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GEOTECHNICAL news

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Message from the President

Bryan Watts, President of Canadian Geotechnical Society

The beginning of 2012 finds the Canadian Geotechnical Society in good health. Our Executive Committee enters its second year with two new members, Dr. Baolin Wang, who will represent the Sections and, Dr. Lukas Arenson, who will represent the Divisons. Dr. John C. Sobkowicz is the VP, Technical, Dr. Jean Marie Konrad is the VP, Communications, and Mr. Peter Gaffran is the VP, Finance. We thank Ms. Marcia MacLellan who represented the Sections in 2011 and, Dr. Chris Hawkes, represented the Divisions. Ably assisting the Executive Committee are our Secretary-General, Dr. Victor Sowa and our Administrator, Mr. Wayne Gibson. Ms. Lisa McJunkin, Administrator Assistant, handles all of our member inquiries and is really the voice of the CGS.

This year is the 125th Anniversary of the **Engineering Institute of Canada** which is the umbrella organization for technical societies in Canada. *"Canada's well-known iron-ring, The Canadian Academy of Engineering and a model for the incorporation of Canada's Provincial Engineering Associations were all originated in the EIC"* (EIC "Celebrating 125 Years of Canadian Engineering Societies", www.eic.ici.ca). The EIC will celebrate with two award ceremonies this year; the first will be at the Westin Hotel on February 25, 2012 in Ottawa and the second in Edmonton on June 7 at the Shaw Convention Centre as part of the Canadian Society of Civil Engineering who were the founding society of the EIC so are also celebrating their 125th year anniversary.

The CGS will be particularly well represented at these award evenings. Our Dr. R. Kerry Rowe of Queen's University will receive the Sir John Kennedy Award, the senior award of the EIC. This follows his Casagrande Lecture at the PanAm conference in Toronto last year, a distinction conferred by the International Society of Soil Mechanics and Geotechnical Engineering. Our Mr. Fred Matich will receive the Julian C. Smith Medal for achievements in the development of Canada. Our Dr. Derek Martin of the University of Alberta will receive the John B. Stirling Medal. Also, our Dr. Doug Stead of Simon Fraser University and Dr. Hesham El Naggar of the University of Western Ontario have been made Fellows of the EIC. Congratulations to all recipients and thanks to all nominators for taking the time to honour your colleagues.

I just finished registering on our new CGS website for 2012. It went especially smoothly. If you have any issues with the website please contact the CGS Administrator. The Executive Committee just concluded a three year

agreement with BiTech for Geotechnical News and distribution of CGS publications. We are printing another 1000 copies of the English version of the 4th Edition, Canadian Foundation Engineering Manual and the French version of the 4th Edition, Canadian Foundation Engineering Manual is well advanced.

The next CGS sponsored conference is the 11th International Symposium on Landslides / 2nd North American Symposium on Landslides from June 3 to 8th in Banff, Alberta. The 65th Canadian Geotechnical Conference will be held at the Fairmont Hotel in downtown Winnipeg, Manitoba, Canada from September 30 to October 3, 2012. The geotechnical group at the University of Alberta will be hosting the **David C. Sego** Symposium to celebrate his retirement from 33 years of teaching and research from 1977-2010. In 1977 I took the permafrost engineering course at the University of Alberta taught by **Dr. N.R. Morgenstern** where Dr. Sego gave occasional guest lectures. I remember those first graduate school years fondly as I shared an office with Drs. Oldrich Hungr, John Sobkowicz, and Jean Marie Konrad!!

Recently, the CGS received an enquiry from the President of a geotechnical society in a Mediterranean European country. That note was to enquire about job prospects in Canada because there was such high unemployment among geotechnical engineers in that country. This reminded me how fortunate we are to live in such a prosperous country with hard-working people. Remember that we need more members in our society; most geotechnical engineers in the world would consider themselves fortunate to belong to such an accomplished technical society.

Le message du président

En ce début de l'année 2012, la Société canadienne de géotechnique est en bonne posture. Notre Comité exécutif entame sa deuxième année en comptant deux nouveaux membres, Baolin Wang, Ph. D., qui représentera les sections et Lukas Arenson, Ph. D., qui représentera les divisions. John C. Sobkowicz, Ph. D., est vice-président technique, Jean-Marie Konrad, Ph. D., est vice-président des communications, et M. Peter Gaffran est le vice-président des finances. Nous remercions Mme Marcia MacLellan, qui a représenté les sections en 2011 et Chris Hawkes, Ph. D., qui a représenté les divisions. Il convient de souligner le très compétent travail de soutien au Comité exécutif de notre secrétaire-général, Victor Sowa, Ph. D., ainsi que de notre administrateur, M. Wayne Gibson. Mme Lisa McJunkin, qui est l'adjointe administrative, s'occupe de toutes les demandes des membres et représente, en fait, la voix de la SCG.

Cette année**, L'Institut canadien des ingénieurs**, qui est l'organisme de regroupement des sociétés techniques du Canada, célèbre son 125ième anniversaire. 《 . . . *l'ICI [est] à l'origine de plusieurs autres associations et organisations d'ingénieurs au pays telles la Société des sept gardiens et l'anneau de fer des ingénieurs canadiens et l'Académie canadienne du génie.* 》(EIC "Celebrating 125 Years of Canadian Engineering Societies", www.eic.ici.ca.). L'ICI célébrera cet anniversaire avec deux cérémonies de remise de prix cette année. La première aura lieu à l'hôtel Westin d'Ottawa le 25 février 2012 et la deuxième à Edmonton le 7 juin, au Centre des conventions, dans le cadre de la Société canadienne de génie civil qui était la société fondatrice que l'ICI et qui, à ce titre, célèbre aussi son 125ième anniversaire.

Les membres de la SCG seront tout particulièrement bien représentés lors des deux soirées de remise de prix.

Kerry Rowe, Ph. D., de l'Université Queen's, recevra le Prix Sir John Kennedy, qui est le plus prestigieux de l'ICI. Cela fait suite à sa conférence Casagrande présentée lors de la Conférence panaméricaine tenue à Toronto. Cette conférence est une distinction accordée par la Société internationale de mécanique des sols et de la géotechnique. **M. Fred Matich** recevra la Médaille Julian C. Smith pour ses réalisations concernant le développement du Canada. **Derek Martin, Ph. D**., de l'Université de l'Alberta, recevra la Médaille John B. Stirling. Enfin, **Doug Stead, Ph. D.,** de l'Université Simon Fraser, et **Hesham El Naggar, Ph. D.,** de l'Université Western Ontario, ont été fait fellows de l'ICI. Nous adressons nos félicitations à tous les lauréats et remercions les personnes qui ont présenté des mises en candidature d'avoir pris le temps de faire honneur à vos collègues.

Je viens de terminer de renouveler mon adhésion de 2012 sur le tout nouveau site Web de la SCG. Le processus a été simple comme bonjour. Si vous avez le moindre problème avec le site Web, veuillez communiquer avec l'administrateur de la SCG. Le Comité exécutif vient tout juste de conclure une entente de trois ans avec BiTech, concernant la revue Geotechnical News et la distribution des publications de la SCG. Nous sommes en train d'imprimer 1000 exemplaires supplémentaires de la 4e édition du manuel *Canadian Foundation Engineering Manual.* La version française de la 4e édition de ce manuel, ou *Manuel canadien d'ingénierie des fondations*, est très avancée.

La prochaine conférence commanditée par la SCG sera le 11e symposium international sur les glissements de terrain et le 2e symposium nord-américain sur les glissements de terrain. L'événement aura lieu à Banff, du 3 au 8 juin 2012. La 65e conférence canadienne de géotechnique aura lieu à l'hôtel Fairmont au centre-ville de Winnipeg (Manitoba, Canada) du 30 septembre au 3 octobre 2012. Le groupe géotechnique de l'Université de l'Alberta organisera un symposium en l'honneur de la retraite de David C. Sego, pour souligner ses 33 années d'enseignement et de recherche de 1977-2010. En 1977, j'ai suivi le cours sur l'ingénierie du pergélisol donné par N.R. Morgenstern, Ph. D., durant lequel le professeur Sego était conférencier invité à l'occasion. J'ai de très beaux souvenirs de mes années de premier cycle universitaire, durant lesquelles je partageais un bureau avec Oldrich Hungr, John Sobkowicz et Jean-Marie Konrad, tous trois Ph. D.!

Récemment, la SCG a reçu une demande de la part du président d'une société de géotechnique située dans un pays méditerranéen. Il souhaitait connaître les possibilités d'emploi au Canada, en raison du très haut taux de chômage chez les ingénieurs géotechniques de ce pays. Cela m'a rappelé combien nous sommes chanceux de vivre dans un pays aussi prospère dont les habitants travaillent fort. N'oubliez pas que notre société a besoin de plus de membres. La plupart des ingénieurs géotechnique du monde se considéreraient chanceux de faire partie d'une société technique aussi accomplie.

From the Society

Call for nominations for CGS Awards

Nominations for CGS Awards are to be submitted to: The Canadian Geotechnical Society Secretariat, 8828 Pigott Road, Richmond, BC, V7A 2C4, Canada; Fax: (604) 277-7529, e-mail: cgs@cgs.ca by not later than June 1, except where noted. The nomination letter must include reasons why the individual merits the award relative to the nomination criteria, and any other pertinent information on the nominee, and attach the C.V. of the nominee. Letters from other Society members supporting the nomination add strength to the nomination.

Nominators are recommended to review the full award details before preparing nominations for the Awards listed below. The Awards details can be obtained from the Society's Awards and Honours Manual, which is available to CGS members in the CGS Members Section of the CGS Website. CGS members can log-in at http://cgs.ca/login.php, then proceed to Online Member Resources, find CGS Manuals, and proceed to the Awards and Honours Manual. Information can also be obtained from Division Chairs, Section Directors, and the Secretariat. Funding for the Society's awards is provided by generous support from the independent charitable body, The Canadian Foundation for Geotechnique.

Members are invited and encouraged to submit nominations for the following CGS Awards:

R.F. Legget Medal - the highest CGS honour

Awarded to an individual for outstanding life-long contributions to geotechnique.

R.M. Quigley Award

Awarded to an individual(s) for the best paper published in the Canadian Geotechnical Journal within the year preceding the year in which the prize is awarded. Nominations are made by the Associate Editors of the Canadian Geotechnical Journal.

G. Geoffrey Meyerhof Award

Awarded to an individual for outstanding and exceptional contributions to the art and science of foundation engineering.

Thomas Roy Award

The award is presented to honour an outstanding contribution to the field of Engineering Geology in Canada.

Roger J.E. Brown Award

The award is presented:

a. to an individual (preferably Canadian) for publishing the best paper on permafrost science or engineering in

- Canadian Geotechnical Journal, or
- Canadian Journal of Earth Scences, or
- Proceedings of National or International Permafrost Conferences, or

b. to honour an individual for his/her excellence in the field of permafrost.

Awarded every second year. To be awarded in 2012.

John A. Franklin Award

The award recognizes an individual (or individuals) who have made an outstanding technical contribution in the fields of rock mechanics or rock engineering in Canada and/or internationally. Awarded every second year. Not awarded in 2012.

Geosynthetics Award

The award was presented for the first time in the 2000 to recognize an individual or individuals who have made an outstanding technical contribution to the use of geosynthetics in Canada and/or internationally. Awarded every second year. To be awarded in 2012.

Geoenvironmental Award

The award was presented for the first time in 2000 to recognize an individual or individuals who have made an outstanding technical contribution to the practice of multidisciplinary geoenvironmental engineering in Canada and/or internationally. Awarded every second year. To be awarded in 2012.

Robert N. Farvolden Award

Following some years as the Hydrogeology Division Award, the Robert N. Farvolden Award was presented for the first time in 2002. The Hydrology Division selects the winner of the award, which recognizes outstanding contributions to groundwater science and engineering in Canada. The Awards Committee of the Hydrogeology Division commonly asks for input from the International Association of Hydrogeologists, Canadian National Committee, (IAH-CNC). Nominations on or before **April 1. Early nomination date this year; see notice in December, 2011 issue of Geotechnical News.**

CGS Graduate Student Award

For the best paper authored or co-authored and presented by a geotechnical graduate student at an accredited Canadian University. The winning paper each year is presented by the student at the annual Canadian Geotechnical Conference. All submissions and accompanying documentation must be received by the Chair of the Student Awards Sub-Committee **on or before May 21** of the competition year. The contact information for the Chair is Nicholas Vlachopoulos, Dept. of Civil Engineering, Royal Military College of Canada, Box 17000 Station Forces, Kingston, ON, K7K 7B4, Tel: 613-541-6000, Ext 6398; Email: vlachopoulos-n@rmc.ca

CGS Undergraduate Student Awards

There are two undergraduate student awards that endeavour to increase student awareness of the Society and their involvement in it.

a. The Undergraduate Student Report, Individual Submission Award was established In 1987 with the main purpose of recognizing and rewarding excellence in the preparation of a geotechnical report by an individual full time undergraduate student in an accredited engineering program or a geoscience program in a Canadian University.

b. The Undergraduate Student Report, Group Submission Award was added in 1990 to recognize and reward excellence of a report prepared by one or more undergraduate students in an accredited engineering program or a geoscience program in a Canadian University.

All submissions and accompanying documentation must be received by the Chair of the Student Awards Sub-Committee **on or before May 21** of the competition year. The contact information for the Chair is Nicholas Vlachopoulos, Dept. of Civil Engineering, Royal Military College of Canada, Box 17000 Station Forces, Kingston, ON, K7K 7B4, Tel: 613-541-6000, Ext 6398; Email: vlachopoulos-n@rmc.ca

A.G. Stermac Awards for service to the Canadian Geotechnical Society

Before 1999, these awards were known as the CGS Service Plaques. A.G. Stermac Awards are presented to members of the Society who have contributed specific or special, worthy and significant service(s) to the Society. All submissions must reach the Society's Secretariat not later than **June 1.**

Call for Nominations for Awards from the Engineering Institute of Canada (EIC)

- Canadian Geotechnical Society (CGS) members are invited to submit nominations for EIC Awards to the Society Secretariat (cgs@cgs.ca) or the Secretary General (vsowacgs@dccnet.com by not later than **July 1, 2012**. Members of the Society are eligible for awards, prizes and honours from the Engineering Institute of Canada. By EIC Policies, all candidates nominated by CGS members to EIC awards must be members of the CGS.

Nominators are to provide nomination documents consisting of four parts, which must include (1) a completed EIC Nomination Form obtained from the EIC Website, (2) the nomination letter, (3) the candidate's *Curriculum Vitae*, and (4) supporting letters from colleagues, who are preferably Fellows of the EIC (FEIC). Nominators are recommended to review the full awards details and criteria prior to preparing nominations for the Awards listed below. More information on the procedure, details and schedule for EIC honours and awards can be found in Sections D-1, D-2 and D-3 of the Canadian Geotechnical Society's Awards and Honours Manual. This information is available to CGS members in the CGS Members Section of the CGS Website. CGS members can log-in at http://cgs.ca/login.php, then proceed to Online Member Resources, find CGS Manuals, and then proceed to the Awards and Honours Manual.

The CGS Executive Committee reviews all nominations submitted by members, as well as other possible candidates by not later than **August 1, 2012**, and forwards them to the Honours and Awards Committee of EIC for consideration. All constituent societies of EIC participate in this program.

Members of CGS are eligible for the following EIC honours and awards:

- The **Sir John Kennedy Medal** is the most senior award of the Institute. This medal is awarded in recognition of outstanding merit in the engineering profession, or of noteworthy contributions to the science of engineering or to the benefit of the Institute.
- The **Julian C. Smith Medal**, established in 1939 by a group of senior members of the Institute to perpetuate the name of a Past President of the Institute. The medal is awarded for "achievement in the development of Canada".
- The **John B. Stirling Medal** was established in 1987 through the generosity of E.G.M. Cape and Company Ltd. to honour a former President of the Company who was President of the Institute in 1952. It is awarded "in recognition of leadership and distinguished service at the national level within the Institute and/or its Member Societies".
- The **Canadian Pacific Railway Engineering Medal** was established in 1988. The medal is presented "in recognition of leadership and service over many years at the regional, branch, section or equivalent levels, within the Institute or its Member Societies".
- The **K.Y. Lo Medal** was created in 1998 and is awarded "to a member of the EIC who has made significant engineering contributions at the international level. Such contributions may include:
    - promotion of Canadian expertise overseas;
    - training of foreign engineers;
    - significant service to international engineering organizations;
    - advancement of engineering technology recognized internationally".
- **Fellowship of EIC (FEIC).** A member of CGS, of at least 45 years of age, can become a Fellow of the Institute on the grounds of excellence in engineering practice and exceptional contributions to the well being of the profession and to the good of the society.
- **Honorary Membership**. The Council of the EIC may elect to Honorary Membership in the Institute, non-members who are not engineers but who have achieved distinction through service to the profession of engineering.

Schuster Medal

Nominations are now being accepted for the **Schuster Medal**, a joint award from the **Association of Environmental & Engineering Geologists** and the **Canadian Geotechnical Society** that recognizes excellence in geohazards research in North America.

All nominees for the Schuster Medal must meet at least two of the following criteria:

- Professional excellence in geohazards research with relevance to North America
- Significant contribution to public education regarding geohazards
- International recognition for a professional career in geohazards
- Influential geohazards research or development of methods or techniques
- Teacher of students who work on geohazards issues

The first Schuster Medal was awarded to the namesake of the award, Robert L. Schuster, on June 7, 2007, at the 1st North American Landslide Conference held in Vail, Colorado.

An awards committee containing representatives from the Association of Environmental & Engineering Geologists and the Canadian Geotechnical Society will select future candidates. The award will be presented at the annual or special topical meetings of either society, as deemed appropriate by the awards committee.

- **Nominations are due April 15** and should be sent to Becky Roland at AEG Headquarters. She will forward all nominations to the selection committee.

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Denver, CO 80246
(303) 757-2926
broland@aegweb.org

Recent Awards

Several CGS members were recently recognized for their contributions and received various awards from the **Engineering Institute of Canada (EIC):**

Dr. R. Kerry Rowe has been awarded the **Sir John Kennedy Medal**, *EIC's highest award, in recognition of outstanding merit in the engineering profession, or of noteworthy contributions to the science of engineering, or to the benefit of the Institute.*

Dr. Rowe has redefined the scientific and engineering basis of barrier system engineering and design for landfills, explaining the processes of contaminant transport and longevity of barrier systems. His findings, computer software and design methods are being used across Canada, in the US and internationally to design and evaluate landfills for municipal solid waste and other waste materials. He has won many best paper awards for his work, and these activities culminated in his selection to be the 45th Rankine

Dr. R. Kerry Rowe

Lecturer by the British Geotechnical Association – widely regarded as the highest honour for Geotechnical Scholarship.

His extraordinary professional contributions include the training of many high level technical experts, his leadership as President of the Canadian Geotechnical Society and President of the Engineering Institute of Canada, and his work as one of the leading researchers in Canada (both in terms of personal productivity and during his ten years as Vice-President Research of Queen's University).

For his contributions, the CGS has awarded Dr. Rowe the R. F. Legget Medal, CGS's highest award. Dr. Rowe has also been awarded both the Casimir Gzowski Medal and the Thomas C. Keefer Medal from the Canadian Society for Civil Engineering, has been elected as Fellow of both the Canadian Academy of Engineering and the Royal Society of Canada, and was awarded the Killam Prize for Engineering. The International Geosynthetics Society has recognized Dr. Rowe with his presentation of the Giroud Lecture and also awarded him the International Geosynthetics Society Award and Gold Medal.

Dr. Rowe's status as one of the leading Civil Engineers internationally was recently recognized when he was appointed as an International Fellow of the Royal Academy of Engineers in the United Kingdom.

M.A.J. (Fred) Matich has been awarded the **Julian C. Smith Medal** *for achievement in the development of Canada.*

M.A.J. (Fred) Matich

Since his arrival in Canada in the mid 1950's M.A.J. (Fred) Matich has made enormous contributions to the development of geotechnical engineering. His exceptional service continues today with his own geotechnical engineering consulting practice at MAJM Corporation Ltd.

Fred has over 50 years of experience in Canada and internationally in applying geotechnical engineering expertise to challenging and high-profile projects. He has been involved with in excess of 5,000 significant projects across Canada and in more than 25 other countries.

He has provided service to several important research, technical and standards committees, reviewing geotechnically sensitive operations. He's been involved in countless mining development projects across Canada and for Canadian mining companies operating abroad in several countries. Fred was not only an engineering expert for those projects, but also notably a goodwill ambassador representing the provision of Canadian experience.

