GATE 2027
MINING ENGINEERING (MN)

DAY - 1

"Big Mines Build a Better Tomorrow"

MINING METHODS

SURFACE MINING Fundamentals & Layout

Surface mining principles, mine layout, benches, pit geometry, working areas, mine development

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Mine Knowledge Today A Better Tomorrow

1. What is Surface Mining ?

- Surface mining is a method of extracting minerals from near-surface deposits by removing overburden and exposing the ore at the surface.
- Used for coal, metal and non-metal minerals occurring at shallow depths.
- Involves removal of overburden, excavation of mineral, loading, transportation and reclamation.

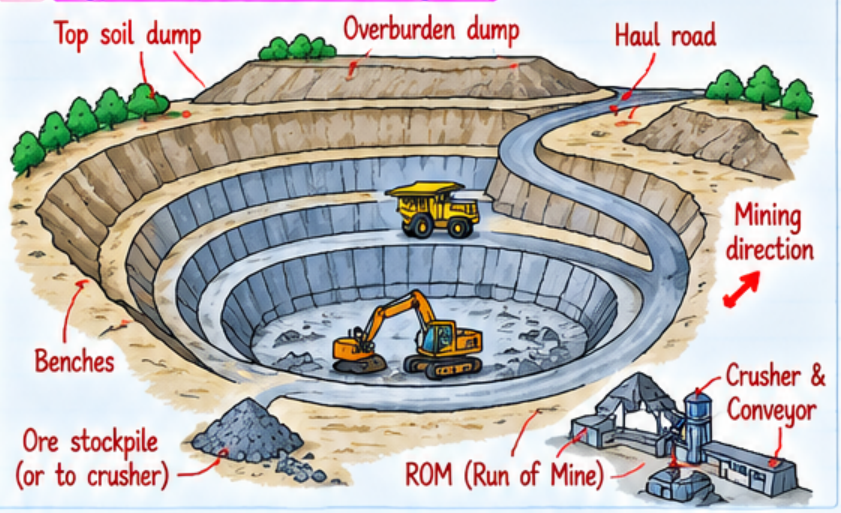
2. Principles of Surface Mining

- Maximum recovery of mineral.
- Minimum cost per unit of production.
- Safe and efficient operations.
- Proper slope stability and ground control.
- Minimum environmental impact.
- Systematic mine planning and development.
- Integration of mining, hauling and dumping operations.

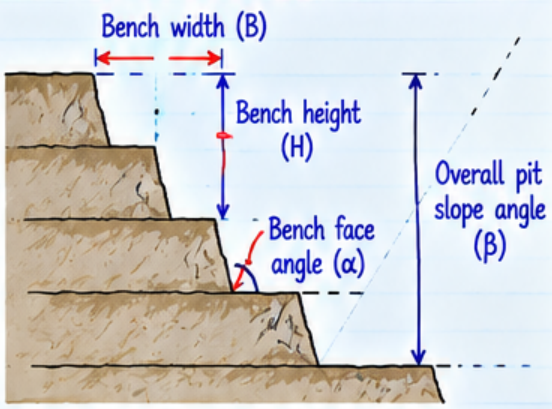
3. Advantages and Limitations

Advantages	Limitations
✓ Low cost of production.	✗ Applicable only to shallow deposits.
✓ High rate of production.	✗ Large land requirement.
✓ Use of large machinery and high mechanization.	✗ Environmental impact.
✓ Better working conditions. and safety.	✗ High initial investment.
✓ Easy supervision and control.	✗ Slope stability problems.
✓ Higher recovery.	✗ Requires major overburden handling.

4. Typical Open-Pit Mine Layout



5. Bench Terminology and Geometry



Important Relations

$$B = \frac{H}{\tan \alpha}$$

Overall slope angle,

$$\beta = \tan^{-1}\left(\frac{H}{B_s}\right)$$

No. of benches,

$$N = \frac{H_{total}}{H}$$

Strip ratio = $\frac{\text{Volume of overburden}}{\text{Volume of mineral}}$

6. Working Areas in Surface Mines



7. Mine Development (Surface)

- Removal of top soil and vegetation.
- Construction of access roads and haul roads.
- Development of initial pits, ramps and benches.
- Arrangement of drainage system.
- Creation of dumping areas.
- Setting up of crushing and conveying systems.
- Progressive deepening and lateral expansion.
- Final mine closure and reclamation.

8. GATE Level MCQs

Q1. Which parameter is NOT a design consideration in open-pit mine layout?
(a) Bench height
(b) Bench width
(c) Face advance rate
(d) Overall slope angle

Ans: (c)

Q2. Overall pit slope angle depends mainly on:
(a) Bench height
(b) Rock strength
(c) Haul road width
(d) Crusher capacity

Ans: (b)

Q3. Strip ratio is defined as:
(a) Ore/Overburden
(b) Overburden/Ore
(c) Bench height/Bench width
(d) Total depth/Bench height

Ans: (b)

Mines Create Resources, Knowledge Creates Opportunities

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MINING ENGINEERING (MN)

MINING METHODS

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DAY - 2

HAUL ROAD DEVELOPMENT

"Good Roads Move Big Mines Forward"

Haul-road alignment, gradients, width, curves, drainage, road construction, safety, numericals

Better Mining Through Better Planning

1. Importance of Haul Roads

- Connects loading, dumping and other working areas.
- Affects production cost and cycle time.
- Should be safe, all-weather and durable.
- Proper design reduces maintenance cost.
- Essential for efficient mine operation.

2. Factors Affecting Haul-Road Design

- Truck size and axle load.
- Traffic volume (unidirectional / bidirectional).
- Terrain and geology.
- Gradient and curvature.
- Drainage and climate (rainfall).
- Type of surface and construction material.
- Safety and visibility.

3. Haul-Road Alignment

- Shortest and most economical route.
- Follows natural contours (to reduce cut & fill).
- Avoids unstable slopes, weak zones and water bodies.
- Provides gentle gradients and minimum curves.
- Should allow for future expansion.

4. Gradient (Grade)

- Gradient = $\frac{\text{Rise}}{\text{Horizontal distance}} \times 100$ (%)
- Generally 6% – 10% for large dump trucks.
- Maximum 10% (sometimes up to 12% in special cases).
- Use switchbacks in hilly terrain.
- Down grades should be gentler for safety.

Gradient (G)

$$G = \frac{H}{L} \times 100$$

H = Vertical rise (m)
L = Horizontal distance (m)

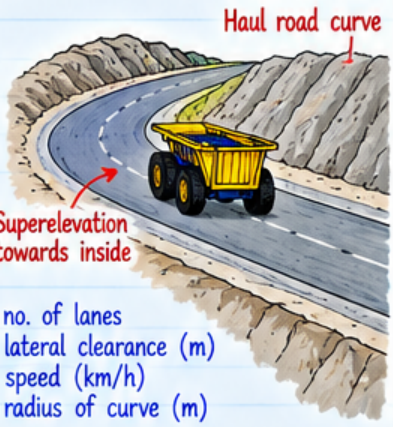
5. Road Width

- Minimum width depends on truck width.
- For two-way traffic: $W = 2T + C$

T = Truck width
C = Clearance (0.5 to 1.0 T)

- For one-way traffic: $W = T + C$
- Typical values: Clearance = 0.5T to 1.0T

6. Curves (Horizontal)



- Large radius to ensure safe movement.
- Minimum radius (R) depends on truck speed, width and superelevation.
- Typical minimum radius: 3 to 5 times the truck wheelbase.
- Provide extra width on curves.
- Avoid sharp curves; use spiral curves if possible.

Extra width (E)

$$E = n\left(l + \frac{V^2}{127R}\right)$$

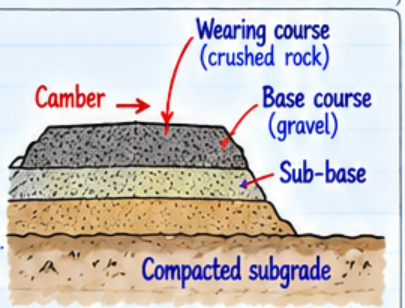
n = no. of lanes
l = lateral clearance (m)
V = speed (km/h)
R = radius of curve (m)

7. Drainage



- Provide side drains and cross drains.
- Camber (cross slope) 2% – 4% for water runoff.
- Catch water from higher slopes.
- Use culverts at natural drainage lines.
- Proper drainage increases road life.

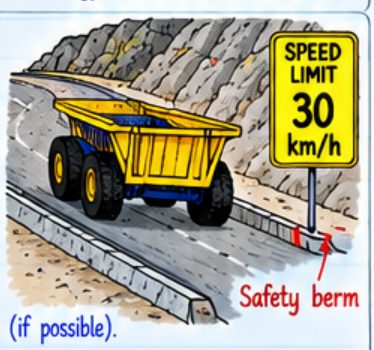
8. Road Construction



Typical section of haul road

- Clear vegetation and loose material.
- Form subgrade and provide proper compaction.
- Use suitable materials: overburden, gravel, crushed rock.
- Provide wearing course for heavy traffic.
- Maintain proper camber and drainage.
- Regular maintenance (grading, compaction, water sprinkling).

9. Safety Measures



- Adequate width and gentle gradients.
- Proper signages (speed limits, warnings).
- Safety berms on outer edges (height ≥ 0.5 × tyre dia).
- Regular inspection and maintenance.
- Proper lighting for night operation.
- Dust control (water sprinkling).
- Drainage to avoid slippery conditions.
- Separate roads for heavy and light vehicles (if possible).
- Train drivers and follow traffic rules.

10. Numerical Example

A haul road has a vertical rise of 60 m over a horizontal distance of 1.2 km. Calculate the gradient. If the truck width is 4.0 m, find the minimum road width for two-way traffic taking clearance as 0.6T.

Solution:

Gradient, $G = \frac{60}{1200} \times 100 = 5\%$

Road width, $W = 2T + C = 2(4.0) + 0.6(4.0) = 11.2$ m

Ans: Gradient = 5% , Width = 11.2 m

11. GATE Level MCQs

Q1. The usual maximum gradient for large dump trucks in surface mines is:

(a) 2% (b) 5%
(c) 10% (d) 15%

Ans: (c)

Q2. Extra width on a horizontal curve in a haul road mainly depends on:

(a) Road gradient
(b) Truck width and speed
(c) Road camber
(d) Type of rock

Ans: (b)

Q3. The purpose of providing camber on haul roads is to:

(a) Increase gradient
(b) Improve hauling speed
(c) Drain off surface water
(d) Increase bearing capacity

Ans: (c)

"Well Designed Haul Roads = Higher Productivity + Lower Cost + Safer Mines"

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MINING ENGINEERING (MN)

DAY - 3

MINING METHODS

LOADING EQUIPMENT

Shovels, hydraulic excavators, draglines, loaders, bucket capacity, digging cycle, productivity

"Right Equipment Loads Success"

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Mining Knowledge Today A Better Tomorrow

1. Role of Loading Equipment

- Used to excavate, loosened material and load it into trucks, rail wagons or conveyors.
- Major factor affecting mine productivity and cost.
- Selection depends on material, production rate, haulage system and mine conditions.

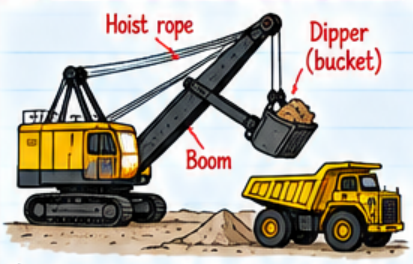
2. Types of Loading Equipment

- Mechanical shovels (rope shovel)
- Hydraulic excavators (backhoe & front shovel)
- Draglines (cable operated)
- Wheel loaders (front-end loaders)
- Others: scrapers, dozers (for short hauls)

3. Selection Criteria

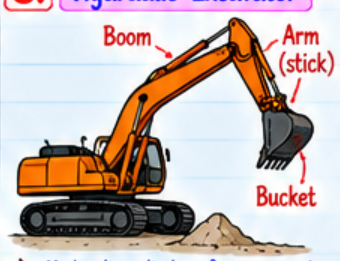
- Nature of material (overburden/ore)
- Production requirement
- Depth and height of cut
- Haulage system (truck/rail/conveyor)
- Maneuverability and space availability
- Operating cost and maintenance
- Flexibility and future expansion

4. Mechanical Shovel (Rope Shovel)



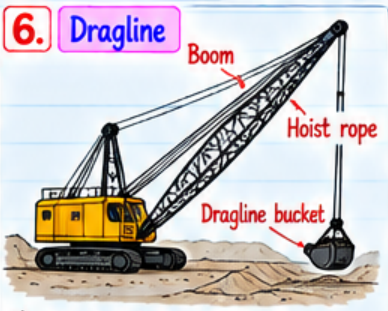
- Uses wire ropes for hoisting and crowding.
- Suitable for hard, compact materials.
- High production capacity.
- Used in large surface mines.
- Types: Face shovel, Backhoe shovel.

