

GEOTECHNICAL SPECIAL PUBLICATION NO. 341

GEO-CONGRESS 2023

FOUNDATIONS, RETAINING STRUCTURES, AND GEOSYNTHETICS

SELECTED PAPERS FROM SESSIONS OF
GEO-CONGRESS 2023

March 26–29, 2023
Los Angeles, California

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

EDITED BY
Ellen Rathje, Ph.D., P.E.
Brina M. Montoya, Ph.D., P.E.
Mark H. Wayne, Ph.D., P.E.



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/10.1061/9780784484685>

Copyright © 2023 by the American Society of Civil Engineers.
All Rights Reserved.
ISBN 978-0-7844-8468-5 (PDF)
Manufactured in the United States of America.

Preface

This is the fourth volume of six Geotechnical Special Publications (GSPs) containing papers from the 2023 Geo-Congress: Sustainable Infrastructure Solutions from the Ground Up, held in Los Angeles, California on March 26–29, 2023. These six volumes contain over 350 contributions that span 22 topic areas of the ASCE Geo-Institute's standing technical committee as well as 11 special topics unique to Geo-Congress 2023.

This volume includes contributions from foundation engineering (both shallow and deep foundations), earth retaining structures, and the use of geosynthetics in geotechnical systems.

This publication culminates two years of effort by the technical planning committee whose focus has been to continue the success of the previous Geo-Congress 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 more than 350 accepted technical papers, that were presented in a wide range of technical 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,

Ellen Rathje, Ph.D., P.E., F.ASCE, University of Texas at Austin

Brina M. Montoya, Ph.D., P.E., M.ASCE, North Carolina State University

Mark H. Wayne, Ph.D., P.E., M.ASCE, Tensar International

Acknowledgments

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

2023 GeoCongress Conference Program Committee

Conference Chair

Yoga Chandran, Ph.D., P.E., M.ASCE

Technical Program Committee

Chair, Scott Brandenburg, Ph.D., P.E., M.ASCE

Beena Ajmera, Ph.D., P.E., M.ASCE

David Albus, P.E., M.ASCE

Daniel Alzamora, P.E., M.ASCE

Ben Leshchinsky, Ph.D., P.E., M.ASCE

John McCartney, Ph.D., P.E., F.ASCE

Amy Rechenmacher, Ph.D., P.E., M.ASCE

Lisa Star, Ph.D., P.E., M.ASCE

Proceedings Editors

Ellen Rathje, Ph.D., P.E., F.ASCE, University of Texas at Austin

Brina Montoya, Ph.D., P.E., M.ASCE, North Carolina State University

Mark Wayne, P.E., M.ASCE, Tensar

Contents

Deep Foundations

Comparative Study on Performance of CFA Piles and Drilled Shafts in Dos Bocas, Mexico.....	1
Chulmin Jung, Juan Carlos Martinez-Rojas, Sergio Zaldivar, Rogelio Monroy, Gabriel Méndez, and Jihoon Kim	
Effect of Degree of Saturation on Behavior of Helical Piles in Frozen Soils	14
Kamran Nawaz and Tugce Baser	
Effect of Seismic Acceleration Coefficients on Seismic Passive Earth Pressure Coefficient of Caisson due to Cohesion	24
Mohit Kumar and Kaustav Chatterjee	
Utilizing Site Investigation and Load Tests to Predict Drilled Shaft Design Parameters and Capacities for Various Geological Formations	34
Hosam Salman, Anand J. Puppala, and Bhaskar C. S. Chittoori	
Static Response of a Pile Group in the Domain of Uncertainty.....	45
Saikumar Kotra and Kaustav Chatterjee	
A Numerical Approach to Correlate Energy Performance of Prototype and Model-Scale Geothermal Piles.....	54
Arvind Kumar Tiwari and Prasenjit Basu	
Evolution of Shaft and Tip Resistance in Energy Piles throughout a Full Heating-Cooling Cycle.....	64
Arash Saeidi Rashk Olia and Dunja Perić	
Case Study: Drilled Shaft Installation in Difficult Site Conditions—Loose Sand and High Groundwater Table.....	73
Anthony El Hachem and Hosam Salman	
Rational Approach to Lateral Load Tests on Single Piles with Measurement of Tiltling at Pile Top	82
Tian Ho Seah, Chulmin Jung, Weeraphon Kitipongpairaj, Wuttichai Samaiklang, and Sujatha Manoj	
Pile Design and Construction at the Opera Residences in Ho Chi Minh City, Vietnam—A Case Study.....	92
Quoc Dung Pham, Hoang Nhan Pham, Truong Nghia Bui, and Ta Le Phan	