Many of our outstanding professionals have at one time or another worked with, and been tutored by, Fred. He has made substantial contributions to setting the standards of geotechnical practice in Canada, and provided invaluable mentoring to scores of young engineers.

Fred has been the recipient of many honours throughout his career, including an Engineering Medal from the Association of Professional Engineers of Ontario; the R.F. Legget Medal from the Canadian Geotechnical Society and the K.Y. Lo Medal; all of which are indicative of his standing among his peers.

Dr. C. Derek Martin has been awarded the **John B. Stirling Medal** *in recognition of leadership and distinguished service at the national level within the Institute and/or its Member Societies.*

Dr. Derek Martin, Professor, University of Alberta, is internationally sought for his expertise in rock

Dr. C. Derek Martin

mechanics engineering. Derek was senior advisor, Canadian Nuclear Fuel Waste Management Program and Head, Geotechnical Research Section of AECL's Underground Research Laboratory for 8 years. Since then, he has been involved with nuclear waste programs in Hungary, Finland, France, Japan, Korea, Sweden, Switzerland, United States and the United Kingdom.

At the national level, Derek served in leadership roles with the Canadian Geotechnical Society, including: Technical Vice-President; Member, Geotechnical Research Board; Chair, Rock Mechanics Division; Associate Editor, "Canadian Geotechnical Journal", and Chair, Canadian Rock Mechanics Association. He also had leading roles in organizing conferences for these organizations in Canada, including Chair, 61st Annual Canadian Geotechnical Society Conference, Edmonton in 2008, and Technical Chair, 18th Tunneling Association of Canada National Conference.

As an extension of his national leadership role, Derek is currently Vice President, North America, International Society of Rock Mechanics, Member, Editorial Advisory Boards of the "International Journal of Rock Mechanics and Mining Sciences" and "Journal of Rock and Soils Engineering", and was Co-Chair, 2010 ITA World Tunnel Congress, in Vancouver.

Professor Martin is the author of over 140 publications on rock mechanics. His awards include the Canadian Geotechnical Society's Colloquium, John Franklin Award, and the prestigious Rocha Medal from the International Society for Rock Mechanics.

Dr. Doug Stead was awarded a **Fellowship of the Engineering Institute of Canada (FEIC)** *in recognition of excellence in engineering practice and exceptional contributions to the well being of the profession and to the good of the society.*

Professor Doug Stead is recognized as an excellent scholar, educator, and

Dr. Doug Stead

engineer. His skills and influence as an educator have been widely sought as a committee member, co-supervisor for students registered at other institutions, and as thesis examiner at a variety of universities.

Dr. Stead's influence on geomechanics and geological engineering is wide reaching and broad. He has worked on issues associated with the geomechanics of surface and underground mining, as well as on unstable natural slopes. He brings a unique ability to understand the geological history of a site, in part by applying innovative and emerging technologies developed for other industries (such as LiDAR and photogrammetry). Several of his technical papers are included on required readings lists for graduate courses in different universities across the country.

Professor Stead has been awarded the John A. Franklin Rock Mechanics Award, and the Thomas Roy Engineering Geology Award, both from the CGS. He has served as Vice-President, Technical for the CGS, and as President, Canadian Federation of Earth Sciences. He has also served the profession as International Committee Advisor, Session Chair, and as a keynote speaker at many conferences in Canada and around the world. He has been Co-Chair of two International conferences: 1st Canadian-US Rock Mechanics Symposium" in 2007 and "International Symposium on Slope Stability and Mining", 2011, both in Vancouver. His impressive contributions and achievements have made him one of the most influential professionals in engineering geology and rock engineering in Canada.

Dr. M. Hesham El Naggar was awarded a **Fellowship of the Engi-**

Dr. M. Hesham El Naggar

neering Institute of Canada (FEIC) *in recognition of excellence in engineering practice and exceptional contributions to the well being of the profession and to the good of the society.*

Dr. M. Hesham El Naggar is Professor of Civil Engineering and Associate Dean – Research and Graduate Studies of the Faculty of Engineering at the University of Western Ontario. He has made many outstanding contributions to the Engineering profession in Canada and beyond over the past twenty five years.

His contributions in the fields of design of shallow and deep foundations, seismic design and foundations for vibrating equipment have significant impact on the-state-of-the-art and the-state-of-practice in these fields. The technologies and methodologies he helped develop are widely practiced and implemented by both researchers and practitioners alike.

Dr. El Naggar developed an approach to predict the bearing capacity of piles using the Statnamic Load Test. This approach is becoming a standard testing method in Canada and worldwide. He developed a method to characterize dynamic stiffness that is incorporated in a design code used by bridge engineers in USA. He also advanced design of machine foundations (e.g. power plants, large pumps, etc.), and co-authored the DYNA5 computer program that is used worldwide for the design of machine foundations.

Dr. El Naggar's contributions to the 4th Edition of the Canadian Foundation Engineering Manual are widely recognized by the profession. His contributions to the theory and practice of foundation engineering have been recognized by the Canadian Geotechnical Society with a G.G. Meyerhof Award and the Canadian Geotechnical Colloquium.

Upcoming Conferences

65th Canadian Geotechnical Conference - GeoManitoba 2012 - Call for Abstracts

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.

11th International Symposium on Landslides (ISL) and the 2nd North American Symposium on Landslides

The Canadian Geotechnical Society, the Association of Environmental and Engineering Geologists and the Joint Technical Committee on Landslides (JTC-1) invite you to the 11th International Symposium on Landslides (ISL) and the 2nd North American Symposium on Landslides at the Banff Springs Hotel in Banff, Alberta, Canada from June 2 to 8, 2012. The theme of the symposium will be ***Landslides and Engineered Slopes: Protecting Society through Improved Understanding.***

Located in Banff National Park, a UNESCO World Heritage site, the conference is set in the heart of the Canadian Rocky Mountains and provides a stunning venue for the international landslide community to convene and share. This location is ideally situated to stage a series of pre, post- and mid-conference field trips will provide delegates with a taste of the culture, geology and landslides issues of Western Canada and the Rocky Mountains.

The local technical committee, in partnership with the international advisory panel, have developed a program of sessions and plenary lectures to highlight the advancements and state-of-the-art in landslide research and practice from around the globe. In addition field trips, workshops, social events and the partner program will make this meeting an unforgettable event.

Canadian Foundation for Geotechnique

Meet the 2012 Trustees for the Canadian Foundation for Geotechnique

The Canadian Foundation for Geotechnique is a registered charitable organization that works at arm's length from the Canadian Geotechnical Society to recognize and foster excellence in the geotechnical field in Canada. It funds the annual CGS' student awards and prizes, the annual Canadian Geotechnical Colloquium, the travel costs associated with the two Cross Canada Lecture Tours each year, and offers its own annual $5000 National Graduate Scholarship.

The Foundation is managed and overseen by 15 volunteer Trustees who typically serve for one or more three-year terms. The tradition is for one-third, or five, of the Trustees to step down or be re-appointed each year. The March issue of Geotechnical News is typically when the new Trustees are introduced to the Canadian geotechnical community. Well, for 2012, no Trustees wanted to step down and all were reappointed. Therefore there are no new Trustees to introduce.

Therefore the Foundation invites the Canadian geotechnical community to take the Foundation's first ever quiz. The first list (numbered 1 to 15) below lists the Trustees, their affiliation, home base, and position on the Board of Directors. The second list (lettered A to O) lists a personal tid-bit about each Trustees, but not in the numbered order. Your task, should you wish to accept it, is to see how many Trustees and tid-bits you can match up. **The answers are given at the end of this CGS News column.** So sit back, relax, and have a bit of fun at the Foundation's expense!

2012 Canadian Foundation for Geotechnique Trustees (in alphabetical order):

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15. Gerry Webb (Golder Associates, Ottawa, ON)

Personal tid-bits not in the same order as above. See if you can match the numbers with the letters!

a. I love to spend time at my off-the-grid shack in the woods.
b. I play bluegrass, jazz and classical music on a 5-string banjo.
c. I'm an avid chess player who still programs in Pascal.
d. I'm the longest serving Foundation Trustee.
e. I love Country and Western music.

f. I was NGI Director #3; recently married NGI Director #2 on the birthday of NGI Director #1.

g. I attended the Masters Golf Tournament in Augusta, GA.

h. I like skiing, both snow and water.

i. I train for and race Ironman Triathlons.

j. I coached four different minor sports between 1996 and 2010.

k. I won a Canadian national pool team tournament.

l. I recently took up the sport of archery.

m. I quoted Lord Byron in a recent technical manuscript.

n. I have read most all of Henning Mankell's novels.

o. I'm shy.

And remember, after having so much fun with this quiz, in order to fulfill its mission the Foundation relies on donations individuals and corporations, and donations and interest-free loans from the local sections and technical divisions of the CGS. To learn more about the Foundation and its activities (but not necessarily more personal tid-bits of its Trustees) visit www.cfg-fcg.ca.

Important additions to the CGS Heritage Archives

The history and archives of the Canadian Geotechnical Society are valuable to the Society and we believe they are important to you. So, the CGS Heritage Committee is pleased to announce that it has amassed a treasure-trove of interesting and useful "new" archives. You can find these on the Heritage Archives of the CGS website at: http://www.cgs.ca/heritage-archive.php?lang=en. Alternatively, you can use the drop-down boxes on the CGS homepage until you reach: *About the CGS - Heritage Archives.*

The 'Documents and Lectures' section now includes:

- *The Bilingual Glossary of Landslide Terms*, produced by the CGS Landslides Committee; and,
- *Principles and Practice of Road-Making as Applicable to Canada*, written by Thomas Roy and published in Toronto in 1841. This is one of the earliest engineering publications in Canada.

The 'Photographic Collections' section now includes:

- *Collapse of the Bridge over the Peace River at Taylor, British Columbia, in 1957*; and,
- *Failure and Righting of the Transcona Grain Elevator in 1913.*

The 'Information and Location for Archival Records' section now includes:

- *Comments and Correspondence on the background of Thomas Roy;*
- *Documents and papers by and about Dr. Geoffrey Meyerhof,* which are stored at the Archives of the Dalhousie University Library in Halifax, Nova Scotia; and,
- *Documents and Papers by Dr. R.F. Legget,* which have been sent to the University Of Ontario Institute Of Technology (UOIT) in Oshawa, Ontario, for safe storage.

The 'Recommended Reading' section now includes:

- *Additional lists of reference publications*, which are considered worth reading on the selected topics.

The 'Online Member Resources' section (you have to be an active CGS member and log-in to access this material) now includes:

- The audio-video record of the Hardy Lecture from the 2010 Annual CGS Conference; and,
- The proceedings of each annual Canadian Geotechnical Conference from 1947(first) to 2010.

Our colleagues at the University of Alberta, especially Sally Petaske, and the Geotechnical Society of Edmonton, deserve an accolade for their important contribution in recovering and scanning all the previously printed proceedings of the CGS annual conferences, which contain a wealth of valuable case studies.

"New" material from on-going projects currently being undertaken by the members of the Heritage Committee will be uploaded to the CGS website as soon as these projects are completed. Meanwhile, please contact the new Chair of the CGS Heritage Committee, Dr. Mustapha Zergoun, at: mustapha.zergoun@metrovancouver.org if you know of any opportunities to acquire material that is at risk of being lost or if you have any suggestions for material that should be considered as welcome addition to our heritage archives on the CGS web site.

Answers for the Canadian Foundation for Geotechnique Quiz

1-E, 2-J, 3-D, 4-O, 5-M, 6-I, 7-L, 8-F, 9-G, 10-K, 11-C, 12-A, 13-N, 14-B, 15-H.

Editor

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The Victor Milligan Award

The Victor Milligan Award is presented annually to an employee of Golder Associates who has published a conference or journal research paper that best exemplifies the innovative and research efforts internal to the company. This year's winning paper was titled, "Influence of exsolved gases on slope performance at the Sarnia approach to the St. Clair tunnel". The paper was authored by J. Paul Dittrich, R. Kerry Rowe, Dennis E. Becker, and K.Y. Lo.

The paper presented the use of a numerical model that incorporated the physical effects associated with the presence of natural gas (methane) in the pore space of a fine-grained soil (subjected to unloading) in conjunction with coupled stress and water flow. The numerical model was used to analyse the history of excavation(s) at the Sarnia approach cut and was successful in capturing the deep-seated slope deformations associated with the construction of the approach to the tunnel.

While the paper was authored by several persons, Paul Dittrich was selected to have played a major role in the project and will be presenting the paper at several universities and geotechnical societies around the world over the next year. Please contact Paul Dittrich at pdittrich@golder.com if you desire to have the 2011 Victor Milligan Award paper presented in your area.

Victor Milligan is one of the founding fathers of Golder Associates and served as President from the early 1960s to the 1980s. Victor was recognized worldwide for his expertise in geotechnical engineering, particularly in the fields of dams and earth embankments, and soft-ground tunnels. In 2004, the Ground Engineering Group of Golder Associates honoured Victor with the creation of the Victor Milligan Award. Victor Milligan passed away in 2009 and the award is presented annually to the authors of the best paper published each year on a ground engineering topic.

* Celebrating thirty years of publishing: 1982-2012!

Thirty years in print

In 1982, a need was felt for a communication vehicle linking the various disciplines within the North American geotechnical community. At that time, expanding upon the focus of the *CGS News*, *Geotechnical News* was formed, with John Gadsby as publisher.

Now in its thirtieth year of publication, *GN* continues to serve as an informative and reliable communications tool for issues of interest to the geotechinical profession. That *GN* has endured for three decades underscores its importance as a worthwhile forum for the geotechnical community.

Thanks go out to GN's intrepid editors whose dedication and diligence over the years have helped this publication endure. Also, thanks to its advertisers whose support has enabled the continuation of this viable and worthwhile endeavor.

In a continued commitment to disseminating news of interest to the geotechnical profession, *GN* is now accessible online at **www.geotechnicalnews.com**, along with current book lists from *Bitech Publishers* and links devoted to geotechnical activities.

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Additional information for the various positions shown below is located on the CGS websire at http://www.cgs.ca

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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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Introduction by John Dunnicliff, Editor

This is the sixty-ninth episode of GIN. One full-length article this time, and a series of brief articles about remote methods for monitoring deformation.

Response values (a.k.a. trigger levels and hazard warning levels)

In the September 2011 episode of GIN I wrote, "I'm working with a colleague to put together answers to the question, 'How should we determine response values?' and hope to include this in a later GIN". The following article by Mike Devriendt helps us to face this challenging task.

Remote methods for monitoring deformation

In the December 2011 episode of GIN I wrote that I was planning to provide an overview of various remote methods for monitoring deformation in one or more later GINs—a one-page overview of each and a concluding article with a comparative analysis of the various techniques. Here's an introduction by me and the first four one-page articles on:

- Terrestrial laser scanning (light detection and ranging): TLS Terrestrial LiDAR, by Matthew Lato.
- Terrestrial interferometric synthetic aperture radar: TInSAR, GBInSAR, by Paolo Mazzanti.
- Robotic total stations (automatic total stations, automated motorized total stations): RTS, ATS, AMTS, by Rob Nyren, Ryan Drefus and Sean Johnson.
- Reflectorless robotic total stations: RRTS, by Damien Tamagnan and Martin Beth.

In the next GIN we'll have 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 one of my colleagues said to me, "The basic difference between these remote sensing techniques and our stuff is that **they** measure on the outside, whereas **we** measure on the inside. E.g. for a landslide, they measure the effect, we measure the cause". Not too shabby!

The next continuing education course in Florida

This is now 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.

Zivili! (Serbia)

Trigger levels for displacement monitoring

Mike Devriendt

Introduction

This article discusses the use of trigger levels for monitoring geotechnical or tunnelling projects. Trigger levels are also known as response values and hazard warning levels. The content of the article focuses primarily on trigger levels for instrumentation used to monitor strain or displacement. However, some of the principles would also extend to trigger values relating to other parameters such as water level, pressure or temperature. The article refers to the measurement of 'displacement' throughout much of the text, while later sections use the term 'deformation' to indicate the interpretation of measured displacements to calculate a strain or other form of distortion of a structure.

Trigger level systems

This section provides a framework for defining trigger levels.

A trigger level is a pre-defined value of a measured parameter. If an instrument reading is higher than this value, then a pre-defined action is carried out.

It is common to use two or more trigger values during monitoring of construction to denote different levels of response, given the magnitude of the reading and urgency or significance of the required response.

From the author's experience the adoption of a 'traffic light' system is most effective, with the use of Green, Amber and Red trigger levels. The use of such a system is useful to provide a simple and robust system that is clear for monitoring and non-monitoring specialists. Some practitioners propose having numerous other trigger levels defining different actions. While further trigger levels may have the benefit of allowing more detailed planning of escalating contingency responses, if a trigger doesn't result in a defined process, it is proposed that there should be no need for the trigger.

The following zones are commonly defined:

- Green = OK, proceed
- Amber = Monitor more frequently, review calculations and start implementing contingency measures if trends indicate the Red trigger may shortly be reached
- Red = Implement measures to cease movements and stop work.

Alternative words are also commonly used to describe the Amber and Red triggers. These include:

Amber = Threshold, Alert, Review, Warning

Red = Limit, Maximum, Action, Response, Tolerable limit

Prior to construction work starting a process and timeframe should be defined that project participants adhere to once a trigger has been reached. It is also recommended that consideration is given, prior to construction work starting, of the actions or mitigations that can be readily deployed once trigger values are reached. This may avoid scenarios where the program is impacted due to cessation of work once a Red trigger has been reached or exceeded.

Consideration should then be given to the rate at which movements are likely to occur. For instance, the rate at which movements take place around a tunnel excavation formed using a tunnel boring machine is generally much quicker than the rate of movement around open or retained cut excavations. This will influence project participants' views on what actions are appropriate and possible as and when trigger values are exceeded.

Defining trigger values

While the previous section provides a framework for defining trigger levels, the following approach is commonly used for defining the value of the trigger levels based upon earlier design analysis:

- Amber trigger is set close to the 'calculated' displacement from analysis;
- Red trigger is based on a tolerable 'damage' or deformation criteria.

When setting Red trigger levels, an alternative definition is, "a conservative estimate of when a serviceability limit state is likely to be exceeded". In this regard it is useful to consider the Amber and Red trigger levels to be set on two separate unrelated scales; one related to calculated movements and one relating to tolerable movements.

An example of how trigger values can be set is provided in Figure 1.

Consideration should be given to the degree of conservatism adopted in the calculation to define the Amber trigger level.

For assessing movements caused by tunnelling and with reference to the example provided in Figure 1, good practice suggests carrying out serviceability limit state calculations using a cautious estimate (or conservative) volume loss rather than a 'best estimate'. Therefore if setting the Amber trigger at 80% of the calculated movement, the actual movement can be expected to be of similar magnitude or less than the specified Amber trigger level. Measured displacements greater than the Amber trigger will therefore identify that the movements are in excess of calculated displacements using 'best estimate' parameters and should therefore prompt a review.

It is also common to relate contractual requirements to trigger values with respect to responsibility of causing impact and requirements for repair to third party structures. Commonly the Amber trigger is used to define where responsibility transfers from the project client or promoter of a project to the construction contractor. The Amber trigger may therefore represent a level that should not be exceeded provided 'reasonable skill and care' is adopted in carrying out the construction work.

Further considerations

What movement is tolerable?

It was recommended above that Red trigger levels should be based on a tolerable damage or deformation criteria. When assessing some third party assets, tolerable deformations are not always easy to calculate. An example of where this could be difficult is assessment of deformation of a tunnel being used as part of an operational urban metro system. Tolerable deformations under this scenario can be related to several elements:

1. Structural deformation;
2. Clearance of trains to tunnel lining;
3. Deformation of track within the tunnel; and
4. Deformation of services and utilities within the tunnel.

Assessing the amount of deformation that each of the above elements can tolerate have varying degrees of difficulty. Specifying trigger levels on each of these factors is also challenging as it may result in a complex range of trigger values for the same 3rd party structure. Where possible it is advantageous to identify the critical element(s) and base triggers on these.

On what parameters should you set trigger values?

