METHOD OF WORKING

THICK SEAM MINING

BY

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NOTES ON

Thick seam mining: Bord and pillar and longwall methods in multi-section; multi-slice methods; inclined slicing; horizontal slicing and cross slicing in ascending and descending orders; under winning methods; sublevel caving; integral caving; blasting gallery

PROBLEMS ASSOCIATED WITH MINING OF THICK COAL SEAMS

Following problems are associated with thick seam mining

1) Difficulty in strata control and its monitoring.
2) Risk of overriding of pillars leading to premature collapse (in case of bord and pillar workings)
3) Low percentage extraction, usually < 50% when extraction is done by bord and pillar method.
4) Chances of high spontaneous heating because of considerable coal loss in goaf.
5) Heavier support requirement in deep seams and longwall method of working.
6) Difficulty in subsidence control due to high magnitude subsidence.

METHODS OF MINING THICK COAL SEAMS

A general classification of methods of mining thick seams is summarized in Fig. 1. Several modifications/variations to these methods are also tried in different mines.

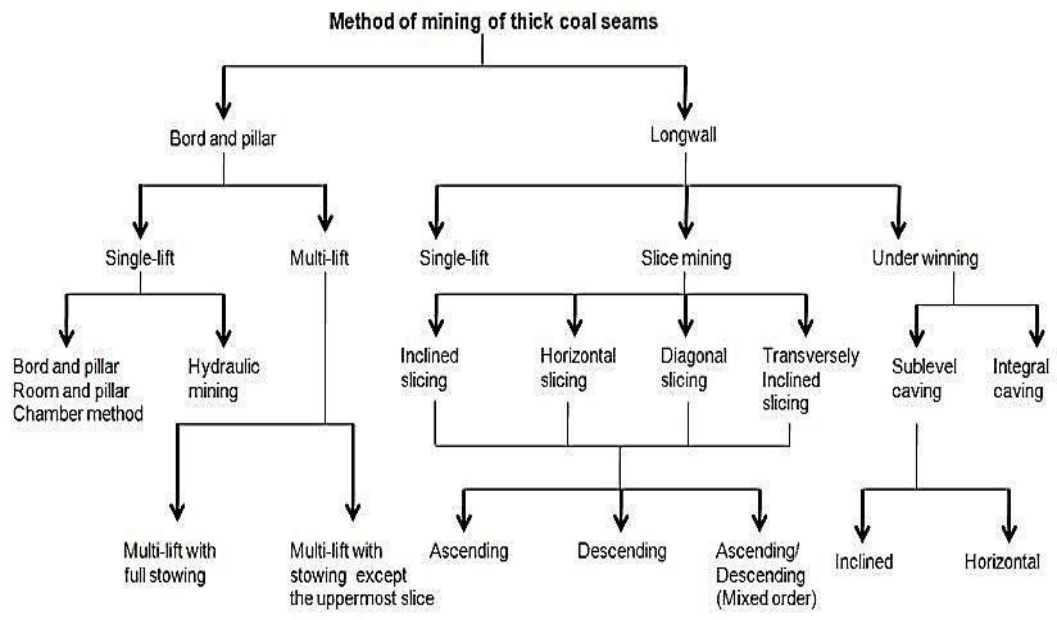

Fig. 1 General classification of thick seam mining methods (Singh, 1997)

Single lift mining is generally limited to heights of 4.8m. However, thick seams are normally mined in multi-slices. This is called slice mining, wherein each slice is mined in onepass. Working of each of slice can be either by bord and pillar method or by longwall method. In general bord and pillar method poses

greater strata control problems than longwall mining and in thick seam mining, this problem becomes very high. Further heavy coal loss takes place in bord and pillar mining. Therefore longwall mining (with multi slicing) is the preferred method of mining for extraction of coal from thick seams. This is also suitable for mining thick as well as steep seams.

Slice Mining

In this method of mining a coal seam is divided into slices of appropriate thickness and each slice is worked in a method similar to that of an entire seam having thickness same as the slice. Coal from the slices can be extracted in ascending, descending or in mixed (both ascending and descending) order (Fig. 2).

