

**Mining Machinery**  
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**Module - 05**  
**Lecture - 24**  
**Surface Mining Machinery:**  
**Machinery for Continuous Excavation: Continuous Surface Miner**

Welcome to our discussions on Surface Mining Machinery. Today, we will be discussing about the another continuous excavation machinery called Continuous Surface Miner.

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**Surface Mining Machinery**  
**Machinery for Continuous Excavation:**  
**Continuous Surface Miner**

The Continuous surface miner is a compactly designed surface cutting excavator that *combines the process of cutting, crushing, loading in one machine.*

**Objectives:**  
**Introduction to the construction, operation and applications of Continuous Surface Miner**

Continuous surface miner are *designed to cut softer rock materials like sandstone, clay, bauxite, hard coal, phosphate, gypsum and marl are operating between 10 MPa and 70 MPa compressive strength.*

Loosening of the surface was done by high speed shearer drums fitted with picks and then transferred over a shield to the onboard conveyors.

The CSM technology is used in mining since 1979. The present manufacturers include Wirtgen GmbH (since 1987), Krupp (since 1988) and Voest Alpine (since 1988), Takaraf.

Surface Miner K5500W in Limestone  
Surface Miner K55022 in Coal

IIT Kharagpur  
NPTEL

This continuous surface miner is a compactly designed surface cutting excavator and it has combined the cutting, crushing, loading all in one machine. This machine was introduced in

India particularly in lime stone mining sector in the late 80s, early 90s, but in coal mining sector it was introduced after 1997 – 98.

And, this machine has come out to be one of the most productive machine because of its many advantages. You can see that this technology is not a new one. It was introduced in 1979 also; this technology were used in mines, but there are machines produced by Wirtgen company. Particularly they were using first is a civil for road paving machines it was developed, but today in India most of the coal mining they are using surface coal mining is using continuous surface miner.

Now, in the picture you can see the continuous surface miner produced by Larsen and Toubro L and T, in their Panchmahal factory in Orissa. You can see this is used in limestone as well as in coal. This is also used for hard Rocks as well. Earlier it was used only with say the different type of a rocks that was the compressive strength were varying from 10 mega Pascal to 70 mega Pascal, but, nowadays it is being tried and it is also getting successful in some harder rock as well.

Now, this loosening it is a done by high speed shearer drums exactly, the machine is a just a billing machine type it is working. You will be learning today how this machine is constructed and how it is operating. Our main objective is to introduction of the construction operation and application of this surface miner.

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**After going through this lesson you will be able to:**

- Explain the construction, operation and maintenance aspects of Continuous Surface Miner (CSM)
- Identify the applicability of CSM
- Compare the merits and demerits of CSM over other excavators



The image shows a presentation slide with a blue header and footer. The main content area is white. On the right side, there is a vertical toolbar with various icons. At the bottom left, there are navigation icons. The slide content includes a list of learning objectives and a photograph of a large mining machine in operation.

Now, so that after this lecture you will be able to explain the construction, operation and maintenance aspects of this continuous surface miner. Also you will be able to identify that where this machine can be used in our mining conditions. And then also you will be understanding what are the merits and demerits of it. So, you can see here in the photograph a Wirtgen machine it is working in stripping of or coal for production of coal.

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**APPLICATIONS**

Most suitable area of application of continuous surface miner is **level seam without fault having compressive strength within 12 to 50 MPa**. The machine can give *better performance when operating on long strips*. The maximum working inclination of CSM is 7°. The climbing capability is limited to 15°. The machine is capable of operating a seam as thin as 2.5 cm.

- 1) The surface miners *can not be applied in hilly terrains*.
- 2) As this machine eliminates the drilling and blasting, it can be *deployed in mines where drilling and blasting are prohibited due to its proximity to developed neighbourhood*.
- 3) The minerals which are generally mined are
  - o **Coal and lignite**: The deposits of coal and lignite are more-or-less level deposit. Large mine face can be created for higher productivity. Selective mining is possible when deposits are interspersed with dirt band, shale, etc. Hence surface miners are very economical to be used.
  - o **Limestone**: The deposits of limestone are sedimentary and more-or-less horizontal. The uniaxial strength varies up to 70 Mpa, which are suited for surface miners. However if the silica - content is high, wear of the picks would be high.
  - o **Sandstone**: Sandstone occurs in heavy deposits and the uniaxial compressive strength varies from 6 to 30 Mpa. However, the silica content is high which results in high wear. Also for **Gypsum, Bauxite, Phosphate**
- 4) **Selective mining**: surface miners can be used effectively in areas of bedded deposits like bauxite or layered formations of coal seam.
- 5) The surface miners completely *remove the need of primary crushing and reduce the transportation cost* drastically.

This application because you know the this machine as I told is suitable for that is a level seam that is if there is a horizontal not much incline seam is there. And where there is not many geological disturbances, there this machine give a very good performance, provided you get a very long strip. Because it will be cutting and then that is if your short strips then there will be repeated turning and all.

So, if you can get a long strike length a level seam, there it will be giving very good performance. Normally, the inclinations up to 7 degree it is ok and then while operating it if it is to climb on ramp and all it can do it can work up to 15 degree. So, there is a while that it can excavated seam very thin seam also even if it is a 2.5 meter thin seam, it can take it out.

Now, you can see here one thing that in India even very valuable high grade cooking coal which are less than one meter thick seam it were never mind it was just abandoned. In Jharia

coal field there were many in the old days this seams were left. Now, even when they were doing by surface mining may a time such type of seams get diluted with the overburden rock.

And then lot of washing problems come in, but this machine by it should method of work you will be learning today that it can take out a small strips also separately it can cut. So, that is a very good advantage of this machine.

And, only disadvantage here the this machine cannot work on a hilly terrain, it cannot work on a there is a lot of disturbance geological disturbance in the seam. And, the this one thing is there when you use this machine then there is no need of drilling and blasting. So, you know that in the mines when drilling and blasting is not there then it will not produce much dust and fume.

So, that means, this machines can be considered as an environmentally friendly machine because it eliminate drilling and blasting. So, with the by elimination of drilling and blasting you also reduce a number of people required to do the mining operations. So, that means, you can downsize the manpower and which will be adding into your profit. So, there is a lot of advantage of this machines

Now, it can work with a as I said that it has got a limitation with the range of the uniaxial compressive strengths. However, it can work in most of the minerals like your coal and lignite it work, it can work in limestone, it works on sandstone and it was also we tested this work in a nulcose punchpet melimines. Even in bauxite it could work with one varieties of machine which study there earlier.

Now, it can do also selective mining; that means, if there is a seam and in between there is a parting, now this parting also can be separately taken it out and put it over there. So, that ultimately it can be excavated as a selective mining this is also possible and then it can as it will be cutting its principle you will be soon learning that the way it cuts it does not produce any big boulders. And, if there is no big boulders then there is no need of a crusher.

So, that means, the requirement of in pit crushing's will has done. So, that means, the fragmentation total fragmentation energy consumptions it also get down.

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**Advantages of CSM in Surface Coal Mines**

- Continuous mining method.
- Low environmental impact from vibration and dust as it eliminates blasting.
- Selective mining possible in horizontal seamed deposits such as coal, salt, potash and associated interburden, etc.
- Machines can cut low to medium strength materials. Typical nominated ratings are based on 40 MPa uniaxial compressive strength material. Larger units can mine over 80 MPa with reduced productivity.
- No drill and blast costs.
- Primary crushing and fragmentation of product: Product is of right size range with no additional costs for crushing required.
- Low fines production compared to blasting.
- Reduced capacity requirements for coal washing/preparation plants.
- High yield of product, less dilution of product.
- Low product loss.
- Less stress and strain on trucks due to minimum impact of the excavated material.
- Less coal loss and dilution.
- Improved coal recovery especially in areas sensitive to blasting.
- Less stress and strain on trucks due to minimum impact of the excavated material.
- Primary crushing and fragmentation of coal.
- Reduced capacity requirements for coal washing/preparation plants.

**Field of Applications vs-a-vis rock strength**

Method	Rock Strength Range (MPa)
CSM	40 - 140
BWE	0 - 40

So, there are so many advantages of this machines. To summarize you can tell that there is a this mining method is a continuous mining method and it will be having low environmental impact, it can do selective mining and it can as a it work with the low strength materials there is no drilling and blasting cost.

