

# Journal of Testing and Evaluation

## Contents:

- 721 A Comparative Study on Dynamic Modulus of Asphalt Concrete with Different Loading Mode**—You Huang, Zhaohui Liu, Xudong Wang, Sheng Li, and Jingyu Liu
- 739 Accelerated Healing in Asphalt Concrete via Laboratory Microwave Heating**—Haopeng Wang, Jun Yang, Guoyang Lu, and Xueyan Liu
- 758 Adopting Chip Sealing Performance-Based Approaches to Determine Rational Design Quantities**—Minas Guirguis and Ashley Buss
- 775 An Ideal Model for a Merger and Acquisition Strategy in the Information Technology Industry: A Case Study for Investment in the Taiwanese Industrial Personal Computer Sector**—Hung-Lung Lin and Cheng-Chung Cho
- 795 Artificial Neural Network to Predict the Compressive Strength of Semilightweight Concrete Containing Ultrafine GGBS**—P. Parthiban and Jayakumar Karthikeyan
- 811 Automatic Recognition of Weld Defects in TOFD D-Scan Images Based on Faster R-CNN**—Zhenhua Chen, Guoliang Huang, Chao Lu, and Guo Chen
- 825 Collaborative Optimization of Nonlinear Hydropneumatic Suspension Dynamic Characteristics**—Wenguang Wu, Lin Hu, and Zhiyong Zhang
- 838 Computational Testing Procedure of the Measure of Performance for Exponentiated Weibull Products under Progressive Type II Right Censoring Scheme**—Jong-Wuu Wu and Ching-Wen Hong
- 859 Correlations on Pulse Velocity and Physic-Mechanical Properties of Impact-Compacted Cement Mortar Containing Quartz and Recycled PP Aggregates**—Kívya M. Nascimento, André L. dos Santos, Alexandre E. Vale, Túlio H. Panzera, Carlos E. S. da Silva, and Paulo H. R. Borges
- 871 Design Proposal for Synthetic Fiber-Reinforced Concrete Pipes Using Finite Element Analysis**—Fouad T. Al Rikabi, Shad M. Sargand, and Husam H. Hussein
- 896 Detection and Characterization of Hidden Corrosion in Aircraft Lap Joints by Optical NDT Method**—M. S. Safizadeh and M. R. RasouliNasab
- 905 Determination of Magnetic Nanoparticles Injection Characteristics for Optimal Hyperthermia Treatment of an Arbitrary Cancerous Cells Distribution**—Reza Roohi, Homayoun Emdad, Khosrow Jafarpur, and Mohammad Reza Mahmoudi
- 922 Effect of Fibers on Strength and Elastic Properties of Bagasse Ash Blended HPC Composites**—Praveenkumar Shanmugam and Sankarasubramanian Gopalan
- 938 Effect of Mono Ethylene Glycol Solution on Mechanical Behavior of a Clay Soil**—A. R. Estabragh, I. Beytolahpour, and A. A. Javad

