A Presentation by
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MINING TECHNOLOGY

OPENCAST MINING TECHNOLOGY
- Shovel-Dumper
- Dragline
- Surface Miner

UNDERGROUND MINING TECHNOLOGY
- Bord & Pillar
- Side Discharge Loader (SDL)
- Load Haul Dump (LHD)
- Continuous Miner
- Longwall
- Shortwall Mining

OTHER MINING TECHNOLOGY
- Highwall Mining
UG MINING TECHNOLOGY

UG MINING METHOD

• BORD & PILLAR
• LONGWALL

INTERMITTENT MINING METHOD

• SIDE DISCHARGE LOADER (SDL)
• LOAD HAUL DUMP (LHD)

MASS PRODUCTION TECHNOLOGY

• CONTINUOUS MINER
• LONGWALL
UG MINING METHODS

BORD & PILLAR Method

- Coal deposits are mined by cutting a network of ‘roads’ into the coal seam and leaving behind ‘pillars’ of coal to support the roof of the mine.

LONGWALL Method

- It involves the full extraction of coal from a section of the seam or ‘face’ using mechanical shearer to cut and remove the coal at the face.
- Self advancing Roof Supports are used to temporarily hold up the roof while coal is extracted.
BORD & PILLAR Mining

• Bord & Pillar is the traditional mining method used in India.
• It is employed where geo-mining conditions are complex.
• Coal is removed from the coal faces initially by developing a set of galleries leaving pillars in between to support the roof.
• Thereafter, the pillars are extracted by de-pillaring.
• Initially only 30% of the coal can be extracted, while most of the remaining coal is extracted during de-pillaring.
Coal deposits are mined by cutting a network of ‘roads’ into the coal seam & leaving behind ‘pillars’ of coal to support the roof of the mine.

These pillars can be up to 40% of the total coal in the seam – although this coal can sometimes be recovered at a later stage by ‘retreat mining’. The roof is then allowed to collapse and the mine is abandoned.

Smaller deposits can have Manual loading & intermediate technologies with continuous miners or LHDs & SDLs.

Mechanisation in Bord and pillar has limitations of gradients. Seams steeper than 12° (1 in 5) are not suitable.
Room and Pillar Mining Technique
BORD & PILLAR MINING

SEMI-MECHANISED METHOD

• Currently, most of CIL mines using Bord & Pillar remove coal from the face by blasting & deploy SDL or LHD for loading and transportation of coal in the active mining areas.

• Coal transportation to surface is either by a series of belt conveyors or rope haulage drawn coal tubs.

• This method requires less capital investment but is more labour intensive.

CONTINUOUS MINING METHOD

• In many of CIL new underground mines, bord & pillar mining is carried out using Continuous Miner method where geo-mining conditions permit.

• The coal is mined by a continuous miner unit & loaded to shuttle cars which deliver coal to feeder breaker linked with belt conveyor for onward transportation to surface.
LONGWALL MINING

• Longwall is a fully mechanised underground mining method where the roof at the coal face is supported by self-advancing powered supports & the coal is mined by a shearer.

• Armoured face conveyor & stage loader-crusher are used for transportation of coal at the Longwall face.

• A series of belt conveyors is used to transport coal to the surface.

• When the mining of a Longwall panel has been completed, the equipment is moved to a new Longwall face.

• The key characteristics of Longwall Mining include high productivity, high recovery rate and safety & reliability.
LONGWALL MINING

• It involves the full extraction of coal from a section of the seam or ‘face’ using mechanical shearers to cut and remove the coal at the face.
• The coal ‘face’ can vary in length from 100 to 350 metres.
• Self advancing Roof Supports (SARS) are used (hydraulically-powered supports) to temporarily hold up the roof while coal is extracted.
• When coal has been extracted from the area, the roof is allowed to collapse.
• Over 75% of the coal in the deposit can be extracted from panels of coal that can extend 3 km through the coal seam.
• Large reserve & uniform deposit are mined by Longwall mining.
• It is a bulk production but capital intensive technology.
For EXTRACTION

