

# International Journal of Geomechanics

## Technical Papers

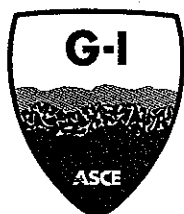
- 353 Estimating Pressure Losses in Interconnected Fracture Systems: Integrated Tensor Approach  
*Abdul Ravooof Shaik, Nam H. Tran, Sheik S. Rahman, and Thanh Tran*
- 364 Analysis and Design of Vibration Isolation System Using Open Trenches  
*G. L. Sivakumar Babu, Amit Srivastava, K. S. Nanjunda Rao, and S. Venkatesha*
- 370 Numerical Simulation of the Influence of Initial State of Sand on Element Tests and Micropile Performance  
*S. Shu, B. Muhunthan, and X. S. Li*
- 381 Undrained Stability of Footings on Slopes  
*J. S. Shiau, R. S. Merifield, A. V. Lyamin, and S. W. Sloan*
- 391 Dynamic Response of Rigid Foundations of Arbitrary Shape Using Half-Space Green's Function  
*Rahim Shahi and Asadolah Noorzad*

## Technical Notes

- 399 Influence of Boundary Conditions in a Finite-Element Analysis of River Levees  
*Marco Redaelli, Annamaria Cividini, and Giancarlo Gioda*
- 406 Reducing the Computational Effort for Performing Linear Optimization in the Lower-Bound Finite Elements Limit Analysis  
*Jyant Kumar and Paramita Bhattacharya*

## Discussions and Closures

- 413 Discussion of "Two-Dimensional Discrete Element Theory for Rough Particles" by Mingjing Jiang, Serge Leroueil, Hehua Zhu, Hai-Sui Yu, and Jean-Marie Konrad  
*Brian C. Burman*
- 414 Closure by Mingjing Jiang, Serge Leroueil, Hehua Zhu, Hai-Sui Yu, and Jean-Marie Konrad



GEO-  
INSTITUTE

Cosponsored by IACMAG

# International Journal of Geomechanics

## Editor in Chief

M. M. Zaman, Ph.D.  
*University of Oklahoma*

## Advisory Editor

C. S. Desai, Ph.D., P.E.  
*University of Arizona*

## Co-Editors

J. P. Carter  
*University of Newcastle, Australia*

C. Felice, Ph.D., P.E.  
*C. Felice & Company, LLC*

G. Gioda  
*Politecnico di Milano, Italy*

J. H. Yin  
*Hong Kong Polytechnic University*

## The Geo-Institute Board of Governors

Edward Kavazanjian Jr., Ph.D., P.E.,  
M.ASCE, *President*

Jean-Louis Briaud, Ph.D., P.E., F.ASCE,  
*Past President*

Larry P. Jedgele, P.E., M.ASCE,  
*Vice President*

Philip G. King, P.E., F.ASCE, *Treasurer*

Craig H. Benson, Ph.D., P.E., M.ASCE

William M. Camp III, P.E.

