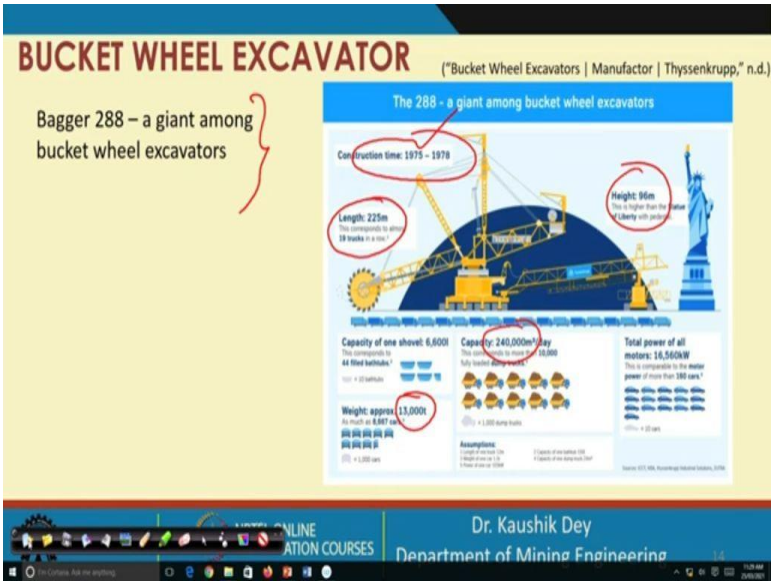

This is before 1975; this was the lower size model. You can see, it is 13,000 ton weight machine; and this is the specification of this machine, which is also a very giant bucket wheel excavator. And you can see its capacity can raise to 2 lakh meter cube per day, and it is having the boom length of 225 meter and height is 96 meter; and it is manufactured in the year 1975.

And that is why these machines are very highly productive, and these are costly also 100 crores, 200 crores, in general, the prices of this machine. And that is why it is essentially required to produce huge quantity of material every day, so that it can be profitable to the mine.

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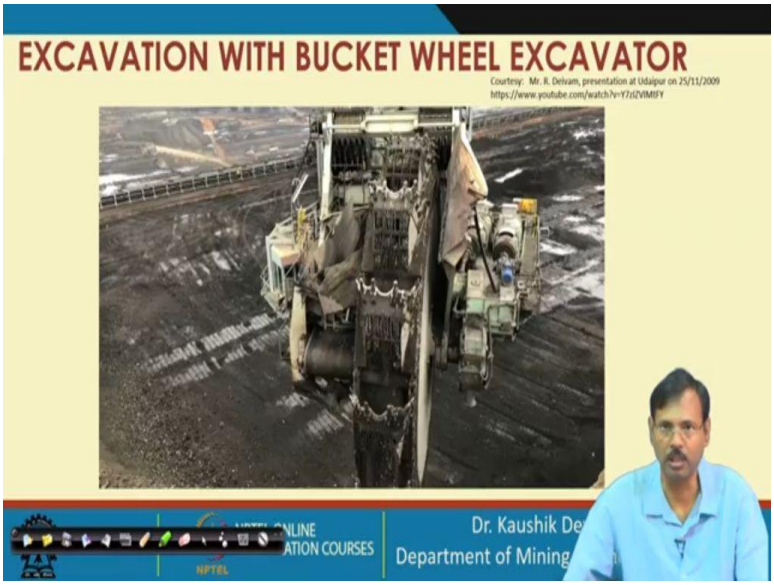

[Video Clip played from 09:02-12:53]

In fact, because of this only, you can find out German lignite mines are able to operate at a depth of 500 meter or so. Despite the lignite prices significantly low, but they can still economically profitable with this type of technology only. So, this is one video available in this YouTube, you can see how the lifts are stuck with the wall; and these are some of the pics are attached with the lift.

