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Volume 30 • Number 2 • June 2012

GEOTECHNICAL news

Integrated instrumentation systems to monitor underground mine backfill

Thesis abstracts 2012

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Printed in Canada

Message from the President

Bryan Watts, President of Canadian Geotechnical Society.

Each year the CGS Executive Committee holds two face-to-face meetings and two teleconference meetings. Our first face-to-face Executive Committee meeting of the year was held in Montreal on May 5. We did this to get an update on the French translation of the *Canadian Foundation Engineering Manual*, 4th Edition (CFEM 4) but also other matters were considered by the Executive Committee. In addition, holding the meeting in Montreal allowed us to get a sneak preview of the venue for the 2013 CGS Annual Conference at the Montreal Hilton Bonaventure. Of course, the 65th Canadian Geotechnical Conference will be held at the Fairmont Hotel located in downtown Winnipeg, Manitoba, Canada from September 30 to October 3, 2012. This promises to be a successful conference; the trade show is sold out and they have nine Platinum sponsors! I went to the 1978 CGC in Winnipeg with a group of graduate students in a truck from the University of Alberta geotechnical graduate school. This time I will be flying to Winnipeg.

As I enter the second year of my tenure as President of your Society, I am impressed by the diligence of your Secretary-General, **Dr. Victor Sowa**, and Administrator, **Wayne Gibson** in their handling of the day to day affairs of the Society. A Society as established as the CGS has relationships with multiple stakeholders beyond its most important relationship, its members. Our administrative personnel constantly interact with other Canadian national engineering societies, international societies, and government agencies. In the fall of last year,

NEW

The GK-604 Inclinometer Readout System from Geokon is fully compatible with practically all existing MEMS and servo type inclinometer probes and cables.

The heart of the system is **an all-weather hand-held Field PC which communicates via Bluetooth® radio** to an interface to which the inclinometer cable is attached. This interface may be located inside an inclinometer cable reel or may be stand-alone. **Stored data can be analysed using GTILT® software.**

Model GK-604-6
Archer® Field PC

Model GK-604-3
Inclinometer Cable Reel With Installed Interface

Model GK-604-4
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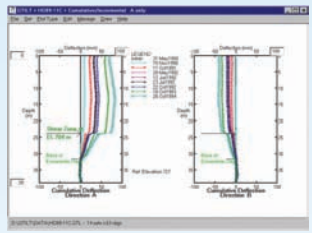

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For more information about the GK-604 Inclinometer System please visit our website

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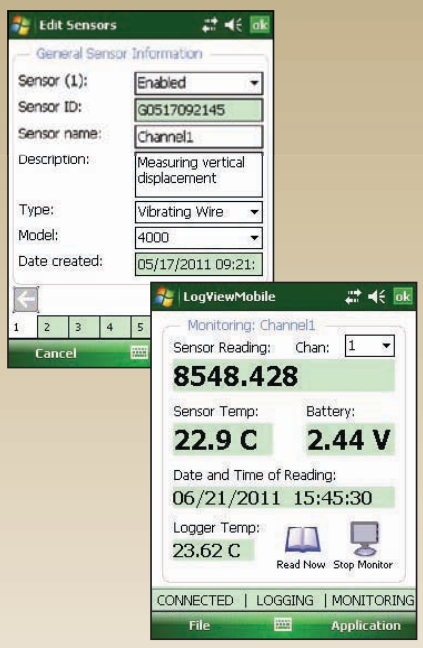

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our national government enacted the *Canada Not-for-profit Corporations Act* (NFP Act) which requires that all not-for-profit organizations (that is us!) transition to this new legislation by October 17, 2014. The national government has produced a transition guide that gives a step-by-step description of how to become compliant with the new legislation. Part of that compliance is to submit by-laws that have been ratified by the membership. The CGS has a concise set of by-laws that will have to be ratified again as part of the submissions under this new legislation. The current Executive wants to complete this process so future executives are not burdened with this task.

After **Mr. Steve Vick**'s successful Cross Canada Lecture Tour (CCLT), we hope everyone is anticipating the 2012 CCLT lectures in the spring and fall. You will have already heard the lectures from **Dr. Lee Barbour** from the University of Saskatchewan on environmental aspects of mining. This fall, **Mr. Mike Jefferies**, of state parameter and liquefaction fame, will be our CCLT speaker. Mike is a resident of the United Kingdom but has worked in Canada for decades. I am looking forward to hearing his strongly-held views and trust that he will precipitate discussion across the country. Mike, together with **Dr. Ken Been,** published *Soil Liquefaction, A Critical State Approach* in 2006; a must read for anyone interested in the subject.

In February, I attended the Engineering Institute of Canada (EIC) Annual Awards ceremony in Ottawa on behalf of the CGS. I also participated in the annual meeting and the meeting of the Honours, Awards, and Fellowships Committee. This year all of the awards given to CGS members by the EIC, mentioned in my last message, were presented at the 125th Anniversary of the EIC in Edmonton in June. I will report on this event in my next message. Hope to see everyone at the 65th Annual Conference in Winnipeg!

Le message du président

Chaque année, le Comité exécutif de la SCG tient deux réunions en personne et deux téléconférences. La première réunion en personne de l'année a eu lieu à Montréal le 5 mai. Nous avions choisi le lieu afin d'avoir une mise à jour sur la traduction française de la 4e édition du *Manuel canadien d'ingénierie des fondations* (MCIF 4), mais aussi pour nous pencher sur d'autres dossiers. De plus, le fait de tenir la réunion à Montréal nous a permis d'aller voir d'avance l'hôtel Hilton Montréal Bonaventure, où aura lieu de la conférence annuelle 2013 de la SCG. Bien entendu, la 65e conférence canadienne de géotechnique aura lieu à l'hôtel Fairmont, situé au centre-ville de Winnipeg (Manitoba), au Canada, du 30 septembre au 3 octobre 2012. La conférence promet d'être réussie; toutes les places du salon professionnel sont réservées et la conférence compte neuf commanditaires platine! En 1978, je m'étais rendu à la conférence annuelle qui avait lieu à Winnipeg en camion à partir de Calgary avec un groupe d'étudiants diplômés de l'école des études supérieures en géotechnique de la University of Alberta. Cette fois-ci, j'irai à Winnipeg en avion.

En ce début de la deuxième année de mon mandat de président de notre Société, je suis impressionné de la diligence dont font preuve notre secrétaire général, **Victor Sowa, Ph. D.**, et notre administrateur, **Wayne Gibson**, dans le traitement des affaires quotidiennes de la Société. En plus de sa relation avec les membres, de loin la plus importante, une société aussi bien établie que la SCG entretient des relations avec de nombreux intervenants. Notre personnel administratif est en contact constant avec d'autres sociétés nationales de génie au Canada, des sociétés internationales et des organismes gouvernementaux. À l'automne 2011, le gouvernement fédéral a adopté la *Loi canadienne sur les organisations à but non lucratif* qui exige que tous les organismes à but non lucratif (nous en sommes un) se conforment à cette nouvelle législation d'ici le 17 octobre 2014. Le gouvernement a produit un guide de transition qui fait une description des étapes à suivre pour être conforme à cette nouvelle législation. Cela exige entre autres de présenter des règlements généraux qui ont été ratifiés par les membres. La SCG a des règlements généraux concis qui devront être ratifiés à nouveau et faire partie des documents à présenter en vertu de cette nouvelle législation. Le Comité

exécutif actuel veut mener à bien ce processus, afin de ne pas en laisser le fardeau à ses futurs membres.

Après la Tournée de conférences pancanadiennes (TCP) fort réussie de **M. Steve Vick**, nous espérons que tout le monde anticipe d'assister aux conférences TCP 2012 du printemps et de l'automne. Vous aurez déjà entendu la conférence de **Lee Barbour, Ph. D.**, de la University of Saskatchewan, sur les aspects environnementaux de l'exploitation minière. À l'automne, notre conférencier TCP sera un spécialiste réputé des variables d'état et de la liquéfaction, **M. Mike Jefferies**. Ce résident du Royaume-Uni travaille au Canada depuis plusieurs décennies. J'ai bien hâte d'entendre ses points de vue vigoureux et je suis sûr qu'il accélérera la discussion à l'échelle du pays. En 2006, il a copublié avec **Ken Been, Ph. D.**, un ouvrage intitulé *Soil Liquefaction, A Critical State Approach*. Il s'agit là d'une lecture incontournable pour quiconque s'intéresse au sujet.

En février, j'ai assisté à la cérémonie annuelle de remise de prix et médailles de l'Institut canadien des ingénieurs (ICI), au nom de la SCG. J'ai également participé à la réunion annuelle et à la réunion du Comité des prix, médailles et fellowships. Comme je le mentionnais dans mon message précédent, tous les prix décernés par l'ICI à des membres de la SCG pour la présente année seront remis lors du 125e anniversaire de l'ICI, en juin à Edmonton. Je ferai un compte rendu de cet événement dans mon prochain message. En espérant vous voir tous à la 65e conférence annuelle à Winnipeg!

From the Society

Cross Canada Lectures

The Canadian Geotechnical Society is now accepting suggestions of potential speakers for future Cross Canada Lecture Tours. Since 1965, more than 80 tours have been organized. They have included lectures by approximately 40 Canadian speakers and a similar number of overseas speakers, with a balance among consultants, academics and government engineers and geoscientists.

Information about the tours can be found in the Society's Awards and Honours Manual (http://www.cgs.ca/cgsdocuments/). Please forward your suggested nominations of speakers to Dr. John Sobkowicz, Vice President, Technical, JSobkowicz@thurber.ca

Funding for the lecturer's travel is supported by contributions from industry to the Canadian Foundation for Geotechnique (http://www.cfg-fcg.ca). Costs in the visited cities are paid by the local Sections of the Society.

Upcoming Conferences

65th Canadian Geotechnical Conference - GeoManitoba 2012

The Canadian Geotechnical Society (CGS) and the Manitoba Section of the Canadian Geotechnical Society invite you to the 65th Canadian Geotechnical Conference. The Conference will be held at the Fairmont Hotel located in downtown Winnipeg, Manitoba, Canada from **September 30 October 3, 2012**. The "GeoManitoba 2012 Building On The Past" conference reflects the heritage of geotechnical engineering in Canada and how our past will help us going forward in new research, developments and advancements in geotechnical engineering. It also reflects the ever increasing need to restore or upgrade our country's aging infrastructure.

Canadian Foundation for Geotechnique

The Canadian Foundation for Geotechnique: What does it do and how can you help?

The mandate of the Canadian Foundation for Geotechnique ('Foundation') is to recognize and foster excellence in the geotechnical disciplines across Canada. In addition to funding the annual awards and prizes of the Canadian Geotechnical Society (CGS) that celebrate the success of outstanding geotechnical specialists, the Foundation also promotes the discipline among young/future engineers and geoscientists by providing a graduate scholarship and prizes, both at the undergraduate and graduate levels.

This brief article describes the activities of the Foundation, and provides details about how you can contribute to this effort and help the Foundation strengthen our national heritage as a bastion of innovative geotechnique.

What does the Foundation do?

While the Foundation and the CGS share many goals, the Foundation functions at arm's length from the CGS. Annually the Foundation provides the funding for the RF Legget Medal (the highest CGS honour), and its funding supports the RM Quigley Award (for the best paper in the Canadian Geotechnical Journal), and AG Stermac Awards, and the various CGS awards that honour the excellence of the contributions in different specialties in various geotechnical disciplines. In addition, the Foundation takes great pleasure in financially supporting the annual CGS undergraduate and graduate student awards, and providing travel support for two younger CGS members to attend the International Young Geotechnical Engineer's conference held every four years.

In 2007, the Foundation established the National Graduate Scholarship, its flagship student award, to support an outstanding graduate student who demonstrates academic excellence and active participation in the geotechnical community. This scholarship, valued at $5000, is provided from a dedicated fund in the Foundation's budget, and donations are specifically earmarked for this scholarship.

The Foundation also provides the financial support to the annual CGS Geotechnical Colloquium, a presentation by a younger geo-professional selected by the Geotechnical Research Board. The Foundation provides travel support to the CGS's Cross Canada Lecture Tours (CCLT) to bring Canadian (Spring CCLT) and international (Fall CCLT) specialists to the geo-professionals in various cities across the country.

How does the Foundation support its activities?

The Foundation relies on donations from individuals and corporations to support its activities. The CCLTs are supported exclusively by generous corporate sponsors. Funds raised from individual CGS members and other local geotechnical groups are used to support the awards, prizes and the National Graduate Scholarship. The Foundation has instituted two special recognitions in recent years: the Legacy Donor Program recognizes significant individual donations, and the Legacy Corporate Sponsor Program acknowledges generous corporate support.

How can you contribute?

The Foundation strongly encourages all geo-professionals, especially CGS members, to support its activities by making an annual contribution. By doing so, you will help promote geotechnique across the country and provide assistance to the future leaders of our profession. The Foundation also accepts interest-free loans from local geotechnical groups. If you are an individual, a local geotechnical group or a corporation and wish to make a donation or a loan to support the Foundation's activities please visit the Foundation's website at www.cfg-fcg.ca for contact details of our President Doug VanDine or Treasurer David Harding.

CGS members can easily contribute to the Foundation when they renew their annual membership on the CGS website. All contributions, big and small, are appreciated very much and will go toward further strengthening geotechnique in Canada. The Foundation is a federally incorporated registered charitable organization and all donations are tax deductible.

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GEO MANITOBA
BUILDING ON THE PAST

65TH CANADIAN GEOTECHNICAL CONFERENCE /
65E CONFÉRENCE GÉOTECHNIQUE CANADIENNE

September 30 – October 3 / 30 septembre – 3 octobre, Winnipeg, Manitoba

Join us in Winnipeg this fall as the Canadian Geotechnical Society holds its 65th annual conference. With over 150 papers expected and more than 50 organizations participating as sponsors or exhibitors there will be something for everyone!

*The **GeoManitoba 2012: Building on the Past** conference theme reflects the heritage of geotechnical engineering in Canada and how our past will help us going forward in new research, developments and advancements in geotechnical engineering. It also reflects the ever increasing need to restore or upgrade our country's aging infrastructure.*

GEOMANITOBA 2012 CONFERENCE PROGRAM HIGHLIGHTS WILL INCLUDE:

- **R M Hardy Address presented by Dr. Rob Kenyon (KGS Group)**
- **Over 400 delegates and more than 150 technical and special presentations over three days!**
- **5th annual CGS Gala Awards Banquet (Monday) and Local Colour Night at the Manitoba Museum (Tuesday)**

TENTATIVE TECHNICAL THEMES

Fundamentals
Engineering Geology
Foundation Engineering
Geoenvironmental
Landslides / Slope Stability / Slope Engineering
Reliability-Based / Limit States Design
Risk Assessment
Rock Mechanics
Soil Mechanics
Seepage / Groundwater
Cold Regions Geotechnology
Soil Stabilization
Hydrogeology

Geotechnical
Revitalization of Aging Infrastructure
GeoHazards
Retaining Walls / MSE walls
Brownfields and Redevelopment
Mine Site Remediation
Design of Earth Dams
Design of Clay Liners
Marine Geotechniques
Harbour and Shoreline Geotechniques
Non-textbook Soils / Waste Soils

Multi-Disciplinary
Geoenvironmental Sustainability
Instrumentation

Short Courses (to be confirmed) (Sunday, September 30)
Peat Soil Engineering
Seismic Considerations For Foundation and Site Classification
Landslide Stabilization

Technical Tours (to be confirmed) (Sunday, September 30)
Winnipeg River Power Generation
Local Tour of Engineering Works

Social Program Highlights
Gala Awards Banquet (October 1)
Colour Night at the Manitoba Museum (October 2)

*The conference will be held at the **Fairmont Hotel** in downtown Winnipeg, Manitoba.*

Please see the conference web site at www.cgs2012.ca for detailed conference information and to register online. Be sure to register before July 16, 2012 to take advantage of early pricing discounts!

Platinum Sponsors:

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(ASCE/G-I member names are bolded throughout).

G-I News

A new look for the G-I website

The G-I website has a new look which should make your visits more informative, helpful and easier to navigate. All the information you are looking for has been categorized into "buckets." Those buckets, following the ASCE website template, include: Knowledge & Learning, Leadership & Management, Issues & Advocacy and Membership & Community.

In addition, there are five new categories of information: Companies, Geo-Professionals, Members, Students and Young Professionals. Take a look for yourself at *www.asce.org/geo.*

JEEG wants your manuscripts

The majority of Environmental and Engineering Geophysical Society (EEGS) members and *Journal of Environmental and Engineer Geophysics* (JEEG) readers are involved in interesting and innovative studies. Whether it is developing a new process or approach, modifying present applications, or applying a common technique in an innovative manner, the JEEG readership would like to know what YOU are doing. JEEG Editor, Janet Simms, encourages you to document your experiences and submit them to JEEG.

JEEG is an internationally recognized journal in geophysics, has an impact factor of 0.837 (2010), and is accessible through both SEG and EAGE libraries, and GeoScience World (GSW), a library database subscribed to by the majority of universities and colleges with a geoscience curriculum. Information on submitting a manuscript to JEEG can be found at *http://jeeg.allentrack.net/.*

G-I monogrammed products now available

Members asked. The Geo-Institute listened. You can now order everything G-I from Land's End. Have the G-I logo stitched on everything from baseball caps and shirts to towels and coolers. Shop the Land's End website at *www.landsend.com/business* and ask that the G-I logo be added to most items. Be sure to provide the Geo-Institute customer # 3575516 and the logo #1011214.

Geo-Strata transitions

Every beginning has an end and Geo-Strata is no exception. With this issue we say farewell to an editor and friend and welcome a new one.

Debra Laefer.

Debra Laefer, a professor at University College of Dublin, joined Geo-Strata's Editorial Board in late 2006. During her 5+ years on the Editorial Board, Debra contributed commentar-

ies (including some on short notice when an article didn't arrive on time), an article and several editor's messages, in addition to her normal editor duties. We'll miss her insights and network of professional contacts in identifying article ideas and authors for them. Debra has stepped down to devote more time to her work and family. Thank you Debra.

Tanner Blackburn.

We welcome **Tanner Blackburn**, assistant chief engineer with **Hayward Baker, Inc**. in Odenton, MD. Tanner is a former assistant professor at Texas A&M University where his research interests included geo-structural instrumentation, deep excavation design in urban environments, and deep foundation load transfer mechanics. At HBI, Tanner is responsible for evaluating technical risk for projects involving new technologies or challenging construction conditions, and providing engineering support for proposal preparation, design submittals and construction quality assurance.

Members

Robertson wins G-I $200 Starbucks card

Peter Robertson, Ph.D., A.M.ASCE, professor emeritus and technical director, Gregg Drilling & Testing, Inc., was presented his $200 Starbucks card during the 2012 Geo-Congress in Oak-

Peter Robertson with his $200 Starbucks award.

land, CA. His name was selected from the many Congress registrants who registered by January 20, 2012.

Robertson has more than 30 years experience as an educator, researcher, consultant and practitioner specializing in the areas of in-situ testing of soils, earthquake design of geotechnical structures, soil liquefaction, pile design and soil structure interaction. He is nationally and internationally recognized as an expert in the areas of in-situ testing and soil liquefaction. He was the principal investigator of the Canadian Liquefaction Experiment (CANLEX) from 1993 - 2000, a $1.8 million collaborative project between industry, universities, and consulting engineers to study the characterization of sand for liquefaction analysis. Dr. Robertson has authored or co-authored 249 publications.

He was an early shareholder in Con-eTec Investigations Ltd. (1984-2004), an in-situ testing company specializing in the Cone Penetration Test (CPT). He has also sat on the Boards of several private and not-for-profit organizations. He also lectures on leadership and management and maintains an active research program in geotechnical engineering.

In his role as Associate Vice President (Research/Industry) at the University of Alberta (1999 – 2005), Dr. Robertson was responsible for leadership in the transfer of technology to the community.

Members in Memoriam

Professor Robert V. Whitman

Professor Robert V. Whitman S.M. '49, Sc.D. '51, a world-renowned geotechnical engineer and expert on earthquakes in MIT's Department of Civil and Environmental Engineering (CEE), died February 25 at age 84. With the exception of two years spent in military service, he remained at CEE from 1948 -1993 where he remained an active member of the MIT community and eventually as a professor emeritus.

"Bob was a tremendous role model as a faculty member, renowned for his ability to clarify the complexities of soil mechanics and earthquake engineering, and for his commitment to serve society at large through leadership in professional organizations," said CEE's department head, Professor Andrew Whittle.

He majored in civil engineering at Swarthmore College with a concentration in structures and later studied structural dynamics with Professor Charles Norris at MIT. He worked with Professor Donald Taylor on the effects of nuclear explosives on

underground structures for his Sc.D. research.

Whitman served in the Navy as an officer in the Civil Engineer Corps stationed at Pearl Harbor, HI. Afterwards, he served on the Air Force's advisory panel for the earliest hardened missile complexes and in the 1960s, worked on developing stable foundations for long-range tracking radar – research that led him to become a leading expert in the new discipline of soil dynamics.

He transitioned into earthquake engineering through a joint study with Professor Harry Seed of the University of California at Berkeley and co-authored the acclaimed textbook "Soil Mechanics" with MIT Professor Bill Lambe. "Of all the things I've done, I'm probably proudest of that book," said Whitman.

During the 1970s, he helped develop the Massachusetts State Seismic Code and worked on framing the National Earthquake Hazards Reduction Program. He later was later drawn into centrifuge research where he helped introduce centrifuge testing to the U.S. geotechnical community.

Whitman served on many scientific and government advisory boards and helped form the Federal Emergency Management Agency's five-year Earthquake Hazard Mitigation Plan and chaired the National Research Council's committee that produced the influential report "Liquefaction of Soils During Earthquakes" (1985). He also made significant contributions to the Applied Technology Council's report Tentative Provisions for the Development of Seismic Regulations for Buildings, which provided the first national earthquake hazard maps.

The EERI inducted him in 1972, where he later served as the society's first president from outside California and received their George W. Housner Medal for sustained leadership and contributions to earthquake engineering. He was elected to the National Academy of Engineering in 1975 and was awarded the ASCE's prestigious Terzaghi Award for outstanding contributions to knowledge in the fields of soil mechanics, subsurface and earthwork engineering. Read his complete obituary at *www.asce.org/geo*.

ISSMGE News

ISSMGE TC-101 International Workshop
"Advances in Multiphysical Testing of Soils and Shales"
September 3-5, 2012
EPFL conference facilities
Lausanne, Switzerland
http://amtss.epfl.ch/

The workshop will focus on the significant advances of knowledge regarding the experimental analysis of soils and shales that have been achieved during the last decade. Some fundamental issues have been solved, and important achievements have been made in certain areas, including the development of multiphase testing facilities for non-isothermal conditions and the characterization of the microstructural arrangement for complex geomaterials.

The workshop should stimulate debate on the advances in experimental geomechanics, contributions on unsaturated soil testing, non-isothermal experiments and chemo-osmotic experimental evidences. A half-day course will also be organized on advanced multiphysical testing for geomaterials. A low registration fee has been set for students to encourage young delegates to attend.

Additional information may be found on the workshop Web site at *http://amtss.epfl.ch/*

Join ISSMGE

ASCE members can join ISSMGE by enrolling on your annual ASCE

renewal form, by logging in to your member account at *www.asce.org*, or by calling 800-548-2723. Annual dues are $15.

Geo-Institute members who are not ASCE members: ISSMGE membership is already included in your membership.

Students

GSI fellowships for students

The Geosynthetic Institute (GSI) announced a worldwide call for requests-for-proposals (RFPs) focusing on innovative geosynthetics research and development projects. There will be multiple awards made, each for $10,000 for the first year, and they are renewable for a second and third year up to a total amount of $20,000 per student. To be eligible, students must have completed their candidacy examinations leading to a doctorial degree in engineering or science. Proposals must be submitted in the following 4-page format. There are no exceptions.

