



PRODUCTIVITY IMPROVEMENT OF SURFACE MINER TECHNOLOGY MACHINE IN OPEN-PIT COAL MINER WITH SPECIAL REFERENCE TO GEVRA PROJECT OF SOUTH EASTERN COAL FIELDS LIMITED, BILASPUR: A STRATEGIC NECESSITY OF COAL INDIA LIMITED TO SCALE EVEREST BY 2020

Hemant Sharad Pande¹ and Dr. C. R. Vichoray²

¹ Chief Manager (Mining), Gevra Area, South Eastern Coalfields Limited.

² Associate Professor, Department of Management Technology,
Shri Ramdeobaba College of Engineering and Management, Nagpur.

ABSTRACT:

Coal India being the single largest coal producing company of world as well as one of the Maharatna company of India, had a gigantic task of scaling almost 1 billion tons of coal by the year 2020. The various procedures of law and legislation are being unchanged, makes it necessary for Coal India Limited that it has to depend on its further scope of improvement in its already producing mines. The plan of reaching 1 Billion Tons of coal will require herculean effort to reach this goal. As regards to countries energy needs everybody is banking on this coal behemoth. At present Coal India Limited is producing 493 Million Tons per annum, so the growth envisaged is almost double to what it has produced in the year 2014-15. The major share of production will be from the opencast coal mines of this company. The production of coal largely depends on the HEMM (Heavy Earth Moving Machineries) deployed for producing coal. The major share of production will be by surface miner machine, which is integrated equipment which eliminates many operations in coal mining such as drilling, blasting and crushing. Due to elimination of so many critical activities the deployment of this machine helps practicing mining engineers to produce coal at very high rate with safety and conservation in mines. The optimization of productivity of surface miner will definitely improve the production performance in the existing mines. The production from this technology will keep on increasing year by year as per the planning done by Coal India Limited. The increase in the number of machines to be deployed to achieve the planned growth itself is area of concern as globally the manufacturers are limited and are already stretched to their full capacity. Hence the subject of optimization of surface miner becomes of high strategic importance for Coal India Limited. The paper will deal with the literature aspects of evolution of the surface miner technology and its current scenario. The paper will also deal with the importance of this machine in reaching the growth planned by the company.

KEYWORDS: Coal Mining, Surface Miner, Production, Optimization, Productivity.

1.0 INTRODUCTION:

The entire focus of the nation is on availability of energy alternatives. Thermal energy being very predominant in India, the responsibility of coal sector increased manifold. The thrust at present is on increasing production from opencast mine. Introduction of new technologies in coal mining will need a time lag so as to achieve the targets in reality. Hence the focus has been on improvements which are possible with the current technologies in vogue. The advent of Surface Miner equipment in mineral sector can be traced since early 90's. The technology has been adopted in coal,



limestone, iron ore, bauxite, phosphate, salt, lignite & gypsum mines. From mining point of view the use of surface miner gives practicing mining engineers following operational edge:

- Operations of drilling & blasting are not required
- Effective control on quality of mineral can be exercised
- Crushing of mineral is not required as mineral is delivered in crushed form
- Positive control on production can be exercised
- Effective reduction can be planned for noise pollution & vibrations

India as country is an upcoming economy and hence the production of minerals along with coal is increasing at a rapid rate. The contribution of surface miner machine in this context is very huge. In coal mining all the mega projects have deployed surface miners and till year 2020 the share of production by this machine will increase every year. At present around 300 surface miners are deployed globally with around 105 machines in India (Ghouse, 2000). In Coal India Limited, the total surface miners deployed at present are 71. In the year 2014-15 the total coal production by surface miner was 198 Million tons which is about 40% of total production. The total growth planned by Coal India Limited is around 84% till year 2020 i.e. almost 16% per annum. Thus a heavy dependence is being placed on surface miner production which will rise approximately to 70%. Hence the surface miner technology assumes a strategic importance for the growth of Coal India Limited as well as for the energy mission of our country.