Then there is no primary crushing's, there is a the production rate of course, will be going as a less because in drilling and blasting as because you can do a heavy blast you can make a big fragmentations and then compatible other big machines can be used. But this machines will

not be able to produce that much quantity or the production rate or productivity of this machines will be less.

So, but the it can be maintained by putting number of such machines, but that may increase the capital cost, but as because this machines will be eliminating requirement of some other machines. So total cost effectiveness can be seen side to side or you can create a simple mathematical model for applicability or its cost benefitness in any particular field.

So, it is a as you said it does not give a dilution, low production loss is there and then as a result your that recoverable mineral that means there is no loss of the initiative mineral. In many of the other mining method with drilling and blasting and all we really leave a lot of coal in the site and which ultimately get burnt and they get create there is a loss of property as well as interior some environmental problem.

Now, comparing all those things this can be a very useful machines because of its less coal loss and dilution. Because of its improved coal recovery, because of this reduction of the primary crushing needs; that means, a saving of energy and though there is a there is no need of coal washing so, by that exactly lot of savings are there. So, this advantages make it a very suitable machine provided the compressive strength of the rock it there.

So, you can see in this figure that in pit crushing and conveying can be done wherever in a very hard rock up to 120, 140 mega Pascal it will do, but a continuous surface miner very comfortably can be used up to 60, 70 mega Pascals. But, there could be improvement in the machines or you can think of they are giving some new technology over here to use it for a hard rock's also.

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Now, coming to this that are different designs of this machines are available, but basically three types of machines are very very much used in our industry.

One is that is your centrally or middle loading machine that is a drum the main cutting drum is located at the center of the machine; that means, the machines will be having a two set of crawlers one pair of crawler in the front and pair of crawler at the back and in between there will be the cutter drum. I will show you the figure in next one.

The other one is your with a front loading, that is, there is a you can see here in a front there is a cutting drum or cutting wheel buckets and that will be cutting and the material will be loaded. It can be loaded on a truck or it can be made in windrow at the back.

And, the other one is your with a front cutting wheel you can see here it will be doing a this will be wheel will be rotating in the opposite direction. And the cutting and the material will be just dumped at the in front of the cutting drum and the machines will be moving in the other directions. So, this is the three types of machines will be just discussing now slowly.

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You can see here how a front cutting machines they work and this is a animated figure will show you how exactly this Vermeer, one company, they have been trying this machine, so that it can strip a material.

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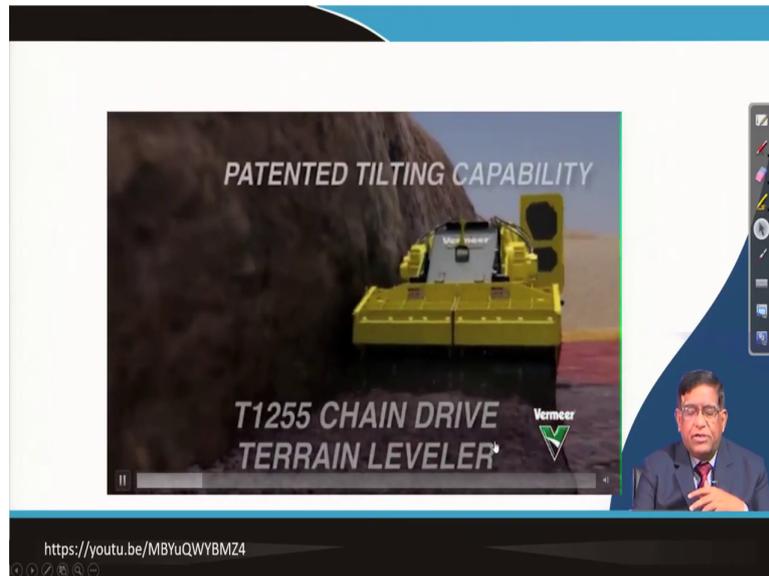
The image shows a YouTube video player interface. The main video content displays a close-up of a mining machine's conveyor belt. The ore being transported is divided into distinct horizontal layers of different colors: a top layer of light brown, a middle layer of dark red, and a bottom layer of yellow. The text "BANDED ORE" is overlaid in large, white, bold, sans-serif capital letters across the middle of the conveyor. The Vermeer logo is visible in the bottom right corner of the video frame. The video player includes a progress bar at the bottom of the video frame, a play button, and a volume icon. To the right of the video frame is a vertical toolbar with various editing tools. Below the video frame, a small inset window shows a man in a suit and glasses, likely the presenter. At the bottom of the player, the URL <https://youtu.be/MBYuQWYBMZ4> is displayed.

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From there you can see this machine how it works exactly.

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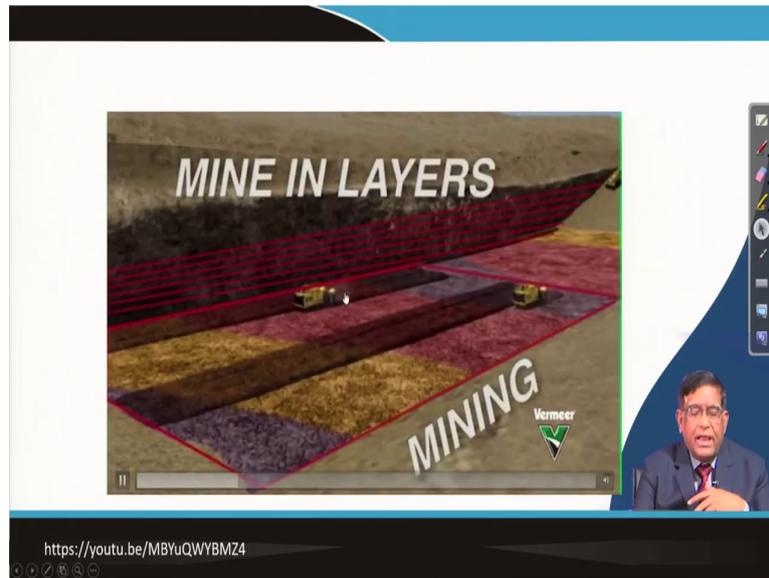
This machine has got a drum at the front which can give a (Refer Time: 12:03) this a this type of rotation tilting in both the sides.

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The image shows a YouTube video player interface. The main video content displays a yellow Vermeer machine operating on a dark, vertical wall. The text "VERTICAL WALL CAPABILITY" is overlaid in white, bold, sans-serif font. The Vermeer logo is visible in the bottom right corner of the video frame. A small inset window in the bottom right corner shows a man in a suit and glasses. The video player includes a progress bar at the bottom of the video frame and a URL bar at the bottom of the player area: <https://youtu.be/MBYuQWYBMZ4>. The player interface also features a vertical toolbar on the right side with various icons for video control.

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And, while it is going to the other direction, it is cutting the material.

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And, then making a windrow in front of it. So, this machine is going this directions and the cut material are placed over here.

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The image shows a YouTube video player interface. The main video content displays a construction site with a large pile of material and a yellow Vermeer machine. The text "SELECTIVE PILING" is overlaid on the video, along with the Vermeer logo. A video feed of a man in a suit is visible in the bottom right corner of the player. The URL "https://youtu.be/MBYuQWYBMZ4" is shown at the bottom of the player.

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If you see that like that it will be going on stripping, and then the strip material can be loaded by a front end loader to a truck and the truck will be taking out the material from the pit.

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The image shows a YouTube video player interface. The main video content displays a yellow Vermeer T1655 Direct Drive Terrain Leveler operating on a dirt slope. The text "T1655 DIRECT DRIVE TERRAIN LEVELER" is overlaid on the video, along with the Vermeer logo. A small inset video in the bottom right corner shows a man in a suit speaking. The video player includes a progress bar and a URL bar at the bottom with the link <https://youtu.be/MBYuQWYBMZ4>. The player is set against a blue background with a white border.