Page 1 – Letter of recommendation from student's department head or advisor

Page 2 – Title and detailed abstract of project

Page 3 – Student's resume

Page 4 – Documentation of completed candidacy examination

The RFPs for the 2012-2013 academic year must be submitted to both Robert Koerner and Jamie Koerner by e-mail by June 15, 2012. Awards will be announced on, or before, July 15, 2012. Review of the proposals is by the nine-person GSI Board of Directors. For information: *www.geosynthetic-institute.org/gsifellows.htm*

Robert M. Koerner, Ph.D., P.E., D.GE, NAE, Dist.M.ASCE, Emeritus Director – Geosynthetic Institute at *Robert.koerner@coe.drexel.edu* and Jamie R. Koerner, special projects coordinator at *jrkoerner@verizon.net*.

Student co-op and internship opportunities

Looking for a co-op or internship opportunity? Then explore the positions listed on the ASCE website to help further your career path. Come back often since new positions are added all the time.

Co-op opportunities

http://careers.asce.org/jobs#/results/keywords=coop&resultsPerPage=12&showMoreOptions=true&selectedTab=bti-facets-education/1,false

Internship opportunities

http://careers.asce.org/jobs#/results/keywords=internships&resultsPerPage=12&showMoreOptions=true&selectedTab=bti-facets-education/1,fals

G-I Chapter News

Call for Abstracts:
Geoconfluence 2012
November 2, 2012
Deadline: July 1, 2012

The St. Louis Chapter of the Geo-Institute is joining with the University of Missouri-Columbia and the Missouri University of Science and Technology for the second annual geotechnical engineering and geo-environmental conference.

This conference will include technical topics and case histories focused on the geotechnical engineering and geo-environmental industry. The conference planning committee is looking for approximately 6-8 speakers to provide a 30-60 minute presentation focused on geotechnical engineering or geo-environmental topics. All persons are encouraged to submit an abstract to Nicholas Roth at *nicholas.roth@psiusa.com* by July 1, 2012. Abstracts should be limited to 250 words. Once the planning committee has reviewed the abstracts, notification will be provided to the selected

presenters by August 15, 2012. The submitted abstracts and presentation slides will be assembled and included in the conference publication.

26th Central Pennsylvania Geotechnical Conference
October 24-26, 2012
Hershey, PA
www.central-pa-asce-geotech.org/

Scheduled speakers:

Cari Bennenga, P.E., M.ASCE – Gannett Fleming, Inc.

Dan Brown, Ph.D., P.E., D.GE, M.ASCE – Dan Brown and Associates, P.C.

Morgan Eddy, P.E., A.M.ASCE – Steele Foundation, LLC

Drew Floyd, P.E., M.ASCE – Moretrench

Robert Holtz, Ph.D., P.E., D.GE, Dist.M.ASCE – University of Washington (retired)

Shad Hoover, P.E., M.ASCE – CMT Laboratories, Inc.

Robert M. Koerner, P.E., D.GE, NAE, Dist.M.ASCE – Geosynthetics Institute

Trevor Lykens, P.E., M.ASCE – Kleinschmidt Associates

Samuel Mazzella, P.E. – GAI Consultants, Inc.

John T. Pusey, Jr. – Earth Engineering, Inc.

Matt Riegel, P.E., M.ASCE – HNTB

James Schmidt, P.E., P.Eng. – Kleinfelder, Inc.

Kevin Stetson, P.E., A.M.ASCE – Sanborn Head, Inc.

J. Michael Duncan, Ph.D., P.E., Dist.M.ASCE – Virginia Tech

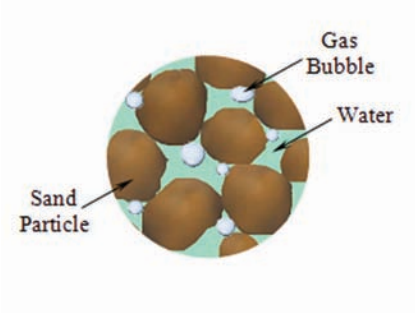
To register: *www.central-pa-asce-geotech.org/uploader/uploads/docs/mail-in-form.pdf*

Registration questions: Jason Garnder at *jgardner@gfnet.com*

Exhibition questions: Bruce Stegman at *bruce.stegman@verizon.net*

Industry News

Preventing ground failure due to liquefaction during earthquakes



Northeastern University was awarded a $1.2M research grant from the National Science Foundation (NSF) through the program George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES). The title of the project is: "Induced Partial Saturation (IPS) Through Transport and Reactivity for Liquefaction Mitigation."

The research program is under the directorship of **Profs. Yegian, P.E., F.ASCE** and **Alshawabkeh, Ph.D., P.E., F.ASCE** at Northeastern University, in collaboration with **Prof. Thevanayagam, M.ASCE** of University at Buffalo, **Prof. Stokoe, Ph.D., P.E., D.GE, M.ASCE** of University of Texas at Austin, **Prof. Farid, Ph.D., P.E., M.ASCE** of Boise State University, Dr. Steidl of University of California at Santa Barbara, and **Prof. Youd, Ph.D., NAE, Dist.M.ASCE**, formerly at Brigham Young University.

Professors Yegian and Alshawabkeh have been developing an innovative, cost–effective and practical field technique for liquefaction mitigation at Northeastern University. Their preliminary research has demonstrated that generating gas bubbles in saturated sands, thus inducing partial saturation (IPS), prevents the occurrence of liquefaction during earthquakes. Also, minute gas bubbles, once introduced within the void spaces of sands, remain entrapped even under ground shaking. This NSF/NEES research project will advance the IPS technique to field applications, which will involve injection of a very low concentration of an eco-friendly chemical, and through groundwater flow and chemical reactivity that slowly generate gas bubbles within a sand deposit. A full patent application on IPS has been filed by Northeastern University.

The research will take advantage of unique experimental and field facilities of NSF's George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES).

ASTM international launches a nuclear portal

ASTM International standards play an important role throughout the nuclear energy industry. To tie together the nuclear-related activity being conducted across its committees, ASTM has added a nuclear portal to its website (*www.astm.org*). The portal, which gathers all of ASTM's standards developing activities in the nuclear field, can be viewed at *www.astm.org/portals/nuclear.*

"This new website aggregates committee specific information into a holistic view of ASTM standards and resources for an industry sector," says Katharine Morgan, vice president, Technical Committee Operations, ASTM International.

The nuclear portal brings together the latest information on newly-published ASTM standards; proposed new standards and revisions to current standards; nuclear-related ASTM standards-developing committees and subcommittees; schedules of upcoming meetings and symposia; and video presentations from nuclear industry officials. In addition, the portal features a blog in which visitors can post comments or questions related to nuclear industry standardization.

The portal also brings together standards from dozens of subcommittees

that are under the jurisdiction of more than 30 different ASTM International committees, including Committees C26 on Nuclear Fuel Cycle and E10 on Nuclear Technology and Applications. Each of these groups develops standards that impact the nuclear energy field from guides and practices for spent nuclear fuel to practices for the use of dosimetry in radiation processing.

Geo-Institute annual congress calendar

Geo-Congress 2013
"Stability and Performance of Slopes and Embankments"
March 3-6, 2013
Town & Country Resort
San Diego, CA

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To submit information for Geo-Strata magazine, or possible posting on the Geo-Institute website at *www.geoinstitute.org*, send us brief news about your recent honors, awards, special appointments, promotions, etc. High-resolution photos must be sent as separate pdf, tif, or jpeg files. Send to *geo-strata@asce.org*. Sales-oriented content should be directed to Dianne Vance, Director of Advertising at *dvance@asce.org*.

Introduction by John Dunnicliff, Editor

This is the seventieth episode of GIN. One full-length article this time, three more brief articles about remote methods for monitoring deformation, and a book review.

Fully–grouted piezometers

This has been an on-going topic in GIN, started by the two-part article in June 2008 by Contreras et al. Here's an update by the same authors. The article is longer than I usually allow for GIN, but because some practitioners still doubt the value of the method, I wanted to give adequate space in an attempt to dispel any doubts.

Remote methods for monitoring deformation

In the previous episode of GIN there were one-page articles about four different remote methods for monitoring deformation: terrestrial laser scanning; terrestrial interferometric synthetic aperture radar; robotic total stations; and reflectorless robotic total stations. Here are three more:

- Satellite interferometric synthetic aperture radar: SInSAR, including DInSAR and PSInSAR, by Francesca Bozzano.
- Digital photogrammetry, by Raul Fuentes and Stuart Robson.
- Differential global positioning system: D-GPS, by Rob Nyren and Jason Bond.

As I said in the previous episode, there are two important action items for you:

- I recognize that, if you've had experience with any of these methods, you may not agree with all that the authors say. If that's the case, or if you'd like to add something that would be useful to readers of GIN, please send me a discussion.
- We've included the commercial sources in North America that we know about, but are likely to have missed some. If you know of others, please tell me, and I'll include those in a future GIN.

Nobody has yet responded to this challenge. PLEASE—GIN shouldn't be just me, and authors who have had their arms twisted—we're all in this together!

Manual of geotechnical engineering

Here's a review of a new 101-chapter book, available in hard copy and on-line. As I've written in the review, in my view the full manual is a 'must have' for the libraries of all firms which practice geotechnical engineering. The more I read, the more impressed I am! Specialists should have their own copies of relevant individual chapters. Although written for the UK scene, this in no way diminishes its value elsewhere.

There are two chapters about monitoring and instrumentation. One about why we use the technology, how we plan for using it, and what we do in the field. The other about the gadgets, and what they're used for.

In a lighter vein, the chapter on geotechnical risks includes some wonderful quotations. For example (reprinted with permission from the author, Tim Chapman):

- "If a builder builds a house for someone, and does not construct it properly, and the house which he built falls in and kills the owner, then that builder shall be put to death." *Hammurabi's Code of Laws. 1700 BC. Mesopotamia.*
- "…as we know, there are **known knowns**; these are things that we know we know. We also know that there are **known unknowns**; that is to say we know there are some things we do not know. But there are also **unknown unknowns** – the ones we don't know we don't know." *Donald Rumsfeld.*
- "Quality is never an accident; it is always the result of intelligent effort." *John Ruskin (1819-1900), who wrote on subjects ranging from geology to architecture, myth to ornithology, literature to education, and botany to political economy.*
- "It is unwise to pay too much, but worse to pay too little. When you pay too much, you lose a little money, that's all. When you pay too little, you sometimes lose everything, because the thing you bought was incapable of doing the things it was bought to do. The common law of business balance prohibits paying a little and getting a lot. It can't be done. If you deal with the lowest bidder, it is as well to add something to the risk you run. And if you do that you will have enough to pay for something better. There is hardly anything in the world that someone can't make a little worse and sell a little cheaper—and people who consider price alone are this man's lawful prey." *John Ruskin (1819-1900).* **Those of you who know my views about low-bidding instrumentation tasks will recognize these sentiments. He's singing my song! And he wasn't an engineer!**

The next continuing education course in Florida

This is scheduled for April 7-9, 2013 at Cocoa Beach. Details of this year's course are on http://conferences.dce.ufl.edu/geotech. The 2013 course will

follow the same general format but with significant updating, including remote methods for measuring deformation. Information will be posted on the same website in late summer this year.

Closure

Please send contributions to this column, or an abstract of an article for GIN, to me as an e-mail attachment in MSWord, to john@dunnicliff.eclipse.co.uk, or by mail: Little Leat, Whisselwell, Bovey Tracey, Devon TQ13 9LA, England. Tel. +44-1626-832919.

Sveiketa (Lithuania).

Update of the fully-grouted method for piezometer installation

Iván A. Contreras, Aaron T. Grosser, Richard H. Ver Strate

[The same authors wrote a two-part article about the fully-grouted method for piezometer installation for June 2008 GIN (Contreras et al., 2008), including a description of the method, grout permeability requirements, a laboratory testing program and field examples, followed by my discussion. Readers are encouraged to read this article and discussion for background to the current update. They are on www.geotechnicalnews.com/instrumentation_news.php. JD, Ed.]

Introduction

The fully-grouted method for piezometer installation consists of installing vibrating wire piezometers in boreholes directly surrounded by cement-bentonite grout. The method is gaining popularity within the geotechnical community because it is a simple, economical, and accurate procedure to monitor pore water pressure in the field. The method allows for easy installation of single or nested piezometer configurations and can also be used in combination with other instrumentation. However, appropriate permeability of the cement-bentonite grout is crucial for the success of the fully-grouted method.

As the method becomes more popular and is used more extensively in practice, several questions and concerns have arisen on its application in the field. These questions and concerns relate to the response time, the behavior of the fully-grouted installation in soft ground, field verification of the relative permeability of the cement-bentonite grout with respect to that of the soil, and the impact of barometric pressure on measured pore water pressures. These concerns are addressed in this article. The article is based Contreras et al. (2011) and is published in GIN with permission from the 8th FMGM Organizing Committee.

Response time

One of the main advantages of vibrating wire piezometers is the short hydrodynamic time lag, i.e. changes of pore water pressures in the soil are measured fairly quickly. To evaluate the response time of vibrating wire piezometers in fully-grouted installations and for further validation of the method, we evaluated the time response in the laboratory and in the field.

Laboratory

To evaluate the response time a response test was performed in the laboratory. The test consisted of placing a vibrating wire piezometer within a grout specimen and letting it cure for 28 days. The cement-bentonite grout mix consisted of a water-cement-bentonite ratio of 1:2.5:0.3 by weight. The specimen was formed by using a cylindrical mold with a diameter of 100 mm and height of 200 mm. In addition to the specimen with the piezometer tip inserted, four identical cylindrical specimens were prepared for permeability and strength testing.

After the grout specimen containing the piezometer tip was cured, it was set up in a triaxial cell. An opening provided with an O-ring seal was built at the top of the cell to pull the piezometer cable out while maintaining a watertight cell. The cell was then filled with water and the cell pressure was applied. The applied cell pressure and the pore water pressure in the piezometer tip were measured independently and simultaneously during application of cell pressure.

Figure 1 shows the results of the response test. For the plot at the left, the cell pressure was increased incrementally in three steps. For the plot at the right, the cell pressure was increased in a single increment. As can be seen in Figure 1, in both tests the elapsed time for the piezometer to read the correct value is generally 2 minutes or less. This elapsed time for actual field applications can be considered instantaneous. Mikkelsen and Green (2003) presented similar results of response tests.

Field

The time response of the fully-grouted method was also evaluated in the field. The following field example consists of a comparison of the time response

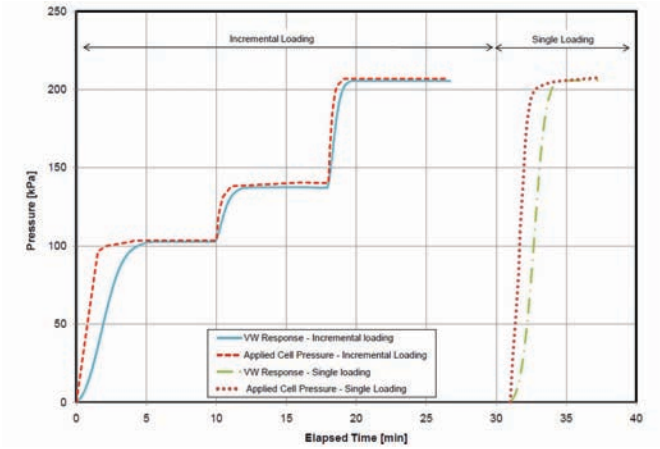

Figure 1. Results of laboratory tests of pore water pressure response.

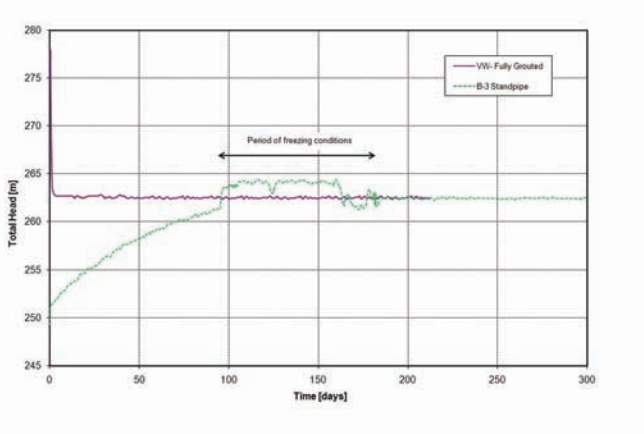

Figure 2. Response times of open standpipe and vibrating wire piezometers in high plasticity clay.

of an open standpipe piezometer installed using the traditional Casagrande sand-pack method and a vibrating wire piezometer using the fully-grouted method in northern Minnesota at a site involving a landslide.

Figure 2 shows the total head readings versus time. The tips of both piezometers were installed within the same formation at about 23 m below the ground surface (tip elevation about 239 m). The installations are approximately 25 m apart laterally. The two piezometers were installed in high-plasticity clay with permeability on the order of $1x10^{-8}$ cm/s. It can be seen from Figure 2 that the total head reading from the vibrating wire piezometer at the time of installation was about 277 m. This total head during installation reflects the pressure exerted on the tip by the column of cement-bentonite grout in the liquid state. As the cement-bentonite grout set up, the total head decreased and after approximately two days became fairly constant.

On the other hand, the open standpipe piezometer had an initial total head of approximately 252 m after installation. Then the total head increased with time as the water level rose inside the standpipe. It took more than 180 days before the total head in the open pipe piezometer reached a similar value to the vibrating wire piezometer. The sudden increase from about 100 to 180 days is the consequence of water freezing within the upper portion of the standpipe.

This field example illustrates the long hydrodynamic time lag in standpipe piezometer installations in low permeability deposits. It also illustrates the rather short time lag in vibrating wire piezometer installations using the fully-grouted method.

Grout permeability requirements

As described by Mikkelsen and Green (2003), the success of the fully-grouted method is based on the fact that the pressure gradients in the radial direction from the borehole wall to the piezometer tip are normally one to several orders of magnitude greater than those in the vertical direction within the borehole. As a result, the radial gradients control the piezometer response. This holds true as long as flow in the vertical direction does not develop due to higher permeability of the cement-bentonite grout than the ground. Therefore, low permeability of the cement-bentonite grout is crucial for the success of the fully-grouted method.

Contreras et al. (2008) developed a computer model to obtain a better understanding of those permeability requirements. The computer model simulated seepage conditions around a piezometer installed using the fully-grouted method. The results of the computer simulation indicated that the permeability of the grout can be up to three orders of magnitude higher than the permeability of the surrounding soil without inducing a significant error. This was an interesting finding and differed from previous assessments (e.g. Vaughan, 1969) which indicated that the permeability of the grout could only be one or possibly two orders of magnitude greater than the permeability of the surrounding soil.

The minimum permeability that is commonly encountered in natural soils is on the order of 10^{-9} cm/s (k_{soil}). Therefore, the cement-bentonite grout mix used in the fully-grouted method is required to have at most a permeability of 10^{-6} cm/s for these low permeability soils.

Field verification of grout permeability requirements

Despite the computer model simulation indicating that the permeability of the grout can be up to three orders of magnitude higher than the permeability of the surrounding soil without inducing a significant error, we believed it was necessary to verify this in the field. We have therefore collected data from a series of locations at which a fully-grouted piezometer exists near an open standpipe piezom-

Table 1: Comparison of total head from fully-grouted and open standpipe installation

Site	k (grout) (cm/s)	k (soil) (cm/s)	Kgrout / Ksoil	Total Head Measured		Normalized Error (%)
				VW (m)	SP (m)	
1	4.30E-06	1.12E-08	393.93	262.44	262.58	0.05
2	4.70E-06	2.50E-06	1.88	474.31	475.63	0.28
3	4.70E-06	2.50E-06	1.88	471.33	474.12	0.59
4	4.70E-06	2.50E-06	1.88	469.59	469.98	0.08
5	4.40E-06	6.24E-04	0.01	462.82	462.87	0.01
6	1.10E-06	4.58E-03	0.00	488.95	489.09	0.03
7	4.30E-06	2.50E-05	0.17	449.83	449.80	-0.01

eter (with sand-pack). In these cases, information about the permeability of the soil and grout is available.

Table 1 summarizes the collected data. The tips of the vibrating wire piezometers (VW) included in Table 1 are within the same soil stratum as the sand pack of the nearby open standpipe piezometers (SP). While their elevation is not exactly the same they are close enough such that a similar total head can be expected at both instruments.

The data in Table 1 were used to develop Figure 3, together with the results of computer modeling that were presented by Contreras et al. (2008). The colored lines in Figure 3 are the summary of the computer model results in terms of the error in the pore water pressure measured as a function of the permeability ratio. The symbols in Figure 3 are the data associated with the actual permeability ratios and normalized errors from Table 1. In developing Table 1, it was assumed that the total head measured in the open standpipe piezometers was the actual total head. It can be seen from Figure 3 that the measured and predicted normalized errors are in excellent agreement.

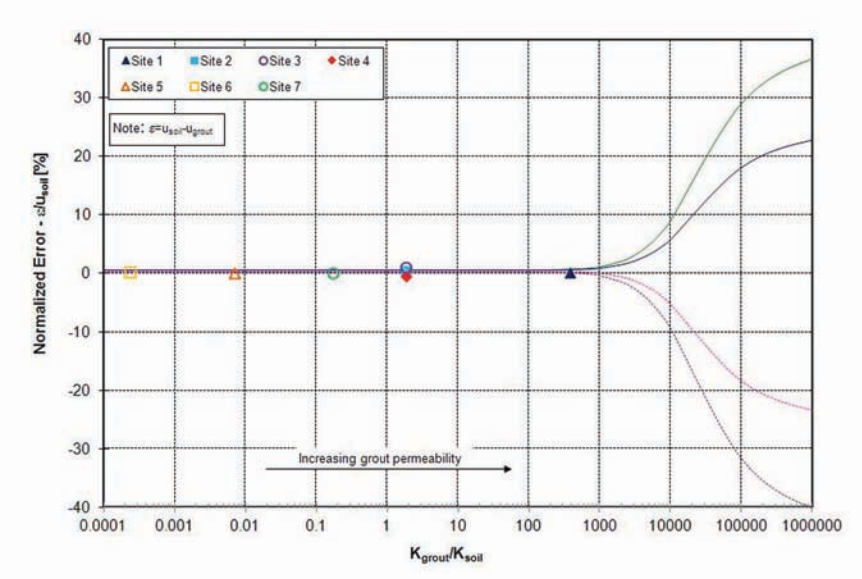

Figure 3. Comparison of normalized errors (field and computer model) with permeability ratio k_{grout}/k_{soil}.

Installation in soft ground

During construction of embankments over soft ground, monitoring typically includes measurement of pore water pressures to track the consolidation process as the excess pore water pressure dissipation and settlement take place. Because the fully-grouted method allows for installation in a nested configuration, it becomes very attractive in this application. However, two concerns have arisen, which might compromise the correct performance of the installations. First, the use of a sacrificial grout pipe might result in false data because of downdrag on the grout pipe as vertical compression proceeds. Second, will the column of grout compress consistently with the soft ground?

We have used the nested configuration in several applications on soft ground without any performance problems. The following presents an example of a nested fully-grouted installation in soft ground.

The project consisted of construction of a tailings dam on top of approximately 20 m of soft fine tailings/slimes that were hydraulically deposited. The fine tailings/slimes have a permeability of 2.5×10^{-6} cm/s. Three piezometers were installed per borehole within the fine tailings/slimes to monitor the pore water pressure during fill placement, and settlement plates were installed to monitor settlement. Due to the soft nature of the fine tailings/slimes, the initial material placement (i.e. working foundation) took place during the winter months when a 1.2 m thick layer of frozen tailings forms at the ground surface, allowing equipment operation over the soft deposit. After spring thaw and in the middle of the summer, construction continued by adding additional embankment material.

