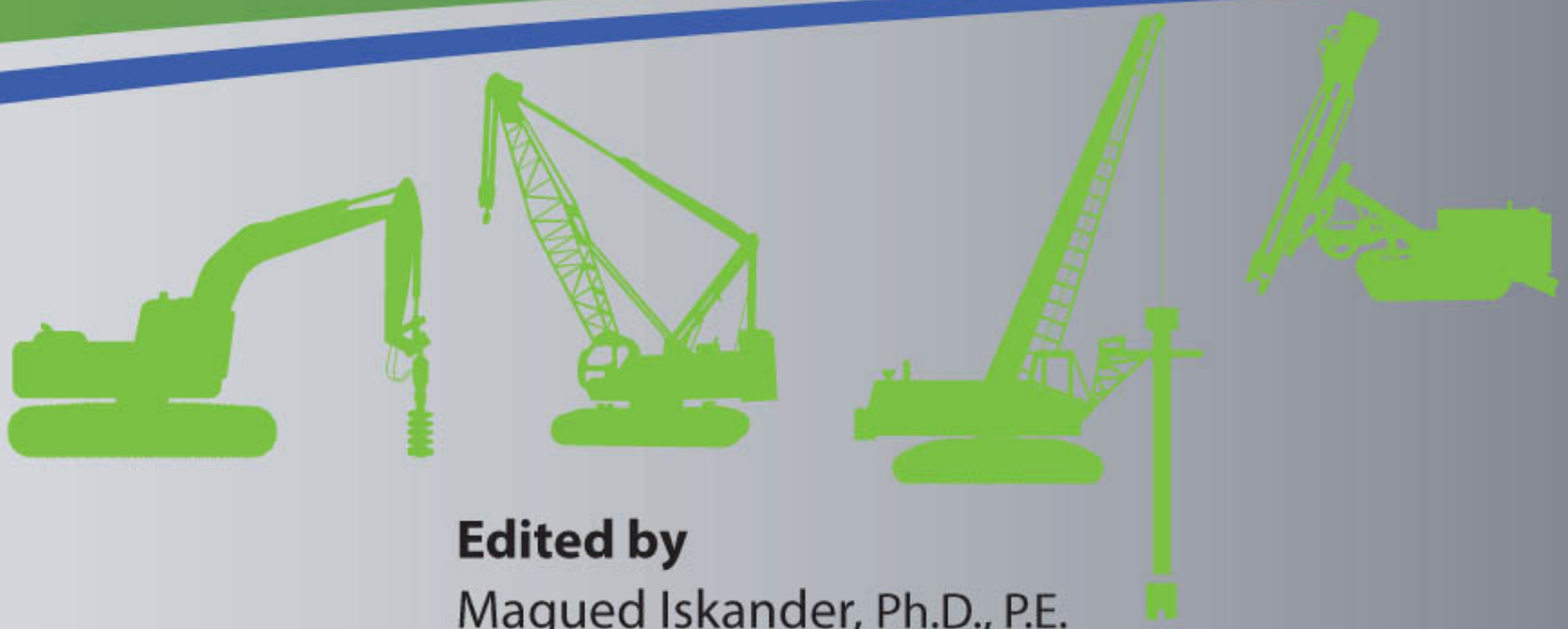
IFCEE 2015

Geotechnical Special Publication No. 256



Edited by
Magued Iskander, Ph.D., P.E.
Muhannad T. Suleiman, Ph.D.
J. Brian Anderson, Ph.D., P.E.
Debra F. Laefer, Ph.D.

ASCE

G-I GEO-INSTITUTE ASCE

GEOTECHNICAL SPECIAL PUBLICATION NO. 256

IFCEE 2015

PROCEEDINGS OF THE INTERNATIONAL FOUNDATIONS CONGRESS AND EQUIPMENT EXPO 2015

March 17-21, 2015
San Antonio, Texas

SPONSORED BY
International Association of Foundation Drilling
Deep Foundations Institute
Pile Driving Contractors Association
The Geo-Institute of the American Society of Civil Engineers

EDITED BY
Magued Iskander, Ph.D., P.E.
Muhannad T. Suleiman, Ph.D.
J. Brian Anderson, Ph.D., P.E.
Debra F. Laefer, Ph.D.

Published by the American Society of Civil Engineers

Published by American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, Virginia, 20191-4382
www.asce.org/bookstore | ascelibrary.org

Any statements expressed in these materials are those of the individual authors and do not necessarily represent the views of ASCE, which takes no responsibility for any statement made herein. No reference made in this publication to any specific method, product, process, or service constitutes or implies an endorsement, recommendation, or warranty thereof by ASCE. The materials are for general information only and do not represent a standard of ASCE, nor are they intended as a reference in purchase specifications, contracts, regulations, statutes, or any other legal document. ASCE makes no representation or warranty of any kind, whether express or implied, concerning the accuracy, completeness, suitability, or utility of any information, apparatus, product, or process discussed in this publication, and assumes no liability therefor. The information contained in these materials should not be used without first securing competent advice with respect to its suitability for any general or specific application. Anyone utilizing such information assumes all liability arising from such use, including but not limited to infringement of any patent or patents.

ASCE and American Society of Civil Engineers—Registered in U.S. Patent and Trademark Office.

Photocopies and permissions. Permission to photocopy or reproduce material from ASCE publications can be requested by sending an e-mail to permissions@asce.org or by locating a title in ASCE's Civil Engineering Database (http://cedb.asce.org) or ASCE Library (http://ascelibrary.org) and using the "Permissions" link.

Errata: Errata, if any, can be found at http://dx.doi.org/10.1061/ 9780784479087

Copyright © 2015 by the American Society of Civil Engineers.
All Rights Reserved.
ISBN 978-0-7844-7908-7 (E-book PDF)
Manufactured in the United States of America.

Preface

This Geotechnical Special Publication (GSP) contains selected papers from the International Foundations Congress and Equipment Expo (IFCEE15) held in San Antonio, Texas on March 17–21, 2015. This Congress combined the 2015 annual meetings of ASCE's Geo-Institute, the International Association of Foundation Drilling (ADSC), the Pile Driving Contractors Association (PDCA) and the Deep Foundations Institute (DFI). This mega event was the first time since 2009 that leading geotechnical organizations joined together to have one annual congress. IFCEE15 provided an international forum to discuss technological advances, case histories, and present challenges related to geotechnical and foundation engineering. The congress was heavily attended by a wide range of geo-professionals including engineers, contractors, academicians, equipment manufacturers, geo-technologists, researches, and suppliers of tools and services.

An international call for papers and a rigorous peer review process yielded 265 accepted technical papers that were presented in 38 sessions, in addition to invited keynote presentations.

The editors would like to express their appreciation for having been provided the opportunity to be a part of this Congress' organization, and hope that these proceedings will be of use to the geotechnical engineering community, for many decades to come.

The Editors,

Magued Iskander, PhD, PE, F.ASCE, New York University
Muhannad T. Suleiman, PhD, Lehigh University
J. Brian Anderson, PhD, PE, Auburn University
Debra F. Laefer, PhD, University College, Dublin

Acknowledgments

The success of this Congress is credited to the authors of the technical papers for their valuable contributions to the geotechnical literature. The commendable quality of the Congress' technical content and these proceedings are also the result of the efforts of the hundreds of reviewers who conducted over 600 reviews. We thank the reviewers for generously contributing their valuable time and expertise, in many cases, under time pressure and demanding deadlines.

Acknowledgment is also due to the many members of the G-I, DFI, ADSC, and PDCA who provided valuable and much needed support to assure the success of this Congress.

The following individuals served as the technical program committee. They deserve special acknowledgment and recognition for their extraordinary efforts in making this Congress a reality and a resounding success: William M. Camp (Co-Chair), J. Brian Anderson (Co-Chair), Peggy Hagerty Duffy, Jesús E. Gómez, Mohamad Hussein, Michael D. Justason, and Mary Ellen (Bruce) Large.

To all of you, and the many others who are too numerous to name, THANK YOU.

Finally, we wish to gratefully acknowledge the support we received from our employers New York University, Lehigh University, Auburn University, and University College Dublin.

