Geo-Congress 2019

GSP 312

Geoenvironmental Engineering and Sustainability





Papers from Sessions of the
Eighth International Conference on
Case Histories in Geotechnical Engineering

Philadelphia, Pennsylvania
March 24–27, 2019

EDITED BY Christopher L. Meehan, Ph.D., P.E.
Sanjeev Kumar, Ph.D., P.E.
Miguel A. Pando, Ph.D., P.Eng.
Joseph T. Coe, Ph.D.

ASCE

G-I GEO-INSTITUTE ASCE

GEOTECHNICAL SPECIAL PUBLICATION NO. 312

GEO-CONGRESS 2019

GEOENVIRONMENTAL ENGINEERING AND SUSTAINABILITY

SELECTED PAPERS FROM SESSIONS OF THE EIGHTH INTERNATIONAL CONFERENCE ON CASE HISTORIES IN GEOTECHNICAL ENGINEERING

March 24–27, 2019
Philadelphia, Pennsylvania

SPONSORED BY
The Geo-Institute of the
American Society of Civil Engineers

EDITED BY
Christopher L. Meehan, Ph.D., P.E.
Sanjeev Kumar, Ph.D., P.E.
Miguel A. Pando, Ph.D., P.Eng.
Joseph T. Coe, 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/10.1061/9780784482148**

Copyright © 2019 by the American Society of Civil Engineers.
All Rights Reserved.
ISBN 978-0-7844-8214-8 (PDF)
Manufactured in the United States of America.

Preface

From the early days of modern geotechnical engineering, sharing field experience on the performance of geostructures in the form of case histories has driven the advancement of knowledge for the geotechnical profession. Starting in 1984, Professor Shamsher Prakash formalized this tradition, organizing the First International Conference on Case Histories in Geotechnical Engineering. This conference brought together over 190 engineers from 38 countries to share their experiences, learn from each other, and advance the profession. By 2013, the Seventh conference in this series had grown to nearly 320 engineers attending from 53 countries spanning the globe, culminating in symposia to honor the legacy of the late Ralph B. Peck and to honor Clyde N. Baker Jr. But the essence of the conference had not changed: to advance our profession through lessons learned from case histories and shared engineering judgment.

Recognizing the significant role that case histories play in the geotechnical engineering profession, the American Society of Civil Engineers (ASCE) has decided to continue the tradition of this long-standing conference series by merging this conference into its annual Geo-Institute Congress. The result is Geo-Congress 2019: The Eighth International Conference on Case Histories in Geotechnical Engineering, which was held in Philadelphia, Pennsylvania on March 24-27, 2019.

The following pages comprise the eighth volume of ten Geotechnical Special Publications (GSPs) containing papers from Geo-Congress 2019: The Eighth International Conference on Case Histories in Geotechnical Engineering. This conference featured experiences and observations from numerous geoengineering projects and case histories, including recent "MegaProjects." Presented topics are organized into the following conference proceeding volumes:

Volume 1: Embankments, Dams, and Slopes
Volume 2: Earth Retaining Structures and Geosynthetics
Volume 3: Foundations
Volume 4: Earthquake Engineering and Soil Dynamics
Volume 5: Soil Improvement
Volume 6: Geotechnical Materials, Modeling, and Testing
Volume 7: Engineering Geology, Site Characterization, and Geophysics
Volume 8: Geoenvironmental Engineering and Sustainability
Volume 9: Soil Erosion, Underground Engineering, and Risk Assessment
Volume 10: Data, Software, Education, and a Tribute to Ralph Peck

Many individuals are responsible for the content of these published works, all of whom contributed to maintaining the high standards that are set for ASCE's GSPs. An international call for papers and rigorous peer review process yielded 403 accepted

© ASCE

technical papers, that were presented in 36 podium sessions and numerous poster sessions, in addition to the keynote award presentations, Geo-PITs (Powerful, Informative Talks), and panel sessions. Papers in these volumes were reviewed in accordance with ASCE's GSP standards, with each paper receiving two or more independent, technical peer reviews. Publication in these Proceedings required concurrence by at least two peer reviewers.

