ANALYSIS OF AVAILABILITY AND UTILIZATION OF DRAGLINE FOR ENHANCEMENT OF PRODUCTIVITY IN SURFACE MINES – A CASE STUDY

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ABSTRACT

Due to operational advantage of dragline in simultaneous excavation and back-filling, the equipment has gained vast importance in open-pit mining. Besides, absence of auxiliary haulage units and a myriad of other benefits are also credited in favor of excavation of muck piles by the draglines. However, the aspects of production, productivity and economics are of utmost significance in dragline operation and planning. In this light, the present paper is an endeavor to analyze availability and utilization of dragline operations. The paper presents a good amount of data for 4-draglines operating in one of the major opencast projects in India. The study reveals the trends of availability and utilization of these draglines during last 11-years. Furthermore, the study also highlights the salient reasons for loss of available hours and for idling of the draglines. Some startling information and facts have been illustrated in form of graphs and pie charts.

KEYWORDS

Productivity, Availability, Utilization

INTRODUCTION

At present, Indian coal mines have about 43 draglines, in operation. The bucket size of these draglines ranges from 5–30 m^3. Dragline has gained tremendous appreciation as versatile equipment for stripping huge amount of overburden especially for large capacity projects producing 10–14 Mt of coal annually at high stripping ratios of up to 1 in 4 to 1 in 6, in Indian context. The walking draglines offer several merits in open pit mining project where long reach, deep digging and high output are essential requisites, at high stripping ratios. For instance, a 1 m coal seam may have 30 m thick over burden cover, which may still be an economic proposition with application of draglines (Rai, Yadav & Kumar, 2011).

Reclamation is facilitated by application of draglines. Future, absence of auxiliary haulage units, higher mineral recovery, easy maneuverability, low maintenance costs and operational advantages under adverse pit conditions are also cited as the merits of deploying draglines. With the deployment of this huge and capital-intensive equipment, it is imperative to keep a strict vigil on the performance of this equipment under the prevalent operating conditions in order to diagnose the operational efficiencies and adopt the corrective measure to improve upon it. In this light the present paper aims at investigate some important productivity parameter of draglines in field setting.

Objective of the study

The specific objectives of the research programme for the draglines are as below:

- To investigate the availability and utilization of dragline in the field for an elaborate period of 10 years.
- To investigate the production of draglines and effect of availability and utilization on the production.
- To investigate the reason for low availability and utilization in the field.
- To suggest the improvement for enhanced productivity levels in the dragline operation.

METHODOLOGY

In the present work, 11 years data on the performance of 4 walking draglines was critically analyzed to obtain the availability (A) and utilization (U) values for the study draglines. The average age of four study draglines is 186,000 hours. For this the data of total work hours (WH), maintenance hours (MH) and idle hours (IH) were categorically tabulated. The sample data, for analyzing the breakdown hours/ maintenance hours and the idle hours, was collected from the maintenance logbooks of one of the 24/96 dragline, which has a meticulous record of shift-wise and day-wise manual inputs. The data was transferred to an excel program for further analysis. The production information was subjected to cross verification by field survey results. The MH included daily, preventive and breakdown maintenance hours.

After obtaining the values of A and U, it was thought appropriate to critically investigate the reasons for low A and U levels. To this end, field data was collected for a period of about two years for one of the four draglines in order to ascertain the reasons responsible for low A and U levels.

CASE DESCRIPTION

The present case study has been carried out in Jayant a major opencast coal mine of Northern coal fields Ltd., Singrauli, India. Jayant coal mine produces almost 13 million tonnes of coal annually. Geographically the area lies between latitudes of 24° 0' to 24° 12' and longitudes 82° 30' to 82° 45'. Figure1 gives a typical cross-sectional view of the pit showing the relative position of coal and overburden benches.

