Surface Mining Technology
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Lecture 39
Highwall Mining-1

Let me welcome you to the 39th lecture of NPTEL Online Certification Course Surface Mining Technology. From this lecture we will start the new topic Highwall Mining there will be three lectures on highwall mining, this is the first lecture on that and in this lecture basically we will introduce highwall mining to you.

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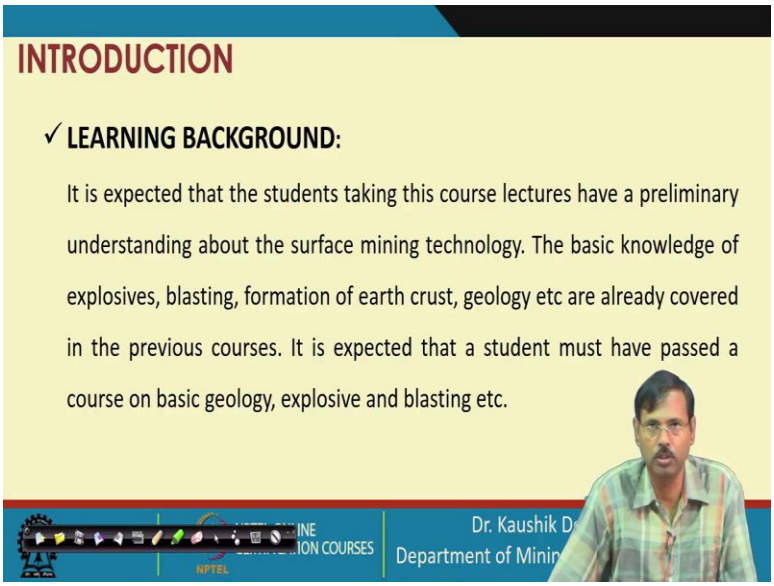


INTRODUCTION

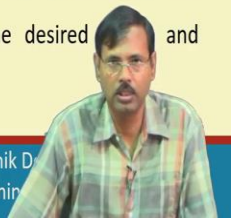
✓ **Learning Objectives of This Course:**

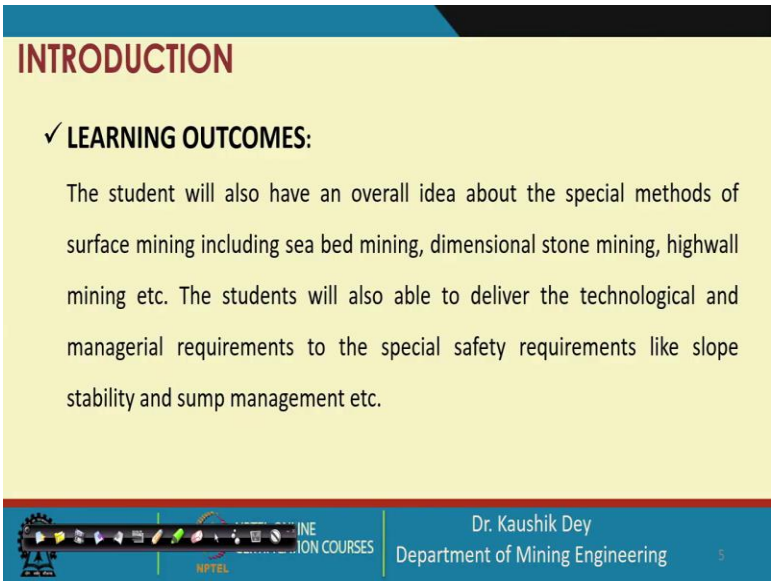
- To know the different unit operations associated with surface mining.
- Methods of surface mining.
- Deployment of machineries in surface mining.
- Productivity analysis of surface mining.
- Safety and environmental control of surface mining operations.
- Special methods of surface mining.

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 and environmental requirements will also be addressed.





But as we do in every class let us have once view the learning background required for Surface Mining Technology Course. And these are the set learning objectives for Surface Mining Technology Course. These are the learning outcomes expected from the participant of Surface Mining Technology Course.

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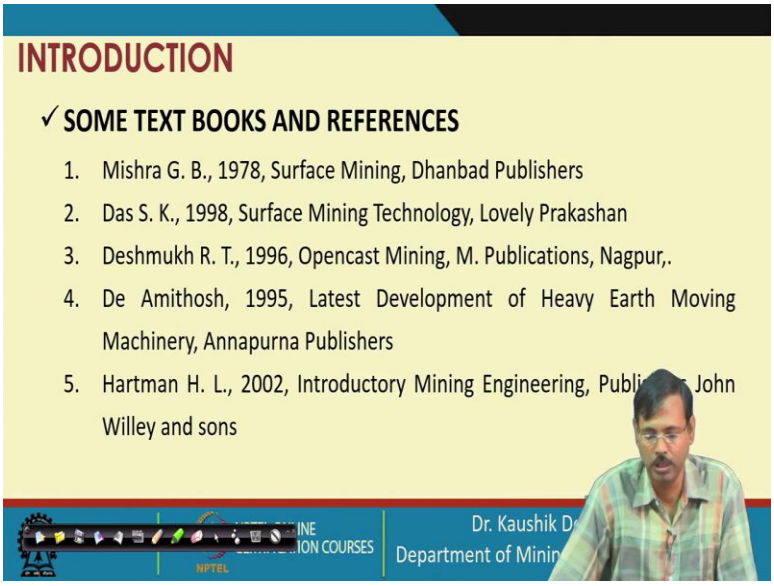

