Geotechnical Instrumentation for Monitoring Field Performance

Reviewed by John F. Peters, Department of the Army, Waterways Experiment Station, Corps of Engineers, Vicksburg, MS 39180-0631.


Use of instrumentation for monitoring performance of earth structures is an important part of geotechnical engineering. For large structures or structures based on novel construction techniques, field observation during construction is an essential part of design. Unfortunately, details of how to select, install, and interpret data from field instrumentation has been largely ignored in academic programs for geotechnical engineers. This deficiency is due in part to the lack of reference material available to students and practitioners. Dunnicliff has provided a book that fills a critical need.

The book is presented in seven parts. Part 1 provides an introduction to both instrumentation and geotechnical engineering. Chapter 1 provides an overview of geotechnical instrumentation that sets the tone for the remainder of the book. Instrumentation is important but must be installed with a purpose and with full recognition of the limits of the instruments, personnel, and organization. Especially refreshing is the recognition that, as with all aspects of geotechnical design, instrumentation programs are not carried out by one highly competent engineer but by a collection of individuals responsible for planning, procurement of instruments and services, installation, and data gathering and engineering.

Increased labor costs have prompted more reliance on automated systems. Increased emphasis on competitive bidding for contractual services has led to greater use of "lowest bid" as a basis for procurement decisions often to the detriment of otherwise well-designed instrumentation programs. Chapter 2 provides a straightforward introduction to behavior of soil and rock, which is intended for the practitioners who have limited formal training in soil or rock mechanics.

Part 2 addresses the planning of monitoring programs in four chapters. Chapter 3 on benefits of field instrumentation is brief but provides a wealth of information for anyone forced to justify the budget for field instrumentation. Chapter 4 serves as the "hub" of the book outlining how a successful monitoring program is planned and executed. Chapters 5 and 6 are devoted to procurement procedures. The material contained in these four chapters may be found a bit dry by many of the more technically oriented readers but will be worth the price of the book for anyone responsible for preparing specifications and other procurement documentation.

Part 3 devotes eight chapters to the technical details of monitoring methods. Chapter 7 deals with measurement uncertainty by making distinctions between uncertainties related to conformance between instruments and the media being monitored, accuracy, precision, resolution, sensitivity, linearity, hysteresis, noise, and error. This chapter will be particularly valuable for students. Chapter 8 gives extensive coverage to the mechanical and electrical principles involved in converting a physical change into a corresponding data record. Chapters 9 through 14 each address the particular instruments used to measure ground-water pressure, total stress in soil, stress change in rock, deformation, load and strain in structural members, and temperature. Each of these chapters begins with a section on instrument applications, which supplements the material on soil and rock behavior presented in Chapter 2. Details are provided on installation of instruments, comparisons of various types of instruments including their advantages and disadvantages, and the relationship between the instrument design and its reliability under field conditions.

Part 4 provides general guidelines on the execution of monitoring programs including installation techniques, calibration, maintenance, data gathering, and data interpretation. Throughout the four chapters of this part the emphasis is placed on practical details of technique.

In Part 5 application examples are presented in seven chapters. The emphasis is placed on considerations for various types of structures rather than types of instruments. The examples include braced excavations, embankments on soft ground, embankment dams, excavated and natural slopes, underground excavations, driven piles, and drilled shafts. Each chapter considers the general role of instrumentation for the application considered, principal geotechnical questions, overview of routine and special applications, and selected case histories. The descriptions of the application do not include detailed accounts of specific case histories although extensive annotated references are presented in tabular form at the end of each chapter.

Part 6 consists of a single chapter, which summarizes the steps to a successful instrumentation program. An analogy to a chain with potential weak links is drawn because "... this chain breaks down with greater facility and frequency than in most other geotechnical endeavors." Twenty-five links are described, 17 of which involve the planning phase of the monitoring program.

Part 7 consists of eight appendixes containing checklists for planning and execution of monitoring, sources for commercially available instruments, dimensions of standard casing, pipe, and other drilling equipment and tables of unit conversion factors. An appendix is included on details of twin-tube hydraulic piezometers. Another appendix contains an example installation for an inclinometer, which serves to illustrate the level of detail needed when preparing written procedures.

It is to be expected that quality technical books have their roots in courses that have been taught often over a period of time. This book certainly conforms to that expectation. Mr. Dunnicliff has been active for many years in teaching the art of field performance monitoring to students, technicians, and practicing engineers. He has made full use of the experience and knowledge of others in the field, which adds considerable depth to the material. This book is recommended to all who are involved in geotechnical projects regardless of whether their role is technical or managerial.
Geotechnical Applications of Remote Sensing and Remote Data Transmission

Reviewed by Donald R. Wiesnet, President, Satellite Hydrology Inc., 450 Maple Ave., E., Suite 212, Vienna, VA 22180.