The Editors

Organizing Committee

MANAGEMENT ORGANIZING COMMITTEE

Chair
Michael D. Moore, Chief Executive Officer, ADSC: The International Association of Foundation Drilling

Co-Chairs
Theresa (Rappaport) Engler, Executive Director, Deep Foundations Institute
Robert Schweinfurth, Director, Geo-Institute of ASCE
Stevan Hall, Executive Director, PDCA

PROGRAM COMMITTEE

Co-Chairs
J. Brian Anderson, Ph.D., P.E., Auburn University
William M. Camp, III, P.E., D.GE, S&ME, Inc.

Members
Peggy Hagerty Duffy, P.E., ADSC: The International Association of Foundation Drilling
Jesús E. Gomez, Ph.D., P.E., D.GE, Ing., GEI Consultants
Mohamad H. Hussein, P.E., GRL Engineers Inc.
Michael D. Justason, P.E., M.Eng., MBA, Bermingham Foundation Solutions
Mary Ellen (Bruce) Large, P.E., Deep Foundations Institute

Proceedings Co-Editor(s)
Magued G. Iskander, Ph.D., P.E., F.ASCE, Polytechnic Institute of NYU
Muhannad T. Suleiman, Ph.D., Lehigh University
J. Brian Anderson, Ph.D., P.E., Auburn University
Debra F. Laefer, Ph.D., University College of Dublin

Short Courses Chair
Van A. Hogan, Pile Driving Contractors Association

Student Program Chair
Aaron Scott Budge, Ph.D., P.E., Minnesota State University, Mankato

GeoCompetition Chair and GeoWall Chair
William A. Kitch, Ph.D., P.E., M.ASCE, California State Polytechnic University, Pomona

GeoPoster Chair
Scott M. Merry, Ph.D., P.E., M.ASCE, University of the Pacific

GeoPrediction, Chair
Eric J. Steward, Ph.D., A.M.ASCE, University of South Alabama

Review Criteria

Review Criteria for Papers Published in this Geotechnical Special Publication

Following standards of practice of the Geo-Institute of The American Society of Civil Engineers, each paper published in this Geotechnical Special Publication (GSP) was peer reviewed by at least two anonymous, qualified, technical reviewers (and in some cases three or four reviewers) and selected for publication by the proceedings editors. An advanced document management service was utilized in order to assure anonymity and maintain uniformity of standards. As such, the papers contained in these proceedings are eligible for discussion in the ASCE Journal of Geotechnical and Geoenvironmental Engineering and for ASCE awards.

Review Board

The following individuals served as Track and Session Chairs. They coordinated and managed the peer review process of the papers included for publication in this Geotechnical Special Publication. The quality of these world-class proceedings is a testament to their professionalism and dedication. Listed in alphabetical order by last name, they are:

Robert Alperstein
Scott T. Anderson
Adda Athanasopoulos-Zekkos
Ömer Bilgin
Dennis W. Boehm
Mary Ellen Bruce
Mark E. Bryant
L. Sebastian Bryson
Raymond J. Castelli
Bhaskar C. S. Chittoori
Jose Luiz Machado Clemente
Brady R. Cox
Peggy Hagerty Duffy
Elizabeth M. Dwyre
Usama Samir El Shamy
Roderic A. Ellman, Jr.
George M. Filz
Quan Gao
Malay Ghose Hajra
Jesús E. Gomez
Jan Jay Hartman
Laureano R. Hoyos
Jianying Hu
John Jenkins
Michael D. Justason
Jeffrey R. Keaton
Larry L. (Lance) Kitchens
Dimitrios C. Konstantakos
Anne Lemnitzer
Roberto A. Lopez
Augusto Lucarelli
Ali Maher
Sanjeev Malhotra
Paul W. Mayne
John S. McCartney
Ramin Motamed

Morgan NeSmith
Won Taek Oh
Anand Puppala
Daniel J. Rich
Helen D. Robinson
Kyle M. Rollins
Charles W. Schwartz
Timothy C. Siegel
Eric J. Steward
Muhannad T. Suleiman
Armin W. Stuedlein
Greg Sullivan
Sai K. Vanapalli
Gerald Verbeek
Andrew C. Verity
Kord J. Wissmann
Nazli Yesiller
Xiong (Bill) Yu
Mourad Zeghal

Reviewers

The editors are grateful to the following 301 individuals for working tirelessly under a tight schedule in order to peer review the papers included for publication in this Geotechnical Special Publication. As a group the following individuals performed over 600 peer reviews, and their service to the geotechnical community is gratefully appreciated.

Yasser Abdelhamid
Hossam Abuel-Naga
Kofi Acheampong
Hana Adem
Waddah Akili
Robert Alperstein
Glen Andersen
Scott Anderson
Ron Andrus
Eng Chew Ang
George Aristorenas
Tom Armour
Jeramy Ashlock
Paul Axtell
Alireza Ayoubian
Juan Baez
Paola Bandini
Curt Basnett
Prasenjit Basu
Andrew Baxter
Ira Beer
Anya Benda
Jomaa Ben-Hassine
Shobha Bhatia
Dale Biggers
Ömer Bilgin
James Blackburn
Derrick Blanksma
Dennis Boehm
Tom Bonnie
Ralph Borjeson
Peter Bourne-Webb
Azadeh Bozorgzadeh
Scott Brandenberg
Sam Brown
Mark Bryant
Lindsey Bryson
Paul Bullock
Marty Burford
Jon Bussiere
Allen Cadden
David Campo
Riccardo Cappa
Terrence Carroll
Raymond Castelli
Francesco Cecinato
Bora Cetin
Ian Chaney
Shunyi Chen
Les Chernauskas
Tatiana Chernova
Bhaskar Chittoori
Andrew Cho
Deepankar Choudhury
Mala Ciancia
Sam Clemence
Jose Clemente
Joseph Coe
Blake Cotton
Brady Cox
Rossana D'Antonio
Shideh Dashti
John Davie
Paul Davies
Hubert Deaton
John Deeken
Peter Deming
Mandar Dewoolkar
Chris Diaz
Stephen Dickenson
Brian Diefenderfer
Vishnu Diyaljee
Paul Doherty
Eric Drumm
Mangtao Du
Margaret Duffy
Peggy Duffy
Elizabeth Dwyre
Usama El Shamy
Roderic (Rick) Ellman, Jr.
Carlos Englert
Melvin Esrig
Matthew Evans
David Fadling
Peter Faust
Bengt Fellenius
George Filz
Brendan FitzPatrick
Mitchell Fong
Kevin Franke
Raymond Franz
Brian Freilich
Patricia Gallagher
Quan Gao
Luis Garcia
Chris Garris
Sarah Gassman
Ehsan Ghazanfari
Dan Gillins
Roger Gobin
Aaron Goldberg