2.0 HISTORICAL PERSPECTIVE:

The technology has evolved over years; surface miners were basically developed for construction of roads. Various companies such as Wirtgen, Bitelli, L&T, Krupp, Voest-Alpine & Huron Easi manufactured surface miners. The first Writgen surface miner was introduced in 1983 in gypsum mine in South Africa. Hofman reported the use of continuous surface miners as a technology for opencast mines in 1987 (Pradhan, 2012). Bhatt identified surface miner as an alternative technology for limestone mining for cement projects in Kutch district of Gujrat state (Bhatt, 1995). In India the first surface miner of Writgen make 1900SM type, was inducted in year 1994 in one of the mines of Gujarat Ambuja Cement Limited for limestone mining. The deployment was successful as soft limestone was well cut by the machine and the necessity of blasting operation was negated. In the year 1994 Madras Cement also deployed Writgen surface miner 2100 SM for its limestone production. National Aluminum Company Limited has also deployed surface miner on trial basis in hard rock excavation in year 2010.

In coal mining context, the first surface miner was inducted in year 1999 at Lakhanpur mine in Mahanadi Coalfields Limited, which is one of the subsidiaries of Coal India Limited. Initial idea was to deploy the surface miner for overburden removal in Lakhanpur mine. But the rock was highly competent and then the surface miner was deployed in coal cutting. The MCL mines then went on large scale deployment of surface miner because of predominant opencast coal mining property. The other subsidiaries companies such as South Eastern Coalfields Limited, Central Coalfields Limited and Eastern Coalfields Limited also deployed surface miners in coal production. In the year 2014-15 total numbers of surface miners deployed in various subsidiaries of Coal India Limited went up to 67. Writgen and L&T make surface miners are holding maximum share of deployment in Indian mines.

The development of surface miner by different manufacturers was done globally adopting the technology which they already have expertise in. Writgen had a past experience of road milling equipment and hence based on basic principle milling, surface miners were developed. The Voest Alpine Miners were pioneer in road headers and hence the same technology was adopted in surface miners. Similarly Krupp had experience in Bucket Wheel excavators and hence surface miners were developed with the same technology.

Writgen can be stated to be the largest supplier of surface miner in India and has wide range of models which are capable of cutting 0.15m and 0.52m thickness with 1900SM & 4200SM respectively. The

other models which this company manufactures are 2100SM, 2200SM, 2500SM, 3000SM & 3700SM. Writgen surface miners can continuously cut and load at a capacity between 1000-2500 t/h and are capable of cutting materials as hard as 6 on Mohr's scale. According to (Bordia, 1987), these machines are suitable for multi-seam coal deposits and have been successfully operated in all coal classes and partings with compressive strength up to 100 Mpa and to a maximum cutting depth of 0.6m.

2.0 TYPES OF SURFACE MINER:

Surface miners are classified depending on the cutting technology adopted in the machine. Basically following three type of cutting mechanism are adopted in surface miners:

- Milling action
- Bucket wheel action
- Ranging-shearer-drum action

Depending on the cutting action adopted the different types of surface miners are divided into following three categories:

- a) **Milling type:** Milling type of surface miners are manufactured by Writgen or Bitelli, East-Miner from Huron, Man Takraf, L&T & Vermeer Terrain Leveller. Generally these machines have cutting drum positioned below the machine in between the front and rear crawlers. The Vermeer and Tesmec cutting drum is at the end of the machines and generally it is wider than the machine and uses top-down cutting which allows the cutter teeth to gain penetration without using machine's tractive effort. In Man Takraf surface miner (MTS250 and 1250) and Tenova TAKRAF the cutting drum is fixed in front of the machine. These types of surface miner are able to cut minerals having compressive strength in the range of 80-100 MPa. It is able to negotiate minerals having compressive strength of 140- 150 MPa with some reduction in the production rate (Mishra, 2007).
- b) **Bucket wheel type:** This machine works on the principle of bucket wheel excavators. This type of surface miner is manufactured by ThyssenkruppFordertechnik. In one of the models i.e. KSM2000 four parallel bucket wheels are mounted on a main frame without boom. The theoretical output of these machines is approximately 1000-1400 banks cubic meters/ hour in a mineral having a average uniaxial compressive strength in the range of 20 to 30 MPa.
- c) **Ranging-shearer-drum type:** This surface miner adopts cutting technology of continuous miner, equipment used in underground coal mines. Voest Alpine's VASM-2 and Raheo's CME-12 are the two models of these types of surface miner. These surface miners can cut rocks up to a compressive strength of 120 MPa though their economic range of operation is up to 80 MPa (Mishra, 2007). Amongst these three types, milling type machines are most preferred machines worldwide and holds a major share of production. The milling action controls the production properly and the machine performance is best as compared to all other types of machines. Mainly, Writgen surface miners are predominantly deployed in Indian mines along with the surface miners of L&T. In coal sector these two type of machines are very popular.

4.0 SURFACE MINER OPERATION METHODS:

The surface miner being a continuous operating machine, the methods of operation are as per the travel of the machine. The travelling path should be in a properly designed sequence so as to avoid repetition of cutting path. The efficiency of the machine will be high if proper cyclic operations are performed. The following operation methods are generally followed in practice:

a) Empty travel back method (Pradhan P. , 2009):

In this method the surface miner cuts the material only in its forward movement. The cutting sequence is as shown in the following figure. The cutting starts from one end of the mining area. The

forward cut ends at the end of length of cutting planned. Then the drum is raised and the machine moves back to the starting point without turning after the completion of the full cut. As the material is not cut during the machines backward movement this method is referred as empty travel back method. The width of the cutting stripes is as shown in the figure.

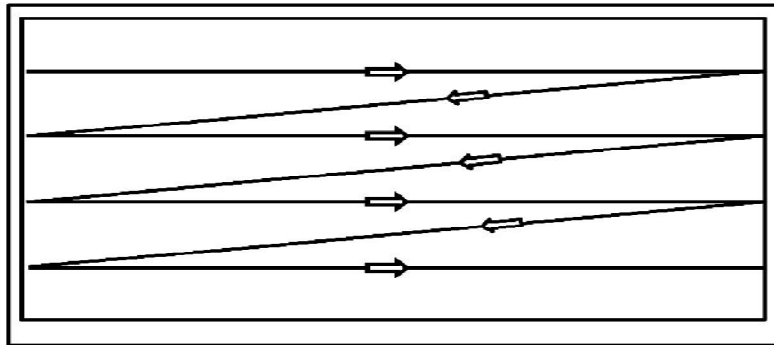


Figure 4.1: Empty travel back method (Pradhan P. , 2009)

This method is generally adopted for a mine having a length less than 200m because the turning time is more than the empty travel time. It is also applicable in bad pit end condition and the machine is not able to turn there or the pit width is not sufficient to allow the turning of machine at the end of the cut.

b) Turn back method: In this method surface miner starts cutting the face from one end and after reaching the end point turns back completely and starts cutting till the starting points are reached. In this method the cutting continues without break. The productivity is more as compared to previous method. The cutting sequence is as shown in the following figure.

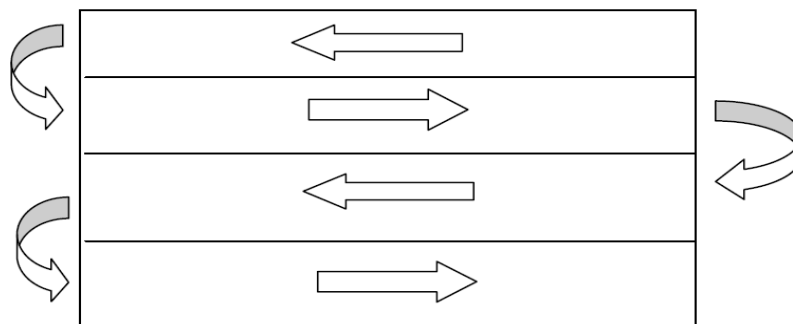


Figure 4.2: Turn back method (Pradhan P. , 2009)