5. Hydraulic Excavator



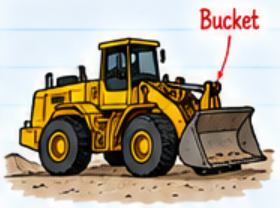
- Hydraulic cylinders for movement.
- Flexible and highly maneuverable.
- Suitable for a wide range of materials.
- Types: Backhoe (common), Front shovel (for higher bench).
- Widely used due to versatility and lower cost.

6. Dragline



- Uses long boom and wire ropes.
- Suitable for soft to medium hard materials (overburden).
- Used in large, low-cost removal jobs.
- High bucket capacity and long reach.
- Common in coal and overburden removal.

7. Wheel Loader



- Rubber tyred, high mobility.
- Used for short distance loading and stockpiling.
- Suitable for loose, free digging materials.
- Common in small and medium mines and auxiliary work.

8. Bucket Capacity

Theoretical bucket capacity (m^3) :

$$V_t = \frac{B \times W \times H \times K}{1000}$$

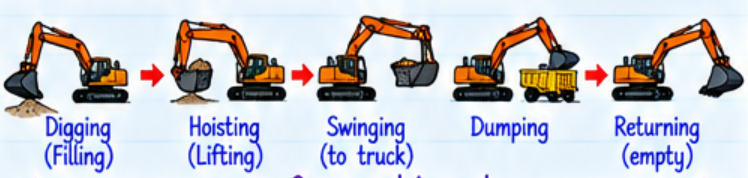
Actual (effective) bucket capacity :

$$V = V_t \times F$$

B = bucket width (m)
W = bucket density/width factor (m)
H = bucket height (m)
K = bucket shape factor (0.8 – 1.1)
F = fill factor (0.7 – 0.9)

Typical fill factor:
Loose material : 0.9
Blasted rock : 0.7 – 0.8

9. Digging Cycle of a Shovel / Excavator



Cycle Time (T_c)

$$T_c = t_d + t_h + t_s + t_p + t_r$$

t_d = digging time
t_h = hoisting time
t_s = swinging time
t_p = dumping time
t_r = return time

10. Productivity

Hourly production (Q) :

$$Q = \frac{V \times 3600 \times E}{T_c} \quad (m^3/h)$$

V = actual bucket capacity (m^3)
E = operating efficiency (0.7 – 0.9)
T_c = cycle time (s)

Operating Efficiency (E)

- Mechanical availability
- Operator efficiency
- Job efficiency (swing angle, truck positioning, etc.)
- Usually 0.7 – 0.9

Typical Productivity Range

Equipment	Production (m^3/h)
Rope shovel	500 – 4000
Hydraulic excavator	200 – 2000
Dragline	1000 – 10000
Wheel loader	100 – 1000

11. Numerical Example

A hydraulic excavator has a bucket of width 2.0 m, height 1.5 m, bucket shape factor 1.0 and fill factor 0.8. The cycle time is 30 s. and operating efficiency is 0.75. Calculate the hourly production.

Solution:

$$V_t = \frac{2.0 \times 2.0 \times 1.5 \times 1.0}{1000} = 0.006\ m^3$$

$$V = 0.006 \times 0.8 = 0.0048\ m^3$$

$$Q = \frac{0.0048 \times 3600 \times 0.75}{30} = 0.432\ m^3/s = 1555\ m^3/h$$

Ans: 1555 m^3/h

12. GATE Level MCQs

Q1. Which of the following is most suitable for removal of large quantities of overburden in soft material with long reach?
(a) Hydraulic excavator
(b) Rope shovel
(c) Dragline
(d) Wheel loader

Ans: (c)

Q2. Fill factor for a shovel in blasted rock is typically in the range:
(a) 0.3 – 0.5
(b) 0.5 – 0.6
(c) 0.7 – 0.8
(d) 0.9 – 1.0

Ans: (c)

Q3. Which time is NOT a part of the digging cycle?
(a) Digging time
(b) Swinging time
(c) Loading time
(d) Return time

Ans: (c)

Efficient Loading → Higher Production → Lower Cost → Successful Mining

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MINING ENGINEERING (MN)

DAY - 4

"Efficient Transportation Drives Profitable Mining"

MINING METHODS

TRANSPORTATION SYSTEMS

Trucks, conveyors, rail transport, crushers, truck-shovel system, transport selection, haulage calculations

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1. Role and Importance

- Transfers mineral from face to crusher, stockpile or plant.
- Major part of mining cost (20 – 60%).
- Affects production rate and overall economics.
- Choice depends on distance, capacity, terrain, material and mine life.

2. Requirements of an Ideal System

- High capacity and reliability.
- Low cost per tonne-km.
- Suitable for mine conditions (gradient, curves, climate).
- Flexible and expandable.
- Safe and environmentally friendly.
- Minimum maintenance.

3. Types of Transportation Systems

1. Truck haulage (dump trucks)
2. Conveyor transport
3. Rail transport
4. Crusher and in-pit crushing
5. Truck-shovel system
6. Combination systems (truck + conveyor, truck + rail etc.)

4. Trucks (Dump Trucks)



- High mobility and flexible.
- Suitable for short to medium hauls (up to 5–7 km).
- Types: Rigid frame and Articulated trucks.
- Capacity: 30 – 400 tonnes.
- Used in most surface mines.

5. Conveyors



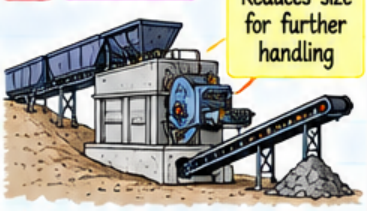
- Suitable for high capacity and long distance.
- Low operating cost.
- Can handle steep gradients (with troughed / pipe conveyors).
- Types: Belt conveyor, Pipe conveyor.
- Used for overburden and mineral.

6. Rail Transport



- Suitable for very large capacity and long distance.
- Low cost per tonne-km.
- High initial investment.
- Used in large surface mines.
- Types: Conventional rail and In-pit rail systems.

7. Crushers



- Types: Primary, Secondary, Tertiary crushers.
- Located at pit bottom or surface.
- Allows use of conveyors and smaller transport equipment.
- Increases overall efficiency.

8. Truck – Shovel System



- Most common surface mining system.
- Shovel loads truck, which transports to crusher/stockpile.
- Match shovel and truck sizes for maximum productivity.
- Factors: bucket capacity, cycle time, truck capacity, haul distance, match factor.

9. Selection of Transport System

Factor	Considerations
Distance	Trucks (short), Conveyors/Rail (long)
Production rate	High capacity systems for large output
Topography	Gradient, curves, ground conditions
Material characteristics	Size, density, abrasiveness, moisture
Initial and operating cost	Capital vs life cycle cost
Flexibility	Trucks (high), Conveyors (low)
Mine life	Short term – trucks, Long term – conveyors/rail
Environment	Dust, noise, emissions
Safety	Traffic management, stability, visibility

10. Haulage Calculations

1. Cycle Time (T_c)

$$T_c = t_l + t_h + t_d + t_r$$

t_l = loading time
t_h = haulage time
d_d = dumping time
t_r = return time

2. Haulage Time (t_h)

$$t_h = \frac{D}{V}$$

D = one way distance (km)
V = average speed (km/h)

3. Hourly Production (Q)

$$Q = \frac{60 \times C}{T_c \times E} \ (m^3/h)$$

C = truck capacity (m^3)
E = operating efficiency

11. Numerical Example

A dump truck has a capacity of 60 m^3. Loading time = 2 min, haul distance = 3 km (speed = 30 km/h), dumping time = 1 min, return speed = 40 km/h. Operating efficiency = 0.8. Calculate the hourly production.

Solution :

Haulage time = $\frac{3}{30} \times 60 = 6$ min

Return time = $\frac{3}{40} \times 60 = 4.5$ min

Cycle time = $2 + 6 + 1 + 4.5 = 13.5$ min

$$Q = \frac{60 \times 60}{13.5 \times 0.8} = 213.3 \ m^3/h$$

Ans: 213.3 m^3/h

12. GATE Level MCQs

Q1. Which transport system is most suitable for very large capacity and long distance in surface mines?
(a) Dump trucks
(b) Belt conveyors
(c) Articulated trucks
(d) Wheel loaders

Ans: (b)

Q2. In a truck-shovel system, productivity mainly depends on:
(a) Shovel bucket capacity
(b) Truck capacity and cycle time
(c) Crusher size
(d) Road width

Ans: (b)

Q3. Which factor is most important in selecting a transport system?
(a) Colour of equipment
(b) Haulage distance
(c) Type of fuel used
(d) Operator skill

Ans: (b)

Right Transport System → Higher Productivity → Lower Cost → Sustainable Mining

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MINING METHODS

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DAY - 5

SURFACE MINE MECHANIZATION

"Mechanization Today Higher Production Tomorrow"

Mechanization principles, equipment matching, productivity, utilization, availability, equipment selection

Mining Knowledge Today A Better Tomorrow

1. What is Mechanization ?

- Mechanization is the use of mechanical equipment for excavation, loading, transportation and ancillary operations in surface mines.
- It replaces manual/animal power, increases production and safety.
- Involves proper selection, matching and maintenance of equipment.

2. Objectives / Principles

- Maximum production at minimum cost.
- Proper matching of equipment.
- High availability and utilization.
- Minimum idle time and cycle time.
- Suitability to mine conditions (material, gradient, haul distance).
- Flexibility for future expansion.
- Safe, reliable and efficient operation.

3. Factors Affecting Mechanization

- Nature of material (hardness, abrasiveness).
- Production target.
- Stripping ratio.
- Mine layout, bench height and width.
- Haul distance and gradient.
- Size and capacity of equipment.
- Availability of power, fuel and water.
- Economic factors (capital and operating cost).
- Maintenance and spares support.

4. Major Mechanized Operations

1. Drilling and blasting
2. Excavation / Loading
3. Transportation (Haulage)
4. Crushing and screening
5. Conveying and stacking
6. Dozing and grading
7. Ancillary operations (water spraying, lighting, workshops, etc.)

5. Typical Equipment in Surface Mines

Drill



For blast hole drilling

Shovel (Rope / Hydraulic)



For loading

Dump Truck



For transportation

Dozer



For dozing and grading

Crusher



For size reduction

Conveyor



For continuous transport

6. Equipment Matching

- Capacity of loading and hauling equipment should be matched.
- Avoid idle time of either unit.
- Consider cycle time, bucket/truck capacity, swell factor and match factor.
- Proper matching increases productivity and reduces operating cost.

7. Important Performance Terms

Term	Meaning
Productivity (Q)	Actual output per unit time (m^3/h or t/h)
Theoretical capacity	Maximum possible output under ideal conditions
Utilization (U)	Actual working time / Available time
Availability (A)	Time equipment is ready for use
Efficiency (E)	U × A
Match factor	Ratio of units (e.g., no. of trucks per shovel)
Cycle time (T_c)	Time to complete one operating cycle

8. Key Formulas

1. Hourly Production:

$$Q = \frac{3600 \times q \times F \times E}{T_c}$$

q = bucket/truck capacity (m^3)
F = fill factor
E = operating efficiency
T_c = cycle time (s)

2. Operating Efficiency: $E = U \times A$

3. Match Factor (N):

$$N = \frac{T_h + T_r}{T_s}$$

T_h = hauling time
T_r = return time
T_s = shovel cycle time

9. Selection of Equipment

- Based on production requirement.
- Suitability to ground conditions.
- Availability and versatility.
- Capital and operating cost.
- Maintenance and spares.
- Compatibility and future expansion.
- Manufacturer support and service.

