GSP 297

IFCEE 2018

Developments in Earth Retention, Support Systems, and Tunneling

Papers from Sessions of the International Foundation Congress and Equipment Expo 2018

Orlando, Florida • March 5–10, 2018

Edited by

Anne Lemnitzer, Ph.D.
Armin W. Stuedlein, Ph.D., P.E.
Muhannad T. Suleiman, Ph.D.

ASCE

G-I GEO-INSTITUTE

GEOTECHNICAL SPECIAL PUBLICATION NO. 297

IFCEE 2018

DEVELOPMENTS IN EARTH RETENTION, SUPPORT SYSTEMS, AND TUNNELING

SELECTED PAPERS FROM SESSIONS OF THE INTERNATIONAL FOUNDATION CONGRESS AND EQUIPMENT EXPO 2018

March 5–10, 2018
Orlando, Florida

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
Anne Lemnitzer, Ph.D.
Armin W. Stuedlein, Ph.D., P.E.
Muhannad T. Suleiman, 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/publications | 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 https://doi.org/10.1061/9780784481608**

Copyright © 2018 by the American Society of Civil Engineers.
All Rights Reserved.
ISBN 978-0-7844-8160-8 (PDF)
Manufactured in the United States of America.

Preface

This is the fourth volume of six Geotechnical Special Publications (GSPs) and one Geotechnical Practice Publication (GPP) containing papers from the 2018 International Foundations Congress and Equipment Expo (IFCEE18) held in Orlando, Florida on March 5–10, 2018. The IFCEE conference series combines a technical conference and equipment show dedicated to the design and construction of foundation systems, using the latest geo-engineering and geo-construction technologies and practices. The IFCEE conference series is a one of a kind event that attracts attendees from around the world for the world's largest equipment exposition dedicated solely to the deep foundations industry. This Congress combined the 2018 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 event was the third Congress in the IFCEE conference series, following the successful 2009 and 2015 meetings, in which these leading geotechnical and geotechnical-related organizations joined together for a single and singular annual congress. IFCEE18 provided an international forum to discuss technological advances, case histories, and present challenges related to geotechnical and foundation engineering. The Congress was attended by a wide range of geo-professionals including engineers, contractors, academicians, equipment manufacturers, geo-technologists, researchers, and service, material and tooling suppliers.

This publication culminates two years of effort by the technical planning committee whose focus has been to continue the success of the previous meetings in the IFCEE conference series. Many individuals are responsible for the content of this volume, all of whom served in the efforts to maintain the standard set by previous proceedings. An international call for papers and a rigorous peer review process yielded 280 accepted technical papers, that were presented in 47 sessions, in addition to invited keynote presentations. Papers were reviewed in accordance with ASCE GSP standards. Accordingly, each paper was subjected to technical review by two or more independent peer reviewers. Publication requires concurrence by at least two peer reviewers.

The Editors would like to express their appreciation for having been provided the opportunity to be a part of this Congress' organization, their sincere thanks to the numerous session chairs and reviewers, and we hope that these proceedings will be of use to the geotechnical engineering community for many years to come.

The Editors,

Anne Lemnitzer, Ph.D., A.M.ASCE, M.DFI, University of California, Irvine
Armin W. Stuedlein, Ph.D., P.E., M.ASCE, M.DFI, Oregon State University
Muhannad T. Suleiman, Ph.D., A.M.ASCE, M.DFI, Lehigh University

© ASCE

Acknowledgments

Thanks are due to the authors, primary reviewers, session chairs, and program committee, without whom this publication would not be possible.

