Contents:

SPECIAL ISSUE ON FLAT DILATOMETER TESTING: APPLICATIONS AND RECENT DEVELOPMENTS
Guest Editors: Paola Monaco and António Viana da Fonseca

Overview

837 Recent Improvements in the Use, Interpretation, and Applications of DMT and SDMT in Practice
Silvana Marchetti and Paola Monaco

851 Effective Stress Strength Parameters of Clays from DMT
Zhongkun Ouyang and Paul W. Mayne

868 Interpretation of the DMT in Silts
Fernando Schnaid, Marcus V. A. Belloli, Edgar Oslebrecht, and Diego Marchetti

877 Theoretical DMT Interpretation in Sensitive Clays
Vincenzo Silvestri

890 Interrelationship between Undrained Shear Strength from DMT and CPTU Tests for Soils of Different Origin
Zbigniew Mięńnik, Jędrzej Kierziński, and Katarzyna Stefaniak

902 The Use of the DMT for the Evaluation of Changes in Stress State in Overconsolidated Clay in Geotechnical Applications
Herman Peiffer, Behnoy Malegier, Wim Haegeman, and Hao Shen

915 Overconsolidation and Cementation in Sands: Impacts on Geotechnical Properties and Evaluation Using Dilatometer Tests
Hyunwook Choo, Woonjung Lee, and Changho Lee

920 Marchetti Flat Dilatometer Tests in a Virtual Calibration Chamber
Joanna Butlanska, Marcos Arroyo, Sara Amoroso, and Antonio Gens

946 Monitoring Ground Improvement Using the Seismic Dilatometer in Christchurch, New Zealand
Sara Amoroso, Kyle Rollins, Paola Monaco, Marco Holtgriter, and Alan Thorp

967 Dilatometer and Seismic Dilatometer Testing Offshore: Available Experience and New Developments
Diego Marchetti
The Geotechnical Testing Journal is published in six issues per year by ASTM International, a nonprofit technical organization that develops and publishes voluntary consensus standards and related information for materials, products, systems, and services. Some issues, in whole or in part, may be Special Issues focused on a topic of interest to our readers. Contributions are peer reviewed prior to publication.

EDITORIAL BOARD
Dr. David W. Akey
University of Sydney, Australia
Dr. Khalid A. Alshibli
University of Tennessee, Knoxville, TN, USA
Dr. Charles Anthony
Texas A&M University
College Station, TX, USA
Dr. Richard J. Baehr
Royal Military College of Canada
Kingston, Ontario, Canada
Dr. Paul J. Bullock
Fugro Consultants, Inc. – Loudoun
Goochland, VA, USA
Dr. Andrew P. Bungay
University of Pittsburgh
Pittsburgh, PA, USA
Dr. Gaymou Cai
Southeast University
Nanjing, China
Dr. Giovanni Cuscarne
University of Waterloo, Canada
Dr. Andrew Curren
Dalhousie University
Halifax, Nova Scotia, Canada
Dr. Pierre Delage
CERME
Ecole Nationale des Ponts et Chausées
France
Dr. Mandar Dowlalkar
University of Vermont
Burlington, VT, USA
Dr. Vincent P. Drenner
Purdue University
West Lafayette, IN, USA
Chadi E. Mohar
University of Texas at Austin
Austin, TX, USA
Dr. Dario Fratta
University of Wisconsin-Madison
Madison, WI, USA
Dr. Majid Ghasemi
University of New Hampshire
Durham, NH, USA
Dr. Karen H. Henry
United States Air Force Academy
USAFA, Colorado, CO, USA
Dr. Lauraena R. Hoyos
The University of Texas at Arlington
Arlington, TX, USA
Dr. Zeboubi Latifa
Ecole Centrale de Lille
Lille, France
Mr. Michael W. Lamy
Tennent Consultants, Inc.
Ottawa, KS, USA
Professor Fook-Hou Lim
National University of Singapore
Singapore
Garland J. Likins
Polymers, Inc.
Cleveland, OH, USA
Dr. Michael Long
University College Dublin, Ireland
Dr. Ning Lu
Closed School of Mines
Golden, CO, USA
Mr. Robert Mackey
SIL, Inc.
Maitland, FL, USA
Dr. Ali Mahler
Rangers University
Postacrow, NJ, USA
Ms. Gabarra Mardal
National Concrete Masonry Association
Huntington Beach, CA, USA
Dr. John S. McCartney
University of California San Diego
La Jolla, CA, USA
Mr. James A. McKeever
Earth Engineering, Inc.
Exton, PA, USA
Dr. Jay N. Meegoda
New Jersey Institute of Technology
Newark, NJ, USA
Dr. Michael A. Mooney
Colorado School of Mines
Golden, CO, USA
Majdi Alou Nour
Reut, Lebanon
Dr. Phillip S. K. Ooi
University of Hawaii at Manoa
Honolulu, HI, USA
Dr. Anand J. Pappula
University of Texas at Arlington
Arlington, TX, USA
Donald T. Robertson
Applied Foundation Testing, Inc.
Green Cove Springs, FL, USA
Dr. Joel Sarout
Commonwealth Scientific and Industrial
Research Organization
Bentley, Australia
Dr. Vincent Silvain
Ecole Polytechnique de Montréal
Canada
Dr. Devendra N. Singh
Indian Institute of Technology
India
Dr. Khalid Sobhan
Florida Atlantic University
Boca Raton, FL, USA
Dr. Muhannad T. Suleiman
University of Texas
San Antonio, TX, USA
Dr. George Voyer
University of Rhode Island
Kingston, RI, USA
Dr. Dharmar Vevickone
University of British Columbia
Canada
Dr. Paul A. Vostell
Global Waste Research Institute
California Polytechnic State University
San Luis Obispo, CA, USA
Dr. Xiong Yu
Case Western Reserve University
Cleveland, OH, USA

