CODEN: JTEVAB

Journal of Testing and Evaluation

Contents:

Special Section on Advancements in the Performance Assessment of Transportation Infrastructure and Materials

Guest Editors: Xiong (Bill) Yu, Chanjuan Han, and Jianying Hu

iv Overview

1 **An Experimental Investigation on the Mechanism of Contact Erosion in Levee Foundations Considering the Characteristics of Particle Shape and Flow Field—***Fayun Liang, Li Zhang, and Chen Wang*

15 **Undrained Responses of Partially Saturated Sand Induced by Biogas under Dynamic Cyclic Loading—***Erxing Peng, Yu Sheng, Xiaoying Hu, and Dingwen Zhang*

28 **DEM Simulations of Energy Dissipation in Sand under Static and Cyclic Loading—***Liwei Tong, Yan Gao, and Yu-Hsing Wang*

45 **Experimental Study of the Performance Characteristics of Sandy Soil Debris Flow under the Effect of Artificial Rainfall—***Z. X. Yao*

60 **Field Tests and Three-Dimensional Semi-Analytical Boundary Element Method Analysis of a Row of Holes as Active Barrier in Saturated Soil—***Lianyong Sun, Gang Shi, Mingyu Li, and Junwei Jin*

82 **Approximate Experimental Simulation of Clogging of Pervious Concrete Pile Induced by Soil Liquefaction during Earthquake—***Xin-zhuang Cui, Qing Jin, She-qiang Cui, Jiong Zhang, and Xiao-ning Zhang*

96 **Effects of Bending Radius and Fiber-Crack Angle on Polymer Optical Fiber Loss for Potential Application in Pavement Crack Monitoring—***Xiangyang Xing, Jiupeng Zhang, Ling Wang, Jianzhong Pei, and Xu Chen*

109 **Detection of Concrete Structural Defects Using Impact Echo Based on Deep Networks—***Juncai Xu and Xiong Yu*

121 **Automatic Vehicle Tracking with LiDAR-Enhanced Roadside Infrastructure—***Jianqing Wu, Yongsheng Zhang, Yuan Tian, Rui Yue, and Hongbo Zhang*

134 **Damage Evaluation of Poro-Elastic Road Surface with Low Polyurethane Content—***Gongyun Liao, Laura Soares, Hao Wang, and Kongqing Qi*

147 **Sediment Transport over a Pervious Pavement under Surface Runoff: Mesoscopic Experiment and Modeling—***Jiong Zhang, Pascal Dupont, and Mustapha Hellou*

160 **A Study on Fatigue Behaviors of Concrete under Uniaxial Compression: Testing, Analysis, and Simulation—***Ziyuan Fan and Yongming Sun*

176 **A Study on the One-Dimensional Flood Numerical Analysis Method in Open Channels of Cascade Barrage Network—***Yong-Gun Kim, Pyol Kim, Myong-Bong Jo, Song-Nam Oh, and Chung-Hyok Paek*

201 **An Alternative Method for the Invariant Threshold Force Evaluation in Incremental Step Loading Tests—***Danilo Eduardo Fonseca Souza, José Eduardo Silveira Leal, Waldek Wladimir Bose Filho, Rosenda Valdés Arencibia, and Sinésio Domingues Franco*

ASTM INTERNATIONAL

Published by ASTM International | 100 Barr Harbor Drive | PO Box C700 | W. Conshohocken, PA 19428-2959

214 **Analysis of Phase Transformation and Mechanical Properties of 55CrMo Steel during Induction Hardening**—*Huiping Li, Weilu Zhou, Haijuan Liu, Zhichao Li, and Lianfang He*

229 **Cement-Improved Wetting Resistance of Coarse Saline Soils in Northwest China**—*Jian Xu, Yanfeng Li, Songhe Wang, Jianwei Ren, Jiulong Ding, Qinze Wang, Dongxing Cheng, and Fan Yu*

255 **Characteristics of Forces in Plane Polishing Based on the Magnetorheological Effect with Dynamic Magnetic Fields Formed by Rotating Magnetic Poles**—*Huazhuo Liang, Qiusheng Yan, Jisheng Pan, Bin Luo, Jiabin Lu, and Xiaowei Zhang*

270 **Characterization of Freeze-Thaw Resistance of New-to-Old Concrete Based on the Ultrasonic Pulse Velocity Method**—*Hongguang Zhu, Jingchong Fan, Cheng Yi, Hongqiang Ma, Hongyu Chen, Jing Shi, and Xiaonan Xu*

