

# **Geo-Congress 2023**

## **Geotechnical Data Analysis and Computation**

Selected Papers from Sessions of Geo-Congress 2023

Geotechnical Special Publication Number 342

Los Angeles, California, USA

26 – 29 March 2023

### **Editors:**

**Ellen Rathje**

**Brina M. Montoya**

**Mark H. Wayne**

ISBN: 978-1-7138-7175-0

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

Copyright© (2023) by American Society of Civil Engineers  
All rights reserved.

Printed with permission by Curran Associates, Inc. (2023)

For permission requests, please contact American Society of Civil Engineers  
at the address below.

American Society of Civil Engineers  
1801 Alexander Bell Drive  
Reston, VA 20191  
USA

Phone: (800) 548-2723  
Fax: (703) 295-6333

[www.asce.org](http://www.asce.org)

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2633  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

# Contents

## *Computational Geotechnics*

<b>Modeling Cracks in Clay at the Nanoscale through Molecular Dynamics.....</b>	<b>1</b>
Zhe Zhang and Xiaoyu Song	
<b>Stability Analysis of Infinite Unsaturated Soil Slope Based on Analytical Probabilistic Approach .....</b>	<b>11</b>
Tanmoy Das and Deepankar Choudhury	
<b>Modelling of Tracks at Transition Zones: Analytical and Numerical Modelling Approach .....</b>	<b>22</b>
Muhammad Babar Sajjad, Buddhima Indraratna, Trung Ngoc Ngo, and Cholachat Rujikiatkamjorn	
<b>Comparison of Simple and Advanced Constitutive Models with Column Collapse Simulations in the Material Point Method .....</b>	<b>30</b>
Joel Given and Kenichi Soga	
<b>Probabilistic Assessment of Bearing Capacity of Strip Footings Seated on Geosynthetic Reinforced Soil Deposits Using Finite Element Limit Analysis (FELA) and Response Surface Method (RSM) .....</b>	<b>40</b>
Masoud Jamshidi Chenari, Meghdad Payan, Reza Jamshidi Chenari, Pooya Dastpak, and Rita L. Sousa	
<b>A Comparative Study on the Performance of CFD/LBM-DEM Coupling in Predicting Soil Fluidization.....</b>	<b>51</b>
Thanh T. Nguyen, Buddhima Indraratna, Cholachat Rujikiatkamjorn, and Shay Haq	
<b>Pseudo-Static Stability Analysis of Vertically Expanded MSW Landfill with Engineered Berm .....</b>	<b>62</b>
Somdutt Pathak and Kaustav Chatterjee	
<b>Characterization and Discrete Element Modeling of LHS-1 Lunar Highlands Simulant .....</b>	<b>74</b>
Zakia Tasnim, Qiushi Chen, Jesus Badal, and Lei Wang	
<b>High-Performance, High-Order Implicit Material Point Method for Progressive Levee Failure Simulations .....</b>	<b>85</b>
Bodhinanda Chandra, Ryota Hashimoto, Miguel Molinos, and Kenichi Soga	

<b>Influence of Seabed Characteristics on Cyclic Pull-Out Behavior of Suction Anchor for Floating Offshore Wind Turbine under Environmental Loads .....</b>	<b>96</b>
Amir Moghaddam and Amin Barari	
<b>Comparative Analysis of Horizontal Self-Burrowing Strategies Using Full-Scale DEM-MBD Co-Simulations .....</b>	<b>106</b>
Yi Zhong and Julian Tao	
<b>Evaluation of an Experimental-Numerical Workflow for Analysis of Shear Zone Development in Clean Sands.....</b>	<b>115</b>
Fernando E. Garcia and Jose E. Andrade	
<b>3D Modeling of Pile-Supported Wharf Subjected to Liquefaction-Induced Lateral Ground Deformations .....</b>	<b>124</b>
Arash Khosravifar and Milad Souri	
<b>Insights on 2D versus 3D Modeling of Strip Loading on Spatially Varying Random Soil Domain.....</b>	<b>134</b>
Ashu Singhal, Gyan Vikash, and Sanskrit Singhai	
<b>DEM Simulation of a Bio-Inspired Self-Burrowing Probe in Granular Materials .....</b>	<b>142</b>
Ningning Zhang, Yuyan Chen, Alejandro Martinez, and Raul Fuentes	
<b>Soil-Embedded Guardrail Post Modeling under Vehicle Impacts.....</b>	<b>151</b>
Mojdeh Asadollahi Pajouh, Tewodros Yosef, Robert W. Bielenberg, and Ronald K. Faller	
<b>A Comparative Study of 2D and 3D Finite Element Analysis for the Estimation of Piled Raft Foundation Performance .....</b>	<b>163</b>
Batuhan Colak, Asli Y. Dayioglu, Tolga Y. Ozudogru, and Mustafa Hatipoglu	
<b>3D Discrete Element Modeling of Cone Penetration into the JSC-1A Lunar Regolith .....</b>	<b>172</b>
Lei Wang, Omer Okur, Zakia Tasnim, Qiushi Chen, Liang Zhang, and Jesus Badal	
<b>Numerical Analysis of FFP Impact on Saturated Sands .....</b>	<b>180</b>
Fuat Furkan Yalcin, Luis Zambrano-Cruzatty, and Alba Yerro-Colom	
<b>Three-Dimensional Fully Coupled Thermo-Hydro-Mechanical Model for Thaw Consolidation of Permafrost .....</b>	<b>190</b>
Min Liew and Ming Xiao	
<b>A Machine Learning Approach to Predicting Pore Pressure Response in Liquefiable Sands under Cyclic Loading .....</b>	<b>202</b>
Yongjin Choi and Krishna Kumar	

