International Journal of Engineering Sciences &Research Technology

(A Peer Reviewed Online Journal)
Impact Factor: 5.164

IJESRT

RESEARCHERID
THOMSON REUTERS

[Tripathi* *et al.*, 8(3): March, 2019]
IC™ Value: 3.00

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

UTILITY OF CONTINUOUS MINER SYSTEM IN UNDERGROUND COAL MINES

Abhishek Kumar Tripathi*[1] & Ramesh Kant [2]

[*] Department OF Mining engineering, Godavari Institute of Engineering and Technology (A), Rajahmundry, India

DOI: 10.5281/zenodo.2608330

ABSTRACT

The usage of coal in the Indian market scenario plays a vital role in power generation and other industries. The application of continuous miners in India coal mining could be a good choice for the improvement of coal production and productivity. Also, the utility of continuous miners' system in underground coal mining is appropriate technology. The continuous miner works in a dark, dusty, and cramped mines, which improves the productivity of the coal winning process. Even a slight improvement in productivity can amount to a few hundreds of thousands of Rupees of additional revenue per machine per hour. The modern continuous miner and the use of other trackless equipment like shuttle cars, roof bolting rigs and scoops have made the bord and pillar mining method economically very attractive for the conventional coal mines wishing to boost production output and same time reduce relative costs of production. This paper demonstrates all aspects of the utility of a continuous mining system in underground coal mines which is able to enhance the production of coal in an efficient and cost-effective manner.

KEYWORDS: Continuous miner, Bord and pillar, Productivity, Shuttle car, Roof bolting rigs.

1. INTRODUCTION

The coal mining industry is one of the largest industries in the worldwide because of its huge demands across the globe [1]. In general, the coal deposition in underground coal seams is located at too deep from the surface. The primary processes of coal winning from underground mines are through Bord and Pillar method which follows the sequences of supporting, cutting, loading, supporting and advancing. In the Bord and Pillar mining method, employs a crawler mounted continuous miner which cuts the coal at a much faster rate and loads it on a shuttle car for the transportation from the face. As the face advances the freshly exposed roof is supported by different types roof supports.

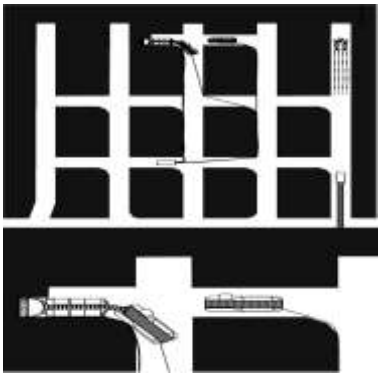

Figure 1. Bord and Pillar Mining

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

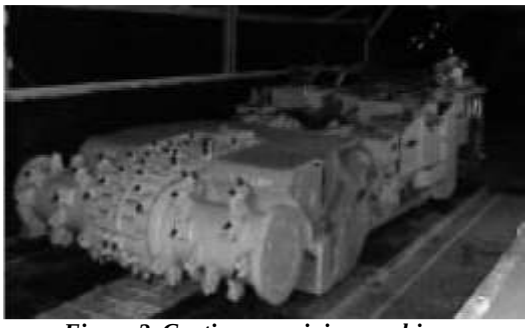

Figure 2. Continuous mining machine

Bord and pillar technique employs the usage of the set of machines which cut a network of lateral and transverse pillars as shown in the Figure 1. In this process, the mined coal is removed and the square coal pillars are left behind to support the roof. The mining of coal is usually mined by the help of a continuous miner. The continuous miner is nothing but a track-driven machine with a rotating cutter head for shearing coal from the face as presented in Figure 2. The shears of continuous miner start its operation from the top of the coal seam face and gradually it come down up to the floor. The on-board conveyer carries the removed coal up to the tail of the machine. At the tail deposited coal either collected on the shuttle car or on a mobile conveyer belt. Thereafter, the coal is transported to a more permanent conveyer from, where it goes out from the mine [2].
Subsequently, a cutting section of coal (which is roughly equal to the length of the machine) the continuous miner retreats and a series of roof bolts are installed to the fresh roofs which supports the roof against roof falling. Also, in longwall mining, the continuous miner machine is used to develop the entries in the section for the provisions of the conveyer's installation, ventilation, and to maintain the longwall equipment [3].

