

# **4th International Symposium on Frontiers in Offshore Geotechnics (ISFOG 2020 in 2022)**

Austin, Texas, USA  
28-31 August 2022  
(Postponed from 16 August 2020)

Volume 1 of 3

**Editor:**

**Zack Westgate**

ISBN: 978-1-7138-6659-6

**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 Deep Foundations Institute  
All rights reserved.

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

For permission requests, please contact Deep Foundations Institute  
at the address below.

Deep Foundations Institute  
326 Lafayette Avenue  
Hawthorne NJ 0750

Phone: 973-423-4030  
Fax: 973-423-4031

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

# The 5th ISSMGE McClelland Lecture

## Introduction to Dr. Ed Clukey, the 5th ISSMGE McClelland Lecturer

*Phil Watson*

1

## The Role of Physical Modeling in Offshore Geotechnical Engineering

*Dr. Edward C. Clukey*

5

## Keynotes

### A Lifetime of Offshore Geotechnics - Career Reflections and Lessons Learned

*Mark F. Randolph*

63

### Bridging Knowledge between Old and New Energy Projects

*Gülin Yetginer and Tor Inge Tjelta*

84

### Data Science Applications in Geo-Intelligence

*B. Stuyts*

120

### Improving the Reliability of the Calculated Axial Capacity of Piles in Sand

*Farrokh Nadim, Suzanne Lacasse, Zhongqiang Liu and Barry Lehane*

150

### Sediment Transport and Scour in the Ocean Environment – Knowledge and Future Directions

*Richard J. S. Whitehouse and Scott Draper*

178

### Whole-Life Geotechnical Design: What Is It? What's It For? So What? And What Next?

*Susan Gourvenec, Professor*

206

## Anchoring Systems

### A Self-Contained, Dynamically Embedded Plate Anchor: Installation and Capacity

*Ying Lai, Hande Gerkus-Harris, Robert B. Gilbert, Jose Eugenio Iturriaga Flores, Asitha I. Senanayake, Yunhan Huang, Aaron S. Bradshaw and Joe R. Giampa*

247

<b>A Time-Domain Model for Embedded and On-Bottom Chains Incorporating Consolidation</b>	
<i>Yih Shan Yap, Conleth D. O'Loughlin and Joe G. Tom</i>	256
<b>Analysis and Design of Suction Anchors Allowing for Trench</b>	
<i>Mark F. Randolph, James P. Doherty, Michael P. O'Neill, Xiaowei Feng, Jean-Christophe Ballard and Camilo Melo</i>	269
<b>Assessment of Suction Caisson Drained Tensile Capacity through Multiscale Physical Tests</b>	
<i>Tulio Quiroz and Aligi Foglia</i>	280
<b>CFD Analysis of an Observed Mooring Line Trench to Assess the Potential for Further Trench Development</b>	
<i>Khalida Sassi, Gerard Fernandez, Joe Tom, Scott Draper and Ming Zhao</i>	290
<b>Cyclic Capacity of Plate Anchors in Loose Sand</b>	
<i>Shiao Huey Chow, Andrea Diambra, Anamitra Roy, Conleth D. O'Loughlin and Christophe Gaudin</i>	303
<b>Cyclic Loading of Helical Pile as Anchor for Floating Windturbines: Centrifuge Tests</b>	
<i>Luc Thorel, Ismat El Haffar, Semaan Maatouk, Jose Antonio Schiavon and Cristina Tsuha</i>	313
<b>Cyclic Loading of Offshore Wind Turbine Suction Bucket Foundations in Sand: The Importance of Loading Frequency</b>	
<i>Han Eng Low, Fangyuan Zhu, Henning Mohr, Carl Erbrich, Philip Watson, Fraser Bransby, Conleth O'Loughlin, Mark Randolph, Mohamed Mekkawy, Thaleia Travasarou and Daniel O'Connell</i>	321
<b>Effect of Fin Shape on the Penetration and Pullout of Torpedo Anchors in Marine Clays</b>	
<i>Abdelazis Ads, Mehdi Omidvar, Stephan Bless and Magued Iskander</i>	332
<b>Frequency Scaling of Physical Model Tests on Tensile Loaded Suction Buckets by Finite Element Analysis</b>	
<i>Patrick Gütz and Martin Achmus</i>	342
<b>Holding Capacity of Suction Anchors with Trench - Centrifuge Test Results and Interpretation</b>	
<i>David Cathie, Khalida Sassi, Matthieu Blanc, Luc Thorel and Regis Wallerand</i>	352

**Horizontal Load Capacity of Multiline Ring Anchor in Soft Clay***Charles Aubeny and Junho Lee*

362

**Long Term Cyclic Stability of Shallow Helical Anchors in a Hydraulically Placed Sand***J. T. Newgard, J. A. Schneider, J. S. McCartney and D. J. Thompson*

372

**Macro-Element Modelling of Plate Anchor Kinematics under Cyclic Loading in Clay***Anderson Peccin da Silva, Dr. Andrea Diambra, Dr. Dimitris Karamitros and Dr. Shiao Huey Chow*

382

**Numerical Study for Liquefaction Response of Taut and TLP Mooring Anchors during Earthquakes***Pourya Kazemi Esfeh, Laura Govoni and Amir M. Kaynia*

392

**Optimisation of Screw Anchor Lateral Capacity in Sand for Offshore Renewable Energy Applications***B. Cerfontaine, M. J. Brown, J. A. Knappett, C. Davidson and Y. Sharif*

402

**Optimising Anchor Design to Achieve Greater Embedment Depth and Holding Capacity***Yinghui Tian, Mark J. Cassidy and Mark F. Randolph*