This publication series culminates two years of effort by the conference organizing committee whose focus has been to build upon and enhance the success of the past International Conferences on Case Histories in Geotechnical Engineering. On behalf of the conference organizers and the ASCE Geo-Institute, we wish to express our gratitude to all of the session chairs and reviewers for their diligent efforts to make these Proceedings a reality. We also wish to extend our thanks to Geo-Institute staff, whose tireless efforts working with authors, session chairs, and members of the conference organizing committee were instrumental in the conference planning process. Finally, we would like to thank the authors for their contributions to the Proceedings. The papers that have been submitted by our colleagues do a great service to the legacy of the previous "Case Histories in Geotechnical Engineering" conferences, and are of great value to the geotechnical engineering profession.

The Editors,

Christopher L. Meehan, Ph.D., P.E., F.ASCE, University of Delaware
Sanjeev Kumar, Ph.D., P.E., F.ASCE, Southern Illinois University Carbondale
Miguel A. Pando, Ph.D., P.Eng., M.ASCE, University of North Carolina Charlotte
Joseph T. Coe, Ph.D., M.ASCE, Temple University

© ASCE

Acknowledgments

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

2019 Geo-Congress Conference Organizing Committee

Conference Co-chair: Scott M. Olson, Ph.D., P.E., M.ASCE
Conference Co-chair: Allen Cadden, P.E., D.GE, F.ASCE
Technical Program Co-chair: Sanjeev Kumar, Ph.D., P.E., M.ASCE
Technical Program Co-chair: Jared Green, P.E., M.ASCE
Technical Program Co-chair: Christopher L. Meehan, Ph.D., P.E., F.ASCE
Proceedings Editor: Christopher L. Meehan, Ph.D., P.E., F.ASCE
Proceedings Editor: Sanjeev Kumar, Ph.D., P.E., M.ASCE
Proceedings Editor: Joseph Thomas Coe, Jr., Ph.D., A.M.ASCE
Proceedings Editor: Miguel A. Pando, Ph.D., P.Eng., A.M.ASCE
Student Activities Chair: Stacey Kulesza, Ph.D., P.E., M.ASCE
Sponsorships and Exhibits Co-chair: George Koerner, Ph.D., P.E., M.ASCE
Sponsorships and Exhibits Co-chair: Archie Filshill, P.E., M.ASCE
Sponsorships and Exhibits Co-chair: Ben Dutton, P.E.
Sponsorships and Exhibits Co-chair: John Grillo, P.E., M.ASCE
Local Liaisons: James A. McKelvey, P.E., D.GE, F.ASCE; Michael Fritzges, P.E., M.ASCE; Conrad Cho, P.E., LEED AP

2019 Geo-Congress Sessions and Session Chairs

Reza S. Ashtiani, Ph.D.
Robert C. Bachus, Ph.D., P.E., D.GE, M.ASCE
Eric S. Backlund, P.E., M.ASCE
Paola Bandini, Ph.D., P.E., M.ASCE
Tuğçe Başer, Ph.D., A.M.ASCE
Melissa S. Beauregard, Ph.D.
Michelle L. Bernhardt, Ph.D., A.M.ASCE
Bernardo A. Castellanos, Ph.D., A.M.ASCE
J. Tanner Blackburn, Ph.D., P.E., M.ASCE
Jan Cermak, Ph.D., P.E., M.ASCE
Deepankar Choudhury, Ph.D., M.ASCE
Maria Chrysochoou, Ph.D.
Jose Luiz Machado Clemente, Ph.D., P.E., D.GE, F.ASCE
Joseph Thomas Coe, Jr., Ph.D., EIT, A.M.ASCE
Shideh Dashti, Ph.D., A.M.ASCE
Haitham M. Dawood, Ph.D., P.E., A.M.ASCE
Ahmed Faheem, Ph.D., A.M.ASCE