Consideration must be given regarding which measured parameters to set trigger values for. One particular challenge is that parameters (or deformations) that cause damage such as imposed curvature are not straightforward to calculate from monitoring results. Interpretation is often required to calculate an appropriate curvature. The requirement for interpretation may lead to disagreement between project participants. Parameters that are easier to report from monitoring data results such as settlement or tilt

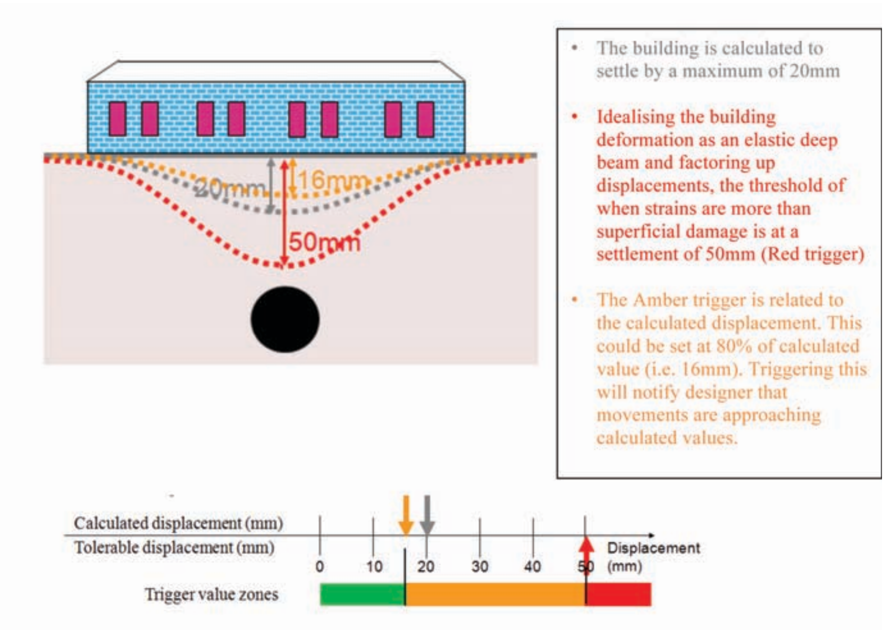

Figure 1. Setting trigger levels for a building subject to settlement from tunneling.

are less susceptible to the requirement for interpretation, however, they may not result in any impact or damage to a structure. For instance if an entire building settled by 25mm or rigid body tilt occurred to the structure, the structure may not be damaged in any way.

A common solution to this issue is to set triggers on parameters that are easier to report such as settlement and tilt, then only calculate and carry out interpretation on parameters such as curvature once the Amber trigger has been reached. There remains some residual risk with this approach and therefore it is prudent for interim checks to be carried out by the engineer responsible for interpreting the monitoring data prior to an Amber trigger being breached.

Trigger values for compensation grouting

Following on from the previous section, further consideration is required regarding triggers where compensation grouting is proposed. Specifying limits on just settlement can lead to significant amounts of grout being unnecessarily pumped into the ground and consequently additional cost. However it is considered prudent to specify triggers relating to heave movements to check against inappropriate operation of the grouting system. Where settlement occurs, it is recommended that triggers are specified relating to limits on imposed gradient and potentially deflection ratio, if agreement can be made among the project participants of how to calculate the latter.

Instrument reading accuracy and triggers

Care should be taken when selecting instruments to ensure they can be read to sufficient accuracy and precision. Accuracy in this article is defined as a measure of how close the measured value of the parameter is to the true value, while precision is the repeatability of a measurement when there is no real change in the parameter being measured. Trigger levels should be at least several times larger than the accuracy of measured changes. Account should also be made of any diurnal trends that could take place and these should be identified from baseline readings. If the calculated displacements are small (for example only a few millimetres) and tolerable values are considerably larger, it is prudent to set the Amber trigger at a displacement higher than the calculated value and in keeping with the general recommendation that they should be at least several times larger than the accuracy of measured changes. This represents an alternative to setting trigger values close to calculated values identified earlier.

Identifying trends of data

As the construction work progresses, it is important to review trends of movement even if the readings are within the Green zone and haven't exceeded any trigger values. Trends within the Green zone can give useful forewarning. A pro-active approach is therefore recommended for reviewing monitoring data. Review of the data and trends must be made with knowledge of the construction progress and any important environmental factors. In determining trigger levels and defining the process initiated once they are exceeded, consideration should be given to the time needed to instigate any pre-planned response to a developing trend.

Conclusions

This short article has identified some of the key considerations for setting trigger values relating to monitoring displacement and deformation. The article has highlighted the requirement that the person setting triggers must have intimate knowledge of the design. Guidance is also given relating to which deformation parameters to set trigger values on and appropriate review of monitoring data relative to triggers during the setup of a monitoring system and during construction.

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Remote monitoring of deformation. Introduction

John Dunnicliff

I was very impressed by the number of papers about remote methods for monitoring deformation at last September's International Symposium on Field Measurements in GeoMechanics (FMGM) in Berlin. Because I knew almost nothing about several of these, with their multiple acronyms, I decided to read the papers and learn. But then a colleague had a better idea – find knowledgeable people and ask each to write a brief article. So that's where we're going.

In this and the following GIN there are/will be seven one-page articles about the monitoring methods in the table below.

Monitoring Method	Acronym(s)	Author(s)	Author's Company
Terrestrial laser scanning (light detection and ranging)	TLS Terrestrial LiDAR	Matthew Lato	Norwegian Geotechnical Institute
Terrestrial interferometric synthetic aperture radar	TInSAR GBInSAR	Paolo Mazzanti	NHAZCA (Natural HAZards Control and Assessment), Italy
Robotic total stations (automatic total stations, automated motorized total stations)	RTS ATS AMTS	Rob Nyren, Ryan Drefus and Sean Johnson	Geocomp, USA
Reflectorless robotic total stations	RRTS	Damien Tamagnan and Martin Beth	SolData, France, USA and other locations
Satellite interferometric synthetic aperture radar	SInSAR, including DInSAR and PSInSAR	Francesca Bozzano	University of Rome, Italy
Digital photogrammetry		Raul Fuentes Stuart Robson	University College London
Differential global positioning system	D-GPS	Rob Nyren Jason Bond	Geocomp, USA Gemini Navsoft Technologies, Canada

I considered including airborne laser scanning (ALS or Aerial LIDAR), but have been advised that this is more applicable to topographical mapping than for displacement monitoring due to the low accuracy. I also considered including digital image correlation, but have learned that this method is still in the R&D stage, and not yet ready for our use on our projects.

We've had full-length articles in previous GINs about three of these methods:

- *Robotic total stations* (by David Cook, December 2006, with discussions by Martin Beth, Brian Dorwart, Richard Flanagan and Trevor Greening, March 2007. Also by Allen Marr, September 2008)
- *Terrestrial interferometric synthetic aperture radar* (by Paolo Mazzanti, June 2011
- *Reflectorless robotic total stations* (by Damien Tamagnan and Martin Beth, September 2011)

but I decided to include them among the current one-pagers for completeness.

So that we'd have some uniformity, I've given the authors some guidelines about format and subheadings.

This episode of GIN has articles about the first four methods in the table (in alphabetical order of first author's name), and the remainder will be in the June episode. To close out this topic, in June there will also be a concluding article by a colleague from Italy who has experience with most of these methods. He will read all the one-pagers and write a comparative analysis of the various methods for remote monitoring of deformation.

This is helping me to clarify my muddled brain—I hope yours too.

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.

Remote monitoring of deformation using Terrestrial Laser Scanning (TLS or Terrestrial LiDAR)

Matthew J. Lato

Principle of operation

Terrestrial Laser Scanning (TLS) is a remote measurement technique that employs Light Detection and Ranging (LiDAR) technology. TLS calculates the distance between the scanner and the target by measuring the time delay between an emitted laser beam and the reflected signal (illustrated in Figure 1). This is a similar technology to total stations; however, the laser is robotically rotated through the scanners field of view measuring up to one millions points per second. The georeferencing of TLS data is done through placement of targets in the scene, typically flat circles are used. The targets are also used for measuring deformation at specific locations.

Main fields of application

TLS is used for geotechnical monitoring of tunnels (during construction and post construction degradation); rockcuts along transportation corridors; construction (piles, shoring, etc.); landslides; dams; and building deformation. Non-geotechnical applications include forensics; archeology; and architecture.

Accuracy and pixel resolution

TLS accuracy is determined by systematic and random error. Systematic error is governed by range error and angular error. Range error is error in the measurement of distance between the scanner and the target. Angular error is the error in the positioning of the scanners mirrors. Systematic errors translates to an accuracy of +/- 5 mm at 25 m, to +/- 30 mm at 1000 m. Random errors are in relation to the incidence angle between the scanner and target, as well as the reflectivity of the target. Random errors affect the precision of the measurement, which is variable, generally 0 – 10 mm, regardless of distance.

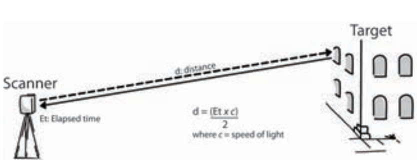

Figure 1. Operating schematic of a TLS scanner.

Pixel resolution of TLS equipment is based on the distance between the target and the scanner, as well as the type of scanner. This value can be as high as 5 mm at 25 m. However, due to beam divergence, the pixel spacing in the point cloud and the sampling resolution must be evaluated for every project.

Main advantages

Using TLS for deformation monitoring is advantageous for many reasons relating to data collection, processing flexibility, and presentation of results. TLS is an extremely fast, accurate, non-destructive technology. Data collection can be integrated with construction projects or implemented in remote regions. Processing options are diverse, including investigating individual TLS models for geometry, comparison to CAD, and temporal modeling over time. As well, the high resolution nature of the data enables realistic images and models for reporting of results.

Main limitations

TLS is an emerging technology with variable equipment and processing options. Users must be aware of their options and the limitations of each system. As well, it is essential that data be collected properly, without occlusion (shadowed regions) and processed in a manner that preserves accuracy.

Future challenges

There are three main challenges for using TLS in geotechnical monitoring: data format, processing standards, and timely collection of data. Data formats are critical in an industry that employs various TLS technologies, each of which uses its own binary format to reduce file size. A standard format will ensure that data collected today will be processable on future computers. For example, airborne LiDAR (ALS) data is stored in the industry-approved LAS format. No such format exists for TLS data. The use of TLS for monitoring is generally performed on an on demand basis; there exist no general guidelines for data manipulation, analysis, or presentation of results. For TLS technologies to be adopted, this must be addressed. Finally, TLS is viewed as a costly tool and therefore is generally used once site conditions have deteriorated. This is a challenge for achieving the optimal monitoring results because a baseline cannot be established. To achieve the best results from TLS, data must be collected before problems arise.

Some commercial sources

- Applied Precision: Mississauga, Canada, www.applied3Dprecision.com, +1 905-501-9988
- Norwegian Geotechnical Institute, Norway, www.ngi.no, +47 414 93 753
- Precitech AB, Sweden, www.precitech.se, +46 31 762 54 00

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Remote monitoring of deformation using Terrestrial SAR Interferometry (TInSAR, GBInSAR)

Paolo Mazzanti

[Please refer to Mazzanti, GIN June 2011, pp 25-28 for more details. Ed.]

Principal of operation

Terrestrial Synthetic Aperture Radar Interferometry (TInSAR, also referred to as ground based SAR interferometry, GBInSAR) is a RADAR technique for the remote monitoring of displacements. By the movement of a RADAR sensor along a linear scanner (i.e. a rail that allows precise micrometric movements of the sensor), 2D SAR images are derived. By comparing the phase difference, i.e. interferometric technique, of each pixel between two or more SAR images acquired at different times, the displacements along the instrument line of sight (LOS) are derived. Thus, 2D color images of LOS displacement can be achieved as well as the displacement time series of each pixel (Figure 1). TInSAR monitoring can be performed by installing the equipment at a stable location in a panoramic position, and it does not require the installation of contact sensors or reflectors in the monitored area.

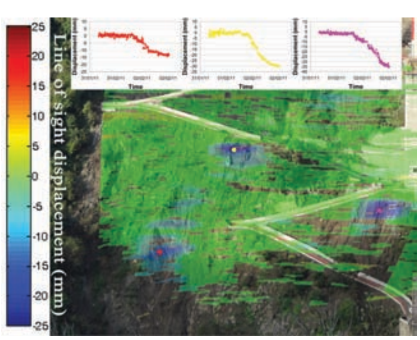

Figure 1. TInSAR displacement map overlaid on the slope picture and time series of displacement.

Main fields of application

The best application of TInSAR is the continuous monitoring of unstable slopes and dams. Other applications include linear infrastructures such as bridges, localized subsidence and buildings. TInSAR monitoring of buildings is quite challenging because although it is possible to collect highly accurate displacement data by a non-contacting technique, it is quite complex to detect vertical movements.

Accuracy and pixel resolution

The theoretical accuracy of TInSAR equipments is on the order of +/- 0.1 mm. However, both the precision and the accuracy are strongly reduced by the atmospheric noise. The precision ranges from few tenths of mm to a few mm, depending on the monitoring distance and the atmospheric conditions. The pixel resolution of a terrestrial SAR image ranges from few decimetres to several meters (depending on the equipment and on the monitoring distance). At a distance of 1 km, the most common commercial equipment has a resolution of about 0.5 x 4 m.

Main advantages

The main advantage of TInSAR is probably the ability to monitor displacements from a remote position without the installation of targets or sensors on the monitored ground or structure. Other advantages include applicability under any lighting and weather conditions, including rainfalls, clouds and fog; high data sampling rate (few minutes); long range efficacy (some km); high accuracy and spatial control.

Main limitations

The main limitation is the complex management, processing and interpretation of TInSAR data. Other limitations include: i) the size of commercial equipment (up to 3 metres long); ii) limited cone of view (some tenths of degrees in both the H and V planes); iii) unidirectional measure of displacement (along the instrument LOS) and iv) signal phase ambiguity (i.e displacement higher than 4.5 mm between two consequent images are not easily detectable).

Future challenges

- The increasing number of applications will contribute to improve both the technique and monitoring good practice.
- Cheaper and smaller hardware may improve the use of TInSAR, especially in urban areas.
- Advanced algorithms and software for the processing of data may improve the usability and effectiveness of TInSAR.

Commercial sources in North America

In the author's knowledge the following two companies are providing services with TInSAR: Olson Engineering Inc., Colorado (USA), http://olsonengineering.com.and C-Core, Kanata, Ontario (Canada), www.c-core.ca. European companies with longer expertise are listed in the article referred to above.

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Remote monitoring of deformation using Robotic Total Stations (RTS)

Rob Nyren, Ryan Drefus, Sean Johnson

Robotic total stations (RTS) are remotely operated theodolites that can deliver continuous (24/7) near-to-real-time survey measurements on reflective prismatic targets. They are also referred to as automated total stations (ATS) and automated motorized total stations (AMTS). In the past 3-5 years RTS systems have become an essential component of performance monitoring programs for urban infrastructure projects across North America. The essence of the RTS system operation has been explained by others in this publication, including David Cook (GIN December 2006) and Allen Marr (GIN September 2008).The authors refer the readers to these issues for additional information.

Applications

RTS systems are most frequently used as a tool for monitoring deformation of buildings and structures due to large civil works. However the authors have used these system to monitor many other applications including load tests (pile loading, lateral loading of bridge foundations, static and dynamic load testing of bridges), MSE wall performance (wall face monitoring and internal strain), ground deformation monitoring around deep excavations for power (please clarify), compaction grouting beneath various structures, automated crack monitoring on basement walls. The application of RTS systems is seemingly limitless.

Accuracy

The best instruments available coupled with proper installations and best operating practice deliver accuracies of +/-0.5mm (0.02in). For this accuracy it is reasonable to expect about 90% of the readings within +/-1mm, and to see statically "real" readings up to +/-2mm every now and then. Consideration of "relative movements" of targets can yield much better accuracies (nearer +/0.3 mm (0.01 in).

Main advantages

RTS systems deliver the highest quality survey data from a fixed survey layout with little manual field effort once installed; multiple readings done at the instrument instantaneously improves overall precision, (why do you need to refer to precision?) accuracy, and helps to identify erroneous readings. Systems can easily accept the addition of new targets to accommodate unforeseen monitoring needs with low cost. Newer systems can capture photographic images in conjunction with monitoring to provide additional information and insight.

Main limitations and other performance considerations

Measurements from RTS systems are optical with accuracy and precision (as above) limited by many conditions, such as weather changes, atmospheric conditions, suspended particulate in air due to construction, traffic, and vibrations. Poor installations of RTS instruments expose them to vandalism and other severe weather issues. Maintenance of difficult-to-access locations (e.g. an RTS high on a building facade) can be both dangerous and expensive; careful planning and system design can reduce maintenance. The RTS system by design concentrates all the monitoring effort to the RTS; any failure of the RTS (including power, remote access, computer software) results in a total failure of the monitoring program until the problem is mitigated. Monitoring points installed at extreme angles from the reference points used for re-sectioning the RTS can contribute to errors. Large zones of construction influence often make finding an adequate quantity of reference point locations problematic.

Challenges

Many RTS monitoring systems used for civil projects in the U.S. are comprised of multiple instruments in urban settings. It has been the experience of the authors that multiple units can be 'networked' to overcome some of the common limitations listed above – notably a lack of good reference sights. In a networked solution each RTS shares common targets with other RTSs. These common targets establish redundant geometries between the RTS positions and known reference locations, and the position of each RTS can be solved using a least squares adjustment solution. This process minimizes random and systematic error associated with raw measurements, gives better solutions on RTSs with poor referential control, and allows the overall movement calculations to be more statistically qualified. With these improvements also come new limitations: the loss of measurements from any one RTS that provides observational continuity along the network can cripple the ability for commercially available software to process raw measurements into monitoring data. Based on this experience, it is recommended that one (or more) spare RTSs be maintained on each project to respond quickly to potential issues when using networked systems.

Commercial sources

Robotic total statin instrument manufacturers include Leica, Sokkia, Trimble. Implementing these systems is best done by professionals experienced with RTS systems (e.g. design, installation, operation, and maintenance); these professionals are most often not traditional land surveyors but instrumentation specialists/engineers with broad geotechnical and structural monitoring expertise.

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Remote monitoring of surface deformation with Robotic Total Stations using reflectorless measurements (RRTS)

Damien Tamagnan and Martin Beth

[Please refer to Tamagnan and Beth, GIN Sept 2011, pp 21-24 for more details. Ed.]

Principle of operation

A remote monitoring system able to measure surface deformation 24 hours a day is made up of:

- A robotic total station (RTS) equipped with a reflectorless distance meter.
- A support platform, electronics box, and 3G or Wi-Fi system.
- A data logger which can be operated remotely with specific software able to drive the total station to the predetermined locations of the monitored points.
- Computation software, which can be more or less advanced, for calculating the movements of the points of interest.

During each monitoring cycle the instrument sights at (see Figure 1):

- The reflectorless surface points (RSPs) on a flat, homogeneous and planar surface for which vertical deformation is to be monitored. RSPs are not physically marked and are not physical objects; they are just a location on the ground at which the RTS is sighting.
- The stable reference prisms, which permit computation of the correct position and orientation of the RTS.
- If necessary, the same total station and software can sight monitoring prisms installed on structures to be monitored in 3D, as for a standard RTS.

On completion of the cycle, the raw and/or calculated data are sent to the database via Wi-Fi or 3G. The system can also trigger alarms sent by SMS or e-mail if predetermined thresholds are exceeded.

Main fields of application

Monitoring of road surfaces during underground work.

Accuracy

The accuracy of the RRTS method has been confirmed by comparing precise levelling with RSP movements. External controls confirmed a consistency better than ±1 mm.

Main advantages

- High frequency of readings possible (down to one reading per hour for example)
- Uninterrupted traffic, neither for installation nor for taking readings
- Very safe, no surveyors on the road
- Very cost effective for high frequency of readings

Main limitations

The range of the distance meter is limited, and so is the angle of incidence of the laser beam on the measured surface. Weather conditions also downgrade the emitted distance meter signal.

Case histories

The RRTS method has been well proven in practice in many work sites since 2005.

- In Amsterdam (Netherlands) over 82 RTS are used to measure more than 5000 RSPs above the tunnel boring machine during the construction of the metro line.
- In Toulon (France) a network of 1830 RSPs has been measured over roads and pavements from 36 RTSs during four years.
- In Barcelona (Spain) long-term monitoring of the high speed railways tunnel and of Metro Line 9 has been set up to monitor settlement on roads, sometimes with heavy traffic.