And these are stucking, the material is coming, then the material is discharged gradually like this; and the conveyor is taking the material at this position. So, this is the discharge system as

the conveyor is taking this material; here the conveyor is transferring this material. You can see the conveyor is rotating here, and the excavator as the wheel is rotating, the excavator is taking the material.

Now, the after taking this material, the material is guided towards the conveyor; this is a feeding system of the conveyor, and the conveyor is fed like this. So here, it is a half-cell type. For a little while, these materials are kept with the bucket, then the material is allowed to discharge into the bin; and it is then taking by the conveyor. Then the conveyor is, this is the conveyor which is primary conveyor which is taking the material. This conveyor discharge the material to the delivery conveyor; delivery conveyor is also can rotate at any direction.

Delivery conveyor may directly unload the material to the shiftable conveyor placed in the backside, which you can see; or it can be clumped with some other conveyors also. So, you can see it provides a very smooth cut, it is providing a very smooth cut in the wall face. And this continuous excavation system is producing huge material in a particular small period.

And you can see this boom is slewable: a telescopic type; it can move, it can rotate; so it can rotate in 360 degree direction. This can move, so you can in telescopic formation you can extend the arm, you can reduce the arm length. And that is why this can negotiate; now it is moved, is reduced, with the reduced arm size; and it can be raised, or it can be lowered. So, that is why it can able to serve a very high bench height also, that is possible with this machine.

So, this is a basically bridge type bucket wheel excavator, where you can see discharge boom is also bridged with another conveyor system. So, either you can have a mobile transport conveyor, which can take the material from the discharge boom of the bucket wheel excavator; and that can be transferred to the shiftable conveyor. So, by providing this type of system, basically operating with is basically extended in this case; so that is a benefit of using this type of system.

So, the frequent transfer of this shiftable conveyor is not required, if some intermediate conveying system in terms of bridge conveyor or in terms of mobile transport conveyor is available in this case. So, this is in a nutshell how the bucket wheel excavator is operating.

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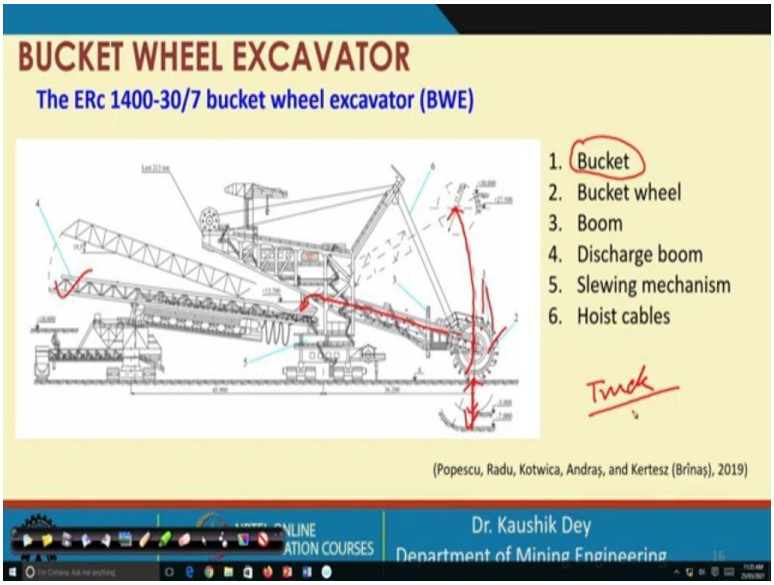

Now, these are the essential components of a bucket wheel excavator. So, first is the bucket, so these are the buckets; second is the wheel, so this is the wheel. These are the booms containing the wheel. So, these are having different provisions, this can be a fixed arm length. This is having the provision to lift up and down, so this is the operating height. In fact, this can be lowered also, so there is a digging depth also associated to this.

