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# Method Extraction of Lower and Upper Coal Seam in Indian Coal Mining Operations

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**Abstract:** *Underground mining methods are still used to excavate large proportions of coal in India. This accounts for up to 70 % of the total coal produced. The opencast is only profitable up to a certain depth; below that underground mining is the only profitable alternative. So more effective underground mining methods are required to be searched for and presented. When two seams are above one another, the workings in one tend to affect the working in another. In India coal seams that are near to one another such that the parting thickness between them is below 9 m are called contiguous. Coal mine regulation number 104 of Coal Mine Regulations, 1957 apply to such seams. First extraction in the upper seam then followed by the lower seam, first extraction in the lower seam then followed by extraction in upper seam or simultaneous extraction of both the seams. In India such seams are extracted preferably by caving or stowing. For such seams when extracted the pillars of one seam shall be vertically above or below the pillars of other seam. The evaluation was carried at two stages of mining, i.e. at development stage and after extraction of two and a half pillars with a single rib left.*

## I. CONTIGUOUS SEAMMINING

The working of the seams may get affected if the distance between the seams is small. If there are two seams in such a manner that one seam is directly above the other one being worked, then the working in the top seam will definitely get affected. An example can be found in Raniganj coalfields where the working of Ponoati seam has severely affected the excavation in the working of the Koitheer seam, which is about 40-45m above the former. Another example is Donets coalfields in former U.S.S.R. Here “under mining” took place. According to one formulae by Shevyakov, 1958, if the distance between the two seams is lesser than  $12h + 3.5h^2$  (h, being the height of the seams in metres) then there remains a chance of under-mining.

If the seams are steep and the parting between them is small then even working in the upper seam may cause under mining in the lower seam. It has been shown by Scurfield, 1970, that in British coalfields, the pillars left in a seam 274 m above the one being worked has affected it.

In India seams that are below 9 m apart are called contiguous seams. For such seams, their workings have to abide by several statutory requirements that have been mentioned in Regulation 104 of Coal Mine Regulation, 1957. According to it, no work in a higher seam or section shall be done over in an area in a lower seam or section which may collapse. Also, it further mentions that where two or more such seams or sections are worked in a mine the pillars in one seam or section- shall, as far as practicable, be vertically above or below the pillars in the other seam or section unless the strata are inclined at an angle of more than 30 degrees from the horizontal, and the parting left between any two of such seams or sections shall not be less than three metres in thickness at any place.

### A. Possible Alternatives for the Extraction of Contiguous Seams

Contiguous seams can be extracted in three possible ways:

- 1) First extraction in the upper seam then followed by the lower seam.
- 2) First extraction in the lower seam then followed by extraction in upper seam.
- 3) Simultaneous extraction of both the seams

### B. Extraction in the Upper Seam followed by the Extraction in Lower Seam

The following effects appear if the upper seam is worked prior to the lower seam:

- 1) The roof in the upper seam get settled.
- 2) The gob of upper seams may get filled with water.
- 3) If the seams are highly inclined and parting is less then there are possible chances of undermining. Also the strata breaks may extend from the upper seam to the lower seam and affect mining.

- 4) Crushing may occur if the parting between the seams is too less. As a result the goaf area of upper seam may puncture into the lower seam.
- 5) Migration of gases as firedamp, etc. may take place from lower seam to the upper seam, which may benefit us for a gas free lower seam working.
- 6) If we work out the upper seam first then distressing takes place in the lower seam giving us advantage if lower seam is prone to bumps.
- 7) More amount of subsidence and angle of draw may be faced for working under a ground broken by the upper seam working.
- 8) The lower seam cannot be worked until the upper seam has been completely exhausted.

*C. Extraction in the Lower Seam Followed by Extraction in the Upper Seam*

The following effects are to be expected for working in lower seam prior to the upper seam.

- 1) Undermining in the upper seam may take place. Problems as Uneven gradients, floor lifts and fractured roof may be faced while working in the upper seam as a result of prior excavation of the lower seam. Controls of such problems are extremely difficult.
- 2) Roof may cave even in the upper seam if the parting is less and as a result pillars may be lost forever.
- 3) Working in the lower seam may cause bed separation in the upper seam. This may prove to be advantageous while blasting of rocks.
- 4) If the parting is less then both seams can be worked out with one and same roadway and even if the lower seam has thinned out in certain areas, still its working will remain possible.
- 5) The surface effect in the seams may be violent but short lived if the working in the upper seam followed quickly the working in the lower seam.

