

## ABSTRACT

Pederson, Bradley M., M.S.M.E., Purdue University, May, 2005. The Influence of Cage Flexibility on Bearing Dynamics and Performance. Major Professors: Dr. Farshid Sadeghi and Dr. Carl Wassgren, School of Mechanical Engineering.

The current study incorporates a flexible cage into a previously developed numerical bearing dynamics simulation. A two-dimensional lumped mass model was developed to represent cage flexibility, the ability of the cage to deform, in deep groove ball bearings. Damped springs connect the lumped masses in the circumferential direction of the cage and torsional springs provide a restoring moment to offset transverse bending deflections of the cage.

An ANSYS model of the bearing cage was also developed to obtain the circumferential and torsional stiffnesses. Experiments validated the ANSYS cage model. A force-deflection relationship for the cage was experimentally determined and the results were corroborated with an ANSYS cage model under the same loading conditions. Experimental Modal Analysis (EMA) of half of the cage was also performed. The EMA results are in very good agreement with modal analysis results of the ANSYS model for half of the cage.

The Flexible Cage Model (FCM) was validated using the ANSYS cage model by investigating the response of the cage subject to various loading conditions. The results obtained from the FCM are in very good agreement with the results obtained using the ANSYS cage model for the same loading conditions.

Extensive parametric studies were conducted to investigate cage motion as a function of the flexible cage circumferential and torsional stiffnesses for multiple loads and speeds. Variations of the ball-to-cage pocket clearance were also investigated. The FCM results were compared to the results obtained from rigid cage dynamic bearing simulations.

Cage flexibility was found to have the largest effect on the initiation of cage whirl for cases of pure interference loading and at small values of the clearance and the circumferential stiffness. The FCM predicts significant decreases in the average ball-to-cage pocket normal contact force when compared to the rigid cage results for the same set of operating conditions. Additionally, increasing the ball-to-cage pocket clearance, in most cases, causes significant increases in the average normal ball-to-cage pocket contact force and a decrease in cage instability for both the rigid and flexible cage models.