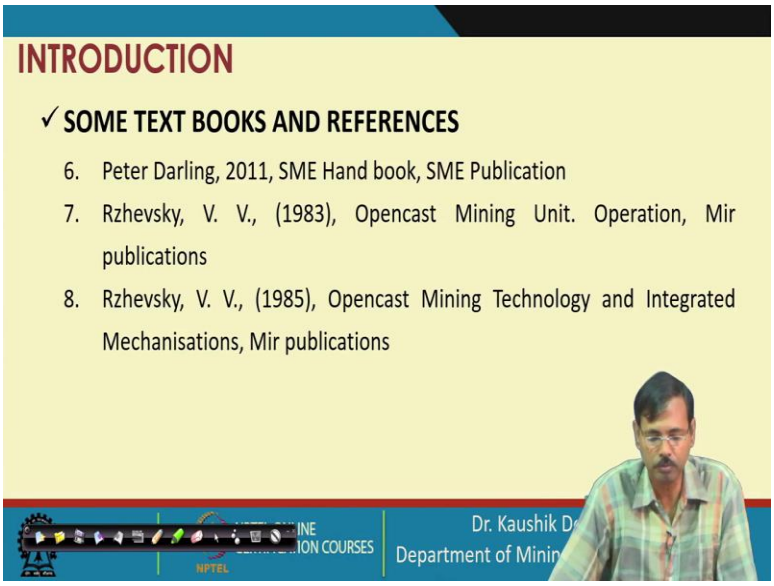

And these are some of the textbooks and references. However, highwall mining is a very new technology in these books and references, those are participant, can refer them for other topics of the Surface Mining. But highwall mining is not available in some holistic manner in these books, though in the SME Handbook some part is there. And apart from that there are n numbers of research papers and web materials available related to highwall mining. In fact, most of this lecture material is taken from the web sources and those are given during those lectures also.

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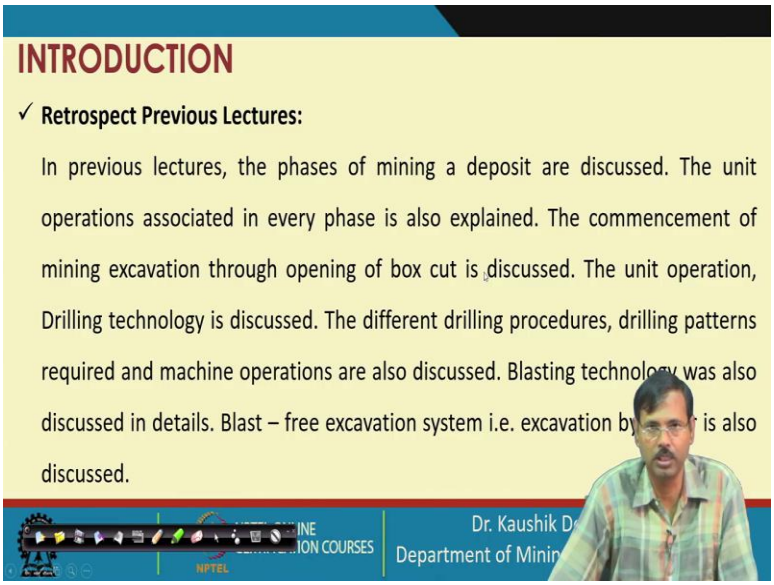

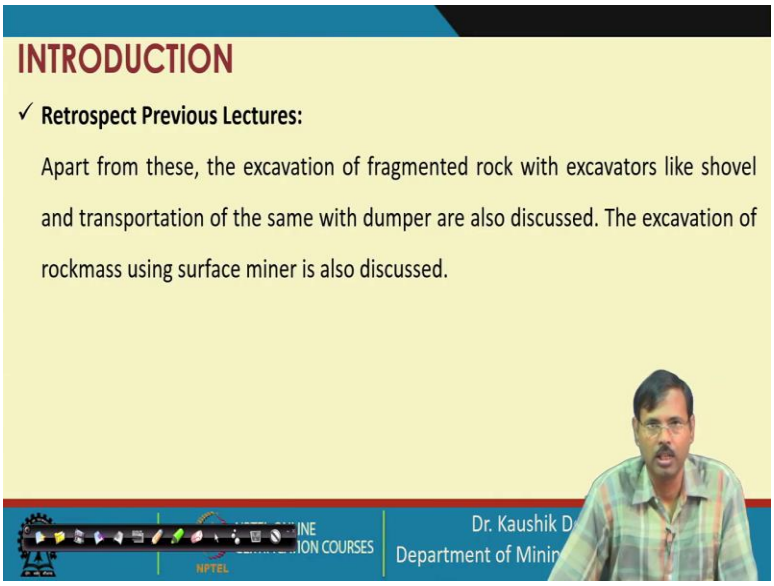

And before this highwall mining, we have covered the phases of mining a deposit. We have covered the unit operations associated in every phases also. We have covered the commencement of surface mining through opening of box cut, the unit operations of drilling technology is discussed, different drilling procedures, drilling patterns are also discussed, blasting technology and how the blast has to be designed that is also discussed.

And blast free excavation system that is, excavation by ripper is also discussed. After that the excavated fragmented material. How that can be handled with the excavator, then it has to be loaded to the transporting systems. And shovel dumper combination transportation transporting systems are also discussed. And excavation by surface miner and excavation by dragline is also discussed before this lecture.

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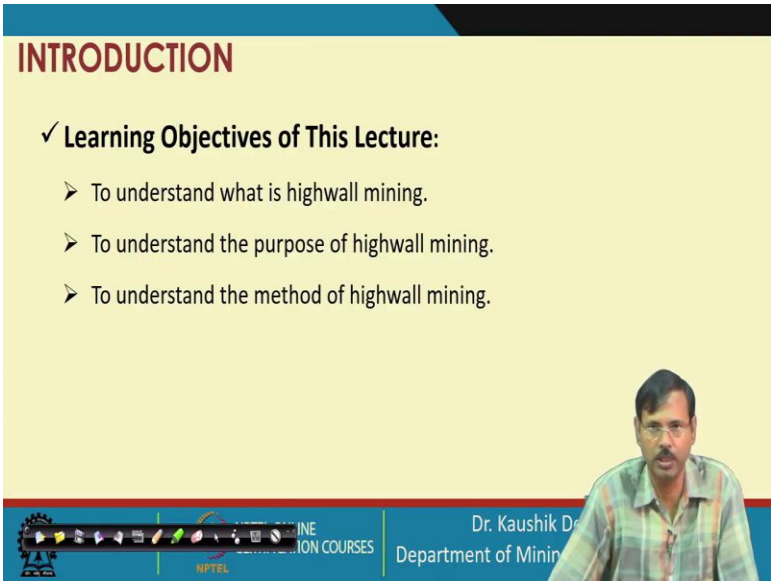

Now, what are the, there will be three lectures on the highwall mining. The objective set for these three lectures are like this. To understand what is highwall mining, to understand the purpose of highwall mining, and to understand the method of highwall mining. So, basically, we set like this in India, we are very new to this highwall technology around 4, 5 highwall miners are under operation in the country very recently.

