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MINE EQUIPMENT SELECTION FOR DEVELOPING COUNTRIES

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ABSTRACT

The objective of this paper is to give certain rules and evaluation in selection of mine equipment for developing countries with particular reference to W/African mining industries. Its scope will serve as reference and guide to the engineers involved in this problem.

INTRODUCTION

The buoyancy of most developing countries external reserves in the past had culminated to relatively wide risk in decision making process in the selection of mining equipment. This risk which is most peculiar to W/African mining industries is due to inability of accurate evaluation techniques in the selection of equipment. However, the present day situation is a gradually visualizing a radical change. The decline in the external monetary reserve of these countries on one hand and the relatively high cost of commodities in the world market on the other has given rise to unfavourable condition. Consequently, there became a serious need for a change of patter in the selective policies of equipment. Anistratov (1987) on criteria of selection/costing mining equipment came to a conclusion that it is always very safe economically to keep not only the cost of extraction-loading operations but also the entire mine equipment to an amount not exceeding forty percent (40%) of the total cost of the entire mining venture. Bukrinski (1989) on evaluation of the capacity of extraction machines noted that the capacity of extraction machines used in quarries and pits is one of the most important production and cost characteristics of opencast mining. He went further to state that it predetermines the required fleet of extraction machines and affects to great extent the output and the required fleet of transport facilities, the labour productivity of the miners and other mining cost. Arlov (1990) on equipment selection pointed out that for a proper evaluation of extraction equipment there is need to adopt the principle of action of extracting machines which show that the extraction machines finding application in quarries are subdivided into continuous action and cyclic-action machines, and according to functioning in to extraction loading machines, and extraction haulage (transport) machines.

All the above have a place in this paper in presenting some norms, rules and a general procedure for equipment selection for an underground and open pit mining operations.

THEORETICAL CONSIDERATIONS

There are many factors to be considered while selecting mine equipment. There include analysis of the characteristics of the deposit, analysis of production requirements and working conditions, selection of the type of equipment most applicable to certain work, determination of the size of equipment and production per hour, analysis of technical characteristics of the equipment.

Finally, other important factors also to be considered include standardization, maintenance, services, performance result, use of catalogs and other information, financing and selection committees.

a. Analysis of the characteristics of the mineral deposit:

In this aspect the geological nature of the deposit including the properties of the minerals and waste are clearly defined. The following parameters are deemed necessary to be determined.

- The size shape and dimensions of the mineralized deposit (dip, length and depth etc)
- Is the mineral massive or scattered, bedded or disseminated, bodies or veins. Here intershop classification of rock by jointing in a massive as shown in table 1 is necessary.
- The nature of waste or mineral extracted or mined (hardness, compatibility etc)
- Character and significance of geological structures (fractures, faults, shear zone, trenches etc). A typical geological map of this assessment is shown on geological map of this assessment is shown on geological map of Itakpe iron ore deposit, fig 1.
- The climatic effect on the equipment.

b. Analysis on Production Requirements and Working Conditions:

The following data are necessary:

- Annual monthly, daily and hourly production of equipment.
- Degree of continuity of production should be ascertained.
- Expected life of operations
- Hours worked per day, number of shifts days per week, days per month and month per year.
- Bench height, availability of energy, type of roads within the deposit.

c. Selection of the Type of Equipment most Applicable to Certain Work:

In this case, it is necessary to determine the type of equipment which technical attributes of work are most applicable to specific operation. To this end a list of technical attributes and applications of various types of equipment available in the market are prepared. For example, while selecting the loading equipment for Itakpe iron ore deposit, Okene, Nigeria, W/Africa, a list of technical attributes of pay loader, electric shovel and hydraulic shovel were outlined and a comparative evaluation which was carried out gave pay loader an edge to be chosen over others considering cost, ability to certify working conditions, maintenance and the geological characteristics of the deposit. The exercise took the following order:

i. Pay Loader

- Gives lower production than shovels.
- Loads well fragmented material.
- Limited to not too high benches.
- Have auxiliary support required.
- Easy to maintain.

ii. Electric Shovel

- Has high level of production
- Can handle all types of materials including big rocks.
- Are limited to very hard and rigid condition of work.
- Requires auxiliary support equipment for waste disposal
- Work with electrical energy.

iii. Hydraulic Shovel

- Requires well trained maintenance and operating personnel's
- Design is more complex with hydraulic pumps and complicated mechanism making its maintenance more difficult.
- For bucket capacity, the dimensions and weight are less than the electric shovel.
- Less mechanical availability than electric shovel.
- Has better mobility and flexibility than an electric shovel, but less than pay loader.
- Has less excavating power that electric shovel
- Has greater loading capacity than an electric shovel in softer materials.