Figure 4 shows the pore water pressure and settlement data. Settlement monitoring started when construction started. The piezometers were installed 160 days after settlement in

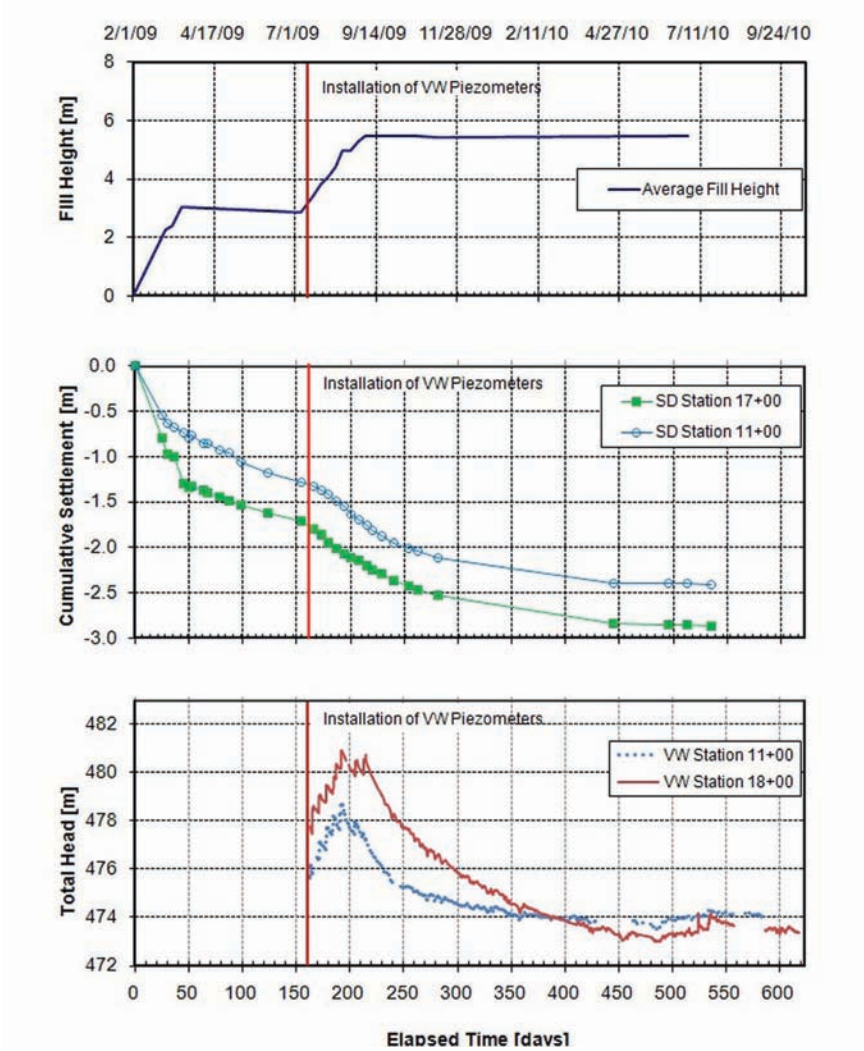

Figure 4. Pore water pressures and settlements response in soft ground.

the range of 1.3 to 1.7 m took place and the initial 3 m lift was placed above the frozen ground. During and after construction the vibrating wire piezometers functioned without any problems with total settlements of up to 2.87 m, which corresponds to a vertical compression of about 11 %.

Table 2 summarizes other sites where we have used the same approach with satisfactory performance. It can be seen from Table 2 that the sacrificial grout pipe can be used in soft deposits in which the expected vertical compression is up to about 11 percent. However, based on our experience at other locations not included in Table 2, the sacrificial grout pipe can be used when the vertical compression of the soft deposit is up to about 15 percent.

We recognize that, because of the two concerns identified above, this conclusion cannot yet be extrapolated to projects where the predicted vertical compression is greater than 15 percent. An option for this application is to attach the piezometers to plastic-covered stranded wire ("aircraft cable") which would accommodate the compression, to use a more compressible grout mix and to extract the grout pipe. The lack of a sacrificial grout pipe would mean that an alternative method for tracking the changing elevations of the piezometers is needed, so that piezometric elevations can be determined. This can be achieved by installing a magnet reed switch probe extensometer nearby.

Table 2: Locations of fully-grouted installation in soft ground

Site	Thickness of Soft Layer (m)	Settlement Since Piezometer Installation (m)	Vertical Compression (%)
1	11.28	1.11	9.8
2	19.96	1.11	5.6
3	18.14	1.15	6.3
4	13.5	1.20	8.9
5	13.81	1.52	11.0
6	18.04	1.35	7.5
7	14.63	1.35	9.2
8	10.97	1.16	10.6
9	10.91	0.78	7.1

Barometric pressure correction

For fully-grouted vibrating wire piezometers, changes in atmospheric pressure can affect the measured pressures. Manufacturers generally provide the correction as a function of elevation above sea level to facilitate the correction. Sometimes users ignore these corrections because they are considered insignificant or not relevant to the project being monitored. While this may be acceptable for some projects, it is not appropriate for most projects where accurate pore water pressure readings are required. Additionally, in some cases, it is assumed that the barometric pressure correction is not needed when the piezometers are installed using the fully-grouted

method because the piezometer tips are "sealed."

We have found that barometric pressure corrections are needed when the piezometers are installed using the fully-grouted method. The piezometer tips are not "sealed" from atmospheric pressure. The following discussion illustrates the need for barometric pressure corrections. We installed two adjacent piezometers, one an open standpipe and the other a vibrating wire piezometer installed using the fully-grouted method. The vibrating wire tip and the porous stone of the standpipe installation were within the same soil stratum and at approximately the same elevation. A barometer was installed separately to monitor the atmospheric pressure. All instruments were connected to a datalogger programmed to take readings every half hour.

Figure 5 illustrates the total head measured in the vibrating wire piezometer without a barometric pressure correction, the barometric pressure, the total head from the standpipe piezometer, and the corrected total head after barometric pressure correction over time. The influence of the barometric pressure in the uncorrected data is apparent. It can be seen from Figure 5 that the change in total head in the uncorrected data mimics the changes in the barometric pressure recorded by the barometer. The changes in barometric pressure on the order of 2 kPa are reflected in a total head change of about 20 cm. After the uncorrected data are corrected by the barometric pressure correction, the total head is smoothed out and the changes in total head are only on the order of a few centimeters.

Figure 5 also illustrates the comparison of the corrected total head from the vibrating wire piezometer and the total head from the standpipe piezometer over the same time period. The comparison of both values (standpipe and vibrating wire) is remarkable. This example illustrates the need for correcting the vibrating wire readings for barometric pressure.

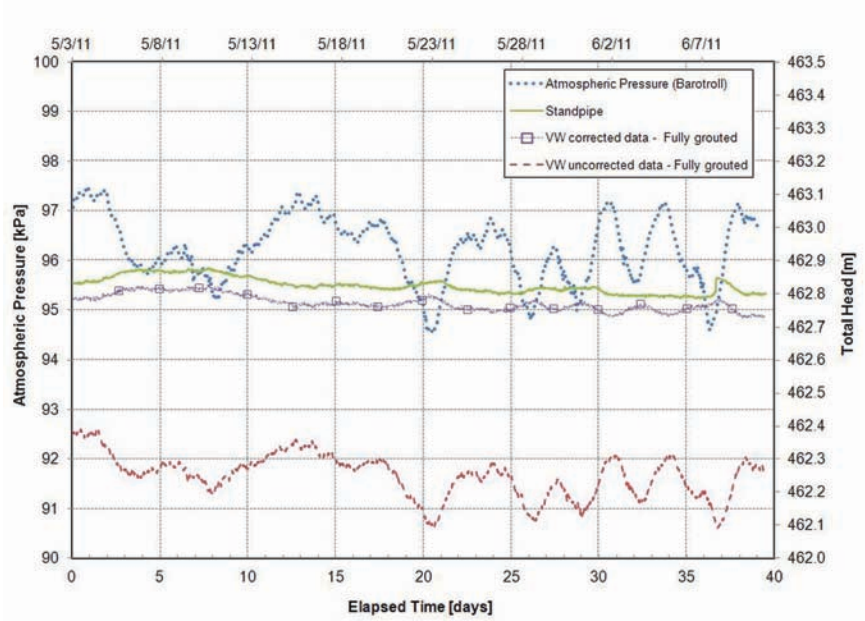

Figure 5. Comparison between measured total head in open standpipe and vibrating wire piezometer using the fully-grouted method, with and without barometric pressure correction.

Summary and conclusions

The fully-grouted method is gaining popularity within the geotechnical community because it is a simple, economical, and accurate procedure to monitor pore water pressure in the field. However, adequate installation procedures (including grout mixing) and appropriate permeability of the cement-bentonite grout are crucial for the success of the method.

This article discusses laboratory and field experiences for response time of vibrating wire piezometers installed using the fully-grouted method. It is shown that the hydrodynamic time lag of piezometers is very short.

Additionally, the article presents a discussion of the permeability required for the fully-grouted method to function properly. It is found that the permeability of the grout can be up to three orders of magnitude higher than the permeability of the surrounding soil without inducing significant error in the measured pore water pressure. This fact is further verified by presenting field evidence of installations where the measured error is not significant for a permeability ratio k_{grout}/k_{soil} of up to three orders of magnitude.

Data presented in this article show that the behavior of the fully-grouted installation (using a sacrificial grout pipe) in soft ground is adequate when the amount of vertical compression is less than 15 percent. In projects involving installation in soft ground where the vertical compression is expected to be greater than 15 percent, the sacrificial grout pipe should be removed. We recommend attaching the piezometers to plastic-covered stranded wire ("aircraft cable") which would accommodate the compression, to use a more compressible grout mix and to extract the grout pipe.

Finally, the impact of barometric pressure on the measured pore water pressure is discussed. It is found that a barometric pressure correction is required for vibrating wire piezometers installed using the fully-grouted method.

Acknowledgements

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References

Contreras, I.A., Grosser, A.T., VerStrate; R.H., 2008, "The Use of the Fully-grouted Method for Piezometer Installation". Geotechnical News, Volume 26, No. 2, June, www.geotechnicalnews.com/instrumentation_news.php

Contreras, I.A., Grosser, A.T., VerStrate; R.H., 2011, "Practical Aspects of the Fully-Grouted Method for Piezometer Installation", Proc. Eighth Int. Symp. on Field Measurements in Geomechanics, Berlin, Germany, Sept.

Contreras, I.A. and Solseng; P.B., 2006, "Slope Instabilities in Lake Agassiz Clays." Proc. 54th Annual Geot. Eng. Conf., Univ. of Minnesota. pp. 79-93.

Mikkelsen, P.E. and Green, G.E., 2003; "Piezometers in Fully Grouted Boreholes." Proc. Sixth Int. Symp. on Field Measurements in Geomechanics, Oslo, Norway, Sept.

Mikkelsen, P.E., 2002, "Cement-Bentonite Grout Backfill for Borehole Instruments." Geotechnical News, Volume 20, No. 4, December, www.geotechnicalnews.com/instrumentation_news.php

Vaughan, P.R., 1969, "A Note on Sealing Piezometers in Boreholes." Géotechnique, Vol. 19, No. 3, pp. 405-413.

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Editor's Note

Another option for monitoring where the predicted vertical compression is greater than 15 percent is to use the push-in method of installation. This entails drilling to about one meter above the piezometer location, pushing the piezometer to its location with a pipe that will also serve as a grout pipe, disconnecting the pipe from the piezometer, grouting the borehole with bentonite slurry, and withdrawing the grout pipe. It is better to arrange for the piezometer cable to emerge from the grout pipe through a slot at the bottom of the borehole, rather than threading it through the grout pipe. But this allows only one piezometer per borehole, and again requires a method for tracking changing elevations of the piezometers. I used this method satisfactorily at the test fill for the new Chek Lap Kok airport in Hong Kong, where vertical compression was up to 35 percent. ***If anyone has experience of this issue, or other ideas, will you please contact me?***

Remote monitoring of deformation using Satellite SAR Interferometry

Francesca Bozzano and Alfredo Rocca

Principle of operation

Satellite SAR (Synthetic Aperture Radar) Interferometry (SInSAR) is a technique able to produce displacement maps of the ground surface both night and day and in the presence of clouds by using microwave signals.

Taking advantage of the orbit of the satellite, the SAR sensor mounted on it can capture an image of an area, when it passes over it. The phase value, contained in every pixel of the image, is correlated to the sensor-target distance. Thus, given two or more images acquired at different times, information about the displacement occurred in a pixel in the time interval between the acquisitions, is achieved by computing the corresponding phase difference.

Main fields of application Classical Differential Interferometry (DInSAR) approach (using only pairs of SAR images) has been already used successfully in the past, in particular to investigate regional displacements phenomena (e.g. earthquakes). Today, Advanced DInSAR (A-DInSAR) techniques, for instance Persistent Scatterers Interferometry (PSI) and Small Baseline Subset (SBAS), which make use of multitemporal SAR data and displacement models, are most common approaches.

Main fields of application are related to monitoring of buildings, structures and land affected by landslides, subsidence and any other process which leads to a displacement of the ground surface, as long as not too fast.

Accuracy and pixel resolution

SInSAR spatial resolution depends on sensor characteristics. For most common monitoring uses, pixel size spans from 25 m (e.g. ERS1/2 and Envisat satellites) to 1 m (COSMO Sky-Med, TerraSAR X, Radarsat satellites).

DInSAR accuracy is in the order of centimetres, while A-DInSAR methods are able to achieve accuracy of few millimetres, from 1 to 5, for a single displacement value, depending on the used techniques. The accuracy of trend displacement average velocity for the whole analysed period, is from 0.1 to 1 mm/yr.

Main advantages

Main advantage of SInSAR is the possibility to obtain measurements of displacements occurred in the past starting from 1992 (ERS1). This great result can be achieved using archived data acquired by the Space Agencies during past decades. In this case a frequency acquisition with a maximum of generally one image per month has to be considered. Furthermore, SInSAR monitoring can be continued in the future, if a new data capture campaign is planned. In this case, thanks to shorter satellite revisit time, more images will be available for shorter time.

Other advantages are: SInSAR data cover wide areas (a single frame has tens of km on each side); Modern A-DInSAR methods allows displacement information spatially widespread over the area of interest; There is no need to install anything on the area under study (although some corner reflectors can be useful sometimes).

Main limitations

Main technical limitations are caused by the geometrical configuration, thus the sensor can observe movements only along the Line Of Sight (LOS). As consequences, image distortions caused by steep topography and difficulty to observe displacements along N-S direction have to be considered. Moreover, the so-called "phase ambiguity" effect (i.e. the inability to recognize too fast displacements) as a function of the signal wavelength and the satellite revisiting time is a typical SInSAR limitation.

Other limitations in terms of feasibility are: the difficulty to investigate vegetated areas and the cost of SAR data in particular for new acquisitions by new sensors.

Future challenges

Data cost reduction would be desirable in order to allow A-DInSAR to be used more frequently as a tool for monitoring. Another interesting challenge for the future is the development of models of displacement better able to detect non-linear trends.

Commercial sources in North America

In the authors knowledge, the following companies provide this service in North America: TRE Canada (www.treuropa.com) and Altamira (www.altamira-information.com). Further companies such as FUGRO (www.fugro-npa.com) and Egeos (www.eurimage.com) can be found in Europe.

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Remote monitoring of deformation using Digital Photogrammetry

Raul Fuentes and Stuart Robson

Principle of operation

Digital photogrammetry is an optical measurement technique that allows the accurate computation of the size, shape and position of a 3D object by measuring discernible features in two-dimensional images. The method supports single images, pairs of images and networks of images taken around an object. Images are captured either in a single instance with several cameras or as a sequential set over time moving a single camera from location to location.

3D coordination is based on triangulation whereby every feature measured in an image provides data analogous to the horizontal and vertical angles provided by a theodolite. Key differences are that multiple features of interest are captured at the same instant rather than sequentially and there is generally no requirement to setup and level a camera over a known point. The location and orientation of each image is modelled either, singly, as a resection or in combination with the complete constellation of images with a network or bundle adjustment.

In its most accurate form, where a single camera is used to take a network of images that converge towards the object, it is possible to utilise off-the shelf camera technology and to ascertain the optical properties of the camera at the same time as imaging the structure. This process is termed self-calibration. Where a constellation of cameras are used, cameras must either be purpose designed for photogrammetry or pre-calibrated.

Main fields of application

Photogrammetry can be applied to any structure (e.g. bridges, heritage structures, deep excavations, buildings, dams, tunnels and wind turbines) and is particularly effective for those exhibiting complex or rapid motion.

Accuracy

Accuracies of the order of +/- 2.0mm are achievable. Principal parameters governing accuracy are: the features to be measured; the geometry of the imaging network, comprising the number of images, their distance from the object and degree of convergence; the physical stability and calibration of the camera(s); the effectiveness of the features measured in the imagery and; the geometry and accuracy of any reference targets or scale bars used to define the coordinate system.

The use of photogrammetric targets allows image measurements to be much more accurate and repeatable than using natural features. For the highest accuracies, circular retro-reflective targets occupying between 5-15 pixels in each image are used.

Main advantages

The main advantages are: Equipment is economical compared with other remote monitoring techniques; Photogrammetry is non-contact, non-destructive and can be real-time; Data capture and use is flexible, safe and not time consuming; Simultaneous full-field capability gives it a great advantage over single-point sensors since a complete structure can be captured through the instantaneous coordination of hundreds of targets, features and surfaces allowing "Monitoring for the unexpected" and; Images add value: contributing to construction records; as-built surveys; characterisation of rock faces and; area and volume calculations.

Main limitations

The main limitations are: Control targets coordinated by conventional survey are required if the results are to be expressed in a particular coordinate system. However, the stochastic properties expressing the quality of the 3D data and the coordinates must be both transformed; Processing can be time consuming as automation is dependent on solving which feature is which within the image network and; In general, accurate photogrammetry, particularly where real-time is a requirement, needs the support of a specialist.

Future challenges

A challenge for photogrammetry is through its adoption within terrestrial laser scanning instruments since this offers the best of active and passive imaging solutions. However due to the low cost of off-the shelf cameras, where targets and highly dynamic structures are concerned it is likely that digital photogrammetry will continue to provide a leading edge solution.

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Remote monitoring of deformations using Differential Global Positioning System (D-GPS)

Jason Bond and Rob Nyren

Principal of operation

The Global Positioning System is a tool for determining terrestrial position from satellites. The system itself consists of 3 main components: Space Segment; Control Segment; and User Segment. The Space Segment consists of the GPS satellites orbiting the earth approximately 20,000 km above its surface. The Control Segment comprises control and monitoring station infrastructure on the earth for managing each GPS satellite. The User Segment comprises the GPS receivers designed to track GPS satellite signals.

The basis of GPS is 'trilateration' or the use of intersecting range/distance measurements to determine position. GPS receivers measure the elapsed time from when the GPS signal is transmitted to when the GPS receiver is received, from which the distance from a receiver to the satellite is determined. The locations of the satellites are determined by the Control Segment and this data (ephemeris) is logged by the GPS receiver.

GPS is based on signal transmit time that necessitates very precise time synchronization of GPS receiver/satellite clocks. Error sources impact the time measurement of signal travel. These include: satellite and receiver clock errors; atmospheric delay errors; signal reflection ("multipath") and signal bending ("diffraction") effects.

Differential GPS (or D-GPS) is used to mitigate error sources. To do this, one receiver is established as a 'reference' and measured differences between the calculated and 'true' position allow observation errors to be estimated. GPS observations made at locations close together on the earth will experience similar errors. As distance between the reference and monitored stations increases, the correlation in measurement errors is likely to decrease. For the best accuracy and precision, these distances are kept less than 10 km.

For geotechnical applications, D-GPS can be used for monitoring movements of any structure (e.g. dams, bridges, buildings, earth embankments, etc). The primary output for these applications is a time series of 3D coordinates. Resonant frequencies of structures can also be extracted for GPS observations using GPS receivers capable of measuring up to 100 Hz.

Accuracy

It is not uncommon to achieve instantaneous positioning for a GPS antenna at accuracies of ± 1 cm horizontally and ± 1.5 cm vertically (one sigma). Using advanced signal processing techniques, mm and sub-mm level trends can be extracted from the real-time solution time series. The highest obtainable accuracy is on the order of 0.5mm. The time required to achieve the highest accuracy varies according to the software package and can vary from hours to several days.

Advantages and limitations

D-GPS has favorable characteristics as a monitoring technology when carefully implemented: a) 3-dimensional position information is provided to mm accuracy; b) position is referenced outside of the deformation zone; c) position updates can be provided at frequencies as high as 100 Hz; d) line of sight is not required between stations; and e) by isolating information of interest from the GPS measurements (mainly in the measurement domain), GPS can also be used to determine orientation and vibration.

Challenges associated with using D-GPS technology for monitoring applications include: a) GPS receivers collect data continuously and therefore must be powered at all times, increasing power demands; b) receivers must have good satellite visibility. In order to achieve the highest accuracy, there must be few obstructions near the GPS antenna and six or more satellites should be visible from all sections of the sky; c) the monitoring network requires a stable reference point for the base station. Finding satisfactory locations can be challenging; and d) readings can be affected by signal multipath (the arrival of the same GPS signal via multiple paths at the antenna, caused by nearby or remote reflectors) and signal diffraction (occurs when the GPS signal is obstructed but still arrives at the GPS receiver and is processed). Identifying and troubleshooting these effects requires both specialized knowledge and experience.

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Book Review

New "ICE Manual of Geotechnical Engineering", edited by John Burland, Tim Chapman, Hilary Skinner and Michael Brown.

Review by John Dunnicliff

The UK Institution of Civil Engineers has recently published a two-volume manual, with more than 100 chapters on comprehensive aspects of geotechnical engineering, each written by one or more experienced practitioners or academicians.

The manual was originally intended for people in the early stages of their careers, but it's now clear that it should also prove valuable to all geotechnical engineering professionals.

From one of the editors to me: "It has been a labour of love, trying to create something that will assist the whole profession for many years to come! I'm proud of our industry—the amount of concerted effort from a huge number of people has been superb—and I think the outcome will be very beneficial for geotechnical engineering".

In my view the full manual is a 'must have' for the libraries of all firms which practice geotechnical engineering. The layout of the 1,500 page text and figures is clear and visually appealing, with numerous cross-references among chapters. The more I read, the more impressed I am! Specialists should have their own copies of relevant individual chapters. Although written for the UK scene, this in no way diminishes its value elsewhere.

Because this text is part of GIN, I'll now focus on the two chapters about instrumentation. Much of the content is an update of a book with a red cover, with enormous help in Chapter 94 from Allen Marr, Geocomp Corporation, Acton, MA and Jamie Standing, Imperial College London.

The chapters are:

- Chapter 94. Principles of geotechnical monitoring. There are three sections:
  - *Benefits of geotechnical monitoring.* The principal technical reasons for recommending a geotechnical monitoring program for a project are described. A common feature of these technical reasons is that monitoring programs generally save money.
  - *Systematic approach to planning monitoring programs using geotechnical instrumentation.* This 20-step sermon will be familiar to many readers of GIN. It includes the vital topic of how to assign tasks for the construction phase such that high quality data are obtained. The sermon is followed by an example of planning a monitoring program for an embankment on soft ground.
  - General guidelines on execution of monitoring programs, including all tasks during the construction phase.
- Chapter 95. Types of geotechnical instrumentation and their usage. There are two sections:
  - *Types of geotechnical instrumentation*. Instruments are described for monitoring four parameters: groundwater pressure, deformation, load and strain in structural members and total stress. The section includes applications, descriptions of how each instrument works, with schematic diagrams, and various other details intended to help the user.
  - *Usage of Instrumentation.* The section indicates the general role of instrumentation for 12 types of construction projects. For each project type a table summarizes the possible geotechnical questions that may lead to the use of instrumentation, and indicates some of the types of instruments that can be considered for helping to provide answers to those questions. Here's an example of those tables, for internally braced excavations.

Information is on www.icevirtual-library.com/icemanuals/MOGE. The hyperlinks at the left indicate the chapter titles and contributing authors. The manual, ISBN 9780727736529, is available in hard copy in two volumes for US$350, $185 for a single volume. It is also available on-line as an e-book, with individual chapters for $30 each. Ordering information is:
www.icebookshop.com,
E: orders@pssc.com,
T: (978) 829-2544.

Paolo Gazzarrini

Overture

Welcome to the 27th edition of the Grout Line, after a short "spring break" (March issue) due to a very busy start to 2012. The grouting industry has been very lively, mainly for the organization and participation in the 4th International Conference on Grouting and Soil Mixing held in New Orleans during the month of February.

