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Experimental Investigation of Bump Metal-mesh Foil Gas Bearings

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1. Introduction

In recent years, bump foil bearings as shown in fig. 1(i) are expected to be used for high-speed machinery. When the upper surface shown in the figure rotates, air hydrodynamic pressure caused by the wedge effect is generated in the bearing gaps composed by flexible foil structures and rotating shaft. Therefore, the bearing surface is deformed flexibly even when external vibration is generated, and the damping action due to friction. Previously, large number of foil bearings have been proposed, however their structures tend to become more complex. On the other hand, the authors proposed a new bump metal mesh foil bearing that combines a general bump foil bearing and a metal-mesh foil bearing as a simple shape foil bearing as shown in fig.1(ii)[1]. In this study, experimentally evaluated its characteristics are investigated.

2. Test Foil bearings

Figure 1 shows the photograph of a general bump foil bearing and a bump metal mesh foil bearing proposed by the authors. Foil bearings are generally composed of a top foil, bump foil, bearing base, spacer, etc. The dynamic pressure generated by rotation deforms the foil structure to form a gaseous lubrication film. The gas film generated by hydrodynamic effect depends greatly on the deformation of the bump foil and top foil. Therefore, the foil structure that constitutes the bearing is extremely important for foil bearings. In this study, we propose a bearing using metal mesh as a material for bump foil and the static and dynamic characteristics are investigated.

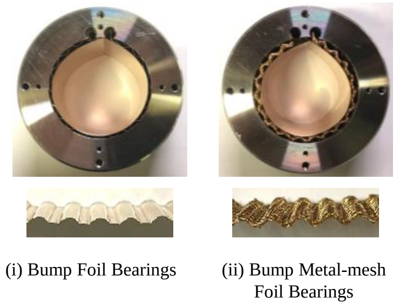

Fig. 1 Test bearings

3. Experimental equipment and method

Figure 2 shows the geometry of our own high-speed bearing test equipment. In this study, we conducted experiment using and compared the characteristics of two bearings. In addition, an eddy current displacement senser is installed on the bearing card ridge to measure the relative distance between the shaft and the bearing, and the bearing cartridge can be rotated in the direction of rotation. By using the structure, the friction torque is also can be measured.

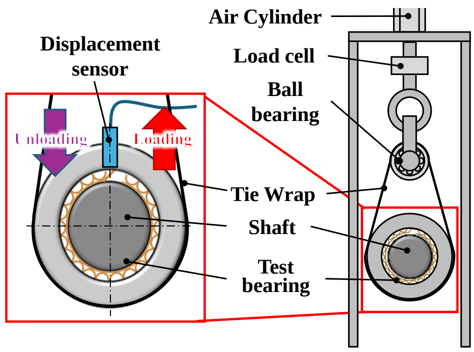

Fig. 2 Geometry of bearing test equipment.

4. Experimental Results

Figure 3 shows the one of the experimental results of structural stiffness. The experiments were conducted once for the applied load, and once for the unloaded load. The difference in the trajectories of the plots during loading and unloading is called the hysteresis loss and is used to evaluate the damping performance. A larger disparity in trajectories indicates superior damping performance. The bump metal mesh foil bearing exhibited superior hysteresis characteristics because the difference in the trajectories between the applied and unloaded conditions was larger than that of the bump foil bearing. This is attributed to energy dissipation by friction inside the mesh, in addition to friction between the top foil and the bump metal-mesh.

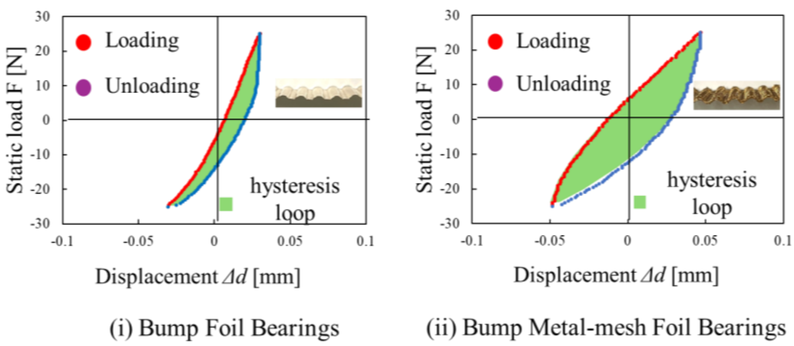

Fig. 3 Results of structural stiffness

Reference

1) Y. Kuwata, M. Ochiai, Tribology online, Vol. 19, No. 4 (2024) 345-351. DOI 10.2474/trol.19.345.