COAL MINE SYSTEMS AVAILABILITY AND RELIABILITY-A DESIGN AND PERFORMANCE ASSESSMENT BASED ON FAILURE DATA

SYNOPSIS

In achieving the satisfactory performance of a mining system the role of reliability evaluation and assessment has already been acknowledged. The failure process, interval between failures and the repair policy are the important parameters which form the basis of reliability evaluation of any mechanical system.

Large scale mechanical systems vis-a-vis a longwallcoal mine may find useful applications of reliability analysis in the areas viz. engineering design, quality control, maintenance, spare allocation and inventory, decision making in aquisition, reliability as a safety and estimation tool and enhancement of reliability by condition monitoring etc. The above features have been amply discussed in the first chapter which introduces reliability concepts and highlights through examples.

The problem of engineering reliability in mining equipments and systems has been looked in the past in different ways primarily due to the varying nature of requirements associated with each system. The application of reliability in general and the references in particular are described in chapter II and III respectively.

Equipment reliability is determined from the primary functions of hazard rate and failure rate. The failures of mechanical equipments at identical environental conditions are dependent on the time they have survived without a failure. Thus instantaneous failure rate or hazard rate is dependent linearly or non linearly with time. Weibull distribution of hazard rate encompasses the linear or non linear dependency with time. Considering that the reliability decreases exponentially over time, the hazard rate is used to find the original expression of reliability. It must be noted that the failure figures are derived from the data logs which are relatively recent and thus reliability expression only gives the current state of performence unlike the expression of a bath-tub curve which spans over the life of an equipment. A case study has been discussed to determine the reliability expression for a group of equipments in a longwall mining system.

Heuristic model to determine the electronic system optimal reliability has been in vogue for quite some time. The model with suitable changes may also be applied to design a mine system at its optimal configuration. To apply this model in a mine, the first step is to develop a minimal configuration of a mine. The mine in example has four

longwall faces and three continuous miner sections to support the development work needed for carrying out furthur exploitation. Four alternative options of availability improvement viz.unit redundancy, component redundancy, proximal spare/repair facility and condition monitoring facility have been tried to design an optimal configuration of an underground mine. The constraint functions are underground space, development and installation cost etc. The total budgetory allocation for optimal size is treated as one constraint function. The result of such an exercise shows that at nearly 7 % of extra expenditure over minimal configuration cost it is possible to achieve nearly 20% increase in the system availability.

For a series production system eg. a longwall face a buffer storage at an optimal location helps in improving the availability of the total system. The buffer connected in parallel with the production system supplies the input e,g coal from its stock to the out put end. A markov chain model from an established methodology can be used to determine the efficacy of the buffer. Such analytical study shows that at a particular condition of failure and repair the coal transfer efficiency of mine conveying network can be improved as high as 17 % if it has a buffer having capacity to supply coal for 15 hours at the expected production rate.

It is a well known fact that mean time between failures, popularly known as MTBF (or failures per month) is a good measure of operational reliability of a longwall mining equipment/system. A quality control technique viz CUSUM model is used to test the effectiveness of predictions on the failures of a longwall mining system. Besides rank estimation has also been referred and followed by a comparison of two methods. It has been found that CUSUM gives better understanding of inservice reliability of equipments like that in a longwall system.

Mine maintenance data bases in India are results of routine and humdrum exercises. They often lack intuitive recognition of many important parameters. The information instead of being pertinent, comprehensive and accurate generally serves the purpose of day to day filling up of the customary maintenance data log books. The present work addresses the basic need of an improved system and suggests some new formats. The new formats offer a more scientific approach in the record keeping in addition to facilitating useful computations related to the failure predictions.

The main findings of this research can be summarised as follows :

i) An analytical method to ascertain reliability of the mining system gives a better understanding of performances.

ii) Optimal mine configuration achieves higher availability than minimal configuration though at a little extra expenditure. But the extra expenditure is offset by the relative advantage gained in terms of higher availability.

iii) Buffer storage connected in parallel with a series mining system can substantially improve the coal transfer efficiency.

iv) It can be safely concluded that the new formats for data logging and methods suggested through CUSUM and rank estimate for reliability predictions are quite encouraging.