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. LING[5]

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. DVORAK[6]

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 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.

REVIEWED BY L. B. FREUND[7]

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

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cluding summaries of 28 invited lectures. The complete texts of the invited lectures will appear in a hard-bound volume which is in preparation. The papers are divided into seven categories: General Theory, Metals and Composites, Geological Materials, Discontinuous Media, Concrete, Granular Materials and Aggregates, and Implementation and Evaluation. The objective of the conference was to stimulate interaction between researchers concerned with the theoretical and experimental aspects of developing constitutive models of deformable solids and those concerned with the implementation of constitutive laws in engineering analysis and design.

Many individuals who are active in the field of the conference contributed articles and, consequently, the volume provides a reasonably complete picture of the current state of development of models for describing the mechanical behavior of solids. Of course, the volume would be more valuable if it contained complete texts of the overview lectures as well as the contributed articles.

Theory of Laminar Flames. By J. D. Buckmaster and G. S. S. Ludford. Cambridge University Press, New York, 1982. 266 Pages. Price $49.50.

REVIEWED BY H. W. EMMONS[8]

A mixture of a gaseous fuel and oxidizer (air) will, if within the appropriate composition range, propagate a reaction that converts the reactants to products and produces heat and light: a flame. The process involves the diffusion of heat and reactive chemical specie from the reaction zone to the unignited mixture: the feedback of energy and specie.

The principal obstacle to the progress in the analysis of laminar combustion is the usually very complex series of chemical reactions needed for even very simple overall chemical reactions and the nonlinear nature of the Arrheneous relation for the chemical rate of each of the many chemical reactions actually occurring.

The book under review undertakes the task of introducing its readers to the progress that has been made in this analysis for very simple hypothetical forward reactions with an activation energy E in the Arrheneous formula which is very large ($E/R \gg T$). Under these conditions singular perturbation methods make it possible to attain solutions with considerable rigor and fair accuracy.

The book begins with a derivation of the required basic equations and continues with their application to a series of flame spread problems. The study of steady flame phenomena is followed by that of slowly varying flames (SVF's) and near equidiffusional flames (NEF's).

The study of nonsteady flames naturally leads to consider questions of flame stability under various perturbed conditions.

The calculation of flow fields is discussed in general terms but is presented at length for flames as discontinuities and for flames in a preassigned approach flow field. There is an occasional discussion of various known experimental facts, even a few flame photographs. These are used as suggestive of the kind of phenomena to be looked for in subsequent solutions. Various reasonable-looking flow fields are analytically reproduced, but no attempt is made to show their quantitative accuracy.

For anyone who desires to get started on the further development of the applied mathematics of problems of the laminar flow of multicomponent reacting gas mixtures, this book is superb. Anyone who is already familiar with combustion phenomena who desires to acquire a knowledge of the present status of the analytic understanding of what happens will find this book superior to the slow process of finding, critically reading, and absorbing the significance of the large number of papers now available. Anyone not familiar with combustion phenomena who wants to acquire that familiarity and the more physical and important intuitive understanding will find this book disappointing. The authors state (for a specific problem but generally applicable to the whole book) ". . .we regard the models as mathematical idealizations whose study can provide some insight into the nature of diffusion flames." And again, ". . ., which shows an early appreciation of activation-energy asymptotics (though not in the formal sense of this monograph)."

Needless to say, the reviewer made no attempt to check the correctness of the 819 equations printed in this book. Only an equation, which for some reason appeared to be wrong was checked and indeed the text formula for γ immediately following equation 60 is wrong ($\gamma = 1/(1 - R/mC_p)$).

Boundary Element Methods in Solid Mechanics. By S. L. Crouch and A. M. Starfield. Allen & Unwin, Winchester, Mass., 1983. 322 Pages. Price $30.00.

REVIEWED BY F. J. RIZZO[9]

The authors are of the opinion that boundary elements methods ". . . have not received the attention they deserve . . ." compared with finite difference and finite element methods. Chief among several reasons for this, in their view, is the apparently somewhat "abstruse" character of many of the ". . . technical papers on boundary element methods." They suggest that the mathematics often used in these papers ". . . has prevented many from seeing the simple and attractive algorithm that ultimately emerges."

From this viewpoint, the authors have produced a book in which physical interpretation and intuitive reasoning are used to the utmost. Indeed, their development is so physical and so directed toward a computational scheme that the steps in their development may significantly alter whatever previous understanding the reader may have had of the terminology "boundary element methods." This terminology, which seems well on its way to supplanting the terminology "integral equation methods" or "boundary integral equation (BIE) methods," has been, since it was introduced, an understandable choice for obvious reasons. But boundary elements always seemed to this reviewer to be at least related to integral equations, i.e., as a way of numerically solving them. In this book, however, it seems that the concept of an integral equation is not at all necessary to introduce, understand, and use boundary element methods. Indeed, integral equations are hardly mentioned until the sixth chapter (of eight) where the concept is definitely less important to the authors' purpose than that of an influence function. All of this strikes thie reviewer as astonishing! Nevertheless, the whole development in this book is interesting, lucid, and, no doubt, correct for its intended audience and purpose such that the expressed astonishment is, in the end, quite pleasant. One may disagree on the degree to which physical interpretation in such detail is necessary or even helpful in understanding boundary elements for one who would not find most of the

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