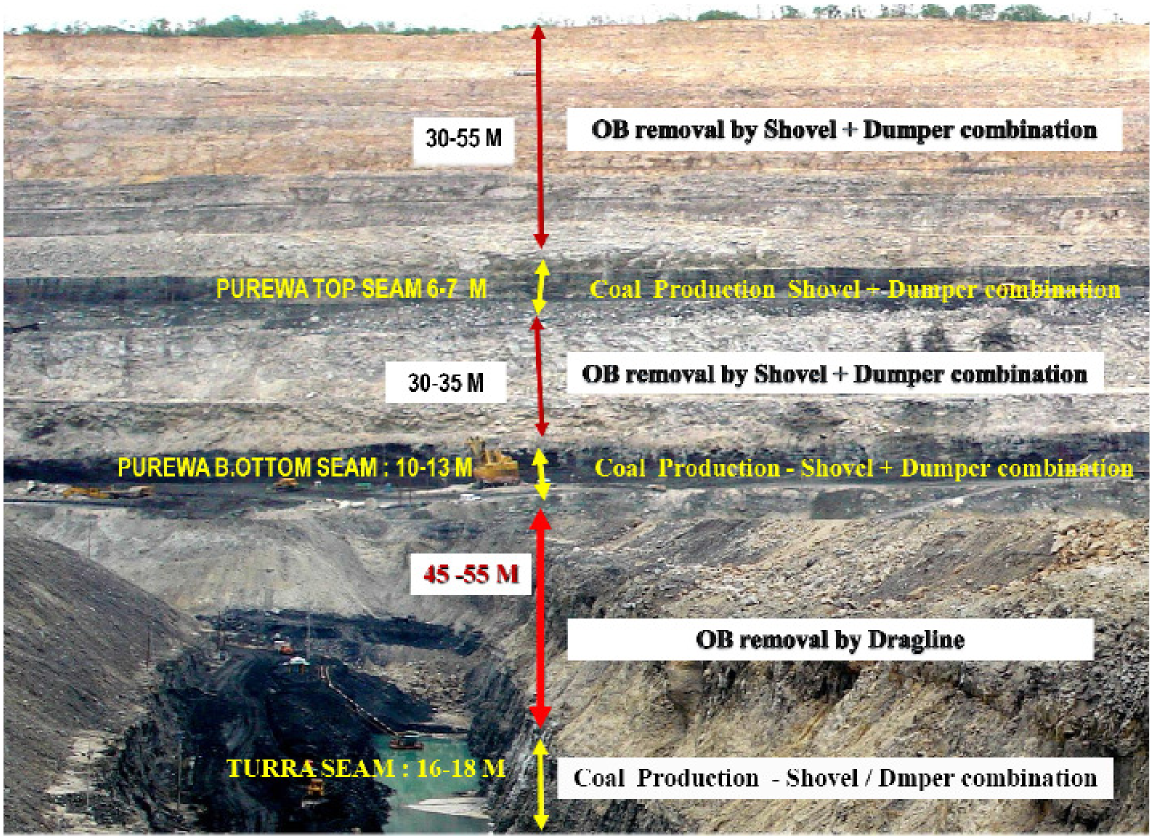

Figure 1 – A typical cross sectional view of the mine

A perusal of Figure 1 reveals the existence of three coal seams namely Turra, Purewa bottom and Purewa top. The thicknesses of these seams are 16–18 m, 10–13 m, and 6–7 m respectively. The average stripping ratio is 2.6 m^3 of overburden per tonne of coal.

The overburden bench above the Turra coal seam is worked by large capacity draglines (24/96, 15/90). Other overburden benches are worked by large capacity shovel-dumper combination. Two flanks, namely East and West, operate in mines with strike lengths of 1.8 and 2.0 km, respectively with total length of 3.8 km.

An average of 80 meter width is taken in the Dragline Cut with average working height of 35 m. Rest of the parting (10 -15 m) is extracted by shovel dumper combination. Also there are 13 nos. of Shovel 10 and 20 m^3 bucket size and 105 nos. of 85, 100 and 120 Te. rear dump trucks working on various benches in the mine.

Availability and utilization

Availability (A) of machinery can be represented by the total number of hours the machinery is free from any event of maintenance or breakdown. It represents the period for which the machine is available for work. Total the number of hours the machine is not available for use within that day or shift includes the number of hours the machine requires for servicing and/or repairs.