284 **Characterization of Mechanical Properties of 3-D–Printed Materials Using the Asymmetric Four-Point Bending Test and Virtual Fields Method**—*M. M. Zhou, W. He, H. M. Xie, and S. Liu*

297 **Damage Accumulation in a Novel High-Throughput Technique to Characterize High Cycle Fatigue**—*Ryan B. Berke, Brandon A. Furman, Casey Holycross, and Onome Scott-Emuakpor*

313 **Effect of Different Creep and Recovery Times on the MSCR Test for Highly Modified Asphalt Binder**—*Matheus S. Gaspar, Bianca Nogueira, Kamilla L. Vasconcelos, Leni F. M. Leite, and Liedi L. B. Bernucci*

329 **Effect of Humeral Locking Plate System on Absorbed Energy in Breast Tissue with Different Radiological Energies Using MCNPX Code**—*B. Güçlü, E. E. Altunsoy, T. Manici, and H. O. Tekin*

338 **Effect of Inertia Forces on Contact State of Ball Bearing with Local Defect in Outer Raceway**—*Yimin Zhang, Hongchuan Cheng, Wenjia Lu, and Zhou Yang*

355 **Effect of Soil Moisture and Granulometry on Soil Conditioning for EPB-TBM Tunneling: Case Study**—*Hamed Baghali, Hamid Chakeri, Mohammad Sharghi, and Daniel Dias*

372 **Equivalence of Friction and Viscous Damping in a Spring-Friction System with Concave Friction Distribution**—*Shanshan Li, Biao Wei, Hao Tan, Chaobin Li, and Xiaomiao Zhao*

396 **Evaluation and Optimization of Geometric Deviations in Abrasive Water Jet Profile Cutting of Inconel 617**—*Anish Nair and Somasundaram Kumanan*

417 **Experimental Analysis on Creep Properties of Frozen Silty Mudstone Considering Conservation of Energy**—*Xiaoyan Liu, Lulu Liu, Zhe Li, and Zhaoming Yao*

435 **Firewater Monitor Trajectories Based on Jet Expansion and Dynamic Breakup Model**—*Wenqian Shang, Xintian Liu, Minghui Zhang, Yang Qu, and Yansong Wang*

452 **Grid-Interconnected Solar Photovoltaic System for Power Quality Improvement Using Extended Reference Signal Generation Strategy**—*K. P. Suresh and S. Ramesh*

473 **Indoor Study on Road Crack Monitoring Based on Polymer Optical Fiber Sensing Technology**—*Shengchao Cui, Jiupeng Zhang, Jianzhong Pei, Rui Li, Xu Chen, Dong Guo, and Honglinag Zhang*

493 **Investigation through Artificial Neural Networks on the Influence of Shot Peening on the Hardness of ASTM TX304HB Stainless Steel**—*Diego Ferreño, Ruth González, Isidro A. Carrascal, Miguel Cuartas, Diego García, Rubén Eraña, Federico Gutiérrez-Solana, and Valentín Arroyo*

509 **Liquefaction Resistance of Different Size/Shape Sand-Clay Mixtures Using a Pair of Bender Element–Mounted Molds**—*A. F. Cabalar, S. Demir, and M. M. Khalaf*

525 **Multilevel Hybrid Firefly-Based Bayesian Classifier for Intrusion Detection in Huge Imbalanced Data**—*K. Umamaheswari, Subbiah Janakiraman, and K. Chandraprabha*

ASTM INTERNATIONAL
Helping our world work better

ISSN: 0090-3973
Stock #: JTE2101

www.astm.org

(Contents continued on page i)

Table of Contents (continued)

537 **Numerical Investigation on the Use of Flat-Jack Test for Detecting Masonry Deformability**—*V. Alecci, M. De Stefano, R. Luciano, A. M. Marra, and G. Stipo*

550 **On the Use of Microscale Abrasion Test for Determining the Particle Abrasivity—***Ane C. Rovani, Tiago A. Rosso, and Giuseppe Pintaude*

562 **Prediction of Dynamic Parameters of Variable Diameter Shell Composite Structure via 2-D Subscale Modeling—** *Behzad Ahmed Zai, Saad Sami, M. Amir Khan, Azeem Anwer, and Tanzeel Ur-Rehman*

573 **Preparation and Properties of Microwave-Absorbing Asphalt Mixtures Containing Graphite and Magnetite Powder—***Shuyin Wu, Jun Yang, Ruochong Yang, Jipeng Zhu, and Song Liu*

