GOVERNMENT POLYTECHNIC JAJPUR

LECTURE NOTE OF UNDERGROUND COAL MINING

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{ Lecture In Mining }

DEPARTMENT OF MINING ENGINEERING

Introduction to Underground Coal Mining:

What is Coal?

→ Coal is a combustible black or brownish-black sedimentary rock, formed as rock strata called coal seams.

→ Coal consisting chiefly of carbonized plant matter. Found mainly in underground seams and used as fuel.

→ Coal is a fossil fuel, formed from vegetation, which has been consolidated between other rock strata and altered by the combined effects of pressure and heat over millions of years to form coal seams.

→ Coal is classified into four main types or ranks.

1. Peat
2. Lignite
3. Bituminous
4. Anthracite

→ The ranking depends upon the types and amount of carbon the coal contains and on the amount of heat energy the coal can produce.

Rock :-

Rock is a substance which is obtained when two or more mineral are compose in a mechanical process.

Mineral:-

Mineral is a naturally occuring homogeneous inorganic substance having definite physical property, definite chemical composition and atomic structure is called as mineral.

Ex:- Quartz, calcite, sulfur etc.

Ore:-

The mineral from which metal can be extracted easily or economically are called ore.

Example:-

Ore	Mineral
~~Aluminium~~ Aluminium	Bauxite Kaolinite
Iron	Haematite - Fe_2O_3 magnetite - Fe_3O_4 Siderite - $FeCO_3$ Iron pyrites - $FeSO_4$
Copper	copper pyrites - $CuFeS_2$ malachite $CuCO_3 \cdot Ca(OH)_2$ cuprite - Cu_2O copper Glance - Cu_2S
Zinc	Zinc blend / Sphalerite calamine - $ZnCO_3$ Zincite - ZnO

Mine:-
The place from which we can excavate the mineral of economic value from the earth crust for the benifits of mankind.

Mining:-
→ Mining is the process of excavating minerals of economic value from the earth crust for benifits of mainkind is called as mining.

Mining Engineering:-
The practice of applying engineering principles to the development, planning, operation, closure and reclamation of mines.

Type of mineral resources:-

① Metallic ores:-
Metallic mineral exhibit lustre in their appearance and consist of metals in their chemical composition.

→ Those ores of the ferrous metals (iron, manganese, molybdenum and tungsten), the base metals (copper, lead, zinc and tin). the precious metals (gold, silver, the platinum group metals) the radioactive minerals (uranium and radium).

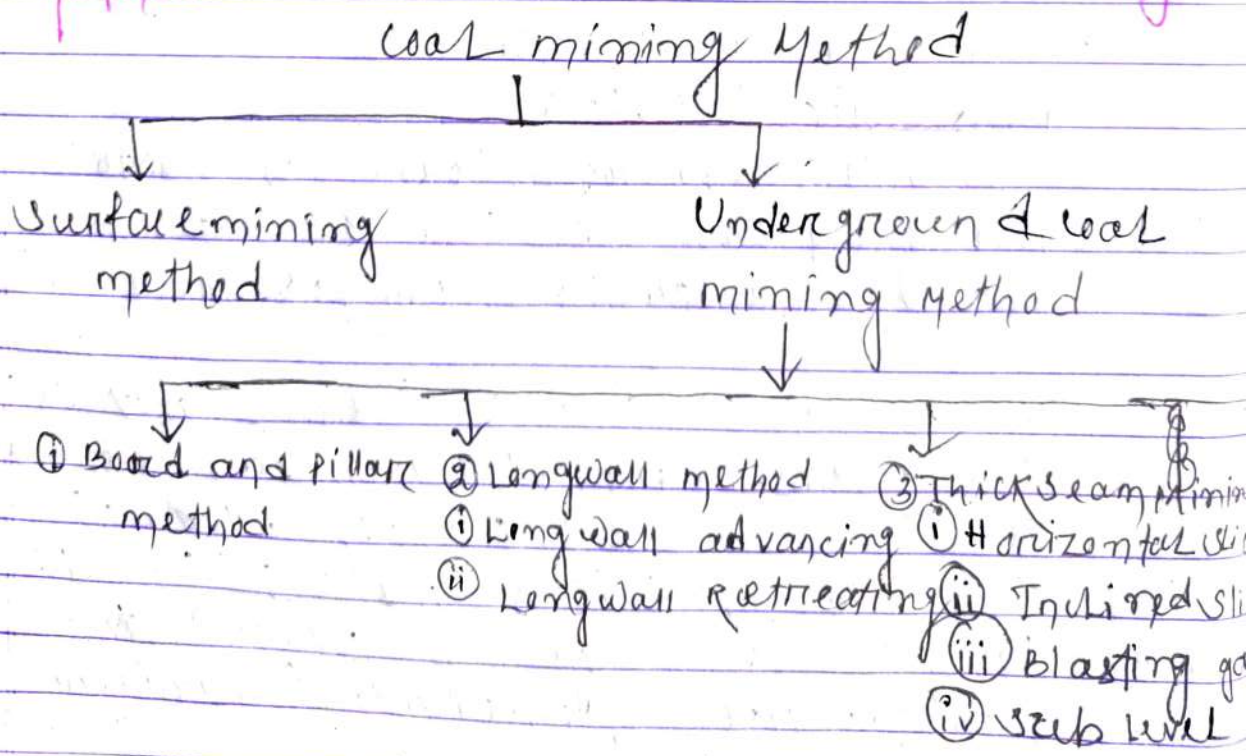
ZnS

② Non-Metallic mineral:-
Non-metallic mineral either show a non-metallic lustre shine in their appearance. metals are not present in their chemical composition.

→ Ex - Limestone, gypsum, mica.

③ Fassil fuel:-
The organic mineral substances that can be utilized as fuel such as coal, petroleum, natural gas, coalbed methane.

Classification of underground coal mining Method:-



CHAPTER – 2

BORD AND PILLER METHOD

* Describe the various application of bord & pillar Method

Various application of Bord & pillar Method:–

→ The Bord and pillar method is adopted for working.

(1) A seam thicker than 1.5 m.
(2) A seam free from stone or dirt band.
(3) Seams at moderate depth.
(4) Seams which are not gassy.
(5) Seams with strong roof and floor which can stand for long period after development stage is over.
(6) Coal of adequate crushing strength.

Basic principle of Bord and pillar method:–

→ The mine are developed by the method of working known as Bord and pillar consist of driving a series of narrow roads separated by locks of solid coal, parallel to one and connecting them by another set of parallel narrow roadways driven nearly at right angle to the first set. The stage of formation of a network of roadways is known as development or first working and these roadways are called Bord or Gallery.

(4) Horizontal mining → When the gallery are developed, a solid block of coal is left surrounded the gallery are known as pillar.

→ The coal pillar formed are extracted after the development of the mine

and this later stage of extracting coal from pillar is known as depillaring. This method is sometimes called room-and-pillar mining.

DESIGN OF BORD AND PILLAR WORKING :-

The main elements of Bord and pillar working are as follow.

1. Size of the panel
2. Size of the barrier
3. Size of pillar

(i) Size of the panel :-

→ When developing a seam, sets of 5-7 galleries are driven which are separated from adjacent sets by a coal barrier this is known as panels.

→ To decide the size of the panel, the incubation period is considered. The size is so fixed that the entire panel can be extracted within the incubation period without the occurence of spontaneous fire. The period in Indian coalfields generally varies between 6 to 12 month.

→ The other factor that influences the size is the rate at which extraction is done. With high rate of extraction mode

possible by mechanization, the size of the panel can be significantly increased.

→ The extraction rate from depillaring districts in Indian coalfield averages about 250-300 tons per day per panel.

② Size of barrier:-

→ The width of the barrier depends on the load which it has to carry and its strength. Greater the depth of working, wider is the barrier and also softer the coal, the more the width of the barrier. In practice, the width of the coal pillars which are enclosed within the panel.

→ In deep mines the width of the barrier may become quite large (up to 45 m) and so during extraction they are thinned down consistent with safety. Too much reduction in the width of the barrier is not advisable as in that case the barrier may be crushed and two goaves may be joined, thus encouraging Safety.

③ size of pillars:-

The size of the pillars is influenced by the following: (a) Depth from the surface and

percentage extraction in the first working & development.

(2) strength of the coal: seams with weak coal require large pillars.

(3) Effect of atmosphere and escape of gas also influence the size of pillars

(4) The nature of the roof and floor: These influence the liability to crush and creep. A strong roof tends to crush the pillar edges whilst a soft floor predisposes it to creep and both calls for large pillars.

(5) Geological considerations: In the vicinity of faults, large pillars are required. Dip and presence of water also influence the decision as to the size of pillars.

(6) Time dependent strain: with time the strain goes on increasing, the load remains constant and if the size of the pillar is not sufficiently large, then it may fail under the time dependent strain, although initially it might be stable.

Describe Various Layouts of Bord & Pillar Method:-

(Layout of Bord & Pillar Method)

→ A road in a coal seam proper is called Gallery or Bord.