Utilization (U) signifies the use of available hours for actual working in the field. A machine may be available but still may not be working in all the available hours due to inordinate idling conditions. Thus, utilization represents a loss in available hours.

Field studies substantiated by the field logs of maintenance, breakdown and operational hours, provided the data on availability of the draglines under study. Mathematically, availability and Utilization are expressed in percentage as follows:

$$\mathbf{A} = \frac{\mathbf{AH}}{SSH} \qquad \textbf{(1)}$$

$$\mathbf{U} = \frac{WH}{AH} \qquad \textbf{(2)}$$

Where,
A = availability factor
U = utilization factor
AH = available hours
SSH= scheduled shift hours
WH = working hours
AH = SSH – MH – BH
WH = AH - IH
MH = maintenance hours
BH = breakdown hours
IH = idle hours

RESULTS

The salient results of non available, idling and working hours are presented together in Figure 2. The result of variation in production vis-a-vis availability and utilization is illustrated in Figure 3. The reasons for lower availability are shown in Figure 4 and loss of idling hours is illustrated in Figure 5.

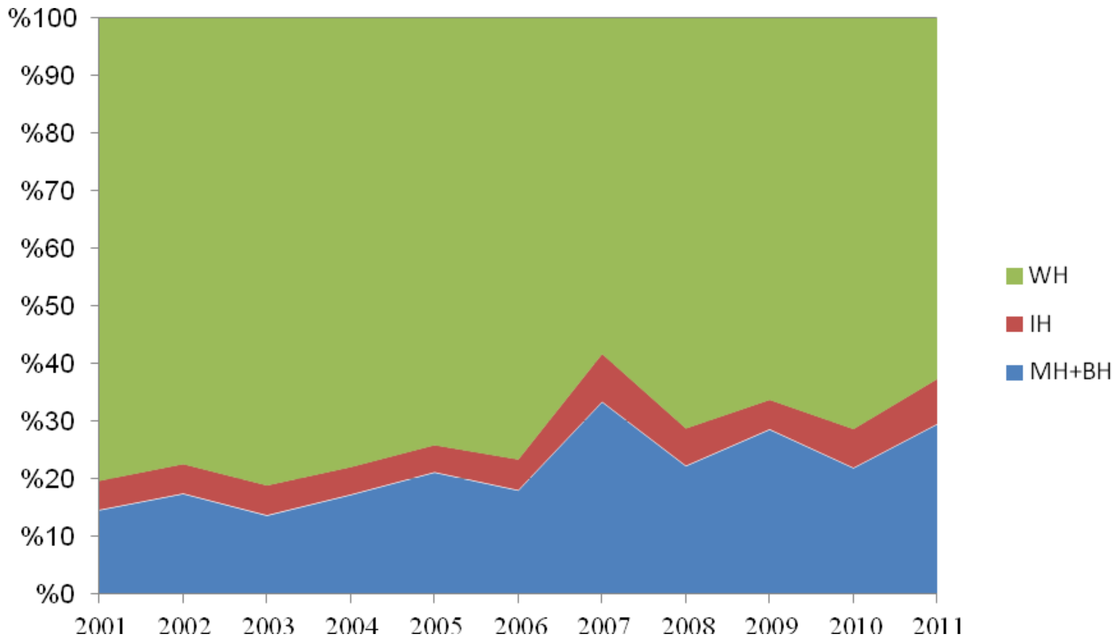

Figure 2 – Non available hours (maintenance and breakdown hours) and working hours.