d. Determination of Size of Equipment and Production Per hour:

After determining the type of equipment and having two or more alternative brands and models to choose, it is necessary to decide on the size and hourly production requirements. Fig. 2 is typical graph of dependence of rock-carrying capacity of extraction machine at Jos Cassiterite deposit on moisture contents. It shows a higher moisture content of argillaceous rock materially deteriorates their carrying capacity. Since the pressure exerted by the scraper is equal to (1.15-1.2) P where P is the inflation pressure of pneumatic type, the cross country capability of the scraper does not permit it use in working clay rocks of moisture content greater than 24-27% without preliminary watering.

Furthermore, the modified formulae for general calculation of the capacity of extraction machines by Rzhevsky (1974) are very important in evaluation of equipment selection.

The certified capacity of extraction machines handling loosened rocks.

$Q_c = E\eta_e$; m^3/h ……………………………………………(1)

Where, E is the capacity of the excavating tool.

$E\eta_e$ is the design number of the emptying tool/hour.

The certified capacity of cyclic action of extraction machines (scraper, bulldozers, single bucket loaders and excavators) is calculated from the formula.

$Q_c = E\eta_c; \quad 3600E/twc, \quad m^3/h$ .....(2)

Where, twc is the certified duration of the machine working cycle.

The technical capacity Q_t which is defined as the maximum possible hourly output of extraction machine in continuous operations under particular mining condition is determined by formula.

$Q_t = Q_c K_r K_{fe} \quad m^3/h$ .....(3)

Where K_r is the factor allowing for the effect of excavated rock; K_r is the factor allowing for the effect of face parameters.

e. Standardization

This simplifies the problems of spares, maintenance, or operation of equipment. Maintenance and operation personnel will finish their job quicker and efficiently, where there is uniformity in the methods and specifications of equipment used. Selecting the equipment with interchangeable part and spares lowers the inventory cost. Most of the mining companies in W/Africa with incentive and desire for mechanization of their operation, are buying equipment of various types from foreign market which is turn bring serious problem due to their lack of standardization.

f. Maintenance

Maintenance is one of the most important factors to be taken into consideration in the selection of equipment. Equipment which is most easily maintained and also works efficiently in mining should be the one selected. Maintenance is a problem in most of the developing countries mining industries because of lack of adequate technological base which lead to inadequate or spare parts etc. this problem of maintenance can adequately be tackled jointly with the mining companies, the suppliers of equipment and research institutes involved in evaluation this problem.

g. Performance Results

Before deciding to buy equipment, it is necessary to obtain information on how effectively it works. This information may be obtained by visiting other mines, both national and foreign, from the reports of industrial engineering, from technical magazines and as well as information.

Obtained from well prepared reports in operations and maintenance (viz: hours worked mechanical availability, production efficiency, cost etc.

h. The Use of Catalogue and Other Suppliers Information:

This is a practice very common in developing countries since they largely depend on imported equipment for their mining industries. But, as calculations are carried out to select the equipment one must be careful when using catalogs and other information provided by suppliers, usually these data are for ideal and optimal situations. Furthermore, their corrections of efficiency factors are not enough; consequently, we must correct this

information with our own factors of efficiency of equipment and operation for our own condition of work.

i. Finance the Equipment

The financing of the equipment to be purchased is many times the determining factor for selection. Different financing terms can be considered such as short term, medium term and long term financing.

CONCLUSION AND RECOMMENDATIONS

The great variety of mining equipment available in the world market these days are of different brands and the lack of experience makes the selection to these extremely difficult.

All mining equipment should be selected on basis of their technical characteristic and performance. The performance can be divided into production, cost per hour, cost per unit and frequency, factors which are intimately linked with the quality of the equipment: each one of them is as important as the other, and to consider one singly would not represent the truth performance figure.

Select the equipment with highest production rate, lowest unit cost, highest efficiency, and that has some technical characteristics or some other desired condition.

It should be common practice in the mines to standardize the equipment, to simplify the maintenance and operative problems: it is recommended to work, as a maximum, with two brands of equipment to encourage competition in production, service and price.

Select the simplest equipment, least complicated, easiest to maintain and which does the work with safety and efficiency. Correct catalogs and other information, supplied by manufacturers, with factors of equipments and operation efficiency for our own working conditions.

Consider financing as a determining factor in the selection of the equipment. Form a committee to study and evaluate selection of equipment of high cost, advanced technology and where there are problems in selecting and making decisions.

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