→ A road which driven along the dip of the seam is called a dip gallery or dip.

→ A road which driven along the strike of seam is called a level gallery or level.

→ A road way in stone connecting two or more coal seams called a drift.

→ A solid block of coal surrounded on all side by galleries is knowns as pillar. It forms the natural supports of the roof in a mine.

→ Where the galleries in a seam are generally along the dip and strike forming seperate and rectangular pillars, a gallery which cuts the pillars, due to its driving along an apparent dip is called cross cut.

→ A borehole directed so as to cut through a rock strata or one vein essentially at right angles to the dip and strike of the rock strata a vein, or a related structure.

→ such crosscut is some times required for facility of ventilation, drainage, haulage and stowing.

→ A gallery in the process of being driven is called heading.

→ The moving front of any working place of any gallery roadway

or drift is called face or working place or working.

→ A district is an area in a mine having a number of working places. It also sometimes called "section.

→ Panel is known as or also sometimes used to donate a district which is separated from other district by an artificial barrier or brick wall or by a natural barrier of coal.

→ Extraction of ore from block and pillar from during the development and supported by filling some incombustible material like sand, mill tailing, block of granite etc. known as stopping.

→ When mineral is extracted from an from an underground mine the void space / goaf is packed with sand or other packing material whatever it conveniently and cheaply and available in sufficient quantity this process is known as stowing.

Classification of Bord and pillar Mining:-

The bord and pillar system of mining can be done in three ways, namely:

1. Develop the entire area into pillars and then extract the pillars starting from the boundry.

2. Develop the area into panels and extract pillars subsequently panel-wise. This is called panel system of mining.

3. "whole" followed by "broken" working in which the mine is opened out by a few Headings only and thereafter development and depillaring go on simultaneously starting from the boundary.

Development of Entire area followed by Pillar Extraction:-

The first system is attractive is that more number of working faces can be made available and thus more number of miners can be given employment. Large output can be quick built up. In the past this system was practiced widely in Indian mines and in certain mines with very few coal cutting machines high outputs were obtained.

But this system has the following dis-advantage:-

→ As the pillars have to stand for a long time before they are extracted, spalling takes place and they get weakened. Consequently, they may get crushed and there is the risk of premature collaps.

→ Ventilation may be sluggish due to greater percentage of air leakage.

→ Treatment of coal dust is costly and difficult.

→ There is greater risk of fire spreading in the whole mine.

→ Coal dust explosion cannot be contained if it occurs, it spreads throughout the mine.

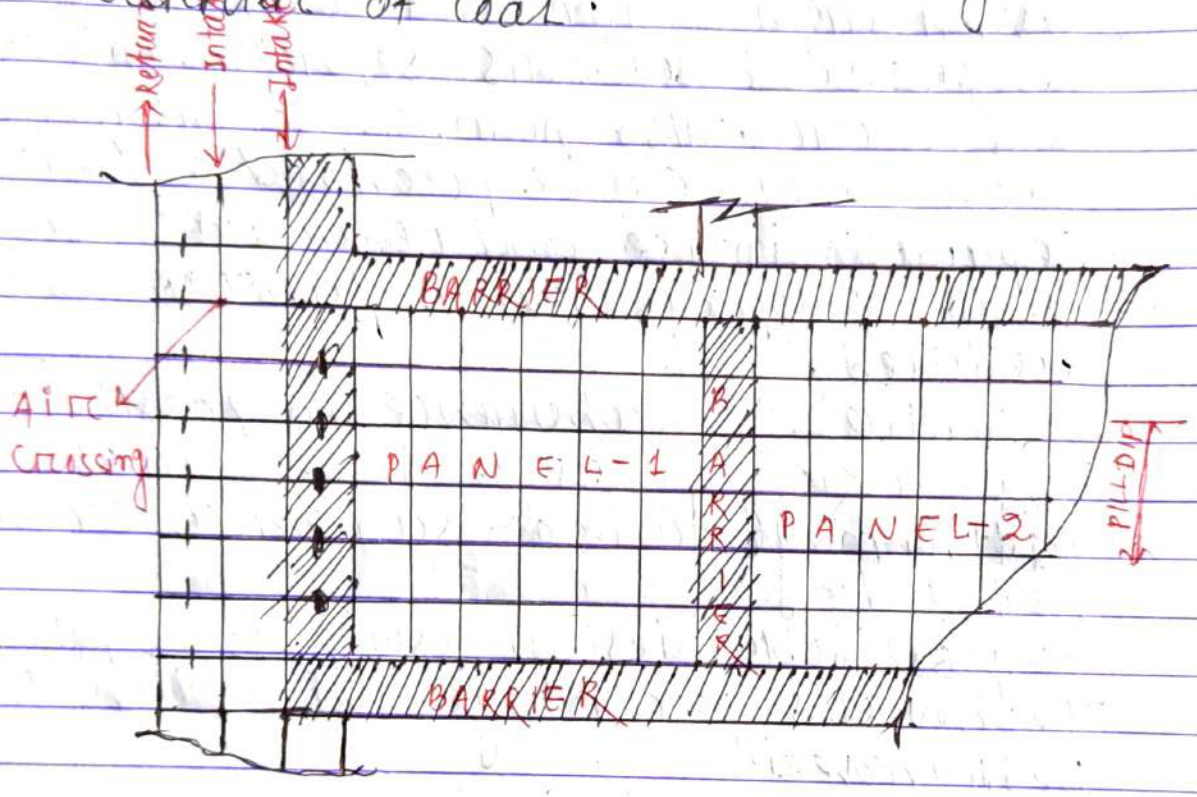
→ Crush and creep cannot be localized.

→ The work is scattered. Consequently, the output per man-shift is low.

✓ Due to these dis-advantage this system is not used these days.

PANEL SYSTEM OF MINING:-

In the panel system of mining the ~~coal~~ coal seam is divided into a number of panels separated from one another by solid barrier of coal.



Advantages:-

→ Risk of loss of coal through spontaneous heating is limited. In the event of fire occuring the panel can be isolated from other parts of the working similarly, explosions can be limited to the panel of occurrence.

→ Crushing of pillars is avoided.

→ 'whole' and 'broken' workings can be

done at the same time i.e in one panel development and in another panel depillaring can be done at the same time.

→ ventilation is improved. Each panel can be provided with its separate intake and return. Also number of air improved. Each panel can be provided with its separate intake and return. Also number of air stoppings can be substantially reduced.

→ control of subsidence is possible. By working panels of sub-critical width, magnitude of subsidence can be reduced.

→ By suitable design using yield pillar techniques percentage extraction can be improved.

Dis-advantage:-

→ considerable amount of coal is lost in barriers, generally, in Indian practice roughly 20% of coal is lost in the boundaries.

→ More number of air crossings are required for ventilation purposes.

→ Each panel must have its own independent coal cutting machine and haulage.

→ Each panel must have its own indipendent coal cutting machine and haulage. Shifting (easy movement) of coal cutting machine from one panel to the other panel is not practicable.

→ Crushing of barriers may result in joining of two panels with consequent spread of fire (if it existed in any one of the panels) and delayed and sudden subsidence.

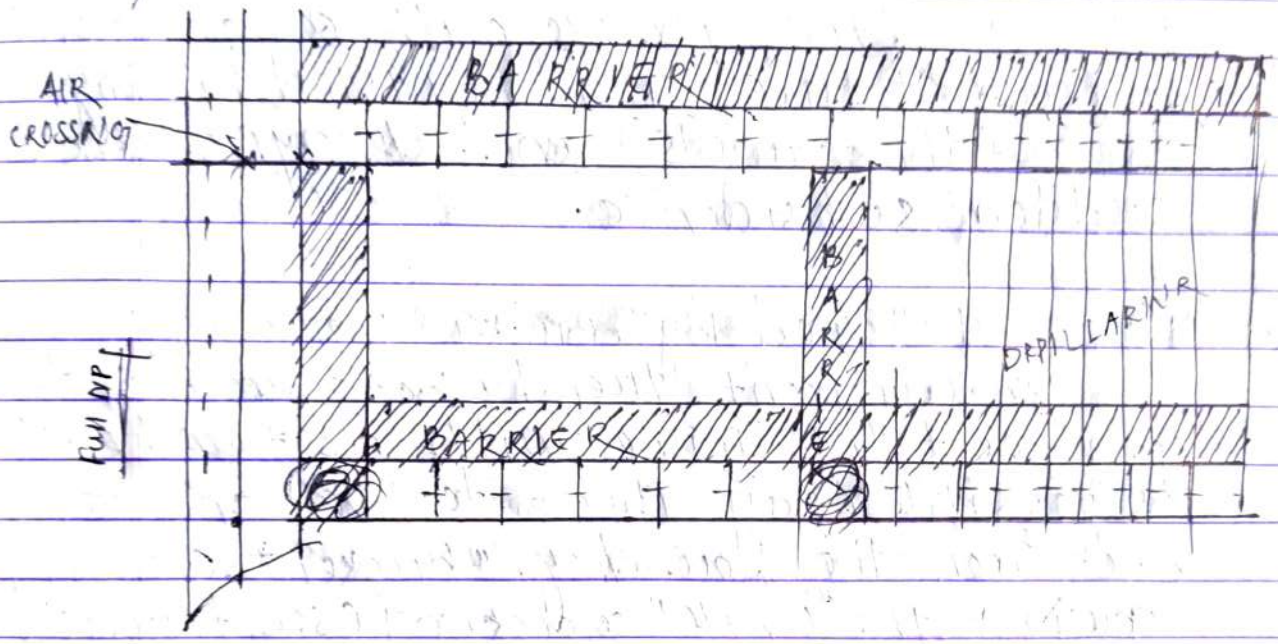
"Whole" Followed By "Broken" Workings:—

In current trend, however, is to open-out the mine with as few headings as possible (say three to five) and retreat back from the boundry, "broken" working following the "whole" working (see figure) in suitable size panels.