412

**Soil Failure Mechanism and Capacity of Stiffened Caisson Anchors in Calcareous Silt***Mohammad A. Mohiuddin, Muhammad S. Hossain, Shah N. Ullah, Youngho Kim and Yuxia Hu*

422

**Suction Caisson Response under Tensile and Compressional Vertical Cyclic Loading in Layered Soils***Marc Stapelfeldt, Britta Bienen and Jürgen Grabe*

432

**Tangential Shear Behavior between Sand and Anchor Chain***Shengjie Rui, Zhen Guo, Lizhong Wang, Wenjie Zhou and Kanmin Shen*

442

**Three Dimensional Numerical Modelling of Embedded Mooring Lines***Yinghui Tian, Wenlong Liu and Mark J. Cassidy*

452

## Axial Pile Response

### **A New 'Unified' CPT-Based Axial Pile Capacity Design Method for Driven Piles in Sand**

*Barry Lehane, Zhongqiang Liu, Eduardo Bittar, Farrokh Nadim, Suzanne Lacasse, Richard Jardine, Pasquale Carotenuto, Mike Rattley, Philippe Jeanjean, Kenneth Gavin, Robert Gilbert, Jens Bergan-Haavik and Neil Morgan*

462

### **A Simple Method to Evaluate the Natural Frequency of Jacket Supported Offshore Wind Turbine under Storm**

*Wenjie Zhou, Zhen Guo, Lizhong Wang, Shengjie Rui, Jiahao Li, Yujie Li and Chencong Liao*

478

### **Axial Capacity Evaluation of Open-Ended Pipe Piles in Medium Dense Silty Sand Using Soil Plugging Length Ratio**

*Osama Safaqah, Subba R. Gudavalli and Spencer S. Jeon*

489

### **Axial Capacity of Large-Scale Piles in Micaceous Soils**

*Jan Dührkop, Luís Berenguer Todo Bom, Ph.D. and Barry Lehane*

500

### **Computation of Interaction Diagrams for Cyclic Axial Loads in Offshore Piles Based on an Effective Stress Method**

*Jose G. Parra and Mariajose Guevara*

510

### **CPT Filter to Estimate the End Bearing of Closed-Ended Driven Piles in Layered Sands**

*Eduardo Bittar, Barry Lehane, Ross W. Boulanger and Jason T. DeJong*

520

### **Cyclic Axial Load Testing of Pipe Piles in Sand**

*Timothy E. Keefe, Ahmed M. Hussien, Aaron S. Bradshaw, Andrew D. Deeks, James A. Schneider, Amir Rahim, Farnyuh Menq and Robert Gilbert*

529

### **Effects of Cyclic History on the Ageing of Shaft Friction of Driven Piles in Sand**

*Eduardo Bittar, Barry Lehane, Phil Watson and Andrew Deeks*

541

### **Evaluation of API and CPT Axial Pile Capacity Methods of Campeche Bay Soils for the Design of Offshore Piles**

*Ivan Zarate, Francisco A. Flores, President and Diego Cruz*

551

### **Examination of Open-Ended Pile Capacity Methods in Estimating Axial Response**

*Trevon M. Joseph and Guy T. Housby*

563

**Impact of the Installation on the Long-Term Behaviour of Offshore Wind Turbine Pile Foundations**

*P. Staubach, J. Machacek and T. Wichtmann*

573

**Numerical Analysis of Offshore Wind Turbine Foundations in Dense Sand Considering Partial Drainage**

*S. Whyte, M. Rattley, M. Ramos Da Silva, C. M. Martin, H. J. Burd and C. Erbrich*

583

**Pile Behavior in Low-Medium Density Chalk: Preliminary Results from the ALPACA Project**

*Róisín M. Buckley, Richard J. Jardine, Byron W. Byrne, Stavroula Kontoe, Ross A. McAdam, Reza Ahmadi-Naghadeh, Tingfa Liu, Fabian Schranz and Ken Vinck*

594

**Review of the Design of Driven Piles Penetrating Weak Rock for Offshore Applications**

*John Barrett, P.E. and Luke J. Prendergast, Ph.D.*

604

**Structural Monitoring of the Keystone "Twisted Jacket" Foundation: A Case Study off the Hornsea Coast**

*P. Doherty and B. Casey*

614

**The Axial Performance of Jetted Conductors in Carbonate Sediment**

*Alex Osuchowski, Phil Watson, Conleth O'Loughlin, Yuxia Hu, Rose Zhang, Meysam Banimahd, Ben Holland and Matthew Kuo*

624

**The Field Behaviour of Drilled and Grouted Piles in Rock for Offshore Foundations**

*Jamie Klapper, Sébastien Manceau, Alexander Hall, Richard Jardine and Pedro Barbosa Moreira*

634

**Torsion at Pile to Pile Sleeve Grout Connection and Proposed Design Procedure of Shear Keys**

*Tewodros H. Tefera*

644

## Data Science

**A Machine Learning Based Quantitative Integration of Geotechnical and Geophysical Data for Deepwater Site Characterization**

*Jinbo Chen, Liqin Sang, Bryce Willems, Jason Newlin, Øyvind Ruden, Ritu Sarker and Shuang Hu*

653

**Analyzing the Driving Performance of Pile Foundations Using Data Driven Models***James P. Doherty, Mark F. Randolph and James A. Schneider*

664

**Comparison of Machine Learning Models in a Data-Driven Approach for Scalable and Adaptive Design of Laterally-Loaded Monopile Foundations***S. K. Suryasentana, H. J. Burd, B. W. Byrne, A. Aghakouchak and T. Sørensen*