The following article has been re-printed from "Deep Foundation", the magazine of DFI (Deep Foundation Institute) and my personal comment about the conference is that: IT WAS A BLAST! For several reasons: number of participants, quality of the papers, quality of key note lectures, quality of the exhibitors and, dulcis in fundo, the Mardi Gras events during the conference.

New Orleans.

For this issue we have also a very interesting article prepared by Jim Warner, and a lot of the top people of the grouting industry as co-authors. The topic of the article is the discussion of continuous monitoring/recording of parameters in our drilling & grouting industry, further to an animated discussion held in New Orleans.

4th International Conference on Grouting and Soil Mixing

reprinted from Deep Foundations, The Magazine of the Deep Foundations Institute

ICOG –explosive growth, exponential growth

The Fourth International Conference on Grouting and Deep Mixing (ICOG) met in February in New Orleans, La., in record-breaking numbers. The group began in 1982 with 419 attendees, and the 2012 attendees numbered over 700. ICOG, which stands for the International Conference Organization for Grouting, has become he informal name for the geotechnical subset specialty professionals. The chairs were Michael Byle, Donald Bruce and Larry Johnsen, who were helped by a committee of 13. DFI managed the entire international event. The core group's original plan was to reconvene every ten years, and that plan has been realized, except for a year's slippage in 2003.

Superlatives abounded at ICOG. Of the 700-plus attendees, the number of non-North American participants rose to 240, who came from Asia, South America, Europe, Australia and Africa highlighting the importance of and the interest in the deep foundations industry's expertise worldwide. There were about 30 concurrent sessions, and roughly 150 separate presentations. These covered state-of-the art in several areas, current research findings, the evolution of the several technologies, and included innovations in grouting, soil mixing and associated equipment. Six keynote speakers drew large audiences even those starting at 7:30 am, notwithstanding the previous evenings Mardi Gras festivities.

The three ICOG chairs, Johnsen, Byle and Bruce, opened the meeting with comments about Hurricane Katrina and its devastation of the New Orleans levee system and the deep mixing techniques used to repair and rehabilitate the post-hurricane damage in a dauntingly short time frame of 14

months. Bruce noted that the work was the largest use of DM outside of Japan. In one of the sessions, Peter Cali, of the U.S. Army Corps of Engineers (USACE) said that the project was undertaken with an "Alternative Evaluation Process," where the production rate was key. This concern led to the selection choice of Deep Soil Mixing. Cali also noted that the high price of steel was a factor in the process. If the work were done the following year, when steel prices were lower, T-walls might have been chosen.

The opening guest lecturer, Eric Halpin, the U.S. Corps of Engineers special assistant for Dam and Levee Safety, said the Corps estimates safety needs at $26 billion for the 2100 levees and 694 dams they oversee and maintain. That assumed expenditure over the coming years bespeaks an impressive need and a market for those in the deep foundations field. Halpin also said 77% of the US levees exhibit seepage and piping. He also mentioned regional challenges posed by Karst formations, the subject of many presentations at ICOG.

More strikingly, Halpin said the Corps is "rethinking failure mode analysis." Some staff thinks it possible that overly conservative design requirements might have been a factor in a reported $2 billion in "avoidable" costs. Cost-effectiveness and risk management are important issues currently. The organization, according to Halpin, is aiming at "Three Rs," resilience, robustness and redundancy in its projects.

ICOG honorees

The "G.R.E.A.T.S." luncheon was a highlight of the meeting, at which ICOG honored "Grouters (dedicated to) Research, Education, Advancement of Technology and Service." This year, all five recipients were from outside the U.S. Organizing committee members, Allen Cadden of Schnabel Engineering, LLC and James Warner, Consultant, presided over the ceremony that honored G. Stuart Littlejohn, U.K.; Freidrich-Karl Ewert, Germany; Giovanni Lombardi, Switzerland; and Mitssuhiro Shibazaki, Japan. The latter two were unable to attend. Sadly, the fifth honoree, A. Clive Houlsby, Australia, died shortly after he was singled out for this honor. A presentation on the life of each of the G.R.E.A.T.S. was made and those present offered acceptance speeches and the two others accepted via video.

The six keynote speakers were also honored by being chosen for exceptional performance and knowledge in their conference subject area. Their names and topics follow:

Stephan Jefferis, Environmental Geotechnics, Ltd, *Cement-Bentonite Slurry Systems*

David Wilson, Gannett Fleming, *Practice, Perspectives & Trends in U.S. Rock Grouting*

George Burke, Hayward Baker, *State of the Practice of Jet Grouting*

George Filz, Virginia Tech, *Design of Deep Mixing for Support of Levees and Floodwalls*

Clif Kettle, Bachy Soletanche, *Compensation Grouting, Evolution, Field of Application and Current State of Art in UK Practice*

Michael Byle, Tetratech EC, Inc., and James Warner, Consulting Engineer, *Limited Mobility Grouting-Past, Present and Future*

Encylopedic subject range

The conference tracks were Grouting and Deep Mixing for Tunneling, Highways and Transportation, Structural Support and Dams, Speakers also addressed performance, analysis and design, grouting applications and new equipment and technologies.

Advances in instrumentation and data acquisition were noted frequently as speakers looked back over the years since 2003, the last ICOG meeting. Many papers also focused on progress and research on dealing with Karst formations. Burke, in his keynote address on jet grouting, said there had been a "dramatic" change in data acquisition, noting the electric cylinder method as one new method. Speaker Richard Hanke of Malcolm Drilling spoke of a "full suite" of electronic data collection in real time at a Seattle site. Burke also mentioned data collection was used in the demonstration project at Tuttle Creek by the Corps of Engineers. Other speakers alluded

Theresa Rappaport and Organizing Committee – left to right: Theresa Rappaport, Justice Maswoswe, Jim Warner, Paolo Gazzarrini, Larry Johnsen, Mike Byle, Donald Bruce, Allen Cadden and Steve Maranowski.

to Wolf Creek Dam as a workshop for information on jet grouting and other cutoff wall techniques. Ground modification and grouting applications were described for mitigation of liquefaction, nuclear waste containment and seismic remediation. Compensation grouting, Clif Kettle's keynote subject, is "not easy and not cheap," typically used as a last resort for historic structures or emergency situations. Stephan Jefferis traced his work using blast furnace slag-fly ash in grouts over the years, while Helen Robinson, Schnabel Engineering, spoke about her research in polyethurene grouts.

Other addresses were diverse and included case histories from around the globe. One example from Norway was the use of accelerated cement to stop inflow under hydrostatic pressure of 540 psi in almost freezing temperatures. Another was a tunnel in Modena, Italy, at which 75% of the tunnel lining was repaired under water repair using bentonite panels. An unusual Hot Bitumen grouting in USA was one of the many presentations focusing on karst formations.

Devon Mothersille from the U.K., spoke about a tunnel in Australia at which all 5,200 grouted anchors were corroded and had to be remediated. The testing and remediation, led to a 9-year multi million dollar (AUD) settlement. From Finland, the case history of grouting in crystalline fractured bedrock to nuclear waste containment was presented and from Portugal, a jet grouting application for load transfer at a resort on the Tagus River to allow for cruise ships. New and smaller equipment for deep soil mixing from Italy was described by professors from the University of Naples. Daniele Vanni, Cesena-Italy, talked about deep soil mixing solution used to restore the listing campanile in Venice's San Marco Piazza. Similarly, cutter soil mixing applications all over the world, were presented by Franz Werner Gerresen, of Bauer Maschinen.

The presentations mentioned here are a small fraction of the total ICOG papers, which will be published in August 2012 by ASCE. ICOG attracted over 20 cooperating organization, over 70 exhibitors and 10 Poster presentations. DFI's management of the vast event was an enormous and successful undertaking.

A Monitoring Ruckus

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Background

A heated discussion occurred during a question period at the 4th International Conference on Grouting and Deep Mixing (ICOG) in New Orleans. The author (Ref. 1) had summarized the investigation and design of a grouting program to arrest settlement of a nearly 100 year old Amtrak bridge pier, located in deep water, and crossing the mouth of the Thames River in Connecticut. While installing piles for a bridge retrofit, one end of the pier supporting the lift span began to settle, threatening a disruption in continued rail service. Initiation of rapid corrective action was imperative, but little was known about either the foundation, structure, or the soils. An exploratory boring program and instrumentation of the pier were immediately initiated, as were consideration of remedial approaches. Although little was known about the underlying foundation, it was concluded that some sort of pressure grouting would be required. Early on the team members considered it important to include a grouting contractor in the planning, and several were interviewed.

There were few absolute requirements other than experience with, and ability to mobilize for, both compaction and permeation grouting, and real time computer monitoring with the original data provided in non-proprietary software such as Microsoft Excel. The latter requirement was negatively received by many, and was refused by some of the prospective contractors. It was this requirement that resulted in the heated discussion at ICOG. The paramount objection was basically that some contractors have developed expensive proprietary monitoring programs which allow all to observe the parameters on a monitor during grout injection, and it is unreasonable to require anything further.

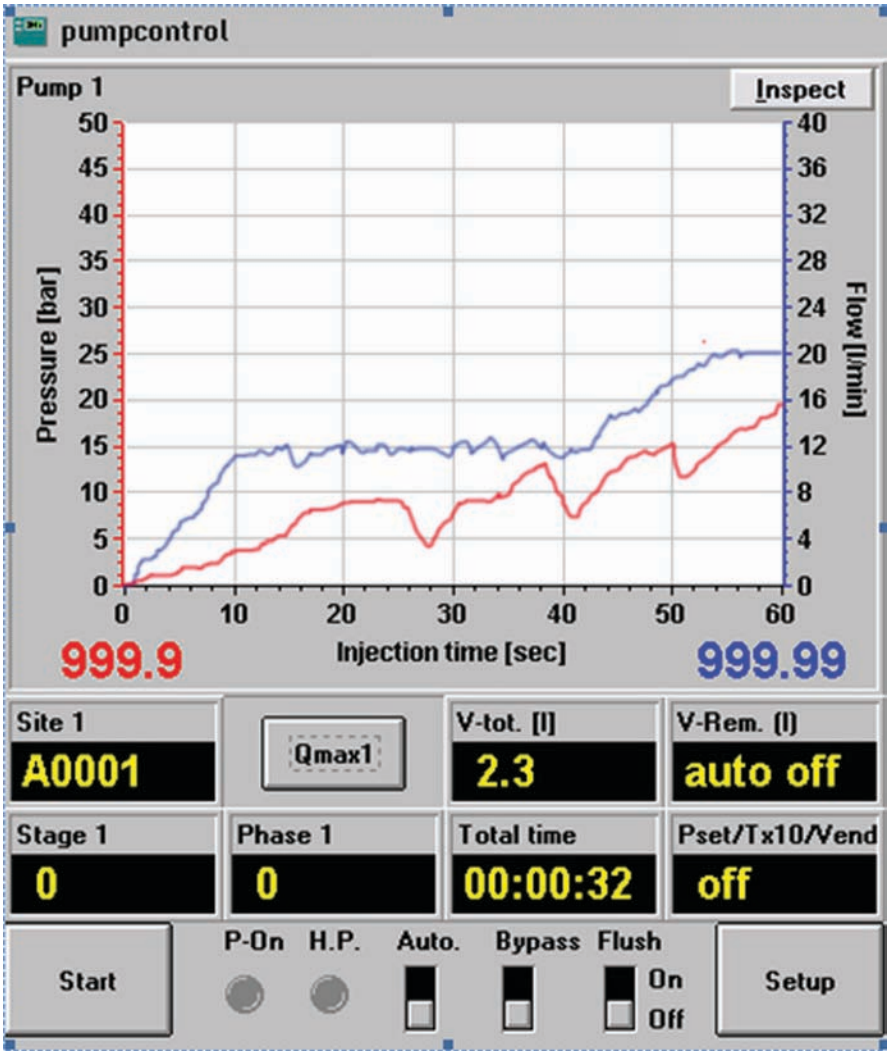
Although it did not arise at ICOG, this 'unreasonable to do more' attitude is actually a much wider issue. There are commercial grouting data acquisition systems with proprietary processing software that allows no more than the limited plot types embedded in the software. And, perhaps even more surprisingly, on larger projects with Owner appointed 'Review Boards', it is not uncommon to encounter reviewers with a 'we have always done it this way and nothing more is needed' viewpoint.

So, what drives these attitudes, and are they reasonable?

Purpose of monitoring

Real time computer monitoring of grouting serves three functions:

1. Display of grouting parameters during injection to allow control of the work, a) to ensure the best possible effectiveness (the result the Owner is paying for) b) to maintain cost-effectiveness (operational efficiency)
2. Providing original data for further analysis and thereby enabling optimization of subsequent work, particularly if any unusual events occurred during injection (in effect allowing validation of the grouting design/protocol/procedures)
3. Providing a record of the grouting
   a) For pay-items
   b) For project archives (used to



Grouting Sample.

resolve claims, and for future reference on large projects that will likely be subject to further grouting).

The authors believe that the listed applications of the data have the status of "Principles" that we all agree apply to grouting works. And these Principles have improved grouting – taking rock fracture grouting as an example, adding electronic monitoring systems enables the industry to routinely grout to a ~ 0.5 Lugeon standard today versus something like ~ 2 Lugeons thirty years ago, while using no more than Type 3 cement, and at ~ 30% less cost. So why the ruckus? We suggest the cause is that while all grouting engineers might agree on the above three principles, there is no common or accepted methodology to set about meeting these principles, and further, there exists a notion that being "proprietary" provides both risk aversion and competitive advantage. None of the above, however, provides best performance for the owner. And none of the above is in the long term interest of our industry.

Background to computer monitoring

A reasonable starting point is to ask: what are the standards/procedures in the industry for monitoring of grouting using computer-based digital data acquisition? For the answer to this question, let us accept that the four New Orleans specialty conferences indicate the state of the industry.

Using fractured rock as an example, these conference proceedings show that although electronic monitoring started thirty years ago (e.g. Ref. 2) there is still no consensus on what needs to be measured or how those measurements should be plotted/displayed. These differences stem from different underlying idealizations and so forth on how grout behaves. The "GIN-sufficient" group (working from Ref. 3 as updated in Ref. 4) are likely happy with a single plot of pressure versus volume injected. The "GIN-misleading" group (e.g. Ref. 5, 6) require pressure versus flow rate, penetrability versus time, and penetrability versus volume injected. Yet others (following Ref. 7) might ask for 'Grout Lugeon' plotted against time. What we should all ask for, but remains absent, is to add real-time measurement of grout rheology (although a good start at this was discussed at the Conference, Ref. 8).

Perhaps surprisingly, the issues and computer systems for monitoring of compaction grouting are similar to those of fractured rock grouting. Largely driven by one extreme application (Bennett Dam; Refs. 9, 10), it is now accepted that compaction grouting should be monitored for injection pressure, grout flow rate, and total grout injected (Ref. 11).

Sorting out unusual occurrences

The evolution of monitoring, from the perspective of these New Orleans conferences, shows good appreciation of the role of computers around Principle 1. But the issues surrounding applying monitoring data to sort out unusual ground response or grout behavior – Principle 2 - has seemingly not been discussed (or at least, we did not find a single paper in our readings of that literature). Here we offer some examples where the ability to retrieve data after grouting for further evaluation has been important (if not crucial)

Computer contol room.

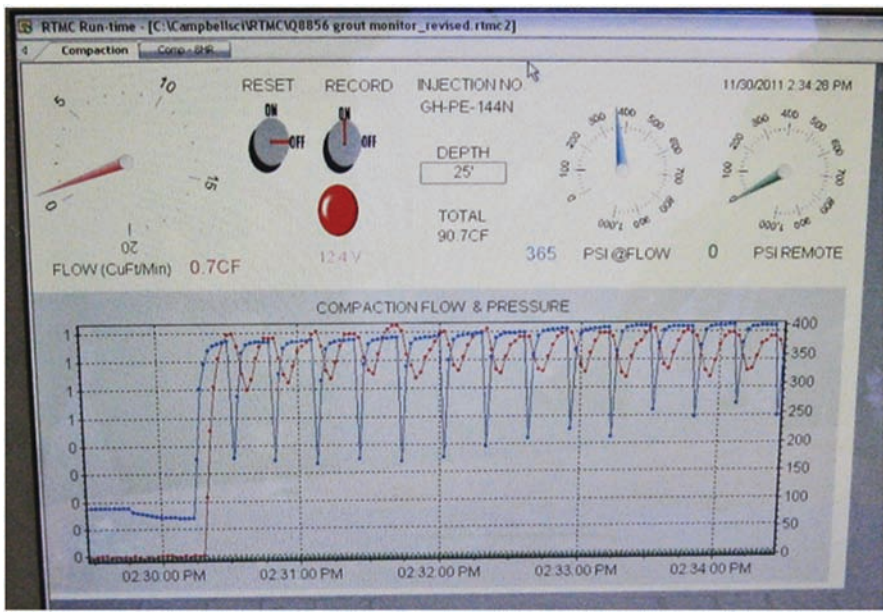
to the work's success.

Bennett Dam: An extensive array of piezometers had been installed adjacent to the area to be grouted. Maximum allowable pore pressure increase had been established for each piezometer, dictating the maximum grout injection rate and resulting pore pressure. Initial injection rate was established based upon analysis and experience, and should have been sufficiently slow to not exceed the allowable pore pressure rise. The reality was, excessive pore pressure rises occurred on several occasions requiring cessation of all operations until they were resolved. The recorded digital record was uploaded into Excel and viewed at an expanded scale, to show what was going on within a single pump stroke. Substantial variation in the rate at which the piston moved was observed, even though the average rate was as intended. The grout pumps were then replaced with higher quality pumps capable of uniform operation, and the excess pore pressure problems disappeared.

California Aqueduct: Internal erosion and piping leakage of an embankment on the California Aqueduct resulted in an emergency grouting operation. Time constraint limited the soils investigation to CPT probes, with this data supplemented through close monitoring of the injection behavior during grouting. Each day's computer monitoring data, again uploaded into Excel, was analyzed overnight, distributed to team members over the internet, and injection parameters adjusted for the following day's work. Upon completion of the emergency work, the data was used to better understand the existing conditions, facilitating future action consideration.

Colorado Oil Shale: A perimeter grout curtain was intended as a component for environmental isolation of in situ recovery of hydrocarbons from the shale. However, initial operations viewed the ground as ungroutable with reported observations that grout "ran away into the formation". This project involved greater than usual depths (more than 400 m working from surface). Grout data was recovered from the data acquisition system and uploaded into Excel for detailed analysis. The following situation was revealed. Grouting started with water-filled tubing, and as grout travelled down the tubing the collar pressure dropped dramatically because of the weight of the grout, until the water in the grout cavitated with consequent loss of flow control – the reported "run away" into the formation. The situation became controlled once sufficient grout had penetrated the formation to build enough hydraulic drag to return the collar pressure to less than that allowing cavitation of the grout. Excel analysis of the data determined low density, high viscosity grouts were needed for the project.

Amtrak Bridge: This project involved



Compaction recording.

emergency remediation of a bridge pier in deep water, subject to tidal variation, founded on a concrete filled timber caisson of unknown strength, condition, or exact dimension. The suspected "faulty" soil was at a depth of 160 to 170 feet, underlying a deposit of organic clay and silt mud approximately 100 feet thick. The soil was variable, consisting of a range of sands, some silt, and even some minor clay. Sampling and sample retrieval were time consuming and very difficult to accomplish, and the soils were not well understood when the grout injection began. Because of the emergency conditions, grouting was actually started boring and installation of instrumentation systems progressed, such that primary guidance for the work was through analysis of the ongoing injection as it progressed. Similar to the California Aqueduct, monitoring data was uploaded into Excel for analysis to guide the ongoing injections. Further, the remediation team members were literally scattered across the country. Many teleconferences were held during which the team members could observe and discuss the original data, transmitted via an FTP site.

The above examples illustrate that "unusual events" can be investigated by exporting data to Excel for cross-plotting (correlating), expanding scales and so forth – data processing features omitted in current "proprietary" software. However, once the data is in Excel we can go one step further to understand what is happening in the ground.

Understanding through analysis

Excel has a programming language "VBA" that is readily accessed from the worksheets (see the 'Macro' menu). Grouting data can be imported and plotted in Excel, with all the plots found in the real-time monitoring systems easily replicated, but with now the possibility of adding formal analysis through VBA. This is easiest appreciated by example.

For remediation of Bennett Dam by compaction grouting, grout injection was simulated in finite element software to develop a set of response 'type curves' that were transferred to a VBA routine. These curves could then be called up from within a worksheet to overlay a simulation on the measured data in an "image matching" process, with the ground parameters adjusted to get the best-fit; those best-fit parameters show the current state of the ground. In effect, each compaction grout injection was treated as if it were a pressuremeter test with the evolution of the estimated ground parameters directly showing how the effectiveness of the work was developing.

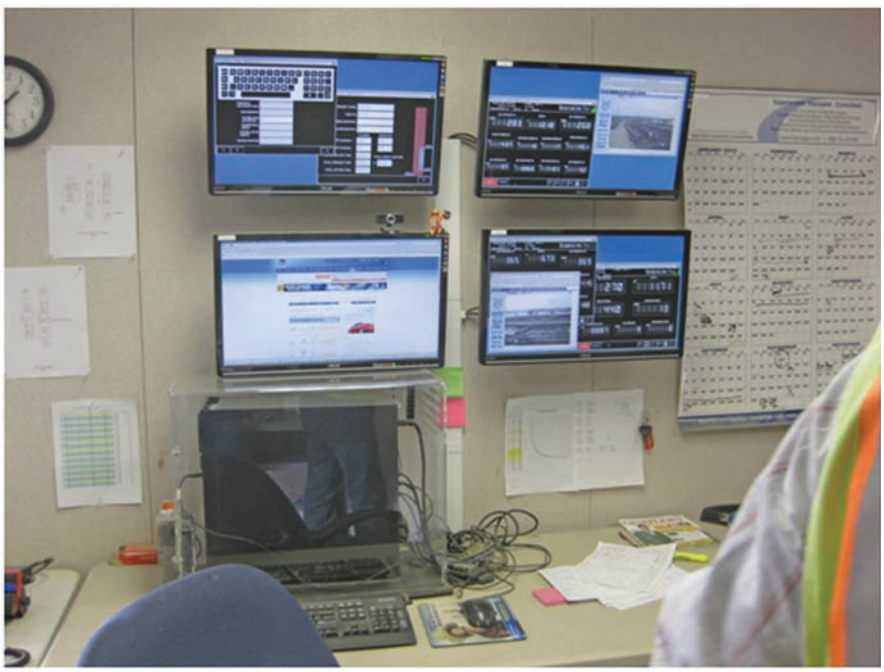
The process of modeling grouting has now been extended to fractured rock grouting. The Bingham equations for flow in rough fractures can be solved directly in VBA. Just like compaction grouting, fracture roughness properties estimated from for example televiewer data,and then adjusted to best-fit the Bingham solution on the measured penetrability versus injected volume curve – giving a measure of how far the grout penetrated into the formation in that stage.

These two examples show the potential power of getting computer-acquired grouting data into Excel. They also illustrate two independent functions for grouting data: i) job-control in real-time situation – that is, activities around Principle 1; and, ii) protocol-assessment within hours of an injection – that is, activity in support of Principle 2. Whether this Principle 2 assessment is done by an onsite grouting engineer, an offsite support engineer, or by the Owner's appointed review engineer, does not matter – it is a distinct function with different purpose from day to day job control. And, today, Principle 2 needs data that can be loaded into analytical software such as Excel.

Of course these two cases of analysis-guided grouting do not represent the current state of practice. But, they do show where the industry might go, and how we can further improve and expand our technology.

Required computer-based data acquisition

Data in support of grouting covers a wide range of drilling and grouting activities, and all the data is needed to guide the work. However, the 'ruckus'



Grout Computers.

was focused on that portion of the data measured by the computer systems monitoring the grout injections. So, let us turn our attention to how we make these measurements.