Moustafa Gouda, P.E., F.ASCE

Barbara A. Luke, Ph.D., P.E., M.ASCE

Carol W. Bowers, P.G., CAE, *Secretary*

**Cosponsored by the  
International Association for  
Computer Methods and Advances in  
Geomechanics (IACMAG)**

## Editorial Board

S. Akutagawa  
*Kobe University*

P. K. Basudhar  
*Indian Institute of Technology*

K. J. Bathe  
*Massachusetts Institute of Technology*

R. Bathurst  
*Royal Military College of Canada*

Z. P. Bazant, Ph.D., S.E.  
*Northwestern University*

G. Biscontin  
*Texas A&M University*

C. Boutin  
*Ecole Nationale des Travaux Publics  
de l'Etat, France*

W. F. Chen, Ph.D., P.E.  
*University of Hawaii*

Y. K. Chow, P.E.  
*National University of Singapore,  
Singapore*

M. Dolezalova  
*Dolexpert-Geotechnika, Czech Republic*

D. Elsworth  
*Pennsylvania State University*

K. L. Fishman, Ph.D.  
*McMahon & Mann Consulting Engineers*

P. Fox, Ph.D., P.E.  
*Ohio State University*

G. Gambolati  
*Universita degli Studi, Italy*

A. Gens  
*Polytechnic University of Catalonia,  
Spain*

J. Han, P.E.  
*University of Kansas*

T. Hueckel  
*Duke University*

D. R. Katti, Ph.D.  
*North Dakota State University*

R. Katzenbach  
*Technical University, Germany*

N. Khalili, Ph.D.  
*University of New South Wales*

P. V. Lade, Ph.D.  
*Catholic University of America*

M. R. Madhav  
*Jawaharlal Nehru Technical University*

B. Muhunthan, P.E.  
*Washington State University*

Y. M. Najjar, P.E.  
*Kansas State University*

F. Oka  
*Kyoto University, Japan*

C. O'Sullivan  
*Imperial College, London*

P. Papanastasiou  
*University of Cyprus*

W. G. Pariseau  
*University of Utah*

D. Penumadu  
*University of Tennessee*

M. E. Plesha, Ph.D.  
*University of Wisconsin*

D. Potts  
*Imperial College of Science, Technology,  
and Medicine, London*

J. H. Prevost, Ph.D.  
*Princeton University*

Y. Qiang  
*Tsinghua University, China*

M. F. Randolph  
*University of Western Australia, Australia*

M. P. Romo  
*National Autonomous University of Mexico*

R. K. Rowe, Ph.D., P.E.  
*Queen's University*

R. Salgado, P.E.  
*Purdue University*

C. Schwartz  
*University of Maryland*

H. F. Schweiger  
*Graz University of Technology, Austria*

A. P. S. Selvadurai, P.E.  
*McGill University, Montreal*

J. F. Semblat  
*Laboratoire Central des Ponts et  
Chaussees, France*

D. N. Singh  
*Indian Institute of Technology*

H. Siriwardene

D. Smith  
*University of Melbourne, Australia*

J. Sulem, Ph.D.  
*CERMES-Institut Navier, France*

H. R. Thomas  
*Cardiff University, U.K.*

E. Tutumluer  
*University of Illinois*

L. Trauner  
*University of Maribor*

K. Ugai  
*Gunma University, Japan*

H. S. Yu  
*University of Nottingham, U.K.*

## General Information

### International Journal of Geomechanics

www.asce.org/geomechanics

The American Society of Civil Engineers-Geo Institute began publishing the *International Journal of Geomechanics (IJOG)* in 2003; the *IJOG* was originated by Chandrakant S. Desai, University of Arizona, Tucson, who acted as its first editor-in-chief, from 2003 to 2008.

**Aims and scope.** The *International Journal of Geomechanics (IJOG)* focuses on geomechanics with emphasis on theoretical aspects, including computational and analytical methods and related validations. Applications of interdisciplinary topics such as geotechnical and geoenvironmental engineering, mining and geological engineering, rock and blasting engineering, underground structures, infrastructure and pavement engineering, petroleum engineering, engineering geophysics, offshore and marine geotechnology, geothermal energy, lunar and planetary engineering, and ice mechanics fall within the scope of the journal. Specific topics covered include numerical and analytical methods; constitutive modeling including elasticity, plasticity, creep, localization, fracture and instabilities; neural networks, expert systems, optimization and reliability; statics and dynamics of interacting structures and foundations; liquid and gas flow through geologic media, contaminant transport and groundwater problems; borehole stability, geohazards such as earthquakes, landslides and subsidence; soil/rock improvement; and the development of model validations using laboratory and field measurements.

*International Journal of Geomechanics* (ISSN 1532-3641) is published bimonthly by the American Society of Civil Engineers. The publications office is at ASCE, 1801 Alexander Bell Dr., Reston, VA 20191-4400. All editorial correspondence should be directed to the Journals Department. Periodicals postage is paid at Herndon, Virginia, U.S.A., and at additional mailing offices.