10. Advantages and Limitations

Advantages	Limitations
✓ High rate of production.	✗ High initial investment.
✓ Lower unit cost.	✗ Skilled operators required.
✓ Reduced manual labour.	✗ Maintenance and spares cost.
✓ Safer operations.	✗ Less flexible for small operations.
✓ Better control and precision.	✗ Dependent on power and fuel.
✓ Continuous and reliable output.	✗ Not economical for very small mines.

11. Numerical Example

A hydraulic excavator with bucket capacity of 3.0 m^3 has a cycle time of 30 s. Fill factor = 0.9 and operating efficiency = 0.83. Calculate the hourly production.

Solution :

$$Q = \frac{3600 \times 3.0 \times 0.9 \times 0.83}{30} = 268.92\ m^3/h \approx 269\ m^3/h$$

Ans: 269 m^3/h

12. GATE Level MCQs

Q1. Which factor is most important in matching a shovel and truck?
(a) Bucket capacity only
(b) Truck speed only
(c) Cycle time and capacity of both
(d) Haul road width
Ans: (c)

Q2. Equipment availability is defined as:
(a) Actual working time / Scheduled time
(b) Time ready for use / Total time
(c) Actual output / Theoretical output
(d) Operating efficiency of equipment
Ans: (b)

Q3. Increase in operating efficiency will:
(a) Decrease productivity
(b) Increase productivity
(c) Have no effect
(d) Increase cycle time
Ans: (b)

Right Mechanization Builds Profitable Mines

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DAY - 6

"Continuous Technology for a Sustainable Tomorrow"

MINING METHODS

CONTINUOUS MINING SYSTEMS

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Mining Knowledge Today A Better Tomorrow

Continuous excavation, bucket-wheel systems, surface continuous mining, conveyors, system layout, applications

1. What are Continuous Mining Systems ?

- A method of excavation, loading, transportation and sometimes dumping carried out in a continuous and integrated manner.
- Material is cut, conveyed and transported without interruption.
- Commonly used in large surface mines (coal, lignite, soft minerals, overburden).
- Provides high production rate, low unit cost and reduced manual labour.

2. Components of a Continuous Mining System

1. Excavation unit (e.g., bucket-wheel, continuous miner).
2. Material handling system (conveyors).
3. Transfer stations and crushers (if required).
4. Stacking or direct dumping system.
5. Power supply and control system.

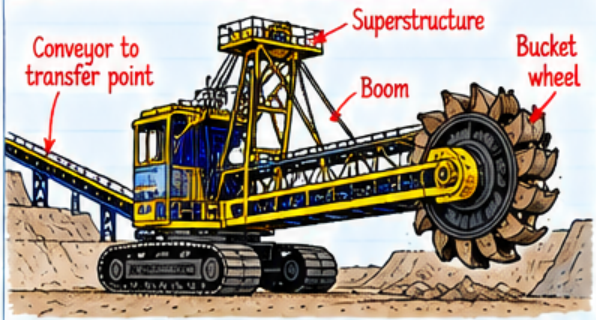
3. Advantages

- ✓ Very high production capacity.
- ✓ Low unit operating cost.
- ✓ Continuous and smooth operation.
- ✓ Less manual labour.
- ✓ Suitable for large-scale operations.
- ✓ Environmentally better (less haul traffic, less dust).

Limitations

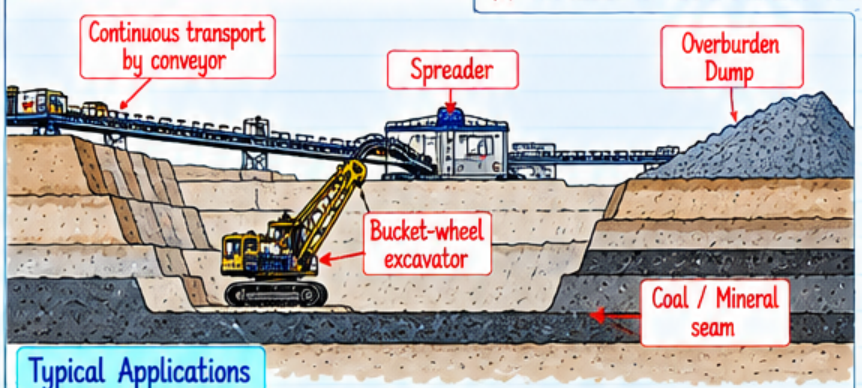
- ✗ Very high initial capital cost.
- ✗ Suitable mainly for overburden/soft materials.
- ✗ Less flexible than conventional systems.
- ✗ Not suitable for hard and abrasive rocks.

4. Bucket-Wheel Excavator (BWE)



- Used for large-scale surface mining (coal, lignite, overburden).
- Rotating wheel with multiple buckets excavates the material.
- Material falls on to an inbuilt conveyor and is transported continuously.
- Suitable for soft to medium hard strata.
- Very high production rate (up to 10,000 m^3/h or more).

5. Surface Continuous Mining System



Typical Applications

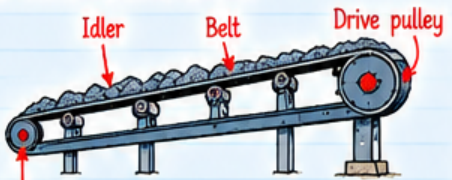
- Large coal and lignite mines (e.g., Germany, Australia, India).
- Removal of thick overburden in opencast mines.
- Mining of soft minerals (phosphates, bauxite, lignite, etc.).
- Land reclamation and large civil works.

6. Continuous Miner (for softer rocks)



- Self-propelled machine with rotating cutting head.
- Used for soft coal, lignite and weak rocks.
- Material is loaded directly on to an inbuilt conveyor.
- Provides continuous cutting and loading.
- Commonly used in surface and underground coal mines.

7. Conveyor Systems



- Most common transport system in continuous mining.
- Suitable for large capacity and long distance.
- Can be overland, in-pit or curved alignment.
- Lower operating cost compared to trucks/rail.
- Types: Fixed, Mobile, In-pit, Pipe conveyors.

8. System Layout (Typical)

Excavation (BWE / Continuous Miner)
↓
Conveyor System
↓
Transfer Station (If required)
↓
Crusher (If required)
↓
Long Distance Conveyor
↓
Stacker / Spreader
↓
Dump / Stockpile

9. Important Performance Parameters

Parameter	Description
Production capacity (Q)	Volume or mass excavated per hour (m^3/h or t/h)
Utilization (U)	Actual working time / Available time
Availability (A)	Time equipment is ready for operation
Efficiency (E)	U × A
Specific energy	Energy consumption per unit volume (kWh/m^3)
Cutting rate	Volume excavated per unit time by cutting head
Conveyor capacity	Depends on belt width, speed and bulk density

10. Simple Conveyor Capacity Formula

$$Q = 3600 \times A \times v \times \rho \times k \quad (t/h)$$

A = cross-sectional area of material on belt (m^3)
v = belt speed (m/s)
ρ = bulk density of material (t/m^3)
k = loading factor (0.7 - 0.9)

Example :
Belt width = 1.2 m, material area A = 0.3 m^2, belt speed = 3 m/s, bulk density = 1.6 t/m^3, k = 0.8. Find conveyor capacity.

Solution : $Q = 3600 \times 0.3 \times 3 \times 1.6 \times 0.8$
$= 4147.2$ t/h ≈ 4150 t/h

11. GATE Level MCQs

Q1. Bucket-wheel excavators are mainly used for:
(a) Hard rock mining
(b) Underground mining
(c) Large-scale surface mining
(d) Shaft sinking

Ans: (c)

Q2. Which parameter is defined as the ratio of actual working time to available time?
(a) Availability
(b) Utilization
(c) Efficiency
(d) Capacity

Ans: (b)

GATE 2027
MINING ENGINEERING (MN)

DAY - 7

"Extract More
Recover Better
Mine Smarter"

MINING METHODS

HIGHWALL MINING

Highwall mining principles, layout, equipment, remotely operated systems, coal recovery, advantages & limitations

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1. What is Highwall Mining ?

- A surface mining method used to extract coal from a steeply inclined or vertical seam exposed in a highwall (bench / pit wall).
- No direct entry of manpower in the seam (remotely operated).
- Coal is cut and loaded from the surface using remote-controlled equipment.
- Commonly used in thick, flat to gently dipping coal seams.
- Provides a safe, low-cost and high productivity method for coal extraction.

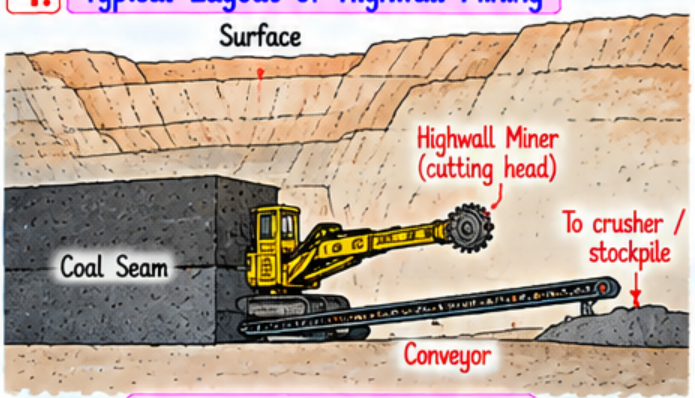
2. Principles

- Utilizes exposed coal seam in pit highwall.
- Coal is cut horizontally into the seam using a highwall miner.
- Material is removed and conveyed to the surface.
- Operated remotely from a safe distance.
- Applicable where surface mining is economical but traditional equipment cannot reach the seam.
- Maximizes recovery of coal left in highwalls after surface mining.

3. Suitable Conditions

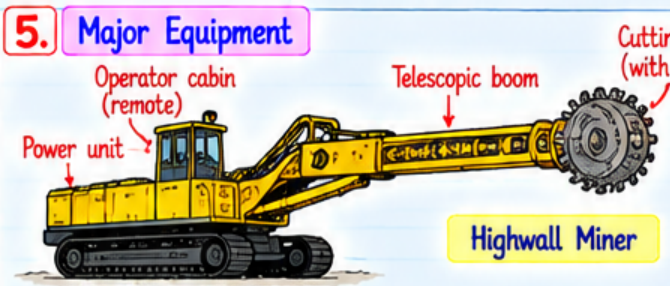
- Coal seam exposed in a highwall of an open-cast mine.
- Seam thickness typically 1.5 – 6 m (usually 2 – 5 m).
- Dip angle: 0° – 20° (preferably < 15°).
- Competent roof and floor.
- Adequate highwall height (> seam height).
- Stable pit wall with minimal geological disturbances.

4. Typical Layout of Highwall Mining



Schematic layout of Highwall Mining

5. Major Equipment



- Highwall miner (continuous miner type with horizontal cutting head)
- Remote control system (radio/telemetry)
- Conveyor system (on-board and external)
- Crusher (if required)
- Stacker (for stockpiling)
- Auxiliary equipment (dozer, grader, water spray, lighting etc.)

6. Remotely Operated Systems

- Entire operation is controlled from a remote location (safe distance from highwall).
- Radio remote control with video monitoring.
- No personnel in the cutting zone.
- Equipped with cameras, sensors and automated functions.
- Improves safety, productivity and allows operation in high-risk areas.



Remote Control Operation

Key Features:

- ✓ Real-time video monitoring
- ✓ Wireless communication
- ✓ Emergency shutdown system
- ✓ Can operate in dusty and hazardous conditions
- ✓ Single operator can control the entire operation

7. Coal Recovery

- Helps to recover coal left in highwalls after conventional surface mining.
- Recovery depends on seam thickness, seam continuity and highwall stability.
- Typical recovery: 50% – 80% of the coal in the highwall area.
- Reduces coal loss and improves overall mine economics.

