BOOK REVIEWS

Underground Excavations in Rock

Reviewed by G. B. Clark, Department of Mining Engineering, Colorado School of Mines, Golden, CO.

REFERENCE: Hoek, E. and Brown, E. T., *Underground Excavations in Rock*, Institute on Mining and Metallurgy—North American Publications Center, Brookfield, VT, 1980, 527 pp., soft cover, $43.25.

This book is concerned with several of the more important aspects of excavation, maintenance, and support of underground openings in several types of rock. It is a review and compilation intended for readers, engineers, and students who have an elementary background in the subject and is designed to provide an introduction rather than to give the detail that is necessary for specialization. Important phases of excavation are covered including basic planning, geological and rock mass analysis, stresses and strengths of rock masses, excavation failure and support, a brief treatment of blasting, and a description of instrumentation used for monitoring underground excavations during and after construction. Over 600 references are provided for those desiring to make more specialized studies.

The material in the book is intended for both civil and mining engineers, or others concerned with underground excavation, and it considers the problems encountered in a wide variety of rocks and geological situations. Examples, problems, and their solutions are presented to assist the student in the solving of problems he or she might encounter. Such factors are treated as the role of structural discontinuities and natural rock properties in controlling the structural stability of underground opening, stress induced instability, criteria for failure of rock and rock masses, stress analysis, choice of excavation methods, and methods of support. For mining engineers such factors are considered as underground mining methods, dependence on dip, and thickness of the orebody. Civil engineering applications include gas and petroleum storage, waste disposal, water conduits, and vehicular tunnels.

Some results of research of other authors are included, but mostly a very usable survey of knowledge in the field is presented. The book will find wide use and application in appropriate areas of engineering and geological science as well as serving as a comprehensive reference source. Illustrations and tables are informative and support the text material. The style is clear, and the material is easy to read and understand.

Limit Equilibrium, Plasticity, and Generalized Stress-Strain in Geotechnical Engineering

Reviewed by M. C. McVay, Department of Civil Engineering, Weil Hall, University of Florida, Gainsville, FL.

REFERENCE: Yong, R. K. and Ko, H.-Y., Eds., *Limit Equilibrium, Plasticity, and Generalized Stress-Strain in Geotechnical Engineering*, American Society of Civil Engineers, New York, 1981, $55.75, ISBN 904-392-0933.

The conference and its written proceedings on constitutive modeling of soil behavior was an excellent idea. A great deal of information concerning soil constitutive models has been previously published. However, little, if any, information regarding the actual selection of soil model parameters, the applicability of the models, or the prediction of different stress paths with the exception of those used in obtaining model parameters have been reported in the literature. The prediction of different stress paths is the general focus of the workshop and its written proceedings.

Scope and Organization

The object of the workshop and its preceedings was to investigate a number of well known and newly developed models. This was done by supplying the predictors (model developers) with laboratory stress-strain information used in obtaining model parameters that enabled the prediction of other stress-strain laboratory results. Later, at the Montreal workshop, the predictors and outside participants discussed and compared the model predictions with laboratory results.

The proceedings of the Montreal workshop were published in a format that is difficult to interpret. In order to read about a particular model, investigate the chosen model parameters, examine its predictions, and read the discussion of the model in its appropriate working session, it is necessary to search through four different areas of the proceedings and make frequent use of the author index. A better organization of the proceedings would have been the following order of presentation: (1) introduction and supplied laboratory information, (2) the reports of the four working sessions with appropriate model parameter determinations, predictions, and discussions (predictors' position papers) following each session in which it was discussed, and (3) synthesis and recommendations. The post-workshop comparisons would have been more appropriate in an appendix than in the middle of the proceedings. Three reasons for this choice of organization are these:

1. The subject matter covered by the proceedings was highly controversial, which was evident by the number of investigated models.
2. Comments and conclusions reached by individual investigators in their papers sometimes contradicted other predictions made in papers presented either before or after them.
3. Most importantly, the points or highlights made in the four working group sessions were difficult to follow from the format of the proceedings.

However, since the explanation of the models, choice of model parameters, and their predictions were presented in the proceedings, this is a very useful source of information for researchers interested in modeling stress-strain behavior of soil.

