839. Vibration analysis of geared rotor system under time varying mesh stiffness effects

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Abstract. The present work contributes to the analysis of the interactions between gears, shafts and journal bearings in a geared rotor-bearing system. Although there are analyses for both of the gear and rotor-bearing system dynamics, the coupling effect of the nonlinear variable pressure angle and geared rotor-bearing system is deficient. In contrast to the majority of the models in the literature, the variable mesh stiffness and pressure angle are introduced in this paper while they were considered as constant in previous models. The equations of motion for the geared rotor-bearing system are obtained by applying Lagrange's equation, and the Runge-Kutta numerical method is used to solve the equations of motion. Numerical results of this study indicated that the proposed model provides realistic dynamic response of a geared rotor-bearing system.

Keywords: gear, rotor system, time varying mesh stiffness.

1. Introduction

The geared rotor-bearing system is one of the main mechanisms for modern power transmission. It is often coupled with bearing systems, power generation and power extraction. On account of the increasing demand for high speed and accurate transportation, the research in the field of geared rotor dynamics is very important. The dynamic analysis of the geared rotor-bearing system with variable pressure angel is investigated in this paper.

The dynamic characteristics of geared rotor-bearing systems have been studied by many researchers [1-4]. Nelson [5] established the shape functions by using Timoshenko beam theory and finite element method, and Bucciarelli [6] presented unbalance response due to instability of rotating shaft. Shiau and Hwang [7] presented a polynomial expansion method for the dynamic analysis of rotor-bearing systems. For geared rotor system, Lund [8] considered the coupling effects of the torsional and lateral vibrations. Iida et al. [9] considered a simple geared system including the coupled torsional and flexural vibration. Neriya et al. [10] extended the model of Iida et al. [9] by representing a single gear with a two mass-spring-damper system. Kahraman et al. [11] developed a finite element model of a geared rotor system. Shiau et al. [12] analyzed the lateral response due to torsional excitation of geared rotor, and Lee et al. [13] developed the coupling of lateral and torsional vibration for the geared rotor-bearing system. The effects of the residual shaft bow and viscoelastic supports were investigated by Kang et al. [14] Kim et al. [15] developed a new dynamic model for the gear set that the pressure angle and the contact ratio as time-varying variables.

2. Modeling of the System

The configuration of a geared rotor-bearing system is shown in Fig. 1. Two uniform flexible shafts are of length L_1 and L_2, and the gear pair is mounted on the shafts. An external torque M exerts upon the driving gear. The contacting mesh force is represented by the gear mesh stiffness k_m and damping c_m along the pressure line. Four bearings are modeled as flexible elements with damping and stiffness denoted as c_j^b and k_j^b. A single shaft system with a rigid disk is shown in