This is the digging depth possible with this excavator; so, that means this can be lowered also. This is the discharge boom. So, when the material is taken by this, or cut by these buckets of the bucket wheel; the material is discharged, we have seen in the video how it is discharged to this primary conveyor. This primary conveyor is sending the material into the secondary conveyor, or discharge conveyor.

So, this discharge boom is containing the discharge conveyor and discharge conveyor is discharging the material. So, there is this also telescopic type, this is also slewable, at any angle this is also raised or lowered. All these facilities are available with this, and these are the different hoist cables, there for hoisting the boom; hosting facilities also available with the discharge boom. And there may be intermittent bridge conveyor system, or other system. In fact, loading to the track from this discharge boom is also possible, if we are having a good one, good size of trucks are available.

Bucket wheel excavator can serve to a truck also; that is the discrete transportation system also. That is also possible for this one; but that may reduce the efficiency of the excavator. So, it is best to deploy the bucket wheel excavator with a continuous excavation system, along with the continuous transportation system, it is highly wanted.

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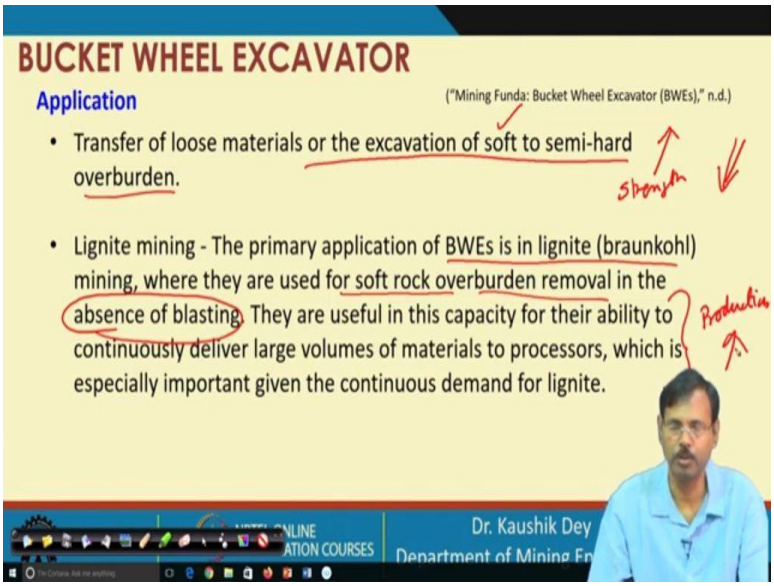

Now, basically as it is a direct excavation machine, or you can see it is directly cutting the material. Essentially, this is applied to the soft or semi hard rock; very hard rock like say, having compressive strength of 200 mega Pascal and etcetera. The performance of bucket wheel excavator will reduce significantly. So, with the strength of the rock with the strength of the rock, the performance is reduced significantly. And that is why it is preferred to be used with the soft and semi hard material.

In India, we are using it in lignite mines and in most of the cases in Germany; the maximum number of buckets will excavators are under operation. These are mostly operated in lignite or coal mines. And these are soft rock overburdens, if these are found soft like sand material coarse grain sand material. In those cases, also the bucket wheel excavator used. The benefit is that this is avoiding the blasting; so this is a blast-free technology.

So, blast-related others problems can be avoided by adopting this bucket wheel excavator technology. The main benefit is that bucket wheel excavator gives us huge production; so, the production rate is significantly high. In fact, from one bucket wheel excavator, yearly production

can reach to 10 million ton or so; so, that that is why it is very popular and considered as the highly productive machine.

