Journal Pre-proofs

Study on Reliability of Shearer Permanent Magnet Semi-Direct Drive Gear Transmission System

Jiajun Chen, Wei Li, Lianchao Sheng, Song Jiang, Min Li

PII: S0142-1123(19)30491-8
DOI: https://doi.org/10.1016/j.ijfatigue.2019.105387
Reference: JIJF 105387

To appear in: *International Journal of Fatigue*

Received Date: 27 June 2019
Revised Date: 21 October 2019
Accepted Date: 19 November 2019

Please cite this article as: Chen, J., Li, W., Sheng, L., Jiang, S., Li, M., Study on Reliability of Shearer Permanent Magnet Semi-Direct Drive Gear Transmission System, *International Journal of Fatigue* (2019), doi: https://doi.org/10.1016/j.ijfatigue.2019.105387

Study on Reliability of Shearer Permanent Magnet Semi-Direct Drive Gear Transmission System

Jiajun Chen*, Wei Li§, Lianchao Sheng*, Song Jiang*, Min Li*

*School of Mechatronic Engineering, China University of Mining and Technology, Xuzhou 221116, China

Correspondence should be addressed to Wei Li: cmeecumt512@yahoo.com§

Abstract: The permanent magnet semi-direct drive cutting transmission system of shearer is taken as the research object, the non-linear dynamic model of the system is established and the Runge-Kutta method is used to solve it. The statistical processing is carried out to gear stress by rain-flow counting method, and an eight-stage random loading model is established. Combining the nonlinear fatigue damage theory, the dynamic reliability of gear is predicted through the modified stress-strength interference model. Finally, the influence of some parameters on gear reliability is further studied, which provides a reference for the reliability optimization of gear in shearer cutting unit.

Keywords: Gear transmission system in a shearer, nonlinear dynamics, gear dynamic reliability, load spectrum, nonlinear damage accumulation

1. Introduction

In the process of coal mining, due to the existence of gangue with high cutting resistance in the coal seam, the coal cutting load has the characteristics of strong impact and large fluctuation, and the cutting unit has always been a high fault-prone area. In order to reduce the gear failure rate, the permanent magnet semi-direct transmission system consists of "the permanent magnet synchronous motor + three-stage spur gear transmission + cutting drum" [1] with lower gear speed and shorter transmission chain is proposed, and on this basis, the reliability of the gear in the system is studied to improve the working performance of cutting unit.

At present, the most commonly used for reliability analysis of components is stress-strength interference model, which essentially calculates the probability that the stress of components is greater than its strength. Since both stress and strength affect the accuracy of reliability calculation, detailed analysis is needed in both aspects. Firstly, the stress section mainly includes the simulation of the coal mining load and the compilation of the gear load spectrum. In the study of coal mining load, the discrete element method is commonly used which allows effective simulation of physical systems consisting of many independent components. Gospodarczyk et al. [2] used it to model the coal seam, they established the method and algorithm to simulate the mining process, and analyzed the movement law of coal flow under different structure forms and motion parameters of shearers. Van et al. [3] used the discrete element method to numerically simulate the tool force generated by rock cutting test, and pointed out that the cutting depth and wear have a great influence on the cutting process. With the consideration of the pure coal, rock and hard block in coal seam, Li et al. [4] established the mathematical model of the drum's random load, then obtained the load of the cutting drum and its variation law. Su et al. [5] performed a three-dimensional numerical simulation of rock cutting test in non-unloading mode, estimated the peak cutting force of the rock based on the mechanical properties of the specimen and the cutting mechanism of the rock. However, the dynamic stress of the component obtained initially has a high frequency of change and a large amount of data, which is not suitable for the calculation of reliability directly. Therefore, it is necessary to make further data statistics and compile load spectrum. On the basis of a large amount of cutting data, He et al. [6] established the joint probability distribution function between