- 955 Effect of Reinforcement on Compacting Characteristics of Aluminum/10-Al<sub>2</sub>O<sub>3</sub>/Fly Ash Metal Matrix Composite**—*Seelam Pichi Reddy, P. V. Chandrasekhara Rao, and Murahari Kolli*
- 970 Effect of Sample Tilt on Measurement of Friction Coefficient by Constant-Load Scratch Testing of Copper with a Spherical Indenter**—*Chenghui Gao and Ming Liu*
- 990 Effects of Compaction on Internal Stability of Granular Soils: An Experimental Evaluation of Particle-Based Methods**—*Jahanzaib Israr and Muhammad Irfan*
- 1014 Employment of Mechanical Testing to Evaluate the Effect of Density on Asphalt Pavement Performance**—*Alireza Zeinali and Phillip B. Blankenship*
- 1031 Energy Investigation in Serpentine Heat Exchanger Using Aluminum Oxide Nanofluid on Solar Photovoltaic/Thermal System**—*Geetha Ramadass, M. M. Vijayalakshmi, and E. Natarajan*
- 1055 Enhancement of Impact Properties by Using Multiwall Carbon Nanotubes as Secondary Reinforcement in Glass/Epoxy Laminates**—*Prashant Rawat, K. K. Singh, and Rohit Pratyush Behera*
- 1071 Estimation and Prediction for the Generalized Half Normal Distribution under Hybrid Censoring**—*Farha Sultana and Yogesh Mani Tripathi*
- 1095 Estimation of Wave Velocity for Ultrasonic Imaging of Concrete Structures Based on Dispersion Analysis**—*Shibin Lin, Sadegh Shams, Hajin Choi, Dewei Meng, and Hoda Azari*
- 1108 Evaluation and Modeling of the Effect of Tool Edge Radius on Machined Surface Roughness in Turning UNS A92024-T351 Aluminum Alloy**—*Ning Fang and P. Srinivasa Pai*
- 1122 Experimental Analysis of Dry Sliding Friction and Wear Behavior of OMMT Nanoclay Added EVA/HDPE/MA-g-PE Compatibilized Polymer Blends with Parametric Study of Influencing Factors**—*Rajeev Namdeo, Sudhir Tiwari, Smita Manepatil, and Navin Chand*
- 1138 Experimental Research on Explosively Driven Crack Initiation and Propagation from Flaws of Various Geometry**—*Renshu Yang and Jinjing Zuo*
- 1155 Experimental Study of Nonpolar Surfactant Mixed with Dielectric Fluid on Die-Sinking EDM of Ti-6Al-4V Alloy**—*Murahari Kolli and Adepu Kumar*
- 1175 Fatigue Performance Evaluation for an Orthotropic Steel Bridge Deck Based on Field Hotspot Stress Measurements**—*Bin Chen, Zengshun Chen, Xu Xie, and Xiaowei Ye*
- 1188 Feasibility of Developing Engineered Cementitious Composite with High Volumes of Fly Ash Using Cost-Effective PVA Fiber**—*Jing Ji, Shilong Zhang, Liangqin Jiang, Lijian Zhou, Zhichao Xu, Yingchun Liu, and Dianyou Yu*
- 1206 Fracture and Strain Field Evolution in Faulted Brine-Saturated Sandstone**—*Yan-Hua Huang, Sheng-Qi Yang, and Matthew R. Hall*
- 1226 Fracture Load Predictions in Short Glass Fiber Reinforced Polyamide 6 U-Notched Specimens Combining the Equivalent Material Concept and the Theory of Critical Distances**—*S. Cicero, A. R. Torabi, F. T. Ibáñez-Gutiérrez, and P. Azizi*
- 1252 Gamma Shielding Properties of Erbium Zinc Tellurite Glass System Using Monte Carlo Method**—*Huseyin Ozan Tekin, Vishwanath P. Singh, Elif Ebru Altunsoy, Mesut Karahan, M. I. Sayyed, Turker Tekin Erguzel, Emel Serdaroglu Kasikci, and Muhsin Konuk*
- 1262 Handheld Metal Detector Characterization Using Spherical Test Objects**—*Nicholas G. Paulter Jr., Donald R. Larson, and John A. Ely*
- 1277 High-Temperature Cyclic Oxidation of 800H Superalloy at 750°C–950°C in Air**—*Islam S. Emam, D. Saber, and A. Waheed*



ASTM INTERNATIONAL  
Helping our world work better

ISSN: 0090-3973  
Stock #: JTE2003

[www.astm.org](http://www.astm.org)

(Contents continued on page i)