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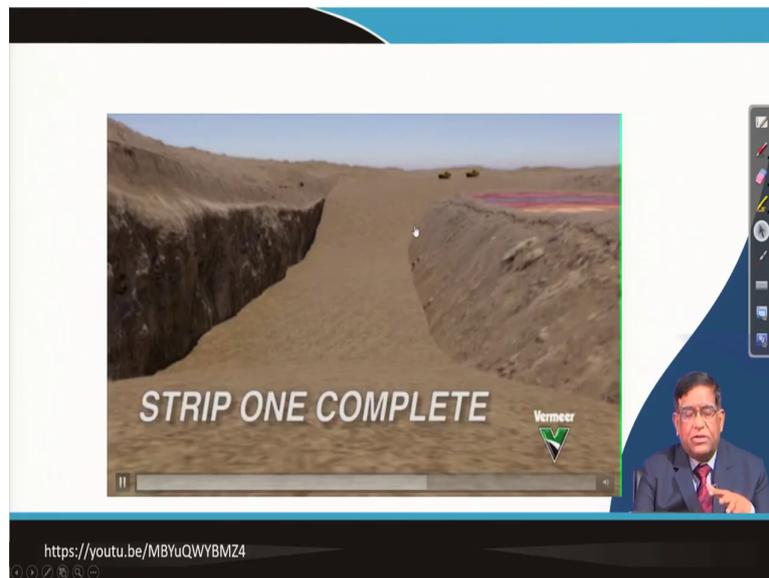
So, that means, this machine is basically it is a producing by it will be doing a cutting that mining phase. Then it will be doing a transporting phase by other one.

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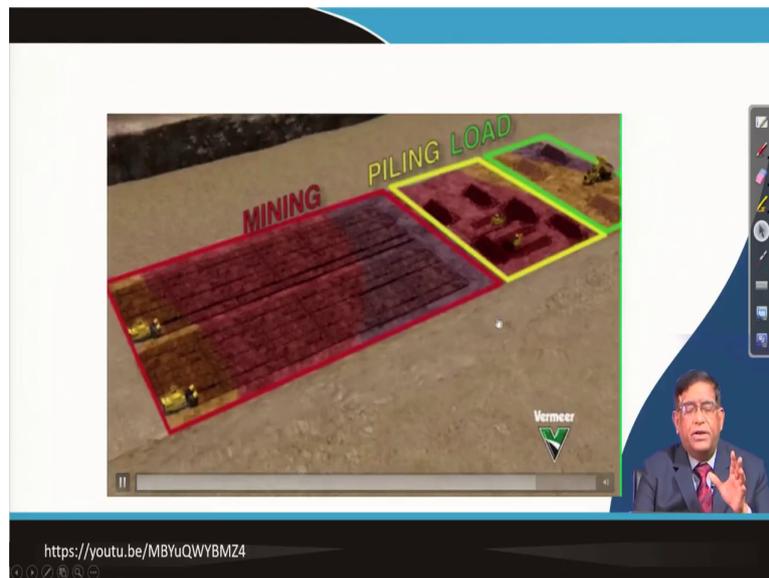
So, that is you can see here the top down cutting the drum will be rotating in this anti-clockwise direction.

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And, the machines is moving that to the opposite directions and the materials are placed over here. So, after that the material is dumped then it can be loaded with a another dumper can take out the material.

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So, it is just with this animated diagram of Vermeer you can know that there is a mining operation, a piling operation and loading operation. These three operations in sequence need to be organized in the field so that you can do the work.

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**General Technical Data**

Table 1. Typical technical specification of CSM (Ghosh et al., 2010).

Parameters	Type of surface miner		
	Middle drum	Front cutting drum	Front cutting wheel
Cutting width (mm)	250–4200	5250	7100
Cutting depth/height (mm)	0–800	1000–5500	0–2900
Capacity	For all machines output is related to material characteristics		
Weight (t)	40–190	135	540
Installed power (kW)	450–1200	750	Up to 3340
Manufacturers	Wirtgen, Bitell, L&T, Hudson	Vermeer, Tesmec, Voest Alpine	Krupp Fordertechnik, TenovaTakraf

Ghosh, A. K., Mondal, S. K., Singh, S. K., & Sinha, A. (2010). Applicability of surface miner in Nongtra limestone mine Lafarge Uniam Mining Pvt. Ltd. In Meghalaya, India. Central Institute of Mining & Fuel Research (Council of Scientific and Industrial Research), Department of Science & Technology, Government of India. Barwa Road, Dhanbad 826015, Jharkhand, India. July.

So, now that basically now you have seen how it exactly you have seen that the front at front drum machine how it works, and there are different machines has got different specifications.

Basically, the cutting width that width it goes from 250 millimeter to 4200 millimeter. Then your front cutting drum can give up to 5250 millimeter and the other one in a front cutting wheel where you can have a just like a wheel excavator bucket wheel excavator or just like your that is your barrel type re-claimer there will be a the front wheel there width is going up to 7100 millimeter.

Now, the cutting depth you can see that in a middle drum they will be doing a teeth will be cutting a thickness of 800 millimeter. Whereas, in the front cutting drum they have got a

capacity of giving a very thick cutting capabilities. Then that capacity of this it will be depending on the rock type and also the machine configurations.

The machines can be weighing up only as low as a 40 ton small machines to some 540 ton of very heavy big machine for cutting in very hard rocks also. So, now the installed power capacity depending on the rock strengths and depending on the expected production rate you will have to have that what will be the total installed power you can find out between 450 to 1200 kilowatt motors electric power can be installed over there and it can do it.

However, in the front cutting wheel depending on its operational capability there could be a large number of that is a that more power can be installed, that power consumptions will be required will be more.

So, there are many companies in the world that this Wirtgen the German company they first introduced this machines in our country. And L and T is the company which started producing this machines in our country. Vermeer they are exactly trying to get market so far, but there are Takaraf is also produced this machines and globally they are the main player now.

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**CSM Construction**

A milling roller module for a surface miner, includes

- *a milling roller operating with undershot for loosening the material from the block being mined,*
- *a support frame for fastening the milling roller to the surface miner, and*
- *a takeup chute for supporting the intermediate conveying of the loosened material in the area of the milling roller and for transferring the material to the downstream discharge belt in a specific manner.*

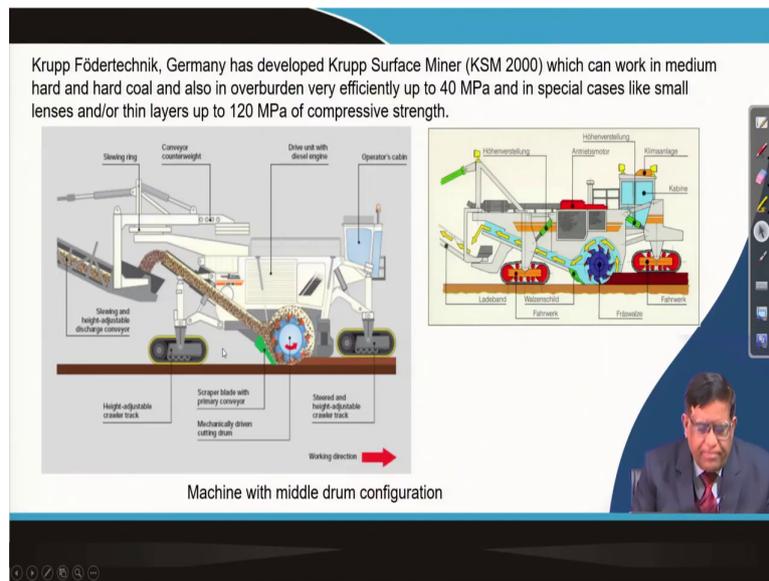
Now, this is a in nutshell you have got the introduction of this machine. Now, if you see their construction wise what is required basically it is a milling that drum which is rotating that drum gives a exactly a milling or roller operations that it is exactly below the machines, it will cut just like a your a drum will be rotating there will be the cutting pitch and then the material will be loosen.

So, basically it is mechanical loosening of the rock and then this drum will have to be there on a supporting frame which will be holding the machines with that as a integrity is maintained with the different your constructional the features of the machines. And, then there will be they take up chute for supporting the intermediate conveying.

Now, what is there that when the drum cut the material that material is fit into a discharge boom conveyer. There will be a conveyer belt by which the material will be going to a

discharge boom and that conveyer can load to a truck. Or there is a provisions that by a just like a your feeder it will be forming and windrow and the material will be just piled up at the from the bridge or the at opposite to the directions of the motions of the machines.

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So, you can see here in this diagram the pictures will be very clear; that means, you can see here this is a machine in which we are having the operators cabin here and then there are two sets of crawler. As I said this is the front side, this is the reverse side and now, this wind is machines will be moving there is a drum cutting drum at a central position.

