

## BOOK REVIEWS

(16) On Dynamic and Static Behavior of Granular Materials (S. Nemat-Nasser).

(17) Fatigue Models for Cyclic Degradation of Soils (H. A. M. van Eekelen).

(18) Shakedown of Foundations Subjected to Cyclic Loads (G. N. Pande).

(19) Comments on the Use of Physical and Analytical Models (P. W. Rowe and I. M. Smith).

(20) Laboratory Investigations of the Behavior of Soils under Cyclic Loading: a Review (D. M. Wood).

(21) The Cyclic Simple Shear Test (W. D. L. Finn, S. K. Bhatia, and D. J. Pickering).

(22) Soil Liquefaction Studies in the People's Republic of China (W. D. L. Finn).

The primary concern of many of the contributions is the constitutive modeling of the soil matrix under cyclic loading. Under cyclic loading the structure of the soil changes progressively with permanent changes occurring in the volume occupied by the soil grains. These permanent changes are referred to by various authors as material degradation or fatigue. If the soil is saturated with water, the reduction in the volume occupied by the soil grains induces an increase in the pore water pressure within the soil structure. If the pore water pressure increases to a value equal to the intergranular pressure, the soil loses its shear strength and the soil mass is said to be liquefied.

Roughly, the contributions contained in this volume can be divided into those that are experimental in nature, those that are theoretical or computational in nature, and those that deal with the practical problem of the evaluation of liquefaction potential at a site. In the following paragraphs some of the contributions in each of these three divisions will be discussed. The relatively few papers concerned with experiments and engineering practice were generally more interesting than the more numerous papers concerned with theory or numerical methods.

The practical engineering problem of site liquefaction analysis has undergone a major change in methodology in the last decade. The "total stress method" of site liquefaction analysis was employed in the late sixties and early seventies. This method assumed that the soil was undrained, that is to say, there was no dissipation of pore water pressure due to water diffusion to other parts of the soil structure. The newer method of site liquefaction analysis is called the "effective stress method" and it accounts for the mitigation of the induced pore water pressure due to water movement. The effective stress method employs the effective stress concept in conjunction with the Biot theory for porous, deforming continua. Contribution (4) gives three excellent and convincing illustrations of the necessity of considering pore water pressure dissipation due to water movement. Contribution (6) describes the evolution of the effective stress method, and assesses its ability to meet the demands of practice. Contribution (7) describes a version of the effective stress method in detail. These contributions illustrate the development of an engineering methodology based on experience, laboratory testing, and theory.

The contributions of theoretical or computational nature are applications or special developments of continuum theories for the mechanical behavior of saturated or partially saturated soils. The Biot theory of flow through porous elastic media is the subject of contributions (1), (2), (3), and (5). Contributions (2) and (3) contain interesting sea bed applications of the Biot theory. Contribution (1) presents an incremental form of the Biot theory that is recast in a format appropriate for the finite element method in (5). Contributions (8), (9), (10), (11), (12), (13), and (16) concern plasticity or viscoplasticity models for soil behavior. The

models assume strain hardening and, generally, nonassociated flow rules are employed. The endochronic theory is applied to soils in contributions (14) and (15). The application of shakedown theories to the soil liquefaction problem is suggested in contribution (18). The analogy between metal fatigue and soil degradation by irreversible soil volume changes is discussed in contribution (17).

There are only two contributions that deal directly with experimental methods, contributions (20) and (21). The question of prime importance in experimental soil mechanics and, in particular, in the experimental soil mechanics associated with liquefaction, is discussed in both of these papers. That is the question of uniformity or homogeneity of the strain field within the test domain of a test sample. Contribution (20) reviews the experimental literature on soil liquefaction research and shows that the basic test procedures of cyclic triaxial testing and cyclic simple shear testing induce inhomogeneities in the strain field during the course of the test. The seriousness of these inhomogeneities leads to the suggestion in contribution (20) that liquefaction testing could be a phenomenological study of imperfection sensitivity. This lack of homogeneity in the test sample poses a fundamental problem for soil mechanics because continuum theories for the mechanical behavior of materials are usually based on data obtained from homogeneous test situations. This is the case, for example, in the theories of elasticity and of viscous fluids. There are two approaches to the solution of this fundamental problem. The first, which is the approach described in contribution (21) for simple shear testing, is to try to achieve cyclic test procedures that are always characterized by uniform or homogeneous strain. The other approach is to consider the test itself as a boundary value problem from which the soil constitutive relation must be deduced by analytical or computational methods. This problem amply demonstrates the degree to which experimental procedures lag behind computational and theoretical developments.

This volume does communicate a consensus of the present status of soil liquefaction research. The consensus, which appears to be shared by practitioner, theoretician and experimentalist alike, is that appropriate effective stress-strain-volume change laws for soils under cyclic loading have not been established. Thus, in spite of developments in multiphase continuum mechanics (Biot theory) and computational continuum mechanics (the finite element method), the immediate future development of liquefaction research is blocked by the nonexistence of a widely accepted constitutive equation for saturated soils. The prime deterrent to development of an accepted constitutive equation is the lack of convincing experimental data and, in particular, the lack of an experimental situation in which the strain remains homogeneous throughout the course of the test.

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**Mechanics of Composite Materials: Recent Advances.** Edited by Z. Hashin and C. T. Herakovich. Pergamon Press, New York, 1983. 499 Pages, Price \$75.00.