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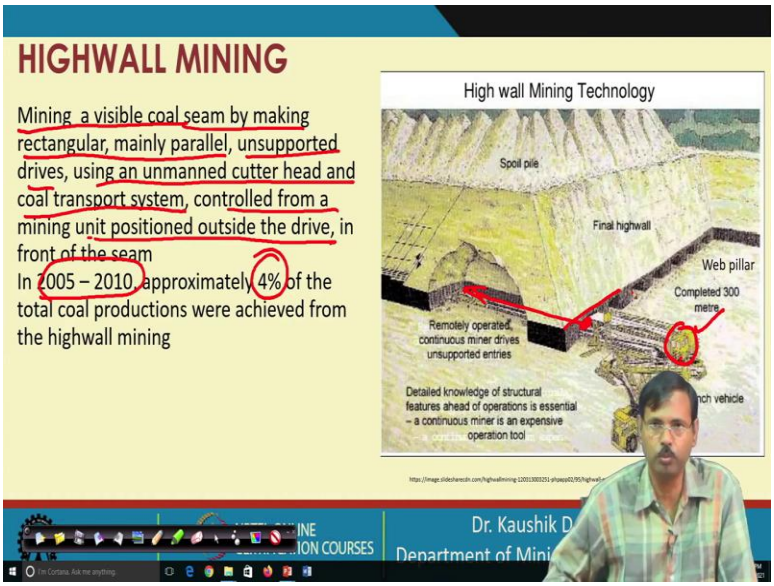

So, let us look into this and try to understand what is the technology. So, if we look into this, highwall mining is basically the mining where a visible coal seam has to be mined by making

rectangular or a circular unsupported drives driven through that using an unmanned cutter head and coal transport system controlled from the mining unit, positioned outside the drive in front of the seam.

So, basically this is the miner which is standing outside the seam. This is the seam and this miner is mining by this automated or remote controlled cutting system. And this cutting system is cutting and generating a drive and this is unsupported drive standing by itself. And the material cut by this cutter is taken out either with the cutting system itself like auger etcetera or there is some transporting arrangement like chain conveyor etcetera placed with that.

That is taking out the material and this material is thrown in the site in the dump yard or it can be taken by the transporting system. So, this type of system is called highwall mining and this machine is called highwall miner. And it is reported that in 2005 to 10 around 4 percent of the total coal production by US is from the highwall mining. In fact, since long around 1970s itself US has auger mining technology.

And they were exporting auger mining and in auger mining is nothing but creating the whole seam, coal seam and take out the material automatically while the auger drilling is carried out. So, in the reverse action the cut material is coming out from that auger drill. So, that is the technology or is called auger mining and that was very popular since 1970s in the US countries.

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Now, let us look into one video this is a caterpillar video, the link is given in this video, the highwall miner 300 manufactured by caterpillar is explained here. So, this is the highwall miner basically and you can see this is a cutting drum rotating and cutting the coal. This is mostly adopted for bedded and soft deposit. So, this is cutting the material and the material is cut and comes out.

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So, this is the pusher beam. So, as the cutter is cutting and it is being pushed from the back by the miner using the pusher beam and this is the discharge conveyor.

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HIGHWALL MINING

Anon, ppt
https://www.youtube.com/watch?v=7o7_rbN_Oug
https://link.springer.com/chapter/10.1007%2F978-3-319-02678-7_18

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So, as you can see these are the cutters attached with the pusher beam and this is considered as the steep limit and in this case it is a basically the excavation from a mountain block coal seam. and this is one installed CAT 300.

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And this is the pusher beam being pushed while the cutter is cutting the material. So, this is the initial cut where cutter is cutting the material and pusher is pushed, this reel is having the control cables as the pusher is pushing the reel is unreeled and the control cables are also being inserted. So, you can see this one excavation is made, this is often called hole because if the auger is basically excavating this one then a drill hole is created.

So that is why it is often called a hole also. And then there is the web pillar left, this web pillar is taking the load and after that another hole or another excavation is made. So, this is an excavation width or also called hole width and this is web pillar width of the web pillar and after construction of few holes we keep a barrier pillar so that the supporting of the roof rock can be maintained. So, this is the propelling system of the highwall miner. So, this is the anchoring system so that the machine will not revert back.