Jesus Gomez
Russell Green
Yuan Guo
Joe Hagerty
Paul Hamilton
Chanjuan Han
Jie Han
Zhong Han
Rick Hanke
Adel Hanna
Sherif Hanna
Kenneth Hanson
Fransiscus Hardianto
Dean Harris
Jan Hartman
Terry Harvey
Youssef Hashash
Chunmei He
Bernard Hertlein
Wing Heung
Terence Holman
John Horne
Sandra Houston
Isaac Howard
Jonathan Howson
Laureano Hoyos
Jianying Hu
Qiangbing Huang
Yuewen Huang
Jeremy Hung
Magued Iskander
Hudson Jackson
Robert Jameson
John Jenkins
Ken Johnson
Allen Jones
TJ Ju
Michael Justason
Ismail Karatas
Wayne Karem
Jeffrey Keaton
Sara Khoshnevisan
Sadaf Khosravifar
Golam Kibria
Phil King
Lance Kitchens
Brandon Kluzniak
Josh Kolz
Van Komurka
Dimitrios Konstantakos
Tanya Kunberger
Lyesse Laloui
Carlos Lazarte
Minh Le
Thomas Lee
Anne Lemnitzer
Bo Li
Yuru Li
Bon Lien
Garland Likins
Guoming Lin
Xiaobin Lin
Roberto Lopez
Barbara Luke
Ronaldo Luna
Alan Lutenegger
Scott Mackiewicz
Ali Maher
Andy Majewski
Sanjeev Malhotra
Kalehiwot Manahiloh
Derek Manheim
Antonio Marinucci
H. Benjamin Mason
James Mason
Frederic Masse
Nasser Massoudi
Paul Mayne
John McCartney
Alexander McGillivray
Andrew Merritt
Dwight Metcalf
Barry Meyer
Ramin Motamed
Michael Mudalel
Kyle Murphy
Mo Nasim
Morgan NeSmith
Kam Ng
Khoi Nguyen
Fawad Niazi
Steven Nicoson
James Niehoff
Robert OConnor
Guney Olgun
Ed O'Malley
Angelica Palomino
Walter Papp, Jr.
James Parkes
Ujwalkumar Patil
Meghdad Payan
Jonathan Pease
Aravind Pedarla
Thomas Pennington
Dayakar Penumadu
Frank Pepe
Lee Petersen
Gregg Piazza
John Pizzi
Eric Pond
Edward Prost
Hefu Pu
Anand Puppala
Sastry Putcha
Shunchao Qi
Jane Raba
Walt Rabe
Al Rasband
Frank Rausche
Ravee Raveendra
Krishna Reddy
John Rice
Daniel Rich
Thomas Richards
Brent Robinson
Helen Robinson
Adrian Rodriguez-Marek
John Rogers
Nidal Abi Saab
Amr Sallam

Samantha Schardein
Charles Schwartz
Kevin Scott
Allen Sehn
E. Anna Sellountou
Hoyoung Seo
Lisheng Shao
Lijun Shi
Timothy Siegel
Lyle Simonton
Nicholas Sitar
Kurt Sjoblom
C.J. Smith
Elizabeth Smith
Jerry Smith
Trevor Smith
Khaled Sobhan
Ali Soleimanbeigi
Moncef Souissi
Sasanka Sravanam
Lisa Star
John Starcevich
Mark Stephani
Eric Steward
Armin Stuedlein
Beena Sukumaran
Muhannad Suleiman
Sonia Swift
William Swigart
Won Taek Oh
Takefumi Takuma
Burak Tanyu
Martin Taube
Aaron Taylor
Firat Testik
Dan Thome
W. Robert Thompson III
Binod Tiwari
Thomas Tuozzolo
Benjamin Turner
Luis Vallejo
Sai Vanapalli
Daniel VandenBerge
Jerry Vandevelde
Rob van Dorp
Soto Vardakos
Mike Vaught
Ravi Vedantham
Gerald Verbeek
Andrew Verity
Lubinda Walubita
Joe Wang
Xueming Wang
Zhijie Wang
Joseph Wartman
Darrell Wilder
Ragui Wilson-Fahmy
Kord Wissmann
Christian Woods
Hong Yang
Xiaoming Yang
Kazuya Yasuhara
Nazli Yesiller
Hao Yu
Xinbao Yu
Xiong Yu
Natasha Zamani
Mourad Zeghal
Dimitrios Zekkos
Bin Zhang

Table of Contents

Analysis and Design

Allowable Bearing Capacity of Strip Footings on Jointed Rock Masses: A Reliability Based Approach 1

B. Munwar Basha, K. Chandrakanth, and Arif Ali Baig Moghal

Numerical Simulation of Earthquake Induced Soil Liquefaction: Validation against Centrifuge Experimental Results 11

Zana Karimi and Shideh Dashti

On Foundations over Salt Encrusted Desert Flats (Sabkha): Properties, Challenges, and Guidelines 21

Waddah Akili

Settlement of a Shallow Foundation Resting on Piedmont Residual Soils of Northern Virginia 32

Behzad Amir-Faryar and Richard E. Finnen Jr.

Soil, Foundation, and Superstructure Interaction (I): Advanced Analyses of Shallow Foundations 42

Hany Farouk and Mohamed Farouk

Soil, Foundation, and Superstructure Interaction (II): Superstructure and Foundations' Tie Beams Analyses 52

Hany Farouk and Mohamed Farouk

Soil-Structure Interaction Effects on Seismically Isolated Nuclear Power Plants 63

Vasileios A. Drosos and Nicholas Sitar

Tactile Pressure Sensors in Centrifuge Modeling of Rocking Foundations 74

Panagiota Kokkali, Tarek Abdoun, and Ioannis Anastasopoulos

A Novel Method to Estimate the Compression Index for Gulf Coast Clayey Soil 84

Minh Le, Shailendra N. Endley, Anand J. Puppala, and Chris Mings

Aging in Sand: Fatigue at Grain Contacts and Modeling Using Discrete Element Method **95**

Zhijie Wang and Radoslaw L. Michalowski

Large Scale Simulation of Granular Materials via Impulse-Based Discrete Element Method **105**

Seung Jae Lee, Youssef M. A. Hashash, and Eun Hyun Park

Model for Consolidation Analysis of Layered Soils under Depth-Dependent Loading **115**

Hefu Pu and Patrick J. Fox

Modelling Ettringite Induced Heaving in Cement Stabilized Soils within a Chemo-Mechanical Constitutive Framework **125**

Pawan Sigdel and Liang Bo Hu

Preliminary Study of Pore Water Chemistry Effect on the Physical and Mechanical Behaviour of Artificial Mixed Soil **133**

T. W. Zhang, Y. F. Deng, S. Y. Liu, and D. W. Zhang

Response of Soil-Foundation-Structure Systems to Multidirectional Seismic Motion: A Micromechanical Approach **142**

Usama El Shamy and Natasha Zamani

Settlement Estimations of Peat during Centrifuge Experiments **152**

Riccardo Cappa, Samuel Yniesta, Anne Lemnitzer, Scott J. Brandenberg, and Ali Shafiee

Settlement of Embankment Constructed with Geofoam **161**

B. Umashankar, S. Sasanka Mouli, and Chennarapu Hariprasad

Strain Rate Dependency of Sand Response under Uniaxial Monotonic Loading **171**

Mohammed Baamer, Eduardo Suescun-Florez, Nikolaos Machairas, and Magued Iskander

Undrained Behavior of Sand by DEM Study **182**

H. B. K. Nguyen, M. M. Rahman, and D. A. Cameron

Validation of a Numerical Model to Analyze Pile-Supported T-Walls **192**

Alex Reeb, George Filz, Jehu Johnson, Richard Varuso, Panagiota Kokkali, Anthony Tessari, and Tarek Abdoun

Enhanced UniCone Expressions for Axial Pile Capacity Evaluation from Piezocone Tests **202**

Fawad S. Niazi and Paul W. Mayne

Probabilistic Seismic Design of Soil-Pile Raft-Superstructure System **217**

Biplab Das, Rajib Saha, and Sumanta Haldar

Service Limit State Design for Individual Drilled Shafts in Shale Using *t-z Method* **227**

Thuy Vu and J. Erik Loehr

State of Practices in Databases for Deep Foundation Load Tests **237**

Naser Abu-Hejleh, Murad Abu-Farsakh, Muhnnad T. Suleiman, and Ching Tsai

The ICP Design Method and Application to a North Sea Offshore Wind Farm **247**

Richard J. Jardine, Andrew S. Merritt, and Felix. C. Schroeder

Using Cone Penetration Testing to Predict the Capacity and Drivability of Tapered Piles in Sands **257**

Terrence Carroll and Shuang Hu

Finite Element Analysis for Spatially Stochastic Soil—Anisotropic Studies **271**

H. B. K. Nguyen and M. M. Rahman

Numerical Investigation of Group Anchors **279**

Buse Emirler, Selçuk Bildik, and Mustafa Laman

Response of Beams on Nonlinear Foundation **289**

S. Haldar and D. Basu

R-LRFD: Robust Load and Resistance Factor Design **299**

Wenping Gong, Sara Khoshnevisan, Hongwei Huang, C. Hsein Juang, and Jie Zhang

Soil-Structure Interactions in a Skewed Integral Abutment Bridge **309**

Karrthik Kirupakaran, Kanthasamy K. Muraleetharan, and Gerald A. Miller

Streamlining of Bridge Pier as a Scour Countermeasure: A Feasibility Study **319**