- Shearer
- Powered support
- Armoured Face Conveyor
- Stage loader - crusher
- Power pack

For DEVELOPMENT

- Continuous miner package or
- Road header package
<table>
<thead>
<tr>
<th>Method</th>
<th>Gradient Criteria</th>
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<tbody>
<tr>
<td>Manual</td>
<td>In all gradients</td>
</tr>
<tr>
<td>SDL</td>
<td>Where the gradient is ( \leq 1 ) in 5 (12(^0))</td>
</tr>
<tr>
<td>LHD</td>
<td>Where the gradient is ( \leq 1 ) in 6 (10(^0))</td>
</tr>
<tr>
<td>Continuous Miner</td>
<td>Where the gradient is ( \leq 1 ) in 8 (7(^0))</td>
</tr>
<tr>
<td>Longwall</td>
<td>Where the property is devoid of fault.</td>
</tr>
</tbody>
</table>
MAJOR UG EQUIPMENTS

WINNING & LOADING
- DRILLING MACHINES (Hand held, Tyre/crawler mounted)
- ROAD HEADER
- SHEARER
- CONTINUOUS MINER
- SIDE DISCHARGE LOADER (SDL)
- LOAD HAUL DUMP (LHD)

TRANSPORTATION
- CONVEYORS (Belt conveyors, Chain conveyors)
- HAULAGES (Direct haulage, Endless haulage, Main & tail haulage)
- WINDING SYSTEMS (Drum winder, Friction/koepe winder)
- MAN RIDING SYSTEMS
- SHUTTLE CARS/RAM CARS
- LOCOS
LOAD HAUL DUMP (LHD)
CONTINUOUS MINER package

• For DEVELOPMENT & EXTRACTION
  • Continuous miner* - 1 no.
  • Shuttle cars - 2 no.
  • Twin/ Quad bolter* - 1 no.
  • Feeder breaker - 1 no.
  • Power pack - 1 no.
  • Mobile goaf edge support (Optional) - 2
    • (* In some package both the machines are integrated into one)
SHUTTLE CAR
POWERED SUPPORT
<table>
<thead>
<tr>
<th>Support UG Equipments</th>
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<tbody>
<tr>
<td><strong>VENTILATION FANS</strong></td>
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<td><strong>PUMPS</strong></td>
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<tr>
<td><strong>SAFETY RELATED EQUIPMENTS</strong></td>
</tr>
<tr>
<td>• Self contained self rescuers</td>
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<tr>
<td>• Gas monitoring devices</td>
</tr>
<tr>
<td><strong>SHOT FIRING EQUIPMENT</strong></td>
</tr>
<tr>
<td><strong>SUPPORTS</strong></td>
</tr>
<tr>
<td>• Shield type hydraulic power support</td>
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<tr>
<td>• Individual hydraulic/friction/screw supports</td>
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<tr>
<td><strong>MONITORING DEVICES</strong></td>
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<tr>
<td><strong>ROOF BOLTER</strong></td>
</tr>
<tr>
<td>• Hand held</td>
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<tr>
<td>• Crawler mounted</td>
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<tr>
<td><strong>COMMUNICATION SYSTEMS</strong></td>
</tr>
<tr>
<td>• Conventional wire based</td>
</tr>
<tr>
<td>• From surface to UG- wireless and from UG to surface – Combination of wire and microwave</td>
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<tr>
<td>Comp.</td>
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PRODUCTIVITY IN UG

SIDE DISCHARGE LOADER
• 110 tonnes per day (For a 5-heading district having 3 SDLs)

LOAD HAUL DUMPER
• 200 tonnes per day (For a 5-heading district having 3 LHDs)

CONTINUOUS MINER
• 1,200 to 2,400 tonnes per day (depending on the seam thickness)