Content

The ultimate goal in developing constitutive soil models is to predict the response of soil behavior, in typical geotechnical engineering situations. The object of the workshop, as stated in the introductory paper, was to investigate the limitations or the appropriate utilization of constitutive models for future prediction of field behavior. However, as stated by many authors in the proceedings, all of the models presented in the proceedings are phenomenological in form or capable of predicting only limited stress histories. This was evident from the inability to predict the circular laboratory stress path from the investigated models. The reader, therefore, may conclude that the choice of the constitutive model depends significantly upon its stress history (applied loads) rather than its soil type. Moreover, it is not clear when a soil model should be considered or not considered for field predictions. A few of the predictors did address this point in their papers; however, a more detailed and unbiased discussion should have been given in the working group sessions.

Finally, the choice of soil model parameters for many of the soil models was made from curve fitting techniques that had limited physical significance. How are these parameters to be determined if sufficient laboratory tests are unavailable? Moreover, if these unknown parameters were selected by engineering judgement, how sensitive are the predicted responses of the models?

In summary, in the proceedings a useful opening forum on constitutive modeling of stress-strain behavior of soil was presented. However, future endeavors should also include actual field situations.

Physical Properties of Rocks and Minerals

Reviewed by A. W. Khair and S. S. Peng, Department of Mining Engineering, College of Mineral and Energy Resources, West Virginia University, Morgantown, WV.

REFERENCE: Touloukian, Y. J., Judd, W. R., and Roy, R. F., Eds., *Physical Properties of Rocks and Minerals*, Vol. II-2, McGraw-Hill/CINDAS, New York, 1981, $44.50.

This book, *Physical Properties of Rock and Minerals*, is one volume of the McGraw-Hill/CINDAS Data Series on Material Properties. It includes evaluated data and critical discussions on the physical properties of rocks and other geologic materials and certain minerals. It consists of 13 chapters. The first two chapters are introductory, and outline the constitution and engineering classification of rocks as well as the common parametric considerations involved in evaluations of physical properties. The next ten chapters deal with the physical, mechanical, electrical, magnetic, and thermophysical properties of rocks. The last chapter considers heat flow in the crust of the earth.

Each chapter begins with the common methods used to measure specific physical properties; parameters that affect measurements are included, and data on physical properties of selected rocks and minerals are tabulated. This is done in a clear and concise manner with sufficient references. There are various simple yet informative tables and graphs to substantiate measurements.

Since the book covers so many physical properties for various materials such as minerals, rock substance, rock mass, and even earth crust, it is obvious a comprehensive list of physical properties for each of the materials can not be compiled, making this volume more of a reference book than a handbook.

Finally, this volume represents an exhaustive list of test methods and results for physical properties of rocks and minerals. It should serve as a useful reference for engineers and researchers dealing with mineral and energy resources.

Introduction to Rock Mechanics

Reviewed by M. M. Singh, President, Engineers International, Inc., Westmont, IL.

REFERENCE: Goodman, R. E., *Introduction to Rock Mechanics*, Wiley and Sons, Inc., New York, ISBN 0471-04129-7, 1981, $31.95.

This textbook is an excellent exposition of rock mechanics for civil engineering students. It consists of nine chapters and five appendixes. Each chapter is well selected and discusses a specific aspect of rock mechanics with which any student of the subject should be familiar. The first six chapters deal with general topics that give the reader a basic knowledge of the nature of rock masses. The last three chapters are applications.

The introduction places the field of rock mechanics in perspective, with an excellent maxtrix that shows facets of the field that apply to various types of engineering activities. Next, various rock mass classifications and rock properties that are commonly used to obtain quantitative data about rock behavior are presented. Failure criteria and the significance of rock strength, with a discussion of the factors that affect these, are given. The major methods of measuring in situ stresses in rock are described, with a brief discussion on how these stresses influence the design of underground structures. The role of weakness planes and methods of quantification of their characteristics are treated next, followed by rock deformation characteristics, both with load and time. Creep is treated at some length, presumably in anticipation of its future role in the design of nuclear waste repositories, geothermal energy exploitation, in situ oil shale extraction, and other structures subjected to high loads or temperatures.

