Technical Editor

Dr. Ernest T. Selig Dept. of Civil Engineering Marston Hall 235 University of Massachusetts Amherst, MA 01003

Editorial Board

Dr. Richard G. Campanella Dept. of Civil Engineering University of British Columbia Vancouver, B.C. V6T 1W5 Canada

Mr. Clarence K. Chan Institute of Transportation Studies University of California 47th and Hoffman Richmond, CA 94804

Dr. Gary N. Durham Ground Engineering and Testing Service 4764 First Avenue North Birmingham, AL 35222

Mr. W. J. Eden Division of Building Research National Research Council of Canada Ottawa, Ont. K1A 0R6 Canada cedures; and (3) to stimulate active participation of the profession in the work of ASTM Committee D-18 on Soil and Rock. The editorial scope of this journal includes papers, technical notes, letters to the editor, discussions of previously published

Purpose and Scope

notes, letters to the editor, discussions of previously published papers, and book reviews that deal with test methods for soil and rock for engineering purposes. Similar material covering sampling, nomenclature, and practices relating to the determination of properties and behavior of soil and rock for engineering purposes will be included. Topics of interest include new testing equipment, apparatus, and procedures for both field and laboratory applications; evaluation of existing ASTM standards and recommendations for new standards for apparatus or test procedures; and test results that give insights into test procedures and techniques. Topics must be related to soil and rock, but can include highway materials testing, such as aggregate properties or pavement performance measurement, and geophysical exploration.

The purpose of the Geotechnical Testing Journal is (1) to provide a

publication of quality that informs the profession of new developments in soil and rock testing and related fields; (2) to provide a forum

for the exchange of information, particularly that which leads to the

development of new test procedures or improves existing pro-

Dr. Charles J. Haas Book Review Editor—Rock Mechanics Rock Mechanics and Explosives Research Center University of Missouri—Rolla Rolla, MO 65401

Dr. Syd S. Peng College of Mineral and Energy Resources West Virginia University Morgantown, WV 26506

Dr. Steve J. Poulos Geotechnical Engineers, Inc. 1017 Main St. Winchester, MA 01890

Dr. John H. Schmertmann Schmertmann and Crapps, Inc. 4509 N. W. 23rd Ave., Suite 19 Gainesville, FL 32601 Mr. Woodland G. Shockley 326 Lakehill Drive Vicksburg, MS 39180

Dr. Marshall L. Silver Dept. of Materials Engineering University of Illinois at Chicago Circle Box 4348 Chicago, IL 60680

Dr. Frank C. Townsend Book Review Editor—Soils Department of Civil Engineering Weil Hall University of Florida Gainesville, FL 32601

-INTERNATIONAL CONTACT MEMBERS-

Dr. Stephen F. Brown University of Nottingham Dept. of Civil Engineering University Park, Nottingham NG7 2RD U.K. Dr. Yoshiaki Yoshimi Tokyo Institute of Technology 4259 Nagatsuta Midori-ku, Yokohama 227, Japan

The American Society for Testing and Materials is not responsible, as a body, for the statements and opinions advanced in this publication.

Geotechnical Testing Journal (ISSN 0149-615) is published quarterly by ASTM as part of the Testing and Evaluation Series, which includes the Journal of Testing and Evaluation (published bimonthil) and Cement. Concrete, and Aggregates (published semiannually). Publication at the Headquarters of the Society, 1916 Race St., Philadelphia, PA. 19103.

Subscriptions: United States and Canada for 1 year \$38.00 (members \$28.00), for 2 years \$60.00 (members \$48.00), for 3 years \$87.00 (members \$60.00), Foreign for 1 year \$43.00 (members \$258.00), for 2 years \$102.00 (members \$102.00), for 2 years \$102.0

Permission to Copy: The appearance of the code at the bottom of the first page of an article in this journal indicates the copyright owner's consent that copies of the article may be made for personal or internal use, or for the personal or internal use of specific clients. This consent is given on the condition, however, that the copier pay the stated per copy fee through the Copyright Clearance Center, Inc. Operations Office, P.O. Box 765. Schenectady, NY 12301, for copying beyond that permitted by Sections 107 or 108 of the U.S. Copyright Law (The per copy fee appears as the last four digits of the code at the bottom of the first page of each article). This consent does not extend to other kinds of copying, such as copying for general distribution, for advertising or promotional purposes, for creating new collective works or for resale. Further information may be obtained from the Copyright Clearance Center's Administrative Office. 310 Madison Ave., New York, NY 10017 (212/ 697-2525).