IFCEE 2018 Conference Program Committee

Conference Chair
W. Robert Thompson, III, P.E., D.GE, M.ASCE, Dan Brown and Associates, PC

Technical Program Committee
Tracy T. Brettmann, P.E., D.GE, M.ASCE, A. H. Beck Foundation Company, Inc.
Allen Cadden, P.E., D.GE, F.ASCE, Schnabel Engineering
Peggy Hagerty-Duffy, P.E., D.GE, Hagerty Engineering, Inc.
Bernard H. Hertlein, FACI, M.ASCE, GEI Consulting, Inc.
Terence P. Holman, Ph.D., P.E., M.ASCE, Turner Construction Company
Michael D. Justason, P.Eng., M.ASCE, McMaster University/Bermingham Foundation Solutions
Mary Ellen Large, P.E., D.GE, M.ASCE, Deep Foundations Institute
Anna Sellountou, Ph.D., A.M.ASCE, Pile Dynamics, Inc.

Proceedings Editors
Muhannad T. Suleiman, Ph.D., A.M.ASCE, Lehigh University
Anne Lemnitzer, Ph.D., P.E., A.M.ASCE, University of California, Irvine
Armin W. Stuedlein, Ph.D., P.E., M.ASCE, Oregon State University

IFCEE 2018 Sessions and Session Chairs

Deep Foundations
Deep Foundations & Seismic Issues
William M. Camp, III, P.E., D.GE, M.ASCE, S&ME, Inc.

Design and Analysis of Deep Foundations
Sanjeev Malhotra, P.E., G.E., D.GE, Consulting Engineer; Elizabeth M. Smith, P.E., G.E., D.GE, Terracon Consultants, Inc.; James W. Niehoff, P.E., M.ASCE, GEI Consultants, Inc.

Field Testing: Axial/Lateral I
Gerald Verbeek, M.ASCE, Verbeek Management Services; John P. Turner, Ph.D., P.E., D.GE, M.ASCE, Dan Brown and Associates, PC; Murad Y. Abu-Farsakh, Ph.D., P.E., M.ASCE, Louisiana State University

© ASCE

Pile Driving: Design and Construction
Michael H. Wysockey, Ph.D., P.E., M.ASCE, Thatcher Engineering Corporation

Practical Aspects of Foundation Installation and Investigation
Sanjeev Malhotra, P.E., G.E., D.GE, Consulting Engineer

Earth Retention and Support
Excavation Support: Design and Construction
Helen Robinson, P.E., GEI Consultants, Inc.

Mechanically Stabilized Earth and Geosynthetic-Reinforced Soil Systems
Ben A. Leshchinsky, Ph.D., A.M.ASCE, Oregon State University

Seismic Aspects of Earth Retention
Ali A. Eliadorani, Ph.D., P.E., P.L.S., M.ASCE, South Carolina State University

Tunnels and Buried Structures
Eric Wang, P.E., LEED AP, M.ASCE, HNTB Corporation; Thomas W. Pennington, P.E., M.ASCE, Jacobs Associates

Ground Improvement & Seepage Control
Bio-Based Soil Improvement
Dimitrios Zekkos, Ph.D., P.E., M.ASCE, University of Michigan & geoengineer.org; Jason DeJong, Ph.D., University of California, Davis; Kenichi Soga, Ph.D., FREng, FICE, M.ASCE, University of California, Berkeley

Geosynthetic/Fiber Reinforcement
Ben A. Leshchinsky, Ph.D., A.M.ASCE, Oregon State University

Ground Improvement: Treatment Case Studies
Christian B. Woods, P.E., D.GE, G.E., M.ASCE, Densification, Inc.

Liquefaction and Densification
Menzer Pehlivan, Ph.D., P.E., M.ASCE, CH2M HILL

Retaining and Cutoff Wall Design and Construction
Kenneth L. Fishman, Ph.D., P.E., M.ASCE, McMahon & Mann Consulting Engineers, P.C.; Nasser Massoudi, Ph.D., P.E., M.ASCE, Bechtel Corp.