2. DESIGN AND WORKING OF CONTINUOUS MINER

A continuous miner typically having a cutting head of 3.3 m wide and the machine is usually "sumped in" between 0.5 m and 0.75 m at roof level. It is also associated with the rear stab jack on the machine lowered if required, and then the head is sheared down to floor level [4-5]. This cycle is repeated 7 to 8 times and the roof and floor are trimmed level during the cycles.

The continuous miner can sump and shear down while waiting for the return of the shuttle car. As the boom enters the pile of coal on the gathering apron, loading rates into the shuttle car are very high. The cutter head usually loads around 8 tonnes per 500mm sump in a 3.5m seam (1.4 m3/tonnes). This equates to one shuttle car load. When the miner opens the roadway width out to 4.8 m the second cut width is then only 1.5m and one sump of 1000 mm is required to fill one shuttle car. Operator proficiency can have a marked impact on the efficiency of operations, with time to change direction and switching on and switching out time at junctions all adding to in-cut delays. The standard layout consists of a five-road development, with the main conveyor and feeder breaker positioned in the central roadway (Figure3) [6].

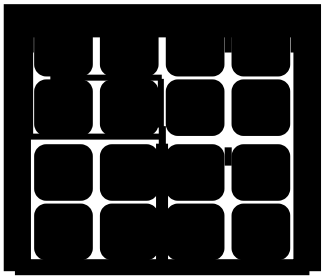

Figure 3. Five entries mechanized bord and pillar

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Impact Factor: 5.164
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This provides working areas to carry out all the main development functions:
1. One heading for the continuous miner to be cut.
2. One heading being roof bolted.
3. One heading being cleaned out by the LHD machine.
4. One heading having the ventilation and direction lines extended.
5. One heading ready for cutting

The usual cutting sequence involves 'place changing'. This is where the continuous miner, operating under remote control, cuts for a specific distance beyond the last row of supports (up to a maximum 15 m, called a "place"), while the workforce (operators) remains under the supported roof. A lesser distance may be advanced at the discretion of operators and supervisors, dependent upon changing geological conditions. Once a "place" is complete, the continuous miner is trimmed to an adjacent heading to commence the cutting cycle over again. An independent roof bolting machine, then supports the area mined out by the continuous miner as a separate operation. The machines operate independently and with greater flexibility for both cutting and roof-bolting operations.

3. PILLAR EXTRACTION

Pillar extraction is the most extensive exercise in Bord and Pillar mining method. The success rate of the Bord and Pillar method (in terms of investment) is highly depended on the effective operation of continuous miner. The stooping line in the process of pillar extraction is kept at 45° to the panel direction. The sequence of pillar extraction is shown in Figure 4. During the pillar-extraction one pillar mined at a time and which follows by the successor pillars which are shown in Figure 5 [7].

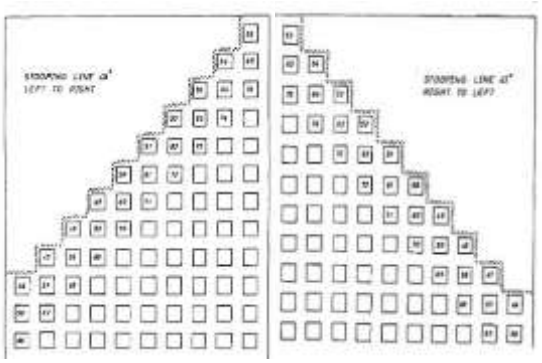

Figure 4. Sequence of pillar extraction (Not to scale)

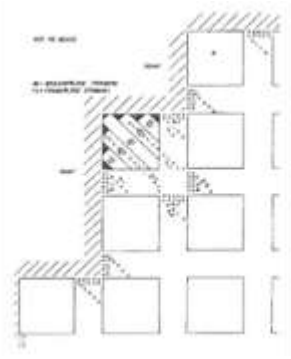

Figure 5. Five entries mechanized bord and pillar

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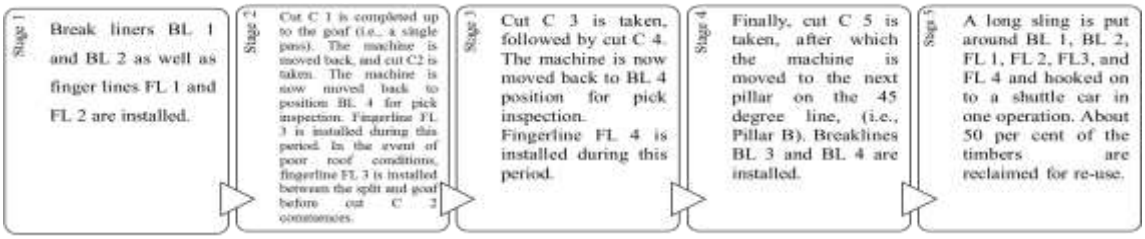
The stages involved in pillar extraction are described below:



4. APPLICATION OF CONTINUOUS MINER IN INDIAN COAL MINE

Over 90% of current underground production in India is produced by bord and pillar methods. Introduction of semi mechanized systems using load haul dumpers (LHD's) and side discharge loaders (SDL's), is well advanced and is proving moderately successful in some areas. However, there is now a considerable awareness of the capability of fully mechanized bord and pillar systems using continuous miners and shuttle cars. Hundreds of millions of tonnes of coal are also tied up in pillars, some of which must be extracted in order to free coal in underlying seams. The introduction of mechanized pillar removal systems and continuous miners and shuttle cars could greatly improve the economic viability of recovering this coal.

The continuous miner, in May 2002, first time introduced in Bord and pillar system in India, at ChirimiriAnjun Hill Mine, South Eastern Coal-fields Limited (SECL). At the time of starting, the system has averaged over 40,000 tonnes per month on the development of a five-entry boom and pillar system and has been achieved over 50,000 tonnes in a month on pillar removal (de-pillaring). Currently there are two fully mechanized continuous miner systems operating in India. Chirimiri mine has good conditions and has achieved exceptional performances [8]. with a potential of over 500,000 tonnes per year. Tandsi mine has difficult roof conditions and is not used to achieving' high production and productivity. Even so, the difficult roof conditions have controlled with modern "world best practice" roof bolting systems and output of up to 1,200 tonnes per day has been achieved. Chirimiri mine in SECL meets most of the criteria in the high potential mine category and has achieved excellent results with an output of over 460,000 tonnes in the first year of operations (including training and a gradual increase in production over the first few months). The likely output in year two as forecast to be well over 500,000 tonnes.

Tandsi mine in WCL has however very difficult conditions and mostly fits in with the low to medium potential mine conditions. Because of this, the output potential is restricted. Although the roof conditions are very poor, the introduction of world best practice 'stiff full column resin roof-bolting' has ensured good success with roof control. However, there are serious infrastructure problems with low capacity belt conveyors, lack of underground bunkers, lack of surface bunkers, no surface coal handling facilities, poor underground pumping, lack of man-riding facilities, lack of a proper material transport system etc. This has lead to over 700 hours of delay time in the first six months of operations. Because of this, it is anticipated that the first year's production will be in the region of 270,000 tonnes. However, much work is now ongoing by WCL to increase the output potential of the mine and good results can be expected in the future.

There are many more mines in India that should be installed continuous miner systems and thereby improving both production and productivity. India has tremendous potential to introduce fully mechanized continuous miner bord and pillar systems. The correct implementation of these systems would make a significant impact upon safety as well as providing a major increase in production and productivity.

All mines in India must be assessed to identify the best mines with the highest potential to introduce fully mechanized bord and pi1lar systems. This will provide a step change in underground output in each of the chosen mines without the need to change the existing manual and semi-mechanized mining districts [9]. For these mines, production and productivity will be greatly increased with an accompanied increase in underground safety.

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5. TECHNOLOGICAL CHALLENGES IN APPLICATION OF CONTINUOUS MINER

The adoption of general recommendations in the mining industry is a tedious task as the nature and hardness of the coal varying from one geographical area to the other. To achieve the optimum cutting and loading by the machine, the pick spacing, drum-rotation & sumping speed, pick an angle, and type of picks has to be selected so that the machine is suitable for the coal being cut [10-11]. The study conducted in different coal mining industries in the world shown 59% utilization of the cutting time by the machine. Further, till now, a few experiments have been carried out to improve the production rate of the machine, and all efforts have been directed towards an improvement in the utilization of the available cutting time.

6. CONCLUSIONS

The success rate of an underground mining depends on the efficient and effective mining system. Still, there is huge automation required in the mining industry to promote its efficient operation at a desired cost of inflow. About a nominal 70 % utilization is a must for the success of any underground mining systems considering high depreciation rate due to high wear and tear. Information and its processing are the keys to success. The next level of continuous miner allowing this automation, initially to first automate small portions of the mining tasks and introduce them into the industry as miners' aids. Thereafter, the gradual increase in the level of automation as the technology develops and industry acceptance widens. This technology will be used to achieve the maximum production and productivity for a coal mining industry.

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