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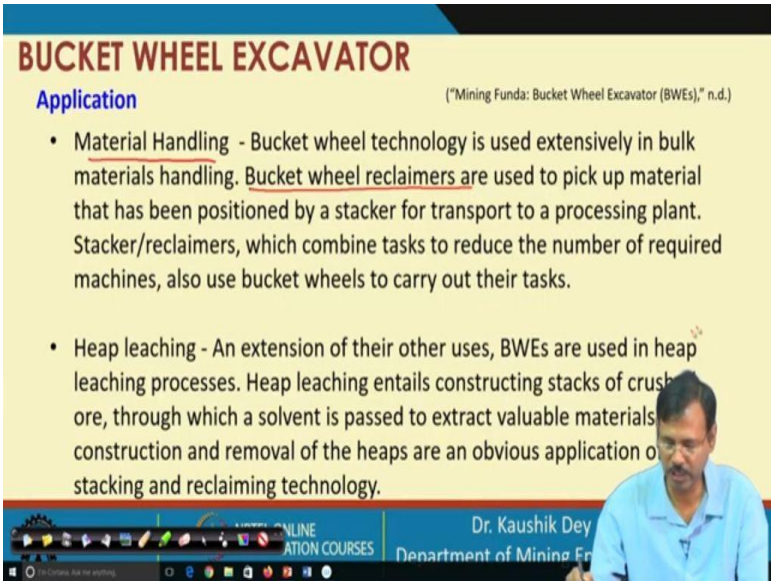

Bucket wheel excavator is also used for the material handling, like if stockpiles are there. In those stockpiles material can be recovered using the bucket wheel excavator. In fact, bucket stock recovery or as a stock reclaimer, as a stockpile reclaimer bucket wheel excavator is one very popular equipment in that case. So, the bucket discharge boom of the bucket wheel excavator can be used as the stacker; and the bucket side can be used as the reclaimer. Apart from that there are many other types of applications available with the bucket wheel excavator.

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[Video Clip played from 18:03-20:32]

This is another video related to this application we can see how the bucket wheel excavator. This is you can see the bucket wheel excavator is digging below its datum level. Here it is above the level, but you can see it is doing in two way. This is the use of the bucket wheel excavator as the stacker; so it is in the back side, it is stacking the material. And this is how the material is discharged from the wheel; and you can see how the cutting is carried out.

You just have some note on the cutting; this will discuss at a later stage, say how these cuttings are carried out. And this is the bucket wheel excavator is fitted with the shiftable conveyor and discharging onto this. This is how the cut material is transferred from the bucket to the primary conveyor. So, this is from the bucket, the material is transferred you can see. Buckets are discharging the material towards the conveyor side; and then it is combined with a mobile transport conveyor.

And that is allowed as the discharging material or stacking the material in the backside. And this is how the bucket wheel excavator move, so this is a huge crawler mounted machine. So, this crawler moves and this is how the shiftable conveyor rapidly shifted from this position to this position. This is the primary conveyor, taking the material from the bucket. And you can see there maybe a angle between the primary conveyor or the cutting boom and the discharge boom.

So, discharge can be carried out at any position; and this is a precise stacking system with the discharge boom. So, bucket wheel excavator is a very huge machine.

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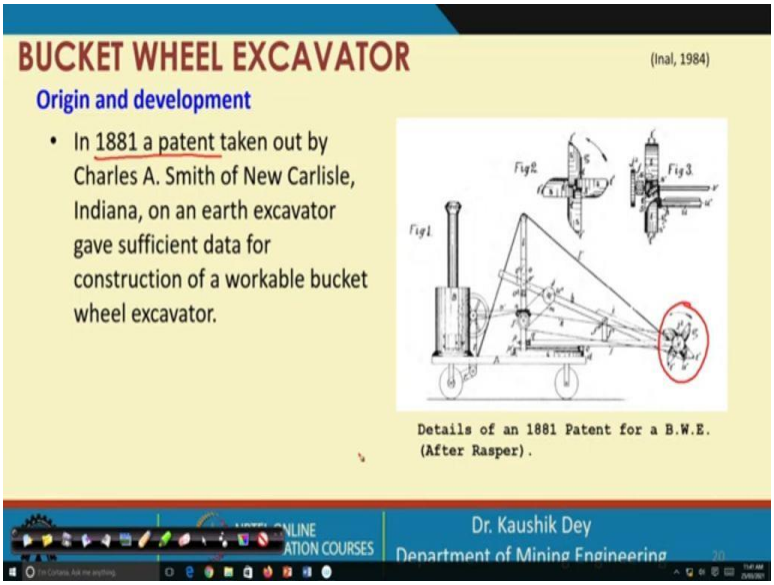