Stone Columns/Piers/Grouting I
Kord J. Wissmann, Ph.D., P.E., D.GE, M.ASCE, Geopier Foundation Company; Jie Han, Ph.D., P.E., F.ASCE, The University of Kansas

© ASCE

Other Topics: Deep Foundations and Site Characterization

Advances in Energy Piles
Omid Ghasemi Fare, Ph.D., A.M.ASCE, University of Louisville; John S. McCartney, Ph.D., P.E., M.ASCE, University of California, San Diego

Bridges: Foundation Design and Construction
Sam Sternberg, III, P.E., M.ASCE, Thompson Engineering

Characterizing the Behavior of Soils
Cumaraswamy (Vipu) Vipulanandan, Ph.D., P.E., M.ASCE, University of Houston; Yazen Khasawneh, Ph.D., P.E., M.ASCE, NTH Consultants, Ltd.

Liquefaction: Analysis and Design
C. Yoga Chandran, Ph.D., G.E., P.E., M.ASCE, CH2M HILL

QA/QC for Deep Foundations
Anna Sellountou, Ph.D., A.M.ASCE, Pile Dynamics, Inc.

Rock Mechanics
Ingrid Tomac, Ph.D., A.M.ASCE, University of California, San Diego; Ehsan Ghazanfari, Ph.D., P.E., M.ASCE, University of Vermont

Site Characterization
Xiong (Bill) Yu, Ph.D., P.E., F.ASCE, Case Western University

Other Topics in Geotechnical Engineering

Constitutive Modeling
Usama S. El Shamy, Ph.D., P.E., M.ASCE, Southern Methodist University; Seung Jae Lee, Ph.D., Aff.M.ASCE, Florida International University

Pavements and Subgrades
Boo Hyun Nam, Ph.D., A.M.ASCE, University of Central Florida

Shallow Foundations
Xiong Zhang, Ph.D., P.E., A.M.ASCE, Missouri University of Science and Technology

Slopes, Dams, Embankments
Timothy D. Stark, Ph.D., P.E., D.GE, F.ASCE, University of Illinois at Urbana-Champaign; Binod Tiwari, Ph.E., P.E., M.ASCE, California State University, Fullerton; Beena Ajmera, Ph.D., A.M.ASCE, California State University, Fullerton

© ASCE

Unsaturated Soils
Farshid Vahedifard, Ph.D., P.E., M.ASCE, Mississippi State University; Rifat Bulut, Ph.D., M.ASCE, Oklahoma State University

Selected Other Topics in Geotechnical Engineering
Matteo Montesi, P.E., M.ASCE, WSP USA; Curt R. Basnett, P.E., M.ASCE. CH2M HILL; Morgan Race, Ph.D., P.E., M.ASCE, Braun Intertec; Kam Weng Ng, Ph.D., P.E., M.ASCE, University of Wyoming; Lori A. Simpson, G.E., P.E., M.ASCE, Langan Treadwell Rollo

Case Histories, Lessons Learned and General Practice
ACIP Piles: Case Histories and Lessons Learned
W. Morgan NeSmith, P.E., M.ASCE, Berkel & Company Contractors, Inc.

Drilled Shafts: Case Histories and Lessons Learned
William F. (Bubba) Knight, P.E., M.ASCE, Loadtest, A Division of Fugro USA Land, Inc.

Driven Piles: Case Histories and Lessons Learned
Michael H. Wysockey, Ph.D., P.E., M.ASCE, Thatcher Engineering Corporation

Excavation Support: Case Histories and Lessons Learned
Richard J. Valentine, P.E., M.ASCE, Valentine Engineering Consultants

Ground Improvement: Case Histories and Lessons Learned
Jose L. M. Clemente, Ph.D., P.E., D.GE, F.ASCE, Bechtel NS&E

Micropiles: Case Histories and Lessons Learned
Steve Davidow, P.E., S.E., P.Eng., Aff.M.ASCE, Quanta Subsurface

Site Investigation: Case Histories and Lessons Learned
Conrad W. Felice, Ph.D., P.E., D.GE, F.ASCE, C. W. Felice, LLC

Slope Stabilization/Earth Retention: Case Histories and Lessons Learned
Timothy D. Stark, Ph.D., P.E., D.GE, F.ASCE, University of Illinois at Urbana-Champaign

