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Dynamic analysis of a high speed rotor-bearing system

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Abstract

High speed rotors are vulnerable to vibrations resulting in the failure of the whole operating system. To avoid resonant conditions at operating speeds, modal analysis of such rotors is very important in the design and development of the system. Full rotordynamic analysis during operating conditions is also mandatory to investigate the dynamic behavior of the rotating structure. In this paper, full dynamic analysis of a high speed rotor with certain geometrical and mechanical properties is carried out using 3D finite element model, one-dimensional beam-type model and experimental modal test. Good agreement between the theoretical and experimental results indicates the accuracy of the finite element models. The Campbell diagram, critical speeds, operational deflection shapes, and unbalance response of the rotor are obtained in order to completely investigate the dynamic behavior of the rotating system.

Keywords: High speed rotor, Dynamic analysis, Modal test, Campbell diagram

1. Introduction

Rotating machines are extensively used in engineering applications. The demand for more powerful rotating machines has led to higher operating speeds resulting in the need for accurate prediction of the dynamicbehavior of rotors. It is vital to precisely determine the dynamic characteristics of rotors in the design and development stages of turbomachines in order to avoid resonant conditions. Thus, much research has been carried out in the field of rotordynamics.

Turhan and Bulut [1] studied the linearly coupled shaft-torsional and blade-bending vibrations in single as well as multi-stage rotor-blade systems. They investigated the variation of the eigenfrequencieswith system parameters. Chiu and Chen [2] analytically studied the shaft-