Proceedings of 2004 ASME Turbo Expo:
Power for Land, Sea & Air
June 14-17, 2004 – Vienna, Austria

GT2004-53860

ADVANCEMENTS IN THE STRUCTURAL STIFFNESS AND DAMPING OF A LARGE COMPLIANT FOIL JOURNAL BEARING: AN EXPERIMENTAL STUDY

Mohsen Salehi, Ph.D.
Salehim@asme.org
Mohawk Innovative Technology Inc.
Albany, NY 12205

Hooshang Heshmat, Ph.D. (ASME/STLE Fellow)
hheshmat@miti.cc
Mohawk Innovative Technology Inc.
Albany, NY 12205

James F. Walton II (ASME /SAE/ASAIO Member)
jwalton@miti.cc
Mohawk Innovative Technology Inc.
Albany, NY 12205

ABSTRACT

This paper presents the results of an experimental investigation into the dynamic structural stiffness and damping characteristics of a 21.6 cm (8.5inch) diameter compliant surface foil journal bearing. The goal of this development was to achieve high levels of damping without the use of oil, as is used in squeeze film dampers, while maintaining a nearly constant dynamic stiffness over a range of frequencies and amplitudes of motion. In the experimental work described herein, a full compliant foil bearing was designed, fabricated and tested. The test facility included a non-rotating journal located inside the bearing. The journal was connected to an electrodynamic shaker so that dynamic forces simulating expected operating conditions could be applied to the structurally compliant bump foil elements. Excitation test frequencies to a maximum of 400 Hz at amplitudes of motion between 25.4 m to 102 m were applied to the damper assembly. During testing, both compressive preload and unidirectional static loads of up to 1335N and 445N, respectively, were applied to the damper assembly. The experimental data from these tests were analyzed using both a single degree of freedom model and an energy method. These methods of data analysis are reviewed here and results are compared. Excellent agreement in results obtained from the two methods was achieved. Equivalent viscous damping coefficients as high as 1050 N.s/cm (600 lbf.s/in) were obtained at low frequencies. Dynamic stiffness was shown to be fairly constant with frequency.

NOMENCLATURE

C	Damping
E	Energy, work
e	eccentricity
f	Frequency
F	Force
K	Stiffness
m	Mass
OD	Outside diameter
t	Time
X, x	Displacement, coordinate axis
Xo	Amplitude of motion
y	Coordinate axis
w	Load, width
:	Coefficient of friction
T	Angular velocity ($2\pi f$)
'	Loss factor