RESONANT RESPONSE OF HELICOPTER GEARS USING 3-D FINITE ELEMENT ANALYSIS

By

Raymond J. Drago
and
Ravi N. Margasahayam

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Mr. Raymond J. Drago
Advanced Power Train Technology
Boeing Helicopter Company
M/S P32-09
P. O. Box 16858
Philadelphia, PA 19142

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Raymond J. Drago
Staff Engineer
Boeing Helicopter Company

Ravi N. Margasahayam
Technical Specialist
Boeing Helicopter Company

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ABSTRACT

Dynamic analysis of a lightweight, heavily loaded, high speed helicopter gear is presented for identification and correction of resonance behavior. Using normal modes solution of MSC/NASTRAN, natural frequencies and related mode shapes were defined. Identification of damaging resonances occurring within the transmission operating range was accomplished with the aid of Campbell diagram technique. A comparison of FEM results and those from actual tests on an existing part indicated good correlation. Often neglected in the initial design process, evaluation of gear resonant response must be fully integrated in the design cycle.

INTRODUCTION

Gear resonance is one of the most insidious and destructive of all gear failure modes. Resonance phenomenon in gears, while not treated widely in the literature can be of considerable consequence in the design of complex helicopter gears. Moreover, improper attribution of resonance-induced failures to other causative factors, has curtailed developments in the area of its identification and correction.

In the design of new gearing, the transmission specialist methodically examines the gear from strength, scoring and durability standpoint. Use of dynamic load correction factors insure gear strength, however, little or no effort is made to understand the dynamic response of these gears [1]. Resonance induced failures usually cause extensive damage, due to separation of large fragments from the blank (Figure 1). This is primarily attributed to gear natural frequencies coinciding with operational excitation condition.

If the gear blank is excited at a frequency sufficiently close to one of its resonant frequencies, deflections and hence the gear stresses can increase to levels where failure can occur within a relatively short time. Often a small change in shaft speed, can result in a substantially large change in the stress levels experienced by the gear.

The prevention of this type of failure is relatively simple once resonance has been identified as the causative factor. The present paper attempts to address this issue of resonance identification early in the design cycle, thereby, eliminating costly redesign.