# Table of Contents (continued)

---

- 1288 Implementation of a PV Module—Integrated Dual-Boost DC-AC Converter—Based Isolated Microinverter for Grid-Connected Application**—*Kamalathiyagarajan Sarasagopalan and Chitra Selvi Shokkalingam*
- 1310 Influence of Surface Finish on Small Punch Testing of 9Cr Eurofer-97 Steel**—*M. D. Richardson, S. Connolly, M. Gorley, B. P. Wynne, and E. Surrey*
- 1319 In-Place Estimation of Concrete Compressive Strength Using Postinstalled Pullout Test – A Case Study**—*Zhengqi Li, Jigar Desai, and Wesley Bullock*
- 1334 Laboratory Characterization of Asphalt Binders Containing a Chemical-Based Warm Mix Asphalt Additive**—*Shivani Rani, Rouzbeh Ghabchi, Syed Ashik Ali, and Musharraf Zaman*
- 1350 Life-Cycle Cost Analysis of Pay Adjustment for Initial Smoothness of Asphalt Pavement Overlay**—*Hao Wang, Zilong Wang, Jingnan Zhao, and Junyu Qian*
- 1365 Measuring Nonequibiaxial Residual Stresses and Mechanical Properties Using Knoop Indentation**—*A. R. Hosseinzadeh and A. H. Mahmoudi*
- 1388 Multi-Well Pumping System Design and Field Application**—*Xiaoli Yin, Yancong Liu, Peng Yi, Zhonghui Zhang, Haixia Chen, and Qiang Zheng*
- 1404 New Insights on the Vane Method to Evaluate Yield Stress of Cementitious Mortars**—*Joseph Jean Assaad*
- 1422 Numerical Study on the Triaxial Stress Condition for Ring-like Fractures around Deep Underground Openings**—*Peng Jia*
- 1439 On the Use of Cox Regression for Statistical Analysis of Fatigue Life Results**—*K. Narynbek Ulu, B. Huneau, E. Verron, A. S. Béranger, and P. Heuillet*
- 1452 Physical Model Test and Evaluation for the Tunnel Stability Influenced by Magnitude and Path of Loading**—*Xian-Jie Hao, Liang Yuan, Jun-Hua Xue, Shao-Hua Wang, Bo Ren, Xiang-Yang Zhang, and Yu-Lin Li*
- 1478 Platoon Control Algorithm Evaluation: Metrics, Configurations, Perturbations, and Scenarios**—*Franck Gechter, Abderrafaa Koukam, Christophe Debain, Baudouin Dafflon, Madeleine El-Zaher, Romuald Aufrère, Roland Chapuis, and Jean-Pierre Derutin*
- 1505 Prediction and Analysis of Abrasive Water Jet Machining Performance on Hybrid Composite**—*S. Vigneshwaran, M. Uthayakumar, and V. Arumugaprabu*
- 1520 Prediction of Crack Depth and Fatigue Life of an Acrylonitrile Butadiene Styrene Cantilever Beam Using Dynamic Response**—*Behzad Ahmed Zai, Muhammad A. Khan, Sohaib Z. Khan, Muhammad Asif, Kamran A. Khan, Ahmad N. Saquib, Asif Mansoor, Majid Shahzad, and Ahmed Mujtaba*
- 1537 Reinforcement Corrosion Research Based on Electrochemical Impedance Spectroscopy for Coral Aggregate Seawater Concrete in a Seawater Immersion Environment**—*Bo Da, Hongfa Yu, Haiyan Ma, and Zhangyu Wu*
- 1554 Run Sum Chart for the Mean with Auxiliary Information**—*Peh Sang Ng, Michael Boon Chong Khoo, Sajal Saha, and Sin Yin Teh*
- 1576 Shifted Exponential Distribution: Bayesian Estimation, Prediction and Expected Test Time under Progressive Censoring**—*Muhammad Aslam, Farzana Noor, and Sajid Ali*
- 1594 Simultaneous Adaptation of AHP and Fuzzy AHP to Evaluate Outsourcing Service in East and Southeast Asia**—*Van Kien Pham, Wing-Keung Wong, Massoud Moslehpour, and Dennis Musyoki*
- 1615 Study of the Strain Response of Asphalt Pavements on Orthotropic Steel Bridge Decks through Field Testing and Numerical Simulation**—*Guodong Zeng, Wei Xu, and Hongming Huang*
- 1634 Superpave Design Aggregate Structure Considering Uncertainty: I. Selection of Trial Blends**—*Said M. Easa*
- 1660 Superpave Design Aggregate Structure Considering Uncertainty: II. Evaluation of Trial Blends**—*Said M. Easa*
- 1683 Temperature Compensation and Correction in Detection of Oxygen Content Found in Glass Medicine Bottles Using Laser Wavelength Modulation Spectroscopy**—*Gaofeng Zhu, Hongqiu Zhu, Chunhua Yang, and Weihua Gui*