674

**Data Driven Assessment of Offshore Wind Turbine Foundation Stiffness***Ross A. McAdam, Anela Bajric, Manolis N. Chatzis, Byron W. Byrne and Cedric Vanden Haute*

684

**Predictive Analytics Application in Developing Regional Suitability Mapping (RSM)***Christian H. Girsang, Muhammad J. Rohani, Noorizal N. Huang, Norhayati Yusoff and Azam A. Rahman*

694

**Foundation Installation / Extraction****An Assessment of the Accuracy of SRD Methodologies for OWF Monopile Installation against a North Europe Driving Records Database***Georgios Perikleous, Themis Stergiou and Sandra Meissl*

704

**Effects of Vibratory Driving of Monopiles on Soil Conditions and Their Cyclic Lateral Load Bearing Behavior***Bastian Hoffmann, Johannes Labenski and Christian Moormann*

714

**Experience from Full-Scale Suction Caisson Trial Installations at the Seagreen Offshore Wind Farm***Lewis Jones and Andrew Harding*

725

**GDP: A New Technology for Gentle Driving of (Mono)Piles***Andrei V. Metrikine, Apostolos Tsouvalas, Maxim L. A. Segeren, Ahmed S. K. Elkadi, Faraz S. Tehrani, Sergio S. Gómez, Rob Atkinson, Federico Pisano, Evangelos Kementzetidis, Athanasios Tsetas, Timo Molenkamp, Kees van Beek and Peter de Vries*

736

**Hydraulic Pile Extraction Scale Tests (HyPE-ST): Experimental Design & Preliminary Results***T. Balder, D. A. de Lange, A. S. K. Elkadi, P. J. P. Egberts, W. J. A. P. Beuckelaers, M. Coronel, J. van Dijk, R. Atkinson and H. J. Luger*

746

**Insights into the Driveability of Large Diameter Piles***David Cathie, Christophe Jaeck, Erdem Ozsu and Sylvie Raymackers*

757

**Large Diameter Monopile Buckling Due to Localized Force - A Numerical Study***Emilio Nicolini, Aram Cornaggia and Anna Pandolfi*

767

**Numerical Simulation of the Installation of Suction Buckets Using MPM***M. Martinelli, E. A. Alderlieste, V. Galavi and H. J. Luger*

777

**Physical Modelling of Pile Tip Damage Arising from Impact Driving***Juliano A. Nietiedt, Mark F. Randolph, Christophe Gaudin, James Doherty, Dan Kallehave, Jens Gengenbach and Avi Shonberg*

787

**Pile Design, Installation and Back-Analysis of 54 in Piles in Gravels at the Wiriagar Deep Platform in Berau Bay, Indonesia***Hugo Galanes-Alvarez, Achmad Makmur, Philippe Jeanjean and Chee Peng Pua*

798

**Pile Driving Instrumentation of 54-Inch Piles in Gravels at the Wiriagar Deep Platform in Berau Bay, Indonesia***Chee Peng Pua, D. S. Murthy, Radha Rao, Hugo Galanes-Alvarez, P. Jeanjean and Achmad Makmur*

808

**Plug Heave Phenomena during Pile Installation***Dirk Luger and René Thijssen*

818

**Suction Bucket Installation: Risks during the Installation Process***Avi Shonberg, Michael Harte, Amin Aghakouchak and Morten Albjerg Liingaard*

828

**Suction Installation of Modular Bucket Foundation for Large Offshore Wind Turbines***Aleksandra K. Koteras, Francisco M. G. Rodriguez and Lars B. Ibsen*

838

**The Impact of Installation Method on Monotonic Loading of Monopiles in Sand***K. G. Gavin, S. D. Blok and G. R. Eiksund, Professor*

849

**The Influence of Friction Fatigue on Pile Drivability Predictions for Large Diameter Monopiles in the Bolders Bank Formation***S. R. Davies, G. Giuliani and M. Vaziri*

858

**Vibratory Driving of a Monopile at a North Sea Site***A. Holeyman, V. Whenham, P. Peralta, J.-C. Ballard and S. Chenicheri Pulukul*

868

**Geohazards and Integrated Studies****A Combined Analysis Procedure for Submarine Landslide Evolution***Andreas Stoecklin and Alexander M. Puzrin*

878

**Centrifuge Study of Seismic Response of Submarine Clay Canyons***Samuel F. M. Tarazona, Maria C. F. Almeida, Márcio S. S. Almeida, Sandra Escoffier and Lucas C. Takayassu*

887

**Computational Modelling of Unburied Offshore Pipelines Crossing Active Tectonic Faults***Aikaterini Triantafyllaki, Ph.D. Candidate, Panos Papanastasiou, Professor and Dimitrios Loukidis, Associate Professor*

897

**Design Focused Ground Models for Offshore Rock-Socketed Pile Solutions: St Brieuc OWF - A Case Study***Jordan Geear, Clement Tam, Andrew Hart, Agustin Bertossa, Indrasenan Thusyanthan and Julien Pitel*

907

**Integrated Ground Modelling from a Geotechnical Perspective***Rasmus T. Klinkvort, Guillaume Sauvin, Carl Fredrik Forsberg and Maarten Vanneste*

917

**Maximum Depth of Liquefaction Based on Fully-Coupled Time Domain Site Response Analysis***Julia Katharina Möller, Stavroula Kontoe, David Taborda and David Potts*

927

**Numerical Assessment of Gas Hydrate Dissociation on Submarine Slope Stability***Xiaoyan Long, Sudarshan Adhikari, Alan Witthoef and Ko Min Tjok*