<b>Hybrid Finite Element and Material Point Method to Simulate Granular Column Collapse from Failure Initiation to Runout.....</b>	<b>211</b>
Brent Sordo, Ellen Rathje, and Krishna Kumar	
<b>Stress Distribution and Fabric Anisotropy of Heated Backfill.....</b>	<b>221</b>
Karam A. Jaradat and Sherif L. Abdelaziz	
<b>Freezing Effects on the Behavior of Diffused Double Layer Using Molecular Dynamics .....</b>	<b>230</b>
Shijun Wei and Sherif L. Abdelaziz	
<b>A Multi-Phase Field Model for Simulating Ice Lens Growth and Thawing in Frozen Porous Media .....</b>	<b>239</b>
Hyoung Suk Suh and WaiChing Sun	
<b>The Effects of Fines on the Response of Granular Soil during Earth Pressure Balance (EPB) Shield Tunneling .....</b>	<b>249</b>
Yang Cao, Hoang Bao Khoi Nguyen, Md. Mizanur Rahman, Md. Rajibul Karim, and Wen-Chieh Cheng	
<b>Effect of Interparticle Friction and Particle Elasticity on Behavior of Granular Materials .....</b>	<b>258</b>
Derrick Aikins, Md. Mizanur Rahman, Md. Rajibul Karim, and Hoang Bao Khoi Nguyen	
<b>Three-Dimensional Spatial Stability Analysis of the Fundão Dam.....</b>	<b>269</b>
Gilson de F. N. Gitirana Jr., João Paulo Tavares Souza, Nicolas R. Moura, Marina Trevizolli, and Murray D. Fredlund	
<i>Data and Software for Geotechnical Engineering</i>	
<b>Strength Prediction by Support Vector Regression (SVR) for Biopolymer-Based Soil Treatment (BPST).....</b>	<b>281</b>
Haejin Lee, Jaemin Lee, Seunghwa Ryu, and Ilhan Chang	
<b>Shield Moving Trajectory Prediction and Anomaly Detection during Tunnelling: A Deep Learning Algorithm Framework .....</b>	<b>287</b>
Xue-Dong Bai and Wen-Chieh Cheng	
<b>Data-Driven Modeling of Seismic Energy Dissipation of Rocking Foundations Using Decision Tree-Based Ensemble Machine Learning Algorithms .....</b>	<b>298</b>
Sivapalan Gajan, Wakeley Bunker, and Alexander Bonacci	
<b>DEM-MBD Coupled Simulation of a Burrowing Robot in Dry Sand .....</b>	<b>309</b>
Sarina Shahhosseini, Mohan Parekh, and Junliang Tao	

<b>On Georeferenced Soil Engineering Properties and Interpolations .....</b>	<b>318</b>
Tifong Chin, T. Matthew Evans, and Ben Leshchinsky	
<b>High-Pass Corner Frequency Selection for Implementation in the USGS Automated Ground Motion Processing Tool .....</b>	<b>327</b>
M. E. Ramos-Sepulveda, G. A. Parker, E. M. Thompson, S. J. Brandenberg, M. Li, O. Ilhan, Y. M. A. Hashash, E. M. Rathje, and J. P. Stewart	
 <i>Data, Remote Sensing, and Cloud Computing</i>	
 <b>Spatial Interpolation of UAV Survey Data for Lift Thickness Determination during Earthwork Construction.....</b>	<b>336</b>
William J. Baker III and Christopher L. Meehan	
 <b>Effect of Machine Learning Algorithms on Detection of Landslides Caused by the 2015 Lefkada Earthquake.....</b>	<b>347</b>
Jhih-Rou Huang and Dimitrios Zekkos	
 <b>Image Analyses of Liquefaction-Induced Settlements and Sand Boil in Shaking Table Tests.....</b>	<b>357</b>
Fu-Hsuan Yeh, Hao-Ching Wang, Wen-Di Lee, and Louis Ge	
 <b>Application of Distributed Fiber Optic Sensing for Subsurface Levee Monitoring .....</b>	<b>367</b>
R. Andrew Yeskoo, John W. Murphy, Peter Hubbard, E. Tyler Vroman, Chien-Chih Wang, Linqing Luo, Richard Costley, and Kenichi Soga	
 <b>Utilizing Remote Sensing and Site Reconnaissance Data to Map Surface Manifestation of Liquefaction.....</b>	<b>377</b>
Timothy M. O'Donnell, Paolo Zimmaro, Eric J. Fielding, and Jonathan P. Stewart	
 <b>Characterization of Soil Crack Patterns Using Deep Neural Networks .....</b>	<b>389</b>
Ali Vafaei, Amin Amirlatifi, and Farshid Vahedifard	
 <b>Water Resources Infrastructure Digital Twins: Design, Development, and Future Efforts.....</b>	<b>400</b>
Lucas A. Walshire, Megan E. Gonzalez, Jeff Lillycrop, Emily Seamster, and Katherine E. Winters	
 <b>Soil Moisture Active Passive (SMAP) Data for Ground Monitoring during Earthquakes .....</b>	<b>409</b>
Ali Farahani, Majid Ghayoomi, and Jennifer M. Jacobs	
 <b>Wholistic Monitoring—Integrated InSAR, Lidar, and Instrumentation.....</b>	<b>419</b>
Travis A. Shoemaker, Matthew Lopez, Michael B. S. Yust, and Allen W. Cadden	