8. Advantages

- ✓ High recovery of residual coal.
- ✓ Safe (no manpower in cutting zone).
- ✓ High productivity and low operating cost.
- ✓ Suitable for thick seams.
- ✓ Can be operated in difficult and hazardous conditions.
- ✓ Environmentally better (less overburden movement).
- ✓ Flexible and easily relocatable.

9. Limitations

- ✗ Applicable only where seam is exposed in highwall.
- ✗ Not suitable for thin, highly inclined or disturbed seams.
- ✗ High initial investment.
- ✗ Requires stable highwall and good geotechnical conditions.
- ✗ Limited selectivity (may cut parting).
- ✗ Not suitable in weak roof/floor conditions.
- ✗ Restricted to surface mining stages.

10. GATE Level MCQs

Q1. Highwall mining is most suitable for coal seams with dip angle:

(a) 0° – 20° (b) 20° – 35°
(c) 35° – 55° (d) > 55°

Ans: (a)

Q2. Which of the following is typically used foo remotely operating a highwall miner?

(a) Hydraulic joystich in cabin
(b) Radio remote control
(c) Electric tethered cable
(d) Pneumatic control

Ans: (b)

Q3. Typical coal recovery in highwall mining ranges from:

(a) 10% – 30% (b) 30% – 50%
(c) 50% – 80% (d) 80% – 100%

Ans: (c)

Recover Residual Resources → Improve Mine Economics → Safer & Smarter Mining

GATE 2027
MINING ENGINEERING (MN)

DAY - 8

"Strong Pillars Support Bright Futures"

MINING METHODS

UNDERGROUND COAL MINING

BORD & PILLAR

Development, panels, pillars, room-and-pillar layouts, pillar design concepts, depillaring, extraction ratios

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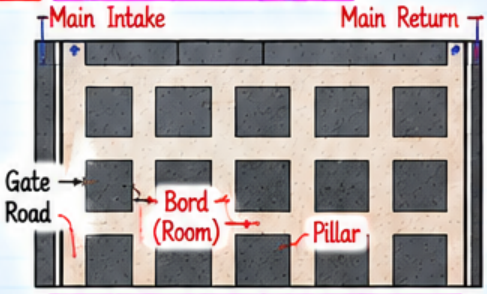
1. Introduction

- Bord and pillar is the most widely used underground coal mining method.
- Coal is extracted in a series of rooms (Bords) leaving coal pillars to support the roof.
- Can be applied to flat and gently inclined seams.
- Simple, flexible and low-cost method.

2. Development

- Main entries (intake and return) are driven from surface to the seam.
- Gate roads are developed along the panel.
- Crosscuts are driven to divide the panel into blocks.
- Room development (bords) is carried out leaving pillars.
- Ventilation and haulage roads are maintained throughout mining.

3. Typical Panel Layout



Plan view of a Bord and Pillar Panel

4. Room and Pillar Layouts

Square Layout	Staggered Layout	Diagonal Layout
Simple and common.	Better stability.	Used in weak roofs.
Easy to develop.	More uniform load distribution.	Greater stability.
Higher stability.		Difficult to develop and ventilate.

5. Pillar Design Concepts

- Pillars must be strong enough to support the overburden load.
- Affected by depth, seam thickness, pillar size and shape, and roof conditions.
- Common empirical formulae:

Salamon–Munro formula :

$$\sigma_p = K \left(\frac{W}{H} \right)^{\alpha}$$

σ_p = pillar strength (MPa)
W = pillar width (m)
H = height of pillar (m)
K, α = empirical constants
(for coal : $K \approx 7$, $\alpha \approx 0.46$)

6. Factors Affecting Pillar Strength

- Depth of cover (overburden pressure).
- Pillar width and height (width to height ratio).
- Pillar shape (square, rectangular, circular).
- Seam thickness.
- Mining method and extraction sequence.
- Roof and floor strength.
- Presence of discontinuities (joints, faults).
- Time factor (creep).
- Environmental conditions (moisture, gas).

Typical W/H Ratios for Coal Pillars

Condition	W/H Ratio
Temporary pillars	4 – 6
Permanent pillars	6 – 10
Weak roof/floor	> 8
Strong roof/floor	4 – 6

7. Depillaring

- Pillars are extracted after the main extraction to increase overall recovery.
- Methods:
  1. Retreat depillaring (most common)
  2. Pillar splitting
  3. Strip or block depillaring.
  4. Controlled depillaring
- Carried out only when roof conditions permit.
- Increases extraction ratio but also increases subsidence and ground control risk.

8. Extraction Ratio

$$\text{Extraction ratio (ER)} = \frac{\text{Area of coal extracted}}{\text{Total panel area}} \times 100$$

$$ER = \frac{A_T - A_P}{A_T} \times 100$$

A_T = total panel area (m^2)
A_P = area left in pillars (m^2)

Typical Extraction Ratios

Before depillaring : 40% – 60%
After depillaring : 60% – 80%

9. Advantages and Limitations

Advantages	Limitations
✓ Simple and widely used.	✗ Pillars left behind reduce recovery.
✓ Low development cost.	✗ Not suitable for steeply inclined seams.
✓ Flexible and suitable for varying seam conditions.	✗ Risk of roof falls and subsidence (especially after depillaring).
✓ Good recovery (with depillaring).	✗ Large surface area required.
✓ Suitable for flat and gently inclined seams.	✗ Pillar design is critical.

10. Numerical Example

A bord and pillar panel has a total area of 400 m × 300 m. Square pillars of 20 m × 20 m are left on a grid of 60 m × 60 m (center-to-center). Find the extraction ratio.

Solution : Area per pillar = 20 × 20 = 400 m^2

No. of pillars = (400/60) × (300/60) = 6.67 × 5 = 33 (approx)

Total pillar area = 33 × 400 = 13200 m^2

Total panel area = 400 × 300 = 120000 m^2

$$ER = \frac{120000 - 13200}{120000} \times 100 = 89.0\%$$

Ans: 89.0%

11. GATE Level MCQs

Q1. Bord and pillar method is most suitable for:
(a) Steeply inclined seams
(b) Flat and gently inclined seams
(c) Very thick seams
(d) Highly faulted seams

Ans: (b)

Q2. Increasing the width of a pillar will generally:
(a) Decrease its strength
(b) Increase its strength
(c) Not affect its strength
(d) Make it more prone to failure

Ans: (b)

Q3. Depillaring is done to:
(a) Increase ventilation
(b) Improve roof support
(c) Increase extraction ratio
(d) Reduce development cost

Ans: (c)

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MINING ENGINEERING (MN)

DAY - 9

"Advanced Methods
Higher Recovery
Stronger Tomorrow"

MINING METHODS

LONGWALL MINING

Longwall layout, face equipment, shearer, AFC, powered supports, retreat/advance systems, productivity

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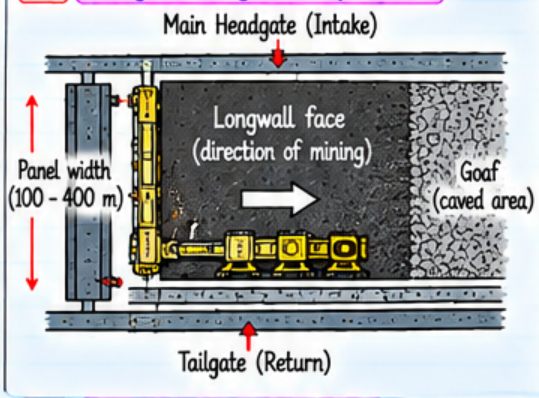
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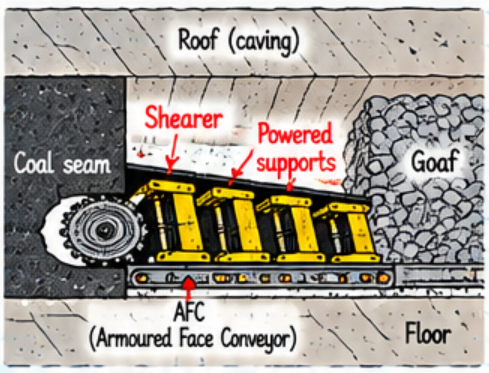
1. What is Longwall Mining ?

- A highly mechanized underground coal mining method in which a long face (100 - 400 m) is extracted using a shearer and powered supports.
- Coal is cut along the entire face and the roof is allowed to cave behind the supports.
- Provides high productivity, high recovery and low manpower.
- Most widely used method for thick and moderately thick coal seams.

2. Longwall Layout (Top View)



3. Longitudinal Section



4. Face Equipment

1. **Shearer** – cuts coal along the face (moves on AFC).
2. **AFC (Armoured Face Conveyor)** – transports coal from shearer to gate end.
3. **Powered Supports** – provide roof support and allow face advance.
4. **Gate End Conveyor** – receives coal from AFC.
5. **Ancillary Equipment** – hydraulic system, pumps, cables, controls, crushers (if required).

5. Key Equipment Details

Shearer



- Cuts coal in horizontal slices
- Travels on AFC.
- Single or double drum
- Electric / diesel / ranging arm type

Armoured Face Conveyor (AFC)



- Heavy-duty chain conveyor
- Handles high production loads
- Enclosed and robust design
- Moves with face advance

Powered Support



- Hydraulic shields
- Support roof and control caving
- Move forward with shearer cycle
- Types: Chock shield, Beam shield

Gate End System



- AFC transfers coal to gate end conveyor
- Gate end conveyor to belt/rail
- May include stage loader/crusher

6. Mining Sequence

1. Shearer cuts coal along the face.
2. Coal falls on AFC and is transported to gate end.
3. Powered supports hold the roof.
4. After cutting a slice, supports are advanced (hydraulically).
5. Process is repeated (continuous).
6. Roof behind supports is allowed to cave (goaf).

Face Advance Cycle

Cut → Transport → Advance supports → Repeat

7. Retreat vs Advance

Retreat Longwall (Most common)	Advance Longwall (less common)
✓ Mining in one direction, leaving goaf behind.	✓ Mining in forward direction (advancing).
✓ Supports move towards intake (retreating).	✓ Supports move towards new area.
✓ Widely used, safer and more efficient.	✓ Used in special situations (stress control, panel layout).

8. Productivity

$$Q = H \times L \times t \times \rho \times \eta$$

- Q = production rate (t/day)
- H = cutting height (m)
- L = face length (m)
- t = face advance per day (m/day)
- ρ = coal density (t/m³)
- η = overall system efficiency

Typical Values	
Face length (L)	100 - 400 m
Daily advance (t)	3 - 8 m/day
Production rate (Q)	5,000 - 20,000 t/day
Cutting height (H)	2 - 5 m
Face efficiency (η)	0.6 - 0.8

9. Advantages and Limitations

Advantages	Limitations
✓ Very high productivity.	✗ High initial investment.
✓ High recovery (70 - 90%).	✗ Requires regular and uniform seams.
✓ Mechanized and safer.	✗ Not suitable for very thin or highly disturbed seams.
✓ Lower unit cost.	✗ Risk of surface subsidence.
✓ Suitable for thick and moderately thick seams.	✗ Complex planning and equipment maintenance.
✓ Less manpower.	✗ Requires skilled operators.
✓ Continuous operation.	✗ Large panel size required.

10. Numerical Example

A longwall panel has face length 250 m, cutting height 3.0 m, daily advance 5 m/day. Coal density = 1.4 t/m³ and overall efficiency = 0.7. Find the daily production.

Solution :

$Q = 3.0 \times 250 \times 5 \times 1.4 \times 0.7$
$= 1837.5$ t/day

Ans: 1837.5 t/day

11. GATE Level MCQs

Q1. Which equipment in longwall mining cuts the coal?

(a) Armoured face conveyor
(b) Powered support
(c) Shearer
(d) Gate end conveyor

Ans: (c)

Q2. Longwall mining provides highest recovery because:

(a) pillars are left in the seam
(b) entire face is extracted
(c) no roof caving occurs
(d) it is used in thin seams

Ans: (b)

GATE 2027
MINING ENGINEERING (MN)

DAY - 10

"Mine Thick Seams Smarter
Recover More
Build a Better Tomorrow"

MINING METHODS

THICK SEAM MINING METHODS

Thick-seam problems, slicing, caving, multi-slice methods, horizon control, recovery and subsidence concepts

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1. What is a Thick Seam ?