937

**Probabilistic Landslide Susceptibility Offshore South West Iberian Margin***Stefano Collico, Marcos Arroyo, Roger Urgeles, Eulalia Gràcia, Marcelo De Vincenzi and Norma Pérez*

947

**Resonance as the Source of High Vertical Accelerations: Field Demonstration and Impact on Offshore Wind Turbines**

*Vasiliki Tsaparli, Stavroula Kontoe, David M. G. Taborda and David M. Potts*

957

**Scour Potential Evaluation of the Western Irish Sea Mud Belt (Scope)**

*P. Doherty, M. Coughlan and S. Creane*

969

**Site Characterisation of a Submarine Volcanic Terrain: The Importance of Data Integration**

*Osama Safaqah, Xuan Nhan Pham, Quang Chung Dam, Chris A. Smith, Lorraine O'Leary, Chris Steven and Jason Goh*

986

**Surficial Crust Effects on Mass Gravity Flow Induced Seafloor Scour Characteristics**

*Aurelian C. Trandafir*

996

## In situ and Laboratory Testing

**A Novel in-situ Test Setup for Measuring the Interface Resistance between Pipelines and Underlying Soils**

*Roba Houhou, Rayan Bou Mjahed, Elie Shammas, Shadi Najjar and Salah Sadek*

1006

**Challenges of Mica Content Determinations**

*Kee Kiat Tho, Nancy Chan, Anders H. Augustesen, Edward Molyneaux, Lone Krogh and An-Bin Huang*

1016

**CPT Data Showing Anomalies - Assessment and Potential Post-Processing**

*J. Peuchen, R. Santos, G. Yetginer, W. S. Eckart, T. Carrington and T. Lunne*

1026

**Depth Accuracy of Data Points in Marine Soil Investigation**

*Joek Peuchen and Rik Wemmenhove*

1036

**Development of New Robust Procedures for the Determination of Maximum and Minimum Dry Densities of Sand**

*Siren Knudsen, John J. M. Powell, Tom Lunne, Nanna V. Thomsen, Lone Krogh and Andy Barwise*

1046

**Effect of Cyclic Load Sequence on the Accumulation of Deformations and Post Cyclic Strength of Sand-Structure Interfaces**

*Kyle B. O'Hara, M.S., S.M. ASCE and Alejandro Martinez, Ph.D., A.M. ASCE*

1056

**Effect of Cyclic Preshear on Strength and Stiffness Properties of Sand in Drained Triaxial Testing**

*Amin Rismanchian, Anders H. Augustesen, Lone Krogh, Tim Carrington and Nanna V. Thomsen*

1066

**Experience with Testing Box Core Samples of Soft Clays Using Miniature Full-Flow Penetrometers**

*Adriane G. Boscardin, Don J. DeGroot and Tom Lunne*

1076

**Field Testing for Monopile to Be Installed in Weak Carbonated Rock**

*E. Palix and A. Lovera*

1086

**Free Fall Penetrometer Deployment Strategies and the Impact on Data Analysis: Pilot Weight Trigger versus Winch-Deployed**

*Nina Stark, Nico Parasie and Joek Peuchen*

1096

**Indirect Measurement of Soils in-situ Horizontal Stress from Matric Suction Measurements: Developing a New Tensiometer**

*Amin Rismanchian, Tim Carrington, Karl Snelling and Jerry Sutton*

1106

**Interpretation of Piezocone Test in Overconsolidated Clays Using SHANSEP**

*Marco D'Ignazio, Knut H. Andersen, Harun Kürsat Engin, Sivasithamparam Nallathamby, Hans Petter Jostad and Gülin Yetginer*

1116

**Laboratory Testing of Soil-Structure Interaction on Rock Dump Carpets**

*Brian Sheil, Thomas Andolfsson, Byron Byrne and Alasdair Maconochie*

1126

**On the Triaxial Testing of Sand for Offshore Wind Turbine Foundation Design**

*Lewis Jones, Jonathan White and Truong Le*

1137

**Portable Free Fall Penetrometer Measurements: Shear Resistance versus Drag Resistance**

*Nina Stark, Dennis Kiptoo, Nick Brilli and Reem Jaber*

1149

**Predictions of Multi-Amplitude Laboratory Tests Using Hyperplasticity Models***T. D. Balaam, B. W. Byrne, G. T. Houlsby, H. P. Jostad and A. M. Page*

1159

**Repeatability of G/sub max/ Bender Element Measurements on Triaxial and Resonant Column Sand Specimens***Pasquale Carotenuto, Yusuke Suzuki, Rune Dyvik, Anders H. Augustesen and Lone Krogh*

1170

**Rigidity Index of Soft Remolded Clays during Thixotropic Hardening***Jing Peng, Don J. DeGroot, Yiming Cao and Guoping Zhang*

1180

**Role of Rheology Testing in Submarine Debris Flow Simulation***Arash Zakeri and Benoit Spinewine*

1190

**Thixotropy of Clays with Various Index Properties***Shaoli Yang, Yubin Ren, Knut H. Andersen, Ying Wang, Graziella M. F. Jannuzzi and Rhamira D. G. Pascual*

1200

**Towards a Combined Use of Chirp Sonar and Portable Free Fall Penetrometer: Case Study Potomac River***Reem Jaber, Dennis Kiptoo, Nina Stark, Navid Jafari and Nadarajah Ravichandran*

