Let ξ denote the probability that a PDU is located at the ith position in second transmission burst when it is first transmitted. The initial state vector, $\Pi_0 = [\pi_1, \pi_2, \cdots, \pi_i, \cdots, \pi_L]$, is derived as follows:

$$\pi_i = pr(\xi = i) = \sum_{j=1}^{L} pr(\xi = i, \mu = j) = \sum_{j=1}^{L} pr(\mu = j)\, pr(\xi = i \mid \mu = j); \tag{3}$$

$$pr(\xi = i \mid \mu = j) = \begin{cases} \dfrac{1}{j-n} & i = L - j + n + 1, \cdots, L \\ 0 & \text{Otherwise} \end{cases} \tag{4}$$

where μ denotes the number of PDUs successfully transmitted during each time the tagged queue obtains the chance of transmission, n denotes the number of PDUs unsuccessfully transmitted in the first lost queue and its probability density function has been given.

Then we can calculate the delivery delay of PDU which is given by

$$D_P = \sum_{i=1}^{N_p - 1} (m_i + 1), \tag{5}$$

where N_P is given in (9), m_i is the ith inter-service time. Thus the average delivery delay is given by

$$E[D_P] = E\left[\sum_{i=1}^{N_P - 1} (m_i + 1)\right] = (E[N_P] - 1)(E[m] + 1). \tag{6}$$

4. Conclusion

A modified cumulative ARQ is surveyed in this paper. On the basis of the traditional cumulative ARQ, we put in the sequence ACK feedback in the transmission. We have studied the PDU delay of the modified mechanism by building the Markov model. The improvement is important to adapt to the environment with wireless channel. Our further research on the cumulative with several sequences feedback is under way.

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DYNAMIC RELIABILITY ANALYSIS ON TRANSMISSION SYSTEM OF SHEARER

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***Abstract**: Mining industry plays an increasingly important role in industrial development of China. The transmission system of shearer loader can be considered as a dynamic model with variable motion, time-varied mesh stiffness and nonlinear backlash. The vibration responses or contact stress should be investigated for safety production in the condition of variable speed and heavy load. An efficient method is proposed to conduct dynamic reliability analysis of the system. Reliability analysis aims at guaranteeing safety in production and improving work efficiency of transmission system in shearer. Reliability sensitivity method is proposed to analyze characteristic and optimize the structure of transmission system in shearer.*

1. **Introduction**

The transmission system in shearer loader undertakes the essential task of movement and support in the mining machinery. The performance has great impact on the reliability of the whole shearer loader. There are multiple failure modes such as fatigue, wear and fracture of

gears to describe the damaged condition. So the reliability analysis on the transmission system is necessary to enhance the working state of the mining mechanism. In the paper, dynamic transmission model is the foundation for the performance analysis. Typical reliability analysis approaches and reliability-based sensitivity methods are introduced to be applied in transmission system of shearer.

2. **Dynamic response analysis**

A mechanism under investigated is illustrated in Fig.1. The transmission model of planetary gears is established to reflect the freedom of each gear in Fig.2. The vibration mechanical model and rigid-body motion model are combined to analyze the movements of traction unit in Eq.(1). Considering time-varied mesh stiffness and nonlinear backlash, the dynamic equations can be represented to describe the vibration responses. Meanwhile, the dynamic contact stress can be calculated via Hertz computational formulae[1] in Fig.3.

$$\mathbf{M}\ddot{\mathbf{u}} + \mathbf{C}\dot{\mathbf{u}} + \omega_c \mathbf{G}\dot{\mathbf{u}} + \left[\mathbf{K}_b + \mathbf{K}_g(t) + \omega_c^2 \mathbf{K}_\Omega + \dot{\omega}_c \mathbf{K}_t\right] f(\mathbf{u}) = \mathbf{T}(t) \qquad (1)$$

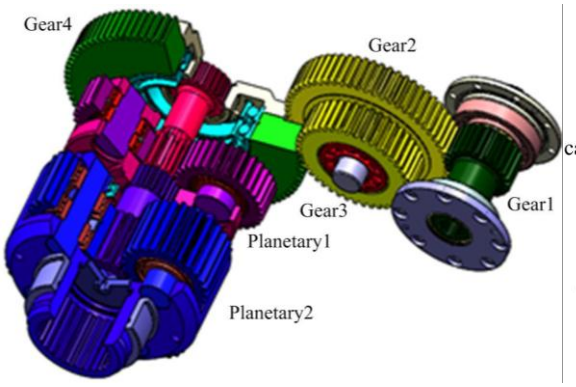

Fig.1 – Model of gear drive train in traction unit

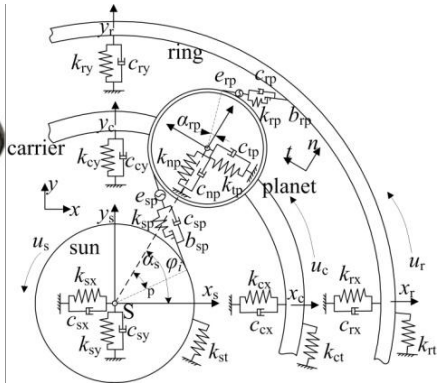

Fig.2 – M odel of planetary transmission system

3. **Reliability analysis**

3.1. Stress-strength interference model

The stress-strength model is the analysis on the interference of the stress placed on the material's strength. The model is not necessarily used for a raw good or part, but can be an entire system in Eq.(2). The method can be established to calculate the reliability at one point. However, PDF of the maximum distribution in the movement can be applied to analyze the dynamic reliability in the whole lifetime. Dynamic reliability analysis needs to evaluate time-dependent failure probability of the transmission system. Order statistic theory and interference model are combined to calculate the dynamic reliability of system in shearer. Transmission system is safe at the first time of dynamic motion. System reliability decreases rapidly in the earlier stage and declines slowly in later period.

