MESH STIFFNESS STUDIES OF SPUR GEAR PAIR WITH TOOTH ROOT CRACK

A thesis submitted by

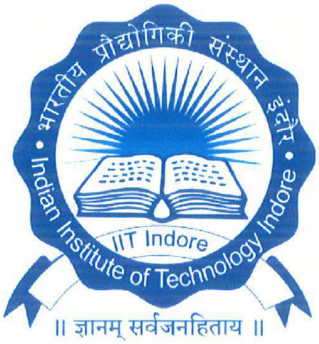
YOGESH PANDYA

for the award of the degree

of

DOCTOR OF PHILOSOPHY

at



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CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled **MESH STIFFNESS STUDIES OF SPUR GEAR PAIR WITH TOOTH ROOT CRACK** in the partial fulfillment of the requirements for the award of the degree of **DOCTOR OF PHILOSOPHY** and submitted in the **DISCIPLINE OF MECHANICAL ENGINEERING, INDIAN INSTITUTE OF TECHNOLOGY INDORE**, is an authentic record of my own work carried out during the time period from July 2010 to August 2013 under the supervision of **Dr. Anand Parey, Associate Professor, Mechanical Engineering Department, Indian Institute of Technology Indore – Indore (India).**

The matter presented in this thesis has not been submitted by me for the award of any other degree of this or any other institute.

17/2/2014

Signature of the student with date
(Yogesh Pandya)

This is to certify that the above statement made by the candidate is correct to the best of my/our knowledge.

30/08/2013

Signature of Thesis Supervisor with date

(Dr. Anand Parey)

Yogesh Pandya has successfully given his/her Ph.D. Oral Examination held on **February 17th, 2014.**

Signature(s) of Thesis Supervisor(s)
Date: 17/02/2014

Convener, DPGC
Date: 17.2.14

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Signature of External Examiner
Date: 17-02-2014

Abstract

Gearboxes are most important and commonly used mechanism for power transmission in various applications ranging from automobiles, industrial machines, aviation, power plant to the equipments used in our daily lives. Health monitoring of gear box is an important aspect to avoid failure of the machines in advance and to ensure reliability and low operating cost. Gear mesh stiffness is a time varying phenomenon occurring between the meshing gear teeth plays a major role in condition monitoring and fault diagnosis of gear boxes. Gear dynamic modeling and computer simulation of a gearbox system enhances the possibility of understanding the effect of time varying mesh stiffness on vibration response. Hence, an experimental method needs to be developed for the measurement of mesh stiffness.

Crack propagation path in gear tooth dictates the variation in gear mesh stiffness. One of the main objectives of this thesis is to illustrate the use of computer simulation and finite element methodology to carry out crack propagation path studies in gear tooth for gear pair with different contact ratios and gear parameters. Calculation of variation in gear mesh stiffness caused by increasing sizes of fatigue cracks can be used to detect the fault at an early stage. In addition to the numerical studies, an experimental methodology based on conventional photo-elasticity technique for computing stress intensity factor (SIF) for cracked spur gear tooth is proposed to measure the gear mesh stiffness. The measurement of stress intensity factor (SIF) can lead to the determination of gear tooth mesh stiffness variation in the presence of crack in a spur gear system. To study the effect of variation in total effective mesh stiffness due to increasing crack length on the vibration response of the gear box, a ten degree of freedom gear dynamic model is developed. Experiments have also been conducted on single stage spur gear box setup and vibration signals were recorded for different levels of pinion tooth crack. The vibration response obtained from dynamic model and experimental setup were analysed using sideband phenomenon in the frequency spectrum.