Change of Address: Please return entire addressing label on wrapper to ASTM, Subscription Dept.-GTJ, 1916 Race St., Philadelphia, PA 19103.

ASTM

Editorial Staff

Robert L. Meltzer, Vice-President, Publications and Marketing Rosemary Horstman, Managing Editor Susan L. Gebremedhin, Assistant Editor M. Bruce Vieth, Manager of Production

Officers

Robert G. Redelfs, Chairman Lendell E. Steele, Vice-Chairman Gladys B. Berchtold, Vice-Chairman Robert Baboian, Treasurer William T. Cavanaugh, President

DIRECTORS

Albert J. Bartosic	Donald R. Johnson
John A. Blair	J. Gilbert Kaufman
Stephen E. Chehi	Benjamin Levadie
F. Greg Clarke	John F. McLaughlin
William P. Dugan	Thomas D. Moreland
Robert E. Elliott	Roman F. Serra
W. DeWayne France, Jr.	Richard O. Simpson
John A. Gilligan	Nancy M. Trahey
Emanuel Horowitz	Alan H. Yorkdale

PAST CHAIRMEN DIRECTORS

Richard H. Goodemote

William A. Goodwin

Committee on Publications

R. C. Deen, Chairman	Richard Kimerle
K. L. Reifsnider, Vice-	E. L. Lewis
Chairman	Leonard Mordfin
J. M. Barsom	J. S. Perrin
E. P. Bartkus, Ex-officio	C. G. Scott
S. W. Dean	P. G. Sullivan
W. G. Dukek	E. T. Wessel
J. H. Kanzelmeyer	R. E. White

Information for Authors

Contributions to the *Geotechnical Testing Journal* are subject to peer review. in accordance with the policy established by the ASTM Committee on Publications. The paper must either contribute to the permanent literature or be of immediate interest to ASTM membership. The subject matter must not be of a speculative nature and the contents must not include materials of an advertising nature. The paper must not be seriously defective as to literary form and structure, continuity of thought, and clarity of expression. The substance of the paper should not have been published previously in the open literature.

Authors preparing papers for submittal should observe the conventions of style explained in the ASTM Style Manual. Since the journal does not request page charges, the author is expected to conform to these standard conventions for style. SI units are to be used throughout: if data were not measured in SI units, a note should appear to that effect and the original units should be included in parentheses after the SI units. Key words should be chosen in accordance with the latest edition of ASTM D 3584. Recommended Practice for Indexing Papers and Reports on Soil and Rock for Engineering Purposes.

The original manuscript and four clear copies, including original illustrations, should be submitted to Kathy Greene, Manager, Acquisitions and Review. ASTM, 1916 Race St., Philadelphia, PA 19103. Papers are eligible for the following ASTM awards⁻ the C. A. Hogentogler Award (papers on soils for engineering purposes), the Sanford E. Thompson Award (papers on concrete and concrete aggregates), and the Richard L. Templin Award (papers on new and useful testing procedures and apparatus).

General

This publication is one of many issued by ASTM in connection with its work in promoting knowledge of the properties and performance of materials, products, systems, and services, as well as in developing standard specifications and test measurement techniques to establish their value. Much of the information results from the voluntary contributions of many of the country's leading technical authorities from industry, scientific agencies, and government. A list of publications and information on the work of ASTM will be furnished on request.

In Appreciation

The high quality of the papers that appear in this publication is a tribute not only to the obvious efforts of the authors represented but to the unheralded, though essential, efforts of their reviewers. It is to the reviewers dedication to upholding the high standards of their profession that this note pays tribute. On behalf of ASTM and the authors as well, we acknowledge with appreciation their important contribution to the success of this journal.