IFCEE 2018 Primary Paper Reviewers

John Abdalkhani	Amir Ahmadipur	Robert Alperstein
Sherif Abdelaziz	Aseel Ahmed	Art Alzamora
Yasser Abdelhamid	Beena Ajmera	Denis Ambio
Kofi Acheampong	Gauen Alexander	Omar Amer
Muthu Adigovindan	Ryan Allin	Joram Amir

© ASCE

Jinwoo An
Donald Anderson
Ed Anderson
Ronald Andrus
Luis Arboleda
Allam Ardah
David Arellano
George Aristorenas
Haydar Arslan
Arul Arumoli
Moi Arzamendi
Reza Ashtiani
Andrew Assadollahi
Paul Axtell
Alireza Ayoubian
Alireza Saeedi Azizkandi
Ahmed Baghdady
Paola Bandini
Aritra Banerjee
Curt Basnett
Prasenjit Basu
Bate Bate
Andrew Baxter
Ira Beer
Jomaa Ben-Hassine
Jonathan Bennett
Keith Bennett
Jorge Bheim
Dale C. Biggers
Jerold Bishop
Tanner Blackburn
Antonio Bobet
Glen Bobnick
Giovanni Bonita
Michael Boone
David Borger
Stan Boyle
Tom Brandon
Kyle Brennan
Tracy Brettmann
Jean-Louis Briaud
Frederick (Rick) A. Brinker
E. Buka
Paul Bullock
Rifat Bulut
Kristi Bumpas
Giuseppe Buscarnera
Allen Cadden
Billy Camp
Franz Campero
Greg Canivan
Junnan Cao
Salvatore Caronna
John Case
Ray Castelli
Jan Cermak
Bora Cetin
Yoga Chandran
Geoff Chao
Lizhou Chen
W. Z. Chen
Les Chernauskas
Bhaskar Chittoori
Byoung Hooi Cho
Sanghyun Chun
Jose Clemente
Russell Cooper
Michael Coryell
Dave Crouthamel
Bobby Daita
Steven Dapp
Domenic D'Argenzio
Steve Davidow
John Deeken
Jason DeJong
Karishma Desai
Jerry DiMaggio
Randall Divito
Yi Dong
Elliott Drumright
Elizabeth Dwyre
Paul Eggers
Paul Eickenberg
Usama Samir El Shamy
Ghada Ellithy
Fathey Elsaid
Mostafa Elseifi
Carlos Englert
Alan Esser
Jeff Evans
Matt Evans
Ragui Wilson Fahmy
Arvin Farid
Ray Fassett
Peter Faust
Sixto Fernandez
Alexander Filotti
Geroge Filz
Jared Fischer
Kenneth Fishman
Michael Flynn
Emmanuel Fosteris
Ray Franz
Murray Fredlund
David Frost
Mo Gabr
Mahi Galagoda
Phillip Gallet
Quan Gao
John Garber
Cyrus Garner
Donald Gerken
Hande Gerkus
Omid Ghasemi-Fare
Akrouch Ghassen
Mohammad Ghavami
Ehsan Ghazanfari
James Gingery
Matt Glisson
Matt Goff
Aaron Goldberg
Larry Goldfarb
Jesus Gomez
Michael G. Gomez
Clay Goodman
David Graham
Donald Gray
Donald Green
Jared Green