### REVIEWED BY Y. WEITSMAN<sup>3</sup>

The subject of Composite Materials covers a wide category of responses and configurations. It provides for an abundance of research topics and practical applications. Several, but

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clearly not all, of those subjects are represented in this book, which forms the proceedings of an IUTAM symposium held at Blacksburg, Va. during Aug. 16–19, 1982.

The proceedings contain 30 papers divided into several groupings which can be roughly delineated as follows:

1 Basic models. This group includes papers on micromechanics, effective properties, statistics of random media, and certain aspects of inelastic behavior.

2 Strength, failure, and damage. This group contains a variety of papers which propose statistical, deterministic, and semiempirical approaches to what is probably the most difficult and urgent problem area in composites.

3 Fracture. Several papers deal with the application of fracture mechanics to composites. The methods vary between numerical, finite-element techniques, and analytical solutions in anisotropic elasticity.

4 Laminate and structural analyses and behavior. This category contains works on higher order laminated-plate theory as well as applications-oriented papers which discuss the response of specific structural components under special loads.

5 Additional papers cover a variety of subjects like structural optimization, dynamic behavior, and experimental techniques.

The papers contain extensive lists of references and provide an up-to-date information on several areas of current concern in composites. This makes the Proceedings a worthwhile book for readers who specialize in the area, especially to those interested in fundamental aspects of the subject.

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**Ultrasonic Testing of Materials.** By J. Krautkrämer and H. Krautkrämer. Springer-Verlag, New York, 1983. 667 Pages. Price \$79.50.

**REVIEWED BY W. SACHSE<sup>4</sup>**

This book is the latest edition of the Krautkrämers' standard reference monograph on ultrasonic materials testing. There are only minor differences between this new third edition and the previous second edition. These include the correction of several misprints, replacement of a few figures in one section, and a minor change in the list of ultrasonic nondestructive testing standards. The copy of the book available for review appeared to be of somewhat lower quality than the earlier edition, principally in the half-tone photographs appearing in the text and the paper stock.

For those not familiar with this reference text it is worth reviewing some of its features. The book is a comprehensive text covering all aspects of ultrasonic testing, including the fundamental principles of such testing, the methods and instruments used, a review of general test procedures and applications with an extended summary of approaches to special inspection situations.

The first quarter of the book contains an elementary overview of acoustics, including wave propagation, scattering and attenuation effects, and the operation of piezoelectric and other transducers. This is followed by a slightly shorter section dealing with various ultrasonic measurement

techniques used for flaw identification and materials characterization. This section also contains specific examples of instruments, transducer configurations and calibration test blocks. In the next, shorter section, aspects of the transducer used in an ultrasonic test are reviewed. The emphasis is on piezoelectric transducers and various means for coupling them to flat or more complex specimen geometries. Also treated by example are the effects of boundaries and the use of specific wave modes in testing situations and procedures for characterizing flaw signals. This section even includes some ideas for organizing an inspection station. The final section of the book is also its longest, being nearly 250 pages long. It is a compendium of results obtained with ultrasonic measurements in specific testing situations. Included are examples of inspecting forgings, railway components, finished and semifinished metal stock (plates, strips, wires, etc.), pipes and cylinders, castings, joints (welded and other), metals and nonmetals, and more.

From the foregoing it should be clear that this book is very comprehensive. Nevertheless, it has several limitations. Principal among them is that while some of the European work and particularly that of Germany is well summarized, much work done elsewhere, in England and the United States and especially in Japan, is missing. The list of references at the end of the book includes few more recent than 1973 and clearly the ultrasonic testing field has advanced most rapidly since then. It is unfortunate that the new edition made no improvements in this regard over the 1977 edition.

As a reference to the science base of ultrasonic materials testing, the book is not especially strong. Mentioned briefly, but not to the extent deserving, are the results of research in acoustic emission, acoustoelasticity and stress measurements, scattering and ultrasonic spectroscopy, imaging, and electromagnetic-acoustic transducers (EMAT's), and laser generation and detection of ultrasound. Absolute ultrasonic measurements including transducer characterization procedures are not considered in detail. The book's focus is more to the existing technology of the field. The examples and figures shown pertain to specific ultrasonic inspection situations. Thus the book is a useful compilation of existing ultrasonic materials measurement techniques which are used in the field and which are of interest to an inspector and which may not be familiar to the ultrasonic researcher but which he should be aware of if his research is to be applicable. As such, this book is a valuable reference text to both groups and it should be familiar and readily available to all who are active in this field.

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**Contact Mechanics and Wear of Rail/Wheel Systems.** Edited by J. Kalousek, R. V. Dukkipati, and G. M. L. Gladwell. Proceedings, International Symposium, University of British Columbia, July 1982. 600 pages. Price \$48.00.

**REVIEWED BY L. M. KEER<sup>5</sup>**

The International Symposium, from which this volume is the proceedings, was held at the University of British Columbia, July 6–9, 1982. The objectives, as stated in the Introduction, were threefold: (1) To celebrate the 100th anniversary of the work of Heinrich Hertz in the field of contact mechanics. (2) To provide a forum whereby theoreticians and applied scientists could meet and discuss problems of mutual interest. (3) To focus attention on the importance of contact mechanics and wear mechanisms in

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