

A Brief Comparison of Longwall Methods Used at Mining of Thick Coal Seams

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ABSTRACT: There exist several different methods in Turkey and in the world to operate longwalls of thick coal seams in underground mines. The most important ones are Single Pass Longwall (SPL), Multi-Slice Longwall (MSL), and Longwall Top Coal Caving (LTCC). In this paper these methods are compared to each other both from the technical and economical perspectives. The advantages and disadvantages of each method are discussed. Finally it is stated that the future trend in operation of longwalls is towards LTCC method all over the world.

1. INTRODUCTION

Total lignite reserves of Turkey amount to approximately 8 Gt, which constitutes 1.52 % of total world reserves. In 2003, totally 60 Mt lignite is produced in Turkey, of which 29 Mt is mined by state-run enterprises and the rest by private companies (Mine Exploration Institute, MTA, 2001; Turkish Coal Enterprises, TKI, 2003). About half of the lignite reserves constitutes of thick coal seams in Turkey (Köse et. al., 1989).

In Turkey, mining of thick coal seams is often carried out employing longwall methods. According to Hartman and Mutmanský (2002), longwall mining is an exploitation method used in flat-lying and tabular deposits, where a long face is established to extract the mineral. In coal longwall mining, large blocks of coal seam (about 300 m wide and 2 to 3 km long) are developed by driving headings, known as "gate roads" or "road ways" around them, and, then the so-called panel extracted in a single continuous operation. The gate roads are important components of longwall mining layout since they are the only escape and access ways to the longwall face.

In Turkey and Europe, main and tail gates have single entries (Figure 1). In these roads, commonly props (wooden or steel) and steel arches are used as support. On the other hand, in Australia, South Africa and the USA, the longwall face is formed by

gates which have two or more entries. Chain pillars are left in order to provide support, also.

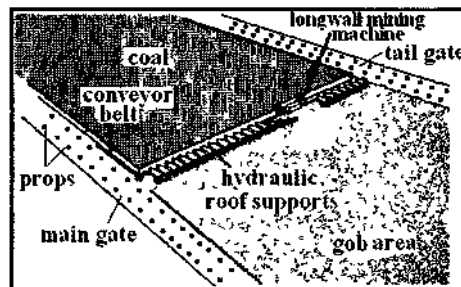


Figure 1 Plan View Longwall Mining

As a point of definition, the term thick seam is applied to any mineable seam thickness greater than the reach of existing development and longwall equipment.

In the 1980s and 1990s, this figure was interpreted as 4.0 m. However, with higher reach abilities of continuous miners and other longwall equipment, an arbitrary figure of 4.5 m has been adopted for all recent studies (Hebblewhite & Cai, 2004). In Turkey, it is assumed that the upper bound of coal seam thickness is about 6 m for employing single pass longwall (SPL) using mechanized equipment (Köse&Tatar, 1997). In India, for example, approximately 60 % of the mineable coal

reserves of the country belong to thick seams (seams thicker than 4.8 m) (Singh & Singh, 1999).

2. LONGWALL METHODS FOR THICK COAL SEAMS

In Turkey, several methods are used to mine thick coal seams. Methods most commonly used can be classified as follows;

- Single Pass Longwall (SPL)
- Multi-Slice Longwall (MSL)
- Longwall Top Coal Caving (LTCC)

2.1. The Single Pass Longwall Method

The SPL method has been gradually increasing both shearer and support heights from 4m and now up to 5m and above (Hamilton, 1999). Although essentially the same as current longwall mining practice, it has technical, equipmental and operational limits at a height of approximately six meters, within the foreseeable 10 to 15 year future (Hebblewhite, 2000). The option of extending the height of a conventional single pass longwall has some limitations such as equipment size, weight and stability, coal seam properties and face conditions. For example, due to existence of soft dirt band in PARK Mining's sector 'C' in Çayırhan, Turkey, a coal seam of 4.2 m thickness is mined out by the SPL method (Figure 2) (Por, 2002).

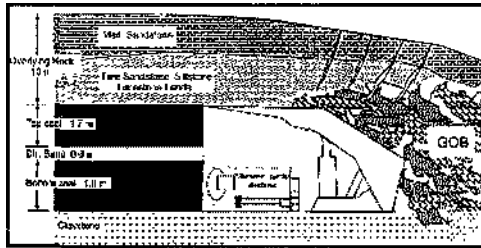


Figure 2. SPL Method in Park Inc. (Por, 2002)

2.2. The Multi-Slice Longwall Method

The multi slice longwall (MSL) method, whereby conventional height longwalls are operated sequentially, in the top half of the seam and then immediately below in the bottom half (using some form of artificial floor/roof between the two or three slices), remains a technically viable option (Hebblewhite, 2000).

SPL cannot be applied to seams which are more than six meters of thickness. In such cases, the thick coal seam should be divided into slices. In flat and low inclined seams, these slices are men extracted parallely to hanging wall and footwall.

In steeper seams, mining have to be carried out as horizontal slices (Köse&Tatar, 1997). This method is being applied in Soma lignite region where the seam is 15-22 m thick. At PARK Mining's sector 'A' where the dirt band is hard, coal is mined by MSL from two faces, having heights of 1.9 m and 1.7 m, respectively (Por, 2002).

Depending on local geology, different methods are employed to extract thick coal seams in China. If a thick seam lies flat or is moderately inclined, it is usually mined either using one-pass mining with shearers specially designed to cut seams between 2.3 to 4.5 m, or using the multi-slice method where seams are divided into slices horizontally but separated by thin layer of coal and an artificial roof between slices (Xu, 2001) (Figure 3).

