

A Multidisciplinary Forum for Applied Sciences and Engineering

Editorial Objectives

The Journal of Testing and Evaluation is published bimonthly by ASTM, a nonprofit technical organization that develops and publishes voluntary consensus standards and related information for materials, products, systems, and services. All contributions are peer reviewed prior to publication.

The editorial objectives of this journal are to serve a broad-based audience by:

- 1. Publishing new technical information derived from the field and laboratory testing, performance, quantitative characterization, and evaluation of these materials, products, systems, and services.
- 2. Presenting new methods and data and critical evaluations of these methods and data.
- 3. Reporting the users' experience with test methods and the results of interlaboratory testing and analysis.
- 4. Providing the scientific basis for both new and improved ASTM standards.
- 5. Stimulating new ideas in the fields of testing and evaluation.

Technical Editor

Donald R. Petersen

Greenleaf Associates P.O. Box 1785 Midland, MI 48641-1785

Editorial Board

George V. Aseff, Sr.

Law Engineering Testing Company 396 Plasters Ave., N.E. Atlanta, GA 30324

Ray Bartnikas

Institut de Recherche d'Hydro-Quebec 1800 Descente, Ste-Julie, Varennes, Quebec, Canada JOL 2PO

James P. Bell

Chemical Engineering and Materials Science Dept. University of Connecticut Storrs, CT 06269

Gary Burnell

31 Highwood Ridge Danebury Rd. Basingstoke RG22 4UU Ū.K.

Brigitte Decamps

Universite de Paris Sud Institut de Sciences des Materiaux (ISMA) Laboratoire de Metallurgie Structurale Bàtiment 413 91405 Orsay, France

Harvey P. Hack

Naval Surface Warfare Center Code 2813 Annapolis, MD 21402

Gerald M. Hodgson

752 Westbrook Dr. N. Tonawanda, NY 14120

Lyle R. Jenkins

Ductile Iron Society 4525 Williamsburg Dr. Decatur, IL 62521

Adam Jostons

Advanced Materials Program, ANISTO Private Mail Bag 1 Menai, NSW 2234 Australia

Arthur H. Landrock

PLASTEC, U.S. Army ARDEC Bldq. 355N Picatinny Arsenal, NJ 07806

Richard E. Link

Naval Surface Warfare Center Code 614 Annapolis, MD 21402

Theodore J. Louzon

AT&T Bell Laboratories Wynnewood, PA 19096

Robert Megargle

Department of Chemistry Cleveland State University Euclid Ave. at East 24th St. Cleveland, OH 44115

M. S. Paterson

The Australian National University Research School of Earth Sciences GPO Box 4 Canberra, ACT 261 Australia

Raymond D. Pavlovich

Exxon Chemical Americas **Polybilt** 13501 Katy Freeway Houston, TX 77079

Alan Riga

The Lubrizol Corp. 29400 Lakeland Blvd. Wickliffe, OH 44092

Robert S. Shane

Shane Associates, Inc. 238 Hemlock Rd. Wynnewood, PA 19096

Richard L. Sheehan, Jr.

3M Co. Packaging Systems Division 3M Center 230-1E-03 St. Paul, MN 55144

Fraser Smith

SARCOS 261 E. 300 S. Suite 150 Salt Lake City, UT 84111

Ulf Wickstrom

Statens Provingsanstalt P.O. Box 857, S-501 15 Borås, Sweden

Alan Wolfenden

Mechanical Engineering Department Texas A&M University College Station, TX 77843

Journal of Testing and Evaluation (ISSN 0090-3973) is published bimonthly by ASTM as part of the Testing and Evaluation Series, which includes the Geotechnical Testing Journal (published quarterly), Journal of Composites Technology & Research (published quarterly), and Cement, Concrete, and Aggregates (published semi-annually). Publication and editorial offices are located at ASTM Headquarters, 1916 Race St., Philadelphia, PA 19103.

at ASTM Headquarters, 1916 Race St., Philadelphia, PA 19103.