Application of Non-Reinforced Rigid Inclusion Columns as Foundation Support for Container Yard	105
Hao Chen, Hanjiang Lai, Shifan Wu, Stephen Lim, Tiancheng Song, and Jian Chu	
Long-Term Field Monitoring of Lateral Loads in Semi-Integral Bridge Foundations.....	114
Behdad Mofarraj and Jorge G. Zornberg	
Pile Driving Refusal Assessment of Steel H-Piles in Schist Saprolite	124
Lei Gu and Ara G. Mouradian	
Optimal Design of a Deeply Embedded Ring Anchor in Soft Clay Overlying Bedrock under Vertical Loading.....	133
Junho Lee, Ragini Gogoi, Krishnaveni Balakrishnan, Charles P. Aubeny, Sanjay Arwade, Don DeGroot, Alejandro Martinez, and Ryan Beemer	
A p-y Q-z Method for Analyzing Helical Piles under Lateral Loading	143
Leon D. Cortes-Garcia, Aaron P. Gallant, and Carlos A. Vega-Posada	
State of the Practice in Florida on Vibrations and Movements due to Deep Foundation Installations	153
Jorge E. Orozco-Herrera, Berk Turkel, Luis G. Arboleda-Monsalve, and Boo Hyun Nam	
Evaluation of a Semi-Empirical <i>p-y</i> Model for Caliche Material Based on Numerical Simulations of Field Load Tests in Cemented Soils	163
Fahim M. Bhuiyan, Ramin Motamed, and Raj V. Siddharthan	
A Machine Learning-Based Method with Integrated Physics Knowledge for Predicting Bearing Capacity of Pile Foundations.....	175
Jun Xiong, Te Pei, and Tong Qiu	
Calibrations of the Innovative S3F Sensor for Normal Stress Measurements in Soil.....	185
Hussein Alqrinawi, Hai Lin, and Shengli Chen	
Karst Resistant Deep Foundation System—A Case History	194
Matthew A. Dettman	
Evaluating the Site Variability Using Bayesian Analysis.....	205
Md. Habibur Rahman, Murad Y. Abu-Farsakh, and Sabarethinam Kameshwar	
Incorporating Site Variability into LRFD Design of Pile Foundation.....	212
Murad Y. Abu-Farsakh and Md. Habibur Rahman	

A Deep Learning Model to Predict the Lateral Capacity of Monopiles220
 Amir Hosein Taherkhani, Qipei (Gavin) Mei, and Fei Han

Behavior of Single Pile and Mono Pile-Raft Foundation under Hydraulic Loading Considering Hysteresis in Unsaturated Soils228
 Sonu Kumar and Ashutosh Kumar

Prediction of Liquefaction-Induced Lateral Spreading Structural Demands on Bridge Foundation Using Deterministic and Numerical Methods240
 Siddharth Marathe and Nadarajah Ravichandran

Assessing the Critical Depth Concept for Piles Driven in Cohesionless Soils251
 Abesh J. Karki and Sherif L. Abdelaziz

Axial Response of Driven Steel Pile in Clearwater, MN, Using Elastic Solution and Seismic Piezocone260
 Paul W. Mayne, Derrick D. Dasenbrock, and Aaron S. Budge

Evaluating the Effects of Asperity Height on Shear Strength of Cohesive Soil-Structure Interface Subjected to Monotonic and Cyclic Axial Loading270
 Mu'ath I. Abu Qamar and Muhannad T. Suleiman

Laboratory Pull-Out Test of a Percussion Driven Earth Anchor Installed in a Clayey Soil Compacted Inside a Soil Box281
 Natnael T. Asfaw, Mehran Azizan, Arjan Poudel, and Xinbao Yu

Earth Retaining Structures

Influence of Strip Load on Seismic Behavior of Cantilever Sheet Pile Walls292
 Akshay P. Singh and Kaustav Chatterjee

An Experimental Study to Investigate the Effect of Biopolymer-Treated Layers on the Lateral Earth Pressure of Retaining Wall Backfill302
 Gi-Yun Kim, Haejin Lee, Gye-Chun Cho, and Ilhan Chang

Shaking Table Tests on Geocell-Reinforced Model Walls309
 Ali Sedaghat and Abbas Ghalandarzadeh

Durability Testing of Geogrid in High pH Conditions for Sustainable Alternative MSE Backfill319
 Laura M. Spencer, John M. Lostumbo, and Joe Friederichs