1211

## Lateral Pile Response

**3D Finite Element Analysis of Monopiles and Its Application in Offshore Wind Farm Design***Angeliki Grammatikopoulou, Felix C. Schroeder, Giuseppe Pedone, Amandine Brosse, Torben Sørensen, David M. G. Taborda and David M. Potts*

1221

**3D Finite Element Modelling of Monopiles in Sand Validated against Large Scale Field Tests***David J. P. Igoe and Soroosh Jalilvand*

1231

**A Consistent, Rigorous and Super-Fast Monopile Design Approach***Rasmus T. Klinkvort, Hendrik Sturm, Ana M. Page, Youhu Zhang and Hans Petter Jostad*

1243

**A Design Framework for Monopiles in Sand Based on Large-Scale Pile Load Tests and FE Analysis**

*Katja Siegl, Jan Dührkop and Severin Spill*

1253

**A Generalised Winkler Model for the Hysteretic and Ratcheting Behaviour of Monopiles in Clay and Sand**

*William J. A. P. Beuckelaers, Harvey J. Burd, Guy T. Houlsby, Ross A. McAdam and Byron W. Byrne*  
1263

**An Investigation of the Contribution of the Pile Base to the Lateral Response of Monopiles in Sand under Static Loading**

*H. Wang, B. M. Lehane, M. F. Bransby, L. Z. Wang and Y. Hong*

1273

**Application of Second-Order Cone Programming Finite Element Methods for Laterally Loaded Monopiles in Offshore Wind**

*D. Abadias, K. Krabbenhoft and J. Krabbenhoft*

1282

**Comparison of Predicted Pile Load-Displacement Response Using PISA and API p-y to Static Laterally Loaded Onshore Test Piles in Sand at Cuxhaven**

*Peter Duroska, Vasilis Avgerinos, Miguel Pacheco Andrade, Kris W. Andersen and Morten Albjerg Liingaard*

1292

**Comparison of p-y Methods with Large-Scale Tests of Impact- and Vibratory-Driven Piles**

*Severin Spill, Aligi Foglia and Jan Dührkop*

1302

**Concept Design Study of Laterally Loaded Monopiles in Sand**

*Stavros Panagoulias, Axel Nernheim, Diego Lisi, Miquel Lahoz and Ronald B. J. Brinkgreve*

1312

**Cyclic Laterally Loaded Medium Scale Field Pile Testing for the PISA Project**

*Byron W. Byrne, Ross A. McAdam, William J. A. P. Beuckelaers, Harvey J. Burd, Ken Gavin, Guy T. Houlsby, David J. P. Igoe, Richard J. Jardine, Chris M. Martin, David M. Potts, David M. G. Taborda and Lidija Zdravković*

1323

**Degrading P-Y Spring Model for Laterally Loaded Piles in Soft Clay**

*Ahmed Q. O. Al-Ramthan, Charles P. Aubeny and Olusola Komolafe*

1333

**Design of Laterally Loaded Monopiles for Offshore Wind Using Small-Strain Properties of Sands**

*Yunhan Huang, Robert Gilbert, Kenneth Stokoe, Shin-Tower Wang, James Munson, Jonas Bauer, Reihaneh Hosseini, Ahmed Hussien and Hossein Fadaifard*

1343

**Design of Monopiles in the North Sea with the New PISA Springs, a Sensitivity Study**

*Guillaume Melin, Martin U. Østergaard, Søren P. H. Sørensen and Evelina Vaitkune*

1353

**Effect of Interface Conditions on the Response of Laterally-Loaded Monopiles in Sand**

*Lidija Zdravković, David M. G. Taborda and David M. Potts*

1364

**Episodes of Cycling and Reconsolidation Effects on Cyclic Lateral Behavior of Monopiles in Soft Clay: Centrifuge Modeling**

*Y. Q. Lai, L. Z. Wang, Y. Hong, B. He and H. Wang*

1374

**Extension of the p-y Curves Framework for Cyclic Loading of Offshore Wind Turbines Monopiles in Soft Rock**

*A. Lovera, S. Ghabezloo, J. Sulem, M. F. Randolph and E. Palix*

1383

**Key Features Impacting Soil-Conductor Lateral Behaviour as Illustrated by Centrifuge Tests**

*Mariajose Guevara, James Doherty, Phillip Watson and David White*

1393

**Large Diameter Pile Testing for Offshore Wind Applications with a Focus on Cyclic Lateral Loading and Rate Effects**

*Róisín M. Buckley, Byron W. Byrne, Sarah C. Martin, Ross A. McAdam, Brian B. Sheil, Amin Aghakouchak and René Lindeboom*