The system is superior over others in the following respects:

→ ventilation is efficient.
→ coal dust treatment is simpler.
→ with intensive machine mining high outputs can be obtained. Even in the opening out stage high output can be obtained using intensive mechanization and output per man shift (OMS) can be high.
→ organization is simpler.

→ As the development and extraction of pillars go together, same transport system as for development can be used for extraction work also in its retreating passage.
→ Control of fire is comparatively easy.



State and describe various Machineries used in working face:-

Various face Machinaries:-

1. Load Haul and Dumber (LHD)
2. Side Discharge Loader (SDL)
3. Gathering Arm Loader (GAL)
4. Coal Cutting Machine (CCM)
5. Continuous Miner
6. Coal Drills Machine
7. Roof Bolting Drills.
8. Belt Conveyor
9. MDCC (Medium duty chain conveyor)
10. HDCC (Heavy duty chain conveyor)
11. Scraper Loader

DEVELOPMENT :-

Development of bord and pillar working involves drivage of a set of galleries in the seam cut by another set of parallel galleries generally at right angle to them thus forming pillars surrounded by bords.

The drivage of galleries can be done in one of the following ways:

* Manual drivage, this method is now almost non-existent.
* Drill and blast, i.e., blasting off the solid and manual or mechanical loading.
* Cut and load mechanically by continuous miners.

Development By Blasting of the solid :-

→ In this method, shotholes are placed on the face by electric drills and coal is blasted off the solid, using ps explosives.

→ On a face 4.2 m wide × 2.2 m high generally 12 shotholes 1.5 m long each are drilled which yield 10-12 tonnes of coal per round of blasting and give a progress of 1.2 m.

→ Coal thus got is hand-loaded. Blasting off the solid is especially suited for drivages in steep seams in which use of coal cutting machines is difficult.

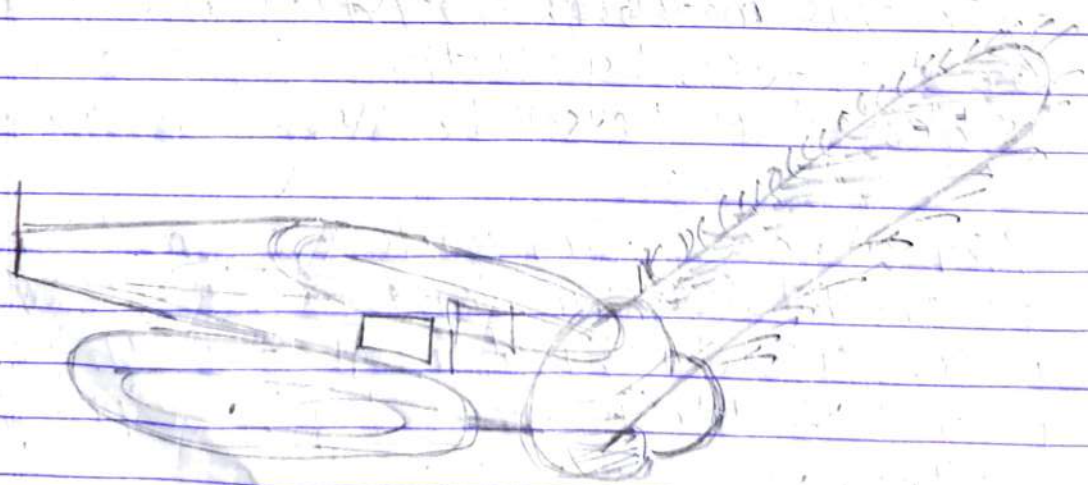
Development with coal cutting machine

→ In the development of a panel with five headings on the strike, the headings are undercut by a coal cutting machine and shot holes are then drilled and charged with explosives and blasted.

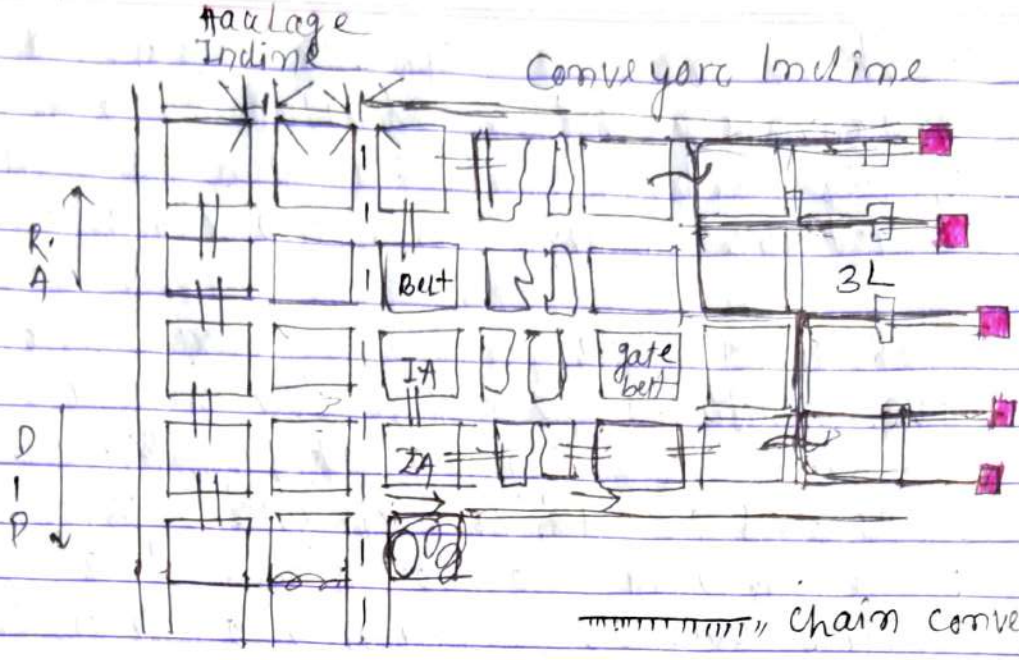
→ Blasted coal is hand loaded on to scraper chain conveyors which transport the coal from the face to a central belt conveyor.

→ The central belt conveyor conveys the coal to the pit bottom.

→ Each heading can be cut twice a shift, thus making a progress of 3 m per shift.



(Coal cutting machine)



(Development with Coal Cutting Machine)

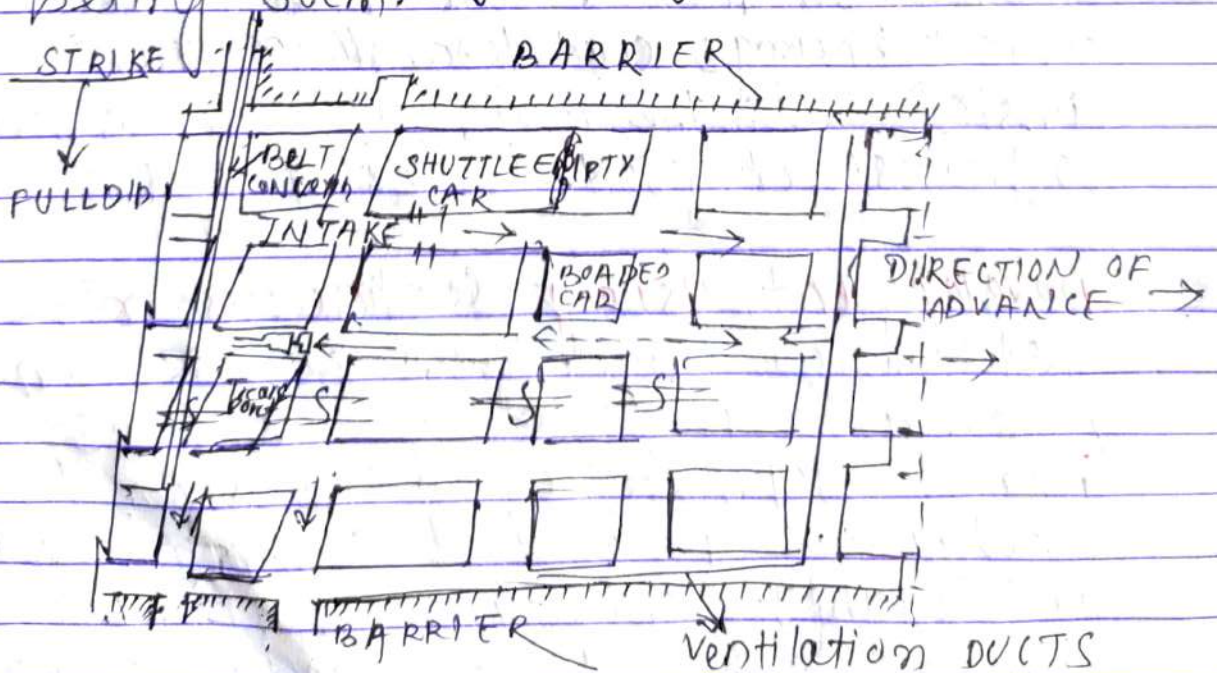
→ The equipments used are Coal cutting machine, hand held electric drill, chain conveyors, and a central belt conveyor which brings coal to a direct rope haulage installed in the main dip of the district to transport coal to the pit bottom.

