included in what could be called the packing anisotropy of the granular materials. This suggests a need for a distinction between packing produced by processes about which we have some knowledge and packing which occurs in naturally occurring media, for which the processes involved in determining packing are largely unknown. But gravity certainly must play a role. In addition to the packing anisotropy, Oda discusses orientation anisotropy induced by the nonsphericity of the grains. It is the latter type of anisotropy which is usually considered in continuum models of liquid crystals and anisotropic fluids, for example. Other papers in this first area discuss experiments which determine particle forces and fabric quantification photoelastically, the effects of inherent anisotropy on stress deformation characteristics of sand, and the effects of small, triaxial "prestress" on the subsequent development of pore water pressure in undrained triaxial shear of sand. Fabric identification and measurement occupies approximately one quarter of the proceedings.

The second broad category described in these proceedings involves statistical approaches to granular materials. The papers here assume a background which is somewhat more specialized than that needed to appreciate the rest of the proceedings. Beran's *Statistical Continuum Theories* could be used to acquaint oneself with the use of statistical concepts in continuum mechanics.

The last group of papers is devoted to continuum approaches and occupies approximately one half of the proceedings. For the solid-like behavior, the theory of Goodman and Cowin is elaborated upon by several authors. In this theory, porosity and porosity gradient are used as measures of fabric and the porosity satisfies its own equation of equilibrium, as in the equilibrium of the orientation vector in a liquid crystal. Cowin brought up the question of identifying the best measures of local fabric in continuum theories and noted that the strong dependence on contact normals observed by Oda must be accounted for. Mullenger suggested that fabric could be characterized with a symmetric second-rank tensor, in analogy to that used for anisotropic fluids, as proposed by Hand in 1962. Elastic-plastic and rate-independent continuum theories of granular materials were also given.

In the continuum approaches to fluid-like behavior, both experimental and theoretical papers were given. Experiments by Savage indicate that, in shear flow between concentric rotating cylinders, shear stress appears to be proportional to the square of the shear rate, and that the stress depends on particle size and the curvature of the cylinders. Umeya's work describes powder-liquid systems in which the behavior is analogous to a fluid suspension. Papers were presented on theoretical aspects of fluid-like behavior based on the model of flowing granular materials developed by Goodman and Cowin in 1971.

The mechanics of granular materials as exemplified by these proceedings is in its infancy in comparison to the mechanics of, for example, the elastic solid and viscous fluid. Interesting as they are, the experiments involving the measurement of fabric of simple models of granular materials are not easily generalized into bulk continuum models. Professor Cowin's challenge to establish the second best measure of fabric for continuum purposes is, therefore, left unanswered. These proceedings provide an up-to-date account of the challenges and frustrations involved in developing an inclusive theory for granular materials.

Les instabilités hydrodynamiques en convection libre, forcée et mixte. Edited by J. C. Legros and J. K. Platten. Number 72 in Lecture Notes in Physics. Springer-Verlag. 1978. Pages 202. Price $12.40.

REVIEWED BY S. LEIBOVICH[6]

This is a series of 18 (most rather short) papers, 11 in French and 7 in English, presented at a Colloquium at the Ecole de Thermodynamique de Bruxelles in April, 1977. The papers, which deal with a wide variety of convective instability problems in fluid dynamics, are loosely arranged in three sections: (*A*) pretransitional effects and study of the critical point (for instability), (*B*) study of convection in Newtonian fluids, and (*C*) stability of non-Newtonian fluids. Experimental, as well as theoretical and numerical works are included, although the majority of the work represented is theoretical in nature.

Section *A* contains six papers on kinetic theory, on the effects of thermal fluctuations on macroscopic behavior near a bifurcation point; and the stability of liquid mixtures, of fluid in porous media, and water-ice interfaces.

Section *B* contains nine papers on convective stability of Newtonian fluids, including magnetohydrodynamic and electrical applied forces, double-diffusion phenomena, and other effects.

The three papers of Section *C* concern nematic liquid crystals and viscoelastic liquids.

The range of physical and chemical phenomena affecting the stability of fluid motion and covered in these lectures is very impressive. This book, serving as it does as a collection of such interesting phenomena, will be a valuable addition to technical libraries, although few are likely to add it to their personal collections.

Wear. Treatise on Material Science and Technology. Edited by D. Scott. Vol. 13. 1979. Academic Press, Inc., New York. Pages 498. Price $49.50.

REVIEWED BY F. F. LING[7]

This volume contains the articles: Theories of Wear and Their Significance for Engineering Practice by F. T. Barwell; The Wear of Polymers by D. C. Evans and J. K. Lancaster; The Wear of Carbons and Graphites by J. K. Lancaster; Scuffing by A. Dyson; Abrasive Wear by M. A. Moore; Fretting by R. B. Waterhouse; Erosion Caused by Impact of Solid Particles by G. P. Tilly; Rolling Contact Fatigue by D. Scott; Wear Resistance of Metals by T. S. Eyre; and Wear of Metal-Cutting Tools by E. M. Trent.

In this effort editor D. Scott has made a superb selection of authors, each an authority in his field. And, I find, collectively, each/each team has/have done justice to the literature while providing very readable exposition to a given area. The illustrations are pertinent and adequate; a feature so important to the field of wear where knowing the phenomena is still a big part of the solution sought. This volume includes a subject index.

Stress Analysis of Notch Problems. Edited by George C. Sih. Noordhoff International Publishers, The Netherlands. 1978. Pages 312. Price $37.50.

