7th World Tribology Congress, WTC 2022
July 10-15, 2022, Lyon, France

Improvement of Gear Unit Load and Noise Reduction by Optimal Design of Tooth Surface Using Principal Component Analysis

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Gear unit, which are often used in drive systems, must be improved load capability and reduced its vibration and noise. In the conventional tooth surface modification design method, it was difficult to simultaneously improve the load capability and reduce vibration and noise. In this study, we made this possible by applying a shape representation method using principal component analysis to tooth surface modification design. This report describes an overview of the method and the results of the effectiveness verification by test.

Keywords : gear, transmission, tooth surface modification, Principal Component Analysis

1. Introduction

To improve the competitiveness of transmissions, overall optimizations such as noise reduction, reliability improvement and weight saving are needed. Currently, tooth surface modification is examined using simple modification parameters such as tooth profile modification [1]. However, this method is difficult to simultaneously improve the load capability and reduce noise. The purpose of this study is to apply principal component analysis to tooth surface modification design and to develop an efficient examination method for optimum tooth surface modification.

2. Tooth surface modification design method using principal component analysis

In this study, we use the parameters obtained by principal component analysis as design parameters to represent the tooth surface shape. The principal component analysis of a shape prepared in advance makes it possible to obtain new shape definition parameters different from the conventional modification parameters such as tooth profile modification and tooth trace modification. Figure 1 depicts the flow for examining a tooth surface shape using principal component analysis.

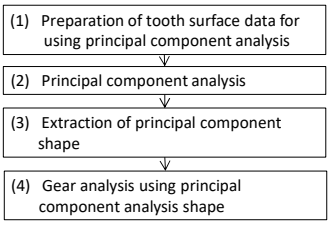


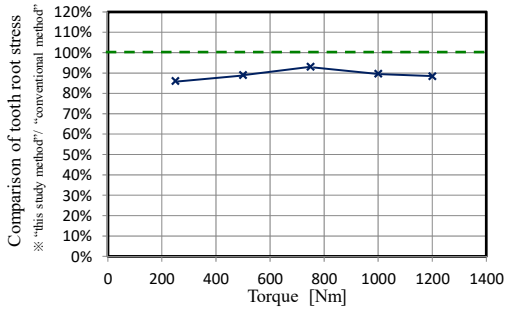
Figure 1: Flow for examining tooth surface shape using principal component analysis

3. Effectiveness verification by test

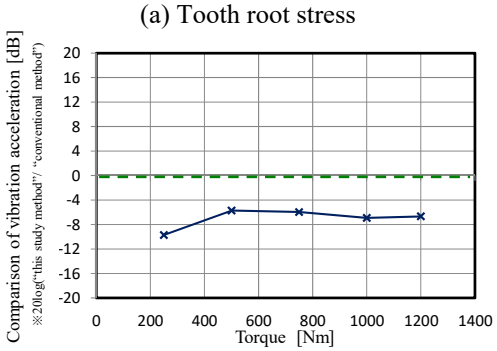
3.1. Test equipment and measurement items
The verification test was carried out using a power circulation type gear tester. In order to confirm the load capacity and noise improvement effect of this study method, the tooth root stress of the gear and the vibration acceleration of the gear box were measured.

3.2. Examination of tooth surface shape for test gear
The tooth root stress, contact pressure, and mating excitation force were analyzed, and the tooth surface shape with low stress and low mating excitation force was selected. In the conventional method, the tooth surface shape was examined by parametric study of tooth profile modification and tooth trace modification.

3.3. Test results and discussion
Fig. 2 shows the measurement results of tooth root stress and vibration acceleration (1Fz). These are arranged by the ratio of measured values of this study method and the conventional method. It has been confirmed that this study method enables design with lower stress and vibration than the conventional method.



(a) Tooth root stress



(b) Vibrational acceleration (1Fz)

Figure 2: Measurement results

4. Conclusion

This study method is more effective than the conventional method in designing downsized gear unit because it can improve both load capacity and quietness.

5. References

[1] Kubo, A. et al., "On the power transmitting characteristics of helical gears with manufacturing and alignment errors" Transactions of the JSME, 43.371,1977, 2771-2779.