Development using Continuous miners:—

→ standard continuous miners can extract Coal at a rate of up to 38 tons a minute depending upon the seam thickness. New, more powerful continuous miners are highly productive and are remotely controlled being designed for a variety of seams and mining conditions.

→ These make possible even fuller recovery of the available coal, while removing the machine operator further from the working area.

→ Following figure shows a panel with five headings on the strike in a seam 8·53 in thick dipping at 1 in 14. The galleries were 4.8 m wide x 3 m high driven along the floor and the pillars were 27.4 m x 27.4 m from centre to centre. The miner cut the full width of the gallery in two setting. first, 2.59 m was cut and then the miner was shifted to the next position to cut the other half of the gallery, the overlap being 30cm.

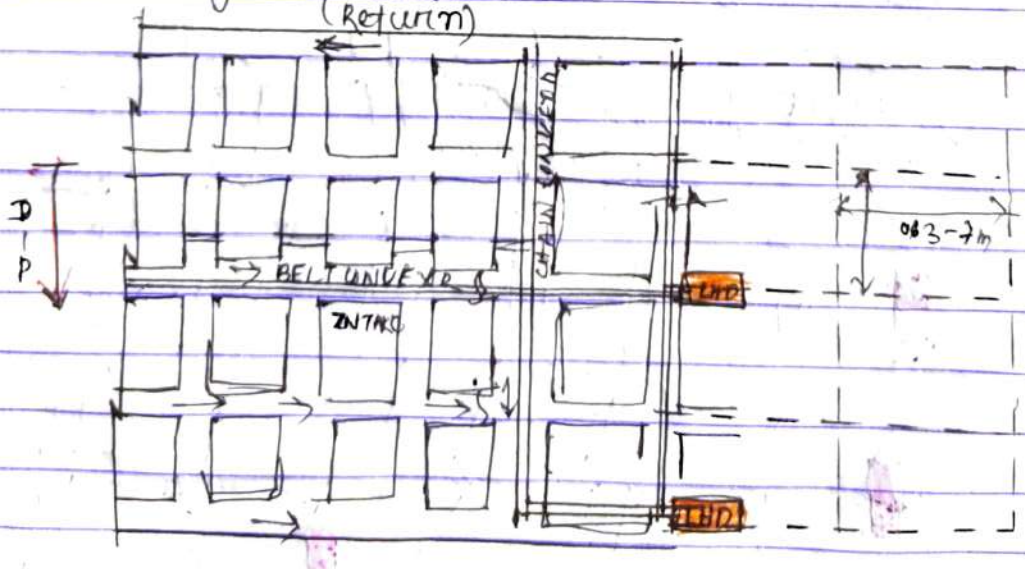


(Development with continuous miner & shuttle car)

→ The coal cut by continuous miner and loaded into a shuttle car, three of which were provided to a miner such that when one was being loaded the other was discharging coal on to the belt conveyor and the third was standing in "queue" to be loaded.

Development With LHD:-

→ Coal seam / face shall be drill by coal drills and extracted by solid blasting.
→ P-5 Explosive and delay detonator shall be used.
→ The blasted coal from face is loaded by LHD & it shall drop coal into chain conveyor.
→ Chain conveyor carried the blasted coal and drop into the belt conveyor. then the belt conveyor shall transfer the coal directly to surface.



(Developments with Load haul dumber (LHD))

DEVELOPMENT WITH GATHERING ARM LOADER:-

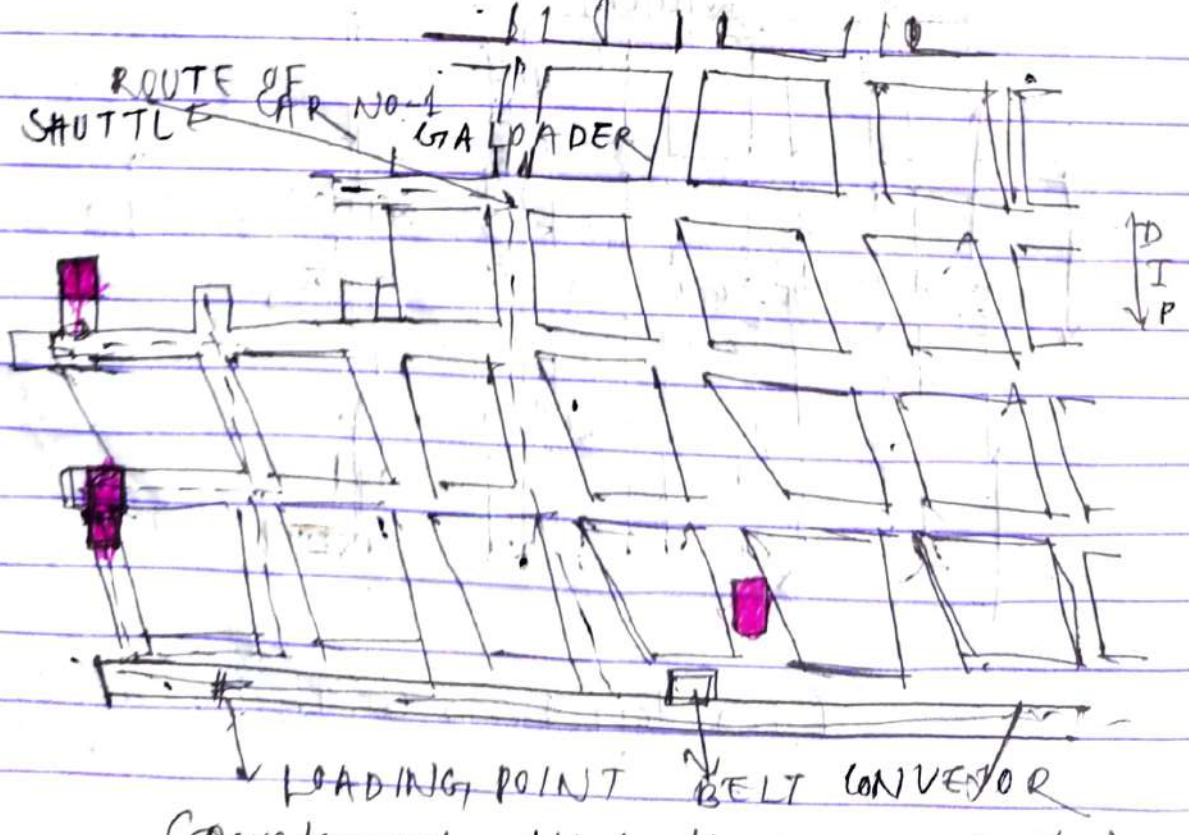
→ The development board & pillar with conventional blasting and loading and transport with gathering arm loader and shuttle car combination.

→ This is applyed where seam 2.5 to 3m thick and nearly flat (1in 20) was developed with 6-7 heading panel.

→ panel length varies 1200m to 1500m and pillar length varies 30 to 35 m

→ Initially face are cut by CCM. then blasting with the conventional method and finally by the loading out operation by means of gathering arm loader.

→ The latter machine feeds alternatively two shuttle car which carry the coal and transfer to belt conveyor.



(Development with Gathering arm loader)

DESCRIBE DEPILLARING METHOD WITH STOWING AND CAVING:-

Pillar Extraction:-

→ After pillars have been formed on the bord and pillar system, consideration has to be given to the extraction of coal from the pillars; the operation is known as pillar extraction. It is also referred to as depillaring, pillar-cutting or broken working.

→ Basically pillar can by extracted by two method.

(1) Depillaring by caving:-

The coal of the pillars is extracted and the roof is allowed to break and collapse into the voids or the decoaled area known as goaf. As the roof strata about the coal seam break, the ground surface develops cracks and subsides, the extent of damage depending upon depth, thickness of the seam extracted, the nature of strata, thickness of the sub soil and effect of drag by faults.

(2) Depillaring with Stowing:-

Depillaring with stowing is a method of pillar extraction in which the goaf is completely packed with incombustible material and in generally practiced where it is necessary to keep the surface

and strata above the seam intact after extraction of coal.