© ASCE

Jean Habimana
Seth Hamblin
Chanjuan Han
Jie Han
Jim Hansen
Nafiul Haque
Nicholas Harman
Dean Harris
Megan Hart
Ahmadreza Hedayat
James Hite
Chu Ho
I-Hsuan Ho
Jon Ho
Oliver Hoops
David Horhota
Zahid Hossain
Xiewen Hu
Jie Huang
Aaron Hudson
Nick Hudyma
Jonathan Huff
Troy Hull
Dana Humphrey
Mohamad Hussein
James Hussin
Nejan Huvaj
Elvis Ishimwe
Magued Iskander
Tyler Jahn
Matthew Janes
John Jenkins
Yan Jiang
Lawrence F. Johnsen
Kenneth Johnson
John Juenger
Hyuk-Sang Jung
Onur Kacar
Arash Kamali-Asl
Peter Kandaris
Xin Kang
Ismail Karatas
Edward Kavazanjian
Qamar Kazmi
Andrew Keene
Ryan Keiper
Yazen Khasawneh
Ali Khosravi
Yoshiaki Kikuchi
Meeok Kim
Sihyun Kim
Sonny Kim
Yonje Kim
Scott Kirts
Junyoung Ko
Prabir Kolay
Josh Koltz
Susheel Kolwalker
Van Komurka
Dimitrious
Konstantakos
Tim Kovacs
Sachin Kumar
Debra Laefer
Mary Ellen Large
John Lawrence
Imsoo Lee
Seung Jae Lee
Anne Lemnitzer
Ben Leshchinsky
Christopher Lewis
Michael Lewis
Paul Lewis
Chang Li
Jiliang Li
Lin Li
Marina Li
Min Liew
Garland Likins
Keng-Wit Lim
Chuang Lin
Xiaobin Lin
Bret Lingwall
Jenny Liu
Shimin Liu
Sebastian Lobo-Guerrero
Libby Loeffler
Erik Loehr
Theresa Loux
John Lupo
Scott Mackiewicz
Ashley Macmillan
Anwar Maharmeh
Ali Maher
Sanjeev Malhotra
Kalehiwot Nega Manahiloh
Brian Martinez
Ben Mason
John McCartney
Alexander Mcgillivray
JT McGinnis
Michael McVay
Nick Meloy
Brian Metcalfe
Peter Middendorp
Marta Miletic
Kevin Miller
Bert Miner
Filippo Mira-Catto
Deb Mishra
Roxbeh Moghaddam
Soroush Mokhtari
Matteo Montesi
Brina Montoya
Joon-Shik Moon
Taehyun Moon
Mike Muchard
Gray Mullins
Finnegan Mwape
Boo Hyun Nam
Soonkie Nam
Mohammad Nasim
David Neilson
Kam Weng Ng
Trung Dung Nguyen
James Niehoff
Mary Nodine
Iraj Noorany
Nicolas Oettle
Kwabena Ofori-Awuah

© ASCE

Ed O'Malley
George Onorato
Phillip Ooi
Hasan Ozer
Sam Paikowsky
Anant Panwalkar
Ujwalkumar Patil
James Pegues
Tom Pennington
James Pergues
Dunja Peric
Howard Perko
Juan Pestana
James Phipps
Gregg Piazza
George Piscsalko
Marc Plotkin
Tyler Poggiogalle
Daniel Pradel
Russell Preuss
Tom Printz
Anand Puppala
Sastry Putcha
Tong Qiu
Morgan Race
Parishad Rahbari
Dhooli Raj
Promod Rao
Deepak Rayamajhi
Mohammad Razavi
Alex Reeb
Kurt Rhoads
Frederick Rhyner
Tom Richards
Charles Roarty
Donald Robertson
Brent Robinson
Helen Robinson
Juan Rodriguez
Mark Rohrbach
Kyle Rollins
Dario Rosidi
Jason Ross
John Rowley
Daniel Ruffing
Cassandra Rutherford
Tom Sabourin
Nick Salisbury
Marika Santagata
Fernando Sarabia
Sagar Satyal
Steve Saye
Zach Scarboro
David Scarpato
Vern Schaefer
Charles Warren Schwartz
Brian Sears
Henry Seawell
Jeff Segar
Al Sehn
Gary Seider
Anna Sellountou
Hoyoung Seo
Jeongbok Seo
Sunil Sharma
Anna Shidlovskaya
Phil Shull
Erin Sibley
Tim Siegel
Gregory Silver
Matt Silveston
Johanna Simon
Bob Simpson
Lori Simpson
Jenn Sketchley
Matthew Sleep
Don Smith
Miriam Smith
Ryan Snook
Kenichi Soga
Ahmad Souri
Eric Steward
Melissa Stewart
Charles (Andy) Stone
Bryan Strohman
Armin Stuedlein
Muhannad Suleiman
Steve Sun
Xiaohui Sun
Oscar Suncar
Sonia Swift
Amirata Taghavi
Takefumi Takuma
Majid Talebi
Gilbert Tallard
Burak Tanyu
David Tara
Junliang Tau
Ed Theinat
Robert Thompson
James Tinjum
Binod Tiwari
Ingrid Tomac
Justin Toney
Lucas Turko
Benjamin Turner
John Turner
Richard (Dick) Vaeth
Richard Valentine
Adriaan Van Seters
Ben Vance
Dan VandenBerge
Philip Vardon
Cumaraswamy Vipulanandan
Michael Walker
Scott Walker
Bill Walton
Dingbao Wang
Eric Wang
Fei Wang
Lei Wang
Shugang Wang
Lei Wei
Darrell Wilder
Daniel Woeste
Jeong Yun Won
Moussa Wone
Timothy Wood
Lee Wooten
Yonggui Xie