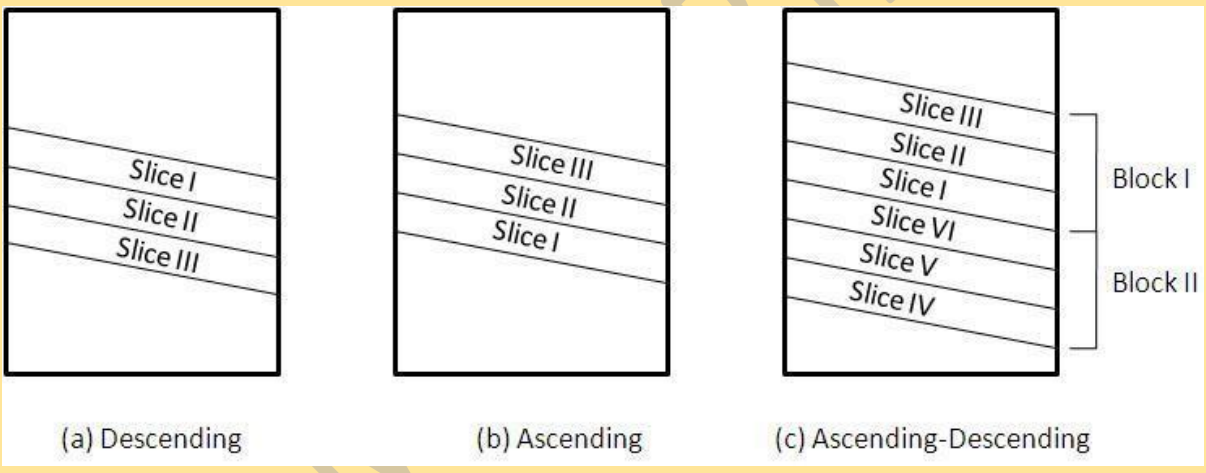

Figure 2: Different orders of slicing thick coal seams (Singh, 1997)

Descending slicing

Descending slicing can be done with or without stowing. In case of descending slicing with caving, spreading of wire netting is required to make artificial roof to arrest material of the broken goaf of the upper slice and this wire netting serves as the roof for the lower slices; i.e., lower slices are worked below the broken goaf. Stowing is rarely practiced in descending slicing(Fig. 2a).

Ascending slicing

In ascending slicing method, the first slice is the bottom most slice which is

excavated first. Working of this slice is like working a seam of average thickness. Subsequent slicing is done with stowing, i.e., the upper slices are worked on the filled surface of the bottom slice and therefore ascending slicing cannot be adopted with caving. The last slice can be worked either with stowing or caving (Fig. 2b).

Mixed order slicing

In this method coal seam is divided into blocks, each block consisting of a number of slices. The slices in the block are worked in ascending order with stowing, while the blocks are worked in descending order. This method is commonly practiced in horizontal slicing method of thick seam mining (fig 2c).

Sublevel Caving

Sublevel caving is applicable to thick seams with caveable roof and soft coal, though by blasting, hard roof can also be caved and hard coal seams can be softened. This system is consists of (i) mining a slice along the roof by normal longwall method with caving with flexible artificial roof laid on coal along the floor of the first slice; (ii) mining of another slice along the floor of the seam, and (iii) taking down the coal parting between the two slices by longhole blasting which is loaded out in a conveyor laid along the floor of the seam. Figure 3shows the method of mining a 6.6 m thick coal seam by sub-level caving. In this method a longwall face takes a slice of 1.8 m along the roof of the seam.

As the face retreats wire netting over steel bands is laid on the floor to form artificial roofing. Some 30 m behind the top face, another longwall face takes a slice of 1.8 m along the floor. The middle coal plate which is usually thicker than the top and bottom slices is mined at a distance of 3.5 m behind the floor longwall face by blasting with long shotholes drilled from under the support of the lower face. The slope of the longwall face of the middle slice should be tilted back with respect to the face by 5-10° from the vertical in the direction of advance of the face. The artificial roof prevents the caved stone from mixing with the coal of the middle plate. The mining in the lower and upper slices can be mechanized by shearers.

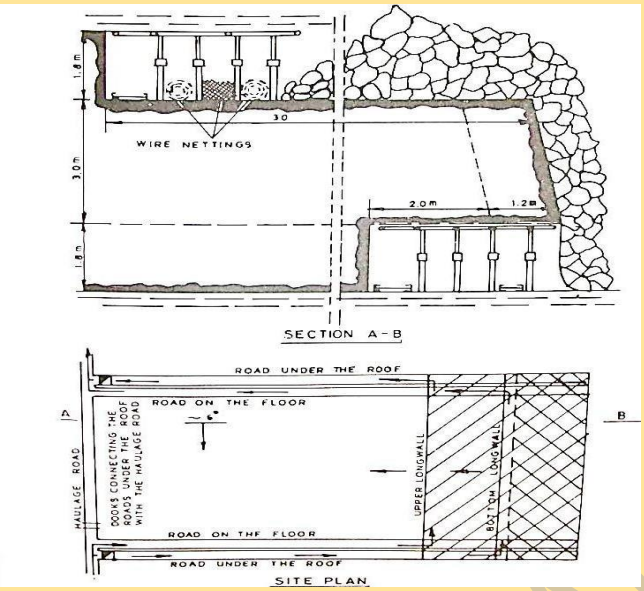

Figure 3: Diagrammatic layout of mining a thick seam by sub level caving (Kasparek1964) (Singh, 1997)

