

# **Geo-Congress 2022**

## **Site and Soil Characterization, Computational Geotechnics, Risk, and Lessons Learned**

Selected Papers from Sessions of Geo-Congress 2022

Geotechnical Special Publication Number 333

Charlotte, North Carolina, USA  
20 – 23 March 2022

### **Editors:**

**Anne Lemnitzer**  
**Armin W. Stuedlein**

ISBN: 978-1-7138-4479-2

**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© (2022) by American Society of Civil Engineers  
All rights reserved.

Printed with permission by Curran Associates, Inc. (2022)

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

## *Soil Properties and Modeling*

<b>Field Results and Model Predicted Unsaturated Hydraulic Behavior of Evapotranspiration Cover.....</b>	<b>1</b>
Md. Jobair Bin Alam, Prabesh Bhandari, and Md. Sahadat Hossain	
<b>Predicting the Stress–Strain Behavior of Alluvial Soil Using Hyperbolic-Weibull Constitutive Model.....</b>	<b>12</b>
Emerzon S. Torres and Mary Ann Q. Adajar	
<b>Reformulation of a Bounding Surface Constitutive Model to Incorporate the Effects of Bio-Cementation on Sands .....</b>	<b>22</b>
Maya El Kortbawi, Katerina Ziotopoulou, and Ross W. Boulanger	
<b>Failure Analyses of Yeager Airport Considering Softening of Shale Bedrock .....</b>	<b>33</b>
Bijoy K. Halder and Kow Eshun	
<b>On the Liquid Limit of Diatomaceous Soils: Complex Behavior of a Non-Standard Material .....</b>	<b>45</b>
J. Wang, T. Chin, D. Moug, and T. M. Evans	
<b>True and Base Friction Angles of Clays .....</b>	<b>56</b>
Binod Tiwari, Beena Ajmera, Mohammed Al-Behadili, and Mohammed Mohammed	
<b>Effects of Small-Strain Soil Behavior on the Load-Deformation Response of Conical Load Tests.....</b>	<b>65</b>
Sergio Marin, Luis G. Arboleda-Monsalve, Manoj Chopra, and Larry Jones	
<b>Characterization of Mechanical Properties of a Synthetic Modeling Clay Used as a Substitute for Natural Soils.....</b>	<b>75</b>
Hyunjin Lee, Nitish Ponkshe, James P. Hambleton, and James D. Van de Ven	
<b>Heat Loss in Landfills as a Function of Landfill Size .....</b>	<b>83</b>
Milind V. Khire, Terry Johnson, and Richard Holt	
<b>Estimation of Soils’ Compression and Recompression Index Using Soil Index Properties—Florida Case Study .....</b>	<b>92</b>
YongJe Kim, Boo Hyun Nam, Kyung-Won Park, Ryan Shamet, and David Horhota	

