

# Steady State and Dynamic Behaviour of Lubricated Roller Bearings

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## Abstract

The analysis of elastohydrodynamically lubricated (EHL) roller bearings is conventionally carried out using infinite line contact theory. In reality, these bearings have finite contact length and are axially profiled towards their ends in order to reduce the edge stress concentration. To have the precise knowledge of the dynamics of bearings and/or rotor-bearing systems, it is very much essential to use the correct values of stiffness and damping coefficients of the support bearings. EHL finite line contact analysis of lubricated cylindrical roller bearing and their influence on the vibration characteristics of rotor system are the topics discussed in thesis.

In the present work, the pressure equation is solved by a multilevel method and the elastic deformation is calculated with a multilevel multi-integration technique. Influence of surface roughness and couple stress fluid on the EHL finite line contact is studied. For the dynamic analysis, linearized first order perturbation method is employed to evaluate the dynamic pressures and later those are used to calculate the stiffness and damping coefficients of a single roller-to-race contact. Based on the numerically evaluated data, the curve fitted relations of stiffness and damping coefficients are derived. These curve fitted relations are used to develop the linear and nonlinear spring-damper model of the lubricated cylindrical roller bearings in order to carry out the vibration analysis.

Results show improvement in the performance of the lubricated contact with the use of couple stress fluids. Significant difference in the film thickness values are reported in surface roughness study with probabilistic approach, particularly at lower values of surface roughness parameter ( $\Lambda$ ). While studying the surface roughness effect with deterministic approach, the increase in coefficient of friction is found to be significant with increasing roughness amplitude for the case of 3D and transverse roughness pattern. From the linear vibration analysis of rotor-bearing system, it is noted that the rotor system with lubricated roller bearings shows higher critical speeds and the lower vibration amplitude in comparison to the case of the rotor with dry contact roller bearings. The nonlinear structural vibrations of cylindrical roller bearing are studied under free condition and due to rotating unbalance for both damped and un-damped cases. Results show that the damping characteristic of lubricated roller bearing is desirable in order to reduce the bearing vibrations.

**Keywords:** Cylindrical roller bearings, Couple stress fluid, Damping, Deterministic approach, EHL, Finite line contact, Nonlinear structural vibrations, Probabilistic approach, Stiffness, Surface roughness.