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book reviews

Rolling Bearing Analysis. By T. A. Harris. John Wiley & Sons, Inc., New York, N. Y.

Reviewed by W. J. Anderson[1]

This book constitutes the first really complete and thorough exposition of rolling bearing theory under one cover. The author is eminently qualified to produce such a work, and he has written what should become a standard in the libraries of engineers and researchers concerned with rolling bearing research, development, and design.

Some of the major topics discussed include bearing types and geometry, contact stresses and deformations and load distribution at low and high speeds, deflections, stiffnesses, and preloading, fatigue, rolling friction, lubrication, and bearing temperatures. Particularly valuable are the presentations of fatigue theory (the first in American literature), high speed dynamics and kinematics, and shaft and bearing system statics. Of special interest to many readers may be the presentations of some of the recent research on elastohydrodynamics and microslip, although the treatment of these subjects is somewhat abbreviated. Considering the lengthy time required to prepare and publish a manuscript, the book is quite up-to-date. One would like to have seen a more complete discussion of material processing effects on capacity and life, and on elastohydrodynamic and contact kinematics, but the knowledge in these areas is developing so rapidly it is impossible to get a book into print fast enough to be really up-to-date.

The author draws heavily on his own work as well as that of Hertz, Palmgren, Jones, and several other rolling bearing researchers. The author's approach, as the title implies, is almost purely analytical. In this respect the book lacks balance. Particularly obvious is the lack of reference to the many papers, both analytical and experimental, that have appeared in recent Japanese literature. Tabor's work on rolling friction and hysteresis losses is not mentioned, and the material presented on p. 434 is essentially Heathcote's differential slip analysis, although Heathcote is not mentioned until p. 443.

One cannot criticize the presentation of analyses which have not been corroborated by experiment. Experimental corroboration is sometimes impractical, and guidelines, even though they may not be exact, are invaluable. Where experimental data are available they should be discussed in conjunction with the analytical work. A case in point is the effect of speed on fatigue life. According to theory the life of a radially loaded bearing decreases continuously with increasing speed because of additional loading at the outer race contacts while the inner race contact stresses remain unchanged. For a thrust loaded bearing, the life may actually increase for certain combinations of thrust load and speed. This is so because the inner race contact angle increases with speed, resulting in a decrease in the contact stresses at the inner race. The increase in inner race life may more than offset the decrease in outer race life.

Experimental data have largely not confirmed this theory. It is an established fact that fatigue life increases with increasing speed, probably due to elastohydrodynamic effects. The author mentions work on the effect of lubrication on fatigue life in which the improvement in life with speed is explained in terms of a film parameter equal to the ratio of film thickness to surface roughness. This, in a sense, contradicts, or at least imposes restrictions on, the previously discussed analysis of speed effects on life.

The author includes numerous numerical examples which should be of considerable assistance to the average reader attempting to get a physical picture of what's going on. These are particularly effective because the author selects a specific bearing and uses it as the basis for sample calculations in succeeding chapters.

As with any complete treatise there are subjects presented about which controversy will arise. This reviewer is not in complete agreement with the following:

1 The discussion of differential expansions (pp. 83–84) does not mention changes in dimension that may occur when temperature gradients exist in, say, the housing. A thick walled housing may actually shrink at the bearing OD, even though heated, if a high radial temperature gradient exists. Equations (3.38) and (3.40) do not include the effects of rolling element expansion.

2 The example 4.4 on p. 101 calculates a new outer race contact angle at high speed assuming the inner race contact angle remains unchanged. This is not really realistic.

3 Equation (13.07) (unreferenced) provides a factor for the influence of hardness on dynamic capacity. To this reviewer's knowledge all available bearing data indicate a much stronger effect of hardness on capacity.

To reiterate, this is a most complete and thorough treatise on rolling bearing theory. A portion of the book will be of interest only to a relatively small group of researchers and analytical engineers. The great bulk of the material is, however, presented so that it is usable to the engineer and designer not having knowledge in depth of rolling bearings. There is such a wealth of material which is not available elsewhere under one cover that purchase is recommended by engineers whose work encompasses rolling bearing design.

Theory and Research in Lubrication. By Mayo D. Hersey. John Wiley & Sons, Inc., New York, N. Y., 1966.

Reviewed by M. C. Shaw[2]

This book presents an extremely complete compilation of work in the field of hydrodynamic bearing design and performance. For those who are familiar with the author's famous book of three decades ago (*Theory of Lubrication*) it may be described as "Hersey" greatly expanded and brought up to date.

Professor Hersey has spent an active and productive career in studying and discussing the literature of lubrication and there is probably no one in the world who is more familiar with what has been done in this field. His book reflects this extensive knowledge. Each chapter begins with a complete history of the topic under consideration written in an unusually interesting way; not as an account abstracted from the literature but rather from the point of view of someone who was on the scene when each classical experiment or development was taking place. Professor Hersey's enthusiasm and warm personality reveal themselves at many points throughout the book.

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According to the article " Rolling Element Bearing Analysis " by Brian Graney and Ken Starry, bearing defect frequencies can be calculated using equations (1) â€“ (4) according to [5]. The amplitudes of these frequencies hint toward the conditions of the bearing, and often increase over time. Faults detection and failures prediction using vibration analysis. Conference Paper. Full-text available.Â The modeling and Analyzing work have experienced with the aid of ANSIS software by means of finite element analysis. A rolling-element bearing, also known as a rolling bearing, is a bearing which carries a load by placing rolling elements (such as balls or rollers) between two bearing rings called races. The relative motion of the races causes the rolling elements to roll with very little rolling resistance and with little sliding. One of the earliest and best-known rolling-element bearings are sets of logs laid on the ground with a large stone block on top. As the stone is pulled, the logs roll along the ground For the last four decades, Tedric Harris' Rolling Bearing Analysis has been the "bible" for engineers involved in rolling bearing technology. Why do so many students and practicing engineers rely on this book? The answer is simple: because of its complete coverage from low- to high-speed applications and full derivations of the underlying mathematics from a leader in the field.