

## ABSTRACT

Ghaisas, Niranjana Vijay, M.S.M.E., Purdue University, December, 2003. Dynamics of Cylindrical and Tapered Roller Bearings Using the Discrete Element Method. Major Professor: Dr. Farshid Sadeghi, School of Mechanical Engineering.

The aim of the current study is to study the dynamic motion of bearing elements in cylindrical and tapered roller bearings. With this aim in mind, a Dynamic Bearing Model (DBM) was developed that can simulate motion of bearing elements in six degrees of freedom. This model can accurately predict bearing performance as a function of various geometrical and operating parameters. Hence, it can serve as a useful design tool and take the place of expensive experimental test data.

The DBM allows for roller-race, roller-cage and cage-race interactions. Hertzian point contact relationships are used for normal force computations in fully crowned rollers. A slicing method is implemented to model normal force interactions for multi-radius profile rollers. Friction force is computed using a traction-slip relationship. Presence of lubricant is taken into account in computing rolling resistance, churning and drag losses.

As a first order validation, velocities of rollers and cage predicted by the DBM were compared against those obtained from a kinematic solution. Predictions for race torque as a function of bearing geometry were compared with published data obtained from quasi-static models. Finally, torque predictions as a function of speed and load for cylindrical and tapered roller bearings were compared against experimental test data. Good correlation was observed between the results in all of these validation studies.

Large-scale parametric studies were conducted to study cage motion as a function of geometric and operating parameters in lightly loaded, high speed cylindrical roller bearings and predict stable and unstable regions of operation. The effects of varying roller-cage and roller-race clearances on cage motion were investigated. Influence of operating conditions such as speed and misalignment were studied. Finally, effects of variation in roller profile, roller size and cage asymmetry on cage motion were analyzed.