

# COAL MINING TECHNOLOGY



A Presentation by

**MANOJ KUMAR SINGH**

**Manager(IE), NCL-HQ, Singrauli(MP)-486 889**

**E-mail : [mks\\_ie@nclhq.nic.in](mailto:mks_ie@nclhq.nic.in), M-9993875526**

# **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 shearers 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.

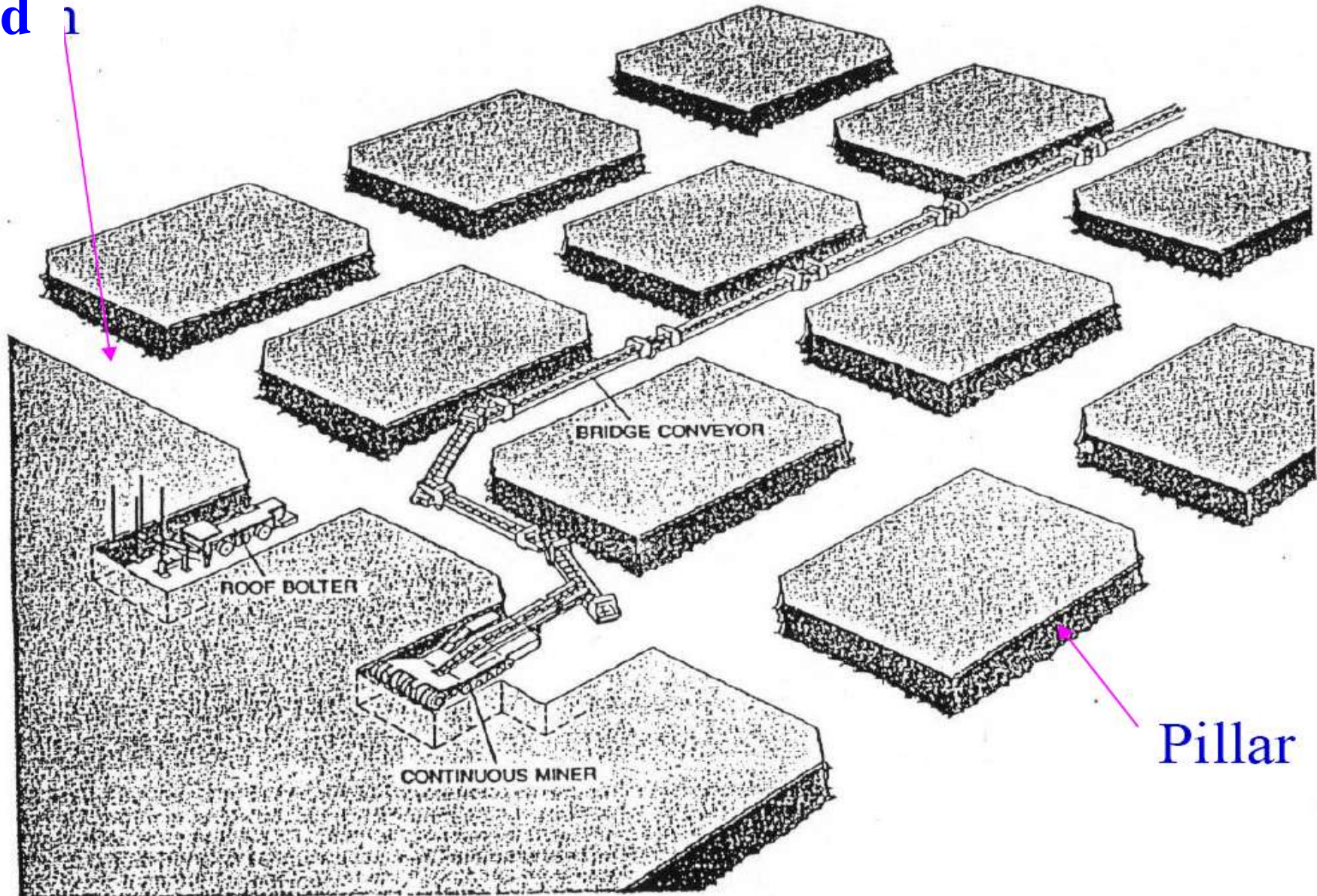
# **BORD & PILLAR Mining**

- **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.**

## BORD & PILLAR METHOD

- 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  $12^\circ$  (1 in 5 ) are not suitable.

