a fluid-filled tube in which the tube can be elastic or viscoelastic but the fluid is assumed to be incompressible and inviscid. All articles are very mathematically and analytically oriented. Nevertheless, the articles cover a fairly wide range of wave propagation phenomena in viscoelastic media. In view of the fact that there are not many books available on viscoelasticity and even fewer on wave propagation in viscoelastic media, the appearance of this volume is welcome. It would serve as a useful reference for those who want to venture into this field.

Plane-Strain Slip-Line Fields for Metal-Deformation Processes. By. W. Johnson, R. Sowerby, and R. D. Venter. Pergamon Press, New York, 1982. 364 Pages. Price $45.00.

REVIEWED BY S. KOBAYASHI[3]

This monograph comprises the previous one *Plane-Strain Slip-Line Fields: Theory and Bibliography*, published by Edward Arnold in 1970, describes most of the advances in the field developed during the last decade, and includes references to many new papers which give results in specific problems.

The Introduction begins with a historical note on plane-strain slip-line fields, followed by a list of physical observations in working metal. In Chapter 2 certain basic aspects of the plasticity theory that are necessary for the development of the methods of solution of the two-dimensional problems are presented. Chapter 3 is concerned with the governing equations of the plane plastic flow of a rigid-perfectly plastic solid, and their solution method. It contains the method of characteristics, properties of slip-line net, hodograph, and the discussion on a complete solution. In Chapter 4 a number of boundary value problems are examined to show how solutions may be developed by a straightforward step-by-step procedure. Construction of slip-line fields, stress boundary conditions, and construction of hodographs are discussed. While Chapters 2, 3, and 4 have dealt with basic plasticity theory, Chapter 5 is devoted to the application of the theory to specific problems of plane plastic flow. Slip-line solutions to many metal deformation processes are presented. They include pressure vessels, compression, indentation, cutting, sheet drawing, extrusion, piercing, forging, machining, swaging, notched bar tension, bending, rolling, and blanking. The discussion is extended to the application of slip-line fields in the area of crack initiation and fracture. More than 500 references are listed in this chapter alone. In Chapter 6 a numerical computational procedure which is referred to as the matrix-operation method is presented in detail. The method was developed recently, and greatly facilitates the solution to problems of the indirect type where there are insufficient known starting conditions for the determination of the slip-line field (or hodograph). The procedure is based on a power series representation of the solution to the governing equations and a vector representation of slip-lines and a system of matrix operators. This chapter contains mathematical formulations for the procedure, matrix operator subroutines, and solution of direct-type and indirect-type problems. The final chapter is concerned with the plasticity problems for other than isotropic rigid-perfectly plastic materials under plane-strain conditions. The method of characteristics is described for plane stress and axisymmetric problems, and for materials such as clay, ice, and soils. Slip-line fields for anisotropic materials are given, and the problems of minimum weight frames, plastic bending of plates and the force-plane diagram for slip-line fields are shown as analogies with metal-forming operations.

This book is the most complete source book on the subject and contains the references in each chapter, totaling almost 900 references. The book indeed provides teachers and researchers with basic material and a bibliography of papers on the theory and application of plane-strain slip-line fields to metal deformation processes.

Impact Dynamics. By J. A. Zukas, T. Nicholas, H. F. Swift, L. B. Greszczuk, and D. R. Curran. Wiley, New York, 1982. 452 Pages. Price $47.50.

REVIEWED BY L. E. MALVERN[4]

This book grew out of a short course taught by the authors, but is more a reference book than a textbook. It covers a wide range from low-speed to hypervelocity impact of projectiles against targets, with emphasis on impacts causing damage.

J. A. Zukas wrote five of the 11 chapters. The first two introduce stress waves and some limitations of elementary theory. Chapter 5 is a well-illustrated comprehensive treatment (with some 160 references) of penetration and perforation of solids. Experimental methods and approximate analyses by force laws are discussed.

In Chapter 10, Zukas presents an authoritative discussion (with 90 references) of numerical simulation of impact phenomena. Several remarkable examples of successful calculation are reviewed, including spall prediction, ricochet, oblique impact by a long-rod penetrator, and the self-forming fragment. The last chapter catalogues available three-dimensional codes (72 references) and closes with a section on current developments. The most serious limitation is not cost or complexity of numerical simulation, but rather the inadequacy of models describing material behavior, especially failure models.

This critical problem of material behavior at high rates is addressed by T. Nicholas in Chapter 8, a comprehensive review of experimental methods (140 references) at strain rates up to about 10,000/sec. The split Hopkinson pressure bar or Kolsky aparatus is treated at length. Biaxial testing is mentioned, but few high-rate results are available. Rate-history effects and their modeling are considered.

At higher rates, inelastic wave analysis is needed to interpret the experiments, but this requires assumed constitutive properties and leads to an iterative procedure for properties determination that may not have a unique solution. Nicholas treats elastic-plastic stress waves in Chapter 4 (116 references).

Damage in composite materials, caused by low-velocity impact, is discussed by L. B. Greszczuk in Chapter 3. A theory is developed and applied for elastic impact of two bodies of revolution made of transversely isotropic and orthotropic materials, including laminated composite targets. Failure criteria are proposed, and a few experimentally observed failure modes presented.

Hypervelocity impact mechanics, at velocities where strength of projectile and target are sufficiently negligible that solids may be considered as fluid, is concisely and clearly treated by H. F. Swift in Chapter 6. Launchers include gas guns, explosive projectors, and electrical accelerators.

In Chapter 7 Swift authoritatively discusses cameras and related image-forming instruments and presents several interesting accounts of ingenious techniques.

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