© ASCE

Michael B. Fritzges, P.E., M.ASCE
Patricia M. Gallagher, Ph.D., P.E.
Sarah L. Gassman, Ph.D., P.E., M.ASCE
Majid Ghayoomi, Ph.D., A.M.ASCE
Ehsan Ghazanfari, Ph.D., P.E., M.ASCE
Michael G. Gomez, Ph.D., A.M.ASCE
Jared M. Green, P.E., A.M.ASCE
Garry H. *Gregory*, Ph.D., P.E., *D.GE,* M.ASCE
Jonathan F. Hubler, Ph.D., A.M.ASCE
Marco Isola, Ph.D., P.E., M.ASCE
James Kaklamanos, Ph.D., A.M.ASCE
Victor N. Kaliakin, Ph.D., M.ASCE
Prabir Kumar Kolay, Ph.D., P.E., M.ASCE
Joseph F. Labuz, Ph.D., P.E., F.ASCE
Ben A. Leshchinsky, Ph.D., P.E., A.M.ASCE
Bret N. Lingwall, Ph.D., P.E., M.ASCE
Barbara Luke, Ph.D., P.E., D.GE, F.ASCE
Kalehiwot Nega Manahiloh, Ph.D., P.E., M.ASCE
John S. McCartney, Ph.D., P.E., M.ASCE
Michael P. McGuire, Ph.D., P.E., M.ASCE
James A. McKelvey, III, P.E., D.GE, F.ASCE
Christopher L. Meehan, Ph.D., P.E., F.ASCE
Brian C. Metcalfe, P.E., M.ASCE
Ashly Cabas Mijares, Ph.D., A.M.ASCE
Marta Miletić, Ph.D.
Matteo Montesi, P.E., M.ASCE
Ramin Motamed, Ph.D., P.E., M.ASCE
Ara G. Mouradian, P.E., M.ASCE
Boo Hyun Nam, Ph.D., A.M.ASCE
Peter A. Narsavage, P.E., M.ASCE
Miguel A. Pando, Ph.D., P.E., M.ASCE
Menzer Pehlivan, Ph.D., P.E., M.ASCE
William K. Petersen, P.E., M.ASCE
Rafael A. Prieto Piedrahita, Ph.D., P.E., Ing., M.ASCE
Krishna R. Reddy, Ph.D., P.E., D.GE, ENV SP, F.ASCE
David A. Saftner, Ph.D., A.M.ASCE
Hosam Salman, P.E., F.ASCE
Kristin Sample-Lord, Ph.D., P.E., M.ASCE
Inthuorn Sasanakul, Ph.D., P.E., M.ASCE
Kallol Sett, Ph.D., A.M.ASCE
Michael R. Simac, P.E., M.ASCE
Timothy D. Stark, Ph.D., P.E., D.GE, F.ASCE
Sam Sternberg, III, P.E., M.ASCE
Muhannad T. Suleiman, Ph.D., A.M.ASCE

© ASCE

Burak F. Tanyu, Ph.D., C.Eng, M.ASCE
Junliang Tao, Ph.D., A.M.ASCE
Stacey E. Tucker-Kulesza, Ph.D., P.E., M.ASCE
Leon A. Van Paassen, Ph.D., Aff.M.ASCE
Daniel R. Vanden Berge, Ph.D., P.E., M.ASCE
Sotirios Vardakos, Ph.D., A.M.ASCE
Andrea L. Welker, Ph.D., P.E., M.ASCE
Clinton M. Wood, Ph.D., A.M.ASCE
Martin Woodard, Ph.D., P.G., P.E.
Zia Zafir, Ph.D., G.E., P.E., M.ASCE
Xiong Zhang, Ph.D., P.E., A.M.ASCE

2019 Geo-Congress Paper Reviewers

Aiyoub Abbaspour
Sherif Abdelaziz
Sherif Abdelsalam
Tarek Abichou
Grace Abou-Jaoude Estephan
Murad Abu-Farsakh
Tiffany Adams
Alireza Afshani
Victor Aguilar
Rafael Aguilar Velez
Asif Ahmed
Junaid Ahmed
Mohammad Ahsanuzzaman
Beena Ajmera
Idil Akin
Arif Ali Baig Moghal
Ihab Allam
Robert Alperstein
Ali Al-Saadi
Mohammed Alsalihi
Daniel Alzamora
Brian Anderson
Donald Anderson
Mohamed Arab
Luis Arboleda-Monsalve
Allam Ardah
Moi Arzamendi
Mojdeh Asadollahi Pajouh
Jeremy Ashlock
Muhammad Asim Ayaz
Kamelia Atefi Monfared
Kleio Avrithi
Paul Axtell
Mohammad Azadi
Eric Backlund
William Baker
Aritra Banerjee
Sujan Baral
Christopher Bareither
Tugce Baser
Christopher Baxter
Melissa Beauregard
Ryan Beemer
Aaron Berkes
K.P. Bhargav Kumar
Amit Bhasin
Shobha Bhatia
Aditya Bhatt
Riya Bhowmik
Britta Bienen
Gregory Biesiadecki
Kari Bigham
Jobair Bin Alam
Tanner Blackburn
Antonio Bobet
Andrew Boeckmann
Gretchen Bohnhoff
Ademola Bolarinwa
Ross Boulanger
Stan Boyle
Aaron Bradshaw
Scott Brandenberg
Thomas Brandon
Michael Brannon
Mark Breitnauer
Jeremy Brown
Donald Bruce
Sebastian Bryson
Aaron Budge