This method is generally adopted in mines where the face length is more than 200m. The higher length of face is required for facilitating easy turning of the machine. The travel time as compared to empty travel back method is less and the productivity is more.

c) Continuous mining method (Meena, Kumar, Jain, & Murthy, 2008): The surface miner machine is capable of cutting mineral continuously and cuts the mineral on level field. The machine moves from one end of the face to the other end, and then it takes gentle angle without raising the cutting drum, so that there is no discontinuity in cutting operation. In this method the cut takes oval shape as shown in the figure. The area of mining gets developed by cutting slice by slice. The cutting depth needs to be set once on the surface miner as continuous cutting is possible in this method.

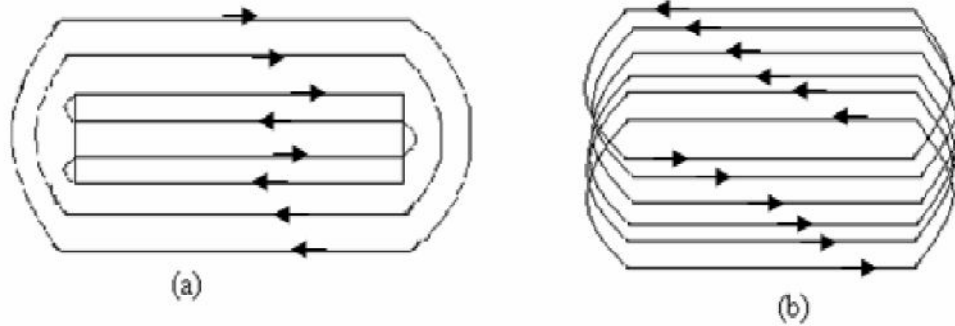


Figure 4.3: Continuous mining method (Meena, Kumar, Jain, & Murthy, 2008)

After the completion of an elliptical movement, adjacent cut is taken. This continues till the elliptical turning gets sharp angle. Then machine goes for turn back method. This can be avoided by overlapping elliptical movement, but the productivity reduces at the overlapping area.

5.0 Surface Miner loading alternatives (Prakash, Singh, & Murthy, 2013): There are three types of loading methods adopted in surface miner operations:

a) Conveyor loading: The mineral is transported by a conveyor system attached with the surface miner and is loaded into haul trucks as shown in the figure.



b) Windrowing: In this method surface miner cuts the coal in one cut length and immediately moves to next cut length and loading of mineral is done by pay loader into tipping trucks as shown in the figure.



c) Side casting: In this method the discharge belt dumps the material on the side of the cut being made by the surface miner as shown in the figure. The dumped material is later loaded to dumper/trucks by loader and taken away. Here the machine operation is free from interference due to loading.



6.0 Application and merits of surface miner (Prakash, Singh, & Murthy, 2013):

The application of surface miner is being done in many minerals worldwide. But here the focus is on its applicability in coal. The machine is integration of many mining operations. Deployment of surface miner will avoid drilling, blasting and crushing of coal. Thus the time cycle of production is fast and hazards of flying rock, vibrations, noise pollution, sound pollutions and air pollution due to blasting fumes are avoided. Also there is saving on operating cost due to maintenance and supervision of a single machine.

Merits: Use of surface miner is a simplified mining technology and possesses several advantages, namely, selective mining, improved productivity and ability to work close to the habitat/ agricultural fields. It is environment friendly with reduced noise emission, reduced fugitive dust emission, total elimination of ground vibration, no drilling and blasting. Precise cutting of designed profiles, stable and clean surfaces/benches with improved overall availability of the system, reduced operating cost, leading to easier coordination and process planning during planning, dispatching and maintenance can be obtained by the use of surface miner. Enhanced ROM- quality, improved exploitation of the deposit, reduced processing requirement after mining, primary crushing stage can be omitted by application of surface miner. Gentle loading of trucks due to sized material, low investment costs in comparison to the range of equipment necessary for conventional mining, energy efficient system and improved safety are also advantageous features of surface miner. Surface miners can maintain the surface of existing haul roads in virgin rock or in opencast mines. It facilitates higher overall travel speed for haulage vehicles due to better road surfaces. Benches with fewer cracks reduce the chances of heating/fire due to breathing of air.