Subscriptions. United States and Canada for 1 year \$103.00 (members \$93.00), for 2 years \$175.00 (members \$158.00), and for 3 years \$232.00 (members \$209.00). Foreign for 1 year \$113.00 (members \$102.00), for 2 years \$193.00 (members \$35.00. To subscribe, please send prepaid order to ASTM, Subgard Evaluation is indexed regularly by Engineering Index, Inc., and is available on microfilm from University Microfilms, A Xerox Co., Ann Arbor, MI. Second class postage paid at Philadelphia, PA.

Copyright © 1994 by the American Society for Testing and Materials, Philadelphia, PA. All rights reserved. This material may not be reproduced or copied, in whole or in part, in any printed, mechanical, electronic, film, or other distribution and storage media without the written consent of the publisher.

Photocopy Rights. Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by the American Society for Testing and Materials for users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the base fee of \$2.50 per copy, plus \$0.50 per page, is paid directly to CCC, 222 Rosewood Dr., Danvers, MA 01923; Tel. (508) 750-8400; FAX (508) 750-4744. For those organizations that have been granted a photocopy license by CCC, a separate system of payment has been arranged. The fee code for users of the Transactional Reporting Service is 0090-3973/09-92 \$2.50 + .50.

Postmaster Send Form 3579 to ASTM Headquarters. Subscription

Postmaster. Send Form 3579 to ASTM Headquarters, Subscription Dept., 1916 Race St., Philadelphia, PA 19103.

Change of Address. Please return entire addressing label on wrapper to ASTM, Subscription Dept.—JTE, 1916 Race St., Philadelphia, PA 19103, along with new address.

Printed in the U.S.A.

Editorial Staff

Thea R. Clark, Editor, Books and Periodical Publications

Barbara Stafford, Administrative Assistant, Secretary, Acquisition & Review

Kathy Dernoga, Manager, Acquisition & Review Susan L. Gebremedhin, Manager, Books and Periodical Publications

Roberta Storer, *Director, Editorial Services*M. Bruce Vieth, *Director, Production and Graphic Arts*

ASTM Officers

C. Ross Thomson, Chairman George C. Moran, Vice-Chairman Arthur Cohen, Vice-Chairman Sheldon W. Dean Jr., Treasurer James A. Thomas, President

Directors

James E. Bihr
Gilbert F. Bourcier
Lawrence C. Bradbury Jr.
G. Thomas Castino
William M. Edmunds
John L. Ferrante
Rodolfo I. Godinez
James L. Hazen
David C. Jeanes

John E. Kean Richard S. Ladd Paul H. Langer James J. Lichtenberg Donald E. Marlowe Michael M. O'Mara Richard M. Park James S. Pierce Garland W. Steele

Past Chairmen

Nancy M. Trahey

Emery Farkas

Committee on Publications

Leonard Mordfin, Chairman Kenneth R. St. John, Vice-Chairman C. Ross Thomson, Ex officio George B. Beestman Victor Chaker

Robert J. Goode Douglas R. Hooton Mark F. Marcus John E. Masters Howard J. Pincus Roger E. Stoller Kurt H. Strauss Mona B. Wolf

Information for Authors

The **Journal of Testing and Evaluation** publishes original articles of the following types:

Full-Length Papers (3000-5000 words)

- Reports of Original Investigations (research and field applications papers).
- Review Articles (state-of-the-art or literature reviews).
- Interlaboratory Research Reports (including data and statistical analysis).
- New Procedures (currently under development by a committee or authored by an individual).
- Case Studies (reports and analyses of noteworthy events or situations).

Shorter Technical Communications (500–1500 words)

- Technical Notes (brief papers on specific topics).
- Research Briefs (advance communications that will be followed by full-length papers).
- Conference Reports (extended abstracts).

Commentary (500-1000 words)

- Discussions of Previously Published Papers.
- Letters to the Editor.
- Invited Editorials.
- Reviews of Books and Standards.

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.

The original manuscript and four clear copies, including original illustrations, should be submitted to Kathy Dernoga, Manager, Acquisitions and Review, ASTM, 1916 Race St., Philadelphia, PA 19103.