© ASCE

Kristi Bumpas
Susan Burns
Brandon Buschmeier
Ashly Cabas Mijares
John Caccese
Daniel Cacciola
Carlos Calderon Macias
William Camp
David Campo
Junnan Cao
Camilo Cardona
Ethan Cargill
Kevin Cargill
Timothy Carlin
Clinton Carlson
Norman Carlson
Nina Carney
Bernardo Castellanos
Raymond Castelli
Elvis Castillo-Camarena
Ignazio Cavarretta
Nilo Cesar Consoli
Sayantan Chakrabaty
Kaye Chancellor
Carlos Chang
Erik Charrier
Kaustav Chatterjee
Santiram Chatterjee
Can Chen
Liang Chern Chow
Jyoti Chetri
Bhaskar Chittoori
Byoung Cho
Ishika Chowdhury
Jose Clemente
Charles Coccia
Joseph Coe
Richard Coffman
David Connolly
Brady Cox
Robert Crawford
Kaley Crawford-Flett
Raphael Crowley
W Cui
Todd Culp
Sheng Dai
John Damm
John Daniels
Vishal Dantal
Jasaswee Das
Shideh Dashti
Jyotishka Datta
John Davie
Dinu Davis Arakkal
Haitham Dawood
Tayler Day
Anirban De
Hubert Deaton
Carl Debono
James Delimitros
Joel Dellaria
Melih Demirkan
Norman Dennis
Daniel Dias
Guillermo Diaz-Fanas
Vansittee Dilli Rao
Jerry DiMaggio
Dan Ding
Vishnu Diyaljee
Yi Dong
Aliasghar Dormohammadi
Joseph Dunbar
Adrian Eberemu
John Edens
Herbert Einstein
May El Khattab
Omar El Khoury
Usama El Shamy
Fathey Elsaid
David Elwood
Rehab Elzeiny
Alan Esser
Jongwan Eun
Jeffrey Evans
Ahmed Faheem
Aly Fahmy
Hamid Fallah
Fadi Faraj
Hadi Fatehi
Aria Fathi
Alomir Favero Neto
Americo Fernandez
Marianna Ferrara
Matteo Ferrucci
Richard Finnoi
Ali Firat Cabalar
Maziar Foroutan
Kevin Foye
Raymond Frantz
Dante Fratta
Brian Freilich
Michael Fritzges
Mohammed Gabr
Mahi Galagoda
Khaled Galal