- A coal seam having a thickness greater than about 3.0 m is generally considered a thick seam.
- Requires special mining methods to achieve high recovery and control dilution.
- Common in many coalfields (e.g., India, China, Australia).
- Mining thick seams is challenging due to roof control, equipment limitations and subsidence.

2. Problems in Thick Seam Mining

- Difficult roof and floor control.
- Increased risk of dilution and loss of coal quality.
- Spontaneous heating (large exposed coal surfaces).
- Gas management problems.
- Higher subsidence.
- Selection of suitable equipment.
- Economic feasibility.

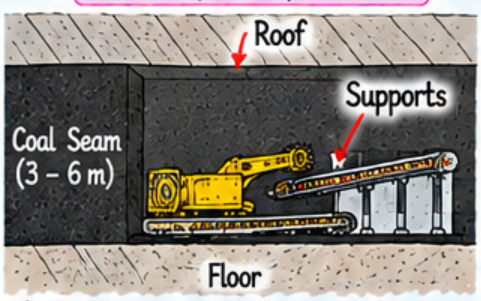
3. Classification of Thick-Seam Methods

1. Single-slice (Full-height) method
2. Multi-slice (Slicing) method
3. Top coal caving method
4. Sublevel caving method
5. Longwall top coal caving (LTCC)
6. Open stope / Chamber method (in some cases)

Choice depends on seam thickness, roof/floor conditions, equipment availability and economics.

4. Single-slice (Full-height) Mining

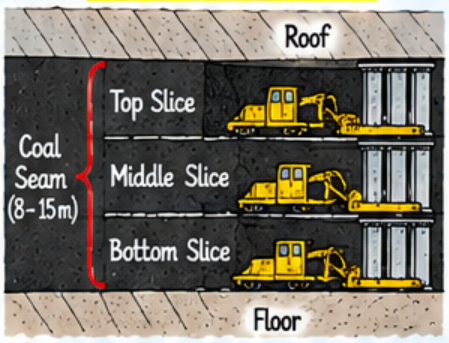
Used for moderately thick seams (3 – 6 m)



- Entire seam is mined in one operation.
- Suitable for seams up to about 6 m (depending on equipment).
- Requires high capacity equipment (e.g., large shearer or continuous miner).
- Simple method but higher roof control challenge.

5. Multi-slice (Slicing) Method

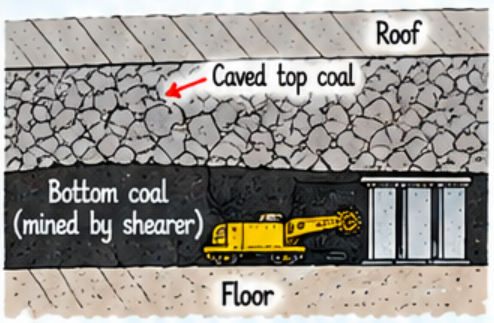
Used for very thick seams (> 6 m)



- Seam is divided into 2 or more slices.
- Each slice is mined separately.
- Provides better roof control and lower dilution.
- Commonly used for seams > 6 m.
- Can be mined in ascending or descending order.

6. Top Coal Caving Method

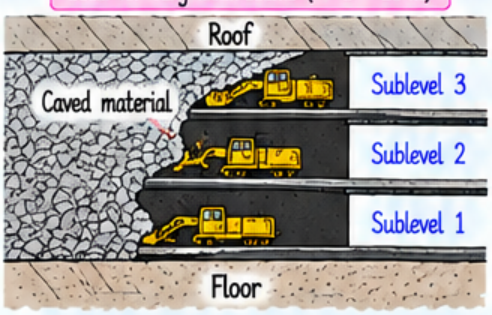
Used for thick seams with strong roof



- Bottom part of the seam is mined, top coal is allowed to cave and is recovered.
- High recovery (70 – 90%).
- Requires strong, competntet roof.
- Common in very thick seams (> 6 m).
- Examples: Longwall top coal caving (LTCC), Sublevel caving.

7. Sublevel Caving Method

Used for very thick seams (> 8 – 10 m)



- Multiple sublevels are developed.
- Coal is drilled and blasted, allowed to cave.
- Drawn from sublevels using LHDs or conveyors.
- Suitable for very thick seams and massive deposits.
- High production and good recovery.

8. Horizon Control

- Maintain proper slice thickness.
- Control deviation between slices.
- Use of roof/floor markers, drilling and surveying.
- Important to avoid dilution and to ensure maximum recovery.

9. Recovery and Subsidence

Method	Typical Recovery (%)	Subsidence
Single-slice	50 → 70	High
Multi-slice	60 → 80	Moderate
Top coal caving	70 → 90	High
Sublevel caving	70 → 90	High

10. Advantages and Limitations

Advantages	Limitations
✓ Higher recovery of coal (greater than thin seams).	✗ Complex roof control.
✓ Better utilization of resources.	✗ Higher initial investment.
✓ Suitable for large mechanized operations.	✗ Risk of dilution.
✓ Can be adapted to different geological conditions.	✗ Increased subsidence.
	✗ Requires skilled manpower and proper planning.
	✗ Not suitable for weak roof in some methods.

11. GATE Level MCQs

Q1. Which method is most suitable for a thick seam of 10 m with strong roof?

(a) Single-slice mining
(b) Multi-slice mining
(c) Top coal caving
(d) Room and pillar

Ans: (c)

Q2. In multi-slice mining, the usual order of extraction is:

(a) Middle → Top → Bottom
(b) Top → Middle → Bottom
(c) Bottom → Middle → Top
(d) Random

Ans: (b)

GATE 2027
MINING ENGINEERING (MN)

DAY - 11

"Deeper Resources
Stronger Nations
Mine the Future"

MINING METHODS

UNDERGROUND METAL MINING

OPEN STOPING

Open stoping principles, room-and-pillar/open stoping, shrinkage, sublevel/open stoping concepts, applicability

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1. What is Open Stoping ?

- A mining method used to extract metallic ore bodies where the ore occurs in large, continuous and competent bodies.
- Ore is mined in large, open spaces (stopes) without leaving permanent pillars.
- Suitable for steeply dipping and massive ore bodies.
- Higher production rate and lower cost per tonne compared to room-and-pillar.
- Commonly used for hard rock metallic minerals (Cu, Pb, Zn, Fe, Au, Ag, etc.).

2. Basic Principle

- Create an initial excavation (drift, raise or sublevel).
- Remove ore in large blocks (stopes) using drilling and blasting.
- Ore is either removed completely or partially (shrinkage).
- Rely on natural stability of the surrounding rock or artificial support.
- Stopes are mined in a sequence to maintain stability and safety.

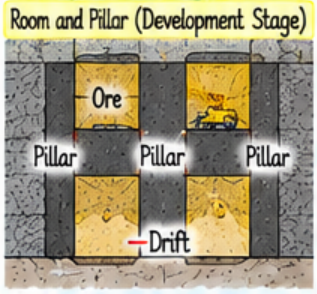
"Mine big, mine smart, let gravity do the work"

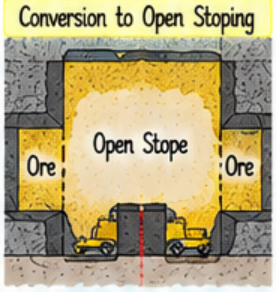
3. Types / Variants of Open Stoping

1. Conventional Open Stoping (simple open stope)
2. Room-and-Pillar to Open Stoping (transition method)
3. Shrinkage Stoping
4. Sublevel Stoping
5. Sublevel Caving
6. Cut and Fill Stoping (for comparison)

Choice depends on ore body geometry, rock strength, ore value, and economic viability.

4. Room-and-Pillar / Open Stoping





- Initially, ore is extracted in rooms leaving pillars for support.
- Later, pillars may be extracted to convert to open stoping.
- Suitable for irregular or weaker ore bodies.

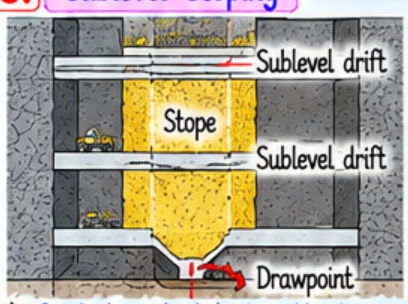
- After establishing stability, pillars are removed.
- Creates a large open void (stope).
- Improves recovery.

5. Shrinkage Stoping



- Broken ore is left in the stope as working platform.
- Ore is drawn from the bottom (drawpoints).
- Provides good ground support.
- Suitable for steeply dipping, competent ore bodies.
- Recovery: 60 – 80%.

6. Sublevel Stoping



- Ore body is divided into sublevels (20 – 50 m apart).
- Long-hole drilling from sublevels.
- Ore is extracted from bottom drawpoints.
- High productivity and suitable for large ore bodies.
- Recovery: 70 – 90%.

7. Sublevel Open Stoping vs Sublevel Caving





- Ore is supported by rock walls.
- No intentional caving of hanging wall.
- Suitable for competent ore bodies.
- Higher recovery and lower dilution.

- Hanging wall is allowed to cave.
- Suitable for large, low-grade ore bodies.
- Higher production rate.
- Lower selectivity, higher dilution.
- Used in very competent rock masses.

8. Applicability

- ✓ Large, continuous and steeply dipping ore bodies.
- ✓ Competent and stable rock conditions.
- ✓ Moderate to high grade ores (e.g., Cu, Zn, Pb, Fe, Au).
- ✓ Depths where natural rock support is adequate.
- ✓ When high production and high recovery are required.
- ✓ Commonly used in hard rock metallic mining.

9. Advantages and Limitations

Advantages	Limitations
✓ High productoun rate.	✗ Requires strong and competent host rock.
✓ High recovery (60 – 90%).	✗ Risk of dilution (especially in caving variants).
✓ Lower mining cost.	✗ Not suitable for weak or highly fractured ore bodies.
✓ Simple and flexible method.	✗ Requires careful stope design and sequence.
✓ Requires less development compared to some other methods.	✗ Risk of ground instability and subsidence.
✓ Can be mechanized.	

10. Typical Recovery Values

Method	Recovery (%)
Room-and-Pillar (initial)	40 – 60
Open Stoping (conventional)	60 – 80
Shrinkage Stoping	60 – 80
Sublevel Stoping	70 – 90
Sublevel Caving	70 – 90

11. GATE Level MCQs

Q1. Shrinkage stoping is most suitable for:

(a) Flat lying thin seams
(b) Steeply dipping, competent ore bodies
(c) Weak and highly fractured ore bodies
(d) Low grade bulk deposits

Ans: (b)

Q2. Which of the following gives the highest recovery in metal mining?

(a) Room-and-pillar
(b) Shrinkage stoping
(c) Sublevel stoping
(d) Cut and fill stoping

Ans: (c)

GATE 2027
MINING ENGINEERING (MN)

DAY - 12

MINING METHODS

SUPPORTED STOPING METHODS

SAR TUTORIAL ACADEMY HYDERABAD

Learn Prepare Achieve

"Support Today Stronger Mines Brighter Tomorrow"

Cut-and-fill, square-set, stull/open supported methods, timber/support requirements, applicability

Mining Knowledge Today A Better Tomorrow

1. What are Supported Stoping Methods ?

- Mining methods in which artificial supports are provided to support the roof and hanging wall during extraction of ore.
- Used where the rock is weak, fractured or cannot stand without support.
- Allows extraction in a controlled manner with higher safety.
- Common methods: Cut-and-fill, Square-set, Stull (open supported).
- Widely used for steeply dipping and irregular ore bodies.

2. Why Provide Supports ?

- ✓ To prevent roof and hanging wall falls.
- ✓ To allow safe working conditions.
- ✓ To recover ore from weak, broken or highly fractured ground.
- ✓ To control dilution.
- ✓ To maintain stability of underground openings.
- ✓ To extend the life of the mine workings.