*D. Simultaneous Extraction in Both the Seams*

The following effects may be observed if the workings in both the seams are carried out simultaneously:

- 1) A good roof control can be obtained.
- 2) If working in the upper seams is done first there is a chance of inrushing water. But in this method it is possible to liquidate both the seams without any risk of such an inrush.
- 3) Even though the surface effects are violent, they are short lived. The surface in both the seams settles down quickly.
- 4) Since there is a simultaneous extraction of both the seams, a high output is obtained.

All the alternatives can be applied as per the requirement of the situations. None of them are universally applicable. Generally the extraction is preferred if done in a descending order along with caving. In India, regulation 104 of Coal Mines Regulations, 1957, is applied when working with seams of contagious nature.

## II. COAL MINE REGULATION 104

Coal mine regulation number 104, states that for a Multi-section and contiguous workings –

- A. “No work in a higher seam or section shall be done over an area in a lower seam or section which may collapse.
  - 1) No workings shall be made in more than one section in any seam, nor shall workings made in any two seams lying within nine metres of each other, without the prior permission in writing of the Chief Inspector and subject to such conditions as he may specify therein.
- B. Every application for permission under the sub-regulation shall be accompanied by two copies of a plan showing the proposed layout of the workings, a section of the seam or seams, the depth of the seam(s) from the surface, the rate and direction of dip, the proposed dimensions of pillars and galleries in each seam or section, and the thickness of the parting between the seams or sections.
- C. Where two or more such seams or sections are worked in a mine, the pillars in one seam or section shall as far as practicable, be vertically above or below the pillars in the other seam or section unless the strata are inclined at an angle of more than 30 degrees from the horizontal.”
- D. The parting left between any two such seams or section shall not be less than three metres in thickness at any place. Provided that the Chief Inspector may, by an order in writing and subject to such conditions as he may specify therein, permit or require a smaller or greater thickness of parting, as the case maybe.



### III. INDIAN PRACTICES OF EXTRACTION OF PILLARS IN CONTIGUOUS SEAMS

In India, the pillars in mines having contiguous seams are extracted in several ways. Basically, two techniques are used:

- A. By caving, or
- B. With stowing.

Where contiguous seams are thick extraction with stowing is generally adopted. Where the extraction is done by caving method a parting of at least 3 m thickness has to be maintained. It may be sometimes necessary to leave some coal in order to achieve this. The coal can be left either at the floor of the top seam or at the roof of the bottom seam in such a manner so that the total thickness of the parting is not in any case less than 3 m. The pillars are extracted simultaneously if the seams lie within 9 of each other. Top to the bottom order is followed generally. If the parting is between 3-6 m, the line in both the seams must remain vertically over each other. The top seam face shall lead the bottom seam face by an amount of half a pillar distance, if parting is 6-9 m. The extraction no more needs to be simultaneous, if the parting between the seams is more than 9 m but still the extraction must be done in a descending order i.e. the upper seam should be worked out first.

When the angle of break line is known, then the optimum distance for the line of extraction in the upper seam and the line of extraction in the lower seam can be determined graphically. An example as illustrated in figure below is shown. The figure has two contiguous seams A and B. in the bottom seam the line of goaf is considered to be at y. the breakage that takes place as a result of caving is at line yy". So for safe extraction of seam A the line of extraction should be beyond y". The line is taken at X after taking in account the span of hold up in seam A that allows for unforeseen reasons. The distance hence formed by XY should be around 10-15 m. So the line of extraction in seam A shall lead the line of extraction in seam B by this distance.