Junhong Li, Junliang Tao, and Xiong (Bill) Yu

Visualizing the Shallow Failure Mechanism of the T-Bar Penetrometer **330**

Jeff F. Wallace, Christopher M. Chini, Cassandra J. Rutherford, and Joshua M. Peschel

Evaluation of Moisture Susceptibility and Healing Properties of Nanoclay-Modified Asphalt Binders **339**

Zahid Hossain, Musharraf Zaman, Mrinal C. Saha, and Takumi Hawa

In-Place Recycling Moisture-Density Relationships for High-Traffic Applications **349**

Ben C. Cox, Isaac L. Howard, and Randy Battey

Investigation of Rheological Properties of Asphalt Rubber toward Sustainable Use of Scrap Tires **359**

Biswajit Bairgi, Zahid Hossain, and Robert D. Hendrix

Merits of Asphalt Concrete Durability and Performance Tests When Applied to Cold In-Place Recycling **369**

Ben C. Cox and Isaac L. Howard

Pavement Repairs' Long-Term Performance over Expansive Soil **380**

Samer H. Dessouky

Recent Discussions of *p-y* Formulations for Lateral Load Transfer of Deep Foundations Based on Experimental Studies **388**

Camilla Favaretti, Anne Lemnitzer, Armin W. Stuedlein, and John Turner

Response of Resilient Modulus to Moisture Variation in Unsaturated Subgrade Soils **400**

Ayan Mehrotra, Murad Abu-Farsakh, and Kevin Gaspard

Sustainable Alternatives in Low Volume Road Base Course Applications Evaluated through Accelerated Pavement Testing **409**

Hasan Kazmee, Debakanta Mishra, and Erol Tutumluer

Use of Fluidized Bed Combustion Ash in Full Depth Reclamation **419**

Shervin Jahangirnejad, Dennis Morian, Barry Scheetz, and Mansour Solaimanian

Vertical Pressures Produced by Controlled Low Strength Material (CLSM) Poured into Pipe Trenches **429**

Medji Sama, David W. Sykora, and Antonios Vytiniotis

Case Histories and Lessons Learned

A Case Study and Lessons Learned: Retaining Wall Design and Construction of the Maid of the Mist Winter Storage Facility **442**

Hosam Salman, Thomas S. Lee, Joseph J. Fonzi, and Mark L. Bajorek

A Synthesis of Pile Performance Monitoring Projects in Downdrag Environments in Minnesota 457

A. S. Budge, D. D. Dasenbrock, and D. J. Mattison

Assessment of Old Stone Walls 472

Issa S. Oweis, Abraham Gutman, and Luma Oweis

Case Histories of Full-Scale Comparative Load Testing of Base Grouted and Ungrouted Test Shaft Pairs 486

Jon Sinnreich and Robert C. Simpson

Current Limitations and Challenges of Driven Piles in Rock as Demonstrated Using Three Case Studies in Wyoming 500

Kam W. Ng, Seyed Yashar Yasrobi, and Todd A. Sullivan

Reconstruction of Route 33 Bridges at West Point, Virginia 518

Jan J. Hartman, Frank Pepe Jr., and Ragui W. Fahmy

Statnamic Load Test for 30-Inch Precast Prestressed Square Concrete Pile: A Case History 533

Raymond R. Mabnkbadi and Aravinda M. Ramakrishna

Dry Soil Mix Column Shear Panels Constructed beneath Lost Lake Dredge Disposal Island Levee 546

Tyson Deklavs

First Known Application of Cutter Soil Mixing for Support of a Heritage Building 554

Chris Leach and Franz-Werner Gerressen

Lessons Learned from Ground Improvement on BART Fremont Central Park Subway Project in Fremont, California 569

Ravi K. Vedantham, Kit Tung, Thomas S. Lee, and Mitchell L. Fong

Moisture Content and Relative Compaction Influences on Swell Potential and Strength of a Compacted Residual Soil 583

Michael Boone and Donald Gerken

Performance of Tanks Supported on DMM Columns in the Gulf Coast: Hydrotest Monitoring and Settlement Analysis 598

Mahi Galagoda, Keun Rhee, and Carlos Fuentes

Stone Columns: Lessons Learned, Settlements, and Future Project Considerations 612

S. Caleb Douglas and Vernon R. Schaefer

Design and Monitoring of a Sheet Pile Wall Installed in Soft Industrial Waste 627

Ming Zhu, Ali Ebrahimi, Meena Viswanath, Laura K. Brussel, and John F. Beech

Electronic Thickness Gauge Measurements on a 36-Year-Old Steel Bar Mat Reinforced MSE Wall 636

Jennifer E. Nicks, Michael T. Adams, and Matt Runion

Geo-Characterization of Brownfield Site for Modernization of a Large Industrial Facility 648

José L. M. Clemente, Dena G. Morgan, and Michael R. Lewis

Old Technology Enhanced by Dynamic Replacement 662

Issa S. Oweis, James T. Malak, and Tom Martin

The Great Salt Lake Causeway—A Calculated Risk 50 Years Later 680

Lynn A. Salvati, Stephen J. Guarente, and S. Caleb Douglas

Deep Foundations

Load Displacement Behavior of ACIP Piles in Mixed Soil Profile 695

Kalaiarasi Vembu and C. Vipulanandan

Overburden Effect on the Axial Resistance of Instrumented CFA Piles 703

Timothy C. Siegel and Peter Faust

Region-Specific Load Transfer Model for Augered Cast-in-Place Piles in Granular Soils 712

Nasim Adami and Armin W. Stuedlein

Thermal Integrity Profiling of ACIP Piles 723

Matthew L. Becker, Travis L. Coleman, and Daniel S. Belardo

A Study of Plane Strain Pile Jacking and Driving in Granular Media 738

Filippo Boccalini, Zhibo Chen, Mehdi Omidvar, and Magued Iskander

Development of Removable Load Distributive Compressive Anchor Technology 748

Carlos M. Englert, Jesús E. Gómez, Chris Wilkinson, and Vaughn Godet

Development of Very Low Head Room Press-In Sheet Pile Driver 763

Takefumi Takuma, Hiroyuki Nishimura, and Shigeru Kambe

Enhancement of Pervious Concrete Pile Subjected to Uplift Load Using Microbial Induced Carbonate Precipitation **775**

Hai Lin, Muhannad T. Suleiman, Hanna M. Jabbour, and Derick G. Brown

Experimental Study of Installation of Concrete Suction Caisson in Clay **784**

W. Guo and J. Chu

Installation and Load Capacity of Torpedo Anchors in Offshore Applications **792**

Anirban De, David Pecorini, and Alberto Morgante

Model Tests of Laterally Loaded Piles under a Horizontally Scoured Condition **802**

Omar K. Ismael and Jie Han

The Effects of Pile Installation on Vertical and Lateral Response **809**

Lusu Ni, Muhannad T. Suleiman, and Anne Raich

The Importance of Interfaces in Geotechnical Foundation Systems **817**

Alejandro Martinez, J. David Frost, and Jiaxing Su

Uplift Tests on Shallow Cast-in-Place Enlarged Base Pedestal Foundations in Clay **827**

Alan J. Lutenegger

Axial Tension and Lateral Capacity of Step-Tapered Helical Piles for Transmission Pole Structures **839**

Mark H. Fairbairn, Lee Goen, Jason Herron, and Gary L. Seider

Bearing and Friction Design Capacity Software for Helical Anchors and Piles **851**

Gary L. Seider

Lateral Performance of Large-Capacity Helical Piles **868**

Mohamed A. Elkasabgy and M. Hesham El Naggar

Monitoring Micropile Foundations of Bridge during Construction **878**

Ronaldo Luna, Devin T. Dixon, Kyle A. Kershaw, and Timothy C. Siegel

Numerical Modeling in Micropile Design for a Pusher Furnace **890**

Timothy C. Siegel and R. Michael Bivens

Axial Load Tests on Drilled Shafts Socketed in Hard Clays and Shales **899**

Terry B. Burkett, Robert B. Gilbert, Robert C. Simpson, John A. Wooley, Antonio Marinucci, and Jose A. Arrellaga