1403

**Lateral Behavior of a Pile Due to Eccentric Horizontal Loads**

*Jian Yu, Maosong Huang, Kanmin Shen and Chenrong Zhang*

1413

**Lateral Behaviour and Failure Mechanism of Stiff Monopile in Clay**

*B. He, Y. Q. Lai, S. X. Zhao, W. Li, J. P. Luo and Z. Q. Jiang*

1421

**Lateral Pile Group Effect: Literature Review and a Numerical Study**

*Y. N. Teng, Y. H. Zhang and Y. Q. Lai*

1433

<b>Long Term Deformation of Cyclic Loaded Monopiles in Sand</b>	
<i>Chenrong Zhang, Feng Yu, Zhiqi Zhu and Maosong Huang</i>	1444
<b>Methods of Numerical Analysis of Monopiles under Pseudo-Random Lateral Loading</b>	
<i>Guy T. Houlsby, Byron W. Byrne, Harvey J. Burd and Toby D. Balaam</i>	1454
<b>Modal Analysis of OWTs in Sand - Comparison between Measured and Predicted Values</b>	
<i>Kris W. Andersen, Peter Duroska, Cameron Brown, Miguel Pacheco Andrade and Michael Harte</i>	1465
<b>Modelling of Offshore Wind Monopile Lifetime Performance</b>	
<i>Christelle N. Abadie, Byron W. Byrne, Guy T. Houlsby, Harvey J. Burd, Ross A. McAdam and William J. A. P. Beuckelaers</i>	1475
<b>Modelling the Response of Monopiles to Complex Cyclic Lateral Loading in Sand</b>	
<i>Iona A. Richards, Guy T. Houlsby and Byron W. Byrne</i>	1485
<b>Monopile Lateral Response Calibration from in-situ Monitoring Data</b>	
<i>B. Stuyts, W. Weijtjens, C. Devriendt, H. Versteele and C. Vanden Haute</i>	1495
<b>Natural Frequencies Estimation of a Monopile Supported DTU-10MW Offshore Wind Turbine</b>	
<i>Philip Alkhoury, Abdul-Hamid Soubra, Valentine Rey and Mourad Aït-Ahmad</i>	1505
<b>Nearshore Large Diameter Lateral Pile Load Test in Medium Dense to Dense Sand</b>	
<i>Mathieu Guinard, David P. Waring, Subra Padmanabhan and Marisa S. Soares</i>	1516
<b>PICASO: Cyclic Lateral Loading of Offshore Wind Turbine Monopiles</b>	
<i>Byron W. Byrne, Amin Aghakouchak, Róisín M. Buckley, Harvey J. Burd, Jens Gengenbach, Guy T. Houlsby, Ross A. McAdam, Christopher M. Martin, Fabian Schranz, Brian B. Sheil and Stephen K. Suryasentana</i>	1526
<b>Scour Protection Effects on Laterally Loaded Monopiles</b>	
<i>Russell O. Mayall, Harvey J. Burd, Byron W. Byrne, Ross A. McAdam, Richard J. S. Whitehouse, Phillipa L. Slater and Steven G. Heald</i>	1536
<b>Study on p-y Curve for Monopile under Cyclic Lateral Load in Soft Clay</b>	
<i>Yuan Zhou, Jingbin Zheng, Dong Wang and Hailei Kou</i>	1546

**The Macro-Element Method for Offshore Wind Turbines Exposed to Extreme Loads in the Asia-Pacific Region**

*Sara C. van Hoogstraten, Sebastiaan J. Hermans, Willem G. Versteijlen, Ana M. Page, Gustav Grimstad, Federico Pisano and Andrei V. Metrikine*

1556

**The Use of Numerical Analysis to Aid the Design of Monopile Foundations for a North Sea Offshore Wind Farm**

*Felix C. Schroeder, Angeliki Grammatikopoulou, Andy Barwise, Stephen MacKinnon, Richard J. Jardine and David M. Potts*

1566

**Ultimate Capacity of Short Piles in Clay under Lateral Loading**

*Chris M. Martin, Harvey J. Burd, Ross A. McAdam, Peter J. Houlston and Isabel von Celsing*

1576

## Pipelines, Risers, and Cables

**A Review of Drag Anchor Penetration Models to Inform Cable Burial Risk Assessment**

*Giuliano Pretti, William M. Coombs, Charles Augarde, Marc M. Puigvert, José A. R. Gutiérrez and Laurence Cross*

1586

**Axial Soil Stiffness for Deepwater Pipeline Walking Analysis**

*Jinbo Chen, David White, Chris Hadley, Kevin Ouyang, Jason Newlin, Shuang Hu, David Bruton and Meng Luo*

1596

**Case Study: Rosetta Channel Pipeline Crossing**

*David Kay, David Rushton, Frans Van Herpen, Aad Van Es, Sanjay Shinde, Martyn Chapman and Stelios Panayides*

1606

**Constructional and Operational Considerations in Assessing the Lateral Response of Buried Subsea Pipelines**

*Hodjat Shiri and Morteza Kianian*

1616

**Drained Residual Conditions for Axially Loaded Flowlines**

*Ahmed M. Hussien, R. B. Gilbert, Y. Huang, C. Sung, J. Han, L. Melo Monteiro, J. Chen, K. Ouyang and M. Luo*

1626

**Effect of Water Entrainment on Seabed Soils during Cyclic Pipe-Soil Interaction**

*F. Sahdi, J. G. Tom, P. Watson, C. Gaudin and M. F. Bransby*

1636

**Field Observations of Pipelines in the Context of SAFEBCUCK Design Guidelines***Daniel R. Spikula, David Kay, Zack Westgate and Andy Hill*

1646

**Inclined and Uplift Resistance of Pipelines Buried in Rock***Conleth D. O'Loughlin, David J. White, Alasdair J. Maconochie and G. J. Yun*

1657

**Large Deformation Analysis of Lateral Pipeline-Backfill-Trench Interaction by Remeshing and Interpolation Technique with Small Strain Model (RITSS)***Xiaoyu Dong, Hodjat Shiri, Wangcheng Zhang and Mark F. Randolph*

1668

**On the Behaviour of Pipe-Clamping Mattresses to Arrest Pipeline Walking***Colm O'Beirne, Conleth O'Loughlin, Phil Watson, David White, Sze-Yu Ang and Sebastiaan Frankenmolen*

1678

**Pipe-Soil Interaction for Surface-Laid Pipelines in Carbonate Sediments***Fraser Bransby, Han Eng Low, Fangyuan Zhu, Romain Clavaud and David White*