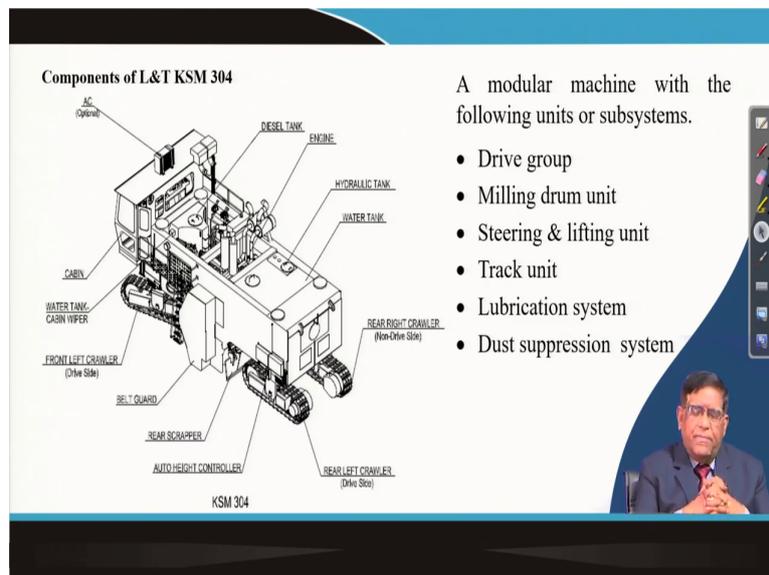
And, then the drive for it is kept over here it could be a diesel engine. From the diesel engine drive by a bill drive or chain drive this drum can be rotated. And, then the when the drum rotates over here it cuts and the cut material with the spiral positions in the drum it get

directed to this feeder, where a conveyer is there. This will be loading the material to another discharge boom.

This boom can be slewed, it can be rotated or it can be luffed; that means, it can be raised and lowered for to giving the loading the material on to the truck. And, then there is a mechanism to how this slewing mechanism will be organized, and then the while it is cutting there will be lot of force will be there. So, that this machine do not get unstable that is why there will be certain counter weight will be also provided. So, that is a basically the constructional features of a continuous surface miner.

When the that drum rotates you can see the drum has got the cutting picks then notice rotates this cutting picks the material it get guided by this spiral between that groups which is there on the drum to a central positions, and this is the way how the material is taken out.

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Here is a picture you can see that the machine which is manufactured at Kansbahal in Orissa that L and T's. This machine's features you can see in the front there is that cabin exactly the operator controls all the things.

Now, all this other functional there are different powered functions there the diesel engine and then the different drives, their clutches, their controls all can be instrumented and the operators cabin can get the real pictures what is going over there.

So, now, in this there is a the why the water tank because while cutting this machine lot of dust will get generated. So, that dust need to be suppressed for that a water tank and then the pump will be there and they will be sprink through nozzles that water to suppress the dust generated.

There will be main diesel tank and then the engine diesel engines will be running basically the pump that is a hydraulic tank for number of hydraulic operations and then the machine is supported on four point support that four crawlers are there. So, that this load is distributed through this crawler to the ground so that the ground pressure given by it is always within the ground bearing pressure. So, that the machine does not sink on that rock where it is working on.

And, then the main that there is a guard this belt guard is the belt drive which is given to the drum that is exactly over here. The engine from the engine shaft the power is taken by the belt through the shaft of the drum which is below and that is why this is a your belt guard is there.

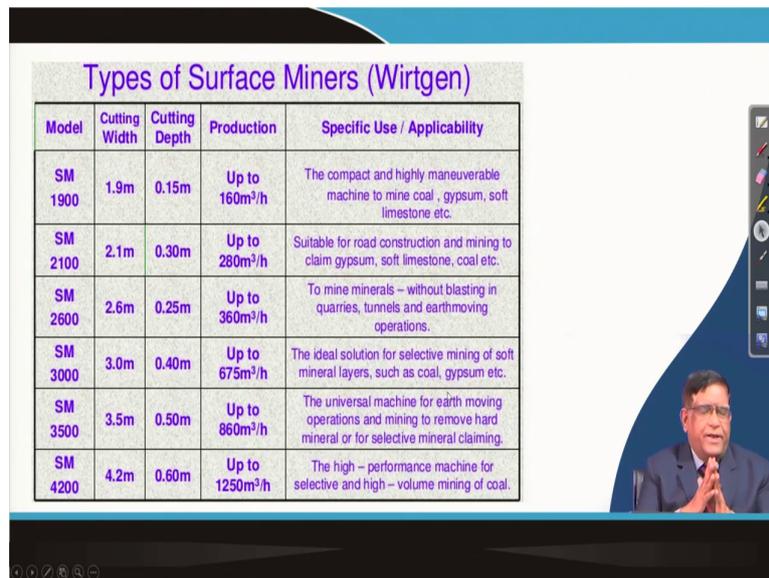
So, there is a controller number of controller is there that is a by which they need to control the speed of the drum they need to control that how much pressures will be given on the drum, or exactly how much how much bite will be given by the drum. So, basically if you are asked that what are the main constructional components of this machine – it has got a drive group, it has got a milling drum unit, it has got a steering and lifting unit it has got track unit, it has got lubrication system and dust separation system.

Lubrication system is for all the rotating parts there a lubricate will have to be provided. So, this is a centralize lubrication system with your this lubricants will be kept and by running a hydraulic your oil pump it will be giving through lines that exactly it will go to each and every point where the fluid is there and then ultimately the circuit will be completed.

So, that lubrication is another main part that we need to be seen during the operations and then you have to do to a maintenance over there. You should see that the all the all lubrication system is working well that will be working by a pump and number of valves giving it to the different points.

So, the periodic maintenance will require at what time you will need to change the lubricant and then there you are the periodicity as well the proper specification of the lubricant should be monitored. And, also if the lubricant conditions get changed because of the dust coming in or because of the thermal behavior if the properties change particularly the viscosity and this the other that it is a cooling property these are very important things. So, that could be seen over here.

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Model	Cutting Width	Cutting Depth	Production	Specific Use / Applicability
SM 1900	1.9m	0.15m	Up to 160m <sup>3</sup> /h	The compact and highly maneuverable machine to mine coal, gypsum, soft limestone etc.
SM 2100	2.1m	0.30m	Up to 280m <sup>3</sup> /h	Suitable for road construction and mining to claim gypsum, soft limestone, coal etc.
SM 2600	2.6m	0.25m	Up to 360m <sup>3</sup> /h	To mine minerals – without blasting in quarries, tunnels and earthmoving operations.
SM 3000	3.0m	0.40m	Up to 675m <sup>3</sup> /h	The ideal solution for selective mining of soft mineral layers, such as coal, gypsum etc.
SM 3500	3.5m	0.50m	Up to 860m <sup>3</sup> /h	The universal machine for earth moving operations and mining to remove hard mineral or for selective mineral claiming.
SM 4200	4.2m	0.60m	Up to 1250m <sup>3</sup> /h	The high – performance machine for selective and high – volume mining of coal.

So, it is a the Wirtgen the company which introduced the this machines in our country in a big way. They have got number of models you can see here the model name from SM 1900 to SM 4200 and there exactly the model they have got the cutting width get changed from 1.9 meter to 4.2 meter that is the how much width of material it can be cut.

If the width is more you can see that the more material will be; that means the width is a dictating what will be the production capacity per hour. And, then the cutting depth which can go up to 0.6 meter, there are machines nowadays even going up to 1 meter cutting depth is possible, but depending on the type of rock it is there.

And, the productions up to 1250 meter cube per hour productions only you can get. So, this is a low production rate, but depending on this exactly that which machine is suitable for what.

So, that means, in our coal mining normally it is 4 SM 4200 or even a bigger size of machines are exactly being used.

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Sl. No	Module	Elements
1	Drive group	<ul style="list-style-type: none"> <li>Engine, clutch, pump drive mounting.</li> <li>Engine fuel line</li> <li>Engine piping</li> </ul>
2	Milling drum unit	<ul style="list-style-type: none"> <li>Drum support arrangement</li> <li>Rear scrapper arrangement</li> <li>Belt tensioning arrangement.</li> <li>Steering arrangement (front &amp; rear)</li> <li>Lifting arrangement (front &amp; rear)</li> </ul>
3	Steering and lifting unit	<ul style="list-style-type: none"> <li>Under carriage assembly</li> <li>Drive group track</li> <li>Idler group track</li> <li>Tension and recoil assembly (track front &amp; rear)</li> <li>Roller group track</li> <li>Link assembly track</li> <li>Guard track</li> <li>Idler assembly track</li> </ul>
5	Lubrication system	<ul style="list-style-type: none"> <li>Lubrication pump assembly</li> <li>Lubrication piping for clutch</li> <li>Lubrication piping for PTO</li> <li>Grease piping-Steering and lifting</li> <li>Grease piping-Rear scrapper</li> </ul>
6	Water system	<ul style="list-style-type: none"> <li>Water piping (suction)</li> <li>Water spray arrangement delivery</li> <li>Spray pump assembly</li> <li>High-pressure washing.</li> </ul>

So, if you see that we have said that there are different constructional component. Now each constructional component or the module what are the main elements will be there. As a drive group that is which gives the drive we will find that there is a engine, clutch, pump drive, mounting and engine fuel line, your engine piping that is your cooling, it is a fuel sections. It is that your the that is a turbo chargers and then this exhaust system all these things are in the drive groups.

