RELIABILITY ANALYSIS OF DRAGLINE USING BAYESIAN NETWORK

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By

Deepak Kumar

DEPARTMENT OF MINING ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY
(BANARAS HINDU UNIVERSITY)
VARANASI- 221005
INDIA

Roll No. 16151005

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Conclusion

8.1 Introduction

This dissertation discusses collection and subsequent analysis of failure data, development of BN and DBN-based models for reliability study as well as maintenance analysis of a dragline. Results of the analysis identifies the important subsystems and components of the dragline that guide devising apt maintenance policies. Finally, the research limitation and future scope of research have been highlighted.

8.2 Conclusion

From the research work conducted on dragline, the following conclusions can be drawn:

i. In this research work, it was identified from the collected operational data of dragline over the period of 52 months during 2011-15 that 40 components belonging to seven subsystems were responsible for 1056 dragline failures.

ii. .Reliability of the dragline system was studied using the developed BN model. Results were compared with the actual reliability of the dragline and with the results of FTA. FTA and developed BN model estimate reliability of the dragline at t=1hr as 59.59% and 62.03% respectively when the operated reliability of the dragline was 70.65% at t = 1 hour. Therefore it can be concluded that the BN model estimates reliability of with more than 80% accuracy.

iii. Failure diagnosis using BN model helps to identify the most critical subsystems of the dragline. This has been validated using Mutual information theory. So BN can be successfully used for importance ranking in reliability analysis.

iv. This research identified the dragging mechanism as the most failure-prone subsystem, experiencing around 17.83% of the dragline failures, followed by electrical auxiliary subsystem (12.02%), swing mechanism (8.70%), hoisting mechanism (8.16%), bucket & accessories (4.12%) and rigging mechanism (0.0031%). Thus dragging mechanism is the most critical subsystem and rigging mechanism is the least critical subsystem of the dragline from its failure aspect.

v. For better performance of the dragline, preventive measures should be devised and the allocation of resources needed to be prioritized as per the rank of the subsystem/components. Also, different maintenance strategies should be developed for the said subsystem/components according to their failure probability and criticality.

vi. Detailed reliability study of the most critical subsystem i.e. dragging mechanism has been done through the DBN. The overall reliability of the drag mechanism is 84.29% after 1hr operation of the dragline. Reliability of the overall dragging mechanism reduced to 1.6% only within 24 hours of operation of the dragline. This shows that reliability of the dragging mechanism changes sharply that may be attributed to frequent failures of drag motors, power supply, brake, and drag socket.

vii. Maintenance policy of the critical subsystem's components suggested two methods based on the repair characteristic of the components. These maintenance models are: (i) imperfect preventive maintenance and (ii) interval-based reliability centered preventive replacement

viii. A cost rate optimization based imperfect maintenance model has been recommended for the repairable components. This maintenance model suggests optimum frequency of maintenance at a minimum cost rate is 2 for drag motor. Thus the suggested preventive maintenance interval for drag motor is 4000hrs.

ix. This study prescribes a replacement policy for a non-repairable component based on the characteristic life and MTTF of the component. The interval between the characteristic life and mean life of a component is a favourable time for opportunistic preventive replacement. Whenever chances do not appear within this interval, a replacement of the component need to be scheduled after MTTF.

x. The estimated characteristic life of the drag rope and drag chain are 751.4251hrs and 433.3874hrs respectively, while the estimated MTTF of these components are 4508.55hrs and 2600.25hrs, respectively. Thus it is suggested that as and when opportunity appears, replace the drag rope between 751hr – 4508 hrs. as a preventive measure. Otherwise, replace drag ropes after 4508 hrs. to avoid undue downtime. These are useful information for inventory management.

8.3 Future Scope of Research Work

This research, has not explored the failure dependency of the dragline on machine sensor, weather condition, production load and operator/maintenance personnel skills/human errors. These can be incorporated in the BN model as the evidence for deeper understanding of the dragline failure.

These information certainly help in preparing a suitable maintenance strategy for minimizing failure and downtimes of the dragline.

Furthermore, Repair/maintenance data and information on other covariates of failures may be included in the reliability study through the BN model. Multi state conditions may be included for deeper understanding of reliability study.

In DBN model, degradation and failure modes can be incorporated for further study of remaining useful life of the dragline.

The maintenance models explained in this work is not limited to the dragging subsystem only. It can be equally applicable to other subsystems of dragline directly or with suitable modification.

Further, the methodology of reliability study detailed in this dissertation can be equally applicable to the other sophisticated and capital-intensive HEMMs used in mines and other industries