ABSTRACT

The coal industry plays a significant role in the development of the Indian economy. Coal is the most important and abundant fossil fuel in India due to the limited availability of oil and gas. In recent years, with the ever-growing energy needs, the demand for coal has increased drastically and will continue to be a major source of energy well into the next century. Coal is commonly extracted through surface mining methods due to its benefits, including a higher extraction ratio, higher productivity, and fewer safety problems. In surface coal mining, overburden (OB) removal is a significant mining operation and calls for efficient and careful planning for the best utilization of the system.

Overburden removal typically makes up more than 60% of the total mining costs in surface coal mines. The amount of overburden removal and coal production are directly proportional to each other. Over the past four decades, draglines have become increasingly popular for overburden handling because of their flexibility and high production rate. As mines expand and demand higher outputs, either higher capacity draglines with larger bucket sizes and radii or tandem operation of draglines are becoming more common.

In recent years, there has been an increased focus on operating draglines in tandem. This involves using two draglines to work together, either in horizontal tandem or vertical tandem, in order to maximize overburden removal and coal exposure while minimizing rehandling. This helps to make better use of these capital-intensive pieces of equipment. To get the most out of such tandem operation, it is extremely important to identify the key operational parameters that increase the rate of coal exposure and reduce the percentage of rehandling. There are two main aspects that have been identified to

improve the rate of coal exposure, considering geo-mining and machine specification parameters to be constant. The first step to increasing the productivity of draglines is to increase availability and utilization. The second step is to develop efficient and careful pit planning and design. The planning process helps identify operational parameters and how to best utilize resources. It is a blend of engineering and economics. It is good practice for planning engineers to assess the productivity of equipment in a given situation before making further operational plans. This will help ensure more meaningful results.

The current study has looked at the planning and design aspect of tandem dragline operation, taking into account the average annual productivity of draglines based on an actual field study. The key dragline performance and efficiency statistics have been gathered to get the average productivity of different capacity draglines, which is needed for further analysis.

Different seating arrangements of draglines are presented in the form of balancing diagrams to help determine the most effective way to utilize the draglines and minimize rehandling. The diagrams are based on synchronized linear advancement of both draglines and show the dragline cut spoil geometry in two dimensions, as well as bench division in horizontal and vertical tandem operation.

The draglines must be correctly deployed using the balancing diagram for draglines running in tandem. However, regularly drawing balancing diagrams by manually could become expensive, time-consuming, and even inaccurate. In order to quickly and accurately calculate the rate of coal exposure, % rehandle, area of cuts, synchronized linear advancement of each dragline, and stripping bench division; computer graphics are most suited for this task.

The purpose of this study is to conduct parametric and field studies of dragline operations in horizontal and vertical tandem configurations to evaluate the importance of various geo-mining, machine, and operative parameters on annual productivity and to offer suggestions for productivity enhancement.

With the aim of simplifying complex tandem dragline operation, an interactive, graphics-based program was developed in C++ language using OpenGL graphics API to help in generating three-dimensional balancing diagrams for draglines operating in horizontal and vertical tandem. This graphics program can be adopted for all decision-making situations, such as deciding the bench height for stripping, the width of cut, rate of coal exposure, percentage rehandle, and linear advancement of each dragline in tandem dragline operation. The computer graphics technique has been deployed as a tool to speed up the tedious procedure of manually drawing the balancing diagram, which is not amenable to repeated reiterations. This program can be used to create balancing diagrams for careful analysis and planning of tandem dragline operations. The computer graphics program produces precise and reliable results.

Field studies were conducted on four different mines of Northern Coalfields Ltd., Singarauli, a subsidiary of Coal India Ltd. Different draglines with different modes of operation and under different mining conditions. The draglines had capacities ranging from 10 to 24 m^3, cut widths ranging from 70 to 90 m, and stripping bench heights of 27 to 45 m. The modes of operation encountered in the field study were horizontal tandem (in the Jayant, Nighai and Dhudhichua mines), and vertical tandem (in Bina mine).

At the end of this thesis, there is a list of references that were mentioned throughout the thesis. The thesis is approximately 312 pages long and includes figures and appendices.

Keywords: Opencast coal mining, overburden removal, HEMM, dragline, tandem dragline methods, horizontal and vertical tandem, dragline planning in opencast coal mines, pit optimization, software development, three-dimensional balancing diagram, field studies, dragline performance and cost analysis, parametric analysis.