Case History: Margaret McDermott Bridge over I-30 **908**

Bo Walker and Andrew Smith

Elastic Analysis of Drilled Shaft Foundations in Soil Profiles with Intermediate Caliche Layers **922**

Moses Karakouzian, Rouzbeh Afsharhasani, and Brandon Kluzniak

Numerical Simulation of a Drilled Shaft in an MSE Wall under Cyclic Loading **929**

Md. Saidur Rahman, Jie Huang, and Sazzad Bin-Shafique

Seismic Site Characterization in Support of Drilled Shaft Design **939**

Rinu Samuel, Yasaman Badrzadeh, Barbara Luke, Andrew J. Lawrence, Raj Siddharthan, and Abbas Bafghi

Separating Contributions from Pre-Mobilization and Ground Improvement for Post-Grouted Drilled Shafts **951**

Tayler J. Day, Andrew Z. Boeckmann, and J. Erik Loehr

Corrosion Study of Existing Steel H-Pile Installed through Cinder-Ash Fill **961**

Lei Gu, Sarah E. McInnes, Jean Hervey Fenton, Stephen J. Welsh, and Ara G. Mouradian

Elastic Analysis of Rock-Socketed Piles **973**

Hoyoung Seo, Monica Prezzi, and Rodrigo Salgado

Evaluation of Pile Set-Up Using iCAP Dynamic Restrike Software Analysis in the State of Alabama **980**

Ronald Jones and Eric J. Steward

Foundation Support Cost—Applications to Driven-Pile Design **990**

Van E. Komurka

High-Strain Dynamic Pile Testing for the I-40/I-240 Interchange in Memphis, Tennessee **1006**

Ashraf Elsayed, Craig Kaibel, Ian Engstrom, and David Arellano

Kentucky Lake Pipe Pile Load Test Program **1021**

Ronald J. Ebelhar, Jeffrey D. Du, Darrin P. Beckett, and Jerry A. DiMaggio

On Design and Installation of Driven Piles in Coral Deposits: A Case Study from the Red Sea Coast of Saudi Arabia **1036**

Waddah Akili

Pile Driving Formulas Revisited **1052**

Ryan Allin, Garland Likins, and Jon Honeycutt

Pile Setup and Axial Capacity Gain for Driven Piles Installed Using Impact Hammer versus Vibratory System 1064

Malay Ghose-Hajra, Rebecca Jensen, and Laura Hulliger

Soil Plugging Mechanism on Large Diameter Pipe Piles: Insight from Discrete Element Simulations 1075

Yuan Guo and Xiong (Bill) Yu

Tension Tests on Driven H-Piles in Sand and Clay 1087

Alan J. Lutenegger, Jahan Khalili, and Thomas Orszulak

Uplift Resistance of Coated Driven Steel Piles 1097

Alan J. Lutenegger and Jahan Khalili

Effects of Demolishing the Deep Excavation Support System Used for Tall Building Construction on Adjacent Metro Line: Modeling and Field Comparison 1107

Bo Liu, Wei Xu, and Krishna R. Reddy

Experimental p-y Curves for a Laterally Loaded Single Pile in Cement-Improved Soft Clay 1122

Hoda Soltani and Kanthasamy K. Muraleetharan

Full Scale Crash Test on a Group of Piles in Clay 1132

Mojdeh Asadollahi Pajouh, Jean-Louis Briaud, Dean Alberson, Dusty Arrington, and Alireza Mirdamadi

Group Effects on Piles Behavior under Lateral Loading 1142

Pooya Allahverdizadeh

Numerical Simulation of Pile Installation and Setup for Bayou Lacassine Site 1152

Firouz Rosti and Murad Abu-Farsakh

Design for Extreme Events

A New Approach to Measure Water Film Due to Void Redistribution in Layered Soil 1162

Quan Gao, Yang Yang, and Xiong (Bill) Yu

Analysis of Drilled Shaft Settlement Caused by Liquefaction 1176

Benjamin Turner, Scott J. Brandenberg, and Jonathan P. Stewart

Assessing Liquefaction-Induced Lateral Spreads Using CPT Cases from the Christchurch, New Zealand, Earthquakes **1189**

Sara Khoshnevisan, Hsein Juang, Yan-Guo Zhou, Chih-Sheng Ku, Lei Wang, and Hai-Jun Ding

Centrifuge Testing of Levees: Saturation Techniques during Model Construction **1197**

Samuel Yniesta, Riccardo Cappa, Anne Lemnitzer, and Scott J. Brandenberg

Comparison of Soil Response during Earthquake Excitation and Uniform Cyclic Loading **1207**

Soheil Kamalzare, and C. Guney Olgun

Experimental Modeling of Rainfall Induced Slope Failures in Compacted Clays **1217**

Binod Tiwari and Santiago Caballero

Liquefaction and Residential Foundations: Lessons Learned from Past Earthquakes **1227**

Levi T. Ekstrom, Kevin W. Franke, T. Leslie Youd, Fernando Fonseca, and Mathew Francis

Liquefaction of Granular Soils at the Microscale **1237**

Usama El Shamy and Yasser Abdelhamid

Magnitudes of Prehistoric Earthquakes at the Hollywood, South Carolina, Site **1246**

Emad Gheibi and Sarah L. Gassman

Multiscale Modeling of Fine Particles Migration in Granular Filters **1257**

Yasser Abdelhamid and Usama El Shamy

Performance of Skewed Abutments from Large-Scale Testing **1267**

K. M. Rollins, K. Palmer, and A. Fredrickson

Regional Geology and Seismic Site Amplification in the Washington, DC, Metropolitan Area **1278**

Mark Tilashalski, C. Guney Olgun, Adrian Rodriguez-Marek, Elizabeth A. Godfrey, Martin C. Chapman, Sharmin Shamsalsadati, and Morgan A. Eddy

Response of a Silty Sand Centrifuge Deposit to Repeated Earthquakes **1288**

Waleed El-Sekelly, Tarek Abdoun, and Ricardo Dobry

Scour Characteristics of Saturated Levees Due to Floodwall Overtopping 1298

Mazdak Karimpour, Kyle Heinzl, Emaline Stendback, Kevin Galle, Siavash Zamiran, and Abdolreza Osouli

Seismic Hazard Curves for the Probability of Liquefaction 1308

Kristin J. Ulmer, Kevin W. Franke, and Brian D. Peterson

Soil Compressibility in Transient Unsaturated Seepage Analyses 1318

Timothy D. Stark, Navid H. Jafari, Aaron L. Leopold, and Thomas L. Brandon

Earth Retention and Stabilization

Design and Construction of a Permanent Earth Retention System in Stiff Fissured Clay and Landslide Rubble 1333

R. J. Valentine and Thomas Brandon

Monitoring a Drilled Shaft Retaining Wall in Expansive Clay: Long-Term Performance in Response to Moisture Fluctuations 1348

Andrew C. Brown, Gregory Dellinger, Ali Helwa, Chadi El-Mohtar, Jorge Zornberg, and Robert B. Gilbert

North American Trends and Developments of Complex Support of Excavation Systems 1358

Robert Jameson, John Starcevich, Rick Hanke, and Nick Turus

Numerical Investigation of Gravity Wall-Granular Soil Interaction 1370

Dimitrios Loukidis and Rodrigo Salgado

Robust Design Optimization Applied to Braced Excavations 1380

Sara Khoshnevisan, Lei Wang, Wenping Gong, and C. Hsein Juang

Apparent Lateral Earth Pressures below the Lowest Support Level 1389

Dimitrios C. Konstantakos

Compressive Strength Variations of Lime-Treated Expansive Soils 1402

Muawia Dafalla, E. Mutaz, and Mosleh Al-Shamrani

Durability of Lightly Stabilised Granular Material Subjected to Freeze-Thaw and Wet-Dry Cycles 1410

Mathanraj Theivakularatnam and Carthigesu T. Gnanendran

Experimental Investigation of Applicability of Sand Tire Chip Mixtures as Retaining Wall Backfill **1420**