As well as it takes the your next in is your milling drum unit, that drum will have to be supported it will have to be exactly moved. It will have to give even if you are giving a tilting

and all then you are the drive by which it will be given that drive belt that, as well as this the tensioning all things are there in that unit.

Similarly, steering and lifting that your drum need to be lifted that is it will be pushed to the ground or it will be that when you are not travelling the machine without cutting at that time drum will have to be lifted. Then there is a the track under carriage on which this whole thing will be moving, there are having those tracks; that means, that driven track and there the there will be your sprocket on which the crawlers will be there.

You have already studied about the under carriage components of other machines, it is similar to that just like your dozers or shovels you have learned about it. The lubrication system will be having a hydraulic pump and then your hoist pipe systems and the number of different type of valves. And then you will have to see that how the sequence is controlled, at what timing that lubrications will be moving.

And, then also there will be inspections, whether the oil is getting contaminated or is it not performing that need to be same.

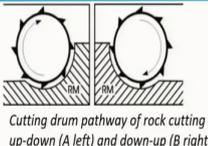
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**Cutting Drum**

- CSM drum is fitted with a *tungsten carbide tipped picks* retained in a *tool holder bolted to the outer edge of the spiral ridges on the drum*.
- Pick spacing on the drum can be varied to suit the characteristics of the material.
- Drum spiral are in the form of double helix which carries the material towards the drum centre.

From centre of the drum cut material is loaded on to a loading conveyor which loads into a slewable, height adjustable discharge conveyor. The machine moves on a crawler truck. Example Wirtgen 4200SM and L&T KSM 304.

The milling drum is made up of cast iron and has pick holders spread throughout the drum in double helix pattern



Cutting drum pathway of rock cutting up-down (A left) and down-up (B right)



Similarly, the most important things of the machine is the cutting drum because ultimately you will have to loosen the rock mass. Loosening the rock mass that means, your this teeth's and the drum they should be strong enough to withstand the cutting that is overcome the cutting resistance of the rock.

Now, for that different rock will be requiring different type of drum, different type of design, but the basically what is there? You can see that on the drum there are some tool holder. On the tool holder it is your tool which is called pick is being mounted. Now, the pick can be of different type, but there is a tungsten carbide tips are there.

So, now, this cutting drum it can it will be when it is it can rotate this is in a towards upward. This way it is cutting from here exactly your bottom down and here it is exactly cutting, taking of the material. You can see here that cutting it is as while it is moving upward it is

taking the material cut and here when the machine is teeth is going downward at that time the material is cut.

So, that depending on normally the front drum they will be cutting in this fashion, while is a central drum they will be cutting in this fashion.

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Round shaft pick with 1.7 in (42 mm) shaft diameter are generally equipped with short clamping sleeves and are used in the HT14 and HT15 toolholder systems. These tools are installed in the holder using a copper hammer. The clamping sleeves assure quick and easy changing of the cutting tools.

Forged steel part for exceptionally high resistance to wear and tear

High-quality carbide insert for top-quality cutting results

Unique wear plate for easy insertion of tools and optimum tool production

Toolholder welded into the apex of the bottom part

Clamping sleeve made of spring steel for easy tool replacement

Especially tough and wear-resistant, yet easily replaceable

Heavy-duty design with larger diameter compared to the HT5 system

Each cutting drum is designed in line with the specific operating conditions it is intended for using state-of-the-art 3D CAD technology

Cutting proves more effective than drilling and blasting

The new HT14 heavy-duty quick-change toolholder system (system) for the quick replacement of tools and reduced machine downtimes

Now, that tips that you can see that the picks it is it can be of different designs and then size and all will have to be depending on your side conditions, rock properties you will have to design that what will be its cutting angle, what will be its clearance angle and what is your this your mainly the angle that how it will be mounted over here. So, and then the what type of holder will be there.

One thing is to be remembered here that come what may with a every sieve rock that tooth will be failing, it is a consumable unit. Now, when you have to replace it, it should not take much time. So, that is why how this pick is fitted into the that your tool holder is very important. So, the designers take care of this.

And, you can see in between there is a spiral group that how the material when it is cut that material is within this spiral groups it gets directed towards the center so that it can loaded on to the next their feeder or to make the formula windrow.

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Round shaft pick with 1.7 in (42 mm) shaft diameter are generally equipped with short clamping sleeves and are used in the HT14 and HT15 toolholder systems. These tools are installed in the holder using a copper hammer. The clamping sleeves assure quick and easy changing of the cutting tools.

**Picks:**  
Some of the picks used in the surface miners are:

**W 47 K19**

**Smaller diameter of tungsten carbide:**

1. Low lifetime.
2. Good penetration.
3. High cutting.
4. Coarse gradation.

**W 47 K19**

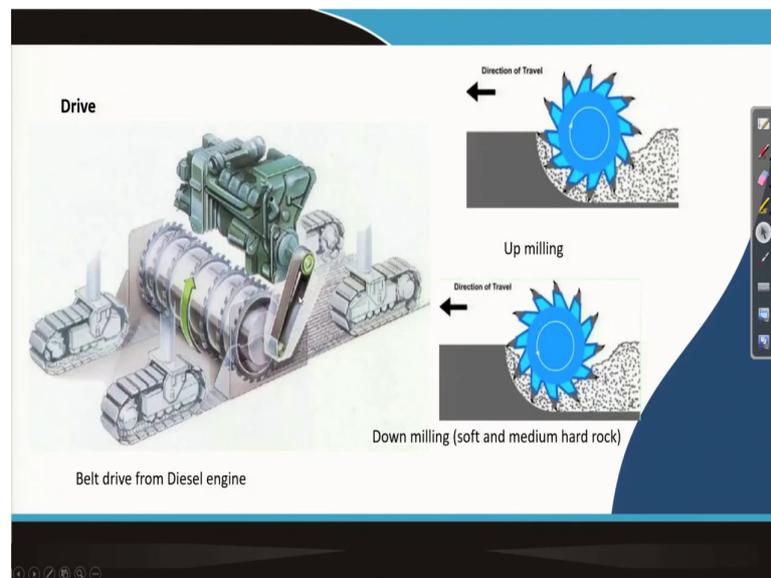
**Large diameter tungsten carbide:**

1. Long time.
2. Poor penetration.
3. Low cutting performance.
4. Fine gradation.

So, here you can see that this dimensions there are different we can say large diameter tungsten carbide picks, or there are smaller diameter tungsten carbide pick. So, this the large diameter one are the normally they have got a long lifetime and then this they have got the

poor penetrations, low cutting performance and fine gradation is given. But, for the smaller diameter tungsten carbide they have that low lifetime, but they give good penetrations.

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So, you can see here how with the direction of travel of the machine, this machine material is getting cut and then the it is loaded at the back. So, in the other things your top up milling or that when it is moving in machine is moving in this directions. As because this machine is going down and that material is loaded over here.

So, you can see here the engine, I told you that from the engine drive is given by belt drive to the drum. And then the exactly this crawlers are getting power and it is the machine is supported at the top of here. So, this gives you a fair idea that how this machines exactly operating.

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A continuously operating surface miner designed basically with a **milling roller** for the accurate, selective mining of sedimentary beds

### Working Parameters

- cutting height
- depth of cut
- nominal cutting width
- drum weight
- engine power
- feed speed
- cutting tool configuration (rake angle, attack angle, clearance angle and tip angle, pick lacing, type of pick, number of pick, and tip material);
- loading points
- manner how the miner begins a block to be mined
- manner how it finishes a block and changes over to a new block to be mined



Wirtgen 2200 Cutting hard limestone in South Australia



So, the to the whole performance of this machine will be depending on what is the cutting height, what is the depth of cut, what is the nominal cutting width, what is the drum weight, what is the engine power, the feed speed at which exactly it is moving. And then cutting tool configurations that rake angle, attack angle, clearance angle, tip angle, that your how the pick lacing.