EXECUTIVE COMMITTEE
Dale F. Bohn, Chair
Taco van der Maten, Vice Chair
Andrew G. Kiro, Jr., Vice Chair
John B. Loger, Chair of Finance and Audit Committee
Ralph M. Paroli, Past Chairman
D. Thomas Marsh, Past Chairman
Katharine E. Morgan, President

DIRECTORS
Ferdinando E. Aprisi
Dale F. Bohn
Joanne W. Chin
Cesar A. Constantino
Olive S. Deller, Jr.
William Ellis
John Fletcher
James G. Galipeau
John Germaine
William C. Grose
Alan Kaufman
Andrew G. Kiro, Jr.
John B. Loger
D. Thomas Marsh
R. Christopher Mathis
Katharine E. Morgan
Derek M. S. Ono
Ralph M. Paroli
Irving S. Scher
Arman Shakkaliyev
James A. Tann
Vicky Taylor
Taco van der Maten
Jeff Weiss
Terry O. Woods

COMMITTEE ON PUBLICATIONS
Den McGlashan, Chairman
William J. Likos, Vice Chairman
Dale F. Bohn, ex officio
Joy Bhatt
K. Russell DePriest
Nichil Gupta
John E. Haddock
Jason H. Ideker
Dr. majdi A. Alshibli
Dr. William W. Bullock
Dr. Andrew P. Bunger
Dr. Michael A. Mooney
Dr. Paul J. Bullock
Dr. Dharma Wijewickreme
Dr. Deryck M.S. Omar
Dr. Khaled Sobhan
Dr. David W. Akey
Dr. Ning Lu
Dr. Robert Mackey
Dr. Jerry S. McCormick

INFORMATION FOR AUTHORS
For details regarding paper submission go to http://mac4.manu- scriptcentral.com/astm-gtj. The subject matter must not be of a speculative nature and the contents must not include materials of an advertising nature. The paper must not be seriously defective as to literary form and structure, continuity of thought, and clarity of expression. The substance of the paper should not have been published previously in the open literature.

AUTHORS preparing papers for submittal should observe the conventions of style explained in the ASTM Style Manual. Since the journal is a subscription service, the author is expected to conform to these standard conventions for style and the inclusion of complete references and high-quality figures. SI units are to be used throughout; if data were not measured in SI units, a note should appear to that effect and the original units should be included in parentheses after the SI units.

IN APPRECIATION OF THE REVIEWERS
The high quality of the papers that appear in this publication is a tribute not only to the obvious efforts of the authors represented but to the unheralded, though essential, efforts of their reviewers. It is to the reviewers’ dedication to upholding the high standards of this profession that this note pays tribute. On behalf of ASTM International and the authors as well, we acknowledge with appreciation their important contribution to the success of this journal.