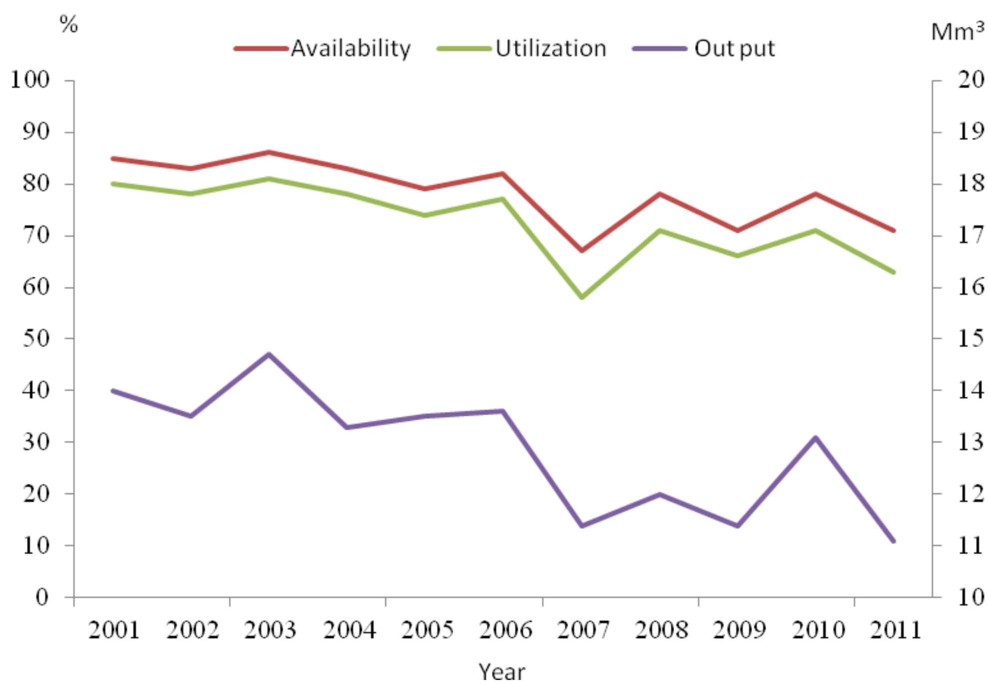

Figure 3 – Availability, utilization and annual production for the study draglines.

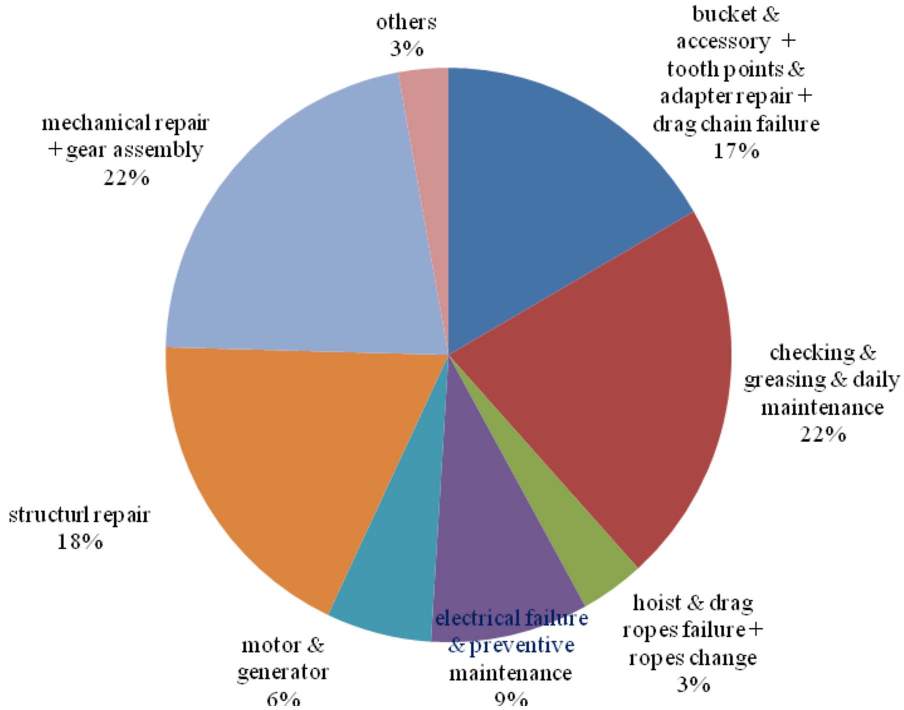

Figure 4 – Break-up of non available hours (breakdown and maintenance) for study dragline