How the picks are packed over there, then what type of pick is used, number of pick and tip of material. So, this about this a cutting picks and things you have studied they also with the other machine, now if you want to study the productivity of the machines you can do a lot of theoretical analysis about this parameter.

When the hourly production capacity in terms of the value of this parameters can be mathematically modeled and then you can find out that real data that is where the main

analytics of the productivity of this machines go. It is a very interesting area where you can work, number of people have done lot of papers they have written you can read them and also you can see the video of this particular machines.

So that you can get the feel of how it works. The loading points that also is a very important that is a where it is loading on to the conveyer belt, loading onto a truck or making an windrow on the surface that is what exactly. And, then how it is being deployed in the mines that is your in the mining how exactly the face is designed that also effect the operation of this machines.

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Technical specification of L&T

	KSM-223	KSM-303	KSM-304	
Milling width/depth	Milling width	2200	3000 mm	3000 mm
	Milling depth	350	300 mm	400 mm
Milling drum	No. of picks	76	106	106
	Cutting diameter	1150 mm	1150	1350 mm
	Drum inclination (max)	7°	7°	7°
Engine	Manufacturer	Cummins	Cummins	Cummins
	Type	VTA 28 C	VTA 28 C	KTA 38 C
	Engine ratings	800 HP @ 1900 rpm	800 HP @ 1900 rpm	1200 HP @ 1900 rpm
	Speed- high idle	1850 rpm	1850 rpm	1800 rpm
	Speed- low idle	800 rpm	800 rpm	800-850 rpm
Tank capacity	Fuel tank	1500 ltr	1500 ltr	2700 ltrs
	Hydraulic oil tank	500 ltr	500 ltr	1550 ltrs
	Water tank (without conveyer)	5000 ltr	5500 ltrs	7300+3500 ltrs
	Water tank (with conveyer)	4500 ltr	----	7300 ltrs
Total weight of machine	Dry (without conveyer)	49	51 ton	110 ton
	Operating weight with water and oil (without conveyer)	56	58 ton	115 ton
	Theoretical Gradability	80%	50%	20%

So, the you can easily find out from the website the specifications of different machines. Please make a table or just like this for different makes for their different parameter, this will give you a fair idea exactly what is the present trend of this machines being used.

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**Large Surface Miner with Front Cutting wheel – KSM**

The KSM is a mobile, continuously operating open cast mining machine. It is suitable for the mining of compacted soils and rocks up to a compressive strength of approx. 70 - 80 MPa without drilling and blasting and loading of the mined masses on downstream transport systems.

**Advantageous Conditions**

1. Mining of large amount of material
2. Selective mining of changing rock layers with thickness exceeding 0.5 m
3. Selective mining with a high separation accuracy
4. Production of lump sizes suitable for belt conveying with less fines
5. Use of cost-beneficial belt conveyors

**Inapplicability**

1. not suitable for the mining of soils with plastic consistency such as clay or loam whose natural water content exceeds the plastic limit. (Soil consistency is the strength with which soil materials are held together or the resistance of soils to deformation and rupture.)

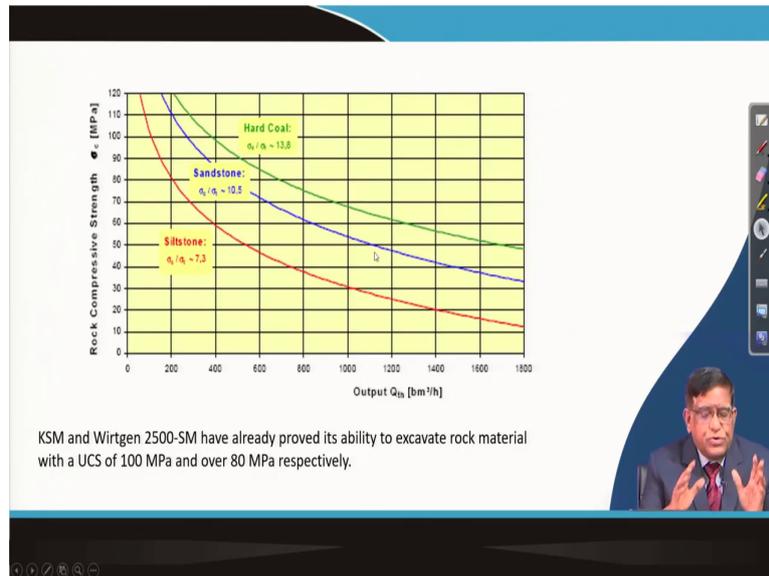
The output = 1400  $\text{bm}^3/\text{h}$  (continuous cutting operation under nominal conditions)  
The output depends on:

1. compressive strength,
2. brittleness,
3. jointing
4. abrasiveness



And then you can see here that there are a group they made some of these machines with a profound drum that is your that it is cutting over here and then loading on to the conveyor belt and it is shrink.

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So, there are if you see that the output it depends on the rocks compressive strength and you can see that with a different rock, different material, your output gets changed in this way; that means, your output will be increasing if your rock compressive strength is less. And, there your exactly which particular machines will be giving you what type of (Refer Time: 32:46) you can see over here.

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### Takaraf Front Drum M/C –truck Loading

TAKRAF Surface Miner MTS is designed for direct loading onto trucks or even slow-moving tripper cars. It claims fast and accurate **cutting of face ends and steep slopes** *minimizes expensive and unproductive site preparation work* and allows for the best utilization of the mineral deposit.

- MTS is equipped with a **cutting drum of large diameter and large width**. The large effective cross-section of the cut allows for the machine's **low operation speed** thus **reducing the energy consumption** and the wear on the travel gear to a minimum.
- All crawlers are located behind the cutting drum in travelling direction and therefore are **always on levelled ground**. This reduces the wear and ensures much smoother operation.
- The three-crawler travel gear with one steering crawler at the rear is highly manoeuvrable and has a small turning radius.
- It is a stable three point support and keeps chain forces and chain wear at a minimum even during turns.
- The machine's main structure contains all components of the drive in a closed and sound-insulated compartment.
- It is levelled by means of the hydraulically actuated leveling system.
- All components are easily accessible by walkways, even within the drive compartment.

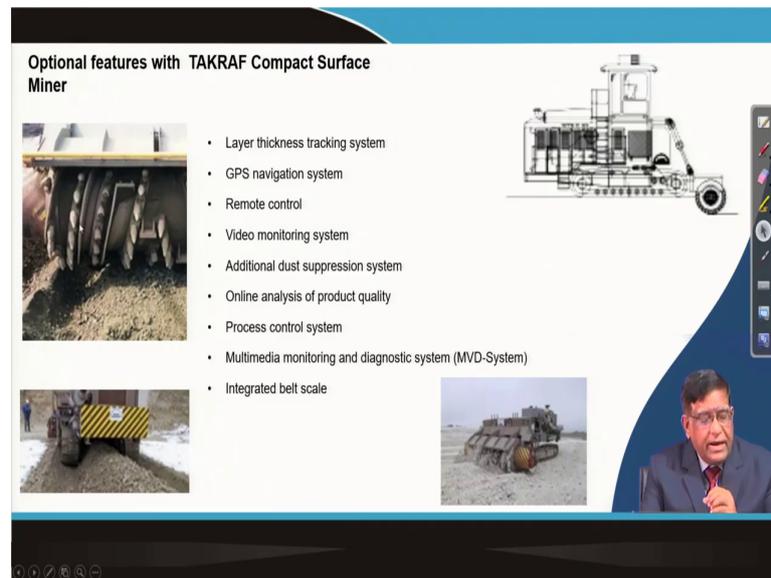
- The cutting drum is hydraulically leveled and adjustable up to +/- 5 % to follow the slope of the mineral seam.
- The material transport is simple and yet highly effective.
- The extracted material is moved by spirals from the cutting drums outer edge to its center and through an opening in the ring chute onto the integrated discharge conveyor underneath the superstructure.
- Behind the drive compartment the material is discharged onto the transfer conveyor.
- The transfer conveyor can be moved up and down and slewed for the best transfer and loading conditions
- The operator's cabin is positioned at the front of the main structure, just above the cutting drum.
- Cabin is ergonomically designed, air conditioned and equipped with TAKRAF's visualization control and monitoring system.
- A robust and reliable manual lubrication system with easy accessible central feed is installed.
- The machine is of modular design for easy transport and assembly.