POWERED SUPPORT LONGWALL
• 3,280 tonnes per day onwards (1 MTY)
Introduction of mass production technology

• Longwall
• Continuous Miner (CM)
• Low Capacity Continuous Miner (LCCM)

Application of UDM, SDL & LHD

• Application of Universal Drilling Machine (UDM) with SDLs and LHDs for improving rate of output in B&P method of working.
• UG mining, by and large remains, a losing proposition
• In the existing pricing mechanism it is difficult to recover the higher cost of UG production
• The average cost of production from UG mining was Rs. 1,819 per tonne (2005-06) of coal
• The coking coal & good grade deposits are largely amenable to UG mining
• In future UG mining will be done from greater depths, further increasing the cost of production
• In this scenario, the customer should be ready to pay higher price.
ENVIRONMENTAL & SAFETY ISSUES

• During UG mining, the inherent dangers of roof & side fall, fire, explosion, noxious gases, water inundation etc. are to be dealt with.

• Roof & side fall remains the most common cause of UG mine accidents.

• Switching to mass production technology will reduce the no. of accidents due to strata control and those related with the handling of explosives.

• Extensive R&D work is being done to limit accidents due to roof fall. One such major R&D work for detecting of early bed separation and hidden slips accompanied with audible warning is going on in IIT Kharagpur

• Use of bolting techniques will reduce the chances of accidents in semi-mechanised mines
KEY SAFETY ISSUES IN COAL MINING

- HIGHWALL AND LOW WALL STABILITY
- INTERNAL AND EXTERNAL DUMP STABILITY
- STABLE PROFILE OF DRAGLINE DUMPS
- SAFETY IN MINING LAYOUTS
- SAFETY IN BLASTING OPERATIONS
- SAFETY RELATED TO MINING OPERATIONS
- SAFETY RELATED TO MINING EQUIPMENT
OC MINING TECHNOLOGY

DISCONTINUOUS MINING
- Shovel-Dumper Mining
- Dragline Mining
- Combined Mining
- Surface Miner

CONTINUOUS MINING
- Bucket Wheel Excavator (BWE)
- Conveyor System
- Spreaders
- Tripper Cars

HYBRID MINING
- In-Pit Crushing & Conveying System
KEY DRIVERS FOR CHANGE IN TECHNOLOGY

• Surge in demand
• Cost competitiveness
• Quality improvement
• Ensuring higher safety in UG & OC mines
• Increase in level of mechanisation in UG & OC operations
• Environmental issues
• Improving man & machine productivity
• Improving percentage of extraction in UG mines
SHOVEL-DUMPER MINING

• It is the most sought after technology in opencast mining due to its inherent flexibility of operation.
• It can be used more or less in all types of deposits from flatter to highly steep, softer to hard rocks etc.
• In future, in addition to shovels, coal industry may go for high capacity wheel loaders (tyre mounted) also.
SHOVEL-DUMPER COMBINATIONS

10cum Shovel + 100T Dumper

17 to 20cum Shovel + 100T/150T Dumper

20 to 22cum Shovel + 150T Dumper

25 to 28cum Shovel + 150T/240T Dumper

34cum Shovel + 240T/360T/400T Dumper

50cum Shovel + 360T/400T Dumper
ROPE SHOVELS

• Low operating & maintenance cost of rope shovels make them ideally suited for stripping overburden in large quantities.
• 42 cum bucket capacity rope shovel at Gevra OCP (SECL) is the biggest rope shovels deployed in CIL & India.
• Internationally the largest Rope Shovel deployed is of 63cum bucket capacity.

HYDRAULIC SHOVELS

• Hydraulic Shovels are ideally suited for selective mining and for operation in low bank heights in medium hard strata conditions.
• Currently, 18 cum bucket capacity hydraulic shovels are the biggest hydraulic shovels deployed in CIL & India.
• The largest Hydraulic Shovels deployed in the world are +50 cum bucket capacity front end shovels.
HYDRAULIC SHOVEL
HYDRAULIC BACKHOE SHOVEL
WHEEL LOADER LOADING IN A REAR DUMP TRUCK
• Dumpers offer the most flexible means of transporting the mined coal or overburden to the designated areas.