<b>Investigation of Sand Fouling and Moisture on Ballast Behavior.....</b>	<b>103</b>
Ruimin Feng, William Radnor, Michelle L. Bernhardt-Barry, and Stacey E. Kulesza	
<b>Geological and Geotechnical Characteristics of Glauconitic Sands.....</b>	<b>113</b>
Zachary J. Westgate, Christopher McMullin, Danilo Zeppilli, Ryan Beemer, and Don J. DeGroot	
<b>Residual Interface Shear Strength under Low Normal Stress Conditions .....</b>	<b>122</b>
Zachary J. Westgate	
<b>Assessment of Compression Index (<math>c_c</math>) of Louisiana Marsh Soils by Considering the Sedimentation State .....</b>	<b>131</b>
Omar Shahrear Apu and Jay X. Wang	
<b>Consideration of One Camera Photogrammetry-Based Method to Reevaluate Some Aspects of Conventional Triaxial Testing.....</b>	<b>141</b>
Sara Fayek, Xiaolong Xia, and Xiong Zhang	
<b>Revisiting the Liquid Limit Determinations Using Casagrande Percussion Cup Method vs. Fall Cone Device .....</b>	<b>152</b>
Fawad S. Niazi, Aranzazu Pinan-Llamas, and Bilal Sulaman	
<b>Soil Water Content from Reflectance of Filter Paper .....</b>	<b>162</b>
Julia I. Loshelder and Richard A. Coffman	
<b>Mechanical-Based Properties of Mine Tailings for Static Liquefaction.....</b>	<b>173</b>
Luis Vergaray and Jorge Macedo	
<b>Reconstituted Compressibility Response of Central Florida Sands.....</b>	<b>183</b>
A. J. Aparicio-Ortube, Luis G. Arboleda-Monsalve, David G. Zapata-Medina, and Larry Jones	
<b>Intragrain Pore Structure of Carbonate Sands .....</b>	<b>194</b>
Elieh Mohtashami, C. Guney Olgun, Chenglin Wu, and Tara Selly	
<b>Effects of Plastic Properties on the Fluidization Behaviour of Subgrade Soil under Heavy Haul Rail Load .....</b>	<b>204</b>
Thanh Trung Nguyen, Buddhima Indraratna, Cholachat Rujikiatkamjorn, Mandeep Singh, Warantorn Korkitsuntornsan, and Isabella Novais Silva	
<b>Effect of Rotational Cone on Penetration Resistance and Its Implication to the Design of a Bio-Inspired Self-Burrowing Robots .....</b>	<b>214</b>
Yong Tang and Junliang (Julian) Tao	

**Bioinspired Horizontal Self-Burrowing Robot .....223**  
Sichuan Huang and Junliang Tao

**Overburden Normalization for In-Flight Centrifuge Miniature Cone Penetration Testing in Sand .....232**  
Jiarui Chen, Scott M. Olson, Soham Banerjee, Mandar M. Dewoolkar, and Yves Dubief

*Risk Assessment and Management*

**RLEM versus RFEM in Stochastic Slope Stability Analyses in Geomechanics .....241**  
Sina Javankhoshdel, Moslem Rezvani, Mahtab Fatehi, and Reza Jamshidi Chenari

**Mapping of Liquefaction-Induced Deformations for Seismic Risk Assessment .....251**  
Claudia Arias, Claudio Cáceres, Juan Pablo Villagrán, and Yolanda Alberto

**The Promise and Threat of Boiling Springs: Identifying and Mitigating Risk to Sanford Dam .....260**  
Adam Paisley

**Safety Assessment of Pile-Founded T-Walls in the Face of Flooding Hazards .....272**  
Liang Zhang, Lei Wang, and Kevin Turcios-Lovato

**Assessing Piping Risks by Finite Elements .....281**  
B. A. Robbins, D. V. Griffiths, and Gordon A. Fenton

**Setting the Stage for a Geotechnical Asset Management Program in the State of Georgia .....290**  
Jose M. Torres, Jorge Macedo, Susan E. Burns, Youngsuk Jung, Kalen Jones, Mary Cooley, Catherine Armstrong, and Adebola Adelakun

*Understanding Risk and Learning from Failures*

**Geotechnical Failure Case Studies—Lessons Learned .....301**  
Robert C. Rabeler

**Challenges in Dewatering for Underground Construction in Flowing Artesian Conditions: A Case Study .....316**  
Roy E. Jensen, Madan Karkee, and Doug Lindquist

**Urban Below-Grade Engineering: Excavation Support and Foundations for Expanding the American Museum of Natural History .....325**  
Sayantani Ghosh and Samuel W. Singer