7.0 Surface Miner scenario in Coal India Limited:

The deployment of surface miner technology dates back to year 1999 in the mines of Coal India Limited. The great success of this technology prompted wide usage in all the possible coal properties of various subsidiaries of this company.

Table No.1: Surface Miner Production share in Coal India Limited

Year	CIL Production (in Mt)	Surface Miner Production (in Mt)	Percentage share of Surface Miners
2007-08	360.913	58.711	16.27
2008-09	379.459	75.274	19.84
2009-10	431.260	81.088	18.80
2010-11	431.320	106.111	24.60
2011-12	435.838	119.716	27.47
2012-13	452.211	155.801	34.45
2013-14	462.422	170.819	36.94
2014-15	494.240	198.388	40.14

The **Table 1** given above clearly shows that the share of production by surface miner technology is increasing with each passing year and has reached a level of 40.14 percent in a span of 8 years in Coal India Limited. This share is further going to increase in the quest of 908 million tons by the end of this decade. The subsidiaries of Coal India limited which will be the fore runner in this quest are Mahanadi Coalfields Limited and South Eastern Coalfields Limited. Hence the trend of production in these two subsidiary companies needs to be evaluated in terms of surface miners' contribution.

Table No.2: Surface Miner Production share in Mahanadi Coalfields Limited

Year	MCL Production (in Mt)	Surface Miner Production (in Mt)	Percentage share of Surface Miners
2010-11	100.280	54.92	54.80
2011-12	103.120	59.13	57.30
2012-13	107.895	73.83	68.40
2013-14	110.440	86.46	78.30
2014-15	121.380	106.82	88.00

Mahanadi Coalfields Limited has been a predominantly opencast mine oriented company and has grown over the years banking on surface miner technology which is quite evident from the above given **Table 2**. The share of surface miner production has already reached a level of 88 percent in the year ending March'2015. The dominance of surface miner can be seen from the fact that last year more than 100 million tons has been produced by the Surface Miners.

Table No.3: Surface Miner Production share in S.E.C.L.

Year	SECL Production (in Mt)	Surface Miner Production (in Mt)	Percentage share of Surface Miner
2010-11	112.705	39.313	34.88
2011-12	113.370	53.247	46.96
2012-13	118.219	71.116	60.15
2013-14	124.261	73.202	58.90
2014-15	128.280	79.331	61.84

Whereas South Eastern Coalfields limited too has embarked upon this technology to achieve its growth. **Table 3** shown above depicts that already around 62 percent share of production is contributed by surface miners. The continuous growth in production is witnessed in this subsidiary on account of growth in surface miner production in opencast mines over the years. In this company around 80 million tons of coal production has been achieved by this technology.

8.0 Surface Miner production share by 2020:

The production statistics of Coal India Limited and its subsidiaries clearly shows large dependence on opencast mining with surface miner as major equipment system for its phenomenal growth in the last decade. The trend which is projected for road map to 2019-20 is also indicating wide usage of surface miner technology. In the year 2019-20, Mahanadi Coalfields Limited has been given the charter to achieve maximum growth in production, of around 128.62 MT, in the next five years so as to enable Coal India achieve its 2020 target. The production of this subsidiary is expected to grow from 121.380 MT in 2014-15 to 250 MT in 2019-20. South Eastern Coalfields Limited is expected to achieve the second highest growth of 110.72 MT, from 128.280 MT in 2014-15 to 239 MT in 2019-20. Out of this 239 MT, the opencast mines will produce 217.54 MT in the year 2019-20 i.e. growth of 105.30 percent over 2014-15 share of opencast mines with a total percentage share of 93.81% in total production.

