Abstract

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

Equipment reliability is determined from the primary functions of failure rate. The present interval of failures at identical conditions is dependent on the time they have operated. The probability density function of Weibull distribution encompasses the linear as well as non–linear dependency of failure rate with time. Considering that the reliability decreases with time following a Weibull distribution the survival function of this distribution is used to find the original expression of reliability. It must be noted that the figures are derived from the data logs which are relatively recent and thus reliability expression only gives the current state of performance. A case study has been discussed to determine the reliability expression for a group of equipments in a longwall face.

The productivity and profits of a mining company arise out of the reliable performance of its major equipment. In a mechanized longwall face a shearer cuts coal and loads to an armoured flexible conveyor which provides a working platform for the shearer and carries the cut coal along the lonwall face. On the other hand a bridge stage loader receives coal from the flexible conveyor and delivers the same to a gate belt conveyor which conveys coal to the out bye end. Reliability analysis of the above equipments is necessary to determine the effectiveness of the system. Longwall cutting and transportation system configuration is complex and can be best analyzed by methods of branching and partitioning the failure events. Fault Tree (FT) analysis is one such method. FT technique has been used in this research work to estimate the reliability of the longwall system. Systematic reliability analysis also reveals the sources of weakness that adversely affects the production of coal and helps finding the loopholes in the system.

For a long time now, as will be found from the literature review, Birnbaum and Fussell–Vesely ranking measures are extensively used in reliability analysis. These measures of importance are probability based and do not include for cost of failure which is one of the important factors in engineering decision. Here a new approach is proposed by evaluating an indicator, called cost-effective indicator (CEI) that accounts for both the component's performance and economic aspects. The indicator is useful in production systems where operational reliability and cost of break down are both of paramount importance. Basic components / events in an FT are ranked as per the decreasing value of this indicator to indicate the favourable area for improvement.

Conventional fault tree analysis uses exact values in estimating the failure probability of system components or basic events. Estimation of failure probability depends on the availability of plant specific numerical data. It is often difficult to evaluate failure probabilities of some components due to non availability of significant data mainly due to the following reasons:

1. Components have long MTTF and therefore have very low number of failures during study time.
2. Data mixed with other failures due to inefficient reporting and poor classification of data.
3. Change in environment and lack of recorded past experience, etc.

To overcome this difficulty a methodology is proposed employing hybrid data in the analysis. In this proposed method failure probabilities of basic events having sufficient data are estimated statistically and fuzzy set theoretic evaluation is done for rest of the events using experts' experience. FT of the same longwall system has been analyzed by this method and components have been ranked as per their Birnbaum factors and Fussell–Vesely correction factors.

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

1. Detailed FT construction and its subsequent analysis give a clear understanding of the failure logic of the system.

2. Statistical analysis of failure data provides important information that may be used to frame maintenance and replacement policy.

3. CEI can be a convenient and effective tool for inspection, maintenance and failure detection activities. These activities can be formulated according to the components' CEI ranks.

4. Experts' experience can be an effective source of information in estimating the failure probability of a component when there is little data for statistical inferences.