<b>Stochastic Stratigraphic Simulation and Uncertainty Quantification Using Machine Learning .....</b>	<b>337</b>
Hui Wang and Xingxing Wei	
<b>Bluff Erosion Stabilization for the Shelby Dell Transmission Tower .....</b>	<b>347</b>
Mary C. Nodine, Jeremy Pettus, and James Nickerson	
<b>Foundation Performance of the Millennium Tower in San Francisco, California: One-Dimensional Settlement Analyses.....</b>	<b>359</b>
Nathaniel Wagner, Micaela Largent, Hannah Curran, Debra Murphy, Jeremy Butkovich, Hamid Nouri, John A. Egan, and Jonathan P. Stewart	
<b>Modeling Resilient Modulus of Unsaturated Subgrade Soils under Concurrent Changes in Water Content and Temperature.....</b>	<b>374</b>
Masood Abdollahi and Farshid Vahedifard	
<b>Risk Assessment of Levee Overtopping Breach Using a Logit Model .....</b>	<b>385</b>
Stefan Flynn and Farshid Vahedifard	
<b>Downstream Impacts on Geotechnical Structures of the Michigan Dam Failures .....</b>	<b>396</b>
Elliot Nichols, Joe Smith, J. David Frost, and Youssef Hashash	
<i>Engineering Geology and Site Characterization</i>	
<b>Estimation of Optimal Spacing between CPT Soundings .....</b>	<b>406</b>
Venkata A. Sakleshpur, Eshan Ganju, Rodrigo Salgado, and Monica Prezzi	
<b>An Overview on Some Engineering Properties of Fine-Grained Soils .....</b>	<b>415</b>
Giovanni Spagnoli and Satoru Shimobe	
<b>A Case History in Foundation Design on Very Soft Soils—The Impact of Low-Cost Geotechnical Design Work .....</b>	<b>423</b>
Trent Parkhill, Troy Covill, and Bret N. Lingwall	
<b>Quantifying Geological Uncertainty Using Conditioned Spatial Markov Chains.....</b>	<b>436</b>
Opeyemi E. Oluwatuyi, Rasika Rajapakshage, Shaun S. Wulff, and Kam Ng	
<b>Interpretation of Field-Measured and Simulated Non-Monotonic CPTu Dissipation Tests.....</b>	<b>446</b>
Andrew P. E. Huffman and Diane M. Moug	
<b>Estimation of In Situ Densities for Tailings and Coal Combustion Residuals Using CPT Correlations.....</b>	<b>456</b>
Christian Armstrong, Longde Jin, and Jean Kugel	

<b>Analytical CPTU Solutions Applied to Boston Blue Clay</b> .....	<b>465</b>
Shehab S. Agaiby and Paul W. Mayne	
<b>Relating the Proportion of Diatom Particles to the Physical Properties of Natural Diatomaceous Soil</b> .....	<b>479</b>
Ariadna Covarrubias Ornelas, Jiayao Wang, Diane Moug, T. Matthew Evans, and Anika Walter	
<b>New Methods of Analyzing SPT Penetration Resistance</b> .....	<b>490</b>
Edward D. Zisman	
<b>Investigation on the Effects of a Hurricane on the Piezometric Head and Lateral Hydraulic Gradient of a Network of Piezometric Sensors in Florida’s Sinkhole Study</b> .....	<b>495</b>
Timothy R. Copeland, Boo Hyun Nam, Ryan Shamet, Heejung Youn, and Young-Hoon Jung	
<b>Identification of Thin Soil Layers Utilizing the <math>q_m</math>HMM-IFM Algorithm on Cone Bearing Measurements</b> .....	<b>505</b>
Erick Baziw and Gerald Verbeek	
<b>Effects of Different Drying Techniques on the Pore Size Distribution of Bentonite at Two Different Hydraulic States</b> .....	<b>515</b>
Nilufar Chowdhury and Omid Ghasemi-Fare	
<b>Assessment of the Seasonal and Spatial Variation in Shear Strength of High Plasticity Clay on Highway Slopes Using DCP Tests</b> .....	<b>524</b>
Shadman Sakib, Md. Aminul Islam, and Md. Sahadat Hossain	
<b>Coupled Thermo-Hydro-Mechanical Effects on Transport Properties of Glacial Tills</b> .....	<b>534</b>
Hyunbin Kim, Jose V. Renjifo Ciocca, and Roman Y. Makhnenko	