"Support the ground Support the future"

3. Types of Supported Stoping Methods

1. Cut-and-Fill Mining
2. Square-Set Stoping
3. Stull (Open Supported) Stoping
4. Overhand and Underhand Cut-and-Fill (variants)
5. Modified Cut-and-Fill (hydraulic fill, cemented fill)

Choice depends on

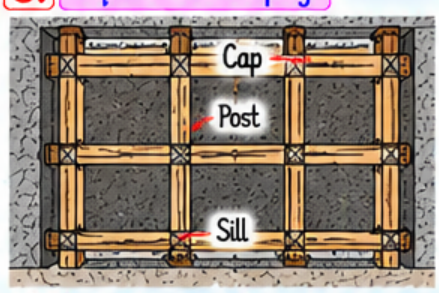
- Ore body geometry
- Rock strength
- Depth of mining
- Availability of timber/ supports
- Cost and recovery requirements

4. Cut-and-Fill Mining



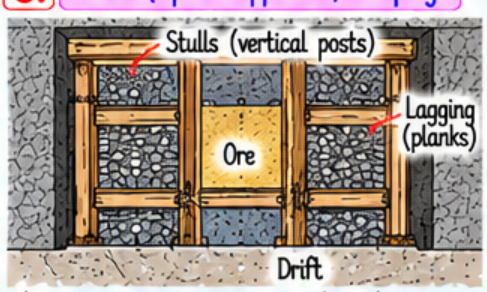
- Ore is extracted in horizontal layers (cuts).
- After extracting each cut, the void is filled with waste (fill).
- Fill provides a working platform for the next cut.
- Fill can be waste rock, hydraulic fill or cemented fill.
- Suitable for steeply dipping, weak and irregular ore bodies.
- High recovery (70 – 90%).

5. Square-Set Stoping



- Systematic timber framework of posts, sills and caps.
- Forms a series of square compartments (sets).
- Ore is extracted from each set, usually from top to bottom.
- Provides strong support in weak and broken ground.
- Suitable for narrow, steep and irregular ore bodies.
- Recovery: 60 – 80%.

6. Stull (Open Supported) Stoping



- Uses vertical timber posts (stulls) with horizontal planks (lagging).
- Open supported method (no complete filling).
- Provides support while allowing easy extraction.
- Suitable for moderate to strong ground conditions.
- Widely used for tabular and steeply dipping ore bodies.
- Recovery: 60 – 85%.

7. Timber / Support Requirements

- ✓ Strong, durable timber (sal, teak, eucalyptus).
- ✓ Proper size and spacing of posts, caps and sills.
- ✓ Lagging (planks) to prevent fall of small fragments.
- ✓ Regular inspection and maintenance.
- ✓ In some cases, steel sets, rock bolts or shotcrete are also used.

Typical Timber Sizes

Posts (Stulls)	15 – 25 cm diameter
Caps / Sills	15 – 25 cm diameter
Lagging (Planks)	5 – 7 cm thick
Spacing	1.0 – 1.5 m (depending on ground)

8. Applicability

- ✓ Used in weak, fractured or broken rock.
- ✓ Suitable for steeply dipping and irregular ore bodies.
- ✓ Useful where high recovery is needed and caving methods are not suitable.
- ✓ Common in metal mining (Pb, Zn, Cu, Au, Ag, etc.).
- ✓ Choice depends on rock conditions, depth, cost and availability of supports.

"Right Support Right Recovery Right Mining"

9. Advantages and Limitations

Advantages	Limitations
✓ Suitable for weak and fractured ground.	✗ Higher cost due to supports and filling.
✓ High recovery (60 – 90%).	✗ Slower production rate.
✓ Provides safer working conditions.	✗ Requires skilled labour.
✓ Flexible and adaptable to irregular ore bodies.	✗ Timber availability can be a constraint.
✓ Can be mechanized (partially).	✗ Not suitable for strong competent ground (caving methods are better).
	✗ Fire hazard in timber supports.

10. GATE Level MCQs

Q1. Cut-and-fill method is most suitable for:
(a) Strong, competent ore bodies
(b) Weak, fractured ore bodies
(c) Flat lying thin seams
(d) Massive ore bodies
Ans: (b)

Q2. In square-set stoping, the main support members are:
(a) Stulls and lagging
(b) Posts, sills and caps
(c) Rock bolts and shotcrete
(d) Hydraulic props
Ans: (b)

Q3. Stull stoping is also known as:
(a) Open supported stoping
(b) Shrinkage stoping
(c) Sublevel stoping
(d) Longwall stoping
Ans: (a)

GATE 2027
MINING ENGINEERING (MN)

DAY - 13

"Break the Rock
Let Value Flow
"Mine the Future"

MINING METHODS

CAVING STOPING METHODS

Sublevel caving, block caving, panel caving, cave propagation, ore recovery, dilution, advantages & limitations

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Mining Knowledge Today A Better Tomorrow

1. What are Caving Stoping Methods ?

- Mining methods in which the overlying rock/ore is allowed to cave and break under its own weight.
- Used for large, low to medium grade deposits with massive ore bodies.
- Gravity and induced stress are used to fragment the ore.
- Highly mechanized and suitable for deep mining.
- Main methods: Sublevel caving, Block caving, Panel caving.

2. Why Caving Methods ?

- ✓ Suitable for large, massive ore bodies.
- ✓ High production rates.
- ✓ Low cost per tonne.
- ✓ Less drilling and blasting compared to conventional stoping.
- ✓ Suitable for deep deposits.
- ✓ Utilizes natural rock stress and gravity.
- ✓ Can be fully mechanized.
- ✓ Commonly used for copper, gold, lead-zinc and other low-grade deposits.

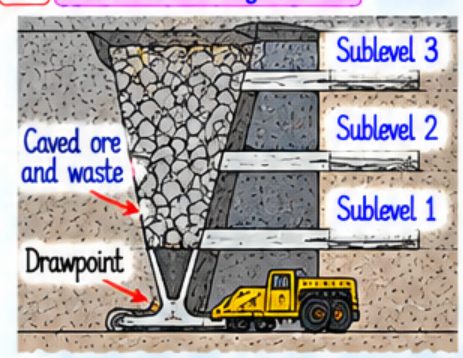
"Let gravity do the mining"

3. Types of Caving Methods

1. Sublevel Caving (SLC)
2. Block Caving (BC)
3. Panel Caving
4. Top Slicing Caving
5. Modified / Variant Methods

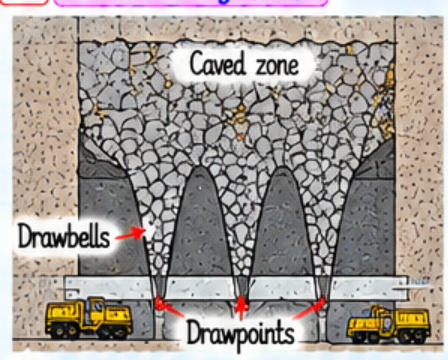
Choice depends on:
- Ore body size
- Depth
- Rock mass conditions
- Equipment availability
- Economics

4. Sublevel Caving (SLC)



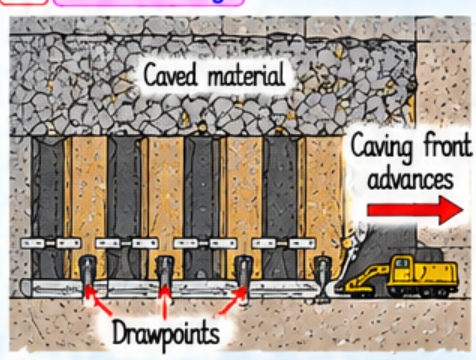
- Ore is undercut from sublevels.
- Overlying ore caves due to loss of support.
- Broken ore is drawn from drawpoints.
- Suitable for steeply dipping, massive ore bodies.
- High production rate.
- Recovery: 60 - 85%.

5. Block Caving (BC)



- Entire ore block is undercut at once.
- Overlying ore and rock cave continuously.
- Drawbells guide the caved material to drawpoints.
- Used for very large, low-grade deposits (at great depths).
- Fully mechanized and high production.
- Recovery: 70 - 90%.

6. Panel Caving



- Ore body is divided into panels.
- Each panel is undercut and allowed to cave.
- Caving is carried out in a sequence (panel by panel).
- Suitable for tabular or wide ore bodies.
- Recovery: 60 - 85%.
- Provides better control than block caving.

7. Cave Propagation



- Cave starts after undercutting and removal of support.
- Propagates upward and outward due to gravity and stress redistribution.
- Rate of propagation depends on rock mass properties, depth and geometry.
- Monitoring is essential to ensure controlled caving.

8. Ore Recovery and Dilution

$$\text{Ore Recovery (\%)} = \frac{\text{Ore extracted}}{\text{In-situ ore}} \times 100$$

$$\text{Dilution (\%)} = \frac{\text{Waste in ore}}{\text{Total material extracted}} \times 100$$

Typical Values

Method	Recovery (%)	Dilution (%)
Sublevel Caving	60 - 85	10 - 30
Block Caving	70 - 90	15 - 35
Panel Caving	60 - 85	10 - 30

9. Advantages and Limitations

Advantages	Limitations
✓ High production rate.	✗ High initial investment.
✓ Low cost per tonne.	✗ Requires large ore bodies.
✓ Suitable for large and deep deposits.	✗ Risk of high dilution.
✓ Fully mechanized.	✗ Difficult to control cave propagation.
✓ Utilizes natural gravity.	✗ Not suitable for small or irregular ore bodies.
✓ Less drilling and blasting.	✗ Can cause surface subsidence.
✓ Suitable for low to medium grade ores.	✗ Requires careful geotechnical monitoring.

10. GATE Level MCQs - 1

Q1. Block caving is most suitable for:
(a) Small, high-grade veins
(b) Large, low-grade deposits at great depths
(c) Flat lying thin seams
(d) Near surface deposits
Ans: (b)

Q2. The main advantage of sublevel caving is:
(a) Complete control with no dilution
(b) Very high production rate
(c) Suitable for small ore bodies
(d) No surface subsidence
Ans: (b)

Q3. In caving methods, dilution is caused by:
(a) Careful blasting
(b) Caving of waste rock along with ore
(c) Use of mechanization
(d) Take of ore from drawpoints
Ans: (b)

GATE 2027
MINING ENGINEERING (MN)

DAY - 14

MINING METHODS

STOPE MECHANIZATION & ORE HANDLING

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"Move the Ore
Make it Work
Stronger Mines
Brighter Tomorrow"

LHDs, loaders, drills, raise/ore passes, chutes, conveyors, trucks, scraper systems, ore-flow systems

Mining Knowledge Today A Better Tomorrow

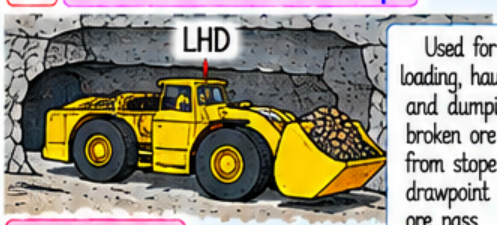
1. Importance of Stope Mechanization

- Increases productivity and safety.
- Reduces manual handling and cost.
- Ensures continuous ore flow.
- Suitable for large, deep and high-grade mines.
- Integrates drilling, loading and haulage systems.
- Improves recovery and reduces dilution.

2. Key Equipment in Stope

1. Drills (production drilling)
2. LHDs (Load-Haul-Dump)
3. Loaders (scoops, trims)
4. Trucks (underground haulage)
5. Scraper systems
6. Raise / ore passes
7. Chutes
8. Conveyors
9. Support equipment (ventilation, lighting, communication)

3. LHD (Load-Haul-Dump)



Used for loading, hauling and dumping broken ore from stope to drawpoint or ore pass.

Advantages

- ✓ High maneuverability in underground workings.
- ✓ Low profile, suitable for narrow stopes.
- ✓ High productivity and reduces manual loading.
- ✓ Can work with remote or automated systems.