**Electronic submission of manuscripts.** Access the journal's welcome page at <http://www.editorialmanager.com/jrnmeng> to register as a new user, view the authors' tutorial, log onto the system, and submit papers, technical notes, discussions, and closures. Manuscripts under review, accepted for publication, or published elsewhere are not accepted. Go to <http://www.asce.org/journals/authors> for complete instructions on manuscript preparation.

**Length requirements.** For most ASCE journals, the maximum number of words or word-equivalents is 10,000 for papers, 3,500 for notes, and 2,000 for discussions. The editor may waive these restrictions to encourage papers on topics that cannot be treated within these limitations. Such topics may include state-of-the-art reviews and detailed case histories. Please use the ASCE sizing worksheet (<http://www.asce.org/journals/forms>) to determine the length and include a copy of the form with your submission.

**Permissions.** Written permission from the original publisher for both print and online reproduction must be provided along with the manuscript if using previously published figures and/or tables. For more information, go to <http://www.asce.org/pubs/compliance>.

**SI units.** The use of Système International (SI) units as primary units of measure is mandatory. Other units may be given in parentheses after the SI unit if the author desires. More information about SI units can be found in the *ASCE Authors' Guide* (<http://www.asce.org/journals/writingstyle>) or from NIST at <http://physics.nist.gov/cuu/Units/index.html>.

**Subscription inquiries and change of address.** Address all member subscription inquiries to Member Records, (800) 548-2723 or [memrec@asce.org](mailto:memrec@asce.org). Nonmembers should contact Customer Service Department, (703) 295-6210 or [onlinejls@asce.org](mailto:onlinejls@asce.org). Allow six weeks for all changes to become effective.

**Subscription pricing.** Subscriptions are filled for the calendar year and must be prepaid according to rates in the table below. To keep member rates inexpensive and ensure price stability of ASCE journals, it is essential that members agree not to forward personal subscriptions to libraries or reading rooms for at least 24 months after publication of the last issue of the calendar year. The following rates apply for 2011:

Subscription Package	International ASCE			
	U.S. ASCE and IACMAG Members	U.S. Institutions	and IACMAG Members	International Institutions
Print	\$122	\$490	\$152	\$520
Online	\$111	\$445	\$111	\$445
Print plus Online	\$139	\$556	\$169	\$586

Paid online subscriptions in 2011 receive access to all archive issues for those journals from 1990 to the present at no additional charge. For a complete schedule of prices and registration information for online access, visit the ASCE Publications Web site at <http://www.asce.org/journals/subscriptions> or inquire through e-mail to [marketing@asce.org](mailto:marketing@asce.org).

**Photocopies and reprints.** You can obtain instant permission to photocopy ASCE publications by using ASCE's online permission service (<http://www.asce.org/permissionrequests>). Requests for bulk copying of 100 copies or more should be submitted to the Reprints Department. A reprint order form can be found at <http://www.asce.org/reprints>.

**Postmaster.** Send address changes to *International Journal of Geomechanics*, ASCE, 1801 Alexander Bell Dr., Reston, VA 20191-4400.

Copyright © 2011 by American Society of Civil Engineers.

*This journal is printed on acid-free paper, which meets the ANSI requirements for permanence.*

**Disclaimer.** 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 expressed or implied, concerning the accuracy, completeness, suitability, or utility of any information, apparatus, product, or process discussed in this publication, and assumes no liability therefore. This information should not be used without first securing competent advice with respect to its suitability for any general or specific application. Anyone utilizing this information assumes all liability arising from such use, including but not limited to infringement of any patent or patents.



This journal is a member of and subscribes to the principles of the Committee on Publication Ethics.