While this method is applicable to irregular seam thicknesses, it has a number of drawbacks. They are:

1) Problem of working the face at the roof if the roof of the seam is undulating and fragile.
2) Winning a previous slice cancels the effect of strata pressure. The coal to be undermined is destressed and requires shotfiring to break it.

INTEGRAL CAVING

The recent development is full 'Soutirage' working or integrated sublevel caving, i.e. recovering in a single operation all the coal of the seam from a face progressing on the floor (Bieau, 1981; Proust, 1979). Figure illustrates this system of mining. The advantages of this method are:

1. The development costs and the investment in face equipment are well below those required for the method of slices parallel to stratification, and this advantage is still further increased by the fact that greater seam thicknesses may be worked.
2. Some coal, which increases with the increasing seam thickness, is extracted by itself by the strata pressure resulting from the winning operations.

3. Automation of support system, with articulated roof bars known as 'banana.
4. Small number of faces can produce large quantity of coal.
5. Supervision is simpler and, therefore, there is greater efficiency of engineers and overmen, *etc.*
6. OMS is high say, up to 20 tonnes.

The Problems of 'Soutirage'/Integral caving working-

1. Methane emission: In gassy seams methane emission is increased because of high Assuring taking place in the sublevel coal, above and in advance of the coal face.

   As a precaution against gas ignition, in gassy mines 'camouflage* blasting should be done with small charges which will only crack the coal mass. Water infusion at low pressure to produce cracks is also helpful.

2. Risk of fire: Crushed coal left in the goaf may catch fire and as a safeguard the following precautions should be taken:
   - i. The working should be done strictly on retreat.
   - ii. There should be slight dip towards the coal face.
   - iii. This helps in goaf control and also permits firedamp or nitrogen (where nitrogen flushing is done) to accumulate in the goaf and make the atmosphere inert.
   - iv. Mud flushing of goaf should be done at intervals to seal the goaf.
   - v. Leakage of air should be eliminated.
   - vi. During holidays the panel should be sealed'.
   - vii. Working should be done in panels which can be extracted within the incubation period.

   Usually a panel length of 400 m is kept in France.

3. Dust Production: The production of dust due to ,,integral caving " may be high and. therefore; adequate counter measures have to be taken against dust production. They are (1) Water infusion from the roadway before the face passes. The infusion holes are drilled from the two gate roads and are arranged in a fan between the floor and the seam. Water infusion increases the natural moisture of coal by 1 to 3%. As a result, the airborne dust is reduced.

4. Heat in the workings: When the depth is high the temperature of the solid coal may be high the solution to the problem is: (i) descensional ventilation in the face, (ii) circulation of a large volume of air. For example, 9 m^3 of air per sec. was circulated at Darcy mine (Proust, 1979). .{You are reading it on mineportal.in} Due to the chimney effect in the sublevel roadways this has the additional advantage of circulating air with relatively low oxygen content at the point where the risk of heating is greatest.

5. Maintenance of gate roads in advance of the face: Road maintenance is difficult due to high convergence. The problem in French mines has been solved particularly by adopting the principle of a double system of roadways in the rock set in the floor of the seam. Sections of the top and bottom roads, driven a very short time before they are used, are linked to this system this length which is relatively small, is inversely proportional to the thickness of the seam.

6. Difficulty in coal face mechanization: There is considerable difficulty in mechanizing coal mining at the face because the roof may be friable and also the coal face is subject to a spill out. Investigations done at the face reveal that:

1) The magnitude of strata movement appears to be clearly linked to the thickness of the seam. Mechanized working of a seam 5-8 m thick is easier than that of a seam 10-15 m thick.
2) Measurements of horizontal expansion show that above the powered supports there is only a more or less deconsolidated mass of coal which tilts progressively 'Soutirage" working, being pushed by the expansion of the beds which occurs at the coal face, in the non-supported zone, and even in advance of the face.
3) Measurements of vertical expansion show that the roof of the seam follows appreciably the same curve as the crown of the coal face.