And that is producing very high also. If we look into the history, it was first patent in the year 1881, by Charles Smith; and in that case, workable buckets were used with a wheel excavator. Similar systems are possible for the water reclaiming also from the pond etcetera; that is also found. So, it was patented in 1881.

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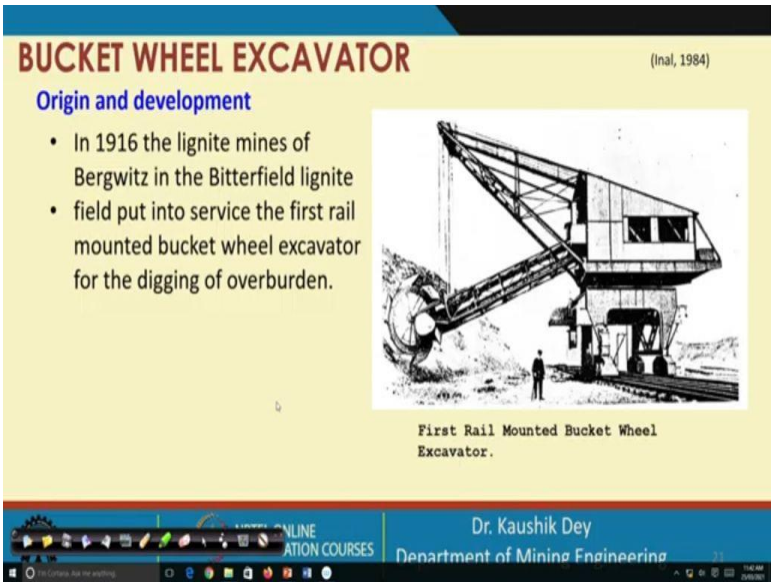

And 1916 it was first introduced to a lignite mines; and later on it gained popularity in mining also. And you can see this is the first rail mounted wheel excavator, introduced when the excavator was allowed to move on the rail.

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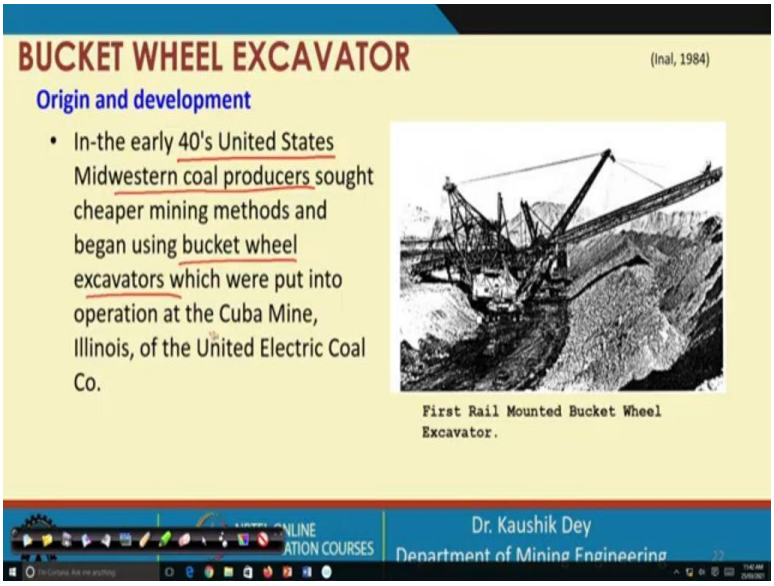

In 1940s, in US, coal producers has gone for bucket wheel excavators; and it was found operated in Illinois.