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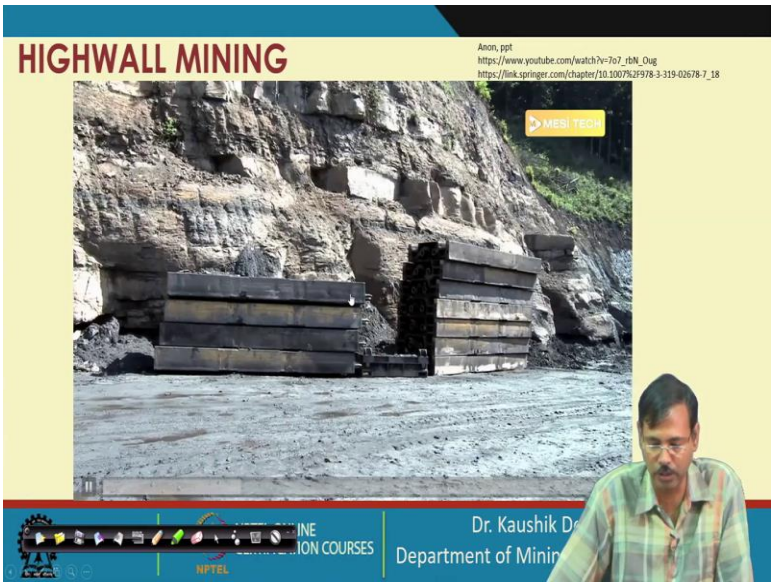

And these are the push beams. These push beams are basically fitted with each other in front of them and that is pushed from the back. So, these are the every units of the push beams which are interconnected, these are lifted and then see this is the coupling made after pushing this one. The couplings are made so that they can remain in intact position. These are adjustable height type so it can move.

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But in case of augers this cannot be adjusted. This is a simple cutting system, the way it is being used in the continuous miner or used in the roadheader. In the similar way this is the cutting drum. These are the control panel. This video is very good and well explained, whenever you can see in the YouTube that soundtrack is also available with this.

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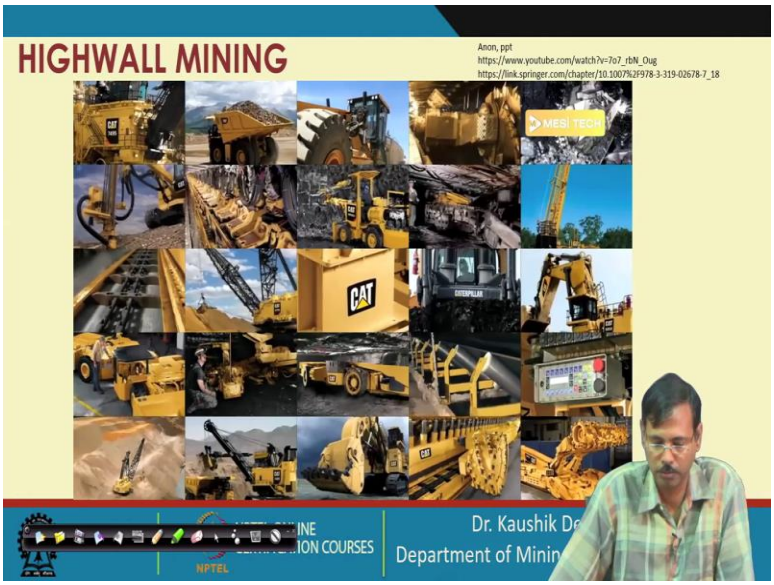

And this reel is very important, this is protecting the cables etcetera. which is basically allowing the power to the cutter head and this is the discharge conveyor. So, in this particular video the pusher beam is allowed, that pusher beam is having inherent auger system. So, this auger is allowing the material movement after cutting. So, this cutting depth can be well maintained.

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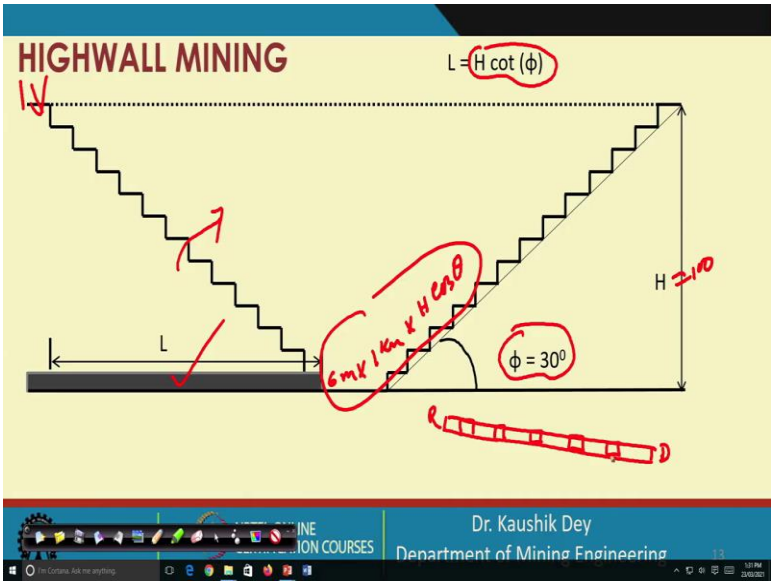

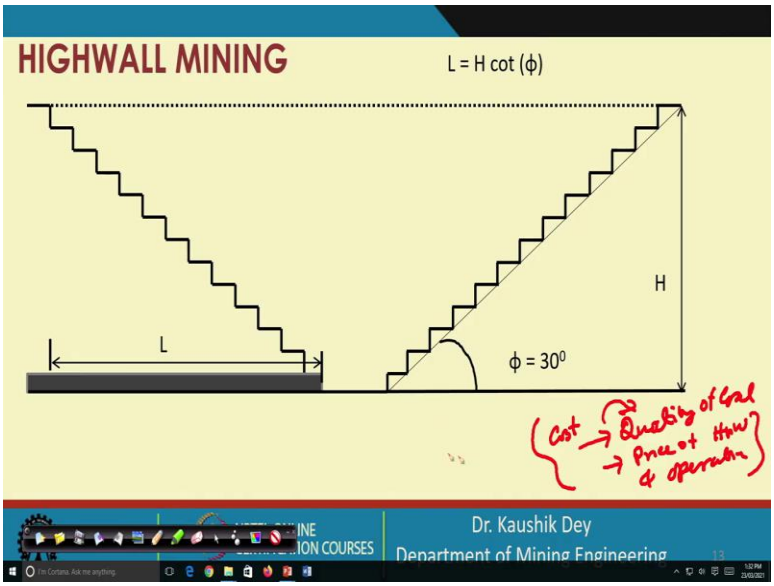

Now, let us understand why we go for highwall mining. Say, in general we are having a coal seam like this one, side from one side we can excavate, but if you look into the highwall that means say if seam is dipping like this in the two sides of the seam. This is rise size, this is deep sight but in the two other side up to which the leasehold area are there, we have to keep highwall in those side. Now, we are taking it from this side but in the highwall side this is staying back just as the coal seam and above that we have to keep the highwall.