1690

**Sensitivity of Fatigue Service Life of Steel Catenary Risers Using Nonlinear Riser-Soil-Interaction Model to Duration of Dynamic Simulation under Randomly Generated Waves***Atmaram Muraleedharan and Mehrdad Kimiaeи*

1705

**Shearing Resistance of Rough Polymer-Sand Interfaces***Henry Milewski, Andrea Diambra, Lawrence W. de Leeuw and Matthew S. Dietz*

1716

**Subsea Pipeline Walking: The Effect of a Bi-Linear Seabed Friction Model***Indranil Guha, Ph.D. Candidate, David J. White, Professor and Mark F. Randolph, Professor*

1726

**The Geometrical Significance of Seabed Trench in Fatigue Performance of Steel Catenary Risers in the Touchdown Zone***Hodjat Shiri and Rahim Shoghi*

1736

**Using Coating Roughness to Control Pipe-Soil Friction and Influence Pipeline Global Buckling Behaviour***Lawrence W. de Leeuw, Andrea Diambra, Matthew S. Dietz, Henry Milewski, George Mylonakis, Oh-Sung Kwon and Anastasios G. Sextos*

1746

## Risk and Reliability

### **Effect of Sea State Realizations on the Geotechnical Design of OWT Foundations**

*Hendrik Sturm and Jørgen Johansson*

1756

### **Probabilistic Site Response Analysis: Methodology and Applicability**

*Daniela Tonoli, Francesca Ioele, Pamela Poggi, Daniele Bertalot, Omar Zanoli, Eric J. Parker and Emilia Fiorini*

1764

### **Reliability of Five Axial Pile Capacity Design Methods – A Case Study**

*Zhongqiang Liu, Sarah Elkhateib, Farrokh Nadim and Suzanne Lacasse*

1774

### **Slope Failures: Quantifying Frequencies and Volumes and Identifying a Potential Trigger Mechanism**

*Eric Liedtke and Daniel R. Spikula*

1785

### **The Statistics of Monopile Foundation Capacity in Spatially Variable Soil: Is Prediction of Axial Capacity Based on a Single CPT Reliable?**

*Y. Cai, M. F. Bransby and C. Gaudin*

1795

## Shallow Foundations

### **Design of Shallow Foundations for Tidal-Stream Energy Structures**

*John Barrett, P.E., Kenneth Gavin, Ph.D., C.Eng. and Tom Doyle, Ph.D.*

1805

### **Pin Foundation on Hard Seabed**

*Emilio Nicolini, F. Dedecker and R. Coquet*

1816

### **Simple Method for Computing Nonlinear Foundation Stiffness and Damping**

*Jørgen Johansson, Nallathamby Sivasithamparam, Youhu Zhang and Harun Kursat Engin*

1824

### **Skirt Penetration Resistance of the Utgard Template**

*Knut H. Andersen, Knut Schrøder, Viggo Karlsen and Egil Solhjell*

1834

### **Sliding Mudmats Design - Current State of Practice and Realistic 3D Simulations**

*Jean M. Audibert, M. Kabir Hossain, SUT, ASCE and John T. Bryant ASCE, AIPG, PTI, ACEC*

**The Effect of Shape on the Failure Envelope of the Cross-Shaped Foundation – Numerical Analyses**

*Emilio Nicolini, A. Alberio and G. Della Vecchia*

## Site Characterization

**An Assessment of the Overconsolidation and Post-Sedimentation Structure of Marine Clay from Offshore Northern Mozambique**

*Logan C. Brant and Rodolfo B. Sancio*

**Analytical Effective Stress Piezocone Methods for Assessing Geoparameters of Offshore Clay**

*Paul W. Mayne, Shehab S. Agaiby and Zhongkun Ouyang*

**Application of Probabilistic Calibration of Geostatistical Parameters in Seismic Travel Time Inversion**

*Moslem Moradi and Zenon Medina-Cetina*

**Characteristic Values for Geotechnical Design of Offshore Monopiles in Sandy Soils – Case Study**

*J. Peuchen, K. Kaltekis, M. Klein, M. Murali, F. C. W. van Erp and M. A. Hicks*

**CPT Correlations for Estimating Undrained Shear Strength of Marine Clay Offshore East Africa**

*Ali Ebrahimi and Rodolfo B. Sancio*

**Cyclic Response of an East African Marine Clay**

*Rodolfo B. Sancio and Logan C. Brant*

**Dynamic Gassy Soils Behaviour, Gulf of Mexico**

*Raúl Nava-Castro and Kuat C. Gan*

**Engineering Properties of Late Pleistocene and Holocene Sediments of the Continental Shelf Offshore Trinidad**

*Daniel R. Spikula and Eric Liedtke*

**Geotechnical Challenges for Offshore Windfarm Foundation Design in Emerging Asian Market**

*Arthur K. C. Cheung, Aslan S. Hokmabadi, Honest P. O. Tang and Jack Yiu*

1942

**Geotechnical Characterization of Mississippi River Delta Front Sediments**

*Jack A. Cadigan, Navid H. Jafari, Ioannis Y. Georgiou, Samuel J. Bentley, Kehui Xu and Michael D. Miner*

1952

**Implementation of Advanced Monopile Design Approaches at the Seastar Offshore Wind Farm**

*M. Rattley, S. Whyte, J. Hilton, D. Burbury, H. J. Burd, C. M. Martin and S. Ingardfield*

1962

**Nonlinear Constitutive Model of Stress-Strain Behavior for Bay of Campeche Sand**

*Francisco A. Flores López, Ernesto Vega Fernández, Victor M. Taboada, Diego Cruz Roque and Prócoro Barrera Nabor*