Blasting Gallery

In this method a seam is developed into panels of about 100 m x 50 m. From the main headings rooms are driven to the full width of the panel and the coal between the rooms is blasted down to the full thickness of the seam and loaded

by remotely controlled loaders. Figure shows the layout of a panel for working by sublevel caved rooms and Figure9 illustrates the sublevel caved rooms. The general line of caving forms an angle of 30-45° with the direction of rooms.

The life of the rooms should he kept as short as possible **so** that they do not undergo excessive convergence and the movement of the vehicles is not rendered difficult. The advantage of this system of mining is as follows:

It makes it possible to win narrow panels or larger panels in which the seam conditions (faults dip) arc unsuitable tor a longwall face .It does not require highly experienced workers as a longwall face with 'Soutirage' working .It requires substantially less investments than those required for a longwall with 'Soutirage" working and the equipment required i.e., heading machines or jumbos and LHD can be easily transferred to other roadways if the method is unsuccessful. Thick seams up to 15 m in thickness can be extracted in one pass with percentage extraction ranging from 65 to 85%.The method is highly flexible in that in a district with several units in operation, even if one of the units is under breakdown, production from the district will continue to come. The time required for preparation of a panel in relation to the total life of the panel if less than with other mechanised methods.

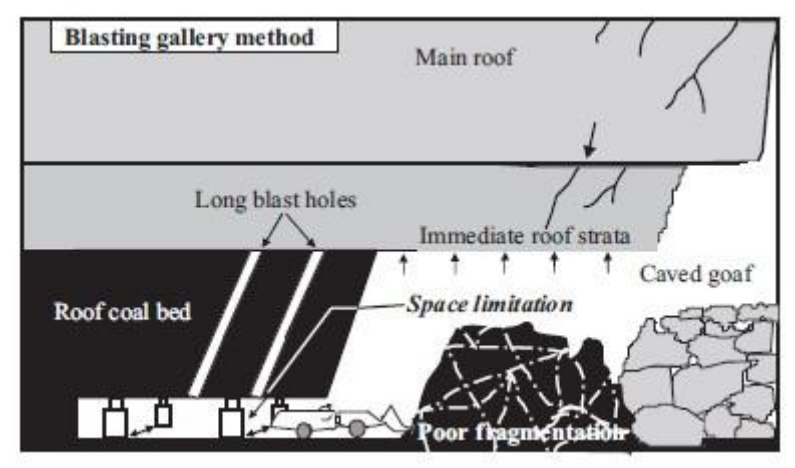

Figure 4: Blasting gallery method

Thick Seam Mining With Cable Bolting

Location: NCPH mine, Chirimiri, SECL
Method: The seam was parted by graphite band so it was very difficult to control the roof. Hence they drilled large holes in the roof and long cable bolts were installed to hold the graphite roof. The seam was blasted in steps and the coal is extracted.

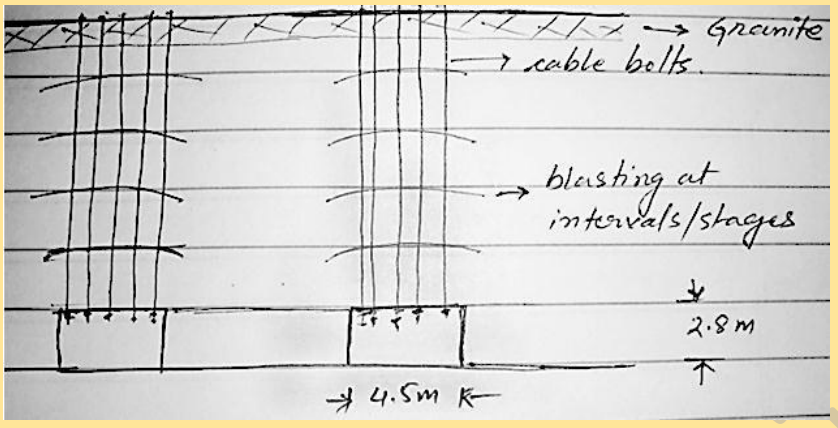

Figure 5: long cable bolts for stage blasting

The seam is extensively developed on bord and pillar pattern, pillar size varying from 20 to 30 m centres along the floor upto 3 m height. Depillaring by splitting and slicing was planned by conventional cycle of drilling and blasting and manual loading of coal into the mine car tubs, tubs being hauled by trolley wire locomotives to the surface. .{You are reading it on mineportal.in}After explosions of three panels by 1985, scraper was introduced for face loading. The conventional method was associated with;

a. Unsafe workings due to progressive failure/separation of coal band along the roof because of poor cohesion, side spalling, ineffective support beyond 4.5 m high roof and
b. Fire hazard due to about 60% loss of coal in the goaf.
