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Effects of manufacturing errors on the static characteristics of aerostatic journal bearings with porous restrictor

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Abstract

Numerical and experimental research on the effects of manufacturing errors on the static performance of aerostatic porous journal bearings is presented. The effects of circumferential waviness, taper, concavity, and convexity on the bearing film thickness were modeled based on the experimental results. The effects of amplitude and spatial wave length on the bearing film pressure, load capacity and stiffness were investigated by solving the Darcy-Forchheimer law and Navier-Stokes equations. Both the numerical results and experimental data show that the bearing static characteristics were significantly influenced by the manufacturing errors. Circumferential waviness errors caused the obvious inhomogeneity of the flow field and the transformation of morphology of the high-pressure region, whereas axial errors had a significant impact on the area and location of the high-pressure region. The bearing load capacity and stiffness can be improved by increasing the amplitude of the manufacturing errors, except for the concavity errors. Both the bearing load capacity difference and stiffness difference increased with an increase in the axial errors' amplitude. For the manufacturing errors, the calculation results are close to the measurement data. Therefore, it is necessary to consider the influence of manufacturing errors on the bearing static characteristics in numerical calculations.

Keywords: aerostatic porous journal bearings; manufacturing errors; static characteristics; Darcy-Forchheimer; Navier-Stokes