Road 1



Pillar

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.<sup>10</sup>

# POWERED SUPPORT LONGWALL



# **POWER SUPPORT LONGWALL package**

- **For EXTRACTION**
- **Shearer - 1**
- **Powered support - 1 set**
- **Armoured Face Conveyor - 1**
- **Stage loader - crusher - 1**
- **Power pack - 1**
- **For DEVELOPMENT**
  - **Continuous miner package or**
  - **Road header package**

# SELECTION OF UG METHOD

## Manual

- In all gradients

## SDL

- Where the gradient is  $\leq 1$  in 5 ( $12^\circ$ )

## LHD

- Where the gradient is  $\leq 1$  in 6 ( $10^\circ$ )

## Continuous Miner

- Where the gradient is  $\leq 1$  in 8 ( $7^\circ$ )

## Longwall

- Where the property is devoid of fault.

# 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**

# SIDE DISCHARGE LOADER (SDL)



# LOAD HAUL DUMP (LHD)





# ROAD HEADER



# CONTINUOUS MINER



# 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



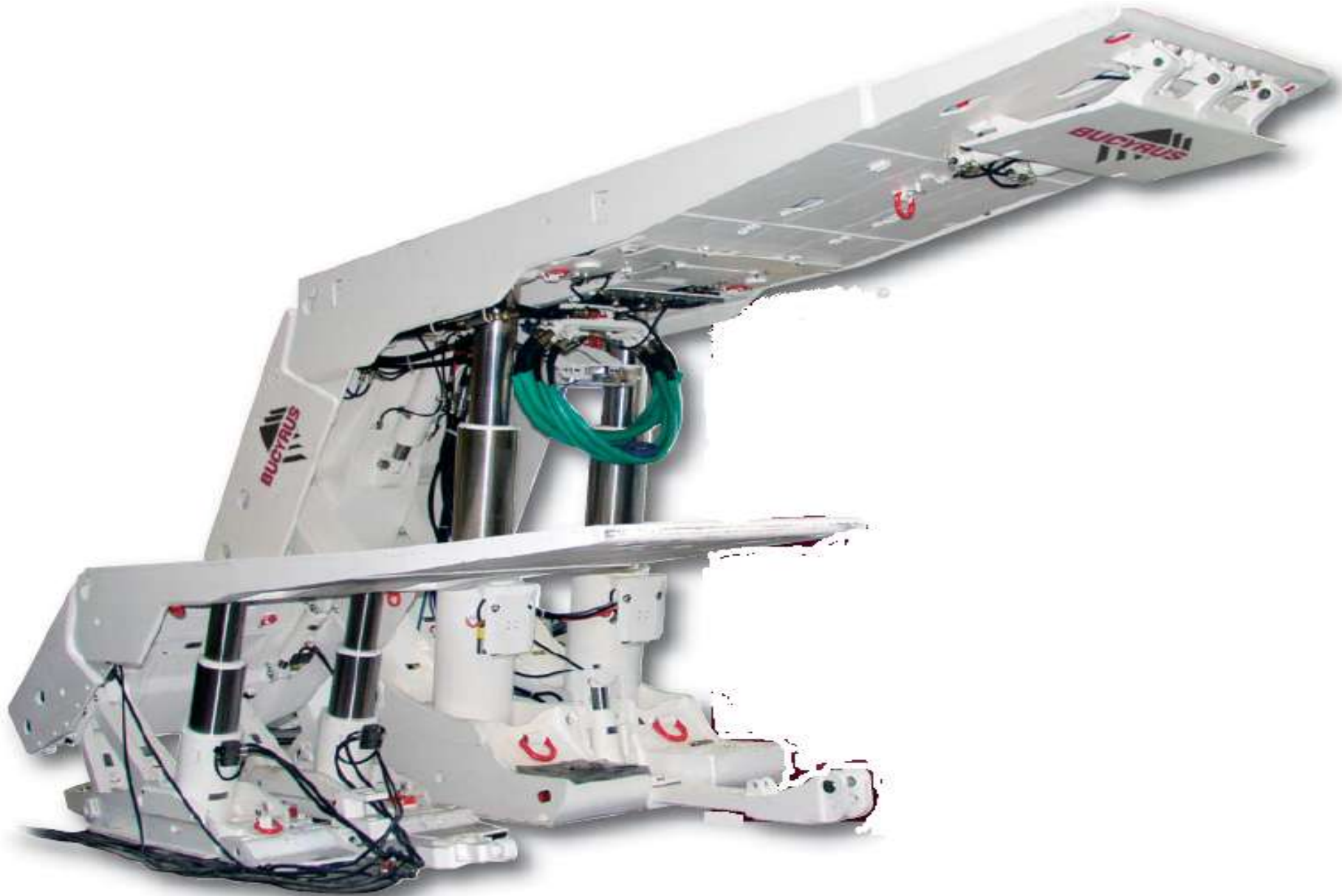
# ROOF BOLTER



# SHEARER



# POWERED SUPPORT



# Support UG Equipments

## VENTILATION FANS

## PUMPS

## SAFETY RELATED EQUIPMENTS

- Self contained self rescuers
- Gas monitoring devices

## SHOT FIRING EQUIPMENT

## SUPPORTS

- Shield type hydraulic power support
- Individual hydraulic/friction/screw supports

## MONITORING DEVICES

## ROOF BOLTER

- Hand held
- Crawler mounted

## COMMUNICATION SYSTEMS

- Conventional wire based
- From surface to UG- wireless and from UG to surface –  
Combination of wire and microwave



# U/G MECHANISATION IN CIL (1<sup>st</sup>.April 2010)

| Comp. | SDL | LHD | High Cap LHD | Road Header | PSLW | SHW | Cont. Miner |
|-------|-----|-----|--------------|-------------|------|-----|-------------|
| ECL   | 154 | 24  | -            | 2           | 1    | -   | 1           |
| BCCL  | 137 | 6   | -            | 4           | 3    | -   | -           |
| CCL   | 19  | 7   | -            | -           | -    | -   | -           |
| NCL   | -   | -   | -            | -           | -    | -   | -           |
| WCL   | 87  | 126 | -            | -           | -    | -   | 2           |
| SECL  | 271 | 111 | 8            | -           | 1    | 2   | 2           |