AWARDS FOR PAPERS
Papers are eligible for the following ASTM International awards:

1. The C.A. Hogentogler Award — papers on soils for engineering purposes.
2. The Sanford E. Thompson Award — papers on concrete and concrete aggregates.
3. The Richard L. Temple Award — papers on new and useful testing procedures and apparatus.

The Geotechnical Testing Journal Award — papers on the practice of geotechnical testing.

PAST TECHNICAL EDITORS
Dr. Ernest P. silly (March 1979 to September 1985)
Dr. Vincent P. Drenner (December 1985 to December 1999)
Mr. Paul Knodel (March 1990 to December 1992)
Dr. Howard A. Paine (March 1993 to December 1995)
Dr. Ronald C. Cheyne and Dr. Kenneth R. Daukas (March 1996 to June 2002)
Dr. Thomas C. Sheahan (July 2002 to December 2002)
Mr. B. Danto (September 2002 to December 2017)

Geotechnical Testing Journal (ISSN 0448-0070) is published in six issues per year by ASTM International. Some issues, in whole or in part, may be Special Issues focused on a topic of interest to our members. The views expressed in this journal are not those of ASTM International. The data and opinions appearing in the published material were prepared by and are the responsibility of the contributors, not of ASTM International.

Copyright © 2018 by ASTM International. All rights reserved. This material may not be reproduced or copied, in whole or in part, by any means, including electronic, mechanical, or other distribution media without the written consent of the publisher.

Subscription inquiries include two formats: online access only or online plus printed volumes. Individual subscriptions: $125.00 for 1 year online access and $295.00 for online access plus printed volumes. Institutional subscriptions: $475.00 for 1 year online access and $693.00 for 1 year online access plus printed volumes. Single copies are $55.00. For multi-site subscription and pricing, please contact Sales or call 1-877-929-ASTM. To subscribe, please visit the ASTM International online store.

Send address change to ASTM International—GTJ, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959 or visit our website:


Subscription rates: $366.00 for 1 year online access plus printed volumes. Institutional subscriptions (one geographic site via IP access): $473.00 for 1 year online access and $693.00 for online access plus printed volumes. For more information on subscription options contact ASTM at 610-832-9508.

Copyright © 2018 by ASTM International. All rights reserved.
Overview

Special Issue on *Flat Dilatometer Testing: Applications and Recent Developments*

The last decades in the field of site investigations have seen an increasing trend to move from the traditional practice based on drilling, sampling, and laboratory testing towards in situ testing, which today often represents the majority of the ground characterization approaches part of an investigation. In situ tests are fast, the results are available immediately, and, by easily covering higher volumes of soil, they are permitted to assess local site variability.

The flat dilatometer test (DMT), developed in Italy by professor Silvano Marchetti in the second half of the 1970s, has expanded the range of direct-push in situ tests and has been gaining increasing popularity in recent years, potentiated by the release of its seismic version (SDMT). Distinctively recognized contributions that the DMT can provide in a routine site investigation are mostly related to its sensitivity to stress history and soil stiffness.

The idea for this special issue on *Flat Dilatometer Testing: Applications and Recent Developments* was launched during the 3\(^{rd}\) International Conference on the Flat Dilatometer—DMT'15 held in Rome, Italy, in June 2015. On that occasion, a large number of papers involving the use of DMT were submitted to the conference by researchers from many countries, covering a wide range of applications and demonstrating the increasing interest of the geotechnical scientific and professional community on the DMT and its applications. In the following months, after an in-depth discussion with Silvano Marchetti, we considered submitting a proposal for this special issue to the *Geotechnical Testing Journal*. In February 2017 the then Editors in Chief of the journal, William Likos and David Suits, accepted our proposal to put this special collection together. Sadly, Silvano Marchetti passed away in December 2016.

Contributions to this special issue were collected by inviting researchers who have been active and innovative in the use of DMT testing, aiming at presenting their works with new results and interpretation methods for geotechnical engineering. Ultimately 10 papers submitted in response to invitations were accepted after rigorous peer review. The final collection contains papers authored or co-authored by researchers located in nine different countries from Europe, North and South America, Asia, and Australasia.

This collection of papers includes an overview paper on recent improvements in using, interpreting and applying DMT/SDMT in practice. This paper summarizes Silvano’s main views and reflects his latest research activity. Unfortunately he could not have been involved in the final stages of the manuscript preparation. The most significant intellectual contribution in the conception of the paper is due to him and was then finalized with the support of one of the guest editors.