© ASCE

Xiaoming Yang
Jun Yao
Fred Yi
Taesun You
Heejung Youn
Xiong Yu
Zia Zafir
Atefeh Zamani
Natasha Zamani
Claudia Zapata
Justin Zarella
Dimitrios Zekkos
Ming Zhang
Xiong Zhang
Katerina Ziotopoulou
Jorge Zornberg

© ASCE

Contents

Earth Retention and Support

Finite Element Analyses of an Urban Cofferdam Using Hypoplasticity Clay Model 1
A. Felipe Uribe-Henao, Luis G. Arboleda-Monsalve, Juan Garcia, and Lisa Star

Temperature and Concrete Time-Dependent Effects on Urban Cofferdams 12
A. Felipe Uribe-Henao, Luis G. Arboleda-Monsalve, Alejandro Velasquez-Perez, David G. Zapata-Medina, and Fernando Sarabia

Analysis of Predicted Capacity versus Load Test Results of Ground Anchors in Multi-Geology Installation 23
Eric S. Backlund and Noel W. Janacek

Innovations in Removable Post Tensioned Strand Ground Anchors 33
Lucian Bogdan and Patrick Wörle

Numerical Modeling of a Tiedback Wood-Lagging Wall during Excavation 43
Soheil Kamalzare, David E. Weatherby, Matthew J. Niermann, and Dominic Parmantier

Investigation on the Effects of Different Nail Diameters, Soil Elastic Moduli and Pullout Rates on the Pullout Shear Resistance of Soil-Nail Interface 54
A. Saeedi-Azizkandi, M. H. Baziar, H. Dashtara, and A. H. Kolahdouzan

Empirical Method to Estimate Lateral Wall Deformation Profiles and Bending Moment in Excavation Retaining Walls 65
L. Sebastian Bryson, David G. Zapata-Medina, and Jorge Romana-Giraldo

Numerical Investigation of the Performance of a Geosynthetic Reinforced Soil-Integrated Bridge System (GRS-IBS) under Working Stress Conditions 76
Murad Abu-Farsakh, Allam Ardah, and George Voyiadjis

Lateral Resistance of Abutment Piles Near Mechanically Stabilized Earth Walls 88
Kyle M. Rollins, Andrew Luna, Ryan Budd, Jason Besendorfer, Cody Hatch, Jarell Han, and Robert Gladstone

© ASCE

Numerical Investigation on the Performance of Geosynthetic-Reinforced Soil Piers under Axial Loading.....99
Mahsa Khosrojerdi, Tong Qiu, Ming Xiao, and Jennifer Nicks

Prediction Model for Estimating the Immediate Settlement of Foundations Placed on Reinforced Soil.....109
Mahsa Khosrojerdi, Ming Xiao, Tong Qiu, and Jennifer Nicks

Interface Studies on Geogrid and Fly Ash 119
K. P. Bhargav Kumar and B. Umashankar