# Table of Contents (continued)

---

- 1694 Test Methods to Rigorously, Reproducibly, and Accurately Measure the Detection Performance of Walk-through Metal Detectors—***Nicholas G. Paulter Jr.*
- 1712 The Open-Circuit Voltage Characteristic and State of Charge Estimation for Lithium-Ion Batteries Based on an Improved Estimation Algorithm—***Ling-Ling Li, Zhi-Feng Liu, and Ching-Hsin Wang*
- 1731 Theory and Application of the Internal Leakage Detection of Open-Circuit Hydraulic Systems Based on Active Hydraulic Test Technology—***Yang Chenggang, Zhao Jingyi, Sun Hao, Yang Lixuan, and Zhang Ruixin*
- 1745 T-Source Inverter-Based Sensorless Speed Control for Permanent Magnet Synchronous Motor—***Dineshkumar Selvam, Senthilkumar Subbaian, Bhuvanesh Ananthan, and Thangasankaran Rameshkumar*

**TECHNICAL NOTE**

- 1769 A Multi-Sample and Multi-Channel Technique for Electrochemical Testing and Corrosion Evaluation—***Yugo Ashida and Shinichi Nishizawa*

## EDITOR-IN-CHIEF

### Dr. M. R. Mitchell

Mechanics & Materials, LLC  
4447 Acrete Lane  
Flagstaff, AZ 86004, USA

## EDITORIAL OBJECTIVES

The *Journal of Testing and Evaluation* is published in six issues per year by ASTM International, a nonprofit technical organization that develops and publishes voluntary consensus standards and related information for materials, products, systems, and services. Some issues, in whole or in part, may be Special Issues focused on a topic of interest to our readers. Contributions are peer reviewed prior to publication.

## EDITORIAL SERVICES—SUBMISSIONS

### Sara Welliver

Supervisor, Peer Review Services  
Journal of Testing and Evaluation  
Editorial Offices  
J&J Editorial Services  
201 Shannon Oaks Cir #124  
Cary, NC 27551, USA

tel +1.919.650.1459, ext. 210  
astm@jjeditorial.com

## PURPOSE AND SCOPE

The editorial objectives of the *Journal of Testing and Evaluation* is to serve a broad-based audience by:

- Publishing new technical information derived from the field and laboratory testing, performance, quantitative characterization, and evaluation of these materials, products, systems, and services.
- Presenting new methods and data and critical evaluations of these methods and data.
- Reporting the users' experience with test methods and the results of interlaboratory testing and analysis.
- Providing the scientific basis for both new and improved ASTM International standards.
- Stimulating new ideas in the fields of testing and evaluation.
- Including papers, technical notes, letters to the editor, discussions of previously published papers, and book reviews as contributions.

## POSTMASTER send address change to:

ASTM International—JTE  
100 Barr Harbor Drive  
P.O. Box C700  
West Conshohocken, PA  
19428-2959

www.astm.org

## EDITORIAL BOARD

### Dr. Ali Abolmaali

University of Texas  
at Arlington  
Arlington, TX, USA

### Dr. Aziz Amoozegar

North Carolina  
State University  
Raleigh, NC, USA

### Dr. Farhad Aslani

University of  
Western Australia  
Crawley, WA, Australia

### Dr. Pranesh B. Aswath

University of Texas  
at Arlington  
Arlington, TX, USA

### Dr. Nemkumar Banthia

University of  
British Columbia  
Vancouver, BC, Canada

### Dr. Neal S. Berke

Tourney Consulting  
Group, Ltd.  
Kalamazoo, MI, USA

### Dr. Filippo Berto

University of Padua, Italy,  
and Norwegian University  
of Science and Technology  
Trondheim, Norway