In late January and early February 1986, ASTM Committee D-18 on Soil and Rock and the International Committee on Remote Sensing and Remote Data Transmission (ICRS&DT) cosponsored an international symposium in Cocoa Beach, FL. This symposium produced a fine series of engineering-applications-oriented papers that Johnson and Pettersson with ASTM support have turned into an outstanding, small, but very nicely done book. A proceedings is a proceedings; but this 277-page book is a lot more! The book is hardcover, set in type, well-reviewed and edited, complete with both an author and a subject index, four appendices (a glossary of remote sensing and remote data transmission terms and definitions, sources of remotely sensed data, a bibliography for additional reading, and abbreviations and acronyms used in remote sensing and remote data transmission).

The purpose of the symposium was to provide interdisciplinary communication between remote-sensing and data-transmission specialists and users of geotechnical data. Both the symposium and this excellent book will do much to achieve the stated purpose.

The book is organized into four sections: remote sensing, remote data transmission, general discussions, and appendices. The largest section, remote sensing, contains 12 papers; remote data transmission has only two papers, but both are excellent. The general discussions section is concise and refers to general questions, standardization of remote sensing data collection and transmission, and a summary of the symposium. While the section is of limited interest to the casual reader, it is of great importance to the international community. The appendices should be of great use to the engineers and others who are neophytes to the jargon of remote sensing but are interested in its applications to their field.

Frankly, this book can and ought to provide a real bridge, uniting engineers and geotechnical scientists with the remote-sensing community. The book is written primarily by engineers and geotechnical scientists, and they are presenting bona fide useful applications to engineering studies as well as the limitations of remote sensing. V. H. Singhroy's leadoff paper is an excellent example. It cites how remote sensing can be of use in the planning and construction of cross-country natural-gas pipelines, the search for suitable near-surface construction materials, the evaluation of sites for the disposal of hazardous waste water, and the identification of conditions likely to give rise to mine-roof instabilities. Color-infra-red aerial photography, aerial video-recording, digital analysis of Landsat MSS, TM, and Seasat SAR, and airborne thermal IR, were all employed in the case histories discussed. The table of recommended techniques for selected geotechnical and environmental applications related to pipeline construction ought to appeal to many engineers. The article is profusely illustrated. The quality of the photos and thermograms is excellent. The 37-page article also has 75 references.

K. D. Peter et al. did a masterful and innovative study in their integration of lineament data derived from Landsat and Skylab images with geologic and geophysical data to provide much insight into the geohydrologic systems of western South Dakota.

An area that I feel has heretofore been inadequately explored, waste-site use and characterization, is thoroughly discussed, and guidelines to the correct choice of remote-sensing techniques are presented for others to use. The historical aspects of remote sensing, that is, its ability to retrospectively view an earlier environment at the site, are stressed by Elfrits and Hathaway. Hui Lin from China gave two papers: one on estimating land use of lands to be flooded by large dam reservoirs and one on updating data bases for a Geographic Information System (GIS). Other topics discussed were: location of potential ground subsidence and sinkholes by remote-sensing techniques; satellite studies of the significance of surficial deposits for surface mining operations; a technique of data processing called "co-riging" to improve the resolution of low-resolution images; optical Fourier analyses of surface features of interest in geotechnical engineering (image subtraction and correlation); the geotechnical applications of three new U.S. Government remote-sensing programs; and a synopsis of the NASA/Geosat Test Case Project.

As stated earlier, R. W. Paulson, the "guru" of data transmission systems, prepared an outstanding and thorough exposition of these systems, and G. L. Chedsey's paper is a much-needed one on the criteria for the selection of remote-data-telemetry methods for geotechnical applications. With these two papers in hand, any engineer ought to be able to begin planning and initiating a program of remote telecommunication.

This book has been cleverly crafted and carefully edited by competent people who care. It was beautifully printed by ASTM with type one can read and with figures and photos excellently reproduced. I highly recommend this book, especially to engineers and geotechnical people who need an excellent reference to get started in applying remote sensing to benefit their projects. It has everything: examples, selection criteria, sources, techniques, a glossary of terms, and abundant references. It is current.

A. I. Johnson and C. B. Pettersson, Eds., should be proud of this splendid contribution that they and ASTM have made, not only to member engineers and geoscientists, but also to the engineering and remote-sensing communities as a whole.

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