Now, in a front cutting this Takaraf is produced is a front loading drum and you can see that this type of machines also are going to be very promising and high productive machines.

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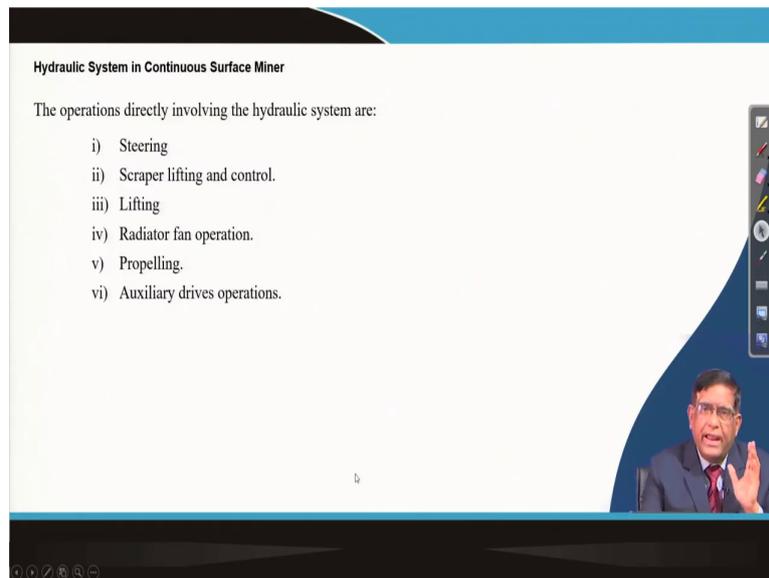
**Optional features with TAKRAF Compact Surface Miner**



- Layer thickness tracking system
- GPS navigation system
- Remote control
- Video monitoring system
- Additional dust suppression system
- Online analysis of product quality
- Process control system
- Multimedia monitoring and diagnostic system (MVD-System)
- Integrated belt scale

Now, there are the spiral you can see over here the cut material how it get exactly brought towards the center. As a result when the windrow is formed the cut material is forming and windrow over in the front of it. So, this is a front cutting drum machines. This also because of the spiral a groups in between the way the teeth are less on the drum, they are exactly making the material to get dumped in front of it. And, then you can see this loose material now can be easily loaded by a the a front end loader to do it.

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**Hydraulic System in Continuous Surface Miner**

The operations directly involving the hydraulic system are:

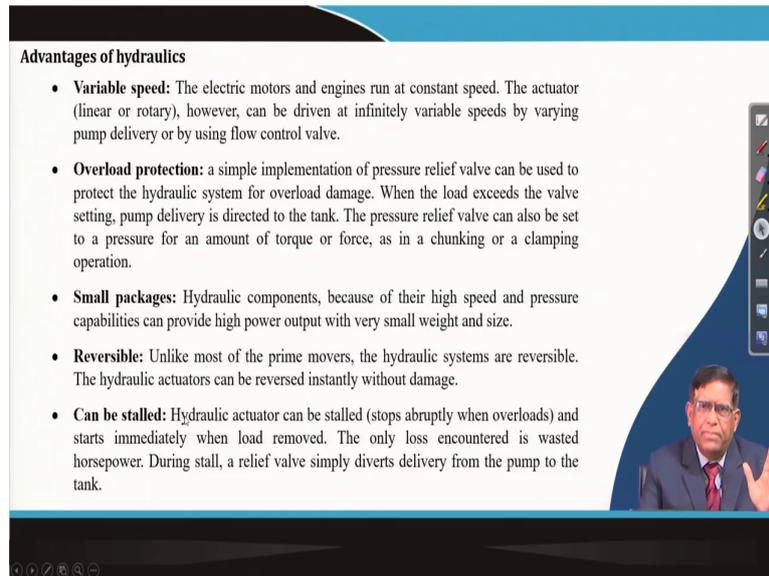
- i) Steering
- ii) Scraper lifting and control.
- iii) Lifting
- iv) Radiator fan operation.
- v) Propelling.
- vi) Auxiliary drives operations.

In the bottom right corner of the slide, there is a small video inset showing a man in a suit and glasses speaking. The slide also features a vertical toolbar on the right side and a horizontal toolbar at the bottom.

Now, when you are operating with this machine you need to consider about how you will be doing the steering, how we will be doing the scraping or lifting the control. How we will make it when we will be lifting, when we will be lowering, then what will be the your cooling and all this operations are going or not, how will you travelling and then what are the different auxiliary operations are there.

So, if you are a mechanic engineer you need to arrange the training of the operator training of this machines to maintain.

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**Advantages of hydraulics**

- **Variable speed:** The electric motors and engines run at constant speed. The actuator (linear or rotary), however, can be driven at infinitely variable speeds by varying pump delivery or by using flow control valve.
- **Overload protection:** a simple implementation of pressure relief valve can be used to protect the hydraulic system for overload damage. When the load exceeds the valve setting, pump delivery is directed to the tank. The pressure relief valve can also be set to a pressure for an amount of torque or force, as in a chunking or a clamping operation.
- **Small packages:** Hydraulic components, because of their high speed and pressure capabilities can provide high power output with very small weight and size.
- **Reversible:** Unlike most of the prime movers, the hydraulic systems are reversible. The hydraulic actuators can be reversed instantly without damage.
- **Can be stalled:** Hydraulic actuator can be stalled (stops abruptly when overloads) and starts immediately when load removed. The only loss encountered is wasted horsepower. During stall, a relief valve simply diverts delivery from the pump to the tank.

The slide also features a small video inset in the bottom right corner showing a man in a suit and glasses, and a vertical toolbar on the right side of the slide area.

So, there you need to study this the manual operators manual or they beneficiaries they provide a checklist that maintenance we will have to be made. But only thing is that to get the proper benefit of this machine, the machine machines hydraulics need to be very well understood.

Because that true hydraulics you get a different type of control. Exactly its speed control, its different type of protections given, then different type of operational possibility, that is controlled by the hydraulic system. So, you will have to study the manufacturer manual and find out that how you can improve that thing and if you neglect or if you do not follow the maintenance schedule you may left into a trouble.

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### Limitations of Existing CSM

- Un-economic in OB mining in coal mining in India due to very high UCS (>70 Mpa) in many areas.
- High maintenance of the cutting unit in hard rock mining
- Less penetration and less productivity

Now, one main important limitation is that in our coal mine, the over burden is sandstone which sometimes go up to 120 – 160 mega Pascal. Under that, this existing machines cannot work. Now, how to improve it is a innovations you need to think of.

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### Potential Solution by Pre-breaking

- Developing cracks and micro-cracks in the rock mass to reduce the resistance to penetration
- Designing energy efficient impactor/pulsator to be attached to CSM

The diagram illustrates a yellow pre-breaking machine with various components labeled. A 'Vibratory impactor' is shown at the front, creating 'Rock Loosening by Pre-breaker' in the rock mass. Other components include a 'Pre-breaker's support roller', 'Pre-breaker Unit', 'Vibrator/percussor', 'Vibration Isolator', and 'Hydraulic Adjustments'. A small inset video shows a man speaking.

So, that something you can think this is exactly not anywhere being done. I am just telling you so that you can think of some innovations by pre-breaking. So, what I conceptualized? I conceptualized it like this that you can have a vibrator or a precursor, if this machine is there if by changing that by studying whatever it is total power if we keep an pre-breaker or an impactor in front, so that it will be giving a crack will be developed over here.

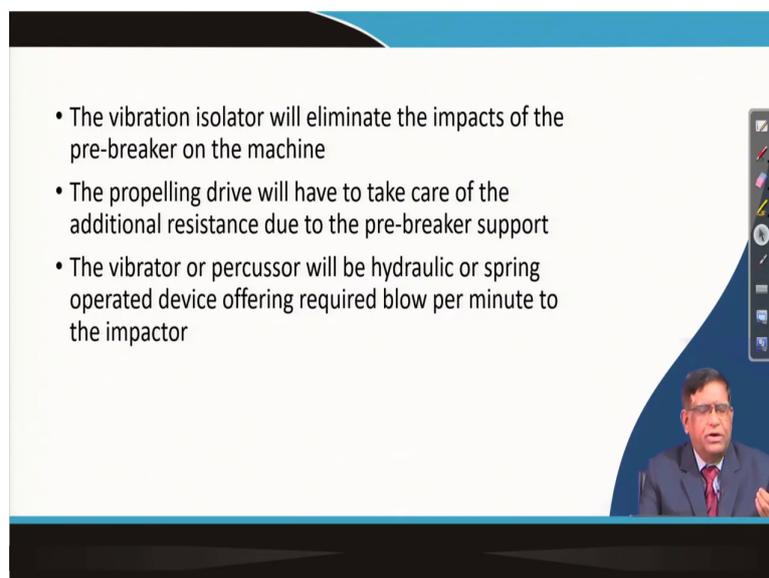
Now, when the machines will be now, if it is a hard intake rock which normally the drum cannot cut, but because of the pre-breaker or a impactor in front it will be able to break it and then it will be able to cut it. So, this was I conceptualized about few days, but no students have yet worked on it.