As the main encumber of this huge production will be shared by these two subsidiaries of Coal India Limited, the role of surface miner assumes primary importance. Thus it can be seen that the productivity of this machine will have a strategic impact on all the plans of enhancing the production to almost double. It was therefore this study was undertaken to assess the productivity of surface miner. The required machines to achieve the large volume of coal in such a short span will be very high and that the manufacturing companies shall have to ensure the supply of surface miners as per the requirement. The surface miner and its allied machines are to be looked into details, so that the mission of one billion tons becomes a reality.

The main thrust of the production growth will be on mega projects in both these subsidiaries. The study undertaken deals with above mentioned aspects of surface miner in Gevra project of South Eastern Coalfields. Gevra project is the largest coal producing mine in Asia with a rated output of 41 million tons. This mine is planned to contribute 70 million tons by the year 2019-20, indicating a massive growth of 70 percent in a span of 5 years. Thus it is evident that the success of Coal India Limited as well as South Eastern Coalfields Limited shall mainly depend on the success of this mine. At present the mining of coal is being done by surface miner technology. During the study, data of Surface Miner Model SM 2200/3800 for the period from July 2013 to June 2015 will be considered for the purpose of productivity assessment.

9.0 Productivity of the Surface Miner:

Productivity of surface miner will of vital importance in the production of Coal India Limited. The huge growth planned will need deployment of additional surface miners' in various mines of Coal India Limited. But the surface miner needs properly planned benches with suitable gradients for effective outcome. Hence it is imperative that a methodical approach is applied to maximize the output from each surface miner. The following inferences are drawn in respect of productivity improvement for the surface miner.

1. The type of study conducted here with regard to surface miner technology will help mine operators to save on account of equipment investment and that this way efficiency of surface miner is expected to go up further.
2. The productivity of surface miner will change with the deployment method adopted for cutting. There are various modes through which this machine is deployed for cutting coal. The method of deployment needs to be planned judiciously to get good results. The deployment of very high number of machines will lead to cramping of working space and will reduce the efficiency of this machine. The mining engineers need to approach this aspect with due diligence and care.
3. The proper projections of requirement and specifications of surface miner have to be decided before hand as per the rate of growth planned by Coal India Limited. The surface miners are deployed in various subsidiaries of Coal India Limited and presently their population stands at 71.
4. The production of around 199 million tons was achieved by various surface miners in this company, which comes to an average of 7900 tons per day per machine. The peak production achieved by this machine was in the range of 11,000 tons per day to 12,000 tons per day. Thus Coal India Limited can

- think of increasing average production by this machine to the tune of 10,000 tons per day which will reduce the requirement of new equipment's and the targets can be achieved with the current fleet size.
5. Thus in the years to come, the induction of new machines can be done in a phased manner. The coal monolith needs to look into this aspect in depth so that the productivity per machine deployed is maximized.

10.0 CONCLUSION:

The surface miner technology will be the most sought after technology in India's quest for 1.5 Billion Tons by the year 2020. The studies in optimization of productivity of this technology will give all the coal producing company a proper insight while planning and investing. The production share as can be seen will be increasing giving rise to deployment space, manufacturers capacity to deliver and investment options with coal companies. Coal India Limited being a major producer of coal in India will need to take proper care in planning by having a firm productivity base for surface miners.

11.0 ACKNOWLEDGEMENT:

The work presented in this paper forms a part of the Doctor of Philosophy Study of the first author. The author expresses his thankfulness towards the supervisor of the study and Department of Management, RCOEM, Nagpur for providing varied facilities due to which this research paper could take present shape. The permission and subsequent field support from opencast coal mine of SECL selected for the study is deeply acknowledged with thanks. The views expressed in this paper are those of authors and not necessarily of the organizations they represent nor of the sector under study.

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