### *Computational Geotechnics*

<b>Liquefaction Instabilities with NorSand Plasticity: Verification and Computational Performance of Explicit Integration Algorithms</b> .....	<b>545</b>
Ferdinando Marinelli, Dawn Shuttle, Sandro Brasile, and Michael Jefferies	
<b>A Phenomenological Breakage Model for Crushable Sand</b> .....	<b>555</b>
Mohd Saqib, Arghya Das, and Nihar Ranjan Patra	
<b>DEM Analysis of the Interplay between Soil Density and Earthquake Surface Fault Rupture in Layered Soils</b> .....	<b>564</b>
Fernando E. Garcia and Jonathan D. Bray	

<b>Accurate High-Performance Fluid-Soil Interaction Modeling and Simulation Using a Projection-Based Material Point Method .....</b>	<b>573</b>
Bodhinanda Chandra, Tianchi Zhao, Shyamini Kularathna, and Kenichi Soga	
<b>On the Influence of Physico-Chemical Phenomena on Shear Strength of Consolidated Kaolinite .....</b>	<b>580</b>
Karam A. Jaradat, Shijun Wei, and Sherif L. Abdelaziz	
<b>Numerical Homogenization of Anisotropic Static Elastic Properties of Soft Mudrocks .....</b>	<b>589</b>
Emad Norouzi, Biao Li, and Emre Erkmén	
<b>Evaluation of Boundary Effects in Simple Shear Tests Using Discrete Element Modelling .....</b>	<b>599</b>
Jikai Guo, Michelle L. Bernhardt-Barry, and Giovanna Biscontin	
<b>Appraisal of Scale Effects in Centrifuge Modeling for the Prediction of Ultimate Settlement of Slurries.....</b>	<b>608</b>
Akhila Vasudev and Tadikonda Venkata Bharat	
<b>Modeling Wellbore Erosion Using Standard and Cut-Mesh Approaches in Material Point Method .....</b>	<b>618</b>
Joel Given, Shyamini Kularathna, Ezra Y. S. Tjung, Bodhinanda Chandra, Kenichi Soga, Haotian Wang, Stephen P. Morgan, Holger A. Meier, and Jorge L. Garzon	
<b>Temperature Effects on the Thickness of the Diffused Double Layer Using Molecular Dynamics .....</b>	<b>628</b>
Shijun Wei and Sherif L. Abdelaziz	
<b>Evolution of Porosity–Permeability Relationships in Bio-Mediated Processes for Ground Improvement: A Pore-Scale Computational Study .....</b>	<b>638</b>
Sina Nassiri and Nariman Mahabadi	
<b>Deep Reinforcement Learning for Controlling the Groundwater in Slopes .....</b>	<b>648</b>
Aynaz Biniyaz, Behnam Azmoon, and Zhen Liu	
<b>Using the Modified State Surface Approach to Explain and Simplify the CASM.....</b>	<b>658</b>
Beshoy Riad and Xiong Zhang	
<b>Foundation Performance of the Millennium Tower in San Francisco, California: Three-Dimensional Settlement and Tilt Analyses.....</b>	<b>669</b>
Hamid Nouri, Jeremy Butkovich, Nathaniel Wagner, Micaela Largent, Hannah Curran, Debra Murphy, John A. Egan, and Jonathan P. Stewart	



<b>Flow in Elastic Medium Containing Fine Particles .....</b>	<b>679</b>
Xinle Zhai and Kamelia Atefi-Monfared	
<b>Soil Behavior in the Earth Pressure Balance (EPB) Shield Tunnelling—A DEM Study.....</b>	<b>690</b>
Yang Cao, Hoang Bao Khoi Nguyen, Md. Mizanur Rahman, and Wen-Chieh Cheng	
<b>Advanced Modeling of Liquefaction-Induced Flow Failure.....</b>	<b>699</b>
Saman Farzi Sizkow and Usama El Shamy	
<b>Use of FEM Analyses to Evaluate Performance of Subgrade Stabilization Technique over Poor Soils .....</b>	<b>708</b>
T. Moon, E. C. Wang, R. Sandiford, and N. Yakubov	