Pradeep K. Dammala, Bali R. Sodom, and Murali K. Adapa

Interface Properties of Metal-Grid and Geogrid Reinforcements with Sand **1430**

B. Umashankar, Chennarapu Hariprasad, and S. Sasanka Mouli

Seismic Performance of Cantilever Retaining Walls with Clayey Backfills **1439**

Siavash Zamiran and Abdolreza Osouli

Three Dimensional Effects of Vertical Stiffeners on Infinitely-Long Sheet-Piles in Cohesionless Soil **1449**

Khaled Lotfy, Rami El-Sherbiny, and Abdelsalam Salem

Analysis of Reinforced Soil Wall Considering Oblique Pullout of Reinforcement Resting on Two-Parameter Pasternak Subgrade **1464**

Shantanu Patra and J. T. Shahu

Effect of Single and Double Anchored Systems on the Behaviour of Cellular Reinforced Fly Ash Walls **1473**

B. Ram Rathan Lal, A. H. Padade, and J. N. Mandal

Impact of Compaction Level and Depth of Fill on the Pullout Resistance of Ribbed Strip MSE Reinforcement **1483**

Priyantha W. Jayawickrama, William D. Lawson, Timothy A. Wood, and James G. Surles

Numerical Simulation of a Geosynthetic Reinforced Soil Integrated Bridge System during Construction and Operation Using Parametric Studies **1493**

Majid Talebi and Christopher L. Meehan

Numerical Study of Deformation Behavior for a Geosynthetic-Reinforced Soil Bridge Abutment under Static Loading **1503**

Yewei Zheng, Patrick J. Fox, and P. Benson Shing

Seismic Thrust vs. Wall Inertia in Non-Yielding Retaining Walls under Earthquake Loading: Synchronous or Asynchronous Action? **1513**

V. G. Kitsis, V. S. Vlachakis, G. A. Athanasopoulos, and A. Athanasopoulos-Zekkos

Case Studies of New York City Projects with Varying Site Constraints **1522**

Arthur J. Alzamora Jr., Laurence E. Ford, and Andrew J. Ciancia

Design and Construction of a Sheet Pile Earth Retention System in Soft Clays **1536**

Justin R. Lewis and Shane J. Farr

Foundation Design and Construction in Urban Environments **1550**

Alfred H. Brand and Ketan H. Trivedi

Foundation Features: Tall Buildings and Braced Excavations in Houston **1560**

Edward J. Ulrich Jr.

Performance of Deep Excavations in Clay in the Boston Urban Environment **1575**

Bryan P. Sweeney and Damian R. Siebert

Reconstruction of Tsunami-Ravaged Levees by the Press-In Piling Method in Japan's Northeast **1585**

Takefumi Takuma, Hiroyuki Nishimura, and Shigeru Kambe

Removable Compressive Load Distributive Strand Anchors: Case History and Lessons Learned **1597**

Jason S. Hertz, Greg Moormann, Michael Paquette, Saul S. Shapiro, and Marc J. Gallagher

Energy Foundations—Wind, Transmission, and Geothermal

Development of a Full-Scale Soil-Borehole Thermal Energy Storage System **1608**

Tugce Baser and John S. McCartney

Effect of the Unsaturated Soil Condition on the Thermal Efficiency of Energy Piles **1618**

Ghassan Anis Akrouch, Marcelo Sánchez, and Jean-Louis Briaud

Experimental Investigation of Bridge Deck Deicing Using Energy Piles **1628**

G. Allen Bowers Jr. and C. Guney Olgun

Full-Scale Field Testing of Energy Piles **1638**

Melis Sutman, C. Guney Olgun, and Tracy Brettmann

Investigation of Construction Specification Effects on Energy Pile Efficiency **1648**

Robert A. Caulk and Ehsan Ghazanfari

Investigation of Thermo-Mechanical Load Transfer (t-z Curves) Behavior of Soil-Energy Pile Interface Using Modified Borehole Shear Tests **1658**

Suguang Xiao and Muhannad T. Suleiman

Numerical Modeling of Thermally Induced Pore Water Flow in Saturated Soil Surrounding Geothermal Piles 1668

Omid Ghasemi-Fare and Prasenjit Basu

Preliminary Studies of the Use of Abandoned Mine Water for Geothermal Applications 1678

Zhen Liu, Jay Meldrum, Pengfei Xue, and Christopher Green

Response of an Energy Foundation to Temperature Fluctuations 1691

John S. McCartney, Kyle D. Murphy, and Karen S. Henry

Sensitivity Study on Factors Affecting the Heat Exchange in Geothermal Heat Pump System 1701

Chanjuan Han and Xiong (Bill) Yu

Temperature Effects on Sand-Steel Interface Shear and Quantification of Post-Shear Surface Texture Characteristics of Steel 1711

James L. Hanson, Andrew Flores, Derek Manheim, and Nazli Yesiller

Thermal Operation of Geothermal Piles Installed in Sand—A Comparative Assessment Using Numerical and Physical Models 1721

Omid Ghasemi-Fare and Prasenjit Basu

Thermal Stress and Displacement Response of Geothermal Energy Piles in Sand 1731

Rajni Saggu and Tanusree Chakraborty

Centrifuge Modeling of Offshore Wind Turbine with Bucket Foundation under Earthquake Loading 1741

Xuefei Wang, Xiangwu Zeng, Hao Yu, and Haijun Wang

Cyclic Performance of Single and Group Micropiles on Loose Sand 1751

Rui P. Matos, Paulo L. Pinto, Carlos S. Rebelo, Luis S. da Silva, and Milan Veljkovic

Mass Soil Mixing for Wind Tower Turbine Foundations 1764

Brett Zitny and Tyson Deklavs

Preliminary Design of Suction Pile for Mooring of Concrete Floating Structures 1773

Juhyung Lee, Duhyun Baek, and Chul Soo Park

Simulation of Dynamic Response of Offshore Wind Turbine with Group-Pile Foundation Using Centrifuge Tests 1781

Xuefei Wang, Xiangwu Zeng, Hao Yu, and Jijian Lian

Geo-Characterization, Risk, and Reliability

A Methodology for Axially Loaded Drilled Shaft Performance Predictions Using DFSAP 1791

Ramin Motamed, Kevin Stanton, Mahdi Nasimifar, Nelson Pearson, and Brandon Kluzniak

Allowable Design Strength of Geosynthetic Reinforcement for Veneer Stability of MSW Landfills: A Reliability Based Approach 1806

B. Munwar Basha, Shilpi Mahapatra, and Bappaditya Manna

Alternative Method of Flow-Back Water Treatment in Shale Gas Development for Environmental Protection 1816

Maria Peraki and Ehsan Ghazanfari

Assessment of Shear Failure Parameters for Sand-Clay Liners 1826

Muawia Dafalla and Mosleh Al-Shamrani

Characterization of Collapsible Soils 1834

John C. Lommler and Paola Bandini

Effect of Parameter Uncertainty on Factor of Safety Calculations in a Slope Stability Problem 1842

Noha Ahmad Rabie, Sherif Adel Akl, and Ashraf Kamal Hussien

Impact of Proof Load Test Programs on the Reliability of Foundations 1850

Youmna Abdallah, Shadi Najjar, and George Saad

Laboratory Determination of the Time-Dependent Interface Frictional Behavior between Cohesive Soil and Construction Materials 1861

Eric J. Steward and Marcus Shekouh

Large Diameter Triaxial Testing of AASHTO Open Graded Aggregates and the Effect of Relative Density on Strength 1870

Thomas Gebrenegus, Jennifer Nicks, and Mike Adams

Predicting Immediate Settlement on Spread Footings for Highway Bridges 1880

Aseel Y. Ahmed, Maria M. Szerszen, and Andrzej S. Nowak

Probabilistic Methodology for Developing Regional and Site-Class Dependent Seismic Site Amplification Factors 1895

Elizabeth A. Godfrey, Adrian Rodriguez-Marek, and C. Guney Olgun

Probabilistic Settlement Analysis of Shallow Foundations on Heterogeneous Soil Stratum with Anisotropic Correlation Structure 1905

Amaneh E. Kenarsari and Reza Jamshidi Chenari

Quantitative Comparison of Direct Monte Carlo Simulation to Simplified Reliability Approaches for Evaluating the Stability of Unreinforced Slopes 1915