Computer data acquisition and monitoring is a rather well-established technology (Ref. 12 is a convenient briefing for grouters). The discussion between various grouting groups on "what" to measure is irrelevant as modern computing systems can measure many more parameters than any grouter will ever need. It is trivial to have eight channels of data. The minimum data suite only uses five: time, pressure, flowrate, volume injected, grout rheology (or mix indicator).

However, the appropriate data acquisition strategy in terms of scanning rate, filtering procedures etc. has been neglected with no industry consensus on "how" to monitor. A computer systems engineer might be horrified with what we are all doing. From a grouting perspective, the most challenging measurement issue is reliably detecting hydrojacking, a process that can initiate in seconds because of the pressure-storage within the grout delivery system. And, this need suggests a minimum standard of filtering at 1 Hz for noise, with a matching 4 Hz scan rate; higher frequencies are fine, but also result in larger files than needed to understand what is going on (inconvenient, but not a "deal breaker").

Data storage format is open to choices, and a proprietary (i.e. binary) format could be used. But, a binary format would be a poor choice as file size is small for grouting records, and the gain from reduced storage in binary format is completely offset because the data can no longer be inspected with a text editor. By far the best choice is a text format complying with the American Standard Code for Information Interchange (i.e. ASCII files). ASCII files are readily imported into Excel for analysis, and are a basic format in any high-level programming language if writing proprietary (custom) software. There is no reason to not use an ASCII format, ideally "comma separated values" (csv), and every reason to so do.

Where proprietary software becomes more of a consideration is with the real-time display. With some systems, a high-level "building block" language is used (e.g. National Instrument's DASYlab) and it is not difficult to add or change the display used on the monitoring computer. Conversely, if the display has been programmed in C++ language changing the display format may be challenging. This points to the need for grouting industry standards, but standards won't develop until we have a consensus on the appropriate plots to be used – and, as an industry, we are some way off from that realization as discussed earlier. Practically, this may not matter in the short term provided the engineering team can bring up the data in Excel for further processing and display.

Final comments and a question

This essay was triggered by a ruckus over proprietary monitoring of grouting. But if we accept that the New Orleans conferences represent the Industry's view of what is appropriate, then the companies offering proprietary systems must address the question: Why should aspects others grouters in the industry consider important be excluded by their "proprietary" system? Or as one of the participants at the Conference inquired "What do they want to hide?"

In reality, "proprietary" systems seem focused on 'job-control' rather than 'engineering-of-adequacy', and owners could live with such proprietary systems provided data can be exported for Principle 2 assessment. However, there is a caution too for such proprietary systems – it is not for the proponents of proprietary systems to determine what is adequate. That is the task of the owners engineers and consultants, and industry-consensus. And if that consensus requires aspects not in proprietary systems, then those systems must be modified to comply with industry standards.

And a final request; open discussion is the way we all learn. Real time computer monitoring has proven advantageous in managing and controlling grouting work, and its use will only increase over time. Original data is often provided in standard format by quality contractors. It is essential that all grouting professionals are aware of its advantages, disadvantages, limitations, and all things related. The authors strongly hope this essay will be the beginning of ample and thoughtful discussion (pro and con) of the subject. Be it a few sentence opinion, or a comprehensive article, send your comments to the Grout Line!

References

1. Kaeck, W. E., Rhyner, F. C., and Warner, J, (2012). Engineering and design for deep foundation creep and grouting at the Thames River Bridge. Proc. 4th International Conference on Grouting and Deep Mixing, New Orleans, 2012.
2. Jefferies, M.G., Rogers, B.T. and Reades, D.W. (1982). Electronic monitoring of grouting. Proc. Specialty Conference on Grouting in Geotechnical Engineering, New Orleans. Vol. 1, pp.769-780.
3. Lombardi, G. and Deere, D.U. (1993). Grouting design and control using the GIN principle. Water Power & Dam Construction, pp. 15-22.
4. Lombardi, G. (2003). Grouting or rock masses. Proc. 3th International Conference on Grouting and Ground Treatment, New Orleans, pp. 164 - 197.
5. Carter, T.G., Dershowitz, W., Shuttle, D.A., and Jefferies, M. G. (2012). Improved methods of design for grouting fractured rock. Proc. 4th International Conference on Grouting and Deep Mixing, New Orleans, 2012.

6. Bonin, G.R., Rombough, V.T., Carter, T.G, and Jefferies, M.G. (2012). Towards better injection control and verification of rock grouting. Proc. 4th International Conference on Grouting and Deep Mixing, New Orleans, 2012.

7. Naudts, A. A. (1995). Grouting to improve foundation soil, Practical Foundation Engineering Handbook, Section 5B, McGraw-Hill, New York, page 5-333.

8. Håkansson, U., Rahman, M., and Wiklund, J. (2012). In-line measurements of rheological properties of cement-based grouts – Introducing the UVP+PD method. Proc. 4th International Conference on Grouting and Deep Mixing, New Orleans, 2012.

9. Stewart, R.A. and Watts, B.D. (1997). The WAC Bennett Dam Sinkhole Incident. Proc. 53rd Canadian Geotechnical Conference, Montreal, 1997.

10. Warner, J., Jefferies, M.G. and Garner, S. (2003). Compaction grouting for sinkhole repair at WAC Bennett Dam. Proc 3th International Conference on Grouting and Ground Treatment, New Orleans, pp. 869-880.

11. Compaction Grouting Consensus Guide Committee, ASCE Compaction Grouting Consensus Guide, ASCE Standard ASCE/G-I 53-10, ISBN 978-0-7844-1094-3, 2010.

12. Taylor, R.M. and Choquet, P. (2012). Automatic monitoring of grouting performance parameters. Proc. 4th International Conference on Grouting and Deep Mixing, New Orleans, 2012.

Editor's comments

Jim asked me to add my name to the list of the co-authors but my first thought was, being the editor of the Grout Line, to be "super-partes" and my original intention was not to take any position in this controversy. But, I have reconsidered and decided to share my thoughts. It is a topic in which I am very passionate considering that I started using computers and continuous monitoring/recording of data in drilling & grouting in 1989 (23 years ago). Since then I have become quite obsessed/addicted with the use of this (at that time, very new) technology. It is a delicate matter and sometimes controversies can happen. For example, battles about the use of computers have been held during the preparation of the "Jet Grouting – ASCE - Guideline Specification".

I agree completely with the content of the article and my first comment/ reminder is that the same concepts can be applicable also to the drilling, with the automatic monitoring/ recording in real time of all the drilling parameters such as speed, torque, pressure on the tool and rotation. Don't forget the drilling!

I concur that it is not acceptable and not admissible to withhold the "raw data". The simple concept is that these "raw data" are a couple of recorded numbers as (in grouting): flow, pressure (and if we want to add rheology) recorded every defined time (1 or 2 or 3 seconds or…). One value for the time and one for the parameter we want to control/record. It can be discussed what shall be the "best" timing interval, but these concepts are quite simple.

Other parameters such as volume or energy (GIN) or penetrability or equivalent Lugeon etc, are usually function of the basic parameters monitored and recorded vs. time. Consequently for these parameters, no additional sensors are required but only simple formulas.

Each manufacturer of recording systems or Contractors have, of course, their own graphical representation and evaluation (and here I agree that their software can be proprietary) but the "raw data" must always be made available to the Owner/Engineer for their exclusive use, and that is not necessarily compatible with the "proprietary" software provided.

Another aspect to analyze is related to what the article says about stage termination criteria or grouting design; GIN or Equivalent Lugeon or "misleading GIN", or…. Of course, the software used for a grouting job shall be adapted/modified depending on the grouting criteria/design specified and also in this case can be proprietary. But again the "raw data" shall always be provided.

In my personal experience, I have used several recording systems available on the market, and all of them were capable of providing "raw data" (ASCII format) readable later in a simple Excel sheet (or equivalent – a lot of spreadsheet programs are available now) or a simple database. So I have never had any discussions about this problem.

Unfortunately I was not present at the "heated discussion" in New Orleans (too many interesting papers to follow) and maybe I missed some other concepts in the discussion. I reiterate, I consider it to be completely acceptable that every manufacturer/contractor has their own "proprietary software," compatible with the needs of the grouting job to be done, but in my opinion it is a lost war for those who argue that the raw data does not need to be made available to the owner/engineer.

If you have additional comments about this interesting topic, or grouting stories or case histories, you can write to me: Paolo Gazzarrini, fax 604-913 0106 or paolo@paologaz.com, paologaz@shaw.ca or paolo@groutline.com.

Ciao!

A new technical committee to promote and coordinate activities in mining geotechnique

Michel Aubertin, Murray Grabinsky, Dharma Wijewickreme, and Ward Wilson

The mining industry is an important asset for the economy of many regions, particularly with respect to exports and employment, but also through numerous technological developments. A large proportion of Canadian geotechnical engineers and geoscientists have been working on mining projects, as indicated by regular presentations at the Canadian National Conference, during the Cross Canada Lecture Tours, and in the Canadian Geotechnical Journal. However, such numerous activities related to mining geotechnique have not been systematically coordinated within the Canadian Geotechnical Society (CGS).

Technical Committees have been created by the CGS to address activities and issues of permanent importance or interest to its members, and these transcend Divisional lines and therefore require a different organizational structure. The field of Mining Geotechnique constitutes one such wide-spanning discipline. The CGS Board recognized this situation and approved the creation of a new Technical Committee (TC) during its fall 2011 meeting to promote the development and visibility of this field. The committee brings together CGS members with an interest in the broad field of geotechnique applied to mining projects.

Many different areas will be included in the mandate of the new TC. This will be the case, for instance, with issues related to the behavior of underground backfilled openings. Canada hosts some of the largest and deepest underground ore deposits, which, to extract these deposits safely and economically, requires the use of local and regional ground support systems. In this regard, stope backfilling is playing an increasingly important role. Both rock fills and hydraulic sand fills have historically been used, but recent advances in thickening and transport technology make it possible to create backfill from tailings with a "paste" consistency, especially for precious metal mines where the ore is finely ground to maximize recovery.

The use of paste backfill is an advantageous way of handling tailings produced by hard rock mines, which have the general characteristics of low plasticity silts. At water contents around 40%, plug flow transport of these tailings can be achieved in pipelines using positive displacement pumps and gravity. Underground, the deposited paste shows a lava-like flow that is non-segregating and produces very little bleed water. Compared to previous backfill technologies, paste can be delivered faster, it more completely fills the mined void space, it dramatically reduces the water to be managed (as compared to hydraulic fills), and it more efficiently uses binder added for the backfill strength needed during subsequent mining.

Significant achievements have been made in mine backfill engineering over the last few years. Backfills in operating mines have been extensively instrumented to provide information about the development of total stresses and porewater pressures during filling and curing, as well as to monitor the response of barricades used to retain the backfill. Analytical models based on vertical stress arching within the backfill have evolved and been compared with model studies and are now being calibrated using field data. Modified Gibson solutions and numerical simulations have been applied to understand backfill consolidation and the dependency of pore pressure dissipation on filling rates and the evolving backfill material properties. Binder chemistry and its interaction with process water chemistry and tailings mineralogy has been investigated. The role of binder hydration and its contribution to dissipating pore pressures through self-desiccation (or chemical shrinkage) is better understood. Fully three-dimensional numerical models that incorporate the coupled hydraulic-mechanical-thermal behaviour of backfill are becoming feasible. Barricade design is also becoming more rational, incorporating advances in reinforced concrete technology or in waste rock behavior.

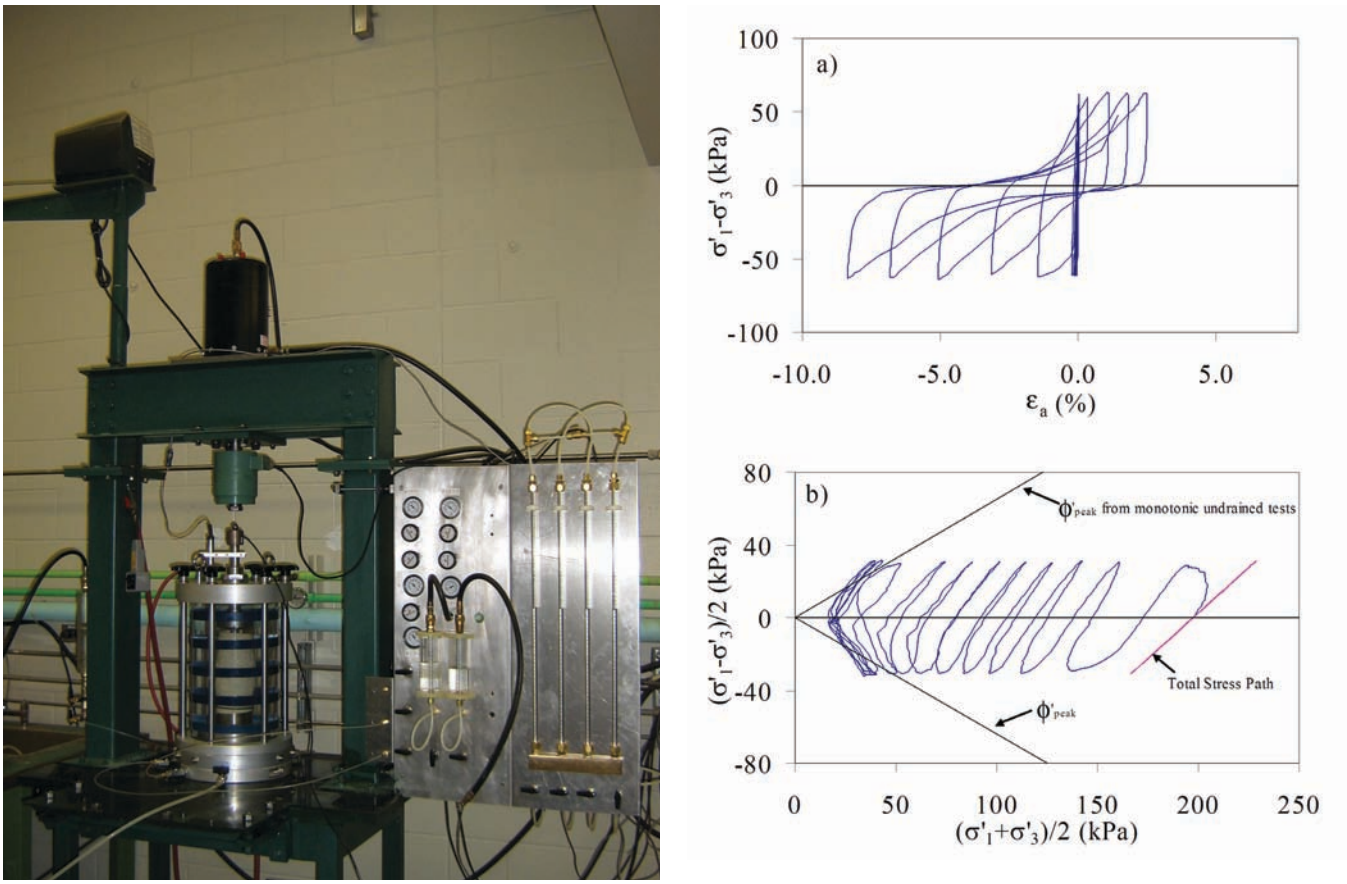
Although recent successes have resulted in safety and efficiency improvements in operating mines, many research challenges lie ahead. A better understanding is needed of backfill's contaminant transport and fate processes for closed mines that lie within a regional groundwater flow system. Significant advances, have yet to be made on the many concrete mix design modifiers that are used routinely in civil engineering. Better in situ strength characterization

Significant advances have been made in integrated instrumentation systems to monitor underground mine backfill, as illustrated in the 3 photos above for a recent field monitoring program.

techniques are needed for mining under or adjacent to backfills where strength may have been compromised (e.g., due to rock bursting or nearby blasting). The effect of creating adjacent openings near existing backfilled stopes is also of interest. Most important, technology transfer needs to continue so that research results become incorporated into the mines' best practices.

On the surface ensuring the stability of tailings storage facilities remains a priority for the industry. This critical aspect is becoming even more challenging in this era of low-grade and large-volume operations. In this regard, the performance of tailings deposits under earthquake loading is one of the key engineering considerations that influence the design of storage facilities situated in seismic zones. Due to the commonly used hydraulic placement methods, as-placed tailings generally exist as loose, saturated deposits. These tailings are significantly compressible, low in shear strength, and generally susceptible to liquefaction. Liquefaction essentially involves a rapid loss in shear stiffness and strength in loose saturated soils due to the generation of excess pore water pressures under shear loading conditions. While static liquefaction has been cited as being responsible for a number of tailings dam failures, liquefaction due to earthquakes is still a major concern.

The seismic assessment of tailings deposits involves addressing the following key concerns: (a) will liquefaction be triggered in significant zones within the tailings impoundment under the design earthquake? (b) if so, are the liquefied shear strengths adequate to prevent a flow failure? and (c) if so, are the displacements tolerable? Answering the above questions is a difficult task in engineering practice due to many reasons, including the highly variable and layered nature of tailings deposits in terms of particle size (i.e., coarse-grained or fine-grained) as well as packing density resulting from the type of discharge strategy being operated during storage. One example of complexity in this regard is the void redistribution that occurs during liquefaction in layers with contrasting particle sizes (and permeability) that is known to introduce significant uncertainty in the estimated liquefied shear strengths. Another major concern is the current limited understanding of the cyclic shear behavior of tailings. For example, the current practice is pivoted



Laboratory testing plays a vital role for the characterization of material behavior for mining geotechnique, including the response of tailings to cyclic loading as illustrated above.

around frameworks that define the state of a given soil using void ratio and effective confining stress only; however, there is a need to account for other effects such as particle fabric, ageing, and field loading modes, which are known to be significant, but are currently often disregarded due to lack of knowledge on the subject.

In addition to the high quality characterization work required to understand the soil, tailings, and groundwater conditions in the field, there is a strong need to advance our understanding of the mechanical response of tailings themselves under seismic loading. Parameters such as strength and deformation moduli, compressibility, and hydraulic conductivity derived from laboratory testing provide essential input for numerical modeling and support and confirm field-based approaches. For example, direct simple shear testing is considered suitable as a laboratory element test to determine cyclic shear resistance since the method is able to simulate the predominant mode of field loading during earthquake shaking. Another important consideration in seismic evaluation of tailings deposits is the validity of numerical models used for the prediction of earthquake-induced ground displacements. Since high-quality data records from field case histories are rare, such validations often become a difficult task. Physical modeling of well-defined boundary value problems using methods such as shaking table and geotechnical centrifuge testing may thus play a key role in generating data for meaningful validation of numerical models. Work is also needed to investigate alternative disposal strategies to control or limit the risk due to liquefaction of tailings.

Mine wastes management also raises many issues related to environmental geotechnique. In this regard, significant progress has been made on prediction and characterization techniques to assess the hydro-geochemical behavior of tailings and waste rocks that contain reactive minerals. This aspect nonetheless remains a challenge, particularly for materials with a low acid potential where static tests are insufficient and interpretation of commonly used kinetic tests results is uncertain in predicting the long-term water quality. Control technologies have also evolved markedly over the last two decades or so. For instance, many laboratory, field, and numerical studies conducted on engineered cover systems, for both dry and wet climates, have shown how such systems can be used effectively to limit the flow of water or oxygen to the reactive wastes underneath and thus prevent

water contamination. These investigations have also helped determine why some covers may have underperformed in the past due to sloping and other geometry effects, natural conditions, or unsuitable material properties. Modifications have also been proposed to traditional design approaches for improving cover performance using alternate layering scenarios and configurations (including suction breaks), non-conventional materials (such as desulphurised tailings), and techniques to increase diversion length. There is nevertheless a need to pursue this line of work to evaluate the long-term response of covers when faced with the natural degradation of geomaterials and geosynthetics exposed to surface conditions, including the effect of climatic extremes and of root penetration and other bio-intrusions.

Major geotechnical challenges also emerge from the Canadian oil sands industry, which manages the largest mining projects on the earth. This industry has disturbed hundreds of square kilometers of land, and the corresponding impact is concentrated into one specific area, contrary to metal and iron mines which are distributed around the country (and elsewhere).

Reclamation and closure practices for the oil sands industry appear to have lagged behind production rates. With the massive expansions proposed over the next couple of decades, enormous pressure has come to bear on the industry to accelerate its tailings management practices. One example is the aim to reduce the accumulation of fluid tailings by capturing the fines in dedicated disposal areas and to create trafficable surfaces for progressive reclamation.

In response for the need to improve tailings management practices, the Canadian oil sands industry has formed a major consortium to share tailings research and technology in order to accelerate advanced tailings management. New technologies being evaluated by this consortium include: consolidated/composite and non-segregated tailings, mature fine tailings (MFT) treatment and atmospheric drying, MFT centrifugation and drying, thickened tailings with thin lift deposition, water capped MFT, and CO2 enhanced fines capture.

The list of mining geotechnique considerations are numerous in terms of issues/challenges linked with rock mechanics and ground control to minimize dilution and provide safety in the workplace; soil mechanics and foundation engineering for the design of dikes and other surface infrastructures; analysis of groundwater problems in terms of seepage, drainage, and water quality; mining in cold regions with the effect of frost and evolving permafrost conditions; the use of geosynthetics in liners and covers; and the role of engineering geology related to material characterization and site selection.

With the foregoing clearly demonstrating the potential for the development of new frontiers, the mining industry is currently seeking the very best and brightest of researchers, students, and practicing engineers to become engaged in the development of advanced mining geotechnique.

The new CGS Technical Committee on Mining Geotechnique will take part in this effort to promote and coordinate these actions. You are welcome to join by contacting one of its Executives (at www.cgs.ca).

The Authors are Executives of the Mining Geotechnique Technical Committee.

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Geoengineer.org is Growing!

For the past 10 years, Geoengineer.org has been providing geo-professionals with the latest informational resources needed to advance in their fields. We have recently surpassed 100,000 visitors per month and would like to sincerely thank our engaged audience and sponsors for their continuous support. We are delighted to have such a unique community sharing our mission of advancing the geo-profession!

If you are interested in joining our cause, consider contributing material or promoting your company through our website and e-newsletters. We would also love to hear from you if you have any comments or suggestions that can help us make an even stronger impact! We have a number of exciting projects underway that we are excited to release in the near future.

Submit your paper to ISSMGE's Case Histories Journal

The International Journal of Geoengineering Case Histories is an official journal of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE), focusing on the publication of well- documented case histories. **The journal is unique in that it is the ONLY refereed journal focusing exclusively on geoengineering practice**. It is also available online for digital download at no cost at all!

By submitting your case histories for publication in ISSMGE's Case Histories Journal you will get the following benefits:

- Your manuscript will be published within days after being accepted. Our review procedure is as strict as in the most prestigious journals, but publication time is minimized.
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- Your paper will always be easily-accessible, searchable by search engines, and promoted in various ways. For instance, when your paper is published, an e-mail will be sent to the subscribed members of the journal's newsletter, promoting your paper!
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To learn more about ISSMGE's Case Histories Journal and what makes it so unique, visit: **http://casehistories.geoengineer.org**

The papers of the journal are made freely available through the financial support of our sponsor GEI Consultants, Inc.

New award for outstanding paper in ISSMGE's Case Histories Journal

ISSMGE has announced the "Outstanding Paper in the International Journal of Geo-Engineering Case Histories Award": this is a new award to recognize the best paper in this ISSMGE Journal.

All awards are to be submitted to the Secretary General who will relay them to the Awards Committee for consideration. The ISSMGE Board will receive the recommendations from the Awards Committee and make the final decision. **Please take time to nominate your most valuable colleagues.** All awards will be presented at the 18th International Conference for Soil Mechanics and Geotechnical Engineering in Paris, France, 2-5 September 2013.

GeoWorld also adopted by geo-companies and organizations

Within a few months, GeoWorld (www.mygeoworld.info) has exceeded 1,700 members (April 2012) while more and more companies and organizations are joining as well! This innovative networking tool for geo-professionals is catching on fast, and with your support we are making further improvements and additions to the current platform.