1974

**On the Cyclic Resistance of Dense North Sea Sands**

*D. Bertalot, D. Soler Sandoval and G. Yetginer Tjelta*

1984

**Overview of Geological and Geotechnical Characteristics of Offshore Sout China Sea Sediments**

*Huo Ping Wang, Her Jia E. Hu, Xiaoyan Long, Nancy Chan and Ko Min Tjok*

1994

**Probabilistic Slope Stability Analysis Using Novel Response Surface**

*Aleksander S. Gundersen, D. Ryghseter, A. Worren, F. Nadim and Z. Liu*

2005

## **Soil Behavior and Modeling**

**3D Finite Element Modelling of the Cyclic Behaviour of Large Diameter Monopiles in Sand**

*Chris Humpheson, Helen Dingle and Anton Pillai*

2013

**An Efficient FEA Tool for Offshore Wind Turbine Foundations**

*Nallathamby Sivasithamparam and Hans Petter Jostad*

2023

**Auto-Calibrated Kinematic Hardening Clay Model with Application to Monopile Foundations for Offshore Wind Turbines**

*Kristian Krabbenhøft, Jørgen Krabbenhøft and Morten Andersen Herfelt*

2033

**Comparison of Two Mesh Regularization Approaches for Large Deformation Finite Element Analysis**

*Jin Chen and Bipul Hawlader*

2043

**Earthquake Loads on Suction Anchors and Piles for Subsea Facilities**

*Amir A. Rahim and Amir M. Kaynia*

2053

**Insight into the Cyclic Response of OWT Pile Foundations in Sand: Numerical Simulation of PISA Field Tests**

*Panagiota Tasiopoulou, Jacob Chacko, Yannis Chaloulos, Amalia Giannakou and Nikos Gerolymos*  
2062

**Investigating the Response of Tripod Suction Bucket Foundations to Multidirectional Lateral Cyclic Loading**

*A. Barari and L. B. Ibsen*

2073

**Investigation of Rate Effects for Monopile Foundations: Laboratory-Scale Model Tests**

*Kuen-Wei Wu, Byron W. Byrne and Guy T. Houlsby*

2085

**Modelling the Effects of Cyclically-Induced Consolidation on Spudcan Capacity**

*Raffaele Ragni, Joe Tom, Britta Bienen and David Mašín*

2095

**Offshore Clays - Parameter Calibration of a New Hybrid Hyperbolic Model**

*Lorenzo Zuccarino, Luca Ottonello and Omar Zanoli*

2105

**Post Cyclic Volumetric Recompression Response of Carbonate Sediments**

*Shambhu S. Sharma, Hackmet Joer and Noel Boylan*

2117

**Practical Approach for the Evaluation of Cyclically Induced Excess Pore Pressure around Offshore Foundations in Sand**

*Jann-Eike Saathoff and Martin Achmus*

2127

**Seismic Response of Offshore Wind Monopiles in Cohesionless Soils**

*J. Seong, C. N. Abadie, S. K. Haigh and S. P. G. Madabhushi*

2137

**Strain Accumulation in Granular Soils under Cyclic Multiaxial Stress Conditions**

*Xiaoyang Cheng, Feng Yu, Maosong Huang, Erdin Ibraim and Andrea Diambra*

2147

**Strength Properties of Subsea Rockfills at Low Stress Level**

*Hongjie Zhou, Andrew D. Deeks, Amir M. Kaynia, Alasdair Macdonochie and Wouter Op den Velde*

2157

## **Spudcans**

**Case Study: Spudcan-Pipeline Interaction at the Maria Field - Challenges of Data Interpretation and Comparison of Predicted and Measured Soil Deformation**

*Khoa D. V. Huynh, Vaughan M. Meyer and Richard J. Pike*

2168

**Comparison of Penetration Mechanisms of Cone and Spudcan in a Multilayer Deposit with Interbedded Sand Layers**

*Stefanus Safinus, M. S. Hossain, M. J. Cassidy, M. F. Randolph and M. A. Mohiuddin*

2178

**Earthquake Soil-Structure Interaction Assessments of Jack-Up MODU for Tangguh Development, Offshore Papua Barat, Indonesia – Part 1**

*Hugo Galanes-Alvarez, Armedito Ramadhan, Philippe Jeanjean, Kevin M. Hampson, Carl Erbrich and Kok Kuen Lee*

2188

**Earthquake Soil-Structure Interaction Assessments of Jack-Up MODU for Tangguh Development – Part 2**

*Carl Erbrich, Kok Kuen Lee, Sydney Lam, Kee Kiat Tho, Hugo Galanes-Alvarez and Armedito Ramadhan*

2198

**Earthquake Soil-Structure Interaction Assessments of Jack-Up MODU for Tangguh Development – Part 3**

*Carl Erbrich, Kok Kuen Lee, Sidney Lam, Kee Kiat Tho, Hugo Galanes-Alvarez and Armedito Ramadhan*

2208

**Effect of Undrained Strength Anisotropy on Spudcan Penetration**

*Jose G. Parra, Marcos Arroyo and Matteo Cuantia*

2218

**Punch-Through Risk of Spudcans: A Comparison of Design Models and Field Measurements**

*Peter O. Van Impe, Adrianna Mirecka, Angelo van Tongeren and Kristine Vandenboer*

2228

**Rapid Penetration of Spudcans in Sand**

*Shiao Huey Chow, Britta Bienen and Mark Randolph*

2238

**Spudcan Penetration in Sand-Over-Clay Considering Soil Variability**

*Lei Song, Tianlongyuan Qin and Jinhui Li*

2248