© ASCE

Patricia Gallagher
Aaron Gallant
Fernando Garcia
Luis Garcia
Victor Garcia
Mauricio Garcia Theran
Sarah Gassman
Philip Gauffreau
Donald Gerken
Hande Gerkus
Ismail Ghaaowd
Omid Ghasemi-Fare
Majid Ghayoomi
Ehsan Ghazanfari
Ehsan Ghazanfari
Shahin Ghazizadeh
Amin Gheibi
Emad Gheibi
Malay Ghose Hajra
Priyanka Ghosh
Sayantani Ghosh
James Gingery
Maria Giovanna Durante
Elizabeth Godfrey
Seda Gokyer
Helena Gomes
Jesus Gomez
Michael Gomez
Guobin Gong
Hongren Gong
Jared Green
Garry Gregory
Athina Grizi
Athina Grizi
Fan Gu
Lei Gu
Nenad Gucunski
Ranjiv Gupta
Sukh Gurung
Marte Gutierrez
Ivan Guzman
Hamid Haddadi
Tarik Hadj-Hamou
Caitlyn Hall
Kaitlin Hall
Kevin Hall
Nasser Hamdan
Sherif Hanna
Jonathan Harris
Youssef Hashash
Mehrdad Hassani
Toshiro Hata
Carol Hawk
Nathan Hayman
Reza Hedayat
Alexander Herzog
Amanda Hess
Carlton Ho
Tasha Hodges
Terry Holman
Edward Hoppe
Shabbir Hossain
Arash Hosseini
Isaac Howard
Liangbo Hu
Jie Huang
Peter Hubbard
Jonathan Hubler
Nick Hudyma
James Hussin
Nejan Huvaj Sarihan
Boo Hyun Nam
Gabriel Iltis
Marco Isola
Dan Jackson
Rowshon Jadid
Navid Jafari
Daniel Jankly
Carlos Jaramillo
Carlos Jaramillo
Priyantha Jayawickrama
Erik Jensen
Pravin Jha
Pravin Jha
Chunyang Ji
Chu Jian
Sarah Johnson
Allen Jones
Tucker Jones
Guillermo Jose Zavala Rosell
Maureen K Corcoran
Onur Kacar
Mehdi Kadivar
James Kaklamanos
Viktor Kaliakin
Arash Kamali-Asl
Edward Kavazanjian
Andrew Keffer
Behnoud Kermani
Majid Khabbazian
Taha Khalaff
Yazen Khasawneh
Hamed Khodadadi
Sara Khoshnevisan
Ali Khosravi

© ASCE

Mohammad Khosravi
Arash Khosravifar
Naji Khoury
Dong-soo Kim
Eunhye Kim
Marcus Kim
Sihyun Kim
Taehong Kim
Eric Klein
Weston Koehn
George Koerner
Sreevalsa Kolathayar
Prabir Kolay
Joshua Kolz
Van Komurka
Alireza Kordjazi
Joseph Krupansky
Levi Kryder
Jeffrey Kuhn
Stacey Kulesza
Ashutosh Kumar
Girish Kumar
Pratap Kumar
Rakesh Kumar
Sanjeev Kumar
Dilip Kumar Baidya
Anil Kumar Choudhary
Sujit Kumar Dash
Anil Kumar Sharma
Sanjay Kumar Shukla
Jan Kupec
Walter Kutschke
Welson Kwan
Tae-Hyuk Kwon
Joseph Labuz
Debra Laefer
Rakam Lama Tamang
Joan Larrahondo
Sam Lasley
Michael Law
Mauakanta Ldon
Jongwon Lee
Michelle Lee Barry
Gang Lei
Ben Leschinsky
Ben Leschinsky
Michael Lewis
Junhong Li
Kun Li
Lin Li
Marina Li
Xin Liao
Cheng Lin
Tim Lin
Bret Lingwall
Zhen Liu
Erik Loehr
John Lommler
Roberto Lopez
Theresa Loux
Barbara Luke
Ronaldo Luna
Matthew Lunemann
David Lutz
Scott Mackiewicz
Mary MacLaughlin
Brian Maggi
Nariman Mahabadi Mahabad
Abinash Mahanta
Farzaneh MahmoodPoor
Enad Mahmoud
Siavash Mahvelati
Roman Makhenko
Islam Mamdouh Ezz
Shahed Manzur
Benjy Marks
Landon Marston
Grant Martin
Alejandro Martinez
Meysam Mashayekhi
Ben Mason
Frederic Masse
Brett Maurer
Carlos Mauricio Rodriguez
Nathan Mayercsik
Mehran Mazari
John McCartney
Ken McCleskey
Monica McCullough
Ross McGillivray
Michael McGuire
James McKelvey
Christopher McKenney
Steven McMullen
Patrick McNamara
Karim Md Zahidul
Zenon Medina-Cetina
Keithe Merl
Scott Merry
Brian Metcalfe
Paul Michaels
Marta Miletic
Marc Miller
Morteza Mirsekari
Debakanta Mishra