STOOKS:-

In the process of depillaring a pillare is formed during development is split in 2 to 4 parts depending on its size, these part of pillars are known as stooks. Then stooks are extracted one by one.

Method of extraction of stooks:-

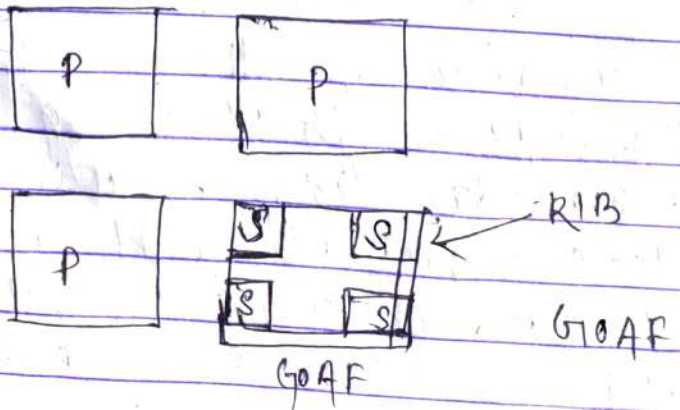
Basically three types of method are used

1. Attacking of entire stooks.
2. Half-moon method.
3. Fender (chowkidar) method.

(1) Attaking of entire stooks:-

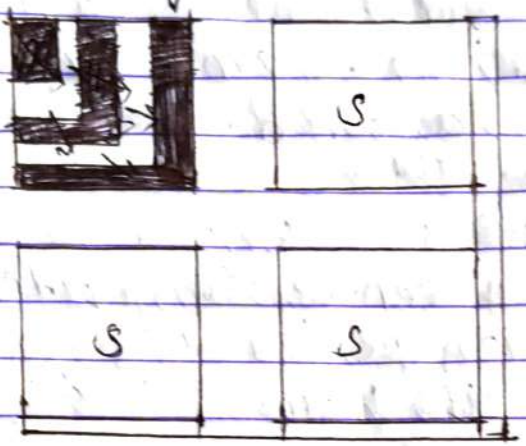
→ Where roof is good leaving a rib of 2m against a goaf, the stoks are extracted from two side.

[Rib- A long rised piece of supporting material in particular]



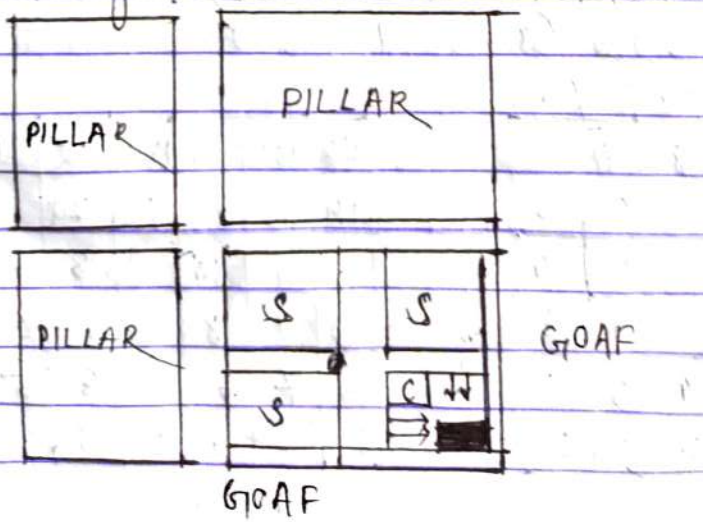
(2) Half-moon Method:-

For good roof stock is attacked from corner in half moon fashion, leaving 2m rib against the goaf. At the end these rib are thinned down as much as possible as per safety.



(3) Fender (chowkidar) Method:-

For bed roof leaving a 10m x 10m fender at corner and 2m rib against goaf, the stock is attacked from two side, on return the rib are thinned as much as safety permits and at the end the fender is taken out by half moon method.



PRINCIPLES OF PILLAR EXTRACTION & TECHNIQUES:

The principles of designing pillar extraction techniques are as given below.

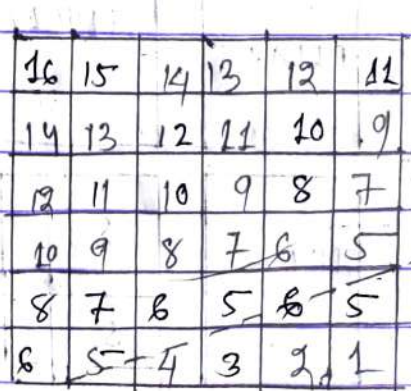
1. Roof exposure at any one time should be minimal. In the Indian coalfields, where caving is practiced, 60 - 90 m^2 exposure is normally allowed.

2. The size of panel should be such as depillaring can be completed within the incubation period. This period commonly varies between 6 to 12 months.

3. The extraction line or goaf line should be so arranged as to facilitate roof control. In practice a diagonal line (Figure A) or step diagonal line of the figure B) is common.

Goaf Line :- A line passing through all the corners of stook under extraction at a time is called line of extraction or goaf line.

(Fig - A)



(Fig - B)

Diagonal or step diagonal line of face provides protection as the working places are supported by solid pillars and also when the roof caves, there is less risk of goaf flushing into the working faces. It is also claimed that diagonal line of extraction helps in the caving of the roof.

→ In the panels worked in conjunction with hydraulic sand stowing step-diagonal line of face is preferred as it facilitates water drainage without flooding the working faces in the lower level.

→ The single-lift extraction is limited to heights of 4·8 m or less. If the thickness of the seam is more than 4·8 m, the extraction is done in multi-lifts and in that case hydraulic sand stowing is insisted upon. Seams upto 4·8 m thick can be mined by caving in one pass.

→ Whatever the method of extraction, the working area is systematically supported by cogs and props.

→ In special cases a steep diagonal line of face (fig·C) or even straight line of face (fig D) has been selected.

16	14	12	10	8	6
15	13	11	9	7	5
14	12	10	8	6	4
13	11	9	7	5	3
12	10	8	6	4	2
11	9	7	5	3	1

DIP

(FIG. C)

6	6	6	6	6	6
5	5	5	5	5	5
6	6	6	6	6	6
3	3	3	3	3	3
2	2	2	2	2	2
1	1	1	1	1	1

DIP

6	5	6	3	2	1
6	5	6	3	2	1
6	5	6	3	2	1
6	5	6	3	2	1
6	5	6	3	2	1
6	5	6	3	2	1

DIP

(FIG-D)

FACTORS INFLUENCING CHOICE OF PILLAR EXTRACTION TECHNIQUES:-

(1) Thickness of the seam If the thickness of the seam is 4.8 m or less, depillaring with caving in one slice may be done. In seams more than 4.8 m thick, pillars must be extracted in lifts in conjunction with stowing. The lift same normally 3m thick or so. The last lift may be upto (4) 8 m high and could be extracted by stowing or caving.

2. Depth of the seam At greater depths, the

pillars must be larger and they are extracted in conjuction with stowing. splits have to be driven on the strike.

(3) Roof of the seam for successful depillaring roof must cave regularly. A roof with compressive strength of less than 500 kg/cm² is normally a cavable roof.

(4). Incubation period of the seam A coal seam with longer incubation period may be extracted in larger panels. To achieve the same effect, i.e to make the panel larger mechanization of operations is necessary in a seam with shorter incubation period so that rate of extraction is increased.

(5). Dip of the seam In steeply inclined seam special techniques of extraction have to be.

Describe Depillaring Method with caving:—

IN THIN SEAM:—

→ Depillaring in thin seams (say up to 3 thick) can be done with caving with diagonal line of face.

→ The pillar formed during development a split into small pillar called stooks.

→ A gallery is driven in the pillar for this purpose is called split.

→ A pillar was divided into four stooks by driving dip and rise and strike splits.

→ As per CMR splitting of a maximum of four pillars, when pillar extraction is to begin.

→ Pillar shall be extracted as per the goaf line, goaf line shall be such as prevent extension of a collapse or subsidence of the goaf.

→ Stooks were extracted by blasting off the solid and the blasted coal was loaded into tubs or conveyor.

→ Area under extraction and upto two pillars shall be kept supports as per the approved SSR (systematic supports rules).

→ Once extraction of a stook is commenced, the extraction work shall be done as fast as practicable and soon after completion of extraction, the support shall be withdrawn to permit fall of roof.

