

# Journal of Testing and Evaluation

## Contents:

- 3035 A Modified Approach for Six Sigma Quality Assessment of Product with Multiple Characteristics in Intelligent Manufacturing Environments—**  
*Kuen-Suan Chen and Tsang-Chuan Chang*
- 3054 A New Method to Measure Bermudagrass (*Cynodon spp.*) Golf Course Putting Green Ball Roll Uniformity—**  
*Eric H. Reasor, James T. Brosnan, and Micah S. Woods*
- 3063 A Novel 3-D-CAD for Breast and Lesion Segmentation of Axial Breast DCE-MRI—**  
*Feten Besbes, Norhène Gargouri, Alima Damak, Wiem Feki, Dorra Sellami, Hela Fourati, Zineb Mnif, and Hatem Besbes*
- 3081 Acceptance Sampling Scheme with Warranty for Life Testing Using Bayesian Inference Methods—**  
*Jianping Zhu, Junge Sun, Hua Xin, Chenlu Zheng, and Tzong-Ru Tsai*
- 3097 An Efficient Method for Macrophage Cells Detection in Atherosclerotic Plaques—**  
*Sana Lafi, Ali Khalfallah, and Med Salim Bouhlel*
- 3112 Analytical and Experimental Investigation of Elastic–Plastic Strain Distributions at 2-D Notches—**  
*D. L. Ball, M. Martinez, A. Baldassarre, D. M. Dubowski, and S. S. Carlson*
- 3132 Assessing the Use of Blending Charts to Estimate the Allowable Reclaimed Asphalt Pavement (RAP) Binder Content for Mixes Containing RAP from Different Sources—**  
*Mohamed Elkashef, Shawn S. Hung, John T. Harvey, and David Jones*
- 3148 Automatically Assessing Low-Temperature Low-Shear Viscometric Response of Engine Lubricants with Decreasing Temperature—**  
*Kenneth O. Henderson and Joseph T. Mastropierro*
- 3164 Behavior of Fiber and Nonfiber Reactive Powder Concrete in an Aggressive Environment—**  
*Luke Menefy, Maurice Guerrieri, and Sam Fragomeni*
- 3183 Biomimetic Metamaterial Design Simulation and Evaluation for Building Acoustics by Impedance Measurements—**  
*Beyza Yazıcı and Zühre Sü Gül*
- 3204 Characterizing Compatibility of Crumb Rubber Modified Asphalt by Customized Drainage Method—**  
*Jin Li, Jiayu Wang, Feipeng Xiao, and Serji N. Amirkhanian*
- 3221 Cryogenic and Aging Treatment Effects on the Mechanical Properties of Ti-15V-3Al-3Cr-3Sn Titanium Alloy—**  
*Nihal Yumak, Kubilay Aslantaş, and Ahmet Çetkin*
- 3234 Decomposition Moisture—The Hidden Reactive Constituent in Coal—**  
*John T. Riley, Mason Marsh, and Adam Darling*
- 3247 Degradation State Identification Method for Piezoelectric Ceramic of Ultrasonic Motor Based on Segmented Fractal Dimension and Sparse Representation—**  
*Guoqing An, Rui Li, Kaiyao Song, Huiqin Sun, Zhihong Xue, and Zheng Li*
- 3266 Determination of Mechanical Properties of FRP Materials Using the DIC Method—**  
*Amirreza Bastani, Soham Mitra, Karla Gorospe, and Sreekanta Das*
- 3282 Effect of Defect Size and Load on the Performance of Thermoplastic Bearings—**  
*Nesrine Gaaliche, Subramanian Chithambaram, and Raouf Fathallah*