### Dr. Krishna Prapoorna Biligiri

Indian Institute of Technology  
Kharagpur, West Bengal,  
India

### Dr. Laura Bix

Michigan State University  
East Lansing, MI, USA

### Dr. Andrew F. Braham

University of Arkansas  
Fayetteville, AR, USA

### Dr. Andreas Brunner

Empa, Swiss Federal Labs  
Switzerland

### Prof. Andrea Carpinteri

University of Parma  
Parma, Italy

### Dr. Wen-Ruey Chang

Liberty Mutual Research  
Institute for Safety  
Hopkinton, MA, USA

### Dr. Dar Hao Chen

Texas A&M University  
College Station, TX, USA

### Dr. Haiqiang Chen

Xiamen University  
Fujian, China

### Dr. Kuen-Suan Chen

National Chin-Yi University  
of Technology, Taiwan

### Dr. Richard A. Coffman

University of Arkansas  
Fayetteville, AR, USA

### Dr. Tong Cui

Qualcomm Packaging  
San Diego, CA, USA

### John S. Dick

Alpha Technologies  
Akron, OH, USA

### Prof. Ying Fang

Xiamen University  
Xiamen, China

### Dr. Peter E. Fortini

Pfizer/Wyeth  
Andover, MA, USA

### Dr. Alessandro Gardi

RMIT University  
Bundoora, VIC, Australia

### Dr. Piotr Gas

AGH University of Science  
and Technology  
Krakow, Poland

### Dr. Yu-Ning Louis Ge

National Taiwan University  
Taipei, Taiwan

### Dr. T. Russell Gentry

Georgia Institute  
of Technology  
Atlanta, GA, USA

### Dr. Jianfeng Gu

Jiao Tong University  
Shanghai, China

### Dr. Meng Guo

Beijing University of  
Technology  
Beijing, China

### Dr. Rajeev Kumar Gupta

University of Akron  
Akron, OH, USA

### Dr. Rakesh Gupta

Oregon State University  
Corvallis, OR, USA

### Prof. Jim Hartman

AZGaitero Engineering  
Tempe, AZ, USA

### Dr. Marcelo Hirschler

Mill Valley, CA, USA

### Mr. Hui-Min Huang

NIST  
Gaithersburg, MD, USA

### Dr. Xiaoming Huang

Southeast University  
Nanjing, China

### Dr. Jiancheng Jiang

University of North  
Carolina, Charlotte  
Charlotte, NC, USA

### Dr. Tao Jiang

University of Connecticut  
Health Center  
Farmington, CT, USA

### Dr. Thomas Jones

Alcoa Howmet Corp.  
Whitehall, MI, USA

### Dr. Sreeramesh Kalluri

Ohio Aerospace Institute  
Brook Park, OH, USA

### Dr. Sivakumar Kandasami

Larsen & Toubro  
Construction  
Chennai, India

### Dr. Xin Kang

TerraSense  
Geotechnical Lab  
Totowa, NJ, USA

### Dr. Vistasp M. Karbhari

University of Texas  
at Arlington  
Arlington, TX, USA

### Dr. Behnoud Kermani

The Transtec Group, Inc.  
Enola, PA, USA

### Dr. Yong-Rak Kim

University of  
Nebraska-Lincoln  
Lincoln, NE, USA

### Dr. Young Hoon Kim

University of Louisville  
Louisville, KY, USA

### Dr. Govindaraju

Kondaswamy  
Massey University  
Palmerston,  
North New Zealand

### Dr. Brandon Krick

Lehigh University  
Bethlehem, PA, USA

### Dr. Chaker Larabi

University of Poitiers  
Poitiers, France

### Dr. Gang Li

Xi'an Jiaotong University  
Shaanxi Province, China

### Dr. William Luecke

NIST  
Gaithersburg, MD, USA

### Douglas C. Meier

NIST  
Gaithersburg, MD, USA

### Mr. Thomas F. O'Connor

Milan, MI, USA

### Dr. Božidar V. Popović

University of Montenegro  
Podgorica, Montenegro

### Dr. William T. Riddell

Rowan University  
Haddonfield, NJ, USA

### Mr. John Riegel, III

R3 Technology, Inc.  
Springfield, VA, USA

### Dr. Elena Romeo

University of Parma  
Parma, Italy

### Dr. Rajarshi Saha

Bridgelux, Inc.  
Livermore, CA, USA

### Dr. Christopher G. Scott

Lubrizol Corporation  
Wickliffe, OH, USA

### Dr. Steven J. Shaffer

Bruker Nano  
Surfaces Division  
San Jose, CA, USA

### Dr. Suraj Sharma

University of Georgia  
Athens, GA, USA

### Dr. Ranganath K. Shastri

Plastics Solutions  
Midland, MI, USA

### Dr. Punith Veeralinga

Shivaprasad  
Clemson University  
Clemson, SC, USA

### Dr. Cy (Chor-yiu) Sin

National Tsing Hua  
University  
Hsinchu, Taiwan, R.O.C.