Matthew D. Sleep and Michael P. McGuire

Reliability-Based Robust Geotechnical Design of Rock Bolts for Slope Stabilization 1926

Lei Wang, Wenping Gong, Zhe Luo, Sara Khoshnevisan, and C. Hsein Juang

Risk Analysis on Bridge Scour Failure 1936

Congpu Yao, Jean-Louis Briaud, and Paolo Gardoni

The Random Finite Element Method (RFEM) in Probabilistic Slope Stability Analysis with Consideration of Spatial Variability of Soil Properties 1946

Pooya Allahverdizadeh, D. V. Griffiths, and G. A. Fenton

Unconfined Compressive Strength and Deformation Modulus Relationship for Two Carbonate Rock Formations 1956

Hazem Sarhan and Mohamed Askar

Updating Single Pile Capacity by Load Tests 1964

Jinsong Huang and Richard Kelly

A New Borehole Tool for Subsurface Seismic Imaging—A Full Waveform Inversion Approach 1971

Pengxiang Jiang and Dennis R. Hiltunen

An Appraisal of a New Generation of Surface Wave Techniques at a Test Site in Florida 1981

Pengxiang Jiang, Khiem T. Tran, Dennis R. Hiltunen, and Nick Hudyma

Bender Element Testing and Discrete Element Modeling of Shear Wave in Granular Media 1993

Asheesh Pradhan and Xinbao Yu

Centrifuge Modeling the Influence of Soil Anisotropy on Seismic Response of Foundations 2003

Jin Qin, Xiangwu Zeng, and Haiyan Ming

Comparison of Image Analyses Algorithms for Video-Based Remote Structure Vibration Monitoring System **2013**

Yang Yang, Nathan Zimmer, and Xiong (Bill) Yu

Creep Behavior of Shale Formations in Shale Gas Development **2024**

Rafael Villamor Lora and Ehsan Ghazanfari

Effect of Different Parameters on Steady State and Monotonic Liquefaction of Gravelly Soils **2034**

M. Payan, P. Ayoubi, and S. M. Mirmo'azen

Geomechanical Properties of Coal Mine Roof Rocks in Illinois **2049**

Abdolreza Osouli and Behrooz Moradi

Reliability of Coal Mine Roof Rating in Mining Applications **2058**

Iman Shafii and Abdolreza Osouli

Settling Characteristics of Fine-Grained Dredged Sediments Used in Louisiana Coastal Restoration and Land Building Projects **2068**

Malay Ghose-Hajra, Christine Mebust, and Gregory Mattson II

Constitutive Modeling of Unsaturated Soils Using Results from Suction Controlled Odometer Tests **2075**

Xiong Zhang

Deformation Non-Uniformity of an Unsaturated Soil during Triaxial Testing **2084**

Lin Li and Xiong Zhang

Evolution of Interphase Contact Angle in Partially Saturated Granular Soils Using Digital Analysis of X-Ray Computed Tomography Images **2092**

Kalehiwot Nega Manahiloh and Christopher L. Meehan

Numerical Analysis of Vertical Moisture Barriers in Controlling Expansive Soils in Presence of Soil Cracks **2102**

Lizhou Chen and Rifat Bulut

Prediction of the Resilient Modulus of Unsaturated Base-Course Materials **2112**

Zhong Han and Sai K. Vanapalli

Shrinkage Induced Pressure Measurement to Address Desiccation Cracking in Expansive Soils **2122**

Raju Acharya, Aravind Pedarla, Tejo Vikash Bheemasetti, Anand J. Puppala, and Nan Zhang

Simplified Equivalent Linear and Nonlinear Site Response Analysis of Partially Saturated Soil Layers 2131

M. Mirshekari and M. Ghayoomi

Suitable Shearing Rate for Triaxial Testing of Intermediate Soils under Vapor Controlled Medium to High Suction Range 2141

Ujwalkumar D. Patil, Laureano R. Hoyos, and Anand J. Puppala

Geotechnical Education

Are There Gender Differences in the Value That Civil and Environmental Engineering Students Place on Service Provided through Service-Learning Projects? 2151

John E. Lens and Mandar M. Dewoolkar

Disciplinary Diversity in the Development of Geotechnical Engineering Undergraduate Education Materials 2161

Arthur Ornelas Jr., Sandra Houston, Wilhelmina Savenye, Claudia E. Zapata, Eddy F. Ramirez, and Allen Corral

Enhancing Students' Problem-Solving Skills through Progressive Integration of Project-Based Learning 2169

Hudson Jackson and Kassim Tarhini

Inclusionary Instructional Methods Addressing a Diversity of Learners in Geotechnical Engineering Education 2179

T. Kunberger

Support of Women Geotechnical Engineering Faculty: History and Initiatives 2189

Sharon W. Alestalo, Shobha K. Bhatia, and Beena Sukumaran

Views and Concerns with Regard to Teaching Geotechnical Engineering: Viable Strategies for the Classroom Environment 2203

Waddah Akili

Ground Improvement and Grouting

A Numerical Study of the Installation-Induced Stresses and Excess Pore-Water Pressures around Rigid Inclusions Using a Linear-Elastic Perfectly-Plastic Soil 2214

Alfonso J. Rivera, C. Guney Olgun, Thomas L. Brandon, and Frederic Masse

Characterization of Smear Zone Caused by Mandrel Action 2225

Buddhima Indraratna, Cholachat Rujikiatkmajorn, and Made Ardana

Contact Fatigue: A Key Mechanism in Time-Dependent Behavior of Sand after Dynamic Compaction 2233

Radoslaw L. Michalowski and Srinivasa S. Nadukuru

Drained Shear Strength of MICP Sand at Varying Cementation Levels 2242

K. Feng and B. M. Montoya

Enzyme Induced Carbonate Precipitation (EICP) Columns for Ground Improvement 2252

Edward Kavazanjian and Nasser Hamdan

Ground Improvement of Marine Clay for Highway Construction in Mumbai, India 2262

Sarika S. Desai, Deepankar Choudhury, and J. S. Salunkhe

Ground Improvement: Difficulties in Measuring Success 2274

James C. Pegues, Jacob A. Jordan, and Yingwu Xu

Mitigation of Earthquake-Induced Liquefaction via Microbial Denitrification: A Two-Phase Process 2286

Edward Kavazanjian Jr. and Sean T. O'Donnell

Post-Grouting Stability of Bentonite Suspensions within Sand Pores 2296

Chadi El Mohtar, May ElKhattab, and Ritika Sangroya

Shear Wave Velocity Measurements of Stone Column Improved Ground and Effect on Site Response 2306

Armin W. Stuedlein, Abbas Abdollahi, H. Benjamin Mason, and Rowland French

Stability Analysis of Embankments Supported by Geosynthetic Encased Stone Columns **2318**

Shaymaa Kadhim, Robert L. Parsons, and Jie Han

Stress-Strain Behavior of Cement-Improved Clays **2328**

Allison J. Quiroga, Kanthasamy K. Muraleetharan, Amy B. Cerato, and Gerald A. Miller

Development of a Flexible Mold for Bio-Mediated Soil Materials **2339**

Lin Li, Farshad Amini, Qian Zhao, Chi Li, Kejun Wen, Mingdong Li, and Ubani Ogbonnaya

Dynamic Centrifuge Tests on Soft Clay Reinforced by Soil-Cement Grids **2349**

Mohammad Khosravi, Shuji Tamura, Ross W. Boulanger, Daniel W. Wilson, C. Guney Olgun, Deepak Rayamajhi, and Yongzhi Wang

Field Investigation on Compaction and Strength Performance of Two Coal Wash-BOS Slag Mixtures **2359**

S. M. Ali Tasalloti, Buddhima Indraratna, Gabriele Chiaro, and Ana Heitor

Ground Improvements for a Sloped Runway Expansion **2369**

Curtis R. Cook, Mark E. Plaskett, and Ed J. Garbin

Implementation of Optimized Ground Improvement Techniques for a Prime Real Estate Location in Southern California **2379**