590 **Short-Term Aging Performance Evaluation of Asphalt Based on Principal Component and Cluster Analysis—** *Pinhui Zhao, Dongxing Gao, Ruibo Ren, Kechao Han, Ziqiao Yang, Weikun Meng, and Wenmiao Fan*

603 **The Deterioration of Cement Mortar under the Coupled Conditions of Stray Current and Sulfate—***Gaonian Li and Baomin Wang*

613 **Vibration Levels of Stacked Automotive Engine Rack in Truck Shipments as a Function of Vehicle Speed and Road Condition—***Péter Böröcz*

629 **What Attributes Determine Overall Satisfaction in Patient Safety Culture? An Empirical Study of the Perceptions of Hospital Staff in Taiwan—***Cheng-Feng Wu, Hsin-Hung Wu, Yii-Ching Lee, and Chih-Hsuan Huang*

REVIEW PAPERS

640 **Enhancement of Defect Detectability in Pneumatic Pressure Equipment Using an Automatic Detection Technique in ECPT—***Bo Zhang, YuHua Cheng, Chun Yin, Xuegang Huang, Sara Dadras, Kai Chen, and Hadi Malek*

661 **Laboratory Investigation of Ultra-High–Performance Fiber-Reinforced Concrete Modified with Nanomaterials—** *Afsaneh Zeinolabedini, Javad Tanzadeh, and Mitra Talebi Mamodan*

TECHNICAL NOTE

675 **Robot-Assisted Track-Scan Imaging Approach with Multiple Incident Angles for Complexly Structured Parts—** *Yujian Mei, Haoran Jin, Bei Yu, Eryong Wu, Liqiang Li, and Keji Yang*

POSTMASTER send address change to:
ASTM International—JTE
100 Barr Harbor Drive
P.O. Box C700
West Conshohocken, PA
19428-2959

www.astm.org

Printed in the USA.

(CONTINUED ON NEXT PAGE)

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 forcused 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.

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
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.

Overview

The special section entitled "Advancements in the Performance Assessment of Transportation Infrastructure and Materials" includes a collection of 11 invited papers from the 3rd International Conference on Transportation Infrastructure and Materials (ICTIM), which was hosted at Jinan, China between July 2–4, 2019. The papers were subjected to the regular review procedures by the *Journal of Testing and Evaluation* (JTE) before their acceptance. The collection of these papers is roughly grouped into four major categories:

1) Characterization of soil behaviors under complex conditions

Three papers are included under this category. The paper "An Experimental Investigation on the Mechanism of Contact Erosion in Levee Foundations Considering the Characteristics of Particle Shape and Flow Field" describes an experimental study that characterized the contact erosion phenomena. The study was implemented with a custom designed testing equipment; it utilized transparent soils and computer vision to track contact erosion processes. The effects of a number of factors contributing to contact erosion were analyzed. The results showed that the flow conditions and particle shape played important roles on the initialization and development of contact erosion. The paper "Undrained Responses of Partially Saturated Sand Induced by Biogas under Dynamic Cyclic Loading" describes an experimental program that characterized the dynamic cyclic responses of de-saturated sand with denitrification bacteria. The microbial denitrification process in saturated sand created unsaturated conditions. The effects of the extent of desaturation on the improvement of soil liquefaction resistance were evaluated experimentally. Factors affecting the extent of improvements were analyzed. The paper "DEM Simulations of Energy Dissipation in Sand under Static and Cyclic Loading" describes a study that employed discrete element method (DEM) to simulate the behaviors of sand subjected to static and dynamic loads, with a focus on the energy dissipation mechanism. The study evaluated the primary modes of energy dissipation and proposed methods to calculate energy dissipation from DEM simulation results. The results showed that energy loss by friction primarily occurs in weak force network, while energy loss by viscous interactions occurred in both weak force network and strong force network.

