

Simulation Based Analysis of Gear Dynamic Behavior in Presence of Multiple Cracks

Authors : Ahmed Saeed, Sadok Sassi, Mohammad Roshun

Abstract : Gears are important components with a vital role in many rotating machines. One of the common gear failure causes is tooth fatigue crack; however, its early detection is still a challenging task. The objective of this study is to develop a numerical model that simulates the effect of teeth cracks on the resulting gears vibrations and permits consequently to perform an early fault detection. In contrast to other published papers, this work incorporates the possibility of multiple simultaneous cracks with different depths. As cracks alter significantly the stiffness of the tooth, finite element software is used to determine the stiffness variation with respect to the angular position, for different combinations of crack orientation and depth. A simplified six degrees of freedom nonlinear lumped parameter model of a one-stage spur gear system is proposed to study the vibration with and without cracks. The model developed for calculating the stiffness with the crack permitted to update the physical parameters of the second-degree-of-freedom equations of motions describing the vibration of the gearbox. The vibration simulation results of the gearbox were by obtained using Simulink/Matlab. The effect of one crack with different levels was studied thoroughly. The change in the mesh stiffness and the vibration response were found to be consistent with previously published works. In addition, various statistical time domain parameters were considered. They showed different degrees of sensitivity toward the crack depth. Multiple cracks were also introduced at different locations and the vibration response along with the statistical parameters were obtained again for a general case of degradation (increase in crack depth, crack number and crack locations). It was found that although some parameters increase in value as the deterioration level increases, they show almost no change or even decrease when the number of cracks increases. Therefore, the use of any statistical parameters could be misleading if not considered in an appropriate way.

Keywords : Spur gear, cracked tooth, numerical simulation, time-domain parameters

Conference Title : ICSV 2017 : International Conference on Sound and Vibration

Conference Location : Boston, United States

Conference Dates : April 24-25, 2017