| MCL   | 21  | 32  | -            | -           | -    | -   | -           |
| CIL   | 689 | 306 | 8            | 6           | 5    | 2   | 5           |

# 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)

# TO ENHANCE UG COAL PRODUCTION IN INDIA

## 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.

## **ECONOMICS OF UG MINING**

- **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.

# ROPE SHOVEL



# HYDRAULIC SHOVEL



# HYDRAULIC BACKHOE SHOVEL



# WHEEL LOADER



# DUMPERS

- 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

- 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.

# DRAGLINE



## BUCKET WHEEL EXCAVATOR (BWE)

- 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 & 1,400 Lt 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.**

# BUCKET WHEEL EXCAVATOR (BWE)



# CONTINUOUS MINING WITH BWE



# IN-PIT CRUSHING & CONVEYING

- 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



## SURFACE MINER

- 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**



# **ADVANTAGES OF SURFACE MINER**

- **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.**

# SURFACE MINER IN OB



Pic.2 : Example of machine with middle drum configuration

# SURFACE MINER IN COAL



# SPREADER



# 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)**

# HIGHWALL MINER



## 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

# HEMM POPULATION IN CIL (1<sup>st</sup>.April 2010)

| Comp. | Dragline | Shovel | Dumper | Dozer | Drill | Surface Miner |
|-------|----------|--------|--------|-------|-------|---------------|
| ECL   | 1        | 58     | 245    | 72    | 44    | -             |
| BCCL  | 2        | 128    | 467    | 136   | 114   | -             |
| CCL   | 0        | 123    | 627    | 176   | 114   | -             |
| NCL   | 19       | 103    | 570    | 157   | 130   | -             |
| WCL   | 4        | 153    | 643    | 164   | 111   | -             |
| SECL  | 9        | 56     | 371    | 152   | 103   | -             |
| MCL   | 5        | 70     | 337    | 101   | 57    | 4             |
| CIL   | 40       | 691    | 3,260  | 958   | 673   | 4             |