Lawrence K. Stark, Gary Taylor, Lisheng Shao, and Thang V. Nguyen

Large-Scale Bending Tests on Soil Mix Elements **2394**

Nicolas Denies, Noël Huybrechts, Flor De Cock, Bart Lameire, Jan Maertens, and André Vervoort

Seismic Soil-Pile-Structure Interaction in Improved Soft Clay: Centrifuge Tests **2410**

Amirata Taghavi, Kanthasamy K. Muraleetharan, Gerald A. Miller, and Amy B. Cerato

Wet Grab Samples vs. Cored Samples as QC/QA Methods at the Rio Puerto Nuevo Project in San Juan, PR **2420**

Filippo M. Leoni and Wesley D. Shcmutzler

Quality, Testing, Instrumentation, and Evaluation

Application and Accuracy of Structure from Motion Computer Vision Models with Full-Scale Geotechnical Field Tests 2432

Logan M. Palmer, Kevin W. Franke, R. Abraham Martin, Brendan E. Sines, Kyle M. Rollins, and John D. Hedengren

Effect of Container Wall Friction on the Consolidation of Clay Specimen 2442

Owais S. Mir, Yashwant A. Kolekar, Dasaka S. Murty, and B. V. S. Viswanadham

Failure Mechanism of Earthen Levee Strengthened by Vegetated HPTRM System and Design Guideline for Hurricane Overtopping Conditions 2452

Pan Yi, Farshad Amini, and Lin Li

Full Scale Crash Test of a 36-Ton Truck against a Barrier on Top of an MSE Wall 2462

D. Saez, L. S. Maddah, R. Bligh, A. Mirdamadi, and J.-L. Briaud

Development of an Improved Calibration Procedure for the Electrical Density Gauge 2472

L. Sebastian Bryson, B. Scott Embry, and Kirk A. Jenkins

The Measurement of Suction Stress Characteristic Curve for a Highly Collapsible Loessial Soil 2482

S. Mohsen Haeri, Ali Khosravi, and Shahin Ghazizadeh

A Framework for Premature Pavement Distress Evaluation 2492

Nazmul Chowdhury, Zahid Hossain, Shu Yang, and Andrew Braham

Construction Monitoring for the Transbay Transit Center Excavation in San Francisco, California 2502

Youssef M. A. Hashash, Mohamad Jammoul, Kaitlyn L. Fleming, Stephen McLandrich, Andrew Yeskoo, Nick O'Riordan, Pierre Gouvin, and Michael Riemer

Dual Tip Penetrometer—A New In Situ Approach to Identify Cemented Sand 2512

Zhihong Hu, Michael C. Mcvay, David Bloomquist, and David Horhota

Exposure of Deep Foundations for the Kentucky Lock Addition Project 2519

Thomas Weinmann, Robert Nyren, and W. Allen Marr

Field Calibration and Data Interpretation of a Settlement Cell System **2533**

Ali Ebrahimi, Meena Viswanath, Ming Zhu, John F. Beech, and Robert Bachus

Initial Steps toward Characterizing Particle Mobilization Using Pore-Scale Particle Mobilization Imaging Experiments **2544**

Benjamin T. Adams and Ming Xiao

Intelligent Compaction of Stabilized Subgrade of Flexible Pavement **2554**

Manik Barman, Syed Asif Imran, Moeen Nazari, Sesh Commuri, and Musharraf Zaman

Strength and Stress Estimation in Soil Bentonite Slurry Trench Cutoff Walls Using Cone Penetration Test Data **2567**

D. G. Ruffing, J. C. Evans, and C. R. Ryan

The Subjective Element in Dynamic Load Testing Results **2577**

Gerald Verbeek, David Tara, and Peter Middendorp

Theory on Measuring Orientation with MEMS Accelerometers in a Centrifuge **2584**

Ryan D. Beemer, Madhuri Murali, Giovanna Biscontin, and Charles Aubeny

Thermal Activity of Geosynthetic Reinforced Soil Piers **2594**

Michael Adams, Jennifer Nicks, and Thomas Stabile

Using Thermal Integrity Profiling to Confirm the Structural Integrity of Foundation Applications **2607**

George Piscsalko, Dean Cotton, Daniel Belardo, and Garland Likins

Visualizing the Fundamental Physics of Rapid Earth Penetration Using Transparent Soils **2617**

Zhibo Chen, Mehdi Omidvar, Magued Iskander, and Stephan Bless

Sustainability

Behaviour of Reinforced Stone Dust Model Walls under Uniformly Distributed Loading **2627**

Sumitra S. Kandolkar and J. N. Mandal

Characterization and Surface Analysis of Commercially Available Biochars for Geoenvironmental Applications **2637**

Erin N. Yargicoglu and Krishna R. Reddy

Influence of Physico-Chemical Properties of Different Biochars on Landfill Methane Adsorption **2647**

Bala Yamini Sadasivam and Krishna R. Reddy

Laboratory Study of Electromagnetically Induced Contaminant Removal **2657**

Vahab Bolvardi, Arvin Farid, Atena Najafi, Jim Browning, and Elisa Barney Smith

Macropore Flow Modeling Using the Root Zone Water Quality Model **2667**

Duraisamy S. Saravanathiiban and Milind V. Khire

Optimum Dimensions of Reinforced Soil Berm for Vertical Expansion of Municipal Solid Waste (MSW) Landfills **2677**

B. Munwar Basha, Shilpi Mahapatra, and Bappaditya Manna

Phytoremediation of Mixed Contaminated Soils: Enhancement with Biochar and Compost Amendments **2687**

Reshma A. Chirakkara and Krishna R. Reddy

Structural Effects on Effective Conductivity of Compacted Clays **2697**

Wassim E. Tabet and Amy B. Cerato

An Overview of Sustainability Applied to Earth Structures **2707**

Daniel R. VandenBerge, Alan J. Esser, and Kristi Bumpas

Beneficial Reuse of Fine Grained Soils for Port, River, and Shoreline Applications **2717**

Mohammed O. A. Bazne, Farshid Vahedifard, and Isaac L. Howard

Beneficial Reuse of Waste Insulation Material in Drilling Applications **2728**

Madison Bertoch, Nazli Yesiller, and James L. Hanson

Carbon Footprint of Tuttle Creek Dam Seismic Retrofit **2738**

Patricia M. Gallagher, Adam Cordi, and Sabrina Spatari

Effect of Compost Soil Treatment on Surficial Slope Stability in Fully Softened Condition **2748**

Minh Le, Anand J. Puppala, and Aravind Pedarla

Effect of pH on the Leaching of Elements from Highway Base Layers Built with Recycled Concrete Aggregates **2758**

Janile Lewis, Bora Cetin, and Ahmet H. Aydilek

Geotechnical Properties of Lightly Stabilized Recycled Demolition Materials in Base/Sub-Base Applications **2767**

Alireza Mohammadinia, Arul Arulrajah, Jay Sanjayan, Mahdi M. Disfani, Myint Win Bo, and Stephen Darmawan

Improving the Shear Strength of Soils by Adding Agricultural By-Products **2777**

Karen Schaefers and Soonkie Nam

Investigation on Clogging Potential of Recycled Concrete Aggregate in French Drain Systems **2787**

Boo Hyun Nam, Zachary Behring, Manoj Chopra, John Shoucair, and Soonkie Nam

Recycling of Municipal Solid Waste Incineration (MSWI) Ash as Aggregate Replacement in Concrete **2797**

Baig Abdullah Al Muhit, Jinwoo An, and Boo Hyun Nam

Soil Crust Development throughout a Two-Dimensional Profile by Discrete Element Method **2807**

Seungcheol Yeom and Kurt J. Sjoblom

Steel Slag: Chemistry, Mineralogy, and Morphology **2816**

Irem Zeynep Yildirim and Monica Prezzi

Stormwater Sediment Filtration Using Sand versus Synthetic Fibers **2826**

Milind V. Khire, Duraisamy S. Saravanathiiban, Mark Verwiel, Christopher Prucha, and Terry Johnson

Sustainability Assessment of Two Alternate Earth-Retaining Structures **2836**

Rajiv K. Giri and Krishna R. Reddy