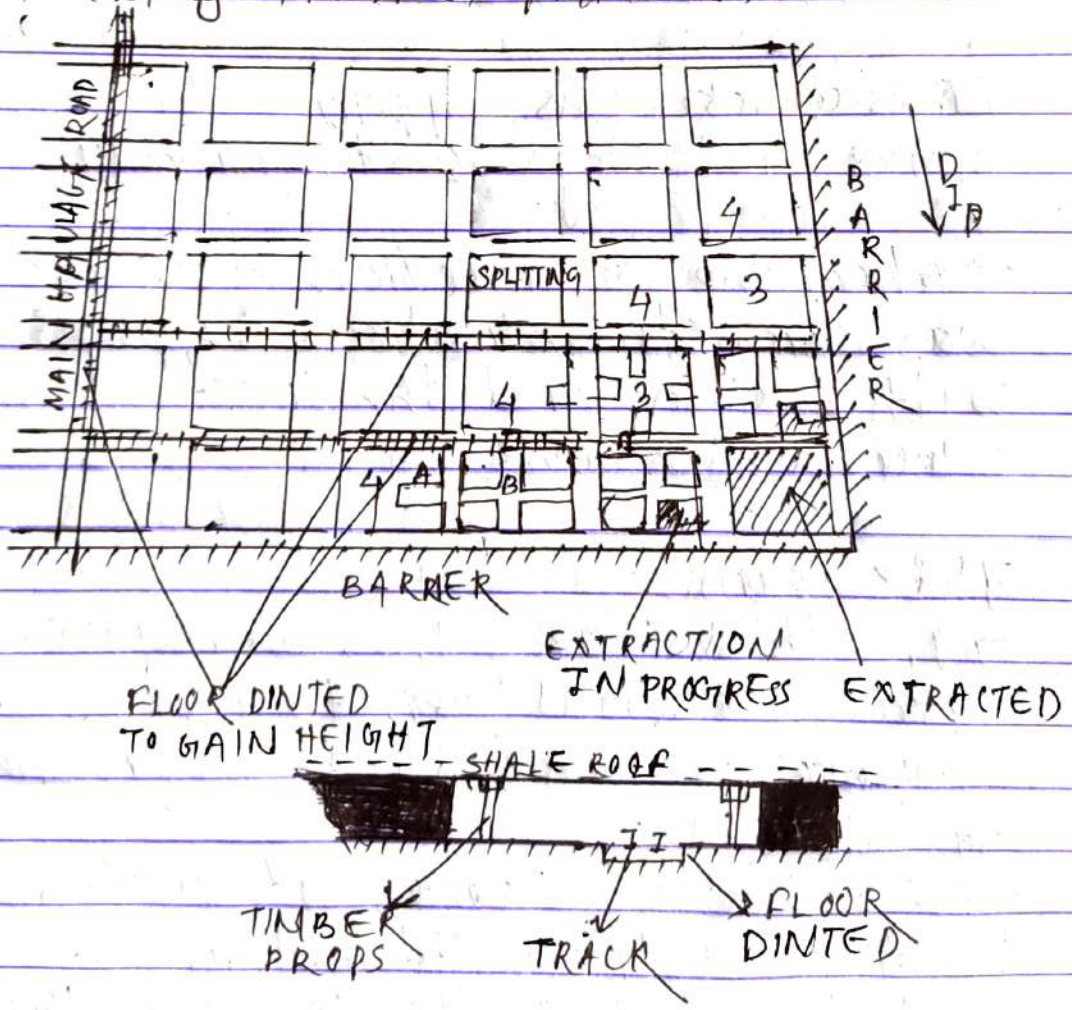
→ No support shall be left standing

in the goaf, If a reason a chowkidar or rib is to be left un extracted, it shall be blasted so as not to prevent collapse of the roof.

→ On getting symptoms of fall of roof all persons shall be withdrawn to a safe place.

→ As soon as work of extraction in the panel is completed, it shall be sealed by closing stopping and the roof was allowed to cave in.

Following figure illustrates the sequence of extraction of pillars:—



COAL seam 3 to 4.5 M thick:-

→ Here pillar was divided into three stooks by driving by dip splits.

→ Each stooks was then extracted by slices from split gallery leaving rib against the goaf.

→ A steep goaf line of face was maintained.

→ After driving the slice to full length the rib is reduced as per safety permitted.

→ The working is supported by wooden props and logs systematically.

→ When the extraction of a slice was completed, timbers supports are withdrawn and the roof was allowed to cave.

THICK seam:-

→ In thick seams the widespread practice has been to divide the pillars in four stooks (equal quarters).

→ Each stook was extracted by blasting of the solid. After the withdrawal of the timber the roof

was allowed to cave.
→ Methods such as the above resulted in heavy losses of coal and quite often led to spontaneous heating of coal.

→ Adverse strata control problems always existed and, in some case premature collapses occurred. Hence, this method is not practiced these days.

FALL OF ROOF :-

(1) Local Fall :-

→ In depillaring district, after supports have been withdrawn from an extraction area (stook or slice), the roof fall called Local fall.

→ It does not extended to the surface and roof rocks up to only a few meters break and fill up the goaf.

→ Local fall takes place in 24 to 48 hours of the withdrawal of support.

(2) Premature Collapse :-

→ In depillaring by caving, after extraction of a stook or slice the supports are withdrawn and the roof fall occur in goaf faces after sometimes is known as normal fall.

→ When sufficient large number of

pillars is extracted the roof fall is unexpected and dangerous called premature collapse.

(3) Over-riding pillar:-
→ If the pillars are not strong enough, they may be crushed due to sudden heavy pressure known as overriding pillar.

(4) Main fall:-
When the goaf of a caving district extends over a large area, the face in the goaf reached the surface which is then crack and sudden fall known as main fall.

→ Main fall occure comparatively short time.

Describe depillaring Method with stowing:-
→ pillars in coal seams more than 4.8 m thick are normally extracted in conjunction with hydraulic sand stowing in lifts of 3m or so. stowing is adopted for better roof control and as a precaution against spontaneous combustion which are more frequent in thick seams. Also, stowing results in improved percentage recovery and conservation.

→ Basically, the method of extraction of pillars with stowing is similar to that with caving excepting that -

(i) The area of exposed roof at any one time may be slightly more than that exposed with caving; with stowing the exposed area of about 100 - 150 sq m may be permitted.

(ii) The line of extraction is usually kept step-diagonal to facilitate drainage of water so that working faces are not flooded.

→ Take example of 14.6m thick seam following figure illustrates the method of extracting pillars by using stowing method.

→ The dip of the seam is 1 in 6.

→ The seam was developed on board and pillar method in two sections (a) along the floor and (b) along the roof with 1.82 m coal left in the roof.

→ The pillars were of 24.35 x 24.35 m from centre to centre. As shown in given figure, a level split was driven in the pillar to be extracted, dip and rise

slices approximately 4·8 m wide were then taken from the original level up to half the distance of the pillar.

→ After extraction of the slice the void was stowed solid with sand leaving a rib of 1·8 m.

→ The next slice was then taken and so on.

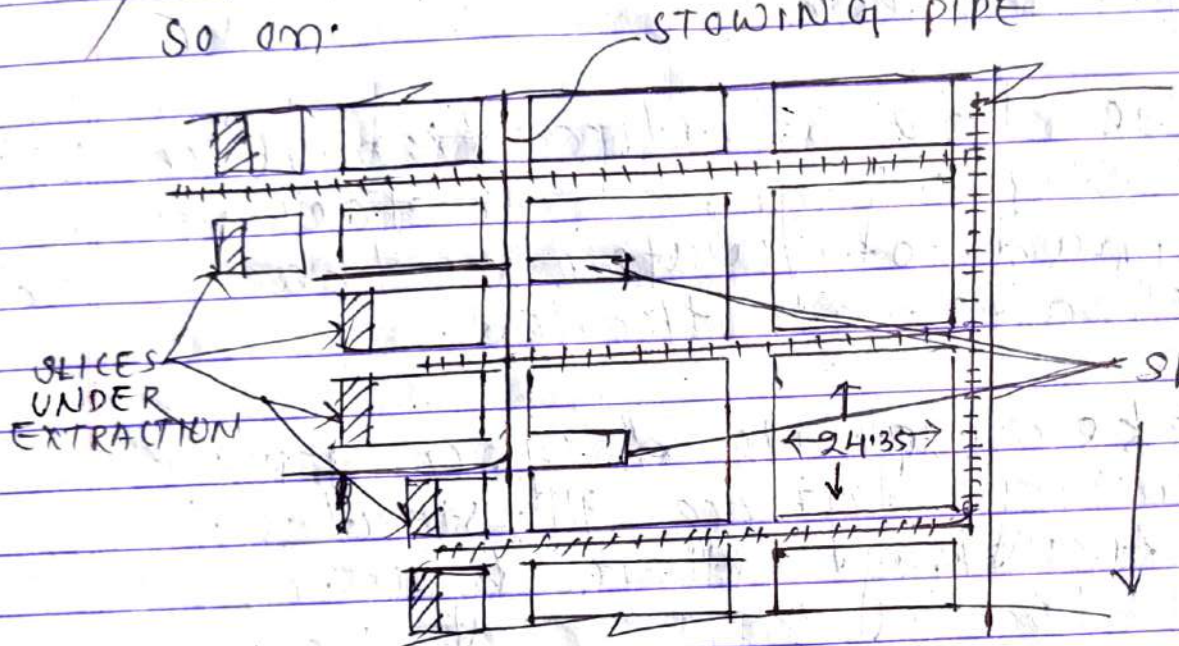


FIG- EXTRACTION of PILLARS IN A THICK SEAM WITH STOWING

→ The diagonal line of face was maintained the working face in the dip level being kept in advance of the upper level face by half a pillar i.e by 9-15 m.