So, there will not be any soft failure from this and often we will find out, though our leasehold area is up to this. But this much of coal up to the leasehold area cannot be excavated because it is

locked under the slope. And you can understand if this phi is kept 30 degree or so, and this is the depth which is say around 100 meter or something like that. Then probably this available length is significantly high which is nothing but the H cot theta.

So, this length is significantly available and a huge quantity which is 6 meter and this length is available say 1 kilometer, then the coal is this plus n multiplied by H cot theta. So, this is the amount of coal which is blocked at this place which is significant enough and million tons of coals can be considered or locked under this condition. However, a part of that can be excavated without compromising the safety of this one if we are taking out some portion of coal using the highwall miner.

And that is the prime objective of this highwall mining. In fact, before deploying a highwall miner this cost calculation must be carried out considering the quantity of coal proposed to excavate then the price of highwall miner and total operating cost of the highwall miner during the lifetime and what is the quantity of coal excavated then we have to go for a cost benefit analysis of the seam.

Then only we can find a find out whether this deployment of this high wall miner is economically feasible or not. So, there are two concepts: one is the economical feasibility analysis; second is the technical feasibility analysis that is the stability requirement. Then what is the quantity, what is the effect of these slopes, all these required to be considered and fire risk etcetera has to be considered during this.

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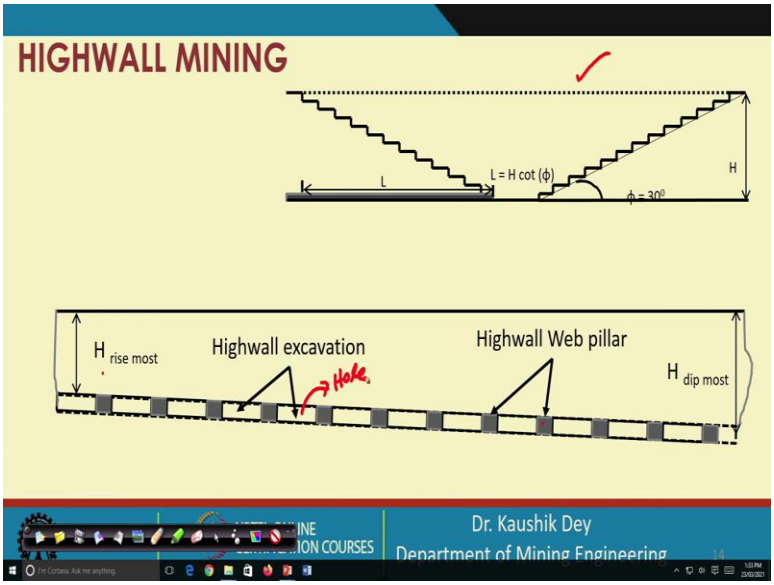

Now, this is another figure, if we are considering this one and this is the rise most height, this is the deep most height, and these are considered as the web pillar and after say 2, 3 pillars we have to keep some barrier pillar also and these are the highwall excavation also called hole. So, this is the general terminology and this is the general convention of highwall mining especially in the better deposit like coal mines.

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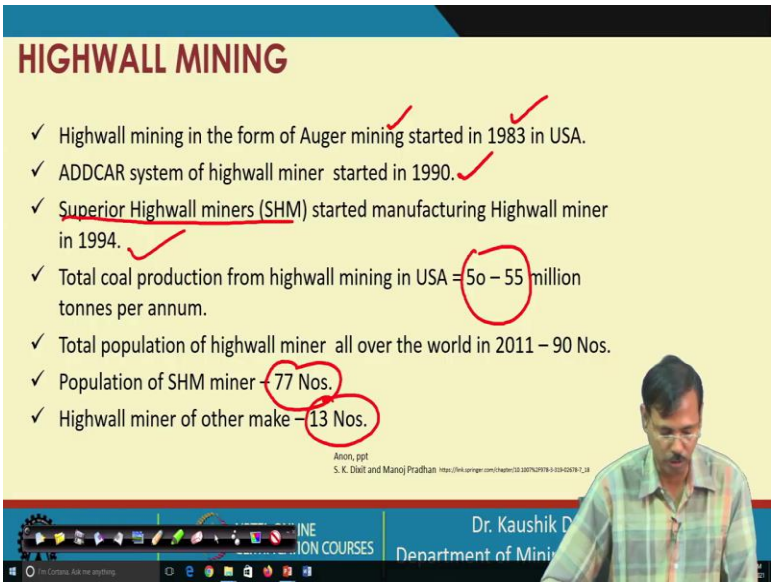

Now, let us look into the status. This is highwall mining in form of auger mining started in 1970s, 80s. ADDCAR highwall miner was started where the cuts are added from the backside

like pusher beams from the highwall miner started from 1990s, most of the highwall miners of this SHM in 1994 they have started manufacturing. And almost 50 to 55 million tonnes are coals are produced in USA 77 highwall miners and 13 from other makes are also available.