REVIEWED BY R. MUKI[8]

This book is the fifth volume of *Mechanics of Fracture* edited by G. C. Sih. The introductory and four chapters are: Strain-energy density and surface layer energy for blunted cracks or notches by the editor; Solutions of notch problems by body force method by H. Nisitani; Analysis of notches using conformal mapping by O. L. Bowie and C. E. Freese; Stress analysis of edge notches by Chih-Bing Ling; and three-dimensional notch problems by M. K. Kassir. Each contributor presents fundamental concepts and methods of analysis pertinent to each topic. The articles by Nisitani and by Bowie and Freese contain a number of well-documented tables and figures exhibiting stress-concentration factors and stress-intensity factors for

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various geometries (mostly two-dimensional and some three-dimensional) under several loading conditions. There are 22 such figures and 20 tables in Nisitani's text while eight figures in Bowie-Freese's text. These are worthwhile and useful as suppliments to Peterson's *Table of Stress Concentration* and to Tada-Paris-Irwin's *Cracks Handbook*

Even though the editor stated in the preface that "The finite-element method has been purposely left out, for it is now becoming common procedure in cases too complex for analysis," one cannot justify the omission of the finite-element method in view of its importance in this class of problems with recent progress of hybrid finite-element methods where singularities at the crack tips are properly carried into the analysis. The reviewer also feels that the usefulness of the book will be enhanced if it includes an article which emphasizes behavior (asymptotic or boundedness) of these factors upon geometrical parameters rather than solution methods along the lines of the article by Benthem and Koiter in the first volume of the series.

The Numerical Treatment of Integral Equations. By C. T. H. Baker. Clarendon Press, Oxford, 1977. Pages 984. Price $49.50.

REVIEWED BY R. L. TAYLOR[9]

This large book consists of six chapters devoted to integral equations and the solution of integral equations by numerical methods. The first chapter briefly summarizes properties of integral equations and their classification, e.g., linear and nonlinear, first and second type, Fredholm and Voltera. Much of the discussion is very brief and some familiarity with integral equations is necessary to fully comprehend the presentation. The second chapter is devoted to the numerical methods which are used in the remainder of the book. Again, the presentations are brief and the reader may need to consult additional materials on numerical methods. Adequate references are provided to direct readers to pertinent literature.

The remaining four chapters are devoted to numerical solutions for eigenproblems, Fredholm equations, and Voltera equations. More than 250 examples are included to illustrate each topic discussed. Theorems and proofs are provided to augment each method with a convergence theory. More than 450 references are provided to direct readers to cited and other information.

This book will be of considerable interest to those interested in solving integral equations numerically. It provides insights into when methods work and when they do not. It is a valuable complement to the recently published engineering problem-oriented books on integral equations (e.g., Jaswon and Symm or Brebbia). Of considerable interest to proponents of boundary integral methods are the extensive discussions on quadrature, collocation, and Ritz-Galerkin methods.

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The Theory of Elastic Waves and Waveguides. By Julius Miklowitz. North Holland Publishing Co., Amsterdam. 1978. Pages XVI and 618, 180 figures. Price $71.

REVIEWED BY R. K. KAUL[10]

This book is about elastic waves and waveguides. To some extent it is a research monograph, and should cater to the needs of an experienced audience. Graduate students involved in research will also find it profitable by studying topics selectively, because the compass of the contents of the book is quite wide.

The book has eight chapters and no attempt will be made to discuss in detail the technical matters contained in each chapter. The first two chapters (pp. 19–118), deal with the fundamentals of linear elasticity theory and elastodynamic waves. Most of the material in these two chapters is now classic and can be found discussed rigorously in several recent books dealing with elasticity, potential theory, and initial value problems. The author has tried to bring these topics together in the first two chapters of this book. Chapters 3 and 4 (pp. 119–229) deal with reflection and refraction of waves at an interface, and elastic waveguides in plates and rods. Again some of the material is classic, but a major part of this section is devoted to Mindlin's contribution in this area, and the author has presented it reasonably well. Some of the results dealing with complex segments and *coincidence* are heuristic in nature, and are presented in the same style as perceived by Professor Mindlin over two decades ago. All of these results are well known in the areas of "advanced analysis" and "critical point theory," and this reviewer would have liked to see them presented in a more rigorous setting. Chapter 5 (pp. 231–296) deals with integral transforms and asymptotic theory. Again the approach is heuristic and is well presented. Recent research in this area, when the saddle points coalesce, or when a saddle point approaches a branch point or a pole are not discussed, though in pulse propagation problems they play a dominant role near stationary values of group velocity, as in the case of Skalak's problem. Chapters 6, 7, and 8 (pp. 298-367-485-571) form a large part of the book and contain both classic and new research material. The topics of discussion are transient waves in elastic half space, elastic waveguides such as rods and plates, and pulse scattering problems by cylindrical and spherical obstacles. A large part of the material is of research nature and shows the prominent role played by the author in the development of this subject. This part of the book is especially well written and is suitable for someone with a minimal exposure to asymptotics and its application in pulse propagation problems. The author has done a thorough and patient job of explaining tedious details, which makes this section of the book a good place to start learning this topic.

This is a monograph written by an expert in a progressing field and therefore it is a very welcome addition to the literature. It is well written, provides a large amount of references,and presents a systematic account of the subject of elastic waves. It is a valuable book for someone considering learning the subject and can be warmly recommended. In the opinion of this reviewer, it is a worthwhile publication.

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