Applications considered in the book include underground openings, slopes, and foundations. The approach to the solution of the various problems encountered in the design of rock structures is illuminating. Selected numerical examples are included in these chapters, and it would have been valuable if a few examples had been included in the earlier chapters.

The appendixes present the mathematical aspects of stresses and strains and the derivations of equations presented in the book, along with sections on identification of rocks and minerals, and the use of stereographic projections. These last two appendixes should prove very helpful to engineering students.

The problems at the end of each chapter are thought provoking, but not necessarily lengthy. The answers at the back are helpful, especially for the person engaged in self instruction.

The book is written in a lucid style and presents concepts in a simple, straightforward manner which is enlightening, even to experienced engineers. Although the subject matter, as presented, has a strong base in mathematics and mechanics, the author has relegated most of the mathematical derivations to the appendixes. The text anticipates an elementary knowledge of matrix algebra and vector analysis.

Every reviewer has some differences of opinion about certain statements in any book. It should be pointed out that rock mechanics courses were being taught in U.S. universities since at least the mid 1950s and even earlier, albeit some were under different names. A reference to the Brazilian test for rock in accordance with ASTM Test for Splitting Strength Intact Rock Core Specimens (D 3967-81) would have been more appropriate than that for concrete in accordance with ASTM Test for Splitting Tensile Strength of Cylindrical Concrete Specimens (C 496-71). When reference is made to the correlation of static modulus to shear wave frequency, it may have been timely to introduce the student to the phrase "petite sismique," which he or she might encounter in the literature.

A little more attention to the editing of the book would have been appreciated. Thus, for example, the reference to Brekke and Selmer-Olsen and Brekke (1970) on page 97 should read Brekke and Selmer-Olsen (1966) and Brekke (1970); there is no AA′ in Fig. 5.9d, as referred to on page 155; the opening parenthesis before the words "shock absorber" in Fig. 6.15 on page 194 is missing; on page 198 the reference is to Fig. 6.18 rather than Fig. 6.15; and on page 273 Fig. 8.11 should read Fig. 8.12. This is not, however, intended to be a complete errata sheet.

These last comments should not deter anyone who is associated with rock mechanics from acquiring a copy. Considerable insight into the subject is provided by a careful perusal. Many of the examples and illustrations in the text are original, which underscores the scholarly nature of the author. This Introduction to Rock Mechanics belongs on the bookshelf of every geotechnical engineer—student or practitioner!

Foundations and Slopes—An Introduction to Critical State Soil Mechanics

Reviewed by F. C. Townsend, Department of Civil Engineering, University of Florida, Gainesville, FL.

REFERENCE: Atkinson, J. H., *Foundations and Slopes—An Introduction to Critical State Soil Mechanics*, John Wiley and Sons, Inc., New York, 1981, $27.95, ISBN 0470-27246-5.

This book is primarily designed for undergraduate civil engineering students and deals with the behavior of slopes, foundations, and retaining walls. Chapters 1 and 2 are essentually a summation of *The Mechanics of Soils* by Atkinson and Bransby, which covers the aspects of the mechanical behavior of soils and develops the fundamentals of Critical State Soil Mechanics (CSSM). Chapter 3 examines the origin of natural soils and in-situ stress conditions. Chapter 4 covers theories of plastic collapse and work done during collapse. Chapters 5 to 8 apply these theories to slope stability, retaining walls, and foundations for undrained and drained conditions. Chapter 7 presents associated fields and slip line methods and because of the mathematics involved is beyond the scope of most undergraduate courses. Chapter 9 presents traditional analyses of bearing capacity and earth pressures, and Chapter 10, traditional methods for estimating settlements of footings.

Although this book is designed as a text for undergraduate students, the nontraditionalism of CSSM and restricted scope of only foundations and slopes suggest the book would be more useful as a graduate level reference. This book and its predecessor *The Mechanics of Soils* are excellent references for learning CSSM concepts and their application to geotechnical problems. Because of the easily understandable descriptions and example problems of these concepts and applications, these books are highly recommended for engineers and students desiring a background in CSSM.

This book is well written and well organized. The example problems at the end of each chapter are very helpful in crystallizing concepts presented in the chapter.