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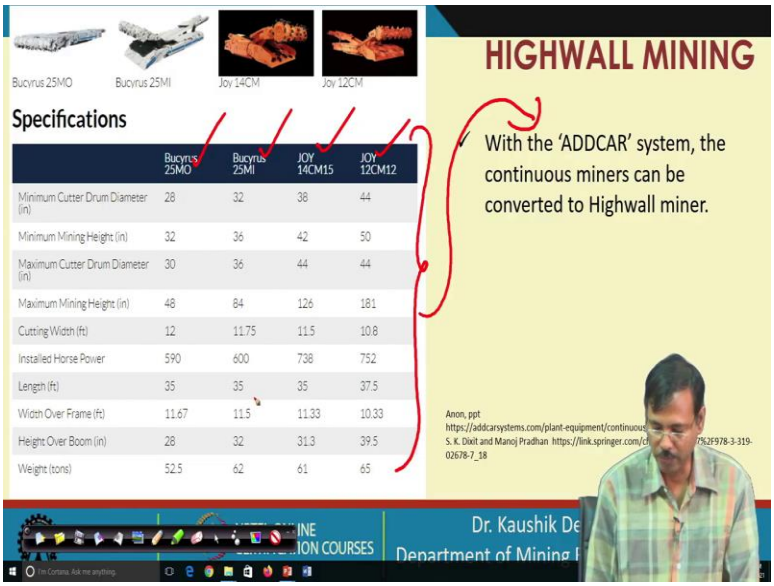

In 2011 after that caterpillar etcetera has come out heavily for manufacturing of the highwall miner and these are some of the highwall miner commercially available. So, this is Bucyrus Joy these are the continuous miners. And these are easily convertible to a highwall miner using ADDCAR system from ADDCAR that is basically the pusher beam which is coming from the backside and basically adding with depth and that can be used easily. And these are the different specification available with this.

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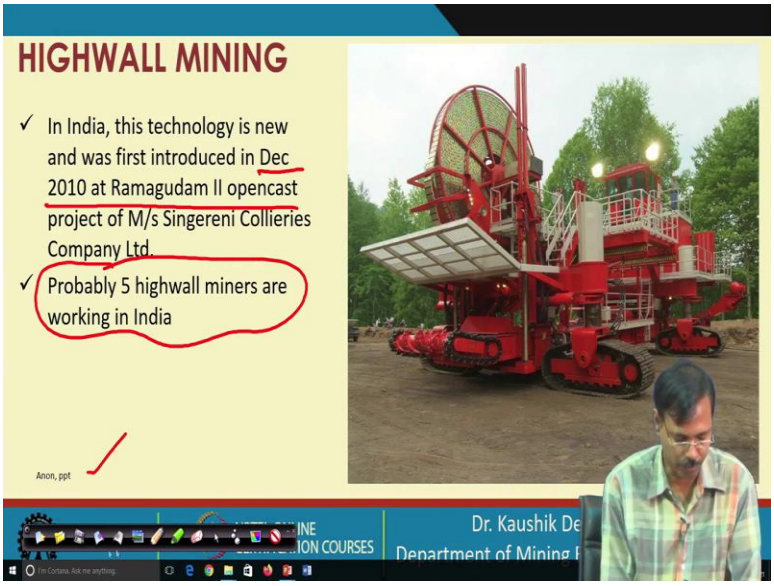

So, in India, highwall mining started from December 2010 at Ramagundam 2 opencast project of Singereni and around probably 5 highwall miners are available. These are the data we have obtained from some highwall miner PPT. These we have obtained.

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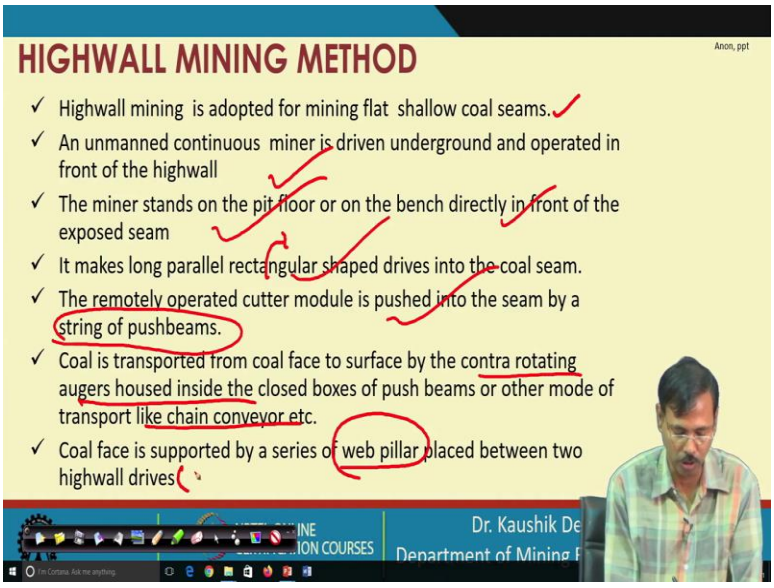

Which is basically presented to for approval of the highwall miner, then highwall mining is adopted for mining flat, these are the applicability's flat shallow coal seams, unmanned continuous miner, is driven underground and operated from outside the mine, stands on the pit

floor and excavate the bench in the front, makes long parallel rectangular shape stripes, it can be circular in case of auger cutter model is pushed into the seam by a string of push beams.

The coal is transported to the coal phase to surface by contra rotating augers or often by the chain conveyor or other systems. And coal phase is supported with a series of web pillar placed between two highwall drives or we can say hole also.

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So, these are some of the figures, these are the push beams fitted with these augers which is basically driving the cut coal by the miner to the back site and this is basically moving back and then followed by this ADDCAR. These are the highwall miner cutter head as it is rotating it is cutting you can see this side one is also fixed with this cutter head. So, it can cut in the side and no material can struck at this position. And in back of this n number of push beams are added to this. So, this is the cutter head, this is the cutter head and this is the reel having that cable etcetera.