### Dr. Stein Sture

University of Colorado  
Boulder, CO, USA

### Dr. Julian Tao

University of Akron  
Akron, OH, USA

### Dr. Ingrid Tomac

University of California,  
San Diego  
San Diego, CA, USA

## EDITORIAL BOARD – CONTINUED

### Dr. Sabrina Vantadori

University of Parma  
Parma, Italy

### Dr. Matthieu Vignes

Massey University Manawatu  
Palmerston North,  
New Zealand

### Dr. Hao Wang

Rutgers University  
Piscataway, NJ, USA

### Dr. Jinfeng Wang

Zhejiang University  
Hangzhou, China

### Dr. Shuying Wang

Central South University  
Hunan, China

### Dr. Xuexin Wang

Xiamen University  
Xiamen, China

### Dr. Shaopeng Wu

Wuhan University  
of Technology  
Wuhan, China

### Dr. Shenghua Wu

University of South Alabama  
Mobile, AL, USA

### Dr. Feipeng Xiao

Clemson University  
Clemson, SC, USA

### Dr. Yang Xiao

Chongqing University  
Chongqing, China

### Dr. Xiong (Bill) Yu

Case Western  
Reserve University  
Cleveland, OH, USA

### Prof. Menglan Zeng

Hunan University  
Changsha, Hunan, China

### Dr. Henglong Zhang

Hunan University  
Changsha, China

### Dr. Xibin (Bill) Zhang

Monash University  
Caulfield East, Victoria,  
Australia

## EXECUTIVE COMMITTEE

Andrew G. Kireta, Jr., **Chair**

John R. Logar, **Vice Chair**

Cesar A. Constantino, **Vice Chair**

Oliver S. Delery, Jr., **Finance and**

**Audit Committee Chair**

Dale F. Bohn, **Past Chair**

Taco van der Maten, **Past Chair**

Katharine E. Morgan, **President**

## DIRECTORS

Amer Bin Ahmed

Klas M. Boivie

Francine S. Bovard

Gregory J. Bowles

Michael J. Brisson

William Ellis

John T. Germaine

William C. Griesse

Alan Kaufman

R. Christopher Mathis

Rebecca S. Mc Daniel

Bonnie McWade-Furtado

David W. Parsonage

Carol Pollack-Nelson

Cassandra Robinson

Rina Singh

Terri O. Woods

Dalia Yarom

## COMMITTEE ON PUBLICATIONS

William J. Likos, **Chair**

K. Russell DePriest, **Vice Chair**

Andrew G. Kireta, Jr., **ex officio**

Jay Bhatt

Donya Germain

John E. Haddock

Jason H. Ideker

Michael R. Mitchell

Richard W. Neu

Majdi A. Othman

Sudarsan Rachuri

George E. Totten

Theresa A. Weston

## INFORMATION FOR AUTHORS

For details regarding paper submission go to <http://mc04.manuscriptcentral.com/astm-jote>.

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 and the inclusion of complete references and high-quality figures. 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.

## IN APPRECIATION OF THE REVIEWERS

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 International and the authors as well, we acknowledge with appreciation.

**Journal of Testing and Evaluation** (Print ISSN 0090-3973; E-ISSN 1945-7553) is published in six issues per year by ASTM International. Some issues, in whole or in part, may be Special Issues focused on a topic of interest to our readers. The views expressed in this journal are not those of ASTM International. The data and opinions appearing in the published material were prepared by and are the responsibility of the contributors, not of ASTM International.

**Copyright** © 2020 ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959. 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.

**Subscriptions** are in an online-only format:

**Individual subscriptions**  
1 year online access \$273.00.

**Institutional subscriptions (one geographic site via IP access)**  
1 year online access \$422.00.  
Single copies \$55.00.

**For multi-site subscription and pricing**  
[sales@astm.org](mailto:sales@astm.org)  
tel +1.877.909.ASTM

**To subscribe**  
Please send prepaid order to ASTM International, Customer Service, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959 or visit [www.astm.org](http://www.astm.org).

## Photocopy Rights

Authorization to photocopy items for internal, personal, or educational classroom use, or the internal, personal, or educational classroom use of specific clients, is granted by ASTM International provided that the appropriate fee is paid to:

Copyright Clearance Center  
222 Rosewood Drive  
Danvers, MA 01923

tel +1.978.646.2600  
<http://www.copyright.com/>