Combined Effects of Corrosion and Migration of Fines on Stability of Mechanically Stabilized Earth Walls	327
S. Mustapha Rahmaninezhad, Thang Pham, Thuy Vu, Ashley Alanis, and Alfonso A. Soto	
Geotechnical and Economical Aspects of Using Mixed Recycled Aggregate from Construction and Demolition Waste for Reinforced Soil Structures	335
Apoorva Agarwal, G. V. Ramana, Manoj Datta, Narendra Kumar Soni, and Rajiv Satyakam	
Analytical Method for Predicting Lateral Facing Deflection of Geosynthetic-Reinforced Soil Abutment Walls.....	345
Thang Pham, S. Mustapha Rahmaninezhad, Andres Palma, Truc Phan, and Thuy Vu	
Technical Review of the Back-to-Back Mechanically Stabilized Earth Walls.....	359
Jie Han and Turki Alsharari	
Axial Load Tests of Geosynthetic Reinforced Soil (GRS) Piers Constructed with Florida Limestone Aggregate and Woven Geotextile	369
Christian H. Matemu, Scott J. Wasman, and Larry Jones	
Long Term Performance of Recycled Plastic Pins in Increasing the Base Resistance of MSE Wall Base	379
Sehneela Sara Aurpa, Prabesh Bhandari, Md. Lutfur Rahman, Zobair Ahmed, and Md. Sahadat Hossain	
A Study of the Use of Ultra-Lightweight Foamed Glass Aggregate for Retaining and MSE Wall Backfill	390
Theresa Andrejack Loux and Archie Filshill	
TBM Tunnel Repair Using a Secant “Horseshoe” Compression Shoring System.....	401
Zachery Shafer, Giuseppe Gaspari, Lisheng Shao, Kaveh Talebi, Noah Miner, Rob Jameson, and Chad Gray	
Field Monitoring of Soil Response for Curved Integral Abutment Bridge during Seasonal Temperature Changes	418
Yusuf Alhowaidi, Seunghee Kim, and Jongwan Eun	

Geosynthetics

Effectiveness of Geosynthetics at Preventing Subgrade Instability under Cyclic Loading.....	427
Joseph Arivalagan, Cholachat Rujikiatkamjorn, Buddhima Indraratna, and Andy Warwick	

Numerical Study of the Influence of Foundation Soil on the Deformation Behavior of Geosynthetic Reinforced Soil-Integrated Bridge System under Service Load Conditions	438
Yihan Jiang, Wenhao Guo, Patrick J. Fox, John S. McCartney, and Yewei Zheng	
Numerical Study of the Dynamic Response of Stone Column and Geosynthetic Encased Stone Column in Soft Clay	447
Yewei Zheng, Jiaxin Wang, and Mingchang Ji	
A Research Update on an Enhanced Lateral Drainage Moisture Management Geosynthetic for Roadways and Civil Structures	456
René Laprade	
Numerical Study on Behavior of Narrow Back-to-Back Geosynthetic Reinforced Soil Walls	466
Ramyasri Rachamadugu, Amit Prashant, and Md. Nayim Siddiqui	
Partial Safety Factors for Hydraulic Conductivity Requirements of Granular and Geotextile Filters	476
Kalore A. Shubham and G. L. Sivakumar Babu	
Geotextile Filter Design Using Pore Size Distribution.....	486
Richard L. Sack, Joel Sprague, and Jeffrey Kuhn	
Experimental Investigation of the Suitability of 3D Printing for Soil-Continuum Interface Studies	497
V. L. Gayathri and Prashanth Vangla	
Shear Response of Non-Dilative Interfaces: A Micromechanical Perspective.....	507
Lalit Kandpal, Prashanth Vangla, and Nitya Nand Gosvami	
Effects of Traffic Loading Magnitude and Frequency on the Performance of Geocell-Reinforced Flexible Pavements	517
Md. Ashrafuzzaman Khan, Nripojoyti Biswas, Aritra Banerjee, and Anand J. Puppala	
Sand-Woven Geotextile Interface Shear Strengths in Different Shearing Directions.....	526
Md. Wasif Zaman and Jie Han	
Direct Shear and Inclined Plane Experimental Activities for Different Interfaces among Geosynthetics and Soils	536
Daniele Cazzuffi, Piergiorgio Recalcatti, and Lidia Sarah Calvarano	

Thermo-Hydro-Mechanical Shear Behavior of Interfaces between a Textured Geomembrane and Geosynthetic Clay Liner	545
Juan Hou, Xing Xing, and Craig H. Benson	

Shallow Foundations

Skirted Footing for Enhancing Load Carrying Capacity	554
Khalid Bashir, Rajesh Shukla, and Ravi S. Jakka	

Evaluation of Settlement Prediction Methods for Shallow Foundations on Cohesionless Soils	564
Tarek F. Haider and Sanjay K. Jha	

Load Transfer Mechanism of an Anchor Foundation System through 3D Finite Element Modeling	573
Osvaldo P. M. Vitali, Mohammad Nasim, and Yazan Khasawneh	

Influence of Soil Destructuration on Bearing Capacity Estimation of Square Footings in Structured Clay.....	582
Abhishek Ghosh Dastider, Prasenjit Basu, and Santiram Chatterjee	

Large-Scale Testing of the Static One-Dimensional Compression Response of Tire-Derived Aggregate	593
Axel Yarahuaman and John S. McCartney	

Modeling of Rocking Induced Permanent Settlement of Shallow Foundations Using Machine Learning Algorithms	604
Sivapalan Gajan	

Seismic Bearing Capacity of an Embedded Strip Footing on Slope Using Modified Pseudo-Dynamic Method	614
K. Halder and D. Chakraborty	

Implementation of Hyperbolic Load-Deformation Model in Reliability-Based Design (RBD) of Shallow Foundations Using Some In Situ Test Results	623
Pouya Pishgah, Hossein MolaAbasi, Arsalan Majlesi, and Reza J. Chenari	