More and more companies and organizations have started using GeoWorld to communicate their corporate identity and offerings, but also engage their community of users and fans. **We encourage any company or association interested in addressing our growing community of geo-professionals to contact us for further tips and guidance**. If you do not have an account in GeoWorld yet, you can do so easily at no cost by visiting www.mygeoworld.info and registering online.

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ASFE nominating committee announces 2012-13 slate

ASFE's Nominating Committee has announced its slate of officers and directors for ASFE's 2012-13 fiscal year. Although the fiscal year starts on May 1, the new Board of Directors will take office immediately after the election. ASFE President-Elect **David A. Schoenwolf, P.E. (*Haley & Aldrich, Inc.*)** *will become president. Those nominated for the other positions are:*

For President-Elect: **Kurt R. Fraese, L.G. (*GeoEngineers, Inc.*)**;

For Secretary-Treasurer: **Steven D. Thorne, P.E., D.GE (*GEI Consultants, Inc.)***;

For Directors-at-Large:

Joel G. Carson (*Kleinfelder*);

Mark K. Kramer, P.E. *(Soil and Materials Engineers, Inc.*);

Gordon M. Matheson, Ph.D., P.E., P.G. (*Schnabel Engineering)*;

Laura R. Reinbold, P.E. (*TTL, Inc.*); and

Woodward L. Vogt, P.E., F.ACI, F.ASCE (*Paradigm Consultants, Inc.)*.

Six of the seven who will be voted on already serve. The "newby" – and also the first woman ever to be nominated to the ASFE Board – is **Laura Reinbold,** a principal of TTL, Inc., a 180-person geoprofessional firm serving the United States from offices throughout the Southeast. Laura began her engineering career more than 25 years ago, after earning her Bachelor of Engineering degree from Vanderbilt University. The manager of TTL's Nashville office, Laura chairs ASFE's Education Committee and also serves on committees of ACEC, the Urban Land Institute, and the Nashville Chamber of Commerce. She is a licensed professional engineer and a LEED Accredited Professional.

Vancouver, BC experimenting with rubber sidewalks

Vancouver, BC is experimenting with a recycled-tire material for use in sidewalks installed in soft-soil areas. The test site – a sidewalk on the 500-block stretch of East 17th Avenue – previously required frequent filling of concrete with asphalt cracks. Now, interlocking grey rubber tiles, each two inches thick and imprinted with a brick pattern, extend along the south side of the street; the north side features a half-block of almost-white concrete reinforced with wire mesh and a half-block of asphalt.

Eco-Flex (Edmonton, Alta.) manufactures the material, using 14 discarded tires for each five-foot-by-four-foot tile. The company grinds the tires, mixes in some glue, and then uses pressure, not heat, to produce its products.

According to Jonas Moon, a project engineer with the city, Vancouver will monitor the rubber surface's performance for four years. "We think that we're going to save on maintenance in the long run because we don't have to go out there and patch cracks or have to replace the whole sidewalk," Moon said. The city calculates it costs $250 to buy and install each square meter of rubber sidewalk. By contrast, one square meter of standard concrete sidewalk costs $150. The higher cost is incurred in part because a rubber sidewalk requires more preparation in soft-soil areas, but it can be ready for use faster than concrete, which needs time to cure. In addition, making concrete and asphalt is resource intensive, whereas using recycled tires to manufacture rubber sidewalks results in far fewer greenhouse-gas emissions and reduces landfill requirements.

Moon said the city has a applied for a grant from Tire Stewardship B.C. to test rubber sidewalks in areas where tree roots cause sidewalks to heave. There, workers can lift the rubber panels, trim the roots, then replace the panels. Rubber sidewalks could also better serve joggers and people using wheelchairs and walkers, Moon said.

Just how important are geoprofessionals and the issues they contend with?

Sometimes when you're in the middle of things for a long time you lose perspective about the importance of what you're doing. This fact was emphasized in mid-December, when your *ASFE NewsLog* editor received an e-mail from *Engineering News-Record* with links to the top ten stories. How many of those stories involved geoprofessional issues directly or indirectly? You be the judge.

The first headline – "Gulf Oil-Spill Report Calls for Revamped Blowout Preventers" – focused mainly on the need to redesign offshore oil-well blow-out-prevention systems, which is only marginally a geoprofessional issue. But then we noticed this:

> Perhaps the most significant factor in the accident, the study authors conclude, was the decision to abandon the Macondo well temporarily despite the results of multiple negative pressure tests. Those tests showed that the cement put in place had not formed an effective seal or barrier to isolate hydrocarbons from the well bore.

We submit that any well-trained, properly motivated CoMET field

representative would have known that test results need to be acted upon, especially when they indicate unsafe conditions, statements like "It doesn't really matter," "Just this once," and "You're going to get us behind schedule and cost us a fortune," notwithstanding.

The next headline? "Legal Settlement To Force Completion of Chicago's Deep Tunnel." Were the issues just legal? Read the following quote:

> Most of the settlement adds legal teeth to the Metropolitan Water Reclamation District's latest construction schedule for the Deep Tunnel, which has been repeatedly delayed by funding woes and engineering hurdles. Officials broke ground on one of the nation's most expensive public works projects nearly 40 years ago.
>
> While the water reclamation district keeps working on two massive flood-control reservoirs, it will also be required to invest in more small-scale "green infrastructure" projects that allow storm runoff to seep into the ground rather than drain into sewers.

"Broad Array of Offshore Firms Provide Help at Fukushima" was the third headline. The story focused mostly on cooling-water filtration systems, which is not really a geoprofessional issue.

"Definitely not geoprofessional" would be an accurate assessment of the story behind headline four: "Federal Grand Jury Is Investigating Solyndra, Court Papers Show."

But not so with headline five: "Company Offers $1M Incentive to Finish Sherman Minto Bridge Repair Early." A quick read indicated that questions exist about the adequacy of post-construction bridge inspection – CoMET QA services – and the manner in which they were reported.

Headline six – "Design for Hanford Vit Plant Pretreatment Facility Completed" – seemed to involve nothing geoprofessional, until we read the article. The following excerpt is telling:

> The final design detailing the structural concrete for the Pretreatment Facility at the Hanford vitrification plant has been completed. The drawing represents the completion of the facility's concrete floors and results from more than 15,000 pages of calculations and 500 drawings. These calculations and drawings provide the details that enable crews to construct the massive concrete structure.

"Feds Move Closer to Approving New Nuclear Reactor" was the seventh headline. The story focused on the U.S. Nuclear Regulatory Commission's likely approval of the Westinghouse AP1000, a standard nuclear power plant design that is already in use outside the U.S. Clearly, using a preapproved standard design has benefits compared to developing a unique design each time. What the story failed to mention, however, was the need for effective site selection and foundation design no matter what design is required, and, of course, the high-level CoMET services needed to ensure that what's designed is what's built. And who will provide those essential site-specific services? Aha!

Headline 8 – "Brazil Prosecutors Seeking $10B From Chevron for Leak" – discussed oil leaking from an off-shore well and the environmental damage being caused. Geoprofessional all the way.

Headline 9 – "Family Files Lawsuit over Conn. Construction Worker Death" – involved a worker who fell from a roof as opposed to what we feared: a worker caught in a trench cave-in, a far more common occurrence. (U.S. Bureau of Labor Statistics data show that, from 2000 through 2006, 271 workers died in trenching or excavation cave-ins.)

The final listing – "Engineers Tease Data from Wreckage of Japan Tsunami" – was a video that showed structural engineers dispatched by ASCE checking building wreckage to learn what happened. Foundation deformation was a critical issue.

So, judge, what's your count? The way we see it, at least half of the headlined stories center on or at least involve geoprofessional issues; more-detailed reportage would have raised that number to eight. That's not too bad, especially considering that legal or regulatory issues were involved or alluded to in "only" six.

A Votre Santé

No matter what language you prefer, it's bound to have an expression used to toast to one's health, because – let's face it – without your health, just about everything else is meaningless. And it's no different for businesses, no matter what their size or specialty: Without health, they're doomed. And just as with people, by doing the right things to stay healthy, it's far more likely that you will, and for a long time, too. But take your health for granted, and who knows what can happen, often suddenly, without warning.

For ASFE-Member Firms, staying healthy is a challenge. But there's one step you can take to meet that challenge, if you have not done so already: Peer Review. It's like a business physical. You get checked out from top to tail by a team of dedicated, experienced peers who use their own reviews and input from client representatives and staff to make an assessment. Then they tell you what they've found and what they recommend. Think you know about everything that's going on in your "outfit"? Think everyone is telling you the plain, unvarnished truth as they see it? Think your firm cannot be any better than it already is? Think the Moon is made of green cheese?

What are you waiting for? Learn what others' experiences have been by ask-

ing them yourself. The folks who can tell you what a benefit they've recently realized are:

James M. "Jim" Handanyan, P.E.
Northeast Geotechnical, Inc.
North Attleboro, Massachusetts

Robert John "John" Byrne, Ph.D.
Ground Support, PLLC
Redmond, Washington

Business 101

Technology has made virtual teams far more common, if only to deal with many workers' desire to telecommute at least one or two days a week. Managing a virtual team is far different from managing a "real" team, however, creating new challenges for those who are far more comfortable with "old-school" situations. The virtual-team manager's challenge is to make the virtual team a real team, to achieve communication, cooperation, coordination, collaboration, innovation, and satisfaction.

In her book *A Manager's Guide to Virtual Teams*, author Yael Zofi identifies eight fundamental characteristics of high-performing virtual teams. Those who manage virtual teams could strive to achieve these characteristics:

- **Team members look outward** where they can identify a common goal. Once team members have a shared goal, they can share in development, refinement, and maintenance of the mechanisms needed to get from here to there. The process creates buy-in, mutual respect, and realization that a team effort will be required to get the job done sell.
- **Team members realize they all are vital** when it comes to achieving the common goal. They understand that they are mutually dependent, thus engendering the mutual respect that leads to self-respect within the team environment. Self-respect helps overcome the isolation that can otherwise occur in a virtual environment.
- **Team members value the candor needed to create an atmosphere of trust and authenticity,** thus helping to counter the miscommunication problems that are more frequent in virtual situations. Team members need to focus on behaviors, not personalities; all need to "walk the talk."
- **Team members exhibit a "can-do" attitude** based on the idea that, if everyone does what they are supposed to do when they are supposed to, all will share in project success. When conflicts occur, they should stem principally from the desire to get the job done well; i.e., differences of opinion about which approach will be best for all. In the case of other problems – e.g., failure to deliver X when due – the goal would be to establish a work-around rather than assign blame.
- **A project plan is essential**, especially when team members are geographically dispersed. All need to contribute to achieve a coordinated work plan designed to achieve the desired outcome ahead of schedule and under budget, thus creating cushion to account for issues that may not and/or could not have been considered in planning.
- **Team members have access to various technologies to enable the reliable information exchanges** need to achieve an easy information flow; all team members must have access to appropriate technology, too. The flow should rely more on "pulled" data (e.g., websites and e-bulletin boards) than "pushed" information (unfiltered e-mails and phone calls).
- **Team members hold one another accountable for communicating meaningfully**, in part by creating and maintaining protocols for when communication will occur (e.g., every X-many days or weeks and/or when certain millstones are reached) and the modes of communication that will be used. Team members should speak with one another synchronously at critical times, be they scheduled or unscheduled.
- **Conflicts, while inevitable, are kept to a minimum**, because they can rapidly erode the trust that is essential to smooth-functioning virtual teams. The virtual-team manager needs to be able to identify potential conflicts and work to deter their realization. When conflicts become real, the virtual-team manager needs to encourage positive outlooks and work to resolve the disagreement. Ideally, those who are in conflict should be able to resolve the matter on their own. The manager needs to follow up to ensure that is the case. The focus needs to be on what's best for the team.

Dr. English

Given that most geoprofessional instruments of professional service – proposals, reports, and messages delivered via memo, e-mail, and texts – rely on the written word, geoprofessionals need to be masters of their language. For that reason, the Fundamentals of Professional Practice program emphasizes proper language use. Everything participants write is reviewed and commented on, and "everything" includes e-mails that commonly begin with just the recipient's name; e.g., John. or Mr. Doe. The FOPP reviewer in those cases circles the salutation in blood-red ink and marks it "41A." The number refers to item 41A in the *You Need To Improve Your Writing Skills* guidance document that is part of the course. Item 41A states:

> In conventional correspondence, people usually write *Dear Name* followed by a colon (in business) or a comma (when the letter is more personal, like a thank-you

letter). For whatever reason, when people correspond by e-mail or fax, some folks just use a person's name as the salutation; e.g., *John,* and then hurry on with the message. Because many people regard *Dear* as a strange way to begin an e-mail, and because *Tom, Dick,* or *Harriet* seems brusque and unfriendly, try *Hi, Tom.,* or *Greetings, Dick.,* or *Good morning, Harriet.* instead. You can also dispense with a salutation and integrate the individual's name in an opening line; e.g., *I enjoyed speaking with you, Tom.* or *Congratulations, Dick. I heard about your….* or *As usual, Harriet, you hit the nail on the head when you….* The same would apply to a fax cover sheet, although the conventional *Dear Name* approach works okay, too.

After receiving a 41A instruction on his e-mail, that was also embellished with a large "RUDE!," a FOPP 21 participant wrote, "Suzy. I am not sure I understand what Mr. Bachner's issue is with using a person's name as a salutation in an e-mail. He seems to believe it is rude. In my experience it is the most common way of addressing an e-mail." John's response may be of value:

> Good afternoon, Joe.
>
> While using a brusque, unadorned greeting – Joe or Mr. Smith – may be the most common way of addressing e-mail, doing so eliminates your ability to create a friendly image while using a communications medium that all too often results in misunderstanding of one's attitude. Besides, in a world where geoprofessionals so often complain "We're treated as though we're all alike, like commodities," why would you want to do that which is common? Shouldn't you want to do things that are somewhat uncommon (in a good way), so you can at least differentiate yourself from your competition? Bear in mind that client representatives never see 97% of what your firm does for them. As such, little things do not mean a lot; they mean *everything.*

Dr. English concurs.

Editorial

After 43 years of existence, ASFE has nominated a female – Laura Reinbold, P.E. (*TTL, Inc.*) – to its Board of Directors. For most of us, it is and is not a big deal. In the "is" category, we could say, "Wow! We've finally ended the men's club. After almost a half a century, we'll have a woman serving on the Board." But on the "is not" side of the ledger, "What's so unusual? Laura's worked hard for ASFE and made some important accomplishments. That gives her the right to work even harder and contribute even more. That's the way it's always been, no matter whom they've nominated to the Board." And that's also true: The cream rises to the top; no big deal. But the "no big deal" attitude stems from what we've grown used to thanks to our society in general. As Americans, we're now accustomed to women doing today what they did not do even 20 years ago. We have also grown accustomed to other "minorities" doing today what they did not do "back then," like being president of the United States. But in the hallowed halls where associations like ASFE convene, you'd have every reason to believe otherwise. In fact, looking around, you'd no doubt be easily convinced that middle-aged white men comprise a huge social majority, and that perception, we submit, is something that cries out for change. We are, after all, a nation (*unum*) of diverse peoples (*pluribus*). The more we encourage that diversity in ASFE, the better our collective brain will be, if only because we'll have more ideas to select from, especially those that stem from perspectives and experiences that are far more diverse than they used to be. True, 200 middle-aged white guys are not all going to think alike. But also true, add some women to the mix; add some younger people; add people whose ethnic heritage is evident on their bones, and – voila – the idea pool expands, as does the notion that "we're all in this together."

Surely it can be said that the middle-aged white-guy "thing" is not the doing of ASFE or the geoprofessions. It's just that middle-aged white guys are overrepresented and others are underrepresented (although that underrepresentation may have been caused by factors uncomfortable to address). Besides, most of the firms represented at ASFE meetings actually strive for staff diversity. And that's an important issue, given that most of the people who represent those firms in ASFE are on the C level and so have the ability to influence, if not decide on, who will attend our get-togethers and who will not. It certainly would benefit ASFE to have more of those "diverse people" involved in the organization, at meetings and especially in committees, where diverse ideas produce better results. Those newly engaged in our organization would benefit, too, of course, and no doubt their ASFE exposure would benefit their employers. And who knows, as we help make the geoprofessions more welcoming, we may attract more people from different backgrounds; more diversity; more good ideas; more hands to pull the oars of progress. So, while Laura's nomination is no big deal in one sense, it could be a really big deal in another; not so much the ending of the past but the beginning of a truly bright new future. With your help, it will be.

From the bench

At the request of Cat Iron, Inc. (Cat Iron), Bodine Environmental Services, Inc. (Bodine) proposed to conduct a complete National Emission Standards for Hazardous Air Pollutants (NESHAPS) asbestos inspection of Cat Iron's about-to-be-demolished Intermet Facility in Decatur, Illinois, and to submit a comprehensive report of its

findings. The cost was not to exceed $6,100. Cat Iron signed the proposal on May 30, 2008, converting it to a contract that included the following limitation of liability (LoL) provision:

> Item 5. Limitations of Liability. The CLIENT [Plaintiff Cat Iron, Inc.] agrees to limit Bodine's liability to the CLIENT and all parties claiming through the client or otherwise claiming reliance on Bodine's services, allegedly arising from Bodine's professional acts or errors or omissions, to a sum not to exceed Bodine's fees for the services performed on the project, provided that such claims are not attributable to Bodine's gross negligence or intentional misconduct. In this latter event, the limit of liability will be increased to $25,000 less any applicable insurance amount covering alleged damages or claims. In no event shall Bodine or any other party to this agreement, including parties which may have claim to have a direct or indirect reliance on Bodine's services, be liable to the other parties for incidental, indirect or consequential damages arising from any cause.

Bodine initiated its services and submitted its report five weeks later. Cat Iron then hired Parkland Environmental Group to remove the asbestos. Soon after he arrived at the building, Parkland Vice President David Stowers met with one of Cat Iron's co-owners, Robb Davis, and pointed out to him close to 200,000 square feet of obvious asbestos-containing materials (ACMs) that Bodine failed to identify. Stowers spoke with one of Bodine's inspectors – Richard Evey – who allegedly said that he couldn't believe that Bodine's inspectors had missed so much, and admitted that Bodine "screwed up."

After what we can only assume were failed negotiations, Cat Iron sued Bodine in federal district court alleging damages in excess of $75,000 on each of four counts: (1) breach of contract; (2) breach of express warranty; (3) negligence (and, in the alternative, willful and wanton acts or omissions); and (4) negligent misrepresentation.

Bodine responded by seeking a partial summary judgment holding that the LoL explicitly limited Cat Iron's damages to $6,100 and, that being the case, the federal district court -- where controversies must involve $75,000 – lacked jurisdiction.

Cat Iron responded that the LoL – an exculpatory clause – should not be upheld because of Bodine's "willful and wanton or reckless misconduct," and because the provision violated Illinois public policy given that the state and federal government both expressed an interest in asbestos-related matters, especially the demolition of asbestos-laden buildings.

The first issue the court had to decide was whether or not the LoL was valid, and it had to do so (by virtue of the contract) according to Illinois law, whose precedents state, in essence:

> Barring fraud or wanton or wanton and willful negligence, exculpatory clauses are valid and enforceable unless: (1) there is substantial disparity in the two parties' bargaining position; (2) upholding the clause would violate public policy; or (3) something in the social relationship between the two parties militates against upholding the clause.

According to the court, "Here, the damages limitation clause would on its face appear to be valid. Both of the parties involved are sophisticated corporate entities, so there is no disparity in bargaining power, and there is no evidence of a fraud." The court went on to note that "willful and wanton acts show an actual or deliberate intent to harm or, if not intentional, an utter indifference to or conscious disregard for a person's own safety or the safety of others….Whether conduct amounts to willful or wanton conduct is usually a question for the jury." Because Cat Iron alleged willful and wanton or reckless misconduct, and because – when it comes to motions for summary judgment – the court must accept "facts in a light most favorable to Plaintiff… the court finds that Plaintiff has successfully plead *[sic]* willful and wanton misconduct." Accordingly, the court ruled on September 28, 2010, "Plaintiff has adequately argued, at this stage of the proceedings, that the damages limitation clause as it applies to willful and wanton misconduct in limiting gross negligence or intentional misconduct claims to $25,000 is invalid. Therefore, as Plaintiff has plead *[sic]* that the alleged reckless conduct…caused damage in excess of $75,000, the court finds the jurisdictional requirement has been met. Defendant's Motion for Partial Judgment on the Pleadings and Motion for Dismissal for Lack of Jurisdiction is DENIED."

Bodine was not deterred. In preparing to file an amended motion for summary judgment, which it subsequently did on February 24, 2011, it filed a Federal Rule of Civil Procedure 30(b)(6) Notice of Deposition, requesting that Cat Iron "designate and produce one or more officers, directors, managing agents, or other persons knowledgeable to testify in detail" about "all facts upon which Cat Iron bases its allegation that Bodine Environmental Services, Inc., engaged in willful and wanton misconduct in allegedly failing to identify or report certain-asbestos-containing materials"…and the "nature, duration, and scope of Cat Iron's investigation in obtaining the facts to support its allegation that Bodine Environmental engaged in any willful and wanton misconduct while working on the Intermet project."

Cat Iron produced Robb Davis to testify at the January 18, 2011 deposition. There, Bodine's attorney repeatedly asked Davis about the facts Cat Iron used to support its willful and wanton misconduct allegations. According to

the court, "The answers provided by Davis, subject to [Cat Iron's] counsel's objections, time and again, stated that Davis was not aware of any facts that supported Plaintiff's claim that Defendant's actions were willful and wanton. Davis said he did not have any facts that Defendant acted with conscious disregard for Plaintiff's business plans with regard to the Decatur facility. Davis also stated that Plaintiff does not know what Defendant's motives 'were or were not' in doing the inspection. Further, Davis and Plaintiff did not have any facts in its possession to show that Defendant acted intentionally or with reckless disregard in failing to allegedly identify all of the asbestos containing material at the Decatur building."

Based in part on Davis' testimony, Bodine's amended motion sought summary judgment on three grounds: (1) Cat Iron admitted it had no facts to support wanton and willful misconduct by Bodine, thus making the LoL enforceable and depriving the federal district of jurisdiction; (2) Cat Iron's claim was for commercial losses only, not threats to health or safety, thus defeating any claim for wanton or willful misconduct; and (3) the economic-loss doctrine barred Cat Iron's negligence claim.

In response, Cat Iron disputed the three grounds and continued to argue that the LoL violated public policy. But the court did not look favorably on the public-policy contention. It said, "Plaintiff has not specifically cited an Illinois statute or case prohibiting a damages limitation provision in a contract relating to asbestos removal. This court must follow established Illinois law, and will not fashion such a rule in federal court for the first time."

As for Bodine's claim that the Illinois economic-loss doctrine (called the Moorman Doctrine there) barred the negligence claim (a tort) because plaintiffs cannot recover for purely economic loss under a tort theory, the court noted that negligent misrepresentation "by a defendant in the business of supplying information for the guidance of others in their business transactions" constitutes an exception, and Cat Iron was alleging negligent misrepresentation. However, the court also noted that "the only claim keeping this case in federal court is Plaintiff's…negligence claim asserting willful and wanton conduct on the part of Defendant. Under Illinois law, exculpatory clauses are generally valid and enforceable, "barring fraud or wanton and willful negligence." Therefore, if Plaintiff cannot show a genuine issue of material fact as to the wanton and willful negligence claim…, those claims will be dismissed, the damages limitation clause will apply, limiting Plaintiff's damages to $6,100, and the case will be dismissed for lack of federal subject matter jurisdiction. Thus, the court will only consider the economic loss doctrine's application to the Count III negligence wanton and willful claim."

The court went on to note, "For the same reasons articulated above on why the court will not apply the economic loss doctrine, the court will not grant judgment on the wanton and willful claim because Plaintiff cited to only commercial losses. Again, the Illinois Supreme Court has held that asbestos, by its very nature, is a uniquely dangerous substance. Implicit in cases involving asbestos removal is a threat to health and safety. The court will not grant judgment on the wanton and willful claim on the issue of commercial losses. This does not mean, however, that because this court declines to apply the economic loss doctrine and declines to find that Plaintiff alleged only commercial losses in its wanton and willful negligence claim that the damages limitation clause is vitiated. The damages limitation clause will apply and thus deprive this court of subject matter jurisdiction unless Plaintiff can show a genuine issue of material fact exists as to whether Defendant's actions or omissions constituted negligence in a wanton and willful manner."