© ASCE

Rozbeh Moghadaam
Merhab Moid
Hossain MollaAbbasi
Matteo Montesi
Jack Montgomery
Brina Montoya
Michael Mooney
Alesandra Morales
Ali Morovatdar
Joseph Morris
Kimia Mortezaei
Sarah Morton
Ramin Motamed
Masoud Mousavi
Sukjoon Na
Maheboobsab Nadaf
Ashkan Nafisi
Dali Naidu Arnepalli
Peter Narsavage
Kalehiwot Nega Manahiloh
Albert Neumann
Peter Neumann
Madan Neupane
Roberto Nevarez Garibaldi
David Nevius
Kam Ng
Thang Nguyen
Peter Nicholson
Jennifer Nicks
Alexandros Nikellis
Sissy Nikolaou
Sanjay Nimbalkar
Zhangwei Ning
Mary Nodine
Sean O'Connell
Lalita Oka
Roberto Olivera
Kimball Olsen
Larry Olson
Scott Olson
Thomas Oommen
Omar Osama El-Shafee
K.J. Osinubi
Abdolreza Osouli
William Ovalle
Anindya Pain
Angel Palomino
Miguel Pando
Sarath Panthangi
Balaji Paramasivam
Siddarth Parida
Choon Park
Youngjin Park
Trent Parkhill
Jonathan Pasco
Ujwalkumar Patil
Aravind Pedaria
Menzer Pehlivan
William Petersen
Vinh Pham
Adrienne Phillips
James Phipps
Alan Poeppel
Tyler Poggiogalle
Carmine Polito
William Pollock
Mihail Popescu
Alex Potter-Weight
Daniel Pradel
Amit Prashant
James Press
Russ Preuss
Adam Price
Rafael Prieto
Jean Provost
Aaron Pullen
Tong Qiu
Ata Radfar
Amin Rafiei
Amr Ragy
Mehrzad Rahimi
Mostaqur Rahman
Raksha Rai
B Ram Rathan Lal
Sarah Ramp
Scott Raschke
Mohammad Rashidi
Ellen Rathje
Nadarajah Ravichandran
K.V.N.S. Raviteja
Deepak Rayamajhi
Krishna Reddy
Alex Reeb
Alex Reeb
Bridgit Reeve
Jose Ricardo Pontes Resende
Stephen Richards
Jesse Richins
Matthew Riegel
Stefano Rignanese
Helen Robinson
Nicholas Rocco
Adrian Rodriguez-Marek
Mark Rohrbach
Kyle Rollins

© ASCE

Brent Rosenblad
Jason Ross
Mary Roth
Michael Rucker
Cassandra Rutherford
M Sabry
Mohammad Sadik Khan
Arezoo Sadrinezhad
David Saftner
Rajni Saggu
Mohammad Saghafi
Sajjad Salam
Reza Salehi Ashtiani
Hosam Salman
Kristin Sample-Lord
Naresh Samtani
Tony Sangiuliano
Ritika Sangroya Kundu
Nicoletta Sanvitale
Surya Sarat Chandra Congress
Raghav Sarathy Ramanathan
Inthuorn Sasanakul
Joseph Scalia
Lilma Schimmel
Kurt Schimpke
Montgomery Schultz
Ian Scotland
Kevin Scott
Peter Scott
Jeff Segar
Asitha Senanayake
Hoyoung Seo
James Serpico
Kallol Sett
Emel Seyhan
Alejo Sfriso
Charles Shackelford
Shahriar Shahrokhabadi
Keshab Sharma
Megha Sharma
Shweta Shrestha
Xiang Shu
Phil Shull
Shafiq Siddiqui
Timonthy Siegel
Francisco Silva-Tulla
Michael Simac
Lyle Simonton
Sugandha Singh
Matthew Sleep
Joel Sloan
Alex Smith
Miriam Smith
David Snyder
Konstantin Sobolev
Antonio Soldo
Behzad Soltanbeigi
Yasser Soltanpour
R Sridhar
Ioannis Stefanou
Isaac Stephens
Sam Sternberg III
Eric Steward
Shelley Stoffels
Armin Stuedlein
Muhannad Suleiman
Richard Sullivan
Lixun Sun
Oscar Suncar Garcia
David Sutfin
Nico Sutmoller
Robert Swan
Bryan Sweeney
Matthew Sylvain
David Taborda
Amir-Ata Taghavi
Abbasali Taghavighalesari
Gilbert Tallard
Claudio Tamagnini
Prajwol Tamrakar
Yong Tan
Hui Tao
Junliang Tao
Thomas Taylor
Thomas Terry
Audai Theinat
Mark Thompson
Cesar Tirado
Binod Tiwari
Dominique Tobler
Ingrid Tomac
Fulvio Tonon
Khiem Tran
Tri Tran
Aurelian Trandafir
Anne Turner
Benjamin Turner
Erol Tutumluer
Edward Ulrich
Farshid Vahedifard
Rouzbeh Vakili
Rick Valentine
Luis Vallejo
Leon Van Paassen