- 3305 Effect of Moisture on the Resistance of Sansevieria Cylindrica—Reinforced Vinyl Ester Composites**—*R. Deepak Joel Johnson, V. Arumugaprabu, and V. Manikandan*
- 3319 Effect of Plural Spray Coating Process Parameters on Bonding Strength of Polyurea with Steel and Aluminum for Liquid Storage Applications**—*T. Arunkumar, G. Anand, P. Venkatachalam, M. Anish, J. Jayaprabakar, and J. B. Sajin*
- 3333 Evaluation of Low-Cost Moisture Meters for Wood**—*Paul Frederik Laleicke, David C. Tilotta, Phil H. Mitchell, and Matthew Byington*
- 3344 Experimental Evaluation of Ball Bearing Performance Using Nanoflake-Blended Greases**—*V. Bhardwaj, R. K. Pandey, and V. K. Agarwal*
- 3366 Experimental Study of Sealing Performance Test Methods and Sealing Mechanism of Shield Tail Sealing Grease**—*Xiangqian Li and Yuyou Yang*
- 3378 Experimental Study of the Acoustoelastic Effect on Woven Carbon/Epoxy Composites**—*Paulo Pereira, Dario Almeida Jané, and Antônio Carlos Ancelotti*
- 3389 Experimental Study on the Effect of Hardness on the Erosion Resistance of Coatings and Rubber for Hydropower Applications**—*Xin Wang*
- 3401 Fabrication and Mechanical Properties of Aluminum/Zinc Lamellar Composite Reinforced with Alumina Nanoparticles**—*Ehsan Etemadi, Mostafa Alishahi, and Seyed Mehdi Hosseini*
- 3412 Fatigue Fracture Investigation of Engineered Cementitious Composites**—*Shuling Gao, Lin Qi, Wenchang Wang, Guanhua Hu, Hongfei Shi, and Abdullah Alhaj*
- 3431 Foam Concrete Pore Structure Effect on Drying Shrinkage and Frost Resistance**—*Jianqing Gong, Wenjie Zhang, and Zihao Zhou*
- 3444 Improvement of Shielding Properties of Cement Paste by Slag Addition from Local Steel Industry**—*A. M. El-Khayatt, M. A. Al-Rajhi, A. T. Hassan, and Hajo Idriss*
- 3460 Influence of Loading Direction on Impact Strength and Small Span Length Variation on Flexural Strength in GFRP Laminate**—*Golakoti Pavan, K. K. Singh, and Mahesh*
- 3482 Influence of Loading Pressure and Sample Preparation on Ionic Concentration and Resistivity of Pore Solution Expressed from Concrete Samples**—*Luca Montanari, Jussara Tanesi, Haejin Kim, and Ahmad Ardani*
- 3506 Investigation of Mechanical Properties of Mg5Sn-xZn Alloys Produced through New Method in Powder Metallurgy**—*Ali Ercetin, Özgür Özgün, and Kubilay Aslantas*
- 3519 Multi-scale In Situ Investigation of Infiltration Parameter in Pervious Concrete Pavements**—*Poornachandra Vaddy, Avishreshth Singh, Prasanna Venkatesh Sampath, and Krishna Prapoorna Billigiri*
- 3528 Odd Burr III G-Negative Binomial Family with Application**—*Farrukh Jamal, Hassan S. Bakouch, and M. Arslan Nasir*
- 3549 Optimization of Pig Positioning Method Based on Uniaxial Magnetoresistive Sensor**—*Wei Xu, Minghui Wei, Dandan Zhao, Peng Zhang, and Zhongxiang Liu*
- 3565 Performance Evaluation of Modified Solar Still Using Aluminum Foil Sheet as Absorber Cover – A Comparative Study**—*Mohammed El Hadi Attia, Zied Driss, Abd Elnaby Kabeel, Mohamed Abdelgaied, A. Muthu Manokar, Ravishankar Sathyamurthy, and Ahmed Kadhim Hussein*
- 3577 Performance Evaluation of SMA Mixtures Modified by Nanoclay**—*Alireza Ameli, Navid Norouzi, Farhang Jalali, Mohammad Khabooshani, Rezvan Babagoli, and Farzin Poorheydari Mamaghani*
- 3602 Performance Validation of PV System Incorporated ZSI-Dynamic Voltage Restorer for Long-Lasting Power Quality Improvement**—*P. Jamuna, G. Ramani, and K. P. Suresh*
- 3620 Permeability Characteristics of Poorly Graded Sand Conditioned with Foam in Different Conditioning States**—*Shuying Wang, Qinxin Hu, Haibo Wang, Markus Thewes, Louis Ge, Junsheng Yang, and Pengfei Liu*



ASTM INTERNATIONAL  
Helping our world work better

ISSN: 0090-3973  
Stock #: JTE2109

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

(Contents continued on page i)