## Technical Papers

- 353 Estimating Pressure Losses in Interconnected Fracture Systems: Integrated Tensor Approach  
*Abdul Ravoof Shaik, Nam H. Tran, Sheik S. Rahman, and Thanh Tran*
- 364 Analysis and Design of Vibration Isolation System Using Open Trenches  
*G. L. Sivakumar Babu, Amit Srivastava, K. S. Nanjunda Rao, and S. Venkatesha*
- 370 Numerical Simulation of the Influence of Initial State of Sand on Element Tests and Micropile Performance  
*S. Shu, B. Muhunthan, and X. S. Li*
- 381 Undrained Stability of Footings on Slopes  
*J. S. Shiau, R. S. Merifield, A. V. Lyamin, and S. W. Sloan*
- 391 Dynamic Response of Rigid Foundations of Arbitrary Shape Using Half-Space Green's Function  
*Rahim Shahi and Asadolah Noorzad*

## Technical Notes

- 399 Influence of Boundary Conditions in a Finite-Element Analysis of River Levees  
*Marco Redaelli, Annamaria Cividini, and Giancarlo Gioda*
- 406 Reducing the Computational Effort for Performing Linear Optimization in the Lower-Bound Finite Elements Limit Analysis  
*Jyant Kumar and Paramita Bhattacharya*

## Discussions and Closures

- 413 Discussion of "Two-Dimensional Discrete Element Theory for Rough Particles" by Mingjing Jiang, Serge Leroueil, Hehua Zhu, Hai-Sui Yu, and Jean-Marie Konrad  
*Brian C. Burman*
- 414 Closure by Mingjing Jiang, Serge Leroueil, Hehua Zhu, Hai-Sui Yu, and Jean-Marie Konrad

## Board Publications Committee

Marc I. Hoit, Ph.D., A.M.ASCE, *Chair*  
D. V. Griffiths, P.E., F.ASCE  
Jon A. Schmidt, P.E., M.ASCE  
Daniel L. Thomas, Ph.D., P.E., D.WRE,  
F.ASCE  
Kevin Womack, Ph.D., P.E., F.ASCE  
Bruce Gossett, Aff.M.ASCE, *ASCE Staff*  
*Contact*

## Publications

Bruce Gossett, *Managing Director and*  
*Publisher*

## Journals Department

Angela Cochran, *Director, Journals*  
Kelly Anderson, *Publishing Manager,*  
*Journals*  
Holly Koppel, *Managing Editor, Journals*  
Elizabeth Guertin, *Publishing Manager,*  
*Journals*  
Emily Sirotta, *Editorial Assistant, Journals*

## Production Department

Matt Boyle, *Director, Publications*  
*Production*  
Shaun Halloran, *Manager, Journals*  
*Production*  
Rajashree Ranganathan, *Assistant Production*  
*Manager*  
Nancy Green, *Senior Production Editor*  
Jennifer Kuhn, *Production Editor*  
Kathryn Doughty, *Production Assistant*  
Xi Van Fleet, *Manager, Information Services*  
Donna Dickert, *Reprints*

## Publishing Office

Journals Department  
ASCE  
1801 Alexander Bell Drive  
Reston, VA 20191-4400  
Telephone: (703) 295-6290  
E-mail: journal-services@asce.org

## Submission Information

*International Journal of Geomechanics*

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

### Types of Submissions

**Technical Papers.** Technical papers are full-length papers of value and interest to civil engineers. They must be original reviews of past practice, present information of current interest, or probe new fields of civil engineering activity. They should report results of thought-provoking studies that contribute to the planning, analysis, design, construction, management, or maintenance of civil engineering works. Technical papers should include a practical applications section whenever possible; theoretical manuscripts should indicate areas of additional research to implement technology transfer. Practical papers are strongly encouraged.

**Technical Notes.** Technical notes present (1) original, practical information; (2) preliminary or partial results of research; (3) concisely presented research results; and (4) innovative techniques to accomplish design objectives.