2) Field and laboratory experiments to characterize and mitigate natural hazards

Three papers are included under this category. The paper "Experimental Study of the Performance Characteristics of Sandy Soil Debris Flow under the Effect of Artificial Rainfall" presents the details of experimental design, data acquisition and analyses to understand the mechanism triggering debris flow. The experimental system was designed to emulate rainfall events. A video based monitoring system captured the process of debris flow development. The status of soil was also monitored with pore pressure monitoring instruments. From the experimental data, major stages of debris flow development were identified. Overall, the paper provided an experimental platform and data analyses protocol that helps to understand the mechanisms for the development of debris flow. The paper "Field Tests and Three-dimensional Semi-analytical BEM Analysis of A Row of Holes as Active Barrier in Saturated Soil" describes a 3D boundary element method (BEM) model that was corroborated with field testing data to evaluate the performance of active seismic barrier via array of holes. The analyses evaluated the influence of the size, depth, and spacing of the whole array for active seismic barrier. From these,

recommendations were made to effectively design and utilize active seismic isolation. The study has practical implications in areas such as seismic isolation of dynamic foundations and protection of infrastructures from seismic events. The paper "Approximate experimental simulation of clogging of pervious concrete pile induced by soil liquefaction during earthquake" describes the experimental study that aims to evaluate the clogging behaviors of pervious concrete pile. Pervious concrete pile accelerates pore water pressure dissipation during seismic events and improves the seismic performance of the foundation. Clogging of pervious concrete pile compromises its performance. This study conducted experiments to investigate factors affecting the clogging behaviors, including the effects of magnitude and frequency of seismic shaking, porosity of the pervious concrete, and spacing between piles. From the experimental results, a clogging model was proposed to assist the design of high performance pervious concrete pile foundation.

3) Technology for Infrastructure Condition Assessment

Three papers are included in this category. The paper "Effects of Bending Radius and Fiber-Crack Angle on Polymer Optical Fiber Loss for Potential Application in Pavement Crack Monitoring" describes the experimental study that ultimately aims to develop fiber optical sensors to monitor cracks in pavement. Experiments were conducted to characterize the behaviors of polymer optical fibers, whose energy loss due to different extent of bending and cracking angles were analyzed. The results of energy loss due to bending matched established models for fiber optical energy loss. The effects of cracking angles on the energy loss in the optical fiber were also evaluated, which potentially serve as the basis for calibration of pavement crack monitoring sensors. The paper "Detection of Concrete Structural Defects Using Impact Echo Based on Deep Networks" describes the development and application of machine learning model to analyze impact echo test signals to determine the existent of damages in concrete structure. The impact echo test signals are converted to images, and subsequently fed into the inputs of a Convolutional Neural Network (CNN). The CNN model was trained with labelled data to classify the impact echo signals according to the existence/nonexistence of structural defects. The results indicated that the analyses of the impact echo signals with the CNN machine learning model achieved high accuracy in determining the existence of structural defects. Overall, this study presented a new approach for impact echo signal analyses leveraging the progress in machine learning model. The paper "Automatic Vehicle Tracking with LiDAR-enhanced Roadside Infrastructure" describes a system to track vehicles using roadside lidar technology. The primary contribution was the development and implementation of computational algorithms that allowed to analyze Lidar data and track vehicles in the real time. The results indicated the developed algorithm achieved high computational efficiency in processing Lidar data.

4) Evaluation of pavement performance

Two papers are included under this category. The paper "Damage Evaluation of Poro-Elastic Road Surface with Low Polyurethane Content" describes an experimental program that characterized the dynamic responses and damage evolution of polyurethane based pavement materials. The specimens were subjected to cyclic loads, from which the dynamic modulus and energy dissipation were obtained. The development of internal damages was also characterized with X-ray computed tomography. Sensitivity analyses were conducted that led to an optimal mixture design recipe that demonstrated high resistance to damages. The paper "Sediment Transport over a Pervious Pavement under Surface Runoff: Mesoscopic Experiment and Modeling" describes a study program that aimed to evaluate factors responsible for clogging of porous pavement. An experimental program was implemented that evaluated clogging process due to factors such as the pavement geometry and slope, flow conditions, sediment conditions, and infiltration rate, etc. From these, major factors influencing pavement clogging were identified. The study also developed a computational fluid dynamics model coupled with discrete element model to simulate the clogging phenomena.

Overall, this collection of papers covers various topics in the development and application of testing methods and data analyses, which aimed to provide better solutions towards the durability and resilience of transportation infrastructure.

Guest Editors:

Xiong (Bill) Yu, Ph.D., P.E., Fellow ASCE
Opal J. and Richard A. Vanderhoof Professor and Interim Chair
Department of Civil and Environmental Engineering
Case Western Reserve University
Cleveland, OH, USA

Jianying Hu, Ph.D.
Associate Professor
Southeast University
Nanjing, China

Chanjuan Han, Ph.D.
Assistant Professor
Shanghai Jiaotong University
Shanghai, China