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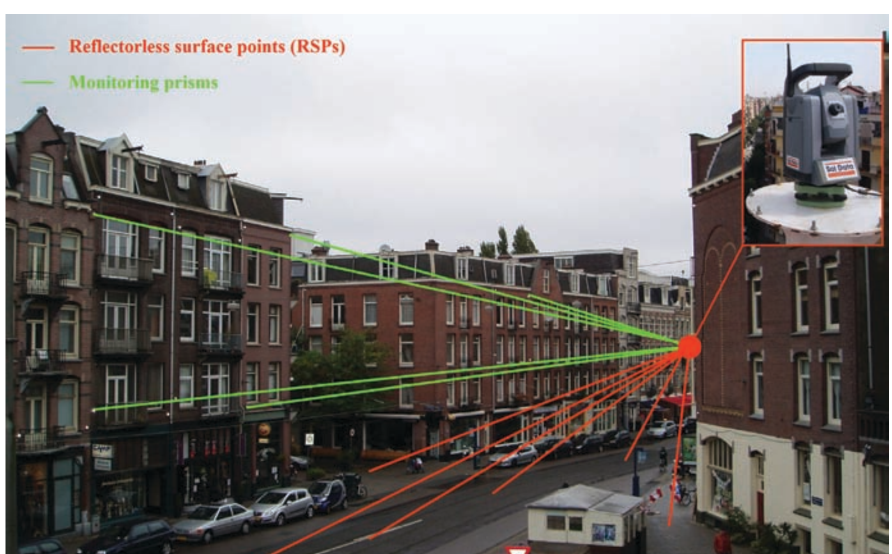

Figure 1. A Reflectorless Robotic Total Station (RRTS) measuring RSPs and prisms.

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Influence of element size in numerical studies of seepage: Small-scale details

Robert P. Chapuis

Many of us use numerical codes to study groundwater seepage within aquifers and aquitards, and often to solve groundwater engineering problems. A previous paper (Chapuis 2010) examined the influence of element size on numerical result for large-scale or regional studies. It was shown that different grid sizes provide different solutions, the convergence towards a correct solution depending on the mesh size. Both convergence and mesh size need to be studied methodically.

One of its conclusions was that all geometric details should be modelled as accurately as possible, especially at places where any sought function (hydraulic head, gradient, velocity, etc.) reaches a local maximum or minimum. The present paper studies two examples of small scale details and how the numerical results are modified by the mesh size for the details. The two examples are: (1) seepage below a partial cut-off wall, and (2) seepage towards a pumping well in an ideal confined aquifer.

First example: dam and partial cut-off wall

The problem geometry appears in Figure 1, with the flow net for one numerical grid. Output data relevant for this engineering problem include (1) the leakage rate through the dam foundation Q ($m^3/m/s$), (2) the risk of soil internal erosion at the toe of the cut-off wall, and thus the maximum value of the hydraulic gradient here, and (3) the maximum exit gradient at the downstream side of the dam, which must be less than 0.200 or 0.167 (1/5 or 1/6) for safety requirements (Chapuis 2009).

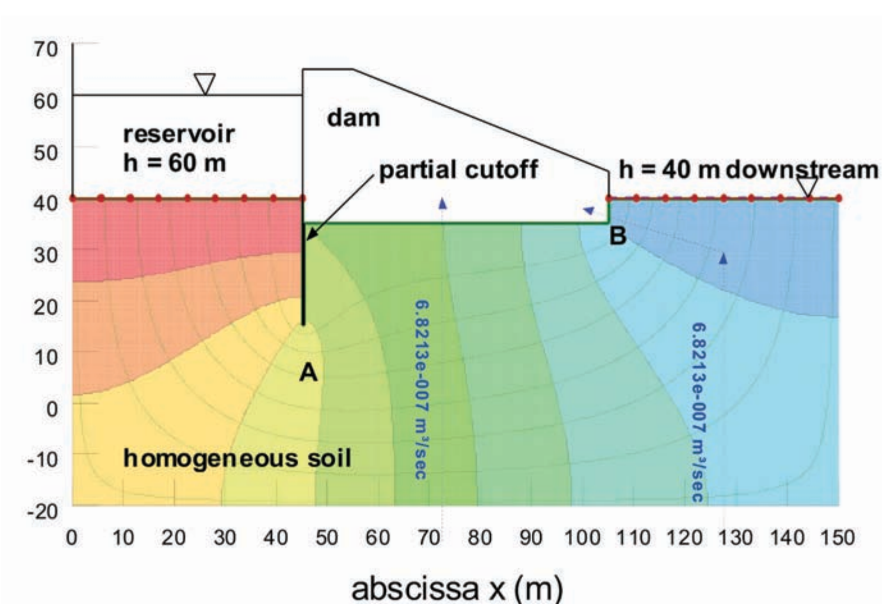

Figure 1. Partial cut-off wall: flownet in the dam foundation.

The finite element code Seep/W (Geo-slope International 2003; 2007), an older version of which has passed a battery of tests (Chapuis et al. 2001), is used here. This code uses the soil characteristic functions, $K(u_w)$ and $\theta(u_w)$, in which u_w is the pore water pressure, $K(u_w)$ is the hydraulic conductivity function, and $\theta(u_w)$ is the volumetric water content function. The generalized equation of Darcy (1856) for seepage, and Richards (1931) for mass conservation, are solved numerically as u_w-based equations. The code can find complete solutions for saturated and unsaturated seepage. Once the numerical analysis is completed, the code provides equipotentials, flow lines and flow rates through previously defined surfaces.

Several grids are considered, starting as always from the simple to the complex or from the coarse to the most detailed. The following output data were obtained using the 2007 most recent version of the code. The uniform meshes had sizes of 10, 5, 2, 1, and 0.5 m whereas the refined meshes started with a 0.5 m uniform meshing before making a refinement, at the toe of the cut-off wall, of 10, 5, 2 and 1 cm. The coarsest uniform mesh size was 10 m. In fact, since the cut-off wall has a width of 0.5 m, the automatic mesh generator drew elements 10 m high and 0.5 m wide under the cut-off, without giving a

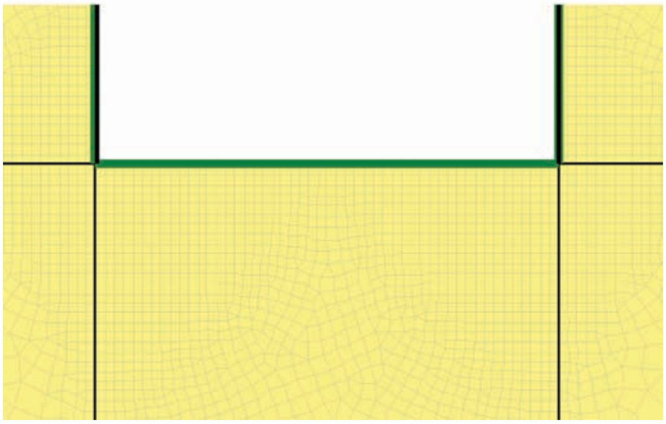

Figure 2. Partial cut-off wall: examples of refined grid around the toe of the cut-off wall.

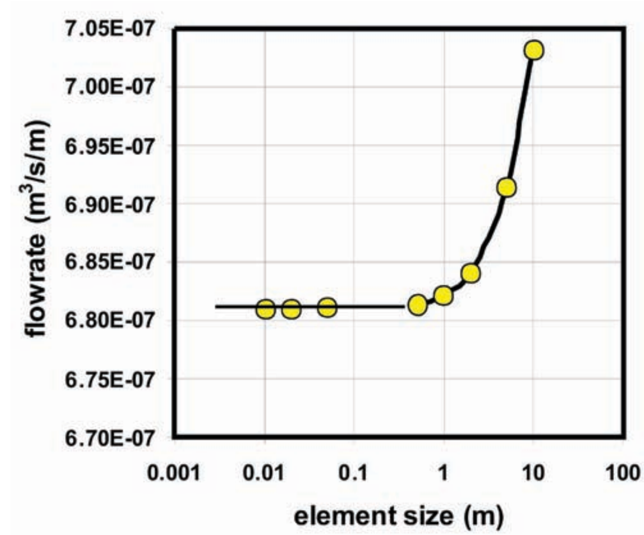

Figure 3. Partial cut-off wall: Convergence of numerical value of the leakage flowrate.

warning for the high aspect ratio of 20, whereas several large elements had a size smaller than 10 m to adapt to the problem geometry. A local view of the finest mesh, with elements as small as 1 cm close to the toe of the cut-off wall and not larger than 0.5 m elsewhere, is given in Figure 2.

Now examine two convergence issues. First, the leakage rate Q is expressed in m^3/s per linear meter of dam perpendicular to the vertical cross-section of Figure 1. Its convergence is easily achieved as shown in Figure 3, as soon as the uniform element size is about 1 m. Even with a grid of 10 m, the error on the leakage rate is only 3%. This insensitivity to grid size explains why it was easy, many years ago, to find the right leakage rate using hand-drawn flow nets.

The hydraulic gradient reaches its maximum at the upstream angle of the cut-off wall toe. Each time the numerical grid is refined, this maximum gradient increases (Figure 4). The gradient is less than unity for a grid size greater than one metre, but increases notably when the grid is refined. Therefore, this is a case of diverging maximum gradient. This happens because the cut-off wall has been modelled as a rectangular impervious domain. At the upstream and downstream toe angles, the model induces a discontinuity in the groundwater velocity vector, which explains the divergence of the gradient value. Therefore, very high hydraulic gradients are generated locally at the angles. This means that seepage forces (which are proportional to the gradient), will induce local erosion (fines are washed off), which in turn will locally increase the soil K value, thus reducing the local gradient and the erosive action. However, this erosive action at the toe could propagate upwards, thus reducing the efficiency of a partial cut-off wall. The risk of local erosion at the toe explains why it is necessary to anchor a total cut-off toe in a solid (not likely to be eroded) material such as bedrock.

In practice, however, a partial cut-off wall will have a rounded toe, due to both excavation process and erosive action due to seepage. This rounded toe automatically lowers the maximum gradient, and the numerical study then provides a convergence towards about 2 for the maximum gradient at the cut-off wall toe.

Second example: pumping well, confined aquifer

The second example has a closed-form solution, which is not the case for the first example. Therefore, in the second example we can establish accurately how the numerical solution converges towards the correct closed-form solution as a function of the grid element size.

A vertical well of radius $r_w = 0.15$ m fully penetrates the confined aquifer that is horizontal, homogeneous (K_{sat} = 4 x 10^{-4} m/s), and of uniform thickness b = 2 m. The well is at the center of an island of radius 600 m, the surrounding lake having a constant hydraulic head h_0 = 22 m. For steady-state the hydraulic head in the well is h_w = 15 m, and the constant pumping rate is Q. The closed-form solution is given by the Thiem equation.

We examine here the numerically calculated value for Q (m^3/d), and also the hydraulic head at a monitoring well located at a radial distance r = 20.15 m. Several regular grids of quadrilateral elements have been used. The element size is 50 m for the coarsest grid and 2.5 cm for the finest grid.

The numerical value of Q converges towards the closed-form solution

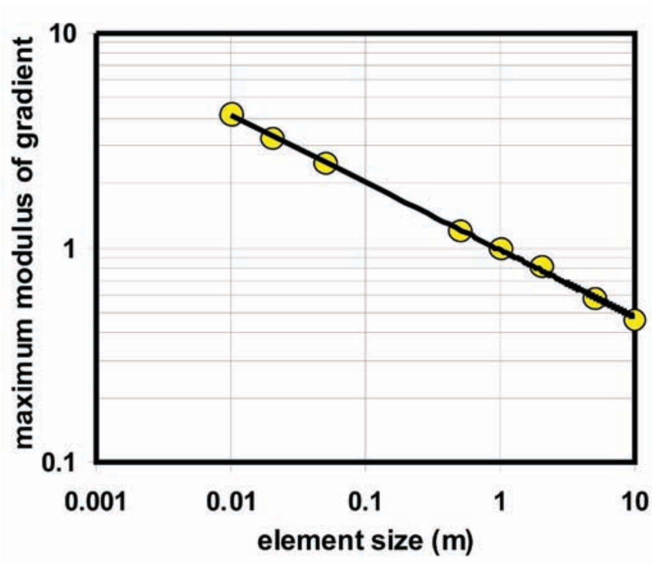

Figure 4. Partial cut-off wall: Divergence of the local maximum gradient at the upstream of the cut-off wall toe.

(Figure 5) but the relative error is still about 7% for elements of 1 m. The error drops to about 1% for elements of 20 cm and about 0.1% for elements of 5 cm. Similarly, the numerical value for *h*(*r* = 20.15 m) converges towards the closed-form solution (Figure 6), but elements of 10 cm or less are needed for a good accuracy.

For this example, note that the 2003 version of the code has a marked advantage over the 2007 version, because it can use a progressive (logarithmic) meshing, which has been removed in the 2007 version that uses a different meshing process. The logarithmic meshing provides a much better accuracy for a much smaller number of elements (Figure 7), which reduces the calculation time, especially for transient problems. It enables the use of very small elements close to the screen, where the gradient reaches its maximum, and large elements at the distant boundary, the size of elements increasing gradually as the radial distance increases.

General rules for meshing

As for large-scale groundwater studies, a few basic principles should be observed for adequately treating small-scale details in numerical studies. First, we must have a preliminary idea of how the hydraulic head varies within the volume of our study. For a first appraisal we can use a coarse mesh, which will give us a first solution. We must examine this first solution and identify the zones with large local variations in hydraulic head *h*, and (for unsaturated zones) in water pressure *u*. These zones are those where our mesh must be refined. For a second appraisal, we can keep the large initial mesh for the volumes where the *h* variations are small, and generate finer meshes in the volumes of high *h* variations (high gradient zones). When examining the second solution and the zones of high variations, we may find that some local refinements are still needed. Once we are satisfied with our last refinement and believe that further refinement would add nothing, we should not be satisfied with our belief, but must prove it. We must prepare a confirmation mesh in which all elements will be smaller (by half, for example) of what we thought would be our last mesh. The confirmation mesh should give the same results (heads, gradients, velocities, flow rates, etc.) as our last mesh. If so, then we have the proof that we have designed and retained a correct mesh. Note that the computing time for the verification mesh may be about four to nine times longer than the time for our final and correct mesh. Thus, we should avoid using the verification mesh for long transient problems (the computing time for this verification could take many hours or even days) but use it first for faster-to-solve steady-state problems (which could then also serve as initial conditions for the longer transient simulations).

Two simple rules to observe are:

(i) The higher the local variations in *h* (anywhere), gradient (anywhere) and u_w (unsaturated zones), the finer the local mesh;

(ii) The final solution must be independent of the mesh size.

Conclusion

This short paper has examined two examples, a partial cut-off wall for a dam, and a steady state pumping test of a confined aquifer. For the two examples, the code used here reached immediate numerical convergence in two steps, the relative error on the modulus of the pore pressure vector being less than 10^{-6}. This rapid convergence is mostly due to the linearity of equations for fully saturated seepage and steady state. However, different numerical solutions were obtained for different grid sizes. In short, we observed that the finer the grid, the more accurate the numerical solution. It is also important to model all geometric details as accurately as possible. In areas where the gradient reaches a local maximum or minimum, the use of progressive or logarithmic meshing was shown to provide a clear advantage in terms of accuracy and calculation time.

To complement this paper which focuses on small scale details with high local variations of the hydraulic head and gradient, and the previous paper on large-scale studies, a forthcoming paper will provide a few examples for cases in which unsaturated seepage plays a key role.

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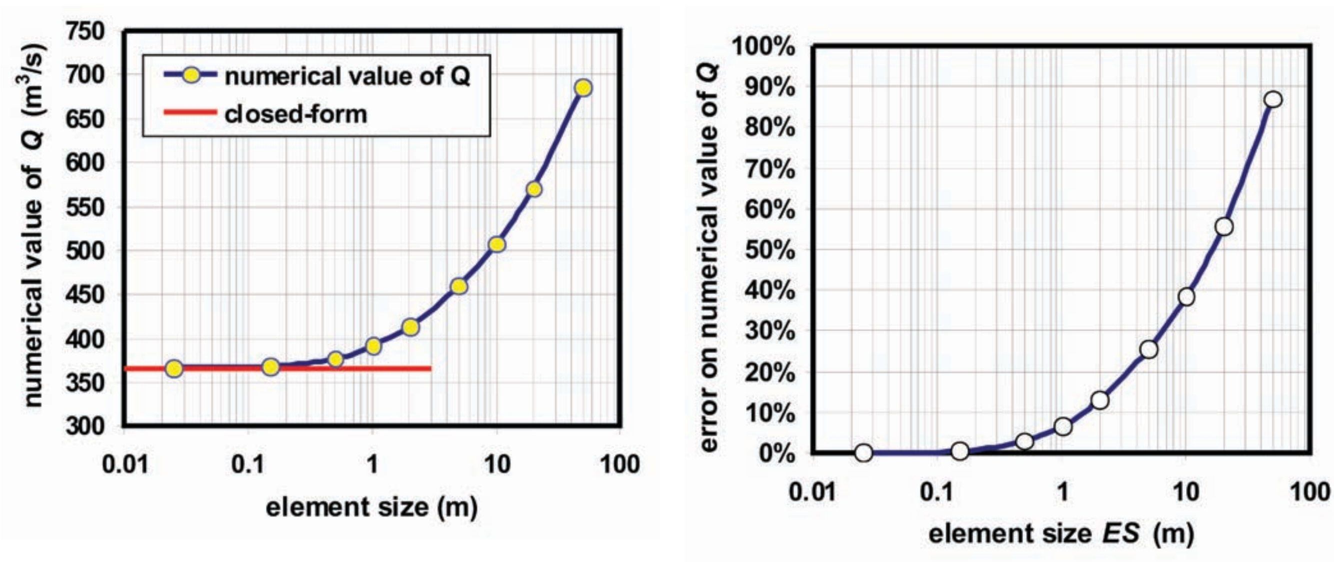

Figure 5. Pumping test: (a) convergence of the numerical flowrate. (b) numerical error.

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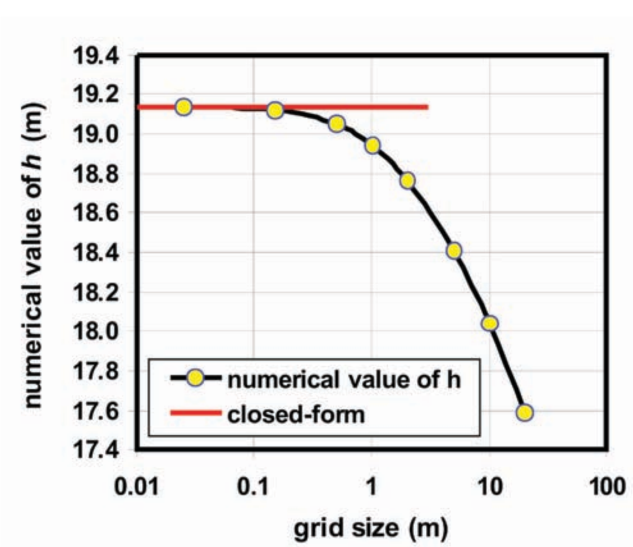

Figure 6. Pumping test: convergence of the hydraulic head at r = 20.15 m.

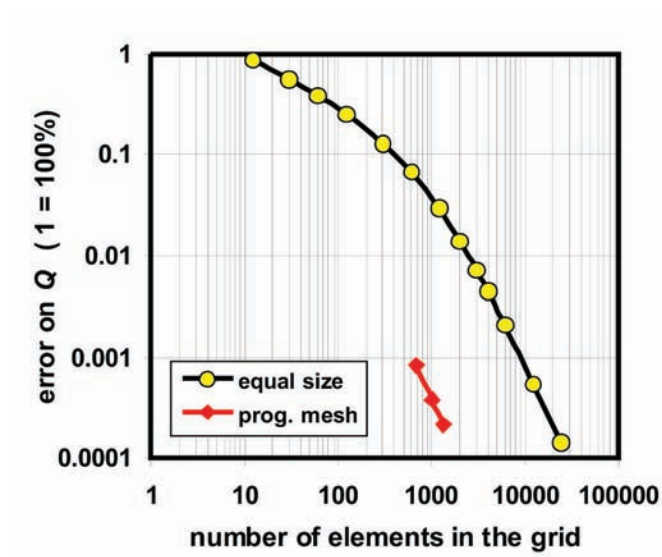

Figure 7. Numerical convergence for the pumped flow rate with two meshing methods, one with equal size, the other with progressive meshing.

Challenges with meeting regulatory compliance in the oil sands industry

Nicholas Beier, Amarebh Sorta, Ward Wilson, David Sego

Introduction

Mining and extraction of oil sands to produce bitumen has been underway in north eastern Alberta for over five decades. The Canadian oil sands deposit is home to an estimated 300 billion barrels of recoverable bitumen. At current and predicted production rates, oil sands exploitation will continue long into this century. A typical oil sand ore deposit is comprised of bitumen (~12 wt%), sand, silts, clays (mineral content ~85 wt%) and water (3-6 wt%). The mineralogy of the clay component is typically kaolinite (50-60%) and illite (30-50%) with some montmorillonite (Beier and Sego, 2007).

