

A chapter on dynamic fracture by D. R. Curran treats recent progress in the microstatistical internal state variable approach to microvoid kinetics and reports on experimental measurements and constitutive modeling of nucleation, growth, and coalescence. Applications include fragmenting rounds, fracture of geologic materials, and quasi-static ductile fracture of metals.

This is a valuable reference, which every research engineer dealing with projectile impact dynamics will want to have.

Tribological Technology, Vols. I & II. Edited by P. B. Senhalzi. Martinus Nijhoff, The Netherlands, 1982. 775 Pages. Price \$109.00.

REVIEWED BY F. F. LING⁵

These volumes constitute the Proceedings of a NATO Advanced Study Institute on the subject held in Maratea, Italy, 1981. To those interested in applied mechanics, these volumes offer a broad view of the field of tribology which beckons innovative solutions to relevant, well-posed applied mechanics problems. Aside from the Introduction and three Appendices, there are 10 Chapters: "Scope of Tribology" by H. Czichos of West Germany; "Surface Interaction" by W. P. Suh of the United States; "Materials in Tribotechnical Applications" by A. W. J. de Gee of The Netherlands; "Surfaces" by M. J. Edwards of the U.K.; two chapters on "Lubrication" and "Lubricants, respectively, by W. O. Winer of the United States; "Contamination in Fluid Systems" by E. C. Fitch of the United States; "Tribological Failures and Mechanical Design" by M. B. Peterson of the United States; "Tribo-Testing" by M. Godet of France; "Monitoring" by D. Scott of the U.K.; and "Multidisciplinary Approach" by B. R. Reason of the U.K.

So far as this reviewer knows, all of the chapters are reviews. By and large they are well written and the reviews are comprehensive. One fine feature of these two volumes is that the authors have been given space to sufficiently render detailed and quantitative treatment of the subject at hand.

Returning to this reviewer's earlier claim that the field of tribology beckons, examples of solutions sought to mechanics problems are: surface mechanics problems with smooth as well as nonsmooth surfaces; rheological problems with pressure and temperature effects; problems involving complex failure mechanisms; problems of fluid flow with entrained particulates; problems in nonlinear mechanics; problems involving various forms of composites; and problems involving interpenetrating continua.

Constitutive Equations for Engineering Materials, Volume I: Elasticity and Modeling. By W. F. Chen and A. F. Saleeb. Wiley, New York, 1982, pp. xii-580. price \$68.50.

REVIEWED BY G. J. DVORAK⁶

Over the past two decades, rapid advances in numerical analysis of engineering structures have stimulated extensive research in constitutive modeling of material behavior. Yet, few books are available that survey the numerous constitutive theories, their experimental verification, and their usefulness in applications. This is especially true in the case of complex

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materials, such as concrete and soils, which are difficult to model, but which are frequently encountered in practice.

The book fills this gap in technical literature. It is written primarily for civil engineers both as a graduate textbook and a reference book. The work comes in two volumes. The first volume deals with elastic, hyperelastic, and hypoelastic models. Plasticity will be treated in the second volume. Time-dependent behavior is not considered.

The first volume is divided into three self-contained parts. *Part One* on Basic Concepts in Elasticity provides an introduction to vectors and tensors, analysis of stress and infinitesimal strain, and to elastic stress-strain relations. This last topic is presented in an elaborate way, with extensive expositions of both linear and especially nonlinear theories. Uniqueness and stability, and their effect on elastic constitutive relations in terms of normality and convexity are discussed together with nonlinear isotropic stress-strain relations based on strain or complementary energy functions, and on modifications of linear models. Incremental (hypoelastic, secant moduli, and variable moduli based) stress-strain relations are formulated and illustrated by many examples.

Part Two on Concrete Elasticity and Failure Criteria treats mechanical behavior, linear and nonlinear elasticity theories, failure criteria, and fracture models of concrete. An extensive collection of classical and more recent results is presented. Four total stress-strain models, and five incremental models for nonlinear isotropic and orthotropic concrete materials are discussed. Applications of some of the models in finite element analysis of concrete structures are illustrated in several examples.

Part Three on Soil Elasticity and Failure Criteria is organized in a similar way as Part two. Mechanical behavior, failure criteria, and nonlinear elasticity formulations are presented. A total stress-strain model, a third-order hyperelastic model, and four incremental models are discussed and illustrated by examples of their finite element applications.

Each of the three parts is rather self-contained, and the book, although well organized, is further divided into seven separate chapters, each with its own table of contents. Thus, there are altogether eight lists of contents in different locations. The material presented is quite diverse due to both the depth of the treatment—which includes basic theories, experimental data, and examples of applications—and the wide range of modeling approaches to deformation, and failure of concrete and soils, which the book covers. The authors have mastered the difficult task of presenting the material well. For the most part, the narrative is clear, the theoretical background is reasonably rigorous, and well illustrated by many examples. Particularly useful to the reader should be the many summaries and conclusions that discuss the validity of the numerous constitutive models described in the book.

Proceedings, International Conference on Constitutive Laws for Engineering Materials, Theory and Application. Edited by C. S. Desai and R. H. Gallagher. January 10-14, 1983, Tucson, Ariz. 604 Pages. Price \$40.00.

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This paper-bound volume contains about 100 papers which were presented at a conference held in January of 1983, in-

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