© ASCE

Sai Vanapalli
Daniel VandenBerge
Wouter Vanderstar
Lee Vanzler
Sotirios Vardakos
Mehdi Veiskarami
Pavana Vennapusa
Osvaldo Vitali
Pavlo Voitenko
Antonios Vytiniotis
Assil Wajdi Abu Diab
Tanya Walkenbach
P Wallbridge
Helsin Wang
Lei Wang
Shin-Tower Wang
Kimberly Warren
Alexandra Wayllace
Jeffrey Weidner
Andrea Welker
Cassandra Wetzel
Kord Wissmann
Daniel Woeste
Louis Wong
Clinton Wood
Dylan Wood
Martin Woodard
Chris Woods
Robert Worley II
Donald Wotring
Zhenzhong Wu
Ming Xiao
Yilong Xiao
Yonggui Xie
Jun Yao
Walter Yerk
Nazli Yesiller
Ronald Yeung
Samuel Yniesta
Xiaomin You
Xinbao Yu
Xiong Yu
Michael Yust
Zia Zafir
Mohammad Zahidul Islam Bhuiyan
Atefeh Zamani
Luis Zambrano-Cruzatty
Siavash Zamiran
Kaveh Zehtab
Dimitrios Zekkos
Bo Zhang
Lianyang Zhang
Ming Zhang
Wen-jie Zhang
Xiong Zhang
Yan Zhang
Aigen Zhao
Jian Zheng
Junxing Zheng
Yewei Zheng
Shengyang Zhou
Ming Zhu
Thomas Zimmie
Katerina Ziotopoulou
Daren Zywicki

© ASCE

Contents

Geoenvironmental Engineering

Evaluation of Field Scale Unsaturated Soil Behavior of Landfill Cover through Geophysical Testing and Instrumentation 1
Md. Jobair Bin Alam, Md. Sahadat Hossain, Linkan Sarkar, and Naima Rahman

Dialysis Method to Measure Diffusion in Sodium and Enhanced Bentonites 12
Shan Tong, Kristin M. Sample-Lord, Gretchen L. Bohnhoff, Andrew B. Balken, and Mustaki Ahmed

Case History of an Exhumed Landfill Double Liner System 22
George R. Koerner and Robert M. Koerner

Bioremediation of High Saline Soil through the Common Collective Microorganisms 33
M. Azizul Moqsud and Kenichi Soga

Hydraulic Conductivity and Soil Water Retention of Waste Rock and Tailings Mixtures 41
Mohammad H. Gorakhki, Christopher A. Bareither, Joseph Scalia, and Michael Jacobs

Mechanism Study of Borehole Instability in Carbonate Reservoir through Discrete Element Modeling 51
Chao Zeng and Wen Deng

Stabilization of Hazardous Solid Waste Landfill on Sloping Ground with Variable Base Inclination 62
Abinash Mahanta, Riya Bhowmik, and Manoj Datta

Monitoring Seasonal Variation of Soil Hydraulic Conductivity of Evapotranspiration (ET) Cover 72
Lucas Hoyos, Md. Jobair Bin Alam, Md. Sahadat Hossain, and Brenda Haney

Velocity and Drag Force Distribution of Fluid Flow in Mono- and Binary-Sized Particulate Porous Media 82
Bahman Sheikh and Tong Qiu

Field Hydrologic Performance of Water Balance Cover in North Texas 95
Md. Jobair Bin Alam, Brett DeVries, Naima Rahman, and Md. Sahadat Hossain