• Currently, 240 T capacity rear dumpers at Gevra OCP (SECL) are the biggest Dumpers deployed in CIL & India.

• The largest dumpers deployed internationally are 400T at present.
• Dragline mining is the most cost effective technology for the bedded deposits and is the first-choice technology for large opencast mining.

• Draglines do not require dumpers for transport of the mine waste as the overburden stripped by the draglines is directly cast into de-coaled pit.

• The largest dragline operating in India is 30 cum bucket capacity & boom length of 96 m (Bishrampur OCP, SECL).

• Internationally, the largest dragline size is 76 to 122cum bucket capacity with 132 to 76m boom length.
• Applicable in flatter deposits with relatively softer strata which do not require blasting e.g. Lignite.
• The BWE is a Continuous Mining Technology and works in conjunction with Conveyor belts & Spreaders.
• The current deployment of BWE is limited to 350 Lt, 500 Lt, 700 Lt & 1,400Lt size units.
• It is expected that **2,800 Lt.** BWE will be deployed in future.
• Conveyor systems of 1,600 mm, 2,000mm & 2,400 mm are in operation in the mines of **NLC & GMDC.**
• It is likely that in future the size of conveyors will be **3,000 mm.**
• In pit crushing of coal is generally found to be economical in high capacity opencast mines where reasonable lead distance and lifts are involved.

• This technology is, however, associated with extremely high Capital & Operating costs.

• Mobile in-pit crushing and conveying technology for coal is in operation at the Piparwar OCP (CCL)

• Shiftable in-pit crushing & conveying of overburden (OB) is in operation at Ramagundem-II Mine (SCCL)
IN-PIT CRUSHING & CONVEYING
• It finds its natural applications in projects where drilling and blasting is prohibited or where selective overburden is required.

• Some of the opencast coal mines of MCL (CIL) are presently using surface miners on contractual basis for extraction of banded coal seams.

• Presently surface miner is used as cutting machine only and pay loader has been added for loading the coal into the tipping trucks.

• Tripper cars and Spreader systems of 11,000 TPH & 20,000 TPH are already in operation in NLC
• 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.
Pic.2: Example of machine with middle drum configuration
SURFACE MINER IN COAL
HIGHWALL MINING

• Highwall/Trench mining is a remote controlled mining method which extracts coal from the base of an exposed highwall via a series of parallel entries driven to a significant depth within the coal horizon.
• It allows recovery of coal from surface pits that have reached final highwall position, or in areas where coal has become sterilized, e.g. in-service corridors.
• A trench of suitable dimension is dug centrally where Highwall is not available, and parallel drivages are made in both directions along dip as well as along rise.
• The technology may have wide application in extracting reserves of thin seams (0.8m to 1.5m).
• The method is under use at Sharda Project (SECL)
Current OC Equipment Sizes in India

- **DRAGLINE**: 24 to 30 cum/96 to 71m
- **ROPE SHOVEL**: 42cum (Gevra-SECL)
- **HYDRAULIC SHOVEL**: 18cum
- **DUMPER**: 240T (Gevra-SECL)
- Bucket Wheel Excavator: upto 1,400 Lt
- Tripper Car & Spreader: upto 20,000 TPH
- In-pit crushing & conveying (Coal): 2,800TPH (Piparwar-CCL)
- In-pit crushing & conveying (OB): 3,500TPH (Ramagundam-II-SCCL)
- Surface Miner: 750TPH
- Drills: upto 381mm, Dozers: upto 850hp
- Motor Graders: upto 280hp
- Front End Loaders: upto 11.50cum
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<tr>
<th>Comp.</th>
<th>Dragline</th>
<th>Shovel</th>
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