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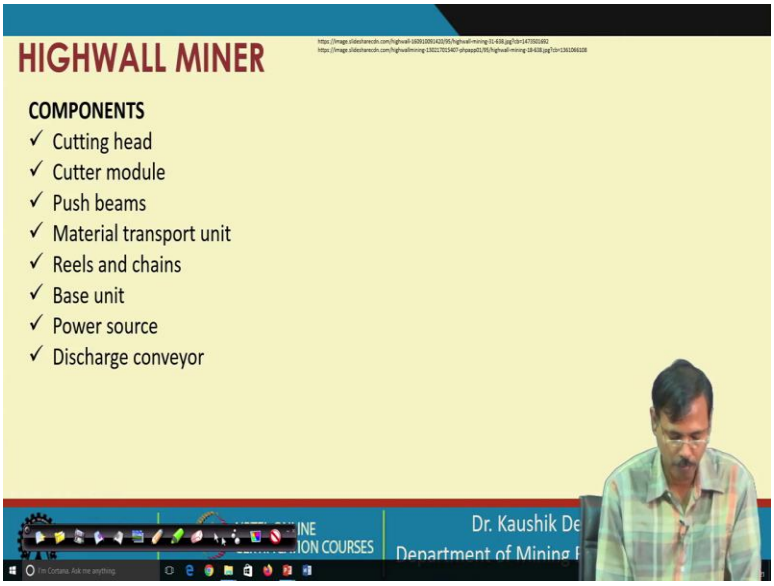

So, the main components of a highwall miner is cutting head, cutter model, push beams, material transport unit, reel and chains, base unit, power source, and discharge conveyor. These are the major components.

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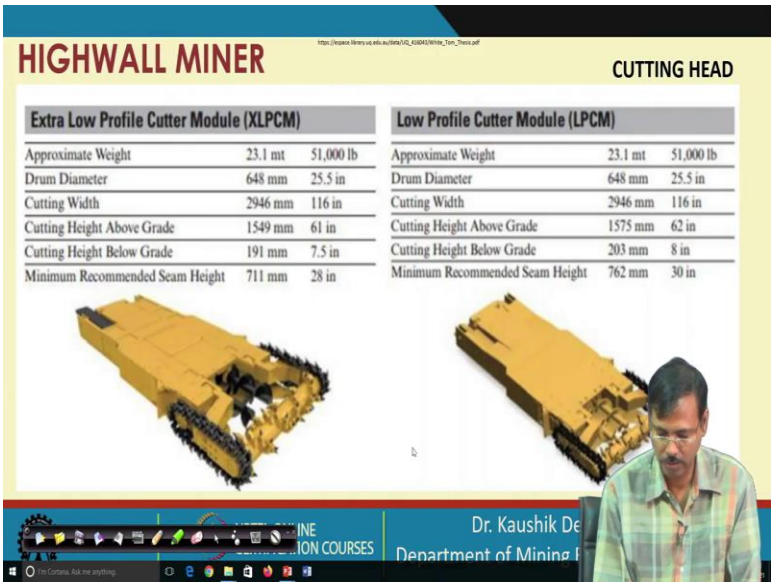

And these are the different variables of the continuous miner, low profile cutter model is available. This is the low profile, extra low profile this is low profile, these are the specification available.

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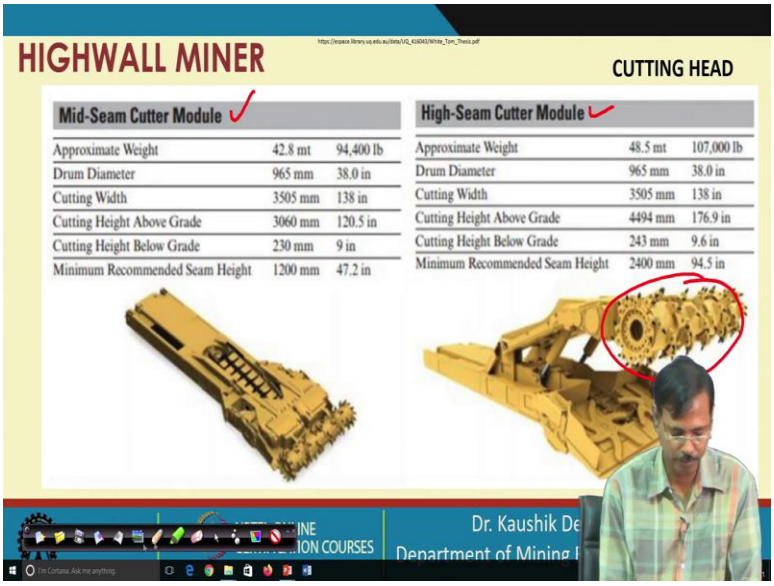

These are mid seam cutters and these are high seam cutter, which is having a facility, which takes the material similar to your continuous miner.

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And these are sometimes auger type cutters directly used where the holes or drills are made and these augers are continuously added behind this one. And that is just like the way drill rod is added with the another drill. Similar way another auger is added behind the first auger and by this way a long drilling is carried out and the material is reverted back through the fledge flank plank of the augers.

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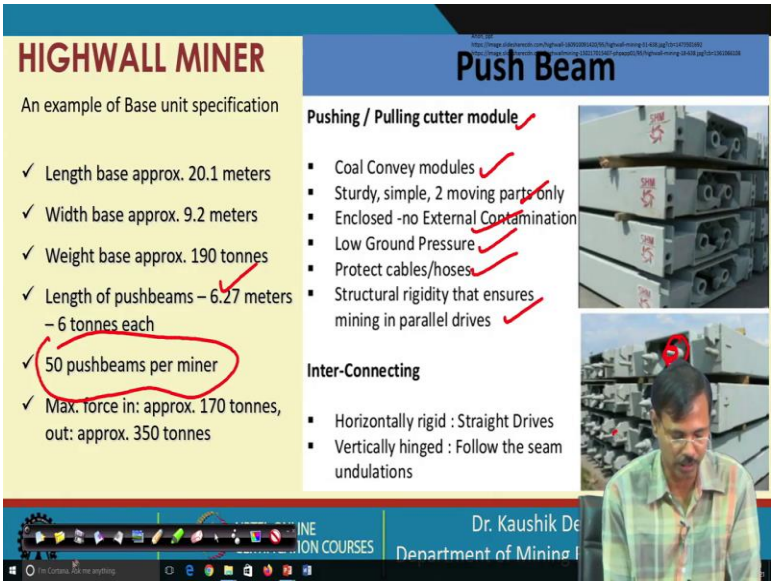

So, these are the push beams which is one of the very important model. Now, you can see, these push beams are also fitted with the augers. So, once the material is cut by the miner that is guided through those openings and these are opening it back to back as the push beams are attached, these augers are also rotating that is also transferring the material in the backside. So, this is actually coal convey model.