4. Loaders (Scoop Trams)



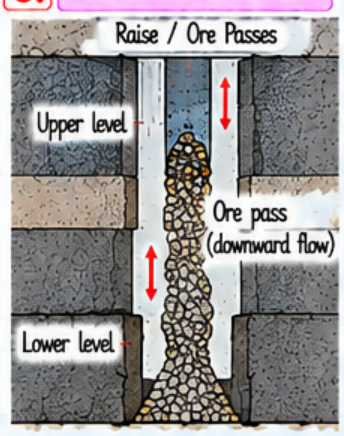
- Used for loading broken ore from stope floor, drawpoints and chutes.
- Available in different bucket capacities (3 – 14 m^3).
- Can be diesel, electric or battery operated.
- Suitable for low profile and high production mines.

5. Drills (Stope Drilling)



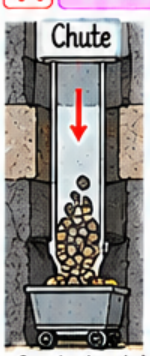
- Used for production drilling in stopes.
- Types: Jumbo drills (single or multi-boom).
- Can be electric, diesel or cordless.
- Provides high accuracy and faster drilling.
- Essential for achieving proper fragmentation and higher productivity.

6. Raise / Ore Passes



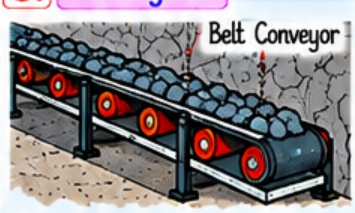
- Vertical or inclined excavations for gravity flow of ore.
- Can be raise bore or conventional method.
- Used to transfer ore from upper stopes to lower levels.
- Reduces haulage distance and cost.

7. Chutes



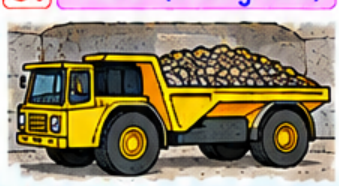
- Short vertical or inclined passages.
- Used to direct ore from drawpoints to trucks or conveyors.
- Can be lined with steel to reduce wear.
- Requires proper design to avoid blockage.
- Used in combination with ore passes and hoppers.

8. Conveyors



- Used for continuous ore transport in underground mines.
- Types: Belt conveyors, chain conveyors.
- High capacity and energy efficient.
- Suitable for large, steady ore production.
- Can be integrated with ore passes, crushers and surface hoisting systems.

9. Trucks (Underground)



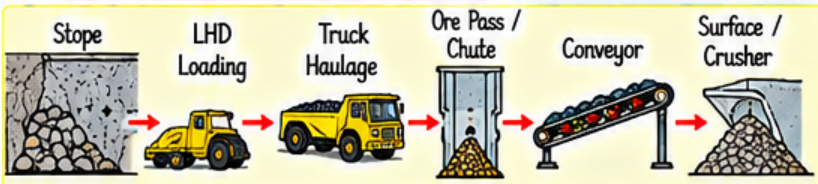
- Transport ore from stope to ore passes, crushers or surface.
- Types: Diesel, electric, battery operated.
- Used where conveyors are not feasible.
- Flexible and suitable for medium distances.
- Typical capacity: 20 – 60 tonnes.

10. Scraper Systems



- Used for low profile and narrow stopes.
- Consists of scraper, cable and winch.
- Ore is pulled to drawpoint.
- Simple, robust and low cost.
- Suitable for small to medium production.
- Widely used in cut-and-fill and small stopes.

11. Ore-Flow System (Complete Chain)



"Efficient Ore Handling = Higher Productivity + Lower Cost"

12. Advantages and Limitations

Advantages	Limitations
✓ Higher productivity.	✗ High initial investment.
✓ Continuous ore flow.	✗ Requires skilled maintenance.
✓ Reduced manual labour.	✗ Not suitable for small or irregular stopes.
✓ Lower operating cost (long term).	✗ Equipment size limitations in very narrow workings.
✓ Improved safety.	✗ Ventilation and power supply requirements.
✓ Integrates with modern automation and monitoring.	✗ Risk of chute/ore pass blockage.

GATE 2027
MINING ENGINEERING (MN)

DAY - 15

"Practice Numericals
Build Accuracy
Crack GATE"

MINING METHODS

25 GATE NUMERICALS

Productivity, equipment capacity, cycle time, haulage, recovery, dilution, extraction ratio, production calculations

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Achieve

Mining Knowledge Today
A Better Tomorrow

1. Excavator Productivity

$$Q = \frac{3600 \times C \times \eta}{T_c} \ (m^3/h)$$

C = bucket capacity (m^3)
T_c = cycle time (s)
η = job efficiency

Find Q = ?

2. LHD Productivity

$$Q = \frac{3600 \times C \times \eta}{T_c} \ (t/h)$$

C = bucket capacity (m^3)
ρ = ore density (t/m^3)
T_c = cycle time (s)
η = job efficiency

Find Q = ?

3. Truck Haulage Capacity

$$Q = \frac{3600 \times C \times \eta}{T_c} \ (t/h)$$

C = truck payload (t)
T_c = round trip time (s)
η = utilization factor

Find Q = ?

4. Drill Penetration Rate

$$PR = \frac{L}{T} \ (m/h)$$

L = depth drilled (m)
T = drilling time (h)

Find PR = ?

5. Blasting Output

$$Q = \frac{V \times \rho}{1 + f} \ (t)$$

V = blasted volume (m^3)
ρ = rock density (t/m^3)
f = swell factor

Find Q = ?

6. Cycle Time (LHD)

$$T_c = T_l + T_h + T_d + T_r + T_m \ (s)$$

T_l = loading time
T_h = hauling time
T_d = dumping time
T_r = return time
T_m = maneuvering time

Find T_c = ?

7. Haulage Time

$$T_h = \frac{D}{v} \ (min)$$

D = one way distance (m)
v = speed (m/min)

Find T_h = ?

8. Number of Trucks

$$N = \frac{T_c}{T_s} + 1$$

T_c = cycle time (min)
T_s = service time (min)

Find N = ?

9. Production per Shift

$$Q_s = Q \times H \times n$$

Q = hourly production (t/h)
H = hours per shift
n = number of equipment

Find Q_s = ?

10. Annual Production

$$Q_a = Q_a \times S \times D \ (t)$$

Q_s = shift production (t)
S = shifts per day
D = working days per year

Find Q_a = ?

11. Stope Productivity

$$Q = \frac{V \times \rho \times R}{T} \ (t/h)$$

V = stope volume (m^3)
ρ = ore density (t/m^3)
R = recovery (%)
T = time (h)

Find Q = ?

12. Recovery

$$R = \frac{\text{Ore produced}}{\text{In-situ ore}} \times 100$$

R = recovery (%)

Find R = ?

13. Dilution

$$D = \frac{\text{Waste in ore}}{\text{Total ore extracted}} \times 100$$

D = dilution (%)

Find D = ?

14. Extraction Ratio

$$ER = \frac{\text{Ore extracted}}{\text{Total mineral in place}} \times 100$$

ER = extraction ratio (%)

Find ER = ?

15. Grade after Dilution

$$G_m = \frac{G_o(1 - D)}{1}$$

G_m = mined grade
G_o = original grade
D = dilution (fraction)

Find G_m = ?

16. Specific Drilling

$$SD = \frac{\text{Total length drilled}}{\text{Volume of rock}} \ (m/m^3)$$

Find SD = ?

17. Powder Factor

$$PF = \frac{\text{Explosive used (kg)}}{\text{Rock broken } (m^3)}$$

Find PF = ?

18. Loading Time

$$T_l = \frac{n_b \times t_b}{3600} \ (h)$$

n_b = number of buckets
t_b = time per bucket (s)

Find T_l = ?

19. Conveyor Capacity

$$Q = 3600 \times A \times v \times \rho \times \eta \ (t/h)$$

A = cross-sectional area (m^3)
v = belt speed (m/s)
ρ = bulk density (t/m^3)
η = efficiency

Find Q = ?

20. Ore Pass Capacity

$$Q = A \times v \times \rho \ (t/s)$$

A = cross-sectional area (m^2)
v = flow velocity (m/s)
ρ = bulk density (t/m^3)

Find Q = ?

21. Scraper Output

$$Q = \frac{L \times A \times \rho}{T_c} \ (t/h)$$

L = scraper length (m)
A = cross-sectional area (m^3)
T_c = cycle time (h)

Find Q = ?

22. Cost per Tonne

$$C = \frac{\text{Total cost (₹)}}{\text{Ore produced (t)}} \ (₹/t)$$

Find C = ?

23. Equipment Requirement

$$N = \frac{\text{Total production (t/h)}}{\text{Equipment capacity (t/h)}}$$

Find N = ?

24. Stoping Rate

$$SR = \frac{V_s}{T} \ (m^3/h)$$

V_s = stope advance volume (m^3)
T = time (h)

Find SR = ?

25. Overall Production

$$Q = n \times q \times \eta \times U \ (t/h)$$

n = number of units
q = rated capacity (t/h)
η = efficiency
U = utilization

Find Q = ?

Common Conversions

1 m^3 = 1 tonne (for $\rho \approx 1$ t/m^3)
1 h = 3600 s
1 km = 1000 m
1 t = 1000 kg

Key Tips for GATE Numericals

- ✓ Understand the formula and units.
- ✓ Draw diagrams where needed.
- ✓ Check assumptions in the question.
- ✓ Keep unit consistency.
- ✓ Practice previous year GATE questions.
- ✓ Improve speed and accuracy.

Focus Areas

- ✓ Equipment productivity
- ✓ Cycle time calculations
- ✓ Ore handling & haulage
- ✓ Recovery, dilution & extraction ratio
- ✓ Production planning
- ✓ Conveyor and ore pass design

GATE 2027
MINING ENGINEERING (MN)

DAY - 16

"Solve More
Think Deeper
Crack GATE"

MINING METHODS

50 MCQ / MSQ / NAT

Conceptual + Numerical GATE-level Questions
Covering the Complete Syllabus

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Prepare
Achieve

Mining
Knowledge
Today
A Better
Tomorrow

Q1. (MCQ – Basics)

Which of the following is a surface mining method?

(a) Room and pillar
(b) Longwall mining
(c) Strip mining
(d) Block caving



Ans: (c)

Q2. (MCQ – Highwall Mining)

Highwall mining is most suitable for:

(a) Thin seams (< 1 m)
(b) Thick seams (> 10 m)
(c) Moderate thick seams (3 – 8 m)
(d) Very deep seams (> 500 m)



Ans: (c)

Q3. (MCQ – Bord & Pillar)

In a bord and pillar layout, the main purpose of leaving pillars is to:

(a) Increase extraction ratio
(b) Support the roof
(c) Facilitate ventilation only
(d) Improve haulage



Ans: (b)

Q4. (MCQ – Longwall)

Which equipment cuts the coal/ore at the longwall face?

(a) Continuous miner
(b) Shearer
(c) Roadheader
(d) LHD



Ans: (b)

Q5. (MCQ – Caving Methods)

Which caving method is most suitable for very large, low-grade, massive ore bodies?

(a) Sublevel caving
(b) Block caving
(c) Panel caving
(d) Shrinkage stoping



Ans: (b)

Q6. (MCQ – Ore Handling)

Which of the following is used for loading and hauling in underground mines?

(a) Dragline
(b) LHD
(c) Dozer
(d) Belt conveyor



Ans: (b)

Q7. (Numerical)

A truck has a payload of 25 t. Cycle time is 30 minutes. If the utilization factor is 0.8, what is the hourly production?

(a) 20 t/h
(b) 25 t/h
(c) 30 t/h
(d) 40 t/h

$$\text{Production} = \frac{\text{Payload} \times 60}{\text{Cycle time}} \times U$$

Ans: (c)

Q8. (Numerical)

A stope produces 5000 t of ore containing 6% metal. If the dillution is 20%, what is the metal content (%) in the mill feed?

(a) 4.0
(b) 4.5
(c) 5.0
(d) 6.0

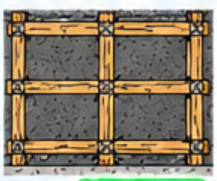
$$\text{Grade after dilution } G_m = G_o(1 - D)$$

Ans: (b)

Q9. (MCQ – Supported Stoping)

Which method uses a series of square compartments of timber/steel sets?

(a) Cut-and-fill
(b) Square-set stoping
(c) Open stoping
(d) Stull stoping



Ans: (b)

Q10. (MSQ)

Which of the following are advantages of mechanized mining methods?