The production of bitumen from the oil sands ore body is based on open pit mining and a hot water extraction process. Warm to hot water, steam and process aids such as caustic (NaOH) are used to extract the bitumen from the mineral matrix. The extraction process recovers 90-92% of the bitumen and produces a tailings stream consisting of water sand silt clay and residual bitumen. Typically, the tailings streams are discharged at approximately 55 wt% (82 wt% sand and 17 wt% fines defined as <44 μm) into tailings ponds to recover water. The coarse fraction of the tailings slurry is used to construct perimeter dykes using cell construction or beach discharge. Some fines are trapped within the sand matrix of the beaches during this process (≥50%), while the remaining fines and water (8 wt% fines) flow into the settling pond (referred to as thin fine tailings). The fines slowly settle over a few years to 30-35 wt% and are referred to as mature fine tailings (MFT). Further consolidation of the MFT is extremely slow (in the order of centuries). The typical Atterberg limits for a range of MFT are shown in Figure 1. On average, approximately 1 m^3 of sand and 0.25 m^3 of MFT have been created for every barrel of bitumen that has been produced thus far (Beier and Sego, 2008). This has led to the accumulation of 800 billion m^3 of MFT (Hyndman and Sobkowicz, 2010) which requires long-term storage in fluid containment structures.

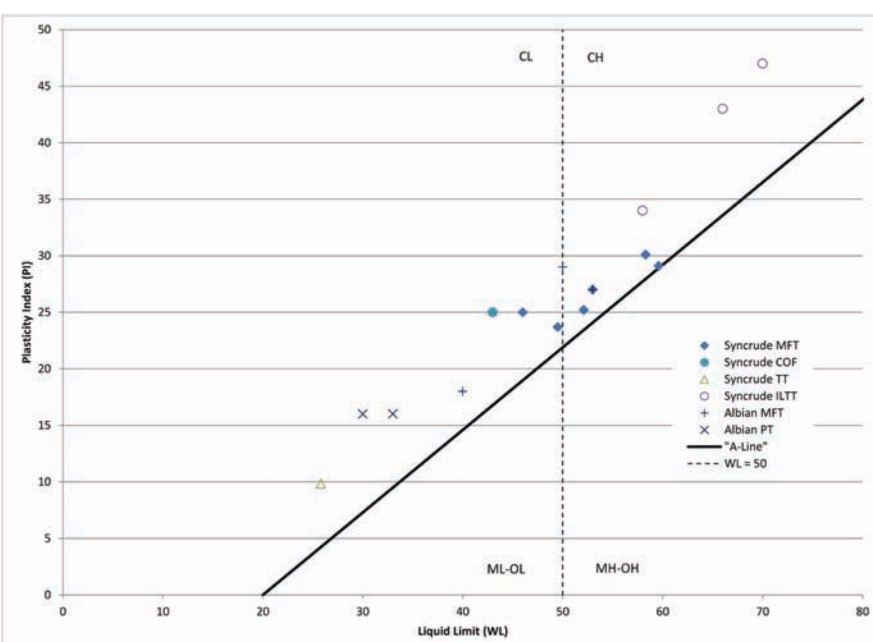

Figure 1. Plasticity chart of oil sand fine tailings.

The oil sands industry has developed methods to deal with this inventory of MFT. For example, the process of mixing sand with the MFT, termed consolidated or composite tailings (CT), requires a mixture of segregated sand (from a cyclone underflow), MFT and a coagulant (gypsum). The CT is mixed at sand to fines ratios (SFR) of approximately 4:1 and is not expected to segregate during transport, discharge or deposition. However, operational challenges have hindered the commercial full scale success of CT. The CT operation must compete for sand that is also used to provide economical containment dykes. Additionally, inconsistent control on the CT slurry densities and/or the depositional technique (shear environment) has lead to segregation of the CT slurries resulting in the release of low SFR materials that are difficult to reclaim (Hyndman and Sobkowicz, 2010). Since the 1980s, technical advances have been made in mining and material handling and bitumen extraction. However, finding practical methods to control and reduce the fluid fine tailings formation build up has been an ongoing challenge.

Oil sands tailings regulations

The Energy Resource Conservation Board (ERCB), Canada's regulatory body responsible for the oil sands industry, has been concerned regarding past tailings management practices, continual accumulation of fine tailings and the associated risks to reclamation activities. As such, they elected to regulate fluid fine tailings through performance criterion, and in early 2009 the ERCB issued Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes. The aim of the directive is to reduce fluid tailings accumulation by capturing the fines in dedicated disposal areas (DDAs) and create trafficable surfaces for progressive reclamation. The Directive requires operators to submit tailings plans, tailings pond status reports, disposal area plans and compliance reports. Compliance with Directive 074 can be directly measured through specified strength performance in the tailings deposits. The Directive requires a minimum undrained shear strength of 5 kPa for tailings material deposited in the previous year. If any material fails to meet the 5 kPa requirement, it must be removed or remediated. Additionally, five years after active deposition, the deposit must be trafficable and ready for reclamation. The metric for "trafficable" after five years requires the deposit to have a minimum undrained shear strength of 10 kPa. It is evident new technologies and processes must be developed to supplement current tailings management plans, specifically, additional fines-management techniques. Specification of a short-term strength requirement may sound like a positive exploit – at least at first glance. However, the regulation may inadvertently misdirect industry efforts. The following discussion attempts to explain some of the issues and challenges.

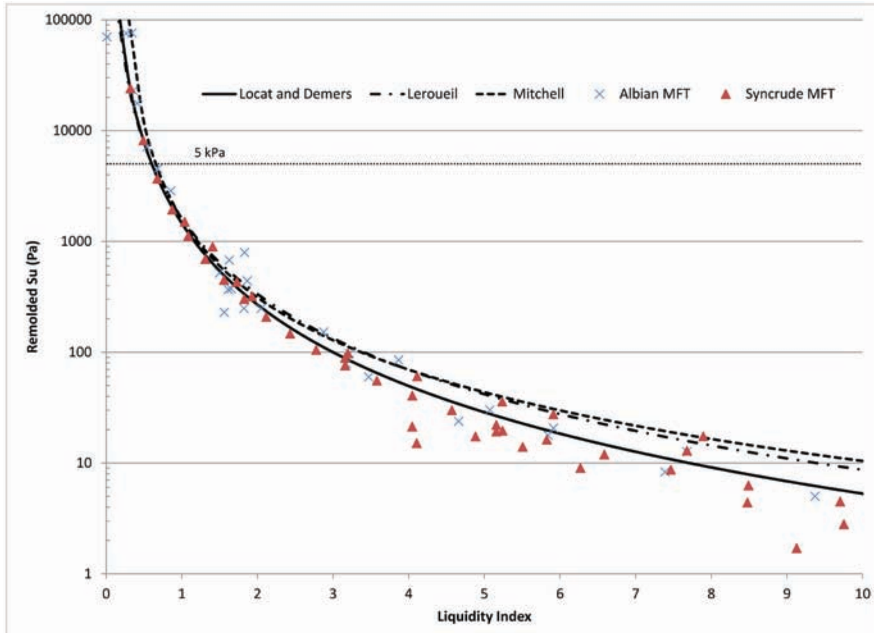

Figure 2. Remolded undrained shear strength of oil sand MFT.

Fine tailings management

Implementation of the ERCB's Directive 074 has driven industry to review current tailings management techniques and investigate the numerous alternative technologies and processes to manage and reclaim fine tailings. Essentially, there are three general methods to incorporate the problematic, clay dominant fine tailings into a closure landscape. The fines can be sequestered into the coarse tailings matrix (CT), placed under a water cap

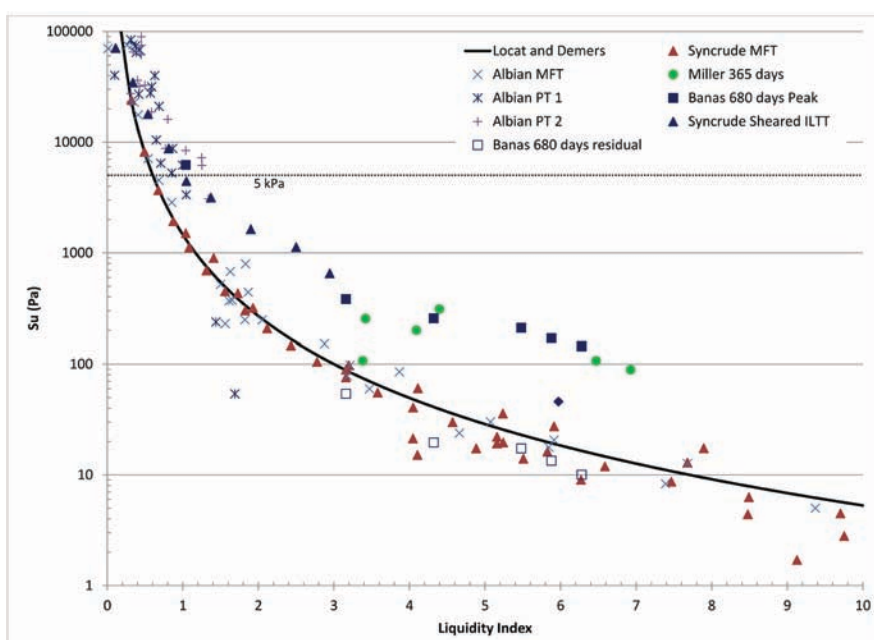

Figure 3. Undrained shear strength of oil sands fine tailings.

(in-pit lake) or dewatered separately creating a cohesive, silty clay deposit. The industry is trending toward managing the fine stream with various chemical, physical and environmental dewatering techniques. In short, the objective is to dewater the fines stream sufficiently to meet the Directive 074 performance criteria.

In addition to Directive 074 requirements, the chosen tailings management process should satisfy both operational and reclamation/closure goals (Hyndman and Sobkowicz, 2010). As the mining operations proceed, tailings should be reclaimed progressively, thereby limiting the accumulation of fluid fine tailings that would require containment, leaving remediation to the end of mine life. Fluid containment structures should be limited to a minimum (i.e., only what is required for effective tailings management). Meeting these operational goals would allow the operator to proceed with reclamation and return the mine site back to the public, thereby achieving the reclamation goals. Essentially, operators would be able to avoid tailings ponds/dams in the closure landscape that would require ongoing maintenance (in the order of decades); transform the tailings deposits into geotechnically stable landforms that are resistant to natural processes and are self-sustaining both physically and environmentally; and ensure these landforms and features are integrated into the future natural ecosystem successfully.

Physical/mechanical dewatering methods include centrifugation and high rate thickeners (thickened tailings [TT]) or paste thickeners (paste thickener [PT]). In centrifugation operations, MFT is dredged from a tailings pond, diluted and then mixed with a polyacrylamide flocculant. The flocculated fines stream is then processed in the centrifuge and dewatered to nearly 55 wt% (water content [WC] of 80%) prior to deposition. The fines stream for thickeners would come directly from the extraction process rather than from the MFT pond. Sand-depleted tailings streams or cyclone overflow (COF) would be flocculated and dewatered in the thickeners prior to deposition at solids contents reaching 60 wt% (WC of 67%). Alternatively, the fines may be dewatered through a combination of chemical addition and strategic deposition. Polymer solutions are injected directly into the transfer pipeline containing dredged MFT or COF (dilution is optional). This process is termed "in-line flocculation" or in-line thickened tailings (ILTT). Two depositional techniques are available for the flocculated fine material. The mixture (well above the liquid limit) can be discharged onto a gently sloped beach in thin layers where initial dewatering occurs due to shear, settlement and drainage from the flocs, followed by environmental dewatering (desiccation, freeze/thaw). The flocculated tailings may also be discharged into large depositional cells (>10 m deep) to promote self-weight consolidation and environmental dewatering via the surface. As water is released to the surface, active water management is required via decant structures and mechanical channeling (perimeter ditching) to promote further dewatering and development of strength. This later depositional technique is referred to as rim-ditching or accelerated dewatering. Each of these fines management techniques involves some form of polymer or chemical addition to promote dewatering and strength gain. However, it is important to note that the dewatered fines are being placed at water contents above their natural liquid limit (LL).

Implications of fines management techniques

The performance measure for fine-grained deposits in Directive 074 requires an undrained shear strength (Su) of 5 kPa one year after deposition. For typical MFT, this would require dewatering from water contents of 233% to below their LL (a Liquidity Index [LI] of 0.6). Figure 2 depicts this relationship between LI and remolded Su for typical MFT from the Albian Sands and Syncrude mining operations. Additionally, Figure 2 contains data for natural clay deposits as reported in Locat and Demers (1988) and Mitchell and Soga (2005). As can be seen, the relationship (Equation 1) proposed by Locat and Demers (1988) provides a good overall fit for typical MFT.

Equation 1.

$$Su_{remolded} = (19.8/LI)^{2.44}$$

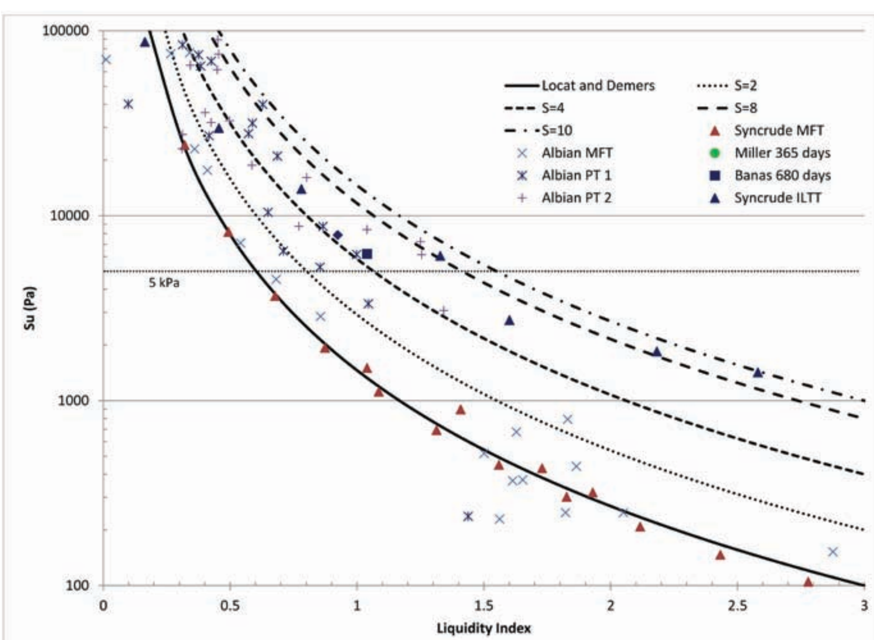

Figure 4. Sensitivity of oil sands fine tailings.

It has long been known that MFT exhibits a thixotropic behavior. This behavior is captured in Figure 3. Data from Miller et al. (2011a,b) on strength gain of MFT after 365 days at rest and combined data sets from Banas (1991) and Suthaker and Scott (1997) on strength gain after 680 days at rest (displayed as "Banas 680 day peak") is compared to the remolded Su of typical MFT in Figure 3. Upon shearing of this thixotropic material (Banas 680 day residual), the Su collapses to the remolded MFT Su line (open box symbols). Also included in Figure 3 are summaries of Su versus LI for various dewatering techniques (PT and ILTT) as reported in the literature (Jeeravipoolvarn, 2010; Masala and Matthews, 2010). For ease of comparison, typical MFT is represented using the Locat and Demers (1988) relationship.

Directive 074 requires Su values in the range of 5-10 kPa or greater. Therefore, the available corresponding data within the range of LI from 0 to 3 is presented in Figure 4. It is evident that strength gain of the fine tailings with polymer/chemical addition to achieve the required Su values of 5-10 kPa is possible, but at much higher water contents. However, this has implications on storage efficiency of the fines deposit (kg fines/m^3). At higher water contents, a chemically modified deposit will have lower storage efficiencies and thus require larger disposal areas (as compared to untreated fines). For mining operations that have limited lease space, there may be operational challenges with managing the larger volumes. Figure 4 also contains lines representing sensitivity (S) as calculated by S = Su peak/ Su remolded. The sensitivity lines are based on the remolded Su relationship of Locat and Demers (1988). From Figure 4, it can be deduced that the chemically modified fine materials (PT and ILTT) may exhibit sensitive behavior based on their reported strengths. Mitchell and Soga (2005) would classify deposits with S = 4-8 as very sensitive and S = 8-16 as slightly quick clays. The dewatering techniques currently under investigation may create potentially metastable and liquefiable deposits. Implications of a sensitive, metastable deposit could mean significant containment is required for these deposits, even though they meet the performance criteria of Directive 074.

Conclusions

Bitumen has been extracted from the oil sands deposits in northern Alberta for several decades. Although technological advances have improved mining and extraction efficiencies, the industry still faces challenges in finding practical methods to control and reduce the formation of fluid fine tailings. It was shown these deposits of "MFT" behave like natural clay slurries and can be represented by Locat and Demers' (1988) LI versus remolded Su relationship. In response to the ERCB's Directive 074 in 2009, the oil sands industry has conducted considerable research on polymer flocculation to augment dewatering and strength gain of the fine tailings stream. However, the chemically amended fines deposits may exhibit sensitive, metastable behavior upon deposition, based on the reported data. There is a significant need to understand and conduct research regarding the sensitivity and long-term behaviour of the flocculated, dewatered fine tailings to best achieve Directive 074's objectives.

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the Water in the Soil - Part 6

Bill Hodge

Now that I am writing the last article in this series I find myself wondering where on earth these ideas might have started out.

Maybe it was back in the 60's when Arrow Dam (now Keenelyside) was been built on the Columbia, and I was there as the junior engineer looking after earthworks and instrumentation. I remember at one stage the glacial till core earthfill was responding to roller compaction by making waves, as is inclined to happen when such material is placed too wet of optimum. As it happened, Arthur Casagrande was due to make one of his routine consulting visits just about then, so I installed a piezometer about 10 feet below grade and attached it to a pressure gauge. Then, as he watched, I had loaded dump trucks pass over the spot where the piezometer was buried. I wanted to see what he would say to the fact that the pressure on the gauge rose as the truck moved over the spot and then dropped back to zero as the truck moved away. Although he looked for a good while, sad to say, he went away without telling me what he thought about it. But now, half a century later, I think that observation might have done it for me.

Excess pore water pressure

As a geotechnical engineer working in design and construction I was acutely conscious of being obliged to deal with soil behaviour at only one or other of two extremes: Fully drained, or no drainage at all. The real world was always somewhere in between - but inaccessible. This wasn't all that bad until earthquakes entered the scene. Then I felt our work was degraded to following some quasi-mystical beliefs set down by university diktat, and coming from the same place as the earthquakes - California. All strangely reminiscent of, and perhaps symptomatic of, times of on-campus student unrest. What forced us into that "soil-dynamics religion" was the absence of a clear understanding of the mechanics of pore pressure generation. And the devil in the mix was the undrained triaxial apparatus which while defending the "established truths" went about its business of mutilating entrapped sand in a manner reminiscent of what was done to nonconformists during the Inquisition. To get out of that mindset, and progress, it was necessary to become a geotechnical heretic.

The first step was to walk away from orthodox belief in the interpretation of what went on inside the membrane of the undrained triaxial machines. What actually happens within this sealed environment is that the vertically moving plunger results in either dilative or contractive deformation of the soil-structure, and that in turn results in either more or less solid area being pushed into physical contact with the membrane. Let's take the case of a contractive soil-structure. As specimen straining continues the volume of the soil-structure diminishes, and with it the proportion of the solid phase in contact with the membrane. Because of this, the load carried by the water inside the membrane will have to increase accordingly in order to maintain radial/horizontal force equilibrium as the solid phase retreats more and more from membrane contact. In consequence the water pressure in the specimen goes up. And at the same time the effective intergranular normal

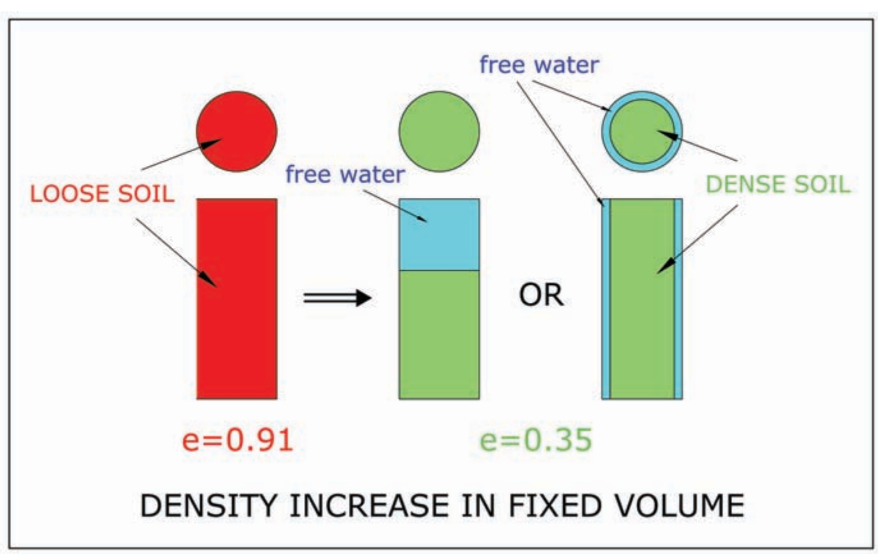

Figure 15. Contractive triaxial specimen.

stresses imposed by the membrane on the soil-structure comes down. The resulting loss of shear strength is not because of the pore pressure increases, it is because of membrane interference.