The other papers cover recent developments in DMT/SDMT interpretation, significant applications, and test equipment. The following topics are addressed: updates on DMT interpretation in intermediate silts and in clays of different origin; theoretical and numerical modeling of the test; assessment of overconsolidation and cementation in sands from DMT; evaluation of changes in stress state due to pile installation and landslides in overconsolidated clay using the DMT; monitoring ground improvement for mitigation of liquefaction hazard using the SDMT; and new technological developments of DMT/SDMT equipment, including offshore testing.

We congratulate all of the authors who contributed to this special issue and thank the many reviewers who critically assessed the original manuscripts. We are indebted to the journal Editors, as well as to the ASTM editorial team, for their efforts to complete this project.

We are very grateful to be the guest editors of this special issue of the *Geotechnical Testing Journal on Flat Dilatometer Testing: Applications and Recent Developments* and for having an opportunity to emphasize the role of in situ tests in geotechnical practice. At the same time, we remind readers that the "Marchetti dilatometer" is, and will be, inseparably linked with the name of its inventor. We are highly indebted to his smart and open-minded influence and we will miss the many positive discussions, for so many years.
This special issue, having the purpose to leave a tribute to a prominent engineer and researcher in the field of ground characterization from in situ testing, will also encourage the geotechnical community to pursue innovative research contributions on flat dilatometer testing in view of its potentiality.

Paola Monaco
António Viana da Fonseca
The Geotechnical Testing Journal is published in six issues per year by ASTM International, a nonprofit technical organization that develops and publishes voluntary consensus standards and related information for materials, products, systems, and services. Some issues, in whole or in part, may be Special Issues focused on a topic of interest to our readers. The views expressed in this journal are not those of ASTM International. The data and opinions appearing in the published material were prepared by and are the responsibility of the contributors, not of ASTM International.

Copyright © 2018 ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959. All rights reserved. This material may not be reproduced or copied, in whole or in part, in any medium, without the written consent of the publisher.

EXECUTIVE COMMITTEE
Dale F. Bohm, Chairman
Taco van der Maten, Vice Chairman
Andrew G. Korpa, Jr., Vice Chairman
John R. Logan, Chairman of Finance and Audit Committee
Ralph M. Parrish, Past Chairman
Dr. Thomas Marsh, Past Chairman
Katharine E. Morgan, President

DIRECTORS
Ferdinando E. Appesi
Dale F. Bohm
Joanne W. Chin
Cesar A. Constantino
Oliver S. Doley, Jr.
William Ellis
John Fletcher
James G. Galipeau
John Germaine
William C. Greeson
Alan Kaufman
Andrew G. Korpa, Jr.
John R. Logan
D. Christopher Mathis
Katharine E. Morgan
Derek S. Mok
Ralph M. Parrish
Irving S. Scher
Armad Khashakhlav
James A. Tait
Vicky Taylor
Taco van der Maten
Jeff Weiss
Terry O. Woods

COMMITTEE ON PUBLICATIONS
Dee Magrino, Chairman
William J. Likos, Vice Chairman
Dale F. Bohm, ex officio
Jay Bhatt
K. Russell DePriest
Sudarsan Rachuri
Suzanne Pecore
Richard W. Neu
Michael R. Mitchell
Nikhil Gupta
Jason H. Ideker
K. Russell DePriest
Donald T. Robertson
Dee Magnoni, Chairman
Terence D. Henshaw
Dr. Andrew G. Kireta, Jr., Vice Chairman
Dr. Andrew P. Buney
Alan Kaufman
R. Christopher Mathis
Vicky Taylor
Taco van der Maten
Jeff Weiss
Terry O. Woods

PAST TECHNICAL EDITORS
Dr. Ernest T. Sugli
(March 1978 to September 1985)
Dr. Vincent P. Dmoch
(December 1985 to December 1990)
Mr. Paul Knoll
(December 1990 to December 1992)
Dr. Howard A. Paine
(December 1992 to December 1995)
Dr. Ronald C. Cheney and Dr. Kenneth B. Darman
(December 1996 to June 2002)
Dr. Thomas Marsh
(September 2002 to December 2005)

INFORMATION FOR AUTHORS
For details regarding paper submission go to http://m44.manuscriptcentral.com/astm-gt. The subject matter must not be of a speculative nature and the contents must not include materials of an advertising nature. The paper must not be seriously defective as to literary form and structure, continuity of thought, and clarity of expression. The substance of the paper should not have been published previously or in the open literature.