At the MSL method, wire mesh requires too much labor. Here, the wire meshes and the canopy should be kept in the same plane to reduce the tensile stress in the wire meshes so they will not burst. In order not to cut the wire meshes, the cutting drums of the shearer or the teeth of the plow should not run near the roof (Peng & Chiang, 1984).

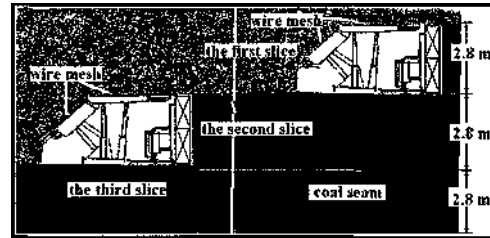


Figure 3. Multi-Slice Longwall (Xu, 2001)

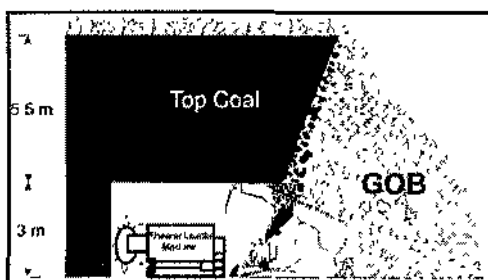
In comparison with top coal caving method, the slicing method is of lower output, higher production cost and less safety (Xu, 2001).

From the economic point of view, investment costs for the panel in MSL are twice higher than at the LTCC method (Köse et. al., 1989).

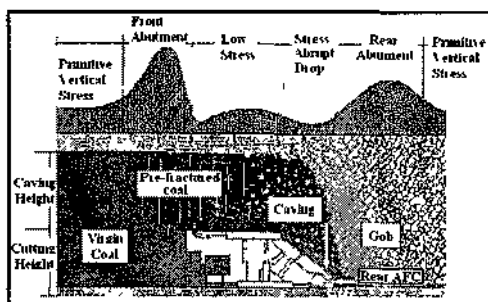
2.3. The Longwall Top Coal Caving Method

In Turkey, the LTCC method has been applying for many years. It is based on the 'Soutirage' longwall caving method originally developed in the French coal mining industry.

In caving methods, usually one face is operated on the base of thick coal seam and the coal left on top is taken from the window of roof support (Figure 4a). The difference of the LTCC method applied in Australia and China from the one applied in Turkey is that there is a rear conveyor which transports the coal behind the face (Figure 4b).



(a)



(b)

Figure 4. LTCC Method in Turkey (a), in China (b)

LTCC is preferable due to its lower face investment and labor cost (no wire mesh). Apart from these advantages, shortest roads are to be developed and minimum equipment is used in the same panel, achieving the result of the lowest production costs. The slicing method, in contrast, ensures a high recovery rate, but requires a new pair of gate drivages and a new set of equipment for each slice. In addition, it requires the infrastructure roads, to which the gate roads are linked, to be maintained for a long period of time.

However, there is a certain disadvantage of this method. This is the high coal loss occurring during the production of the top coal, resulting in a significant decrease of coal recovery. In the study of Şenkal et. al. in 1988, it is found that 24 % of the coal reserve of a panel operating by LTCC is left behind the face. Today, in the same thick coal seam,

about 20 % of the production is being left in the gob which causes spontaneous combustion.

Similarly in China, the caving method normally results in a somewhat lower recovery percentage, about 80-85%, comparing with 97% recovery by slicing method. However, the caving method has facilitated the control of support operators because of several years practice, the coal recovery percentage is increasing year by year (Xu, 2001).

3. DISCUSSIONS AND RECOMMENDATIONS

The LTCC method is advantageous compared to the MSL method since it is more economical, easier to be applied in thick seams and requires less labor. In China, only 5 % of thick coal seams are mined by the MSL method.

The Xinglongzhuang mine in China, where the coal seam is 8.6 m thick, a total of 6.1 Mt is produced from the two LTCC faces. Today, in China, this method is used even in seams of 15 m thickness. The negative sides of the LTCC method are the coal left behind the face and the danger of spontaneous combustion. Spontaneous combustion is controlled primarily by careful ventilation balancing. As long as the operator of roof support accommodates to the system, the production efficiency would increase to 90 % from 80-85 % (Xu, 2001).

For instance, let assume a coal seam of 10 m thickness. Here, two alternatives to operate the seam can be recommended. The first one is extracting the seam as four slices of 2.5 m height each. The reason selecting such a height is that because it is the most economical value considering production recovery, equipment costs, labour costs and the characteristics of coal seam, besides hanging wall and footwall conditions (Köse&Tatar, 1997).

Second option is to operate 2.5 m from the base by the LTCC method and let the rest 7.5 m cave in, which would be produced from the rear conveyor behind the face. Face equipment required in the MSL method (with four slices) is four times more than the equipment required in the LTCC method. In addition, if the top coal recovery is increased (> 80 %), the LTCC method will be more economic and advantageous. In conclusion, even though the loss of coal in the LTCC method is a negative effect, the LTCC is still preferable to the MSL method due to its advantages.

4. CONCLUSIONS

Mines which are more than 6 m thick cannot be operated by the SPL method. At these mines, either

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the MSL or the LTCC method is employed In Turkey and the whole world (especially in China) the MSL method is replaced by the LTCC method Production capacity with the MSL method, which is around 1 Mt of coal yearly, can be increased up to 4-5 Mt by the LTCC method due to less labor, no necessity for wire mesh, and shorter time for development Hence, according to the amount of production, the LTCC method is preferable compared to the MSL method in thick coal seams.

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