Factors Affecting the Kinetics of Urea Hydrolysis via *Sporoscarcina pasteurii* 105
Shahin Safavizadeh, Brina M. Montoya, Mohammed A. Gabr, and Detlef R. U. Knappe

© ASCE

Migration of Aqueous Benzene through a Subsurface Concrete Utility Pipe under Saturated Soil Conditions 115
S. Alhomair, P. Hosseini, M. Gabr, M. Pour-Ghaz, and D. Knappe

Life Cycle Analysis as a Tool to Assess the Sustainability of Waste Management Practices in Bangalore City 125
P. Sughosh, N. Anusree, and G. L. Sivakumar Babu

In Situ Compaction Characterization of Dry Stacked Coal Combustion Residues 135
David J. White, Pavana Vennapusa, Brendan FitzPatrick, Eric Hageman, Jason Hill, and Nick McClung

Shear Response of Interfaces in Liner System under Accelerated Degradation of MSW in Bioreactor Landfill 149
Girish Kumar and Krishna R. Reddy

Effect of Moisture Content on CO_2 Sequestration by BOF Slag in Landfill Cover 158
Jyoti K. Chetri, Krishna R. Reddy, and Dennis G. Grubb

Synthesis of Friedel's Salt for Application in Halide Sequestration Using Paste Encapsulation Technology 167
Abhisek Manikonda, Vincent O. Ogunro, Kirk M. Ellison, and Keith Moo-Young

Stresses in Soil-Bentonite Slurry Trench Cutoff Wall 177
Jeffrey C. Evans and Daniel Ruffing

Sustainability in Geotechnical Engineering

Role of Water Absorption on Rainsplash Erosion Performance of Natural Fiber RECPs 185
Jennifer L. Smith and Shobha K. Bhatia

Potential of Tire Waste as Infill Material in Geocells for Soil Retention Systems 193
Sreevalsa Kolathayar and C. Rajesh Kumar

Numerical Simulation of Cellular Reinforced Fly Ash Slopes 202
Maheboobsab B. Nadaf and J. N. Mandal

Evaluation of Composite Subgrade Reaction Modulus of Geosynthetic-Stabilized Recycled Subbase over Subgrade 212
Tanya N. Walkenbach, Jie Han, Zexia Li, and Robert L. Parsons

Innovative and Sustainable Uses of Volcanic Ash as a Natural Pozzolan for Dust Abatement and Unpaved Roadway Improvement 222
Matthew D. Sleep and Morgan Masley

© ASCE

Experimental Studies on Bottom Ash and Blast Furnace Slag Based Geomaterial under Compressive Loading 232
B. Ram Rathan Lal, Vicky A. Hinge, Sonali S. Nawkhare, and K. Shanker

Application of Triple Bottom Line Sustainability Framework to Select Remediation Method at Industrial Contaminated Site 241
Krishna R. Reddy and Girish Kumar

From Sky to Sea: Geotechnical Challenges of Transforming a Former Philadelphia Airfield into a Future Marine Terminal 252
Eric W. Pauli and Vatsal A. Shah

Strength and Deformation Characteristics of Bottom-Ash Reinforced with Single Geocell Mattress Made of Waste Pet Bottles 263
Anil Kumar Choudhary, J. N. Jha, and Sujata Fulambarkar

Performance of a Field-Scale Shallow Horizontal Thermal Energy Storage System 273
Tuğçe Başer, Candice Hanna, and John S. McCartney

Experimental Study of Load and Settlement Behavior of Bamboo Grid Reinforced Sand 282
Sunil K. Ahirwar and J. N. Mandal

Use of Repurposed Fibers to Decrease Hydraulic Conductivity without Compromising Load Restrictions in Urban Roof Farms 291
Ivan L. Guzman and Sandra M. Torres

Evaluation of Waste Foundry Sand and Blast Furnace Steel Slag as Geomaterials 304
K. P. Bhargav Kumar, Geetha Krishna, and B. Umashankar

Geotechnical Resilience Engineering Guidelines for Upland Confined Disposal Facilities: A Case Study Approach 314
Matthew M. Lunemann and W. Scott Douglas

Performance Evaluation of Municipal Solid Waste as a Sustainable Backfill Material in RE Wall 328
Kinjal H. Gajjar, Manish V. Shah, and Alpa J. Shah

© ASCE