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Journal of APPLIED MECHANICS

Book Reviews

Residual Stresses

Residual Stresses and Fatigue in Metals. By J. O. Almen and P. H. Black. McGraw-Hill Book Company, Inc., New York, N. Y., 1963. Cloth, 6 × 9 in., xiii and 226 pp. $12.50.

REVIEWED BY T. J. DOLAN[1]

THE goal of the authors is to provide a step-by-step discussion of the occurrence and of the effect of residual stresses on the strength characteristics of components of machines. Their analysis of practical cases is illustrated by a detailed treatment of numerous specific case histories to serve as guides for improved designs with better fatigue strength. The emphasis throughout is placed on the importance of *compressive* macro residual stress as a means of limiting the peak tensile stresses developed under fluctuating loading in service. In each case their procedure is to add the calculated stress produced by the loads to the initial residual stress and use this as an index of the strength of the part in fatigue. Little reference is made to the range of stress in each cycle of loading (though this stress range is known to be of equal importance in setting a criterion for failure).

Detailed treatments are included to describe methods of producing residual stresses by thermal sources, plastic deformation, or mechanical prestressing. A short chapter is included on measurement of residual stresses without presenting quantitative techniques.

The chief value of the book is contained in the numerous charts analyzing 55 selected case histories encountered by the authors. The diverse examples include springs, axles, wheels, rails, gears, fan blades, bearing races, and bolted joints. It should serve as a useful reference to machine designers and engineers responsible for production processing of modern machinery.

Continuum Mechanics

Nonlinear Theory of Continuous Media. By A. Cemal Eringen. McGraw-Hill Book Company, Inc., New York, N. Y., 1962. Cloth, 6 × 9 in., xii and 477 pp. $14.50.

REVIEWED BY P. R. PASLAY[2]

THIS book is a proposed text on continuum mechanics from an engineering-science viewpoint. It should be obvious to workers in this field that the preparation of a text in this area is complicated by the rapid development of the field. The material in the book represents the state of affairs up to about 1961.

It is not surprising that such an attempt led to a product which is nearer a treatise than a text. The subject matter coverage is, in general, complete but the pedagogy is poor. For example, numerous specific problem solutions are presented in detail but little interpretation of the significance of these results is given.

The approach to the material covered is essentially, in format and notation, the same as that followed by Truesdell in his 1952 article ("The Mechanical Foundations of Elasticity and Fluid Dynamics," *Journal of Rational Mechanics and Analysis*, vol. 1, pp. 175–300). The book gives more detail and is more nearly up-to-date than Truesdell's monograph. One way in which this updating is apparent is the extensive use of the principle of objectivity in derivations.

With regard to some more detailed observations, the stress-rate presentation is particularly poorly motivated and the thermodynamics section has fallen short of giving an up-to-date coverage. Useful additions beyond the material in Truesdell's article appear in chapters on elastic-plastic bodies, viscoelastic bodies, and electroelasticity.

Although the book is not well suited for a text in continuum mechanics, it represents a necessary and valuable addition to the libraries of workers in this area.

Irreversible Processes

Introduction to Thermodynamics of Irreversible Processes. Second Revised Edition. By I. Prigogine. John Wiley & Sons, Inc., New York, N. Y., 1962. 5 1/8 × 8 1/2 in., xi and 119 pp. $5.

REVIEWED BY J. KESTIN[3]

THIS is a magnificently clear though concise introduction into the study of irreversible phenomena in near-equilibrium systems. The subject is developed briskly and efficiently from the differential form of the First and Second Laws of thermodynamics, as they apply to open systems and quasi-static, but irreversible, processes. The Second Law is written in a form which contains explicitly Clausius' uncompensated heat.

Throughout the booklet, the argument is illustrated with applications chosen from the field of interest of a physical chemist, and the treatment of chemical reactions features prominently in it. Chapter V contains a careful and comprehensive discussion of the phenomenological laws required by the macroscopic theory and of the effects arising from the coupling of irreversible processes—termed "interference effects" in the treatise.

As far as engineers are concerned, the author's interest stops short of satisfying his needs which are primarily in the study of continuous systems as they occur in fluid mechanics, in heat and mass transfer, in elasticity theory, etc. These are mentioned only in two brief sections. Curie's principle which is important in determining the presence or absence of coupling is merely mentioned in a statement which does not clarify it for the reader.

Your reviewer admires Prof. Prigogine's masterful clarity, his ability to seek out the essential with the utmost economy in words, and his vivid style of writing. The booklet is set in clear type, and the quality of its production fully matches the excellence of its all too brief contents.

Heat and Mass Transfer

Introduction to Heat and Mass Transfer. By E. R. G. Eckert. Translated by Joseph E. Gross. McGraw-Hill Book Company, Inc., New York, N. Y., 1963. Cloth, 6 1/2 × 8 in., xxi and 346 pp. $9.95.

REVIEWED BY P. D. RICHARDSON[4]

THIS book is closely similar to the well-known "Heat and Mass Transfer" by Professors E. R. G. Eckert and R. M. Drake. It treats of the same range of topics but in nearly 200 fewer pages. This reduction is accomplished by contraction of the discussion of some topics and the elimination of others. For example, solutions of the partial differential equation for unsteady heat conduction are not developed in any detail. The publishers have been able to make extensive use of the earlier book; nearly three quarters of the figures in this new book are identical copies from it.

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