Handbook on Stiffness and Damping in Mechanical Design, by Eugene I. Rivin. ASME Press, New York, 2010, 754 pp., ISBN: 978-0-7918-0293-9. The ASME Member Price is US $ 137, and the non-member price is US $ 175.

REVIEWED BY LUCJAN KOPS[1]

Handbook on Stiffness and Damping in Mechanical Design by Eugene I. Rivin is an important and long overdue publication, which provides comprehensive and detailed information on important design issues involving the subject. Except author's 1999 sold-out book on the subject, there have been very few publications addressing stiffness- and damping-related issues, and many issues were left untouched. This much expanded monograph corrects the situation.

The author, an internationally renowned expert in mechanical design with extensive experience in R&D institutes, manufacturing industry and academia, widely published and with more than 60 patents, approaches such a large subject by presenting it in the form of conceptual issues. Addressing various aspects of structural stiffness and structural damping and their role in design, the author considers both stiffness and damping jointly, as in case of dynamics and vibrations, those are frequently closely interrelated.

The Handbook is organized in eight chapters and seven appendices. Chapters contain 80% of the volume, of which 30% cover general concepts, where the author leads the reader from the basic notions and definitions, and the introduction of the conceptual issues of negative stiffness and damping, to the modes of loading and stiffness of structural components, followed by nonlinear and variable stiffness systems. The remaining 70% deals with specific design categories and design techniques. It is here that the author shows his mastery as designer-practitioner familiar with the intricate details of a wide range of designs and associated issues as well as various approaches to solutions. Thus, the subject of contact (joint) stiffness and damping is covered with particular focus on tooling for both cylindrical and taper connections, and the discussion of supporting systems addresses also the influence of foundation on structural deformations. The coverage of stiffness and damping of transmissions system and drives includes parameter reduction in mathematical models as well as practical examples related to robots. Of the last two chapters, the first deals with the design techniques for reducing structural deformations, presenting structural optimization techniques to enhance stiffness. The last chapter provides extensive coverage of the "managed stiffness" in design, focusing particularly on tooling in machining systems and presenting techniques and benefits of intentional stiffness reduction, usually seeking optimum. Flexures, the anisotropic elastic elements serving as limited travel bearings, are also discussed here.

While closed-form analytical expressions for calculating stiffness of critical design elements are given, practical conclusions are also drawn; such is a study of a modular tooling system with axial tightening the analysis of which revealed that, according to the author's tests results, the optimal magnitude of the tightening torque is one-half of the value recommended by the manufacturer. Detailed analytical treatment is given in a few cases, which was never published before or when was published is hard to obtain sources, e.g., in a language other than English. Indeed, a number of Russian publications listed in References reflect the fact that many important issues on stiffness and damping were studied in depth in the former USSR. The material presented in the book is based in substantial degree on author's own professional experiences and his own research results.

Very valuable material is included in the appendices. These cover such topics as dynamic systems with damping, particularly nonviscous (hysteretic) damping which better represents real dynamic systems, as well as stiffness-damping-natural frequency criteria—useful practical criteria. The power transmission couplings and the characteristics of elastomeric (rubberlike) materials, which are difficult to find in mechanical design literature, have the most extensive treatment.

The Handbook is very well written and has a wealth of illustrations supporting the text. The rich material assembled in the Handbook makes a fascinating reading; it will guide and enrich the knowledge of any engineer designer—practitioner or scientist, educator, and student—all those who deal with issues of stiffness and damping in the broad spectrum of mechanical design. This Handbook is a must for any engineering library.

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