And two moving parts only includes no external contaminations, low ground pressure protective cables, and hoses are also there. It is very rigid system and it has been found that highwall miners, the base unit which we have seen is crawler mounted up to 50 push beams can accommodate in this and each push is of length of 6 meters. So, up to 300 meter or so, it can be taken, it can consider that highwall miner can use that one and consider the productivity pertaining to that.

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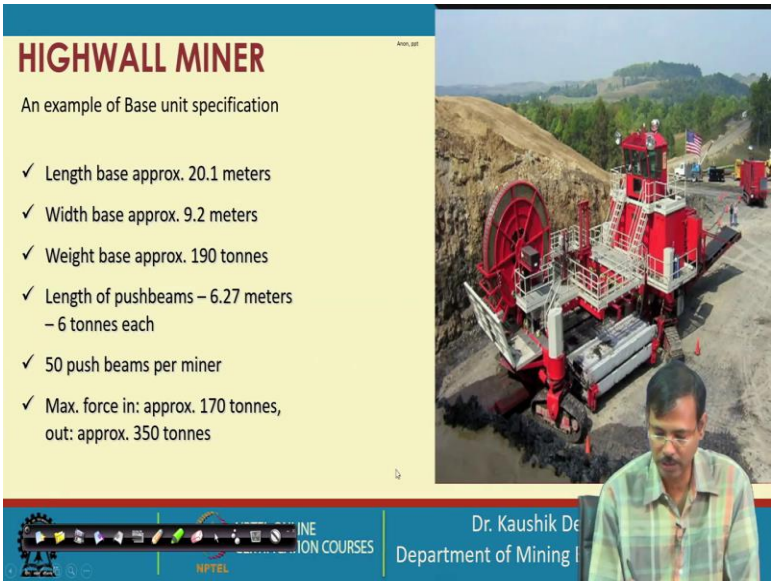

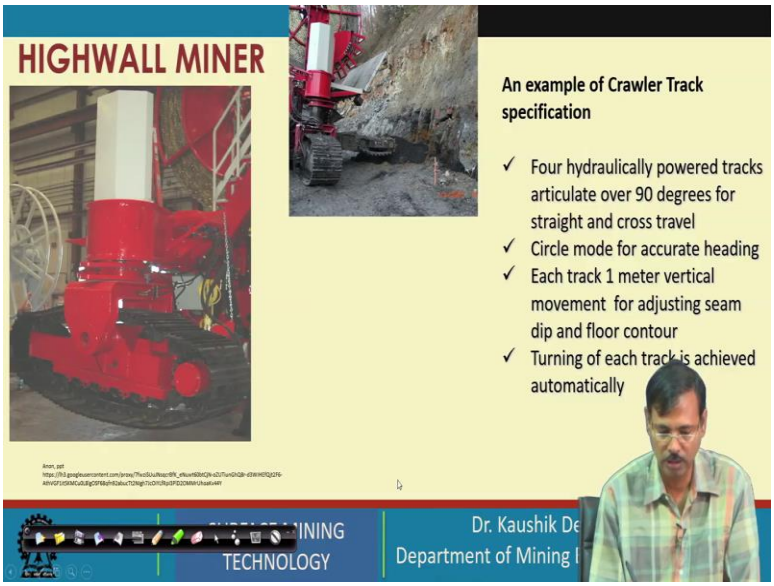

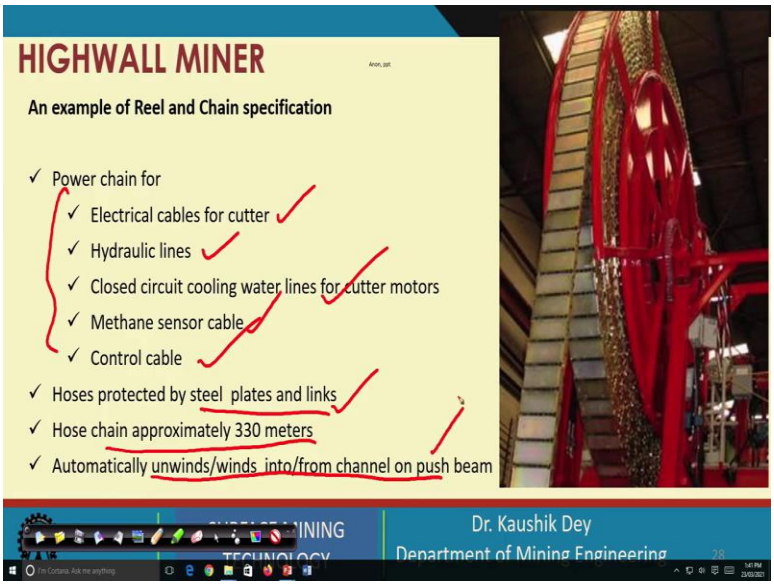

So, this is the base unit. These are the propelling system of the highwall mining: often 4 crawlers are used. This is the reel chain which is for electrical cable for cutter hydraulic lines, close circuit cooling water lines, methane sensor cable, control cables, if the cutter is having the hoisting arrangements lifting arrangements that has to be controlled all those control cables are provided.

These all are protected with the steel plates and links, and chains are approximately 330 meter or more also available and these are wind unwind along with the push beam to accommodate the length. So, this is reel: very important for controlling the, for controlling the highwall miner. So, this is the end of the introduction to highwall miner. The method of operation of a highwall miner we will discuss in the next class. Thank you.