Cyclically Induced Deformations in Lightweight Cellular Concrete Backfilled Retaining Structures 130
Binod Tiwari, Beena Ajmera, and Diego Villegas

Fragility Analysis of Seismic Response of Cantilever Retaining Walls with Cohesive and Cohesionless Backfill Materials.....139
Siavash Zamiran and Abdolreza Osouli

Seismic-Induced Deformations of a Geosynthetic Reinforced Soil Bridge Abutment Subjected to Longitudinal Shaking 147
Wenyong Rong, Yewei Zheng, John S. McCartney, and Patrick J. Fox

Experimental and Numerical Investigation of Lateral Earth Pressures Generated from Repeated Loading.....158
Jakob R. Walter, Amr M. Morsy, and Jorge G. Zornberg

Comparison of Measurements and Limit State Solutions for Soil Pressures on Deep Flexible Underground Structures.....169
Lohrasb Keykhosropour and Anne Lemnitzer

Assessment of Dynamic Load Allowance for Buried Culverts.....179
Mehdi Kadivar, Kalehiwot Nega Manahiloh, Victor N. Kaliakin, and Harry W. Shenton III

Compensation Grouting Program to Mitigate Settlement of Utilities from Tunneling 189
James C. Myers, Jonathan Taylor, and Lucian P. Spiteri

Design Methodology to Evaluate Hydraulic Jacking in Pressure Tunnels 201
Mohammad Moridzadeh and Peter Dickson

Ground Improvement and Seepage Control

Soil-Bentonite Slurry Trench Cutoff Wall Longevity 214
Daniel Ruffing, Jeffrey Evans, and Nathan Coughenour

Emergency Bridge Pier Foundation Repair with Pressed-in Piles 224
Takefumi Takuma and Takayuki Sakai

© ASCE

Evaluation of Water Vapor Sorption and Electrical Conductivity Methods to Determine Bentonite Content of a Soil-Bentonite Barrier 238
Idil Deniz Akin, Jiannan Chen, Craig H. Benson, and William J. Likos

Slopes, Dams, and Embankments

Geotechnical Stability Analysis of Earthen Levees in the Face of Uncertainty.....247
Lei Wang, Michael Powers, Michael Studiner, Mohammed Fallatah, and Wenping Gong

Strain in a GRS Bridge Abutment: Strain Gauge Attachment Techniques, Performance and Survivability during Construction and Operation 257
Majid Talebi, Christopher L. Meehan, and Tyler M. Poggiogalle

Changes in Temperature Distribution in a Geosynthetic Reinforced Soil Abutment and Their Effect on Measured Strain.....267
Tyler M. Poggiogalle, Majid Talebi, and Christopher L. Meehan

Lessons Learned: Oklahoma State Highway 99 over the Washita River.....278
Kristi K. Bumpas, Chad E. Grinsteiner, and Jennifer Koscelny

Influence of Slope Density on the Stability and Deformation of Clayey Slopes 293
Binod Tiwari, Beena Ajmera, Mohammed Khalid, Samin Donyanavard, and Rosalie Chavez

Impact of Variation of Small Strain Shear Modulus on Seismic Slope Stability Analysis of a Levee: A Sensitivity Analysis 302
Sayantan Chakraborty, Aritra Banerjee, Jasaswee T. Das, Leila Mosadegh, and Anand J. Puppala

A Landslide Model with the Shear Band Propagation: Modification for Unsaturated Condition.....314
Sihyun Kim, Brian J. Fiedler, and Seunghee Kim

Effect of the Core on the Upstream Stability of Dams under Sudden Drawdown Conditions.....324
Salama Al-Labban and Manoj Chopra

Experimental Investigation of Effects of Sliding Distance on Impact Force from Granular Sliding Mass to a Rigid Obstruction.....333
Amir Ahmadipur and Tong Qiu

Design Optimization of I-Wall Levee System Supported by Sand Foundation.....341
Parishad Rahbari and Nadarajah Ravichandran

© ASCE