**Discussions.** Discussions are papers that present significant comments or questions about the technical content of a technical paper or note published in an ASCE journal, or a paper presented at a specialty conference or other meeting that has been published in an ASCE proceedings. They are limited to 2,000 words. They may be submitted during a 5-month period following the date of publication of the paper or note. Discussions should not contain matter readily found elsewhere, advocate special interests, contain obvious commercial intent, controvert established fact, or be purely speculative. Discussions follow the requirements for other manuscripts except that they do not have abstracts, introductions, or conclusions. Separate discussions must be submitted for companion papers (a study presented as Parts I and II).

**Closures.** Closures are responses written by the author(s) of the original paper or note. The author(s) addresses and clarifies issues raised in discussions and provides conclusions to the issues. Closures and discussions are published together.

**Forums.** Forums are essays of opinion and founded in fact, often on thought-provoking topics, which generate further discussion. They normally do not exceed 5,000 words. Not all ASCE journals publish forums.

**Book Reviews.** Book reviews assess new books whose content is judged important. They summarize the work, illuminate its strengths and weaknesses, and place it in context with existing literature. Reviews are limited to 1,200 words and are usually written upon request by a journal's book review editor or editor. Not all ASCE journals publish book reviews.

**Errata.** Errata are corrections of errors that appear in print. If errors are serious enough to impair understanding or mislead readers, authors should submit errata to the ASCE Journals Department. Errata are published in earliest available issue.

### General Guidelines

Review and publication procedures will be faster if authors follow the basic requirements listed here and at <http://www.asce.org/journals/authors>

- Include e-mail addresses, phone, and fax numbers of all authors.
- Restrict the length of titles to 100 characters and spaces.
- Include each author's full name and Society membership grade

(if applicable) immediately beneath the title. Each author's present title, affiliation, and complete mailing address must appear as a footnote at the bottom of the first page of the paper.

- Provide an abstract of 150–175 words. An abstract should not contain jargon, but should be written in plain language and include a summary of the key conclusions. It should be written for a general engineering audience such as recent graduates/beginning graduate students. To be most useful to the engineering community, the following should be clear: the purpose of the work, the scope of the effort, the procedures used to execute the work (if of special interest), and the major findings. The abstract should include this information to enhance the ease of locating the paper in information retrieval systems. Revised abstracts are routinely requested from authors prior to the assignment of papers for review if the abstract is incomplete.
- Provide written permission (to publish both electronically and in print) from original publisher if using all or part of previously published figures or tables.
- All text, including abstract and references, originally created in MS Word should be formatted as double-spaced (not 1.5-spaced). Manuscripts originally created in LaTeX should be triple-spaced so they will appear double-spaced onscreen.
- Submit line art, halftones, and color images electronically in tiff, ps, eps, or pdf format at high resolution (e.g., at least 300 dpi). For maximum readability, present letters in upper and lower case in a sans serif typeface. Letters should be no smaller than 2 mm (6 pt) when reduced to fit in one or two columns. Background screening and grids should be eliminated. If possible, submit artwork in the size at which the figure will be printed. Note that most figures will be reduced to one column, which is 3.5 inches wide.
- All text, figures, and tables should be formatted on 215 × 280 mm (8.5 × 11 in.) paper. Each figure and table should appear on a separate page.
- Provide mathematics in typewritten, not graphic, format, and identify special symbols. Define letter symbols in the text when they first appear and arrange alphabetically in a section entitled "Notation" at the end of the paper.
- Use standard definitions and symbols.
- Use SI (Système International) units and units acceptable in SI. Other units may be given in parentheses following the appearance of SI units or in an appendix.
- State the uncertainty of results if experimental data and/or relations fitted to measurements are presented. The uncertainty must include both systematic (bias) errors and imprecision.
- Include a practical applications section, if appropriate.
- Cite all references in text and list in alphabetical order in a "References" section at the end of the manuscript.
- Restrict the maximum number of words or word-equivalents to 10,000 for papers, 3,500 for notes, and 2,000 for discussions. The editor may waive these restrictions to encourage papers on topics that cannot be treated within these limitations. However, authors are advised that most topics can be covered within these word limits, and that the editors require clear justification for longer manuscripts.
- End the paper with a set of conclusions.