And then came the kicker: "Defendant argues that, since Plaintiff's Rule 30(b)(6) representative stated, under oath, that Plaintiff had no facts to support those allegations, it cannot sustain a claim for the alleged conduct.

"Plaintiff counters that the evidence from the deposition is not admissible because defense counsel's questions to Davis elicited 'opinions phrased in terms of inadequately explored legal criteria.' To answer the questions, Plaintiff argues, Davis had to form a legal opinion on the topic of willful and wanton misconduct and then make legal conclusions based on his own definition instead of basing it on clearly defined legal criteria. Without this evidence, Plaintiff argues, Defendant's motion must be denied."

The court then cited a variety of precedents to support its conclusion (citations deleted): "The Notice informed Plaintiff that Defendant sought a deponent who could testify as to 'all facts' upon which Plaintiff based its allegation that Defendant acted in a 'wanton and willful' way in failing to identify or report certain asbestos containing materials. Further, while it is true that Davis, Plaintiff's co-owner and the Rule 30(b)(6) designee, was not a lawyer, the term 'wanton and willful' is not such a legal term of art that Davis could not understand what it meant or is in some way incomprehensible to a layperson, and at least one court has allowed Rule 30(b)(6) designees to testify as to what facts supported a claim of wanton and willful misconduct. Therefore, the court will allow in as evidence in the motion for summary judgment, over the objection of Plaintiff's counsel, the testimony given at the Rule 30(b)(6) deposition that Davis has no knowledge of any facts to support Plaintiff's claim of wanton and willful misconduct. However, the court does not find that this testimony necessarily results in judgment for Defendant on Plaintiff's claim of wanton and willful

misconduct. Rule 30(b)(6) testimony can be used as evidence, but not a judicial admission that ultimately decides an issue, and the court will not hold Plaintiff as absolutely bound to the designee's recollection. The court will consider Davis's statements in support of Defendant's motion for summary judgment, but allow Plaintiff to rebut those statements with competent evidence."

The court then ordered that its ruling would be "reserved on whether a genuine issue of material fact exists as to wanton and willful negligence on Defendant's part. If it is shown that a genuine issue of material is present, the damages limitation clause is void, pursuant to Illinois law, and the case may continue. If no genuine issue of material fact exists, the limitations clause applies, limiting damages to $6,100, and this court will be deprived of subject matter jurisdiction."

Cat Iron filed its supplemental brief on October 7, 2011. According to court records, "Plaintiff included the following facts to support the willful and wanton negligence claim: (1) Defendant failed to identify all ACMs located at the Intermet Facility; (2) some of the ACMs that were not identified by Defendant were easily identified by Stowers after he arrived at the facility to begin asbestos remediation; (3) the areas of asbestos found by Stowers, which included exterior walls and accessible rooftops, were large, visible and accessible; and (4) after Stowers pointed out what the ACMs looked like to Davis, Davis was personally able to identify similar ACMs at the Facility." Additionally, Stowers in his affidavit commented, "For an experienced inspector to miss this many square fee of visible and accessible ACMs was either intentional or the inspector acted with incompetence, or with an extreme departure from the applicable standards. Richard Evey, the inspector from Bodine, told me he could not believe they missed this much. He admitted that Bodine screwed up."

Bodine filed its reply on October 14, 2011, arguing that Stowers' opinions were not evidence, and that the actual, admissible evidence fell far short of establishing that Bodine acted in a willful and wanton manner.

In deciding the matter, the court explained that two types of willful and wanton conduct exist in Illinois – intentional or reckless – and that the two "are distinguishable based on the mental state of the defendant." Intentional willful and wanton conduct occurs when the defendant's action or omission is committed with an actual intent to harm. Reckless willful and wanton conduct is committed with "utter indifference" to or "conscious disregard" for the property or safety of others. Additionally, Illinois case law indicates a defendant's failure to follow the standard of care is enough for a fact-finder to find the defendant's conduct willful and wanton. In that case, however, allegations must be supported by admissible evidence – such as that provided by an expert – that the defended failed to adhere to the standard of care.

The only really damning "evidence" that Cat Iron could provide was Stowers'. But, said the court, "Stowers is not an expert, and even if he was, he failed to provide sufficient explanation of how he arrived at his opinion that Defendant acted intentionally, incompetently, or with an extreme departure from applicable standards. Stowers did not explain what standards he was referring to and certainly did not list the specific standards that the Defendant failed to follow. Therefore, Stowers' opinion will not be considered by this court, because it is an inadmissible, speculative opinion provided by a fact witness."

The court went on: "In this case, it is clear that the Plaintiff has failed to offer any admissible evidence supporting a finding that Defendant was either intentionally or recklessly willfully and wantonly negligent.… Although it is true that a departure from the applicable standard of care is sufficient for a fact-finder to find that the defendant's conduct is willful and wanton, Plaintiff offered no admissible evidence which either established the applicable standard of care or… that demonstrates that Defendant was careless or reckless in preparing its report. Therefore,.… summary judgment is granted in part with regards to Plaintiff's claim based on willful and wanton negligence" meaning the LoL "remains valid and operates to limit the available damages in this case to $6,080. Although the amount in controversy at this point of the litigation fails to exceed $75,000, as required for federal diversity jurisdiction, this court disagrees with the Defendant that dismissal of this case is now mandated." And then it went on to rule.

"After granting partial summary judgment in favor of the Defendant on the willful and wanton negligence claim, the Plaintiff's remaining claims are as follows: (1) breach of contract; (2) breach of express warranty; (3) ordinary negligence; and (4) negligence misrepresentation. However, as determined by this court, any damages that Plaintiff may recover on these four remaining claims will be limited to a combined total of $6,080 – the fees charged by the Defendant for the services performed at the Intermet Facility – because of the impact of the limitation of liability clause contained in the contract entered into between the parties." *Cat Iron, Inc. v. Bodine Environmental Services, Inc*. (United States District Court, Central District of Illinois, Urbana Division, Case No. 10-CV-02102)

Observations/speculations by the editor (who is not an attorney)

- The plaintiff did not suffer any real damages that we're aware of. Bodine may have performed poorly, but the cost to remove the asbestos would have been the same even if Bodine had found every scrap. This seems to be a classic case of a plaintiff equating disappointment (having to pay

more than anticipated) with being damaged (paying money for nothing). Bodine likely would have made such arguments had the case gone to trial. Did the company try to make such points before then?

- Be mindful of how long it takes to resolve these disputes and how much money. The $6,080 limit was no doubt a pittance compared to the cost of legal defense and the value of billable time spent. While Bodine can claim "We won," the fact is it simply lost less – maybe a lot less – than it otherwise might have. Cat Iron likely would have lost nothing at all were it not for the fact it decided to sue.
- Plaintiffs generally argue that LoLs should not be upheld because: they are against public policy; the firm involved was willfully, wantonly, recklessly, or grossly negligent; or the firm committed fraud. These arguments seldom prevail.
- It's somewhat surprising that a limit as low as $6,080 was upheld. The man who conceived the idea of LoL for geoprofessionals and others – Ed Howell – convened a national panel of attorneys to suggest an appropriate limit. They suggested $50,000 – in 1970!
- Knowing that one can in Illinois infer "willful and wanton misconduct" from simply failing to uphold the standard of care, and knowing that expert testimony is needed to establish what the standard of care was, why didn't Cat Iron have an expert testify? It would not have been too difficult to prove that missing 200,000 square feet of ACM constituted a failure to uphold the standard of care. Of course, for negligence to have occurred, it has to be shown that the failure to uphold the standard of care damaged the plaintiff. See bullet one.

Human resources management

"Phantom praise." That's how a young geoprofessional described what he perceived as unexpressed praise. "They give you a good bonus, which is nice, but they seldom come out and say, 'Great job' or words to that effect. I know they must be thinking that and that they appreciate my contributions; that's what the bonus is for. But you'd think…."

Yes, you'd think that geoprofessionals who toil in praise-free zones would be eager to dole out praise when they arrive in a position to do so. Regrettably, many don't and even those that do may not do the best job of it. All of which may explain who so many geoprofessionals who leave one firm for another explain their move by saying they weren't appreciated by their former employer.

Some employers make sure they dole out praise by creating an easy-to-implement, formulaic employee-of-the-month program. The programs aren't bad, but their benefits are extremely limited, given that praising employees should:

- reward their efforts and accomplishments,
- reinforce positive behaviors,
- boost their confidence and self-esteem, and
- build their motivation and enthusiasm.

So how do you praise employees so they and you get maximum benefit? Consider these five possibilities, and note that each has one key element in common.

1. Ask for help. Asking for help is an act of vulnerability: It's admitting to the person you ask that you have a weakness of some kind or lack a certain skill. As such, by asking, you demonstrate trust while also showing that you respect the other person's skills or intellect, especially when the help you need is only somewhat (or not at all) related to the other person's job. Consider this anecdote contributed by a branch manager who attended a meeting "at corporate," where the subject was lay-offs. The branch manager was opposed and tried to win others to his way of thinking, to no avail. By the time he returned to his own office, word had spread. "So, we're going to have lay-offs," an employee said to him, to confirm the rumor's truth. "I hate it, but that seems to be what's best for the company," the branch manager replied. "I don't know how I'm going to tell the troops. Do you have any ideas?" The employee thought about it and then said, "Tell them the truth and then let them know where we go from here." The branch manager did exactly that and, later, the employee told him how much it meant that he had asked and that he followed the advice.

2. Ask for ideas. This is similar to asking for help in that it's best to ask for ideas for improving functions the employee doesn't perform. In other words, instead of asking, "What are your ideas for performing your work faster?" try, "You always meet or beat your deadlines. I don't know how you do it. But we continue to have problems in getting our bills out on time. How'd you like to take a look at the process we use and maybe come up with some suggestions?" Doing this could result in the development of some good ideas, and it also says, "We think you're so good at doing something, we want you to use it elsewhere in the company." That's a pat on the back that a pat on the back cannot duplicate.

3. Assign a short-term leadership responsibility. Assigning a short-term leadership responsibility tells a person that you trust the individual's skill and judgment. The more important the task, the more significant the praise and self-esteem boost. As an example, "We're having a problem with a major activity for a major client, Jim. I can't get to it; I don't have enough time. Can you take two people and figure out what needs to be done?"

4. Do something together. You and your employees do not have the same standing; you're the boss and they're not. As a result, you can recognize

an employee's value by offering to do something together, as equals. For example, you might say, "I'm attending a writing seminar so I can improve my proposal-writing skills. Would you be interested in going with me?" This is flattering to the employee because the company wants to invest in the person's skills improvement, and because it regards the employee as someone who will be writing proposals.

5. Let people name their own reward. Rather than giving a standard this or that for work well done, ask people what they want; e.g.: "You did an amazing job on that Foley project. What can I do to reward you?" Doing this can be scary, but it demonstrates trust. And more often than not, the reward sought is not that grandiose, but it does have real meaning to the person that deserves it.

What's the common element in each of the five? Each uses a different means to say, "I trust you." That can be powerful praise indeed.

You've just got to be kidding

Let's hear it for the late Philip A. "Phil" Contos, of Parish, NY, an avid Harley Davidson fan and an even more avid opponent of mandatory motorcycle-helmet laws. Combining his love and hate, Phil decided to join fellow members of the NY chapter of American Bikers Aimed Towards Education (ABATE) in a bare-headed, Saturday, July 2, Independence Day-weekend ride to protest what he regarded as an infringement of his inalienable right to experience a serious-but-avoidable head injury and lay comatose in a hospital for 20 years at taxpayers' expense. Phil climbed aboard his 1983 Wide Glide and was off, heading south on Route 11 in Onondaga, the wind in his face. Not too much later, at 1:30PM, Phil hit the brakes for reasons unknown, causing his bike to fishtail. Phil lost control, went over the handlebars, hit his head on the pavement, and died on the spot. According to State Trooper Jack Keller, evidence at the scene and information from the attending physician indicated that Phil would have survived had he been wearing a Department of Transportation-approved helmet.

Road warrior

There seems to be no such thing as a standard airplane seating layout. Each airline decides its own design. So how do you know what the best seats are? Simple: http://www.seatguru.com/. Just insert the name of your airline and the flight number, and you'll learn how your plane is configured and so, where to sit. Face it: Every little bit helps!

Thought for the issue

Cheap geoprofessional services can be expensive.

Philadelphia courts named "top judicial hellhole"

Philadelphia's civil courts comprise the nation's worst "judicial hellhole," with courts in California coming in second, followed by West Virginia's in third, according to the new *Judicial Hellholes 2011-12* report issued by the American Tort Reform Association (ATRA), a group ASFE helped found in 1986. ATRA accorded fourth place to South Florida's courts, perennial all-stars thanks to the dedicated work of the area's well-known auto-accident fraud racketeers.

Two neighboring counties in Illinois – Madison and St. Clair – combined to make a triumphant return to the hellhole list, in fifth place, after recent civil-justice reform efforts there stalled. New York City and Albany collectively took sixth place, thanks to a never-ending stream of petty lawsuits and personal-injury lawyers who block reform. In seventh, Clark County, Nevada, earning its recognition because of "an ongoing half-billion-dollar miscarriage of justice, which, at the very least, has contributed to spot shortages of a widely used anesthetic." And in eighth – making it to the list for the first time (*drum-roll please*) – McLean County, Illinois, which adopted a novel asbestos-liability theory that makes it unnecessary for plaintiffs to show they were actually exposed to a defendant's product.

The report also includes "dishonorable mentions," with the top accolade going to "an astounding Mississippi Supreme Court decision that creates unprecedented product liability for defendants that never manufactured or sold to consumers the products in question." Also criticized: an Arkansas Supreme Court ruling that strikes down the state's statutory limit on punitive damages and Missouri appellate court decisions upholding "a shameless class-action coupon settlement first reported last year."

But it's not all gloom and doom! According to ATRA president Tiger Joyce, "This year's report, more so than any other in the past, also emphasizes a boom in *good news* from the states with an expanded Points of Light section. Nearly 50 positive tort reform laws were enacted in more than 20 states throughout 2011." Why? "As anemic economic growth and high unemployment continue to plague much of the country, many governors and state legislators were determined to make their states more competitive and attractive to employers. A variety of tort reform measures figured prominently in these policymakers' pro-growth, job-creation agendas," Joyce said, citing new, comprehensive reform packages in Wisconsin, Tennessee, Alabama, and North Carolina.

Hand-held device can quickly assess concrete structure's integrity, Alizadeh says

Aali Alizadeh, the 33-year-old CEO of **Giatec Scientific**, says that he and his team have created a hand-held device engineers can use to quickly assess the structural integrity of concrete buildings and other structures. The device

takes chemical samples when it's connected to a piece of exposed rebar and the concrete structure itself. The samples are then computer modeled to assess the structure's integrity, particularly with respect to the condition of the rebar. Rebar often rusts after years of exposure to road salt or sea water, Alizadeh explained, noting that, when the rebar rusts it can expand by up to six times its original diameter, breaking the concrete apart.

Giatec's technology is based on almost ten years of research at the University of Ottawa, where Alizadeh studied, and Carleton University, where his partner, Pouria Ghods, studied. The two have won awards from the Ottawa Centre for Research and Innovation for their research in the field. Patents for the pair's work are pending.

Alizadeh is already offering units for sale in 2012, reportedly for for $10,000-$15,000.

The company is also working on wireless sensors that could be located on the sides of bridges, overpasses, et al., to monitor structural integrity remotely.

Building green: fad or future?

Think that building green is just a passing fancy? If so, you have another think coming: The U.S. Green Building Council (USGBC) on August 31st announced certification of the 10,000th LEED commercial project; the Live Oak Family Resource Center in Santa Cruz, CA (LEED Platinum). More than 1.4 million square feet of new and existing buildings are LEED-certified *every day*. According to "the founding father of LEED" Rob Watson, CEO and chief scientist of the EcoTech International Group, "Milestones like this – 10,000 buildings or the soon-to-be 2 billion square feet of certified floor area or the imminent cumulative 10 billion square feet of projects registered and certified – show the incredible impact that LEED has had on the building market." GBCI is not at all the only player in the green game, but it seems to be a good place to start! www.gbci.org

Is there a PEO in your company's future?

The nation's 300 or so PEOs already employ as many as 3 million people and the number is growing. Will a PEO benefit you? Maybe. The acronym stands for professional employer organization, also known as an employee-leasing company, and it functions to handle a variety of HR administrative duties – like administering benefits and processing payroll – thus making your business life that much simpler. In essence, a PEO hires all your company's employees (you included), then "leases" them back to your company. Because the PEO is likely to employ thousands of people, it probably can offer better and less costly insurance options to your staff. By the same token, however, you may not have a choice about the health insurance and other benefits offered. That's just one of the issues you need to discuss when selecting a PEO. Others, suggested by the National Association of Professional Employer Organizations (NAPEO; **www.napeo.org)**, include:

- Identify PEOs that serve your area Review their websites to learn about the services they offer.
- Identify and list the services you might be interested in.
- Identify the PEOs that seem the most promising. Check the history and reputation of each. Find out how long each has been in business. Speak with colleagues to learn what people are saying about the company.
- Contact each of the candidate PEOs. Ask for references. Require that the references be individuals who are associated with a current client of the PEO.
- Speak with the references. Ask how long they have worked with the PEO and whether or not they worked with another one previously. If so, what was its name and why did they switch? Inquire about the services they obtain and how well the PEO responds to problems and situations your business might face.
- Ask to meet with a PEO's representatives at the PEO's offices. Insist that those representatives include the specific people you would be working with.
- Ask how employee benefits are funded and what benefits are offered.
- Make sure the company meets all the requirements set by your state.
- Have an attorney review any contract offered. Does it clearly lay out your and the PEO's responsibilities and liabilities? What guarantees does the PEO provide? Under what situations can you or the PEO cancel the contract, and are there fines or penalties for doing so?

On copyright and bureaucratic correctness

Bengt H. Fellenius

When we submit a manuscript to a journal, we always have to sign over copyright to all the illustrations, i.e., photos, figures, diagrams. We consent to sign lots of little things like that, whether it is sending a child to a hockey practice or swim team, or other extracurricular activity, so why not also the right to reproduce the figures of our paper? The form to sign is long, but that's only legalese, right?, so we do not see any problem in essentially giving the journal the power to do just about anything they'd want with the figures, now and "for perpetuity". Nobody minds that the journal publishes and reproduces our paper. We'd mind if they did not! So, the more that body, to whom we give over the right, publishes and exposes our work, the happier we are. But, what about our own rights?

Well, the American Society of Civil Engineers (ASCE) uses a form that states: *"The undersigned author retains the right to revise, adapt, prepare derivative works, present orally, or distribute the work provided that all such use is for the personal noncommercial benefit of the author"*. Covers all desired and more, eh?

The Canadian Geotechnical Journal (CGJ) uses a form stating: *"Ownership of the copyright in the material contained in the Manuscript remains with the Author, provided that, when reproducing the Manuscript or extracts from it, the Author acknowledges and references publication in the Journal"*, and a little bit further along in the legalese the right *"to reuse all or part of the Manuscript in other works created for noncommercial purposes, provided the original publication in an NRC Press journal is acknowledged through a note or citation in a format acceptable to NRC Press"*. In effect pretty well what the ASCE lets us retain.

So, would anyone have a problem with this? Perhaps not, but the proof of the pudding lies in the eating. What many do not realize is that, by signing over the copyright, we do not own our material any longer. Obviously, we are free to use and re-use it for any non-commercial purpose. Note the ASCE words with regard to the rights of the author: *"to reuse for personal non-commercial benefit of the author"* and the NRC Press *"to reuse for noncommercial purposes"*. However, where they catch us is in the *"noncommercial"*. Most journals are entities for-profit, i.e., commercial enterprises, so re-using, say a photo, that was published in the CGJ in paper submitted to the ASCE Geotechnical Journal, means that the figure is being re-used in a commercial context. Therefore, we are required to obtain proof of permission to re-use from the publisher of the first paper (CGJ), to be presented to the second publisher (ASCE), and the soacquired permission has to be indicated in the manuscript. The issue is not our rights, commercial or otherwise, it is the commercial right of the legal owner of the property, the Journal having published the figure the first time.

It does not matter whether an image to re-use is from the author's own previous paper or from that of some other person, the figure is owned by the journal that published the paper, and, in addition to stating the source of the image (done by standard publication reference), permission for reuse has to be obtained and proof of permission has to be provided to the for-profit Journal that is going to publish the new paper. Note, your paper will not be accepted with re-used images, unless you obtain a permission to reuse and submit this to the publisher. I have just had the experience of serving as an assistant editor to a book to be published by the ASCE, where I had to convince more than one author (with senior company position) that I was serious in my request that he provide a letter signed by himself that permits himself to use a diagram from his company report in the paper authored by himself. More than a couple of the authors, when asked to arrange for the permission for re-use of a figure from an earlier paper, replied—generously—that *"I wrote that paper and I permit the re-use of the figure"*. They are not lying, they did write the paper, but they do not own the rights to re-use the figures. There's more to reality than political correctness. Bureaucratic correctness, for instance. We have to learn to live with both.

The rules for reuse apply to all previously published material, including photographs. Of course, between the well-established professional journals, this is little bother. The CGJ, for example, has an efficient on-line procedure. What's a half-an-hour of time compared to the 100 hours of productive work that went into the writing of the new paper? However, when the previous publication was in

less common publication, say a trade magazine, obtaining the permission sometimes becomes less simple. Such magazines often want to cash in on the publicity by asking for an acknowledgment running at the figure caption with complete reference that contains one or two lines of text in the figure caption (in addition to the source listing in the References section of the paper). That may require two extra lines for each such figure. Rightly, authors may find a series of such extra lines undesirable, as they may impact the fitting all of the material to the length limit assigned for the paper. But the magazine has the right to demand it. Before permitting the re-use of an image, some magazines require that a copy of the image in question is forwarded for their review and verification that it is not changed; in some cases also that a little processing fee be provided—they are commercial entities, after all.

Still a minor problem. More awkward is that when using, say a diagram from an article in a magazine that now has ceased to exist. Their copyrights still exist, however, but how does one locate the owner of the rights so a permission can be solicited? In the US, most organizers of conferences require the authors to grant the conference to publish the paper in a proceedings. As the forms are more or less shortened or expanded versions of the ASCE form, the effect is that the author has signed away the commercial right. The problem is that if the author a few years after the conference was held wants to use a figure from a proceedings paper, where do you establish whether or not the proceedings are under commercial copyright, and, if they are, where do you find the rights holder who could be asked for the permission? Material produced by government—taxpayer money—are not under copyright, and copyright cannot be created by using a such figure in a paper, so re-use is allowed. It is sometimes difficult to establish that the figure you want to use is one of those, however.

Actually, a conference does not have to be that far back in time to make it next to impossible to locate the person in charge who can issue the permit. And, how does one prove that the issuing person does have that authority? Really, the organizers of ad-hoc conferences should seriously consider following the lead of the Canadians: With regard to copyrights, for papers submitted to an Annual Conference, the Canadian Geotechnical Society commendably limits the subject matter to requesting that the authors permit the conference to publish the paper, leaving the copyright with the authors, stating: *In assigning the rights and permissions to the Conference/CGS, copyright for the paper remains with the author(s).* Therefore, once the reference of source is indicated in the caption as a paper to a CGS conference, the issue is resolved for figures you produced yourself. However, if you use that figure again, make sure that the figure caption indicates the original (the first) use of the figure as the source.

How do we best cope — I almost write "fight back"—with the permission to re-use requirement? Well, regarding photos, in this age of digital photography, it is easy to take, and store, more than one photo of an event. More often than not, you will find a duplicate photo in your files. Using it instead of re-using the previous photo will let you always to identify the image in your manuscript as "author's photo" not used before. The attitude that *"as it is not clear who took or owns the photo, I call it mine to use"* is not satisfactory from legal and ethics point-of-view, as I was carefully lectured about during my brief bout as assistant book editor.