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[Video Clip played from 22:11-24:19]

And this is the modern one and in 1960s, it is introduced to Neyveli ignite mine. So, this is the operation of bucket wheel excavator in Neyveli lignite mines; you can see these are the 8 crawlers allowing the bucket wheel excavator to move. And this is the operation of bucket wheel excavator in the overburden rock; and this bucket wheel excavator is operating along with the

bridge conveyor at this side. So, now you can see this is digging it at a level lower that its standing level; so, it is digging. And you can see it is now operating in hub block method; the front portion is left, the top part is top block is now being excavated.

So, we will discuss this method in the next class; but, these are some of the video which you can see, and you can relate. And by this way the bucket wheel excavator can dig its own ramp also, as it can dig the bottom part also. So, now you can see how this mobile transport conveyor or bridge conveyor is taking the output from the bucket wheel excavator; and dumping that to the shiftable belt conveyor.

So, this is the discharge boom is discharging onto this mobile transport conveyor, and mobile transport conveyor is discharging that to the shiftable belt conveyor. So, this is a very common technique of deployment of the bucket wheel excavator.

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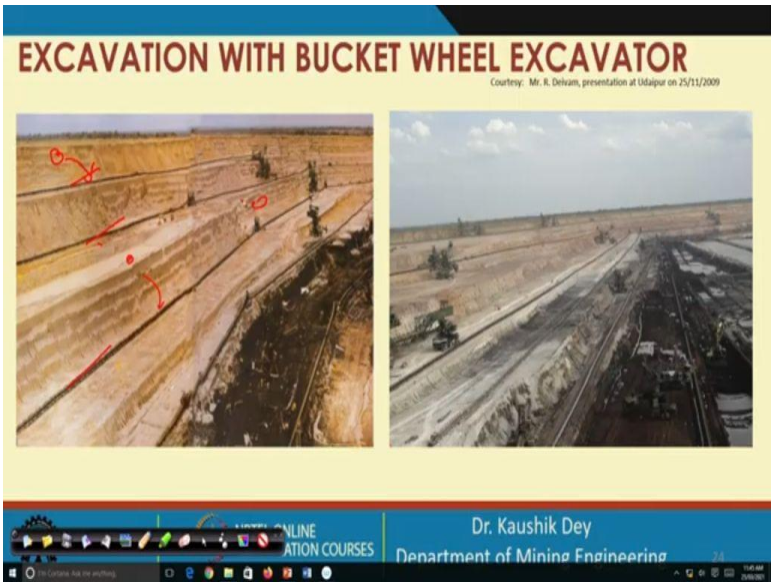

And now let us look into some of the photographs, which are taken during the early deployment of the bucket wheel excavator in the Neyveli lignite mines. So, these are the early deployment you can see, in every benches a shiftable conveyor is provided. And the bucket wheel excavator which is operating at this position is dumping the material in the shiftable conveyor. And at the end, there is a main conveyor, which is taking the output from the shiftable conveyor; and dumping the overburden material to the dump yard. And if it is coal like here, it is taken to the coal stock yard.

So, these are allowing the bucket wheel excavator to take the material. In fact, bucket wheel excavator at this position is taking the material and dumping that to here. Here also the machine is taking that one and dumping that to here. And similarly, these are the shiftable belt conveyor which is taking material for the overburden discharging; and this is for the coal. So, this is for discharging the lignite in this case.

So, these are some photographs of the Neyveli lignite mines, which is a pioneer in using the bucket wheel excavator in the country. Nowadays, few other lignite mines in Gujarat etcetera are also using bucket wheel excavators as their main excavating equipment. So, these mines are opted mostly for the blast-free technology. Occasionally, they go for blasting if some hard rock formations are coming; otherwise, bucket wheel excavator is a very good excavating system, which can go for fairly highly productive mines. Thank you.