Authors preparing papers for submittal should observe the conventions of style explained in the ASTM Style Manual. Since the journal does not request page charges, the author is expected to conform to these standard conventions for style and the inclusion of complete references and high-quality figures. SI units are to be used throughout; if data were not measured in SI units, a note should appear to that effect and the original units should be included in parentheses after the SI units.

IN APPRECIATION OF THE REVIEWERS
The high quality of papers that appear in this publication is a tribute not only to the obvious efforts of the authors represented but to the unheralded, though essential, efforts of their reviewers. It is to the reviewers’ dedication to upholding the high standards of their profession that this note pays tribute. On behalf of ASTM International and the authors as well, we acknowledge with appreciation their important contribution to the success of this journal.

AWARDS FOR PAPERS
Papers are eligible for the following ASTM International awards:

- The A.C. Hinegardner Award — papers on soils for engineering purposes.
- The Sanford E. Thompson Award — papers on concrete and concrete aggregates.
- The Richard L. Temple Award — papers on new and useful testing procedures and apparatus.
- The Geotechnical Testing Journal Award — papers on the practice of geotechnical testing.

PAST TECHNICAL EDITORS

Dr. Thomas Marsh
(September 2002 to December 2005)

Dr. Thomas Marsh
(September 2002 to December 2005)

Dr. Thomas Marsh
(September 2002 to December 2005)

Dr. Thomas Marsh
(September 2002 to December 2005)

Dr. Thomas Marsh
(September 2002 to December 2005)

Dr. Thomas Marsh
(September 2002 to December 2005)

Dr. Thomas Marsh
(September 2002 to December 2005)
# Geotechnical Testing Journal

## Contents:

SPECIAL ISSUE ON FLAT DILATOMETER TESTING: APPLICATIONS AND RECENT DEVELOPMENTS
Guest Editors: Paola Monaco and António Viana da Fonseca

<table>
<thead>
<tr>
<th>Overview</th>
</tr>
</thead>
</table>
| 837 Recent Improvements in the Use, Interpretation, and Applications of DMT and SDMT in Practice | Silvana Marchetti and Paola Monaco  
| 851 Effective Stress Strength Parameters of Clays from DMT | Zhongkun Ouyang and Paul W. Mayne  
| 868 Interpretation of the DMT in Soils | Fernando Schnaid, Marcus V. A. Belloli, Edgar Oslebrecht, and Diego Marchetti  
| 877 Theoretical DMT Interpretation in Sensitive Clays | Vincenzo Silvestri  
| 890 Interrelationship between Undrained Shear Strength from DMT and CPTu Tests for Soils of Different Origin | Zbigniew Miñanik, Jędrzej Wierzbicki, and Katarzyna Stefaniak  
| 902 The Use of the DMT for the Evaluation of Changes in Stress State in Overconsolidated Clay in Geotechnical Applications | Hermann Pfeiffer, Beining Malangier, Wim Haegeman, and Hao Shan  
| 915 Overconsolidation and Cementation in Sands: Impacts on Geotechnical Properties and Evaluation Using Dilatometer Tests | Hyunwook Choo, Wojsin Lee, and Changho Lee  
| 920 Marchetti Flat Dilatometer Tests in a Virtual Calibration Chamber | Joanna Butlanska, Marcos Arroyo, Sara Amoroso, and Antonio Gens  
| 946 Monitoring Ground Improvement Using the Seismic Dilatometer in Christchurch, New Zealand | Sara Amoroso, Kyle M. Rollins, Paola Monaco, Marco Hofftrigter, and Alan Thorp  
| 967 Dilatometer and Seismic Dilatometer Testing Offshore: Available Experience and New Developments | Diego Marchetti  

The Geotechnical Testing Journal is online.

**TAKE ADVANTAGE OF THESE BENEFITS:**
- Search Papers and Authors
- View Abstracts
- View Table of Contents
- Download Individual Papers
- IP access is available

For information, visit: www.astm.org

Published bimonthly by ASTM International | 100 Barr Harbor Drive | PO Box C700 | W. Conshohocken, PA 19428-2959