7-2007

Review of Rotordynamics

Jerzy T. Sawicki
Cleveland State University, j.sawicki@csuohio.edu

Original Citation

Sawicki, J.T. (2007). Review of Rotordynamics. Journal of Engineering for Gas Turbines and Power, 128(3), 888.

Book Review

Rotordynamics, by Agnieszka (Agnes) Muszynska. CRC Press, Taylor & Francis Group, Boca Raton, FL, 2005, 1128 pp., ISBN: 0-8247-2399-6

REVIEWED BY JERZY T. SAWICKI[1]

This 1128-page monograph presents comprehensive rotordynamic problems in rotating machinery. These problems are recognized by machine monitoring data and correlated with modal models obtained by multi-mode modal identification. Being directly related to the modal characteristics, with practically identifiable parameters, multi-mode models have a solid base for further application in such areas as stability and post-stability self-excited vibrations, sensitivity analysis, active control, solid-fluid interaction, local/global dynamic effects, fractional resonances, chaotic vibrations, and many others. The emphasis is on understanding rotordynamic physical phenomena. Multitudes of experiments, described in detail, not only support the presented analytical material, but perhaps may also stimulate an enthusiasm to repeat and extend these experiments. This book also sets out fundamentals of vibration monitoring and malfunction diagnosis of rotating machines.

In Chapter 1, dynamics of the fundamental two-lateral-mode isotropic model of a rotor, as well as principles of modal identification are introduced. This model is extended in Chapter 3. Chapter 2 presents an introduction to vibration monitoring and data processing for rotating machinery, and reviews trends in machinery management and monitoring programs.

The most comprehensive Chapter 4 discusses important fluid-related problems known as "rotor fluid-induced instabilities," arising from rotor/fixed structure clearances in rotating machines. The Bently/Muszynska (B/M) model of the fluid forces in rotor clearances, based on the strength of the fluid circumferential flow, rep-

resented by the "fluid circumferential average velocity ratio" (denoted by λ is introduced. The rotor malfunction phenomena, fluid whirl, and fluid whip, are identified as limit cycles of self-excited vibrations. New phenomena, such as higher mode fluid whirl and fluid whip, are discussed, experimentally demonstrated, and adequately modeled. This chapter also introduces a formal, but unconventional, derivation of the fluid forces, starting from the classical Reynold's equation. The presentation clarifies some paradoxes, which are described in the rotordynamic literature. Comparisons are also presented between the B/M model and classical bearing/seal coefficients, thus providing a tool for extracting the meaning value of λ and other parameters of the B/M model from the coefficient tables. Identification methods of rotor/bearing/support system parameters are also discussed.

Chapter 5 presents rotor-to-stator dry contact-related rubbing. Experimental results, mathematical models of rubbing rotors, their solutions, and diagnostic recognition patterns are presented.

Chapter 6 discusses a series of important rotordynamic topics: balancing, stress in rotating and laterally vibrating rotors, multi-mode modal modeling, basing on modal data, rotor coupled lateral/torsional vibrations, loose rotating parts, role of damping in rotating structures, and early detection of rotor cracks using vibration data.

Chapter 7 outlines vibration diagnosis of various malfunctions in rotating machines based on vibrational data and illustrated by means of basic simplified mathematical rotor models.

Extensive references and a list of mathematical notations follow each chapter. Ten Appendices and a Glossary of terminology complete the book.

The book does not contain worked examples and there are no problems or suggested laboratory exercises at the end of each chapter that could be assigned to students. This would make it difficult to use as a textbook in a course dealing with dynamics and diagnostics of rotating machinery. This monograph represents an invaluable resource for professionals and practicing engineers concerned with rotating machines.

[1]Department of Mechanical Engineering, Cleveland State University, Cleveland, OH 44115-2214; e-mail: j.sawicki@csuohio.edu