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Book Reviews

Dynamic Fracture Mechanics, L. B. Freund. Cambridge University Press, New York, 1990. 563 pages. Price: $59.50.

REVIEWED BY JOHN W. HUTCHINSON[1]

This monograph covers fundamental aspects of dynamic fracture mechanics which have not previously appeared before in a book format. It is written by one of the foremost contributors to the subject. The monograph pulls together basic mathematical developments which have taken place over the past 20 years or so, and it provides a foundation on which further work can rest. Parts of the subject are far from easy. Unlike the mechanics of quasi-static fracture, there are very few closed-form solutions to problems for dynamically running cracks. This has led to controversy in the interpretation of experiments and in the specification of fracture criteria. In recent years there has been a convergence of opinion among researchers in the field on the underlying concepts and criteria for dynamic fracture. This new state of affairs is reflected in this monograph. Its timing is perfect.

Chapter 1 gives a brief review of the relevant continuum mechanics (linear elasticity for the most part) along with a few pages of some of the mathematical methods employed in later chapters (complex variable theory and Laplace transform methods.) Chapter 1 concludes with a synoptic overview of the central concepts and main theoretical results of dynamic fracture. The next two chapters deal with stationary cracks under dynamic loading, including a discussion of experimental data on the influence of initiation toughness and loading rate. The asymptotic behavior of the stress and strain-rate fields at the crack tip of a running crack is treated in Chapter 4. The effects of inertia, plasticity, and viscosity are all considered and delineated with definitions of the controlling crack-tip intensity measures. The review of the singular crack-tip fields leads naturally to the next chapter on energy concepts which includes the fundamental relation between the dynamic stress intensity factors and the energy release rate, path-independent integrals specialized to various conditions, and weight function methods. Chapters 6 and 7 deal with running cracks in elastic bodies under a variety of conditions including general transient conditions. This is difficult material, but no one is better qualified to write about it than the author. Here is where the mathematical richness of the subject comes out. Equations of motion governing the motion of the crack tip are gone into in detail and a number of examples are discussed. The last chapter focuses on cracks growing in elastic-plastic materials. For the most part, consideration is limited to steady-state growth under conditions of small-scale yielding. Near-tip criteria are invoked to draw conclusions on the role of inertia, plasticity, and strain-rate effects on dynamic toughness.

This is a book that everyone working in fracture or in elasticity with at least an occasional interest in cracks (isn't that everybody?) will want to own. It falls somewhere between a text and a research monograph. It is not likely to stand alone as a text for a graduate course on fracture, but it would serve well for a segment of a course dealing with dynamic fracture.

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Plasticity Theory, by J. Lubliner. Macmillan, New York, 1990. 495 pages.

REVIEWED BY B. MORAN[2]

This book is intended as both a textbook for advanced undergraduate and graduate students and a primary reference for researchers in the fields of solid and applied mechanics. Since Hill's *The Mathematical Theory of Plasticity* (Oxford, 1950; 1983 paperback) many important advances in plasticity theory have not been adequately treated in either textbook or monograph. This book addresses many of these developments including modern constitutive theories, continuum thermodynamics, large deformations, and numerical methods. Traditional treatments of elastic-plastic boundary value problems, slip line theory, and limit analysis are also included. The result is a comprehensive account of the field of plasticity as it exists today.

The book contains eight chapters. A generous number of exercise questions are provided in each chapter. Chapter 1: Introduction to Continuum Thermomechanics contains a 68-page introduction to the subject. While many books have been written on this subject, the presentation here is motivated by the desire to make the book self-contained, and it sets the overall tone of the book in terms of both style and pedagogy. The treatment of tensor analysis is in terms of Cartesian components, and large deformation kinematics are deferred to a later chapter. A good deal of emphasis in this chapter and throughout the book is on constitutive theories of inelastic deformation from the viewpoint of internal variables. Chapter 2: The Physics of Plasticity contains an introduction to the

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underlying physical mechanisms of metals, soils, rock, and concrete. In Chapter 3: Constitutive Theory, an excellent account of commonly accepted theories of viscoplasticity and rate-independent plasticity and such related topics as stability postulates and uniqueness theorems is given. The chapter concludes with the introduction of extremum principles, limit analysis, and shakedown theorems. The latter topics are treated thoroughly in Chapter 4: Problems in Contained Plastic Deformation, Chapter 5: Problems in Plastic Flow and Collapse I – Theories and "Exact" Solutions, and Chapter 6: Problems in Plastic Flow and Collapse II – Applications of Limit Analysis.

The final chapters deal with two important topics rarely covered in texts on plasticity. Chapter 7: Dynamic Problems contains an excellent introduction to dynamic plasticity. The author begins with dynamic loading of structures and then considers one-dimensional wave propagation in both rate-independent and rate-dependent elastic-plastic bars. He concludes with a section on three-dimensional waves and a discussion of acceleration waves in elastic-plastic materials. Chapter 8: Large Deformation Plasticity contains an introduction to large deformation continuum mechanics followed by a good account of constitutive theories for finite strain plasticity including sensible and balanced treatments of objectivity and kinematics of elastic plastic deformation at finite strain. The author concludes the book with a brief discussion of the advantages of hyperelastic methods in the numerical solution of problems involving large elasto-plastic deformations.

Several of the topics in the book receive only a cursory treatment. This is no doubt due to the author's aim to be comprehensive but not exhaustive. Numerical methods are emphasized throughout the book and an introductory treatment of some of the more common approaches to finite element analysis of elastic-plastic boundary values problems is given in Chapter 4, although only highlights of the topics are presented.

This book is somewhat more advanced than the author suggests and will likely prove too difficult for undergraduate students. Graduate students without a firm understanding of continuum mechanics and/or some previous introduction to plasticity may also find some of the material difficult although this in itself should not be a deterrent.

In the preface to the book, the author, espousing the belief that small is beautiful, indicates his initial desire to write a little book on plasticity. Alluding to the growth of the book to its present 500 odd pages, he expresses the hope that readers will "...find this would-be-little book useful". Students and researchers in the fields of solid and applied mechanics will find this book useful. It is the most comprehensive and up-to-date treatment of plasticity available and it is recommended both as a reference and as either a primary or supplemental text for graduate courses in plasticity.