

On the Frictional Damping Characterization of Compliant Bump Foils

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High-speed rotor systems use either fluid film or rolling element bearing supports, depending upon their design and operating constraints. Regardless of bearing type used, these systems require specific bearing and support stiffness and damping characteristics to achieve the desired stable and low vibration operation. Building upon the technology of thin metallic corrugated bump foils presently used in a particular class of film riding hydrodynamic bearings, a novel corrugated bump foil damped mount is introduced which provides stiffness and damping for application with rolling element bearings. These damping elements are capable of operating at elevated temperatures where implementation of conventional squeeze film dampers is ruled out. The frictional damping results from micro-slip motions between the bump foils and the mating surfaces. A semi-empirical model, based on a one degree of freedom model was developed in which damping is replaced by an equivalent frictional force in order to gain insight into the dynamic friction coefficient of the individual damping element interfaces. Experimental results, obtained in the form of hysteresis loops were compared to the developed model with good agreement. The variation in damping and dynamic coefficient of friction was found to be dependent primarily upon three factors: vibration frequency, amplitude of motion and applied static load. These parameters were tested within the range of 50–1400 Hz, 2.54–12.7 micron and 45–135 N, respectively. The tests were conducted at room and 538°C ambient temperatures under both dry and vapor phase lubricated conditions. Using the resulting empirical data, several bearing dampers were designed, built and tested in a small, high-speed gas turbine engine simulator. The tested novel foil dampers were capable of operating reliably under extremely high levels of shaft imbalance (i.e., 320 times greater than the air bearing supported with specification of 0.0002 oz-in) even while operating at temperatures to 560°C. These results show the great potential for wide application of these dampers on gas turbine engines and high-speed rotating machinery. [DOI: 10.1115/1.1575774]