To clarify this important point I'll resort to a "*reductio ad absurdum*" style of reasoning. Figure 15 shows to the left, to honest scale, the space required within the membrane to accommodate a mass of uniform spheres at their loosest packing (e=0.91). In the centre and to the right, the volume required by this same mass of spheres is shown for their densest packing (e=0.35). It is apparent that changing from the loosest to the densest packing (extreme contraction) must involve an increase in the proportion of the cell pressure conveyed to the water, with obvious consequences to the load bearing capacity of the soil column.

The idea that pore water pressure increases cause failure is simply wrong-headed. In fact, in terms of soil-structure stability, excess pore water pressure is not intrinsically a bad thing. But if it is changing in magnitude then it is a clear indication that the solid phase is trying to move through the liquid phase, and that things are not at rest. This is because deformation of the soil-structure results in the creation of pressures in the void water, and those responsive pressures act in a manner so as to oppose the movement of the soil particles. Essentially, the changes in pore water pressure are an effort of the system itself to rectify the situation; its own attempt to prevent movement and maintain the *status quo ante*.

In trying to visualize how the pore pressure generation mechanism works I found the analogy of a hydraulic piston helpful. I try to imagine what would be going on as a piston is being pushed into a rather leaky cylinder. Needless to say the piston is a particle and the leaky cylinder is the saturated soil-structure with drainage from a natural boundary some distance away. Now, if we leave the unreal "undrained" condition behind us, and look instead at an apparatus which does a fair job at representing soil behaviour in a natural setting we may see if the "leaky piston" helps. What I have in mind is the laboratory consolidation machine, or oedometer.

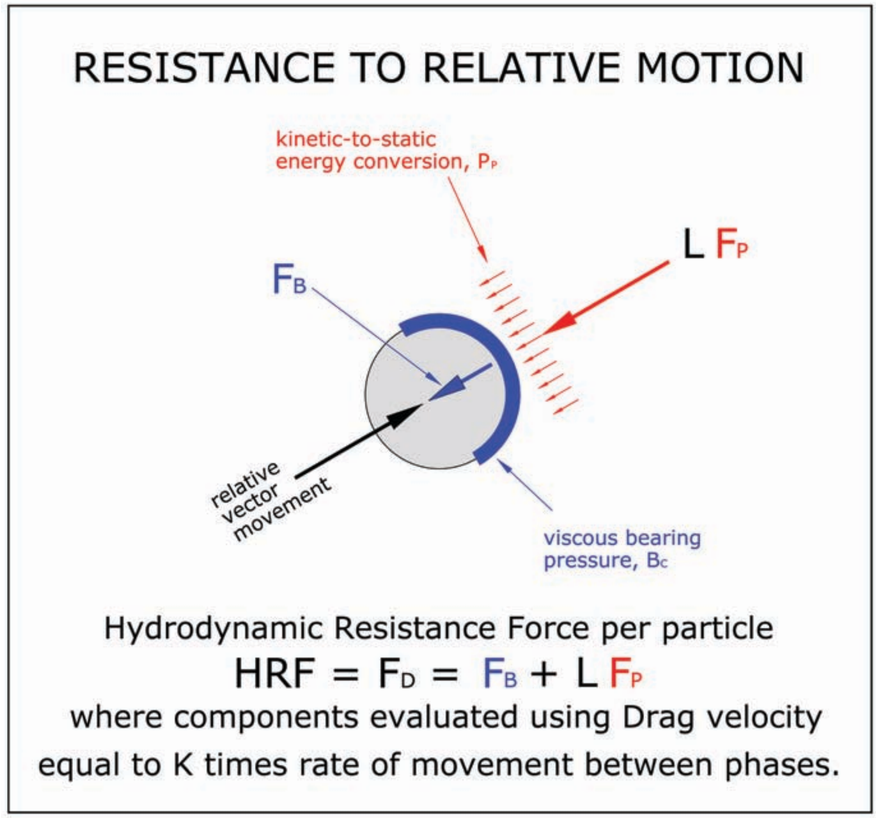

Figure 16. Resistance to relative motion.

For simplicity let's consider one-way drainage from an impervious solid base to an upper highly porous platen. When the consolidation force is applied to the platen, that force is transferred entirely to the topmost layer of particles, with the water continuum carrying virtually none of it. This is because, apart from having very little shear strength to provide bearing capacity, the water in physical contact with the porous platen can escape through it with very little resistance/effort. The soil-structure responds to the load by contracting into a more resistant intergranular arrangement. This involves all the particles moving towards the base, and this relative motion between the phases generates a pore water pressure field which grows in magnitude, particle after particle, until the solid base is encountered. At the base there can be no particle movement and therefore the pressure generation ends there. This generation of a hydraulic gradient within the specimen creates the required condition for seepage flow (leakage) from it. As consolidation progressed, and the soil-structure gets stronger, the rate of movement slows down, and with it, the generation of pore pressure. Eventually, the time comes when the soil-structure can carry the newly applied load without further movement, and consolidation leakage ends at this moment.

Calculating pore pressure generation

Figure 16 illustrates the water forces generated by relative motion between the phases of a soil-structure immersed in water. As we are concerned here only with hydrodynamic forces, no effort is made to represent inter-particle forces on this schematic.

For a single particle, represented here by a sphere, the Crowding Factor, K is = 1. As discussed earlier, in the case of soil aggregations K > 1, where that value depends on particle sizes, packing density, and fluid velocity. Depicted here are the two component forces, viscosity and pressure, which together make up what I call the Hydrodynamic Resistance Force [HRF], and which I treat as the fundamental quantum of resistance offered by each soil particle to soil-structure deformation. It is here that the axiom "pore pressure is the response to movement, and not the cause of destabilization" is most clearly expressed.

In order to perform the tedious calculations required for determining the viscous drag and pore water pressures generated in saturated non-cohesive soil gradations, I wrote the computer program EPWPGRAD. This program is freely available from Geotechnical News as a Fortran compiled DOS executable file. Anyone who might want the source code can write me. The program works in the following manner:

A. The program requires the following input:

- Soil gradation in terms of paired mesh size and percentage of soil passing that mesh for each of the soil fractions. In other words, the normal output determined during a sieve analysis.
- Void ratio.
- Water temperature.
- Rate of relative motion between the phases.
- Dimensions of a prismatic element (rectangular box) of soil to be assessed.
- Permeability of the soil if known; if not known a built-in subroutine PERMSOIL is used to estimate it.

B. The program then goes about the following routine:

- For each soil fraction, an average size is used to determine the L-factor in this range. At the same time, the number of individual particles of this size within the soil element is found/calculated.
- The permeability of the soil element for this particular rate of soil-structure movement is either taken as user input, or calculated by PERMSOIL.
- The hydraulic gradient across the element is calculated from permeability, and then used to evaluate the element's Seepage Force in the direction of relative movement.
- By a process of iterating on the void velocity, the unique overall value for the Crowding Factor, K, is found which would make the total Drag Force across the element numerically equal to the Seepage Force that would prevail for that same element of soil if it were subjected/exposed to the velocity of movement.
- The magnitudes of the two components of HRF are calculated for each soil fraction using the L for that size, and the common K for the aggregation. By summing these components for each and every particle within the soil element the total force exerted against the upstream face of that rectangular prism is arrived at.
- Energy and pressure gradients across the element in the direction of solid phase translation are then readily available as part of the program output.

As a point of interest, PERMSOIL goes about estimating soil permeability (hydraulic conductivity) in the following way. It takes as input the void ratio, particle size distribution, and water velocity being currently used in the parent/main program. It determines for itself the fluid (in this case, water) viscosity from the temperature given.

It uses the J.S. Kozeny (1931) inspired technique whereby an equivalent pipe diameter can be assigned to a particular soil aggregation. He realized, quite brilliantly, that this could be justi-

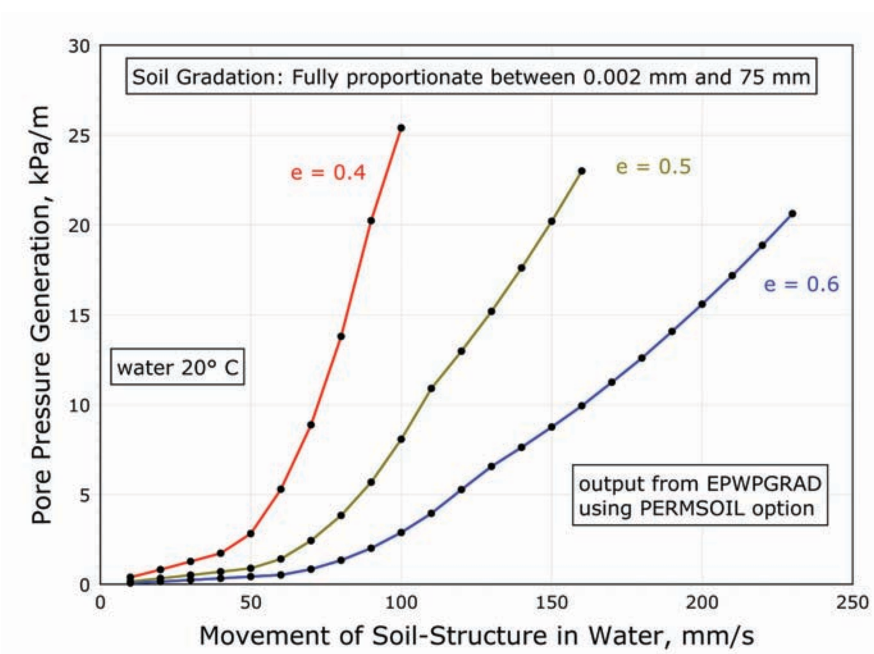

Figure 17. Pore pressure generation v. soil-water relative motion.

fied by equating the Fluid Mechanics parameter, hydraulic radius, to the Soil Mechanics ratio of pore volume to surface area of all the grains. Once in the pipe analogy mode it is a simple matter to determine permeability from a combination of the Darcy-Weisback formula and the Colebrook equations for surface roughness (e/D = 0.05 adopted herein). Flows ranging from laminar to turbulent are assigned based on R_E, or where transient conditions are sometimes found to be appropriate for coarse sands.

C. The program provides the following output:

Figure 17 is a plot of three sets of data points produced by the computer program EPWPGRAD. The soil gradation is what I call fully proportionate, with a grain size ranges from 75mm down to 0.002mm. What I mean by fully proportionate is that each size is equally represented with respect to dry weight. In other words this is a perfectly well graded silt and sand and gravel.

A range of packing densities (e = 0.4, 0.5 and 0.6) was evaluated for the purpose of illustrating the strong influence of this parameter. The permeability for each of these "specimens" at 20°C was calculated for the appropriate flow type (laminar to turbulent) using the built-in PERMSOIL subroutine. The Crowding Factor found for these void ratios (respectively) were in the ranges: 6.4 to 10.9; 3.6 to 6.7; and, 2.3 to 4.5.

The plot in Figure 17 shows the theoretical relationship linking rates of movement between the phases with the pressure generated in the water phase as it opposes motion. The magnitude of pore pressure generation is shown in terms of gradient, and this is because it is built up, one particle after another in sequence, increasing progressively in the direction of the relative motion of the solid phase. It is only the pressure component (F_P) which is involved here, since the viscous component (F_B) cannot be seen by pressure sensitive devices.

Figure 18 shows how each of the two separate hydrodynamic components, that is, viscosity and pressure, contribute to the overall resistance. Here it may be seen that for the range of conditions depicted, pressure is the dominant component, and the contribution of viscosity becomes less as velocities increase and void ratios decrease.

Deformation

Up to this point the computations have been dealing with the type of motion that is best described as translational – the case of an intact, and unchanging, arrangement of separate particles which make up a stable soil-structure moving as an undisturbed fixture through water. As seen in Figure 17 void ratio is a sensitive parameter in this context. And so, to put a number on the additional contribution made by soil-structure deformation to pressure generation, the procedure involves looking at void ratio changes, which are an accompaniment of deformation, as the key to the solution.

From the data plotted in Figure 17 it can be seen, for any chosen rate of relative motion, that the pore pressure increases with decreasing void ratio. This is what we know as contractive behaviour. Similarly, it can be seen that dilation would cause pore pressure reduction; again, something which fits well with accepted and rational ideas. And finally, needless to say, if there are no void ratio changes then there is no reason to expect other than translational pressure changes in the pore water.

What this suggests therefore is that in order to evaluate the response of pore water to deformation we need to superimpose the effects of void ratio changes on those associated with translation of the intact structure as it moves relative to the fluid phase. As a consequence of this reasoning, the methodology I propose for the evaluation of pore pressure changes (either positive or negative depending on whether the soil-structure responds to the deformation in a contractive or dilative way) is to first create a translational plot, and from this, determine the magnitude and rate of additional pore pressures contributed by how the void ratio alters with time.

Hydraulic gradients

The most important fact to bear in mind about pore water pressure is that a hydrostatic pressure distribution has no influence whatever on the behaviour of the soil-structure, however loose and unstable. I've been down to 135 feet in open water protected by no more than swim trunks and experienced no distress whatever because of the added 58 psi (400 kPa) of water pressure. And I'm sure enough that mineral grains of quartz aren't any more sensitive.

In still open water there is no hydraulic gradient. A deeply submerged slope will have very high pore water pressures, but they are irrelevant if there is no pressure differential across the bottom/ground, such as might be brought about by the passage of storm waves. Otherwise it is like standing in still air under atmospheric pressure. You are not aware of the air pressure - and, it isn't until a wind picks up that you know the air is there at all. So, being told the pore water pressure at a single point in the soil is of little use to us. We need data from at least three separate points to know the hydraulic gradient magnitude and direction (vector) before we can have some idea about what might be going on.

Figure 19 was prepared to illustrate the similarities and differences between seepage forces and forces generated during two-phase relative motion. The top sketch shows a permeameter, which is the laboratory equivalent of steady state seepage, as for instance under a dam. The hydraulic gradient is the locus of the pressure head along the flow direction; it is parallel to the "energy line" and lies below it by an amount equal to the velocity head. There's nothing new here except that it shows the difference the orientation of a piezometer's sensor can make to the reading. If the sensor confronts the flow the velocity head will register, otherwise it will not be seen.

The bottom sketch was constructed to make as clear a comparison as I can between the pressure losses of seepage and the pressure gains of motion. In this case I've used the oedometer as the laboratory equivalent of relative motion between the phases. Referring back to the free-body diagram in Figure 16 we see that relative movement between the phases results in hydrodynamic pressures being generated across the particle diameter: This constitutes an elemental hydraulic gradient. If we now consider the sequence of adjoining particles within a soil-structure we can appreciate that what results is in effect a continuous potential gradient. This, like the seepage gradient, is a vector, and the "motion head" will register on a sensor only to the degree that this vector is orthogonal to the sensing face.

The basic difference between the two sketches is that instead of the motion gradient being externally imposed, as is the case for steady state seepage, this gradient is built up from within, by virtue of the forces imposed on the water by the moving solids, one particle after another. In both cases the gradient increases upstream.

The real value of this comparison is to justify the assumption made in EPWPGRAD, and that is that the relative motion velocity used to compute the viscous and pressure component forces is equal to the approach velocity used in computing the Seepage Force. This becomes apparent once the velocities at the left hand side boundary of both top and bottom soil elements are compared.

Practical implications

If this new way of accounting for pore water pressure has any value then it should be able to give us some practical help in the various aspects of geotechnical engineering practice.

Laboratory

My views on the undrained triaxial compression test have been expressed already. As I see it, the intrinsic mechanical problem with this device, and the impression it gives that increasing pore water pressure leads to failure, is that within a sealed membrane, with no place for the water to flow, there is no possibility of a hydraulic gradient existing – the water potential is short-circuited. Here I am referring to things at the specimen and sensor scale. Of course at the microscopic scale, water must flow around individual particles as they are shuffled around, but the pressure sensor itself shorts these out.

In both the permeameter and the oedometer water is allowed to flow, and so there is no conceptual difficulty with regard to hydraulic gradients. Here it would be of interest to know the pressure distribution within the specimens. That would be a check on the notion that for smaller particles undergoing slow deformation the viscous component should predominate, thus reducing the measurable pressure component accordingly. And in consolidation testing, what if the particles are small enough that the only resisting force to motion is the viscous component? Would the motion be controlled by viscous creep rather than by seepage flow?

Site investigation

The CPT probe penetrates the ground at a rate of 20 mm/s, recording the pore pressures caused by the cavity expansion straining at the tip. A typical trace of these on-the-run dynamic pore pressure responses [Bq] shows large swings from positive to negative Bq as the cone passes through contractive and dilative strata. A particular type of trace, which I have heard people call "hydrostatic", and is at first sight puzzling, presents a challenge to the hypothesis being advocated here to find an explanation.

These "hydrostatic" traces are apparently quite common in the sands of the Fraser River channel/delta. The name comes from the fact that the dynamic pore pressures follow a straight line coincident with the open water pressure line. In other words, the cavity

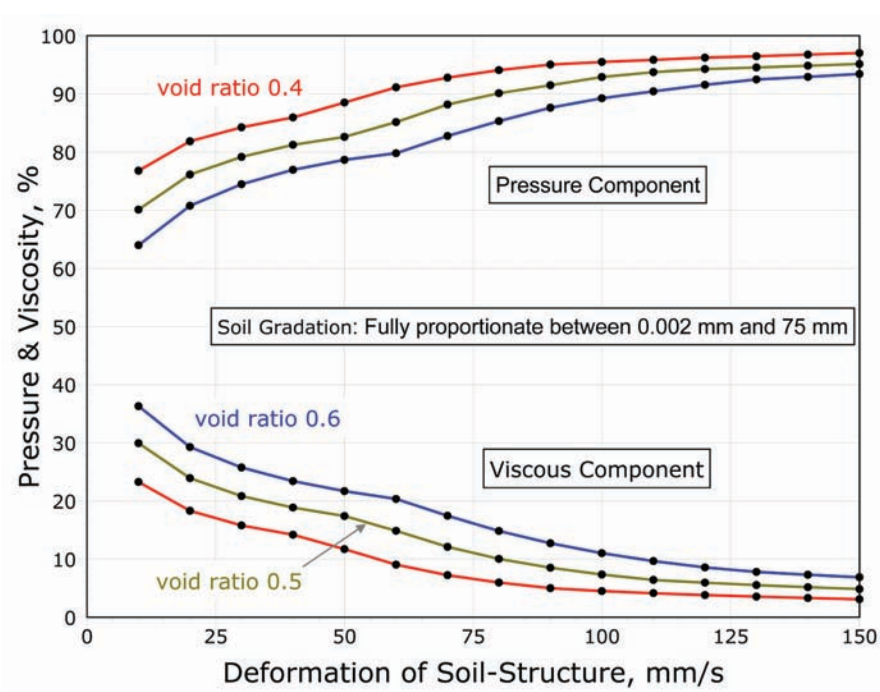

Figure 18. Pressure & viscosity % v. soil-water relative motion.

expansion results in no pore pressure change. My interpretation, using the ideas presented in these articles, is as follows:

Bearing in mind that it is the cone tip which is moving and not the soil, the fact that there is no change in pore pressure in response to soil-structure deformation can only be because there is no change in void ratio during deformation. This is consistent with the classic case of constant volume straining. My opinion as to how sand could end up in this rather unique state of packing is that these sands were placed by bedload transport: a deposit moved so far and so often that it now exists at the constant volume void ratio. This suggests to me that these sands, although soft, are not liquefiable.