# Table of Contents (continued)

---

- 3637 Process Optimization of Antimicrobial Treatment on Tencel Knit Fabrics Using Chitosan Biopolymer—**  
*B. Senthil Kumar, K. M. Patchiyappan, and C. B. Senthil Kumar*
- 3646 Properties and Characterization of Temperature-Responsive Asphalt by Using Thermochromic Powder—**  
*Wu Bo, Jinzhou Liu, Weizhi Peng, Wenchuan Peng, and Bin Yu*
- 3665 PV Module Integrated Dual Boost Three-Port dc-dc Converter—Fed T-Type Multilevel Inverter for Shunt Active Power Filters—***K. Vinoth and M. Ramesh Babu*
- 3685 Ratcheting Examination of 1045 Notched Steel Plates under Low-High and High-Low Sequences—***K. Kolasangiani, M. Shariati, and A. Varvani-Farahani*
- 3701 Regional Characteristics of Deformation and Failure of Coal and Rock under Local Loading—***Hongbao Zhao, Tao Wang, Jinyu Li, Yihong Liu, and Boyi Su*
- 3716 Reliability Evaluation of Piston Pump Based on Comprehensive Evaluation Index—***Guo Rui, Zhao Zhiqian, Zhou Jinsheng, Zhao Jingyi, Yang Zhe, and Gao Dianrong*
- 3734 SAE 4340 Fracture Toughness Evaluation Following Wang's Formulation for Spiral Notch Torsion Test Specimens—**  
*Guilherme Bernardes Rodrigues, Marcelo Torres Piza Paes, Francisco Francelino Ramos Neto, Sinésio Domingues Franco, Rosenda Valdés Arencibia, and Waldek Wladimir Bose Filho*
- 3756 Study on Anisotropic Mechanical Properties and Failure Modes of Layered Rock Using Uniaxial Compression Test—**  
*Shuangying Zuo, Donglei Zhao, Jing Zhang, and Shiwan Chen*
- 3776 Study on the Influence of Different Aqueous Solutions on the Mechanical Properties and Microstructure of Limestone—***Huayan Yao, Denghui Ma, and Jun Xiong*
- 3795 Test Objects for the Accurate and Reproducible Evaluation of the Threat Detection Performance of Walk-Through Metal Detectors—***Nicholas G. Paulter Jr., John A. Ely, and Dwight Barry*
- 3811 Tool-Work Contact Ratio and Parametric Influence in Ultrasonic Vibration-Assisted Turning of Ti6Al4V Alloy—**  
*D. Venkata Sivareddy, P. Vamsi Krishna, and A. Venu Gopal*
- 3828 Variability of Friction Measurements Using Three Common Walkway Tribometers—***Dennis D. Chimich, Benjamin S. Elkin, and Gunter P. Siegmund*

## REVIEW PAPER

- 3838 A Proposed Evaluation Method for Three-Point Beam Tests of Fiber-Reinforced Concrete—***Károly Péter Juhász*

## TECHNICAL NOTES

- 3859 A Field Study of Dynamic Compaction in the Construction of a Stone-Filled Embankment—***Shifan Qiao, Ping Xu, Tong Qiu, and Xiao Sun*
- 3869 Discrete Element Modeling of Vibration Compaction Effect of the Vibratory Roller in Roundtrips on Gravels—**  
*Kai Wu, Weichen Sun, Songyu Liu, and Haibo Huang*
- 3885 Effect of Polypropylene Short Fibers on Energy Absorption Capacity and Durability of Concrete—**  
*Javad Eidan, Iraj Rasoolan, Davood Poorveis, and Abbas Rezaeian*

## 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. 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. Tâmara França**

Mississippi State  
University  
Starkville, MS, 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

**Prof. Jim Hartman**

AZGaitero Engineering  
Tempe, AZ, USA

**Dr. Leila Hashemian**

University of Alberta  
Edmonton, Alberta  
Canada

**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

**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. C. Elizabeth Stokes**

Mississippi State University  
Starkville, MS, USA

**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

(CONTINUED ON NEXT PAGE)

## EDITORIAL BOARD – CONTINUED

### Dr. Blanka Tomkova

Technical University of Liberec  
Liberec, Czech Republic

### 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

John R. Logar, **Chair**

Cesar A. Constantino, **Vice Chair**

William A. Ells, **Vice Chair**

Bill Griesse, **Finance and Audit**

**Committee Chair**

Taco van der Maten, **Past Chair**

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

Katharine E. Morgan, **President**

## DIRECTORS

Amer Bin Ahmed

Klas M. Boivie

Francine Bovard

Gregory J. Bowles

Michael J. Brisson

Scott Fenwick

Linda Freeman

Bonnie McWade-Furtado

Timothy J. Morris

Elise Owen

David W. Parsonage

Carol Pollack-Nelson

Christopher R. Reid

Cassandra W. Robinson

Julia C. Schimmelpenninck

Rina Singh

Brian P. Shiels

Dalia Yarom

## COMMITTEE ON PUBLICATIONS

William J. Likos, **Chair**

K. Russell DePriest, **Vice Chair**

John R. Logar, **ex officio**

Jay Bhatt

John E. Haddock

Yinlun Huang

Jason H. Ideker

Ibironke Lawal

M. R. Mitchell

Richard W. Neu

Majdi A. Othman

Sudarsan Rachuri

Donya Stubbs

Theresa A. Weston

Nazli Yesiller

## 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** © 2021 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 \$281.00.

**Institutional subscriptions**  
(one geographic site via IP access)  
1 year online access \$434.00.

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/>