Want to re-use a previous diagram? Well, you have the data, so just replot the figure with whatever adjustment of the axes, symbols, etc. you find suitable. Then, don't reference the previous paper by indicating it as the "source of the figure", but as the "source of the data". Write in the caption: *"data from Migsjälv A. et al. (year)"* per standard style. It satisfies the requirement for indicating the source of the data (the previous paper) and it establishes you as a creator of the diagram. There is no difference in this regard whether the image is a previous figure in a paper you wrote or one from a paper that somebody else wrote. You are always allowed to use published data. So, if the previous paper is by somebody else, scan the figure into an image, then, digitize the image to extract the data, and, finally, plot the data so-extracted. I use a commercially available software called "Didger", marketed by Golden Software. With it, a graph containing one or two curves with, say, five or eight points each, I can digitize into a text file in five minutes. It will take me another five minutes to import the text file to Excel and produce a graph for my paper. The effort of time invested in less than that required to compose a letter requiring permission to reuse and then to provide proof of the permission to the Journal. You know, particularly for a figure from the olden days when a trained draughtsman plotted the figures, I can get the data in sixteen decimals, whereas the draughtsman worked from at the most two. And, if the figure is from later days, my plot is probably a good deal neater than the original image.

The Canadian Geotechnical Journal papers can be download for free by members of the CGS, which means that when you want to use a figure, you can get a print screen from a high quality pdfformat electronic version to digitize, rather than by scanning it from the annotated multi-generation xerox copy in your files. (If you want to re-use the image rather than extracting the data, you do need to get that on-line permission, though). In contrast, you have to pay $25 for every paper you want to download from the ASCE Journal or pay a substantial one-shot annual fee (I'd be quite surprised if the costs of managing that is covered by the income generated).

Be careful when you use figures from the Web. Many of them are not under copyright, but some are. It is almost impossible, always time-consuming, to prove that a particular illustration is not under copyright. You can always use a figure from Google Map if you keep the Google logo and the ©-sign. However, some Google Earth figures do have copyright and getting permission to use may be a bit time-consuming. Note, if a figure, a photo, or a drawing is older than 75 years, the original copyright has expired and the figure is in the public domain. But make sure that the re-use is an image from the original oldie and not a younger reproduction that might have re-created a copyright.

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Estimating the Soil–Water Characteristic Curve using Grain Size Analysis and Plasticity Index

Gustavo Torres Hernández

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The infrastructure is built in Unsaturated Soils. However, the geotechnical practitioners insist in designing the structures based on Saturated Soil Mechanics. The design of structures based on unsaturated soil mechanics is desirable because it reduces cost and it is by far a more sustainable approach.

The research community has identified the Soil–Water Characteristic Curve as the most important soil property when dealing with unsaturated conditions. This soil property is unpopular among practitioners because the laboratory testing takes an appreciable amount of time. Several authors have attempted predicting the Soil–Water Characteristic Curve; however, most of the published predictions are based on a very limited soil database.

The National Resources Conservation Service has a vast database of engineering soil properties with more than 36,000 soils, which includes water content measurements at different levels of suctions. This database was used in this study to validate two existing models that based the Soil–Water Characteristic Curve prediction on statistical analysis. It was found that although the predictions are acceptable for some ranges of suctions; they did not performed that well for others. It was found that the first model validated was accurate for fine-grained soils, while the second model was best for granular soils.

For these reasons, two models to estimate the Soil–Water Characteristic Curve are proposed. The first model estimates the fitting parameters of the Fredlund and Xing (1994) function separately and then, the predicted parameters are fitted to the Fredlund and Xing function for an overall estimate of the degree of saturation. Results show an overall improvement on the predicted values when compared to existing models. The second model is based on the relationship between the Soil–Water Characteristic Curve and the Pore-Size Distribution of the soils. The process allows for the prediction of the entire Soil–Water Characteristic Curve function and proved to be a better approximation than that used in the first attempt. Both models constitute important tools in the implementation of unsaturated soil mechanics into engineering practice due to the link of the prediction with simple and well known engineering soil properties.

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Carbonate Diagenesis and Chemical Weathering in the Southeastern United States: Some Implications on Geotechnical Behavior

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The Savannah River Site (SRS) deposits in the Southeastern US between 30-45 m of depth are calcium carbonate-rich, marine-skeletal, Eocene-aged sediments with varying clastic content and extensive diagenetic alteration, including meter-sized caves that coexist with brittle and hard limestone. An experimental investigation including geotechnical (P- and S-wave velocities, tensile strength, porosity) and geochemical (EDS, XRD, SEM, N2-adsorption, stable isotopes, K-Ar age dating, ICP-assisted solubility, groundwater) studies highlighted the contrast between hard and brittle limestones, their relationship with cave formation, and allowed calculation of parameters for geochemical modeling. Results demonstrate that brittle and hard limestones bear distinct geochemical signatures whereby the latter exhibits higher crystallinity, lower clastic load, and freshwater-influenced composition. Results also reveal carbonate diagenesis pathways likely driven by geologic-time seawater/freshwater cycles, microorganism-driven micritization, and freshwater micrite lithification. The SRS surface soils are largely coarse-grained and rich in iron oxides with various degrees of maturity. These soils were simulated in the laboratory using Ottawa sands that were chemically coated with goethite and hematite. Surface (SEM, AFM, N2-adsorption) and geotechnical properties (fabric, small-strain stiffness, shear strength) were investigated on the resulting "soil analog". Results indicate that iron-oxide coated sands bear distinct inherent fabric and enhanced small-strain stiffness and critical state parameters when compared to uncoated sands. Contact mechanics analyses suggest that iron oxide coatings yield an increased number of grain-to-grain contacts, higher surface roughness, and interlocking, which are believed to be responsible for the observed properties.

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Soft Computing Based Spatial Analysis of Earthquake Triggered Coherent Landslides

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Earthquake triggered landslides cause loss of life, destroy structures, roads, powerlines, and pipelines. Even though future earthquakes can hardly be predicted, the identification of areas that are highly susceptible to landslide hazards is possible. For geographical information systems (GIS) based landslide hazard analysis, the grid-cell approach has been commonly used in conjunction with the relatively simple infinite slope model. The infinite slope model together with Newmark's displacement analysis has been widely used to create seismic landslide susceptibility maps. The infinite slope model gives reliable results in the case of surficial landslides with depth-length ratios smaller than 0.1. On the other hand, the infinite slope model cannot satisfactorily analyze deep-seated coherent landslides. In the case of coherent landslides, two- or three-dimensional models are required to accurately analyze both static and dynamic performance of slopes. These models are rarely used in GIS-based landslide hazard zonation because they are numerically expensive compared to one dimensional infinite slope models. Building metamodels based on data obtained from computer experiments and using computationally inexpensive predictions based on these metamodels has been widely used in several engineering applications. With these soft computing methods, design variables are carefully chosen using a design of experiments (DOE) methodology to cover a predetermined range of values and computer experiments are performed at these chosen points. The design variables and the responses from the computer simulations are then combined to construct functional relationships (metamodels) between the inputs and the outputs. In this study, Support Vector Machines (SVM) and Artificial Neural Networks (ANN) are used to predict the static and seismic responses of slopes. In order to integrate the soft computing methods with GIS for coherent landslide hazard analysis, an automatic slope profile delineation method from Digital Elevation Models is developed. The integrated framework is evaluated using a case study of the 1989 Loma Prieta, CA earthquake (Mw = 6.9). A seismic landslide hazard analysis is also performed for the same region for a future scenario earthquake (Mw = 7.1) on the San Andreas Fault.

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GIS-enabled Spatial Analysis and Modeling of Geotechnical Soil Properties for Seismic Risk Assessment of Levee Systems

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Flood protection systems are complex, interconnected engineered systems, where failure at one location means the failure of the entire system. Earthen levees, the systems' major component, are at risk from many causes of failure including seepage, erosion and instability due to seismic loading, yet there are currently no guidelines available for the seismic design of levees.

Levees stretch for long distances and are formed through various geologic processes and human activities over time, however information regarding soil properties is collected only at limited point locations and varies significantly both laterally and with depth. Levee vulnerability analyses are currently performed only at locations with known soil properties. Prediction of levee performance in locations where no soil data is available becomes a limitation for system risk assessment studies.

A simplified methodology is proposed to predict soil variability in riverine geologic environments for the seismic risk assessment of earthen levee systems. A key step in this methodology is to provide a continuous characterization of soil conditions throughout the system. The proposed model correlates soil properties to preselected regional variables and is implemented, using geostatistical kriging, in a Geographic Information Systems (GIS) environment. GIS was crucial in this research and proved to be the appropriate platform for input, manipulation, analysis, and output presentation of spatial and non-spatial data.

Correlation relationships between soil strength parameters and geological and river geometry factors are presented for a pilot study area in California. Global observations that apply across the study area included the increasing trend of shear strength, Su, with increasing distance from the river, and decreasing trend of Su with increasing river Sinuosity Index levels. Only local trends were observed in the relation of friction angle, ϕ, with Sinuosity Index, as well as in the relation of Su and ϕ with geological formations. The proposed methodology also includes steps for seismic response analysis of levee segments, and flood scenarios in protected areas. Since seismic response of earthen structures is controlled primarily by input ground motions, a methodology for selecting ground motions based on their mean period, Tm, for liquefaction triggering assessment of levees is also developed.

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A Laboratory Investigation and Modeling of Dynamic Modulus of Asphalt Mixes for Pavement Applications

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Traditionally, stiffness of hot mix asphalt (HMA) has been used as a measure of the pavement's ability to carry vehicular traffic loads without undergoing excessive deformation. Early deterioration of pavements due to rutting, fatigue cracking, and other type of distresses may be attributed to inadequate stiffness. The mechanistic empirical pavement design guide (MEPDG) emphasizes the use of dynamic modulus of asphalt mixes at all three levels of flexible pavement design. HMA mixes and aggregates that are commonly used in Oklahoma for the construction of flexible pavements were characterized in this study.

A database of dynamic modulus and master curves was developed for the mixes used in this study, which is expected to be useful in the implementation of the MEPDG for the design and analysis of flexible pavements. In addition, the effect of plant production and sample preparation methods on different aggregate shape parameters was evaluated. The results indicate that texture and form of coarse aggregates can change significantly during plant production and compaction in a gyratory compactor. No significant differences were observed for fine aggregates. The present study also compared the shape properties of three different types and sizes of coarse aggregates. The larger size aggregates were found to be rougher and more cubical compared to the smaller size aggregates, indicating that aggregate particles become smoother and elongated with a reduction in size.

Three different input levels of the MEPDG for modified and unmodified mixes were compared in this study. It was found that the accuracy of Level 2 and Level 3 depend on the mix type. The current study also evaluated the strengths and weaknesses of four empirical models (i.e., Witczak 1999, Witczak 2006, Hirsch, and Al-Khateeb) that are commonly used in estimating dynamic modulus. Analyses of the results show that the performance of a model varies with air voids and temperature. Statistical and neural network (NN) models were developed to estimate dynamic modulus including angularity, texture, form, and sphericity of aggregates as variables. Inclusion of shape parameters is found to enhance the predictive capability of a model significantly. It was found that the long-term oven (LTO) aging resulted in approximately a 42% to 60% increase in dynamic modulus, depending upon the amount of reclaimed asphalt pavement (RAP) in the mix and air voids. Overall, enhanced characterization of aggregates and asphalt mixes is found to be extremely important for pavement design applications.

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Stability of Levees and Floodwalls Supported by Deep-Mixed Shear Walls: Five Case Studies in the New Orleans Area

Tiffany E. Adams

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Increasing interest, from the U.S. Army Corps of Engineers (USACE) and other agencies, in using deep-mixing methods (DMM) to improve the stability of levees constructed on soft ground is driven by the need to reduce levee footprints and environmental impacts and to allow for more rapid construction. Suitable methods for analysis and design of levees supported on deep-mixing methods (DMM) shear walls are needed to ensure that the DMM technology is properly applied.

DMM shear walls oriented perpendicular to the levee alignment are an effective arrangement for supporting unbalanced lateral loads. Shear walls constructed by overlapping individual DMM columns installed with single-axis or multiple axis equipment include vertical joints caused by the reduced width of the wall at the overlap between adjacent columns. These joints can be made weaker by misalignment during construction, which reduces the efficiency of the overlap. Depending on the prevalence and strength of these joints, complex failure mechanisms, such as racking due to slipping along vertical joints between adjacent installations in the shear walls, can occur. Ordinary limit equilibrium analyses only account for a composite shearing failure mode; whereas, numerical stress-strain analyses can account for other failure modes.

Five case studies provided by the USACE were analyzed to evaluate the behavior of levee and floodwall systems founded on soft ground stabilized with DMM shear walls. These projects identified and illustrated potential failure mechanisms of these types of systems. Two-dimensional numerical stability and settlement analyses were performed for the case studies using the FLAC computer program. Key findings and conclusions for the individual case studies were assessed and integrated into general conclusions about design of deep-mixing support for levees and floodwalls.

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Modeling Macro-scale Clay Behavior at Micro-scale Clay Particle Interfaces

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Clay consolidation has generally been considered from a macro-scale perspective by measuring the macro-scale compression of a clay soil over time. Clay particles in consolidation tests experience shear and normal forces at the inter-particle level due to force applied to the soil at the macro-scale. These shear and normal forces cause the particles to slide at the micro-scale and produce macro-scale changes in soil volume and shape. By considering the inter-particle interactions at the micro-scale, the shear force - normal force - velocity relationship can be described by the Rate Process Theory (RPT). This research investigated the use of RPT for analyzing sliding at clay particle contacts during secondary compression to describe macro-scale clay behavior.

The novel micro-scale friction experiments conducted in this research demonstrated that an Atomic Force Microscope (AFM) can be used to obtain coefficient of friction measurements for montmorillonite. This method allows for measurements to be performed over spatial scales of several microns, can be conducted under dry conditions or a wide range of aqueous solutions, and requires no calibration beyond a few microscopic measurements of the probe. The micro-scale AFM and macro-scale triaxial shear, ring shear, and direct shear experimental data of the coefficient of friction as a function of velocity were found to match well with those calculated using RPT. A discrete element method (DEM) model was also developed to calculate clay particle movement in three dimensions during compression using RPT as a contact model.

This research provides evidence of the close correspondence between macro-scale and micro-scale coefficient of friction measurements and contributes to multi-disciplinary understanding of factors that control friction between clay particles and deformation of clay masses. The results from this work can be applied to a wide range of time-dependent phenomena such as clay secondary compression, shear deformation, and fault dynamics behavior.

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Critical Height and Surface Deformation of Column-Supported Embankments

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Column-supported embankments with or without basal geosynthetic reinforcement can be used in soft ground conditions to reduce settlement by transferring the embankment load to the columns through stress redistribution above and below the foundation subgrade level. Column-supported embankments are typically used to accelerate construction and/or protect adjacent facilities from additional settlement. The column elements consist of driven piles or formed-in-place columns that are installed in an array to support a bridging layer or load transfer platform. The bridging layer is constructed to enhance load transfer using several feet of compacted sand or sand and gravel that may include one or more layers of high-strength geotextile or geogrid reinforcement. Mobilization of the mechanisms of load transfer in a column-supported embankment requires some amount of differential settlement between the columns and the embankment as well as between the columns and the foundation soil. When the embankment height is low relative to the clear spacing between columns, there is the risk of poor ride quality due to the reflection of the differential foundation settlement at the surface of the embankment. The minimum embankment height where differential surface settlement does not occur for a particular width and spacing of column is the critical height. The conventional approach is to express critical height as a fixed ratio of the clear span between adjacent columns; however, there is no consensus on what ratio to use and whether a single ratio is applicable to all realistic column arrangements. The primary objective of this research is to improve the understanding of how column-supported embankments deform in response to differential foundation settlement. A bench-scale experimental apparatus was constructed and the equipment, materials, instrumentation, and test procedures are described. The apparatus was able to precisely measure the deformation occurring at the sample surface in response to differential settlement at the base of the sample. Critical heights were determined for five combinations of column diameter and spacing representing a wide range of possible column arrangements. In addition, tests were performed using four different column diameters in a single column configuration with ability to measure the load acting on the column and apply a surcharge pressure to the sample. In total, 183 bench-scale tests were performed over a range of sample heights, sample densities, and reinforcement stiffnesses. Three-dimensional numerical analyses were conducted to model the experiments. The critical heights calculated using the numerical model agreed with the experimental results. The results of the laboratory tests and numerical analyses indicate that critical height depends on the width and spacing of the columns and is not significantly influenced by the density of the embankment fill or the presence of reinforcement. A new method to estimate critical height was devel-

oped and validated against extensive case histories as well as experimental studies and numerical analyses performed by others.

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Column-supported Embankments: Full-scale Tests and Design Recommendations

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When an embankment is to be constructed over ground that is too soft or compressible to adequately support the embankment, columns of strong material can be placed in the soft ground to provide the necessary support by transferring the embankment load to a firm stratum. This technology is known as column-supported embankments (CSEs). There are two principal reasons to use CSEs: 1) accelerated construction compared to more conventional construction methods such as prefabricated vertical drains or staged construction, and 2) protection of adjacent facilities from distress, such as settlement of existing pavements when a roadway is being widened. One of the most significant obstacles limiting the use of CSEs is the lack of a standard design procedure which has been properly validated. Twelve design/analysis procedures are described in this dissertation, and ratings are assigned based on information available in the literature.

A test facility was constructed and the facility, instrumentation, materials, equipment, and test procedures are described. A total of 5 CSE tests were conducted with 2 ft diameter columns in a square array. The first test had a column center-to-center spacing of 10 ft and the remaining four tests had center-to-center spacings of 6 ft. The Adapted Terzaghi Method of determining the vertical stress on the geosynthetic reinforcement and the Parabolic Method of determining the tension in the geosynthetic reinforcement provide the best agreement with the test results. The tests also illustrate the importance of soft soil support in CSE performance and behavior.

A generalized formulation of the Adapted Terzaghi Method for any column/unit cell geometry and two layers of embankment fill is presented, and two new formulations of the Parabolic Method for triangular arrangements is described. A recommended design procedure is presented which includes use of the GeogridBridge Excel workbook described by Filz and Smith (2006, 2007).

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Pipe-soil Interaction Aspects in Buried Extensible Pipes

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The performance of buried pipelines in areas subjected to permanent ground displacements is an important engineering consideration in the gas distribution industry, since the failure of such systems poses a risk to public and property safety. Although, the ground movements and its variations over time can be detected and mapped with reasonable confidence, these data are of little use due to a lack of reliable models to correlate such displacements to the condition of the buried pipe. The objective of this thesis is to develop methods to estimate the pipe performance based on the measured ground displacement.

An analytical method was developed to estimate the pipe performance when the pipe is subjected to tensile loading caused by the relative ground movements occurring along the pipe axis. As a part of the derivation, a modified interface friction model was developed considering the increase in friction due to constrained dilation of the soil, and the impact of mean effective stress on soil dilation. This interface friction model was combined with a nonlinear pipe stress–strain model to derive an analytical solution to represent the performance of the pipe. Using the proposed model, axial force, strain, and mobilized frictional length along the pipe can be obtained for a measured ground displacement can be obtained. Large-scale field pipe pullout tests were performed to verify the results of the proposed analytical model, in which good agreements were observed for tests conducted at different soil/burial conditions, displacement rates and pipe properties. Considering the similarities in the axial pullout mechanism, the analytical model was extended to explain the pullout response of geotextiles buried in reinforced soil structures. In this derivation, a new interface friction model was developed for planar members by considering the changes in normal stress due to constrained soil dilation.

Another analytical model was derived for the case of a pipe that is subjected to combined loading from axial tension and bending when the initial soil loading is acting perpendicular to the pipe axis. With the direct account of the axial tensile force development, more realistic pipe performance behaviors were obtained as compared to the results obtained from traditional numerical formulations.

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Three-Dimensional Nonlinear Analysis of Deep-Corrugated Steel Culverts

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Deep-corrugated steel culverts (with a corrugation wavelength of 400mm and amplitude of 150mm) can be used as an effective alternative for short-span bridges. Current design methods are typically based on two-dimensional finite element analysis. This thesis reports results from three-dimensional finite element analysis, with explicit modelling of the geometry of the corrugated plates (called corrugated analyses) and employing the orthotropic shell theory (called orthotropic analyses), for a specific box culvert having a 10 m span and 2.4 m rise. The results were compared to previously reported experimental data where a specific large span box culvert was tested under controlled laboratory conditions. The box culvert was modelled when subject to fully loaded dump truck, and when loaded using a tandem axle frame to service and ultimate loads. It was found that the orthotropic model overestimated the culvert stiffness at the ultimate limit state, but provided effective estimates of response up to the factored design loads. The corrugated model with geometric nonlinearity was required to capture the real behaviour of the corrugated plates up to the ultimate limit state. New insight into the failure mechanisms of the box culvert were provided by the corrugated model analysis. A parametric study was then performed for 86 different long-span box and arch culverts, examining live load spreading in the axial direction, number of loaded lanes, design truck position, culvert geometry, plate thickness, and the existence of pavement. The results were then compared to the moment and thrust equations in the 2006 Canadian Highway Bridge Design Code (CHBDC) to check the performance of the current design equations. CHBDC equations overestimated the earth and live load bending moments, and did not give the correct trend for different spans. CHBDC thrust equations were found to underestimate the earth and live load thrust values for arch culverts.

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Effects of Loading – Unloading and Wetting – Drying Cycles on the Geomechanical Behavior of the Colombian Andes Mudrocks

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The Colombian Andes mudrocks, particularly those that exhibit low grade of cementation (bonding), are very much susceptible to degrade when the environmental conditions change, representing a lot of problems for the engineering works. This research develops environmental conditions simulated by lab techniques in order to monitoring physics and mechanical properties changes, whit these actions and to establish some real effects on the material mechanical competence. For the research aim, were developed activities as geotechnical characterization, from physics – chemical – mechanical and compositional points of view, and their respective experimental design and lab sets, implementing recent techniques as Vapor Equilibrium (VET) in order to apply wetting – drying cycles, controlling relative humidity (controlled suction), and loading – unloading cycles during the triaxial tests, trough ultrasonic wave velocities technique; this was possible due to coupled transducers to the compression machine (Hoek cell), determining also the stress – strain behavior front these actions. The most relevant results are, between others: the principal failure mechanisms for the laminated mudrocks starts on the microscopic scale by fissures coalescence, exhibiting as well as physics and chemical degradation phenomenon; the strength is reduced up 100% and 60% and rigidity is reduced up 70% and 30%, for three wetting – drying and loading – unloading cycles, respectively; the global geomechanical behavior to get across between a ductile like rock to a fragile like soil, but obtaining engineering values according the monitoring lab set, compared with the in-situ conditions.

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North America's Leader in Geotechnical Construction

Earth Retention
- Anchors
- Anchor Block Slope Stabilization
- Gabion Systems
- Micropile Slide Stabilization System (MS^3)
- Sheet Piles
- Soil Nailing
- Soldier Piles & Lagging

Grouting
- Cement Grouting (High Mobility Grouting)
- Chemical Grouting
- Compaction Grouting (Low Mobility Grouting)
- Fracture Grouting
- Jet Grouting
- Polyurethane Grouting

Ground Improvement
- Dry Soil Mixing
- Dynamic Compaction
- Injection Systems for Expansive Soils
- Rapid Impact Compaction
- Rigid Inclusions
- Vibro Compaction
- Vibro Concrete Columns
- Vibro Piers™ (Aggregate Piers)
- Vibro Replacement (Stone Columns)
- Wet Soil Mixing

Structural Support
- Augercast Piles
- Drilled Shafts
- Driven Piles
- Franki Piles (PIFs)
- Helical Piles
- Jacked Piers
- Macropiles™
- Micropiles
- Pit Underpinning

Additional Services
- Earthquake Drains
- Slab Jacking
- Slurry Walls
- TRD – Soil Mix Walls
- Wick Drains

Design-Construct Services

800-456-6548 ◆ www.HaywardBaker.com

For a complete list of our offices, visit: **www.HaywardBaker.com**