→ After the first lift of all the pillars in a panel was extracted and coal replaced with sand up to a height of 9·43 m, the second lift was developed over the stowed goaf of the first lift and was extracted

from top section already developed initially below which about 3m coal was left to form a solid floor.

SPONTANEOUS HEATING:-

→ The process of self-ignition of coal due to due to oxidation resulting eventually in its ignition is known as spontaneous heation.

Incubation period:-

→ It is the period between, when the coal is first subjected to condition favorable for spontaneous heating and the time indication of heating.

→ The incubation period changes from coal and place to place.

→ For Indian Coals the incubation period varies 6 months to 12 months.

INUNDATION:-

The sudden inrush of water and flooding into the mines and the overspread with water everywhere known as inundation.

state precautions against fire and water during and after depillaring:

state precautions against fire during and after depillaring:-

(i) coal shall be worked in panels system with proper barrier, depillaring shall not started without making isolation stopping and preparatory stopping.

(ii) pillar extraction shall be completed within the incubation period.

(iii) production need to speed extraction.

(iv) Minimum amount of coal left in the coal.

(v) In every depillaring district shall be tested (co (white damp) at least once in 7 days;-

(vi) Adequate and sufficient arrangement shall be made in every mine for early detection control and extinguishing any fire.

(vii) Good construction and regular inspection of isolation stopping.

(viii) Regular air sampling and analysis to keep a watch on condition of sealed off area.

(ix) Not leave any coal in the goaf as far as possible.

(x) No person shall light a fire or permit a fire to be lighted in any working belowground.

State precautions against water during and after depillaring:—

Before extending working when depillaring zone is within 60 m of any working which containing water, permission shall taken from chief inspector of mines.

following instruction given by him:—

(i) whenever seepage of water in any seam found which is not normal, the working shall be immediately stopped and chief inspector and regional inspector shall be informed

(ii) Depillaring below a water logged area should be avoided. (If possible stream, river, pond etc. on the surface should be diverted).

(iii) If overlying strata containing a water bearing layer, unless pumping capacity is adequate, no caving method should be adopted.

(iv) No depillaring operation conducted,

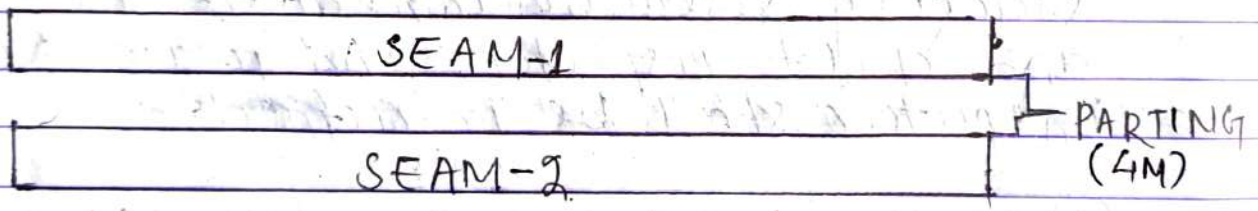
which area likely to be cause subsidence of the surface which below the highest flood level of river, lake or stream.

(v) When depillaring in bottom proceed from dip to rise, the top seam may be dewater.

Define contigous seam:-

→ When parting between two seams is less than 9m, they are called contiguous seam.

→ For development of both seams at a time or one by one, permission has to be taken from DGMS.



Describe working of contiguous seam:-

Working of contiguous seam:-

→ The Method of extraction of contiguous (very close or connected) seams depends primary on the thickness of the parting. As has been stated earlier, development galleries are driven in the seems such that galleries and pillars are vertically coincident.

→ First permission shall be taken from DGMS for working on contiguous seam.

→ If the stone in the parting between the two contiguous seams, less than 1 m thick only one seam is developed and the two seams are treated as one seam during pillar extraction. The stone parting is blasted is blasted out and thrown in the goaf.

→ If the stone parting is between 1 and 3 meteres so that it is not economic to blast out the stone the seams or sections are depillared simultaneously, that is, the depillaring is conducted in the two seams or sections such that the line of extraction of the lower seam is vertically (or nearly so) below that of the upper seam.

→ According to CMR 2017 Reg. 99 pillars shall be developed 30 m x 30 M with gallery 4 m width.

→ Development shall be as per the approved layout. panel barrier in the two seam shall be kept vertically coinident.

→ where parting is less than 3 m, coal shall be left in roof of the bottom seam.

→ For convenience of ventilation haulage, pumping and supervision, the two seam shall be interconnected by necessary number of staple pits / drifts.

→ Working of both seams shall be under the charge of same overman.

~~→ Any new face shall be under of charge of same overman.~~

~~→ Any new face shall carried out survey once in a week.~~

→ The surveyor shall carried out survey once in a week

→ Any new face shall be open only after the surveyor shall give a centre line.

→ The withdrawal of supports is done simultaneously.

→ If the top section supports are withdrawn before those in the lower, the roof fall in the top section punctures the parting and affects the bottom section's supports.

→ If bottom seam supports are withdrawn first, the parting may collapse and supports in the top section may be lost in the collapse.

→ Coal of both the sections is loaded at one point wherever possible.

→ When the stone parting is thicker than 3m the two seams are developed with galleries and pillars vertically (coincident (development shall be pillar over pillar and gallery) either throughout the mine or a panel of two seams (at) and extraction proceeds in the same time almost simultaneously with line of goaf in the top seam not more than one or two pillar ahead of the bottom seam line of goaf.

Describe Working of seams above and below Goaved out area:-

Working of seams below Goaved out area

→ The extraction in the lower seam should be conducted under a settled goaf of the top seam so that the parting is not subject to impact of kinetic forces.

→ A period of 3 to 5 years is considered sufficient to allow the goaf to settle.

→ Steps should be taken to prevent inundation from water logged top seam goaf.

→ The main fall is much quicker if the top seam is goafed and extraction must be planned with this in view.

→ Heavy timbering support is essential because of the weight of top seam goaf.

Working of seams Above Goaved out area

→ Under CMR 2017 Reg. 104 no work in a higher seam shall be done over an area in the lower seam goaf.

→ The working of upper seam is possible only when it is virgin and lower seam to settle down.

→ If the parting between the seams is 30 m or more than only such attempted is made.

→ If the top seam is developed before depillaring in the bottom seam, roof of top seam develops numerous cracks and it is too dangerous to work in top seam.

State Advantage and dis-advantages of Bord and pillar Method:-

Advantage of B&P Method:-

(1) Working performance is smoother and more convenient.

(2) Production of coal starts during development stages.

(3) Roads are made up of solid coal thus maintenance cost is low.

(4) No unproductive work is involved.

(5) Railway, river mega structures are not disturbed by this method of mining.

(6) Supervision work becomes easy.

(7). It required slow capital investment and very simple equipment.

(8) Working plan was much simpler.

(9) It gives highest coal recovery.

Dis-advantage of B&P Method:-

(1) Ventilation work becomes sluggish due to greater percentage of air leakage.

(2) The greater risk of fire spreading in the whole mine.

(3) OMS is less.

(4) The work is scattered.

(5) Treatment of coal dust is costly and difficult.

CHAPTER-5

HORIZON MINING

State conditions, advantages, dis-advantages and limitations of horizon mining:-

Horizon Mining:-

Horizon Mining is a system of mining which coal seams are opened up by level roads driven in the rock, the system consists of more then one level means all main and secondary roads driven at the same depth or in the same horizon.

Applicability condition:-

(i) It is applicable to inclind undulating seams.

(ii) It is also applicable to relatively flat seams where all the coal seams are extracted between pre-determined horizon, level or plane.

(iii) The seams have medium and high thickness.

Limitations:-

(i) The seams should be steeply inclind.

(ii) There should be number of seam available.

(iii) There should be sufficient reserve.

(iv) Each horizon have a life of about 15 to 20 years.

(v) Each horizon have a life of about 15 to 20 years.