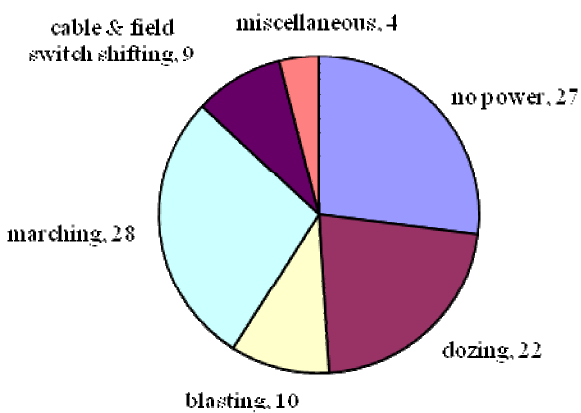

Figure 5 – Break-up of idle hours for study draglines

DISCUSSION

Discussion of availability results

The Figure 3 shows that dragline availability in the year 2001was 85% and declined to as low as 71% in the year 2011. This is a severe downfall in the availability factor. Rai, Trivedi and Nath (1999); Kishore (2004) also reported low availability factor in their studies, while investigating the balancing diagram of the draglines. International norms stipulate an availability of almost 95% for a cost-prohibitive equipment like dragline. The diminishing availability clearly reflects problems in maintenance of the draglines. It may be observed from the Figure 4 it is quite evident that despite adhering to a stiff daily and preventive maintenance schedules, the dragline witnessed a host of breakdowns that lowered the availability. Chief breakdowns were found to be related to bucket teeth, chains, adapter and other accessories, structural components, ropes and motor-generator set. Hence, looking at the loss in availability and also at the breakdown percentage, the maintenance program of the draglines needs greater attention.

Discussion of utilization results

Figure 3 illustrates a loss in utilization factor of draglines in eleven years. The utilization in 2001 was 80% whereas it came down to a low level of 63% in 2011. Again, the utilization factor is much below the international norms. To this end, Figure 5 clearly speaks about the salient reasons of machine idling. Rai, Trivedi and Nath (2000) also found low utilization factor of draglines due to inordinate idling. It may be surprising to note that marching and dozing alone contribute to 50% loss in utilization. Also, non availability of power for highly capital intensive draglines was unavoidable due to sudden power crash downs, electrical faults & repairs and technical snags with the trailing cable. Excessive marching reflects some deficiency in the operational planning. Similarly, inordinate dozing reveals improper muck pile displacement after blasting. Both these losses can be curtailed by efficient planning and blasting on dragline faces. No power situation should be negotiated between the government and mining company such that dragline gets continues power. Furthermore, loss of time due to blasting should be minimized.

Discussion of production results

Annual production of dragline is computed by following equation:

$$\mathbf{O} = \frac{BC \times BF \times SF \times SSH \times A\,(U \times \mathbf{3600}}{C} \qquad \mathbf{(3)}$$

Where,
O = annual output (Mm^3)
B = bucket capacity (m^3)
BF = bucket fill factor
SF = swell factor of material to be excavated
SSH = scheduled shift hours
A = Availability factor
U = Utilization factor
C = Average cycle time (sec)

From equation 3, it is obvious that availability and utilization directly affect the production, Figure 3 also shows the synchronism amongst availability, utilization and production. As such, with the diminishing values of availability and utilization, the production from draglines has also revealed down trend. To enhance the production, the availability and utilization must be enhanced.

CONCLUSIONS

Following conclusions may be drawn from the present study:

- Availability and utilization of the study draglines show a diminishing trend over last 11 years.
- Ageing of the draglines is perhaps the biggest reason for lower availability levels.
- The reasons for lower availability reveal that despite following daily and preventive maintenance schedules, the draglines had to undergo breakdown maintenance. Hence, the daily and prevent maintenance schedules call for strict attention.
- Besides, bucket teeth, adapter, chains, hoist and drag ropes, motor generator unit, trailing cable and structural units need to be attended rigorously for better maintenance.

- The reasons for lower utilization reveal that operational planning and blasting operations need to be performed carefully in order to avoid excessive marching and dozing operations.
- In order to overcome the excessive loss of work hours in dozing, the blast design and the throw of the muck pile need to be carefully designed and monitored.

The production and productivity in dragline operations is highly dependent on availability and utilization factors

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