$$R = \int_{-\infty}^{+\infty}\left[\int_{s}^{+\infty} f(h)\mathrm{d}h\right] g(s)\mathrm{d}s = \int_{-\infty}^{+\infty}\left[\int_{-\infty}^{h} g(s)\mathrm{d}s\right] f(h)\mathrm{d}h \qquad (2)$$

3.2. Saddle-point approximation method (SAM)

The method has been widely used in statistics, engineering sciences, applied mathematics for parent distribution estimation. Comparing to probability methods in the literature, saddle-point approximation method[2] provides accurate parent distribution estimation in an efficient manner. SAM for estimating the cumulative distribution function (CDF) in Eq.(3) and probability distribution function (PDF) in Eq.(4) of response relies on the cumulate generating function (CGF) and the performance function. PDF and CDF of dynamic performance function of transmission system can be estimated on the base of dynamic analysis in Fig.4.

$$F_L(l) = P\{L \le l\} = \phi(w) + \varphi(w)\left(w^{-1} - v^{-1}\right), w = \mathrm{sgn}(s)\left\{2\left[sl - K_L(s)\right]\right\}^{1/2}, v = s\left[K_L''(s)\right]^{1/2}; \qquad (3)$$

$$f_L(l) = \left\{2\pi K_L''(s)\right\}^{-1/2} \exp\left[K_L(s) - sl\right]. \qquad (4)$$

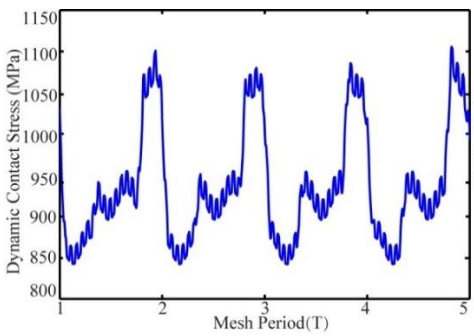

Fig.3 – Dynamic contact stress of system

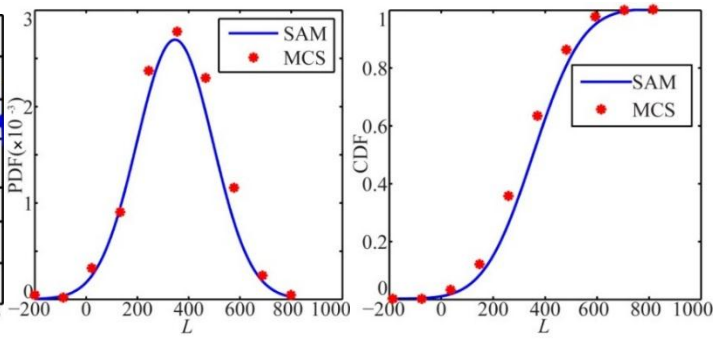

Fig.4 – PDF and CGF of system (MCS- Monte Carlo simulation)

3.3. Reliability-based sensitivity analysis

Reliability-based sensitivity is the partial derivative of distribution parameter for basic random variable. The mean-value sensitivity and standard deviation sensitivity are used to analyze the characteristics of variables in the transmission system in Eq.(5). The sensitivity analysis method is widely used to find the sensitive factor, research parameters' effects and optimize the structure. For example, the tooth thickness of sun gear is the most significant random structural parameter with respect to other gears' thicknesses in the transmission system. The sensitivity value implies the influence of mean and standard deviation of corresponding variables on the system reliability.

$$S_\mu = \frac{\partial R}{\partial \mu_j}\cdot\frac{\mu_j}{R} = \int_\Omega \frac{\partial f_L(l)}{\partial \mu_{X_i}}\cdot\frac{\mu_j}{R}\mathrm{d}l,\ S_\sigma = \frac{\partial R}{\partial \sigma_j}\cdot\frac{\sigma_j}{R} = \int_\Omega \frac{\partial f_L(l)}{\partial \sigma_{X_i}}\cdot\frac{\sigma_j}{R}\mathrm{d}l. \quad (5)$$

Conclusion

Stress-strength interference model and Saddle-point approximation method are proposed to analyze the dynamic reliability of transmission system in shearer loader. A reliability-based sensitivity method is proposed to improve the system performance on the basis of dynamic response analyses.

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SOLUTIONS OF FOOD POLYSACCHARIDE BLENDS FOR EDIBLE FILMS PRODUCTION

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Abstract. *The study of the rheological properties of aqueous solutions of starch blends with sodium alginate and agar-agar as well as the physico-mechanical properties of bicomponent films on their basis has been carried out. The extreme behavior of polymer blends with low content of one of the polymers is described in terms of mutual solubility or thermodynamic compatibility. There is a tendency of mechanical properties and water solubility increase with the increasing of SA and AA polymers in corn starch matrix. Obtained data evidence the benefits of bicomponent films production instead of starch-based films.*