Slope stability

Where steady state seepage conditions prevail within a natural slope, or on the downstream side of an embankment dam, we expect to see a loss of hydraulic potential as we go downslope. Since this reflects the water energy lost to particle drag forces as the water moves through a stable soil-structure, this is as it should be. This downhill drag is the destabilizing influence trying to flatten the slope. After allowing for seasonal alterations in differential head across the system, we don't expect to see that hydraulic flux change over time. And that is what we hope to see from any piezometers we have installed for monitoring the slope. A pressure distribution other than the established pattern would indicate either a change in the permeability of the section (soil erosion), or be a warning sign of movement within the slope.

The upper part of Figure 19 is an instance of steady state seepage through a stable soil-structure. It is the lower part of this sketch, based on the ideas introduced here, that provides some additional insight into what might be going on within the slope. This applies more to natural slopes which are often composed of fine grained soil, and thereby prone to a larger viscous component of energy, than to the coarser soils used in earthfill embankments. A piezometer will not see the viscous drag forces pulling down the slope, it will only show the pressure component. But in either slope, a change in piezometric head, not attributable to changing potential difference across the slope, is a definite warning sign: And this holds true whether the head increases or decreases.

Ground improvements

Once we acknowledge the fact that escalating pore pressures are a result, and not the cause, of soil-structure contraction or collapse, then it comes time to look again at what we think we are doing when we install vertical drainage devices in the ground to enhance the groundwater's natural drainage. Certainly, in the case of non-granular compressible strata, we hasten ground settlement by such means as wick-drains. And that is a good thing. We are venting the pore pressures which are resisting and retarding downward movement. And when we install similar vertical drainage elements in what is feared to be liquefiable sands, it is exactly the same thing we accomplish: We speed up post-failure settlement. And that's about all.

Soil grains are not spheres

The numbers of particles of gravel, of sand, and of silt required to make up one cubic centimetre of soil are: One single piece of gravel would do it; 40,000 sand grains would be needed; and, for silt, the number is a stag-

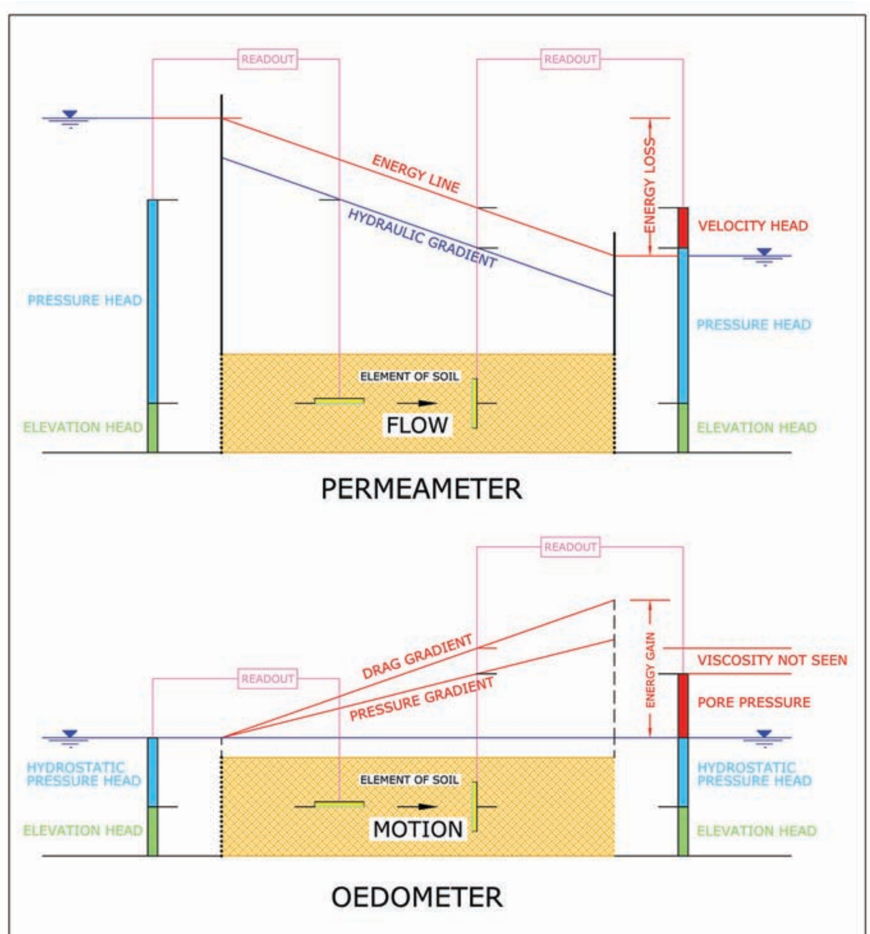

Figure 19. Pressure gradients in seepage and relative motion.

gering one billion. I used spheres of 10mm, 0.3mm, and 0.01mm diameter, at a relative density of 50% to calculate these ballpark figures. Now, since it takes a million ccs to make a cubic metre, then, whether they be silt or gravel, there is obviously no way of dealing with real soils in the field other than statistically. Even in the laboratory, determining the size and shape of each particle in a small specimen of sand is utterly impractical. And once it came to dealing with soil grains theoretically I knew I had no option but to simplify the shape to the extreme.

Spheres have the great benefit that their shape, no matter what way you approach them, is exactly the same. And their geometry is entirely defined by one dimension – diameter. The next simplest shape is a cube, again definable by a single length, but a cube looks different depending on the view point. Also, a cube has kinematic characteristics which are absent in a sphere and so difficult that my theoretical work is constrained to spheres.

The need to have a simple geometry which is amenable to mathematical treatment is more of a scientific necessity than an engineering one. It is a fundamental tenet of scientific advancement that propositions describing natural phenomena be expressed in mathematical terms. That way the reasoning can be fully and continuously traced through the mathematical formulation: It makes the proposition more amenable to falsification, and allows it to be either dismissed or subsequently built upon by others. As this is a new idea I'm presenting here, it needs to leave an uninterrupted mathematical trail behind.

Before ending this series I would like to draw attention to something I've being watching myself with some amusement while writing these articles. And that is the difference between the pore water pressure equation I suggested in Part 1 and what I am offering now. There's a substantial difference. Even before Part 1 went to print I knew it could be improved on. But I decided to leave it alone, and let it stand. I wanted it to be a benchmark for myself, to see how much my ideas would change over the year and a half it took to get to where I find myself at now: The end of this series of articles.

Acknowledgements

It is quite necessary for me at this juncture to mention my good old friend Nigel Skermer. He has willingly read the drafts of each of these articles and I am most grateful to him for guiding me towards some measure of logical continuity, and we hope, avoiding serious lapses in reason. Thank you, Nigel.

Thanks also to John Gadsby for agreeing to publish this series, and of course, to Lynn Pugh for keeping me in line throughout the effort to put the ideas into print.

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Pacific Northwest Cascadia Fault

One of the most dangerous faults in North America is the Pacific Northwest's Cascadia fault – an offshore, subduction zone fault capable of producing a magnitude 9 earthquake that would damage Portland, Tacoma, Seattle, and Victoria, British Columbia, and generate a large tsunami. Yet there are currently no instruments installed offshore, directly above the fault, for measuring the strain that is currently building up along the fault.

But a recent $1 million grant from the W. M. Keck Foundation to scientists at the Woods Hole Oceanographic Institution (WHOI) will change that. An interdisciplinary project led by WHOI geologist Jeff McGuire, an expert in global earthquake seismology and geodesy, and John Collins, director of WHOI's Ocean Bottom Seismometer Lab, will build and install the first seafloor geodesy observatory above the expected rupture zone of the next great Cascadia earthquake.

Scientists agree there will likely be another magnitude 9 earthquake off Oregon and Washington. Information that is critically important for modeling how much the fault will slip – and hence how much the ground will shake – and for predicting the maximum height of the tsunami that could be generated.

The real-time data flowing from the fault on the seafloor will not only advance our understanding of earthquakes but can help city planners and emergency response managers.

The Cascadia subduction zone is a very long sloping fault that stretches from mid-Vancouver Island to Northern California. It separates the Juan de Fuca and North American plates. For many years, according to conventional wisdom, the Cascadia subduction zone slipped without earthquakes. But in the last 30 years, geologists have uncovered sedimentary records as well as historical records in Japan showing that indeed, the fault repeatedly had these huge earthquakes with big tsunamis.

Cascadia's last big event occurred in 1700 and was likely very similar to the March 2011 Japanese earthquake – a magnitude 9 quake and tsunami that traveled all the way across the Pacific. This similarity is foreboding for earthquake scientists, as a key scientific lesson of the Japanese earthquake has been that the standard datasets collected onshore are completely inadequate for characterizing the upcoming ruptures on an offshore subduction zone thrust fault.

One key limitation in the seismic hazard estimation for subduction zones is the use of geodetic data recorded onshore – primarily GPS data – to determine the extent to which offshore faults are locked and building up strain for the next big earthquake. GPS can detect surface motion to unprecedented precision – a fraction of a millimeter per year – but land-based GPS is too far away from offshore faults to be sensitive enough to that motion.

We know the fault is locked around the coast but we don't know how far offshore it's locked. One goal is to determine if the fault really is locked all the way to the trench or not. Instruments are needed out there to be really sensitive to it. One reason that's important is for understanding what the next tsunami will be like. The March Japan earthquake had such a big tsunami because most of the fault motion was really shallow and close to the seafloor. Figuring out exactly where the locking starts at the shallow end of the fault is a primary goal.

To do this, tiltmeters will be installed at a location approximately 4 kilometers above the Cascadia subduction zone thrust interface. Tiltmeters are standard instruments on land – most volcano observatories have them. These instruments are very, very sensitive to tiny little deformations that occur in the rock. The movements can be subtle. They can be slow. Something a seismometer is not sensitive to.

The tiltmeters will be located within a 300 meter-deep borehole, a study site established by the Integrated Ocean Drilling Program, and will take advantage of an existing seafloor cable infrastructure – NEPTUNE Canada – enabling immediate access to the data collected by the instrument. The instrument array should be installed and returning data by summer 2013.

If such a data stream had been available in real time from the Japanese subduction zone in the days preceding the March 11 quake, the scientific community might have known that the potential for a large earthquake was very high because the fault was already slipping slowly.

Part of the reason for installing a tiltmeter in a borehole is because of interesting signals collected in boreholes in the past, signals that provide clues to better understanding of earthquakes. It all feeds back into understanding the fault system – how the stress changes over time in the fault system."

The Woods Hole Oceanographic Institution is a private, independent organization in Falmouth, Mass., dedicated to marine research, engineering, and higher education. Established in 1930 on a recommendation from the National Academy of Sciences, its primary mission is to understand the oceans and their interaction with the Earth as a whole, and to communicate a basic understanding of the oceans' role in the changing global environment. For more information, please visit www.whoi.edu.

MILESTONES

Hayley Croteau joins RST Instruments as Sales Engineer

Hayley Croteau, P. Eng. has joined RST Instruments Ltd., in Maple Ridge, British Columbia, as Sales Engineer. Hayley has 5 years of experience in geotechnical consulting and mining and completed her B.A.Sc. in Geological Engineering at The University of British Columbia. She has experience with geotechnical instrumentation, geotechnical design, landslide monitoring, slope stability analysis and geotechnical field review.

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- The G-I/ASFE 1.5-hour geo-professional business session: *"Demonstrating the Value Geo-Professionals Provide to Projects"* Monday, March 26, 10-11:30 am

The winner of the $200 Starbucks gift card for registering for Geo-Congress by January 20, 2012 is: Peter Robertson, Ph.D., A.MASCE, Technical Director, Gregg Drilling & Testing, Inc.

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From award-winning projects like the Orange County, CA Groundwater Replenishment System to smaller-scale projects like the Marysville, WA park-and-ride lot, civil engineers are applying principles of sustainability to deliver "triple bottom line" benefits to the public. ASCE's Web site features a new library of project profiles that demonstrate how sustainable infrastructure contributes economic, environmental and social benefits. Featured profiles span all sectors and include projects ranging from under $1 million to more than $1 billion. The expanding library will help civil engineers research solutions, share data and information with clients and find sources for further research. The site also allows users to rate and comment on profiles, and encourages submission of additional profiles via an easy-to-use online form.

To browse the project profiles: *www.asce.org/PPLContent.aspx?id=12884909359*

To submit a project profile: www.asce.org/formcontent.aspx?ekfrm=12884904893

The official ASCE sustainability page: *www.asce.org/PPLContent.aspx?id=7085*

Geotechnical professional development corner

ASCE/G-I Webinars

LRFD for Geotechnical Engineering Features: Earth Retaining Structures - Fill Walls
Friday, March 9, 2012 / 12-1:30 pm
https://secure.asce.org/ASCEWebsite/Webinar/ListWebinarDetail.aspx?ProdId=120853715

Integrity Assessment of Deep Foundations: Principles and Limitations
Monday, March 19, 2012 / 12-1:30 pm
https://secure.asce.org/ASCEWebsite/Webinar/ListWebinarDetail.aspx?ProdId=120853962

LRFD for Geotechnical Engineering Features Design of Ground Anchors and Anchored Wall Systems
Thursday, March 29, 2012/12-1:30 pm
https://secure.asce.org/ASCEWeb-

site/Webinar/ListWebinarDetail.aspx?ProdId=120854358

For more webinars: *http://www.asce.org/events/Default.aspx?fc=1&from=11/09/2011&topic=2147483862*

ASCE/G-I Seminars

Earth Retaining Structures Selection, Design, Construction and Inspection: Now in an LRFD Design Platform
April 19-20, 2012
Hyatt Regency Tech Center Denver
Denver, CO

Introduction to Dam and Levee Safety, Evaluation and Rehabilitation
May 3-4, 2012
Seattle Crowne Plaza
Seattle, WA

Soil and Rock Slope Stability
May 17-18, 2012
Aloft Charlotte Uptown @ the Epicenter
Charlotte, NC

Earthquake-Induced Ground Motions (*Newly Updated*)
May 31-June 1, 2012
Radisson Hotel Rochester Riverside
Rochester, NY

For seminar information: *https://secure.asce.org/ASCEWebSite/Webinar/ListSeminar.aspx?CatCode=CED-GEOT*

Members in Memoriam

Barry F. Beck
1944-2011

Barry Beck, Ph.D., M.ASCE, passed away Nov. 28, 2011, at the age of 67, following a series of strokes that left him debilitated with "Locked-in Syndrome" for the past two years.

Beck held a bachelor's degree in geology from Rensselear Polytechnic Institute and a master's and Ph.D. degree in geology from Rice University in Houston, TX.

His interest in caves led him to Puerto Rico to work for the Department of Natural Resources where he conducted investigations in tropical karst, researched caves on the island and hosted expeditions for cavers exploring Puerto Rico.

He moved to Georgia where he worked first for the Georgia Department of Natural Resources in Atlanta, then as professor of geology at Georgia Southwestern College in Americus, GA where he led caving expeditions with students.

Beck then moved to Florida to became the sole director of the Florida Sinkhole Research Institute at the University of Central Florida. There he conducted karst research, studying caves and sinkholes, as well as establishing the series of international multidisciplinary sinkhole conferences.

The closing of the Sinkhole Institute brought Beck and his family to Oak Ridge, TN, where he joined P.E. Lamoreaux & Associates, Inc. and directed the firm's Oak Ridge branch for the next 18 years. In 2004, the NSS (National Speleological Society) presented him with their highest award, Honorary Membership, for his lifetime of contributions and study of speleology and karst.

Wilson Tang
1944-2012

On January 5, 2012, Wilson H. Tang, Ph.D., Dist.M.ASCE, passed away in Chicago after a long and courageous battle with his illness. He held a bachelor's and master's degree from the Massachusetts Institute of Technology, and completed his doctorate from Stanford University. All were in civil engineering.

He taught at the University of Illinois at Urbana-Champaign for 27 years before joining the Hong Kong University of Science and Technology as Chair Professor and head of the Department of Civil Engineering in 1996.

Tang made significant contributions in the areas of safety and reliability analysis in civil engineering and led the profession in promoting and pioneering the use of reliability based methods for risk mitigation and design in various areas, particularly in geotechnical engineering. His expertise covered application of probability methods to the wide area of civil infrastructure engineering and management. He had over 250 technical publications and his co-authored book (with A. H-S Ang) on Probability Concepts in Engineering Planning & Design, revised in 2007, has been widely adopted by top universities worldwide.

He led and served on several international boards and committees. His many awards included the State of the Art award, Fellow and Distinguished Member from the ASCE, T.K. Hsieh Award from the Institution of Civil Engineers UK, US Offshore Energy Center's Hall of Fame, Guggenheim fellow, Harza Best Paper Award, Natural Science Award from the Ministry of Education of China, Fellow and Vice President of the Hong Kong Academy of Engineering Sciences, and Honorary Professorship at several major universities.

The prestigious keynote lecture, **Wilson Tang Lecture** of the serial conferences of International Symposium on Geotechnical Safety & Risk, was inaugurated in 2009 to recognize and honor his significant contributions.

Students

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Organizational Member News

The Geo-Institute welcomes its newest organizational members (OM)

Dan Brown and Associates, located in Jasper, TN, is a consulting engineering firm specializing in geotechnical and foundation engineering with emphasis on problem-solving relating to foundation engineering and slope stability problems. The firm, led by President/Senior Principal Engineer Dan A. Brown, Ph.D., P.E., D.GE, includes associates with special expertise in construction, design, testing and research. Brown has a distinguished career of practice, research and instruction in the field of deep foundations and is particularly known for his expertise in design, load testing and construction of deep foundations.

Tolunay-Wong Engineers, Inc. (TWE) is a small private firm, incorporated in Houston, TX in August 1993 by Zeki A. Tolunay, P.E., and Daniel O. Wong, Ph.D, P.E., that provides quality engineering consultation, detailed geotechnical studies, foundation design, environmental engineering and construction materials testing services. TWE's more than160 employees include engineers, scientists, technicians, geologists, hydrogeologists and associated laboratory and support personnel spread throughout offices in Texas, Louisiana and Florida. The firm is committed to meeting its clients' needs for technical quality, practical solutions and performance while meeting budgetary and schedule commitments.

News you need to know as a G-I OM

- Contact *lbayer@asce* for OM membership and event questions.
- You should have received your 2012 G-I OM renewal invoice for $1,000. Payment is due at this time.
- Register for Geo-Congress 2012 in Oakland at a 50% discount by using the individualized 6-digit code you received in January.
- Here is your recruitment opportunity at Geo-Congress 2012. Two employees from each OM firm are invited to a special career reception on March 26, 2012 from 7-9 p.m. in Oakland, CA. The first 45 minutes are devoted to OM recruiting efforts among the 50 student stipend winners that your dues helped bring to the conference. The remainder of the time is for you and all the registered students. Your OM contact should have already received their personalized invitation.
- The special OM/ASFE session "Demonstrating the Value Geo-professionals Provide to Projects" will be held on Monday, March 26, 2012 from 10-11:30 a.m. as part of the 2012 Geo-Congress in Oakland, CA. Please plan to attend.

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President's Six-Month Report

ASFE is moving forward with its purpose, to maximize the geoprofessions' importance and value to the marketplace. The aim of this purpose is to counter the marginalization and commoditization that threaten the welfare of our professions. In the past three years we have established this bold purpose, aligned our committees and structures with the purpose, and are ramping up our activities and programs toward achieving our vision. We are very encouraged by the enthusiastic response to our purpose from Member Firms and beyond.

We put in place a 2009-2012 Strategic Plan (http://www.asfe.org/index.cfm?pid=10588)and, almost impossibly, we have accomplished everything the plan called for. This included expansion of staff to include an Organizational Relations Director and Membership Director, both positions now being filled by Colleen Knight. To fund that expansion, we established our Foundation for the Future campaign (http://www.asfe.org/index.cfm?cdid=12601&pid=10344), asking concerned firms to pay four years' worth of dues over a three-year period. The economy notwithstanding, we're getting that done, too.

A critical and bold accomplishment called for in our Strategic Plan is to collect and coordinate alliance organizations, because we can't get the job done alone. And what ASFE has done in that respect – thanks to our External Relations Committee – is absolutely stunning. We have put together the formative meeting of alliance organizations whose interest is, in essence, the same as ASFE's. Seventeen geoprofessional organizations were represented at the October 6 meeting. Just having so many groups sitting around the same table for anything is impressive. To have them all focused on the same goal is remarkable.

As additional elements of our external relations, we have created a definition of the geoprofessions (http://en.wikipedia.org/wiki/Geoprofessions) that is now securely ensconced in Wikipedia; we have updated our bylaws to create new membership categories (for geoconstructors, geoprofessionals in government, and geoprofessional students); and we have initiated the process of gathering case histories to support our recently created geoprofessionals' value proposition (http://www.asfe.org/index.cfm?pid=11740), namely, that wise selection and deployment of geoprofessionals saves owners time and money while reducing overall project risk.

