PREVENTION OF CAGE WEAR IN CYLINDRICAL ROLLER BEARINGS BY REDUCING ROLLER MASS

D. Suzuki [a*], K. Takahashi [a]
*suzuki.daisuke.83@rtri.or.jp
[a] Laboratory of Lubricating Materials, Railway Technical Research Institute
2-8-38 Hikari-cho, Kokubunji-shi, Tokyo 185-8540, Japan

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ABSTRACT
When cylindrical roller bearings are used without preload, with light loads, and at high rotational speeds, they may become unusable due to cage wear rather than raceway fatigue. An example is the cylindrical roller bearings used in the traction motors of railway vehicles, which are replaced due to cage wear. The prevention of cage wear can result in longer life for such bearings. From this viewpoint, the purpose of this study is to prevent cage wear which causes malfunction of roller bearings in the traction motors. Forces in the bearing that cause cage wear are shown in Fig. 1. In the no-load zone, the roller intermittently contacts the cage because the orbital speed of the roller is decelerated by the pressure force exerted by the oil film. As a result, a force to decelerate the cage F_{dec} is generated. In contrast, in the load zone, the roller contacts the cage continuously to compensate for the momentum of the cage that is lost in the no-load zone. As a result, a force to accelerate the cage F_{acc} is generated. In a previous paper [1], the authors showed that when these forces are applied, adhesive wear follows Archard's equation occurs in the cage, and cage wear is proportional to the impulse caused by these forces per cage rotation. Furthermore, the impulse per cage rotation was measured experimentally, and based on this measurement, a method for calculating the impulse by dynamic analysis was proposed.

In this paper, reducing the roller mass was considered to prevent cage wear. This is because the impulse is caused by the collision of the roller and the cage, and the roller mass m should affect the collision. It is assumed here that the cylindrical roller bearings (NU214) are operated with a radial load of 922 N and a maximum rotational speed of 6100 min^{-1}, which are the operating conditions of a traction motor. The roller mass m was changed by using bearing steel rollers (13 g/roller) and lighter mass ceramics rollers (5.5 g/roller). The results of the dynamic analysis used to verify the effect of the roller mass reduction are shown in Fig. 2. It was confirmed that reducing the roller mass also reduces the impulse per cage rotation; therefore, rotational tests were conducted on bearings assembled with the respective rollers until seizure. The results of the bearing rotational tests are shown in Fig. 3. The total number of rotations is greater with lighter rollers, which is considered to prevent cage wear.

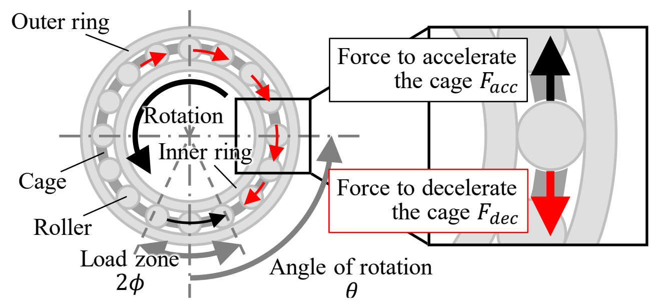

Fig.1 Forces in bearing that cause cage wear.

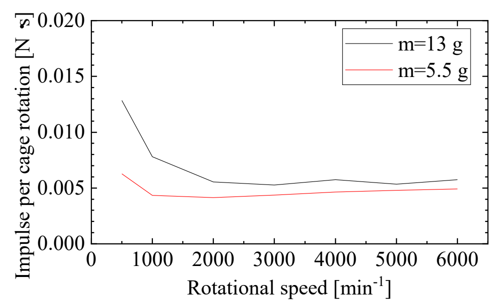

Fig.2 Calculation results of dynamic analysis.

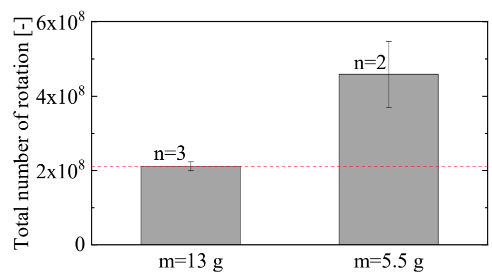

Fig.3 Results of bearing rotational tests.

REFERENCES
[1] Suzuki, D., Takahashi, K., Itoigawa, F., and Maegawa, S., "Study on Cage Wear of Railway Traction Motor Bearings Based on Analysis of Rolling Element Motion," Machines, 11, 6, 2023, 594.