Describe the layout of Horizon Mining:-

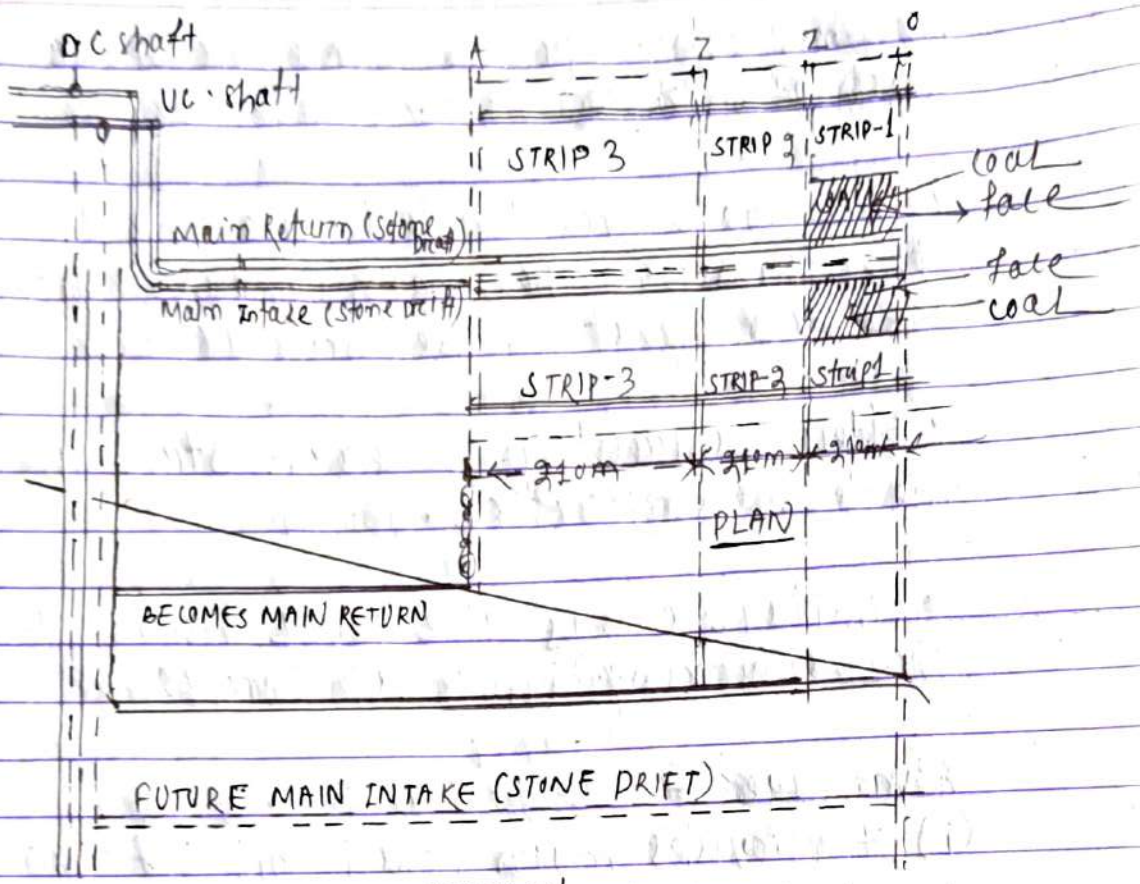
→ The first step is to drive two roadways horizontally from the shaft on the direction of the full dip of the deposit to intercept the seam in the different horizon.

→ These roadways from the main route of the mine through which coal is transported throughout the site of mines.

→ At least two leves are driven at different horizons lower level called haulage level is used for haulage and serves as intake airway and upper level called ventilation or return level is used as return and supply roads.

→ The connection is made to each of the seam laying between these two levels and the portion of seam intersect The level is divided into section by staple pit or drift or blind shaft.

→ the vertical interval between the two drift varies in different cases according to the dip of the beds, the number of seams to be worked, but range between 60 m to 200 m.



SECTION

→ The next step is to drive lateral level roadways from the seam middle at and right angle to the main drift.

→ The roadway represents the main intake and conveyor level for first working faces.

→ From end point of lower seam the coal is load into on mine car.

→ In this method, each strip of coal is worked in the way be longwall advancing method.

→ In strip 2 and 3 are conveyors the coal after reaching the seam to the main haulage.

roadway by spiral conveyor situated in each of steeple pit.

→ The coals are loaded into the tubs on the tubs on the main intake drift the transport to the surface.

→ After extraction of each strip the stowing method is practice.

→ similar ways the level horizon method are working in next horizon.

Advantages :-

(i) It provides main road for efficient and a adaptable haulage system, so high output is possible.
(ii) It makes possible high ventilation system.
(iii) Maintenance cost of roadways is low.
(iv) Easy to work in several seams.
(v) It is suited for steeply inclind and for areas of high seam density.

Dis-advantages:-

(i) High capital expenditure for development work.

(ii) It takes much longer time.

(iii) More development work required.

CHAPTER-6

HYDRAULIC AND PNEUMATIC STOWING

Hydraulic stowing:-

The filling of the waste in mine by waterborne material by pipeline.

Describe Hydraulic stowing:-

This process is widely used in India in those collieries which are situated within 16 K of rivers giving plentiful supplies of sand, the commonest stowing material in our mines.

The following factors have made stowing possible in many Indian mines:-

(1) Availability of sand from rivers flowing near the collieries within 16 km.

(2) Roof and floor of seams are not affected by water.

(3) seams not being very deep, humidity is not a major problem.

(4) Mines are usually at depths exceeding 100 m and the seams are inclined Hydraulic sand stowing is not successful where the seam is at a Low depth from the surface and is flatter than 5°,

From the stage of collecting sand at river end till the sand is packed in the goaf, the following operations are necessary:-

(1) Gathering of sand at the river bed.

(2) Transport of sand from river end to the bunkers on surface at the colliery.

(3) Transport of sand hydraulically from the bunkers to the underground stowing site through pipes.

(4) stowing of the sand in the area from where coal has been extracted

Arrangement Made for sand stowing:-

(1) supply of sand and water:-

→ sand collected from river and stone at colliery. sand bunkers by haulage

→ Supply of water pump from water reservoir or sump.

→ If possible pumping of water from river.

(2) Sand bunker and Water tank:-

→ The sand storage bunker is always situated to the rise side of the underground area to be stowed.

→ The bunker is situated on one side of a shaft and a drift inclined at 1 in 3 or 1 in 4 is driven from the mixing chamber (situated directly below bunkers)

to the shaft carrying the stowing pipe range.

→ Sand from the bunkers drops through a chute into a "mixing cone" (in fact, an inverted cone) fitted below the floor of the bunker.

→ The water is supplied by 125 to 175 mm dia. water pipes from the surface reservoirs situated close to the mixing chamber and provides sufficient head for water for flow through the pipes leading from reservoir to mixing cone.

→ In practice, sand bunkers have a capacity of 2 days' requirement of sand, and water tanks, a day's requirement.

(3) Mixing Chamber :-

→ The place where the mixing cone is located is called mixing chamber.

→ The chamber has an access either through an incline from the surface or by a cage operated by a small hoist in the case of a stowing shaft.

→ On the mixing cone there is a screen to prevent pebbles or stones larger than 25 mm size from going into the shaft.

range with sand-water mixture. These rejects have to be packed up and collected in the chamber from where they are removed to surface.

→ The chamber should have sufficient lighting and as the work goes on in humid conditions all fittings and cables should be moisture proof.

(4) Stowing pipes and their layout:-

→ The sand water slurry pipe, from mixing chamber downwards, may be installed in a borehole, in a steeply dipping stone drift or in a shaft.

→ The pipes used for sand stowing range are C.I mild steel hot rolled seamless tubes or alkathene. They have flanges for joints (except in bore holes). C.I pipes are heavy, have a low tensile strength of only 15 kg/mm² and are used for more or less permanent installations in drifts, shafts, main cross-cuts etc. their use is not favored at the face. sizes in use bore 125 to 150mm bore, 3m long.

(5) Boxing:-

→ At stowing face a barricade is made restrict stowing materials and allow water to drain out.

(6) Telephone:-
Signaling or telephone arrangement is provided for communication between the mixing cum operator and the underground stowing supervisor so the supply of sand, water, or both can be stopped or adjusted according to the underground requirements.

(7) Drainage:-
→ For proper sand stowing water drain are required.

Hydraulic stowing operations:-
→ Before a goaf is packed a boxing (a barricade of bamboo matting) should be constructed as near the face as possible, leaving space for conveyor path, coal cutting machine and roof supports.

→ on a long wall face the width between previous boxing of sand pack and new boxing under construction is generally 4 to 5 m. width smaller width of packs, cost of boxing becomes high and face work gets distrupted frequently.

→ Bamboo matting or hessian cloth, can be used 3 to 4 times and has thus an economic advantage over the bamboo matting chassin cloth

which can be used only once.

→ Wooden props or telescopic rails are erected along the new boxing line and the hessian cloth or bamboo matting is fixed to it by wire nails or strings from the floor to the roof. In some cases props are placed slightly inclined.

→ When the new boxing is complete the old boxing is dismantled and props, coir matting, planks, etc. are recovered from it, unless the old boxing is required to protect equipment of gate roads.

→ At the commencement of stowing the stowing range is extended so as to keep the end of stowing pipe nearly 7.5 m away from the dip side boxing.

→ The velocity of sand; water mixture would depend upon the pressure head available. A nozzle is attached to the pipe end to increase the throw in special cases. Without nozzle the throw in one case was 3 m but with the help of nozzle it was increased to nearly 7m.

→ The nozzle is of mild steel and tapers from 125 mm dia. to 85 mm dia. within 1.2 m length.

→ To stop the stowing, the flow of sand into the mixing chamber at the surface should be stopped first and then, after 3-4 minutes, the flow of water should be stopped first and then, after 3-4 minutes the flow of water should be stopped when the discharge through the nozzle is only of water. This avoids pipe jam.