(a) Higher productivity
(b) Lower manual labour
(c) Better safety
(d) Applicable in very small deposits

Ans: (a), (b), (c)

Q11. (MSQ)

Which of the following are correct about ore passes?

(a) Used for gravity flow of broken ore
(b) Can be vertical or inclined
(c) Reduce haulage distance
(d) Always lined with steel

Ans: (a), (b), (c)

Q12. (NAT)

The extraction ratio of a deposit is 75%. If 12 million tonnes of ore is extracted, what is the in-situ ore reserves? (Write numerical answer in million tonnes)

$$ER = \frac{\text{Ore extracted } x}{\text{Total in-situ ore}} \times 100$$

Ans: 16

More Practice Questions

- ✓ Conceptual Questions – 25
- ✓ Numerical Questions – 15
- ✓ Multiple Select Questions (MSQ) – 5
- ✓ Numerical Answer Type (NAT) – 5
- ✓ Covers entire Mining Methods syllabus

Topics Covered

- ✓ Surface, Highwall & Underground Mining
- ✓ Bord & Pillar, Longwall, Thick Seam Methods
- ✓ Open, Supported & Caving Stoping
- ✓ Stope Mechanization & Ore Handling
- ✓ Productivity, Haulage, Recovery, Dilution
- ✓ Extraction Ratio & Production Calculations

Tips for GATE

- ✓ Read the question carefully.
- ✓ Check units and assumptions.
- ✓ Draw neat diagrams if required.
- ✓ Eliminate wrong options.
- ✓ Practice time-bound solving.
- ✓ Focus on concepts + numericals.

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Study
Practice
Succeed

Mine More Questions → Build Stronger Concepts → Crack GATE

GATE 2027
MINING ENGINEERING (MN)

DAY - 17

"Formulas in Mind
Facts in Hand
Select the Right Method
Crack GATE"

MINING METHODS
FORMULA + FACT SHEET

Key Formulas | Equipment Facts | Method-Selection Criteria
Comparison Tables | Advantages & Limitations

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Learn
Prepare
Achieve

Mining Knowledge Today
A Better Tomorrow

1. Important Formulas

(1) Production (Q)

$$Q = \frac{3600 \times C \times n \times \eta}{T_c} \quad (t/h)$$

C = bucket/truck capacity (m^3 or t)
T_c = cycle time (s) n = no. of units
η = efficiency (0.7 - 0.9)

(2) Cycle Time (T_c)

$$T_c = T_l + T_h + T_d + T_r + T_m \quad (s)$$

T_l = loading, T_h = hauling, T_d = dumping
T_r = return, T_m = maneuvering

(3) Grade after Dilution

$$G_m = G_o (1 - D)$$

(4) Recovery (%)

$$R = \frac{\text{Ore produced}}{\text{In-situ ore}} \times 100$$

(5) Dilution (%)

$$D = \frac{\text{Waste in ore}}{\text{Total material}} \times 100$$

(6) Extraction Ratio (%)

$$ER = \frac{\text{Ore extracted}}{\text{Total mineral in place}} \times 100$$

(7) Stope Advance Rate

$$SR = \frac{V_s}{T} \quad (m^3/h)$$

V_s = stope advance volume, T = time

2. Equipment Facts (Typical)

Equipment	Capacity / Size	Typical Use
LHD (Load-Haul-Dump) 	3 - 14 m^3	Loading & hauling in underground mines
Scoop/Loader (Underground) 	3 - 10 m^3	Loading at stope and drawpoints
Underground Truck 	20 - 60 t	Haulage of ore and waste
Jumbo Drill (Electric/Diesel) 	3 - 6 booms	Production drilling in stopes
Raise Borer 	0.6 - 3.0 m diameter	Raises / ore passes
Scraper System 	5 - 25 t	Short distance haulage (low profile)
Belt Conveyor (Underground) 	300 - 3000 t/h	Continuous ore transport

3. Method-Selection Criteria

- ✓ Ore body size, shape and grade
- ✓ Depth and ground conditions
- ✓ Rock strength and stability
- ✓ Dip and thickness of the ore body
- ✓ Continuity and extent of the deposit
- ✓ Required production rate
- ✓ Degree of mechanization possible
- ✓ Ventilation and drainage conditions
- ✓ Cost and economic considerations
- ✓ Environmental and subsidence impact
- ✓ Availability of equipment and skilled labour

"Right Method → Right Mine
Right Economics → Sustainable Future"

4. Comparison of Mining Methods

Method	Suitable Ore Ore Body	Production Rate	Cost	Dilution	Remarks
Bord & Pillar	Flat to moderate dip	Low - Medium	Low	Low	Simple, suitable for coal
Longwall	Thick, flat	High	High	Low	Fully mechanized
Sublevel Caving	Large, deep	Very High	High	High	For massive, low-grade
Block Caving	Very large	Very High	High	High	Fully mechanized
Cut-and-Fill	Irregular, steep	Low - Medium	High	Low	Flexible, safe
Square-Set	Irregular	Low	High	Low	For weak ground
Open Stoping	Steep, stable	Medium - High	Medium	Medium	Common in metal mines

5. Advantages & Limitations

Method	Advantages	Limitations
Bord & Pillar	Simple, low cost, suitable for flat seams	Lower recovery, pillars left behind
Longwall	High production, fully mechanized	High initial cost, not suitable for irregular seams
Sublevel Caving	Very high production, low unit cost	High dilution, requires strong ground
Block Caving	Largest tonnage, fully mechanized	Very high dilution, high initial investment
Cut-and-Fill	Flexible, good control, suitable for irregular ore bodies	Low production, high labour cost
Square-Set	Safe in weak ground, selective mining	High cost, low production
Open Stoping	Higher production, simple method	Requires strong ground, not suitable for massive bodies

6. Key Facts for GATE

- ✓ Longwall → most productive for coal
- ✓ Sublevel caving → common for large, low-grade metal deposits
- ✓ Block caving → used for very large deposits (Cu, Au)
- ✓ Bord & pillar → widely used for coal
- ✓ Cut-and-fill → suitable for irregular ore bodies
- ✓ LHD → most common underground loading equipment
- ✓ Conveyors → high capacity & energy efficient
- ✓ Dilution increases with depth and caving methods
- ✓ Recovery is highest in fully mechanized methods (60 - 90%)
- ✓ Extraction ratio is an important economic parameter

"Know the Formulas
Understand the Facts
Choose the Right Method
Succeed in GATE"

7. Quick Data & Values

Parameter	Typical Value
LHD capacity	3 - 14 m^3
Underground truck capacity	20 - 60 t
Conveyor capacity	300 - 3000 t/h
Raise diameter (raise boring)	0.6 - 3.0 m
Scraper system capacity	5 - 25 t
Production drilling rate	0.5 - 2.0 m/min
Overall equipment efficiency (η)	0.7 - 0.9
Recovery (underground)	60 - 90 %
Dilution (caving methods)	15 - 35 %
Stope advance rate	5 - 50 m^3/h

8. Remember

- ✓ Draw neat diagrams in the exam.
- ✓ Write units for all calculations.
- ✓ Mention assumptions clearly.
- ✓ Compare methods wherever asked.
- ✓ Use flowcharts/tables for better answers.
- ✓ Focus on both conceptual and numerical questions.
- ✓ Revise previous GATE questions.

"Practice Today → Higher Ranks Tomorrow"

GATE 2027
MINING ENGINEERING (MN)

DAY - 18

"Test Yourself
Improve Yourself
Crack GATE"

MINING METHODS
FULL MOCK TEST

Mixed MCQ + MSQ + NAT | Numerical Problems
Method-Selection Questions | GATE-Level Revision

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Learn
Prepare
Achieve

Mining Knowledge Today
A Better Tomorrow

Exam Pattern (GATE Style)

- ✓ Total Questions : 25
- ✓ MCQ : 10 (1 mark each)
- ✓ MSQ : 5 (2 marks each)
- ✓ NAT : 10 (2 marks each)
- ✓ Total Marks : 40
- ✓ Time : 60 minutes

Instructions

1. Read each question carefully.
2. Attempt all questions.
3. For MSQ, one or more options may be correct.
4. For NAT, enter the numerical answer (no units).
5. Use diagrams and assumptions wherever required.
6. This test covers the complete Mining Methods syllabus.

Topics Covered

- ✓ Surface, Highwall & Underground Mining
- ✓ Longwall, Thick-seam Methods
- ✓ Open, Supported & Caving Stoping
- ✓ Stope Mechanization & Ore Handling
- ✓ Productivity, Haulage, Recovery, Dilution
- ✓ Equipment Selection & Method Comparison

"Revise Practice Perform Succeed"

Q1. (MCQ)

Which mining method is most suitable for extraction of a coal seam of 12 m thickness with weak roof?

(a) Longwall mining
(b) Room and pillar mining
(c) Sublevel caving
(d) Open cast mining

Ans: (a)

Q2. (MCQ)

The main purpose of providing goaf in longwall mining is to:

(a) Support the roof
(b) Facilitate caving
(c) Increase production rate
(d) Reduce haulage distance

Ans: (b)

Q3. (MCQ)

Which equipment is used for undercutting the coal seam in longwall mining?

(a) Continuous miner
(b) Shearer
(c) Roadheader
(d) LHD


Longwall Shearer

Ans: (b)

Q4. (MSQ)

Which of the following are advantages of sublevel caving?

(a) High production rate
(b) Low dilution
(c) Suitable for large, massive ore bodies
(d) Low operating cost

Ans: (a), (c)

Q5. (MSQ)

Select the correct statements regarding stope mechanization.

(a) LHDs are suitable for narrow stopes
(b) Jumbo drills increase drilling accuracy
(c) Scraper systems are used for low profile haulage
(d) Belt conveyors are suitable for continuous ore transport

Ans: (b), (c), (d)

Q6. (MSQ)

Which factors are important in method selection for underground mines?

(a) Depth and ground conditions
(b) Shape and size of ore body
(c) Grade and value of ore
(d) Availability of skilled labour

Ans: (a), (b), (c), (d)

Q7. (NAT)

A mine produces 6000 t of ore per day using 3 LHDs. Each LHD has a bucket capacity of 6 m^3, cycle time of 1.5 min, utilization factor of 0.8 and ore density of 2.5 t/m^3. Find the number of LHDs required to produce 8000 t per day.
(Write answer in nearest integer)

Ans: 4

Q8. (NAT)

A stope has dimensions 30 m (length) × 15 m (width) × 25 m (height). The ore density is 2.8 t/m^3. If the recovery is 85% and dilution is 10%, calculate the tonnage of ore sent to the mill.
(Write answer in tonnes)

Ans: 96412

Q9. (NAT)

A conveyor has a belt width of 1.2 m, belt speed of 2.5 m/s and material bulk density of 1.6 t/m^3. If the cross-sectional area of material on the belt is 0.35 m^2, calculate the conveyor capacity in t/h.
(Write answer in t/h)

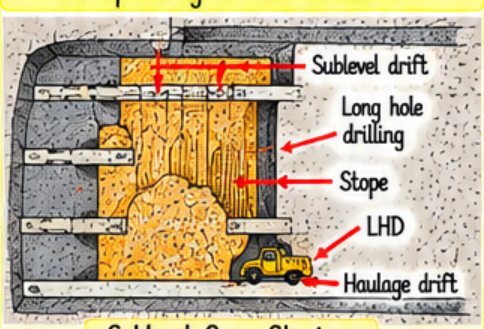
Ans: 5040

Q10. (NAT)

An ore pass has a diameter of 1.5 m and height of 50 m. If the bulk density of ore is 2.4 t/m^3 and the pass is filled to 80% of its volume, find the tonnage of ore in the pass.
(Write answer in tonnes)

Ans: 6786

Sample Diagram for Evaluation



Sublevel Open Stoping

Final Check Before Exam

- ✓ Have you revised all methods?
- ✓ Are you comfortable with numerical problems?
- ✓ Can you select the right method for different conditions?
- ✓ Have you practiced diagrams?
- ✓ Do you know key formulas and equipment data?
- ✓ Are you confident? → GO FOR GATE!