So, this is an idea you can do and other things you may think of yourself that how a new machines can be developed in India that if the group comes or they if they L and T they want

to buy make an add on into their machines and make it capable or if it is a productivity can be increased in a hard the sandstones which are available in our mine, then we can use it in the overburden also.

Today, this machine is being used in the mainly which coal some attempts are going on in the sand in the over burden also, but the economics of that need to be yet to be proved. So, there you please think of your innovative idea how you can do it.

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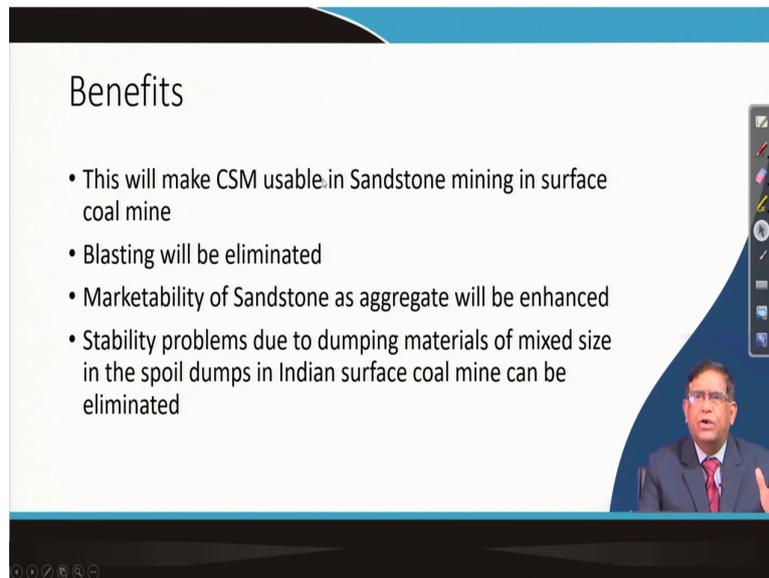
- The vibration isolator will eliminate the impacts of the pre-breaker on the machine
- The propelling drive will have to take care of the additional resistance due to the pre-breaker support
- The vibrator or percussor will be hydraulic or spring operated device offering required blow per minute to the impactor

In the bottom right corner of the slide, there is a small video inset showing a man in a dark suit and glasses speaking. To the right of the slide content, there is a vertical toolbar with various icons for editing and navigation.

So, what I have shown here that if we want a vibrating impactor over there, you will have to isolate that vibrations from the main machines how will you design that. Then the propelling drive will have to take care of the additional resistance of the pre-breaker support that will be there in front so then they whether the machine dynamics will be properly managed or not, so

that they it will be a whether it will be a spring loaded mechanical or hydraulic that type of things as a innovators you need to do some creative thinking and do it.

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The image shows a presentation slide with a white background and a blue header. The title 'Benefits' is in a large, black, sans-serif font. Below the title is a bulleted list of four points. In the bottom right corner of the slide, there is a small video inset showing a man in a suit and glasses speaking. The slide is framed by a dark blue border.

## Benefits

- This will make CSM usable in Sandstone mining in surface coal mine
- Blasting will be eliminated
- Marketability of Sandstone as aggregate will be enhanced
- Stability problems due to dumping materials of mixed size in the spoil dumps in Indian surface coal mine can be eliminated

But, if you can do this make this type of hard rock mining capability comes it will give a multimillion dollar business in India because India producing more than 500 million ton of coal from surface mines. And if it comes with such a huge amount of 1 is to 4 stripping ratio over burden can be removed. There will be needs of a large number of such machines.

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Needs

- Fabrication of the attachment and accesories
- A laboratory scale testing for the concept
- Field test with a prototype

Thanks

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**Productivity**

- $P = (60 \cdot Q_a) / (t_1 + t_2 + t_3)$   
 $Q_a$  = actual amount of material filled in the tipper =  $(Q_t \cdot F_f)$   
 $Q_t$  = theoretical capacity.  $F_f$  = fill factor
- $t_1$  = time required to fill a tipper (min)  
 $t_2$  = Machine turning time per tipper (min)  
 $t_3$  = spotting time of tipper
- $t_1 = Q_a / (w \cdot h \cdot v \cdot d)$   
 $w$  = width of cut in (m)  
 $h$  = cutting depth in (m)  
 $v$  = operating speed  
 $d$  = bulk density in  $t/m^3$ .
- $n = (L \cdot w \cdot h \cdot d) / Q_a$   
 $n$  = no. of tipper filled in one stretch.  
 $L$  = length of bench in (m)

The slide is part of a video recording, as evidenced by the speaker's head and shoulders in the bottom right corner and the standard Windows taskbar icons on the right side of the slide area.

And, a another things to finally I tell you, that the productivity of this machines will be depending on how much exactly the time we can do how quickly you can do the work. And, that is your actual amount of material fill to the tipper and then your that what is that if the theoretical capacity which is given over there.

So, there is a standard procedure for calculating the productivity and also it depends on their cutting dipped and operating speed and the bulk density of the material. So, from there you can find out this calculate out this parameters and ultimately you can how many number of trucks it can fill within a short period you can find it out.

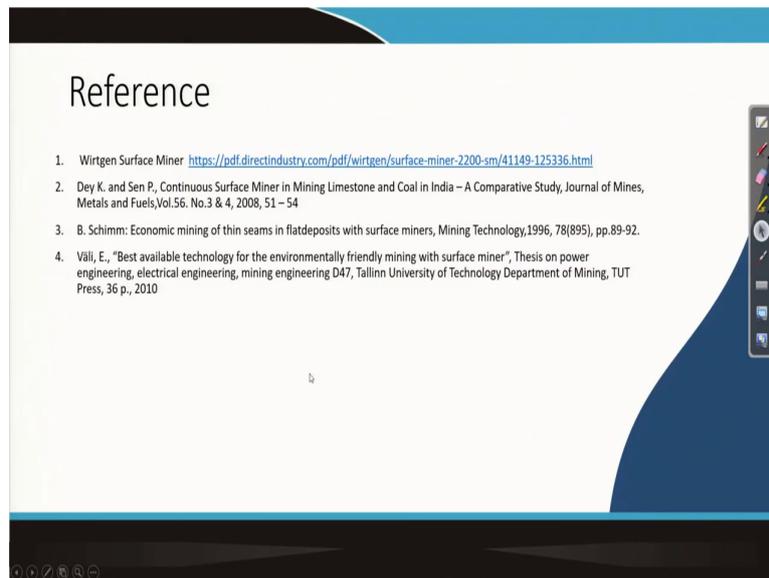
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So, depending on the application site the productivity will be different, but ultimately one thing is to be known that the surface miner it is a versatile useful equipment. But, you need to plan its uses in the field properly and for that the knowledge is power you will have to learn the mechanism how it works. It has got electrical component, it has got hydraulic component, it has got mechanical component and they will have to be maintained.

So, that is why today I have just introduced you that this is the machine which can be studied and it has got a future in India and it requires certain modifications, certain development and some improvements over here.

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So, basically what we have learnt is we have talked about the constructions and then this machines is a in a modular machine. And then its operations operator need skill of controlling particularly steering, lifting and then managing the that how much exactly will be the bite and he need to put on observations on how the teeth are getting worn out.

Now, one most important disadvantage is here that the teeth which will let be just wearing out very fast is a replaceable item you will have to maintain an inventory. And, the original equipment manufacturers normally keep the right to give their on lit it.

And there a manufacturing in India, the invent that is your spare parts and the teeth that could be also a another business, some start-up and business can come up. So, I hope you have understood this machines and please prepare and study from the different available resources.

Thank you very much.