<b>Early Warning Protocol against Highway Slope Failures in Mississippi .....</b>	<b>430</b>
Nobahar Masoud, Salunke Rakesh, Khan Mohammad Sadik, and Amini Farshad	
<b>Increasing Data Transfer Efficiency and Accuracy through DIGGS: Expanding DIGGS to Include Permeation and Compaction Grouting.....</b>	<b>440</b>
Amanda Wachenfeld, Daniel Ponti, Allen Cadden, and Chadi El Mohtar	
<b>Methods to Reduce Geotechnical Uncertainty and Risk Using Big Data Collected during Construction .....</b>	<b>450</b>
Michael A. Mooney, Jacob Grasmick, and Rajat Gangrade	
<b>Relational Database for California Strong Ground Motions .....</b>	<b>461</b>
Tristan E. Buckreis, Chukwuebuka C. Nweke, Pengfei Wang, Scott J. Brandenberg, Silvia Mazzoni, and Jonathan P. Stewart	
<b>A Cross-Platform Approach Using Remote Sensing and Geophysical Monitoring to Streamline Geotechnical Asset Management.....</b>	<b>471</b>
Rakesh Salunke, Masoud Nobahar, and Mohammad Sadik Khan	
<b>Soil Moisture Characterization from UAV-Based Optical and Thermal Infrared (TIR) Images .....</b>	<b>482</b>
Rakesh Salunke, Masoud Nobahar, Omer Emad Alzeghoul, and Mohammad Sadik Khan	
<b>Machine Learning Applications in Geotechnical Earthquake Engineering: Progress, Gaps, and Opportunities .....</b>	<b>493</b>
Katherine Cheng and Katerina Ziotopoulou	
<b>Prediction of Liquefaction Induced Lateral Spreading Displacements by Artificial Intelligence Based Model .....</b>	<b>506</b>
Pelin Ozener and Okan Cetinkaya	
<b>Application of Unmanned Aerial Vehicle (UAV) for Reservoir Embankment Inspections.....</b>	<b>516</b>
Surya Sarat Chandra Congress, Anand J. Puppala, Prince Kumar, and Louie Verreault	
 <i>Education for Geotechnical Engineering</i>	
<b>Development of Multiphysics Enriched Mixed Reality Game for Geotechnical Engineering Education.....</b>	<b>526</b>
Chenchen Huang, Weiling Cai, Cheng Zhu, Ying Tang, Sarah Bauer, Lei Wang, and Ryan Hare	

<b>A Geotechnical Living Laboratory for Teaching and Researching Soil Erosion and Slope Stability.....</b>	<b>535</b>
Bret N. Lingwall and Heidi Sieverding	
<b>Early Exposure to FEM to Enhance Undergraduate Engagement in Geotechnical Engineering .....</b>	<b>544</b>
Osvaldo P. M. Vitali, Amy Getchell, and Marika Santagata	
<b>Beginning to Develop and Assess Engineering Judgment in an Introductory Geotechnical Engineering Course.....</b>	<b>554</b>
Ryan Carkin, Victoria Bennett, Yevgeniya V. Zastavker, Alyssa Richtarek, Casper Harteveld, and Tarek Abdoun	
<b>Building Critical Thinking Skills through Geotechnical CAT-Apps.....</b>	<b>563</b>
Daniel R. VandenBerge and Prince Turkson	
<b>Video Presentation Assignments in Civil Engineering Courses during the COVID-19 Virtual Period and Beyond.....</b>	<b>573</b>
Jessica V. Lewis and Isaac L. Howard	

***Virtual/Mixed Reality***

<b>Augmented, Virtual, and Mixed Reality in Practice .....</b>	<b>584</b>
Travis A. Shoemaker, Adam Saylor, W. Kortney Brown, Matthew Marchisello, and Fred Snider	