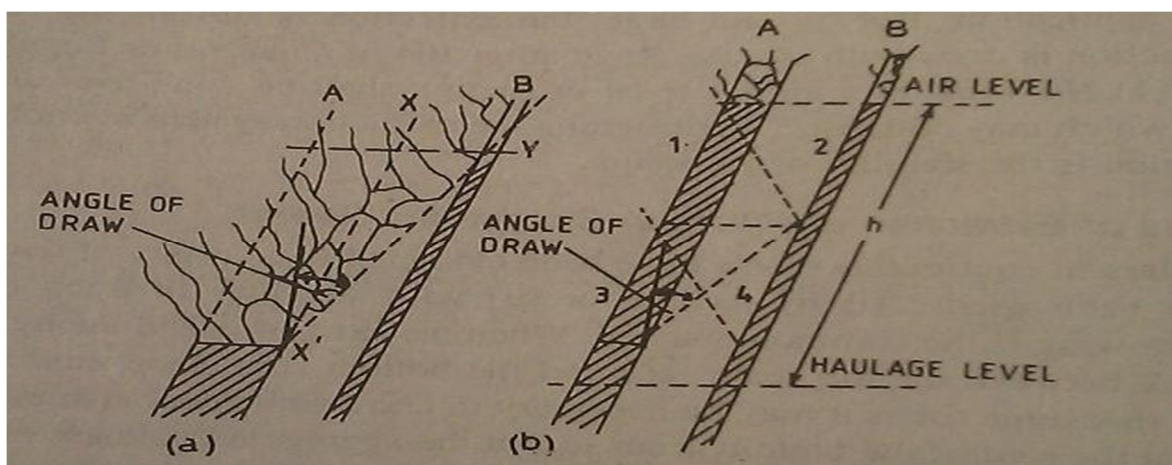


Fig. 1 Angle of Draw and face lag between the two seams

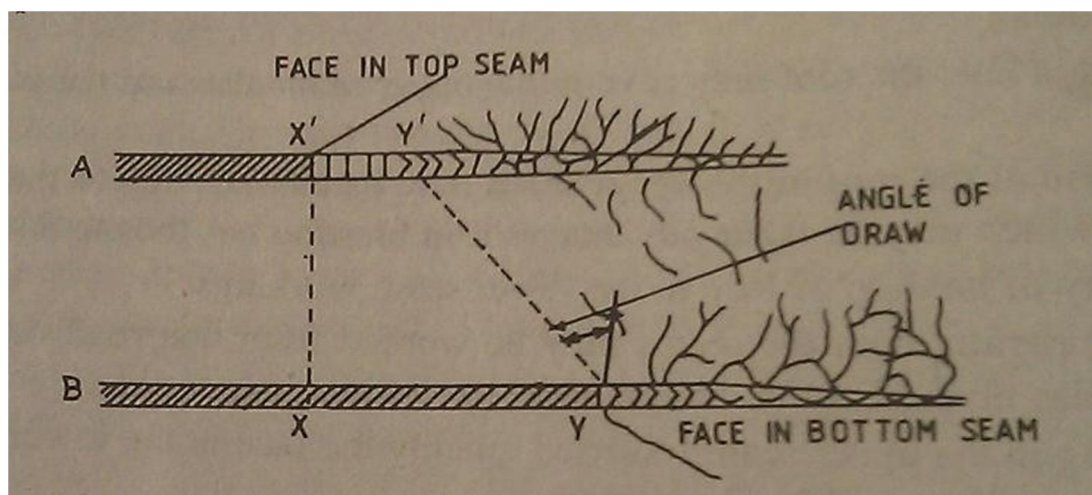


Fig.2 Angle of Draw for two inclined seams

In certain situations the mining in upper seam may cause undesirable undermining in the lower seam. The figure below shows this condition as an example. There are two steeply inclined seams A and B. working in seam A at XX" may cause a break along the line X"Y. This line cuts the seam B at Y. So the part of the seam B lying above Y may get undermined. As a solution the sequence of mining in both the seams shall be as properly aligned so that they do not affect the stability of one another.

In places where the pillars are to be extracted in conjunction with stowing, a greater flexibility is available in order of extraction of different seams. However, if there are two thick seams contiguous to one another, then partial extraction with stowing of the lower seam first is preferred. Then extraction in the upper seam is carried out with full stowing or by caving in the upper slice to a maximum allowed height of 4.8m.

#### IV. CONCLUSION

The maximum stress increased in pillars after development stage in both the seams, with increase in parting thickness. The effect observed was little for top seam while more for bottom seam. Change in parting thickness had no effect in stooks for both the seams. The maximum stress increased in the ribs for the top seam with increase in parting thickness but remained more or less constant for the bottom seam. The maximum stress in the parting remained constant for both after excavation of two and a half pillars for change in parting thickness. The maximum stress increased in pillars and stooks for both top and the bottom seams for increasing depth covers. The maximum stress increased in ribs first and then decreased, for increasing depth covers. The ribs seem to have yielded after moderate depth. The maximum stress in parting after development stage increased with increase in the depth cover. The maximum stress in parting after extraction of two and a half pillars increased with increase in depth covers.

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