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Book Review

Three-Dimensional Elastic Bodies in Rolling Contact, by J. J. Kalker, Dordrecht, The Netherlands, 1990. 314 pages.

REVIEWED BY K. L. JOHNSON[1]

The traction, braking, guidance, and stability of wheeled vehicles is governed by the distribution of friction forces in the small area of contact between the wheel and the surface on which it rolls. The behavior is far from simple, since the contact area is almost invariably divided into regions of "stick" and regions of "slip" whose disposition is unknown at the outset.

Professor Kalker has devoted his professional life to a study in depth of this problem in contact mechanics. He has brought the rigor of his mathematical calling to the subject, while aiming to provide working numerical programs for engineers needing to apply the results of his researches. For many years his doctoral dissertation: "On the rolling contact of two elastic bodies in the presence of dry friction" (1967) provided the standard reference on the subject. The present volume greatly extends the scope of the dissertation and will become a reference work for many years to come. Although the principal technological application of this field of research lies with wheeled vehicles, the approach is not specific to vehicle technology and important applications can be found in other areas such as rolling contact bearings.

In Chapters 1 and 2, the problem is stated and modelled; the question of numerical methods of solution is discussed. Chapter 3 is devoted to the "simplified" or "elastic foundation" model of contact, in which the elastic displacement of any point in the contact is a linear function of the traction *at that point only*. Kalker rightly emphasizes the value of this approach to obtain quick solutions of reasonable accuracy to a wide variety of steady and transient problems. A rapid, efficient program is developed.

In general, non-Hertzian contact problems the shape of the contact area is not known in advance. Kalker has followed the approach of Duvaut and Lions in developing a variational theory of frictional contact. This has the advantage of being soundly based upon theorems of existence and uniqueness, while lending itself for implementation to the well-developed methods of numerical optimization. This forms the basis of his most comprehensive programs which will handle static as well as rolling problems. Although slow in operation, they can be implemented on a personal computer.

Chapter 5 includes the results of a wide variety of problems which have been computed using the author's programs. This chapter includes some new results relating to rolling with combined creepage and spin, transient rolling contact, and to the unloading of a static contact between dissimilar elastic spheres.

The treatment is (understandably) restricted to homogeneous, isotropic elastic bodies, hence its direct application is to rail vehicles. Nevertheless the concepts discussed are equally applicable to road vehicles with pneumatic tires. As the author comments, ". . . the automotive tire is perhaps the supreme challenge of continuum rolling theory".

The author has a rather cryptic style in which mathematical symbolism plays a large part and which some will not find easy reading. But the fact that the author's theories and programs are used by the majority of the world's railways shows that the effort is rewarding.

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