The Education Committee is developing new and more effective ways to bring all the great ASFE "stuff" into your firms. One of the most important new developments in this regard is creation of the new *ASFE Resource Catalog* (http://www.asfe.org/index.cfm?pid=12675) we'll premier at the 2011 Fall Meeting. Further, we are launching a new webinar service with more offerings being developed as I write.

We have also pursued efforts to continually enhance our risk-management/business-management programs, services, and materials, so we can deal effectively with the symptoms of the commodity/marginalization problem while elevating our Member Firms' ability to serve clients as trusted professional advisors. The Business Practice Committee issued an excellent new *ASFE Practice Alert* on safety and another conveying results of our annual Financial Performance Survey. And hats off to our extraordinarily productive Construction Materials Engineering and Testing (CoMET) Committee, which has produced three documents on quality assurance; one in the form of a report or proposal insert sheet, one in the form of a message to owners, and one as a message to architects, civil engineers, and structural engineers. And just for good measure, the Committee also developed a new ASFE Practice Alert about the new ACI 301 initial field-curing standard, identifying ambiguities and how to deal with them. We have also initiated a comprehensive refinement of Peer Review. If all that isn't enough, the Emerging Issues and Trends Committee has looked into the crystal ball on our behalf, and will report on findings and recommendations at our 2011 Fall Meeting.

I believe it's also appropriate to point out that ASFE is taking a strong position in the field of sustainability, becoming a charter member of the Institute for Sustainable Infrastructure and developing a statement on sustainability we are fulfilling in part by converting *ASFE NewsLog* to an e-newsletter only and by eliminating much of the paper we used to distribute at meetings (we've even gone so far as to create a smart-phone meeting app you can download for free for your Android, iPhone, iPad, Blackberry, or Windows Mobile device).

Looking ahead, your Board of Directors has almost completed the new, 2012-2015 Strategic Plan that we'll unveil at the 2012 Winter Leadership Conference, as we continue our long-term efforts to overcome the marginalization and commoditization of geoprofessionals, one three-year bite at a time

This six-month President's Report is also new – replacing *Doing It* – to make the report somewhat more personal and delivering it electronically so you can easily link to the many resources noted. Another change – one we instituted in May last year – is conducting an Annual Member Satisfaction Survey to get your comments about what we›re doing, because, when all is said and done, what we do is all for you. Of course, I'm one of you, too, except I have the great honor and pleasure of serving as president of our extraordinary organization; an honor and pleasure I have you to thank.

David R. Gaboury, P.E.
ASFE President, 2011-2012

100s of practice-management resources listed, described in all-new ASFE catalog

Some 750 model documents, audio-education programs, A-V instructional programs, guides, client-focused educational "messages," monographs, practice-focused research reports, magazine columns, newsletters – even an instructional computer game – are described in the new interactive *ASFE Resource Catalog* (http://www.asfe.org/index.cfm?pid=12675).

According to Education Committee Chair Laura Reinbold, P.E. (*TTL, Inc.),* "I am excited that the electronic catalog does exactly what we intended, making the wealth of educational resources from ASFE's extensive library easier to explore and navigate, and helping member firms and colleagues find exactly what they need to educate their staffs and clients. Many of the resources focus on risk management with emphasis on managing risk through better performance, not by shifting responsibility and liability to others. For other offerings, risk management may not be their principal concern. ASFE's expert witness guide is a genuine classic, as is its contract reference guide. We have extensive resources such as proposal- and report-insert sheets developed specifically for those who provide construction-materials engineering and testing (CoMET), geotechnical, geological, and environmental services. The catalog also showcases the popular eBrownbag A-V presentations, archived webinars, case histories of project lessons learned, and do-it-yourself lunch-and-learn seminars. It's an amazing collection."

Ms. Reinbold noted that all of the resources are available to members and most associate members at no cost, a policy that comprises a principal benefit of ASFE membership. Most are available to nonmembers, too, some free of charge.

Students eligible free membership in ASFE!

In order to start influencing the next generation of geoprofessionals NOW, ASFE is making an offer to our Faculty Members: Send us a list of your students who want involvement in ASFE and we will gladly give each one a free Student Membership. Student membership entitles an individual to obtain everything we have without cost: newsletters, *Practice Alert* monographs, manuals, guides, texts, and so on. These can be extremely useful for any geoprofessional students who have an interest in private practice. Faculty Members: Send us a list of those you want to have Student Membership. Identify each student's name, e-mail address, physical address, major, and year of expected graduation and the degree involved. Questions? Concerns? Contact John Bachner (john@asfe.org; 301/565-2733, ext. 223) or Colleen Knight (colleen@asfe.org; 301/565-2733, ext. 230).

Johnny CAN read: ASFE members prove it

Youngsters read significantly more and comprehended/retained significantly more in two pilot projects; one in Newark, NJ, the other in Houston, TX. Local geoprofessional firms sponsored both projects as part of the Engineering Better Readers program developed by the Engineers' Leadership Foundation. According to Foundation President (and ASFE Past President) **Gerald J. Salontai, P.E**. (*Salontai Consulting Group*), the engineering firms work closely with school administrators and teachers, purchasing several thousand dollars worth of toys, games, sports equipment, and electronics that act as incentives. The more students read and retain – as verified by independent testing – the more points they earn. They can then use those points to "purchase" the incentives. Mr. Salontai noted, "Engineers are problem-solvers. Usually we think in terms of technical solutions to technical problems. In this case, however, the problem is getting kids to read, and that's a serious problem indeed. Studies show that kids who fail to master reading skills by third grade have learning difficulties later and are far more likely to drop out before high-school graduation."

ASFE-Member Firm **Birdsall Services Group**, a multidisciplinary engineering firm headquartered in Sea Girt, NJ, sponsored an Engineering Better Readers Program for grades K-3 at the Camden Street School in Newark, NJ. From Fall 2010 to Spring 2011, students participated in 67 individual Accelerated Reader program studies, each study providing test results for an entire class, including general education classes and those for special-needs students. On average, students showed a phenomenal 84% reading-test improvement; *in 31 of the 67 tests, students demonstrated a 100% reading improvement.* Additional findings, based on changes between Fall 2010 to Spring 2011, were:

- 96.4% of Grade 3 tests demonstrated improvement with 70% achieving a 100% improvement;
- 76% of Grade 2 tests improved;
- 87% of Grade 1 tests improved; and
- 90% of Kindergarten tests improved.

Engineering students from the New Jersey Institute of Technology (NJIT) served as mentors one day a week, encouraging students to read.

ASFE-Member Firm **Fugro Consultants**, an international geoprofessional consultancy, sponsored Engineer Better Readers at Longfellow Elementary in Houston, TX, where the firm's U.S. operations are based. There, the children who read the most also improved their reading comprehension and retention, with a genuinely impressive 57% of them showing growth on the Stanford Achievement Test Series, Tenth Edition (Stanford 10). According to the school, "These students were highly motivated to achieve at higher levels because they truly wanted to earn points every time they took an Accelerated Reader test."

According to the Foundation's program director, Patty Bain Bachner, "Powerful incentives are needed to encourage kids to read. Then, once the kids experience the joys of reading, going for the points is a pleasurable challenge. Kids were reading on the buses to and from school, during lunch, and at recess. We believe that the addition of mentors can magnify the overall effect, because mentors give the kids an extra incentive to read, so they can impress their mentors and discuss what they've read with them." Ms. Bachner indicated that the Newark and Houston programs both have been renewed for the 2011-12 school year, with additional pilots being considered in four to five other locations. She said that the program focuses on elementary schools where a high proportion of students receive free or reduced lunches, "because these are the kids most at risk. A secondary objective of the program is to interest kids in engineering as a career, not by urging them to get involved in math and science, but rather by exposing them to engineers who can tell them how much they like what they do. Still, first and foremost, the engineer-mentors' principal role is to encourage kids to read and help them do it, in service to the future of their communities. If we continue to achieve results like this – and we have every reason to believe we will – it could change how we get kids to read in America and we'd finally have a program that works."

For more information about the Engineering Better Readers program and the Engineers' Leadership Foundation, visit www.engineersleadership.org or contact the organization at info@engineersleadership.org or 301/588-6650.

Huge prevailing-wage victory in Pennsylvania

In a stunning reversal of opinion, Pennsylvania's Department of Labor & Industry has ruled in an October 6, 2011 letter that CoMET personnel are NOT subject to the state's prevailing-wage law. Hats off to **Dave Charles** (*Duffield Associates*), **Joe Hughes** (*David Blackmore & Associates*), and **Ward McMasters** (*Earth Engineering*) for leading the resistance! Obtain a copy of the letter by sending your request to info@asfe.org.

What's old is new again: It's time to revisit ASFE White Paper No. 2

"This *ASFE White Paper* has been developed particularly to help establish realistic estimates of public-sector costs that might otherwise be calculated improperly or go overlooked. One of the *White Paper's* philosophical underpinnings holds that, because the public owns all government agencies, all government costs must be considered in order to accurately assess the public's real cost of a given government service. For example, many state and local governments assign their core human-resources management tasks to a central division, office, or department that provides overall jurisdictional support. As a consequence, the budget of the agency that employs design engineers could show a zero expense for human resources, even though the "owner" of that agency – the public – provides and pays for all the agency's human-resources

management needs, just as the owners of private-sector organizations do. In other words, while payment may come from different pockets, all payments, including those for hidden taxes, come from John Q. Public's pants."

Does that sound like music to your ears? Do you believe, as various studies have shown, that the private sector can accomplish public-sector design faster, more effectively, and for less money than the public sector? Or do you believe, as other studies have shown, that the public sector can do it for less?

But there's something fishy about those "other studies," because they fail to consider the cost of centralized services, like HR, just as they forget the cost of legal defense (paid for by John Q. Citizen), as well as the cost of professional-liability insurance pay-outs (good old John Q. covers all losses). Unquestionably, public agencies need top-flight geoprofessionals to manage projects, but do they need huge design staffs that get paid year-in and year-out no matter what the workload?

ASFE developed *White Paper No. 2* about a dozen years ago to identify all the costs associated with public-sector design, to help effect the apples-to-apples comparisons that voters need to make informed decisions. It's a great piece of work, White Paper No. 2. You might want to take a look and print out copies for those with a genuine need to know. It's available free at www.asfe.org.

Two new quality-assurance messages from the CoMET committee

"Done right, quality assurance (QA) can save time and money; prevent claims and disputes; and reduce risks. Many owners don't do QA right because they follow bad advice." So say two new "message" documents – one for owners; the other for architects, civil engineers, and structural engineers – developed by ASFE's redoubtable Construction Materials Engineering and Testing (CoMET) Committee. Both messages provide important information owners and project professionals can apply to achieve high-quality QA. As examples:

Most construction materials engineering and testing (CoMET) firms – they're the firms that provide QA – are not accredited.

Many CoMET QA personnel are not certified for what they do or at all.

Properly calibrated equipment is essential; many firms don't have it.

CoMET QA field-representatives require good judgment. They cannot do an effective job by just filling in blanks.

Select CoMET consultants carefully. They're the last line of defense.

Take advantage of CoMET consultants' knowledge and experience. Have them serve as active members of the project team from project start to project finish.

Another firm's field representatives will not report issues to the geotechnical engineer of record; don't split responsibilities.

How QA services are contracted for is important, especially when special inspections also are involved.

The so-called "low-cost providers" want owners and design professionals to believe all CoMET firms are alike, because – were that actually the case – lowest fee would mean best value, and that seldom, if ever, is true.

Both new documents are available free of charge at the ASFE website. Get *Project Quality Assurance: A Message to Owners* at https://netforum.avectra.com/eweb/shopping/shopping.aspx?site=asfe&prd_key=c117ddcd-a7a4-4418-b5a8-dbdde0ea9c85. *Project Quality Assurance: A Message to Architects, Civil Engineers, and Structural Engineers* is available at https://netforum.avectra.com/eweb/shopping/shopping.aspx?site=asfe&prd_key=3adfbf4b-989c-4180-8943-daca811c4912.

ASFE Practice Alert 52: Initial curing of concrete test specimens in the field: Who is responsible for what?

ACI Standard 301-10, *Specification for Structural Concrete*, sets forth ambiguous requirements for initial curing of concrete test specimens in the field, stating that has replaced the well-established ACI Standard 301-05. The old version requires the contractor to "Provide and maintain adequate facilities on the project site for safe storage and initial curing of concrete test specimens as required by ASTM C31/C31M for the sole use of the testing agency." This requirement has generally been interpreted to mean that, during the initial curing period in the field, it's the contractor's responsibility to provide a curing environment that satisfies the requirements of ASTM C31. The new version (at section 1.6.2.2.d) says the contractor is responsible for "[providing] space and source of electrical power on the project site for facilities to be used for initial curing of concrete test specimens as required by ASTM C31/C31M, for the sole use of the Owner's quality assurance testing agency." This change in wording could lead to uncertainty and confusion. Does "space" mean that the contractor must set aside an area at the construction site where the construction materials engineering and testing (CoMET) consultant or some other party will place or construct initial curing facilities? Or does "space" mean "an environmentally controlled space" for initial curing in the field? Because uncertainty and confusion are common precursors of delays, disputes, and claims, and because CoMET consultants are likely to be blamed for any that occur, CoMET consultants need to take appropriate action NOW to help the project team avoid related problems. How? The answers to that are now available in *ASFE Practice Alert 52: Initial Curing of Concrete Test Specimens in the Field: Who Is Responsible for What?* developed by ASFE's Construction Materials Engineering and Testing Committee.

Terra offers new risk-management videos, free of Charge

Established by the same forward-thinking geoprofessionals who created ASFE, Terra Insurance Company is now America's second-oldest insurer specializing in professional-liability (PL) coverages for design and environmental professionals. It may also be the most successful PL insurer, given that its owner/insureds – all ASFE-Member Firms – report an astoundingly low **one claim per $25 million generated in fees**. How do they do it? Terra has begun production of a series of audio/visual risk-management presentations explaining just that. The first – *Critical Success Factors, Part One* – features Terra CEO David L. "Dave" Coduto, who discusses focuses three of the most important critical success factors that, according to Terra research, can lead to fewer and less-severe claims, fewer deductible payments, less productive time lost to claims handling, and lower insurance rates. The three factors are a nonautocratic, solutions-oriented corporate culture; the ability to respond quickly to problems; and financial wherewithal.

The second video – *Contract Negotiation: Engineers Doing the Right Thing* – focuses on elements of contract negotiation. Prepared for engineers and client representatives alike, and also featuring Dave Coduto, the video addresses indemnities, defense requirements, warranties and guarantees, and certain standard-of-care provisions that, on the one hand, greatly expand an engineer's liability exposure and, on the other hand, afford no insurance protection for the added risk. As Mr. Coduto explains, engineers who call these problems to client representatives' attention are smart, honest, conscientious, and fair. While they risk being regarded as messengers of bad news, how much better for clients to learn that news before the project begins, rather than later, when the anticipated insurance coverage cannot materialize.

Watch either video free of charge by clicking to http://www.terrarrg.com/RiskManagement/index.cfm?ac=videos. Terra also offers a variety of risk-management guides and monographs, also free of charge.

Foundation for the future honor roll

We're getting "there"; that place where we need to be in order to achieve our purpose; to combat the commoditization and marginalization whose symptoms make geoprofessional risk management so continuingly essential. The energy source? The generosity of ASFE-Member Firms and Associate Member individuals who have volunteered to pay four years' worth of dues (or even more, in some cases) over a three-year span. If you haven't yet stepped up to the bar, fear not! It's never too late to get involved. Just contact EVP John Bachner or Membership Director Colleen Knight; telephone either at 301/565-2733 or e-mail john@asfe.org or colleen@asfe.org. In the meantime, let's all join in a round of applause for:

ASFE-Member Firms

Active Environmental Services, Inc.

AMEC Earth & Environmental

Anderson Engineering, Inc.

Blackburn Consulting

BSK Associates

Creative Engineering Options, Inc.

DiGioia, Gray & Associates, LLC

Dr. Clarence W. Welti, P.E., P.C.

EARTH SYSTEMS, Inc.

French & Parello Associates, P.A.

GAI Consultants, Inc.

GEI Consultants, Inc.

GeoEngineers, Inc.

Geotechnical Consultants, Inc.

Geotechnical Services, Inc.

Geotechnology, Inc.

Haley & Aldrich, Inc.

Hirata & Associates, Inc.

Hultgren-Tillis Engineers

Jeffers Engineering Services, LLC

Kleinfelder

Klohn Crippen Berger Ltd.

LAN Associates Engineering Planning Architecture Surveying Inc.

Lee James & Associates

L. Edward Wilson and Associates, Inc.

Lourie Consultants

Northern Geotechnical Engineering - Terra Firma Testing

NTH Consultants, Ltd.

Padre Associates, Inc.

Paradigm Consultants, Inc.

Richard T. Reynolds, P.E., Consulting Geotechnical Engineer

S&ME, Inc.

Sanborn, Head, & Associates, Inc.

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SCI Engineering, Inc.

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Soils Engineering, Inc.

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TTL, Inc.

Consultant Member

Gerald J. Salontai, P.E., Salontai Consulting Group, LLC

Terry Scanlan, Skellenger Bender

Faculty Member

Dr. Charles C. Ladd, MIT

ASFE meeting app debuts for Phoenix

There's an app for that, and now that almost-trite expression applies to ASFE meetings, thanks to the debut of the *ASFEFall11* meeting app. The next one – likely to be called *ASFESpring 12*! – will be particularly useful for meeting attendees and for those unable to attend, as well. The app will provide the latest information about the meeting's schedule, activity locations, attendees, speakers, and topics. It will also provide links to speaker presentations and handouts. Essential to ASFE's sustainability initiative, the new app will be updated as premeeting, last-minute changes are received, a benefit paper materials cannot provide. (ASFE's 2011 Fall Meeting was the first where hard-copies of presentation materials were provided only on request.)

According to ASFE Executive Vice President John P. Bachner, "The app brings our meetings into the modern age. We can keep attendees updated in real-time with the latest information at their fingertips. It also aligns with ASFE's commitment to pursue sustainability in all we do."

ASFEFall11 is available free for Android, Blackberry, and Windows Mobile devices, in addition to iPhones and iPads. Get yours at http://www.asfe.org/index.cfm?pid=12662.

Better, thanks

So, why do firms undergo ASFE **Peer Review**? Is it because they're ill? No. In fact, just the opposite usually is true: They're healthy and want to get even healthier, because they understand that, in almost any organization of two people or more, problems of one kind of another are bound to exist, and many are kept below the surface, growing in the dark. They are the quintessential molehills that, left alone, can grow into mountains. **Peer Review** helps firms identify them and take action sooner rather than later. But there's more to it than that, because Peer Reviewers are peers; individuals who can identify techniques and technology they know you can apply because they understand your firm and have applied them successfully themselves, or have reviewed other firms that have. In fact, they bring a wealth of knowledge and experience you just cannot get elsewhere. Just ask the good folks listed below who have completed **Peer Reviews** of their own. What are you waiting for? A mountain?

Kenneth R. Miller, P.E.
Civil & Environmental Consultants (Pittsburgh, PA)

Barry K. Thacker, P.E.
Geo/Environmental Associates (Knoxville, TN)

Michael W. Reed. P.E., G.E.
GRI (Beaverton, OR)

David O. Cram, P.E.
Materials Testing & Inspection (Boise, ID)

Michael D. Kleames, G.E.
Pacific Crest Engineering (Watsonville, CA)

Meeting management

Meeting management involves more than managing meetings. It also means managing the events leading up to the meeting and managing what occurs after. In the latter category, we've already discussed the importance of issuing minutes within no more than 24 hours after a meeting, and how to do it within 30 minutes after a meeting. The minutes should identify each action item: who is going to do what, when. But, to manage this aspect of a meeting effectively, you need to contact every person with an assignment to say, "Please note that you are committed to doing thus and so and providing it to us by when." If you have received nothing by the halfway point, contract the person again. "Hello, Joe. I'm just checking to see what progress you've made on the assignment. PLEASE let me know… and also let me know if there's anything I can do to help."

If that type of missive gets no response, fear the worst and call. If you have to leave a message and hear nothing in a few days, send another e-mail and/or call again. You might want to say, or suggest, "I understand how things can come up and create conflicts. Please let me know if you will be unable to do thus and so by the deadline. It's important that it get done, if not by you then by someone else. Please let me hear from you. Thank you!" If that elicits no response, then use the phone and e-mail to notify the person that you will reassign thus and so to someone else, and then do just that.

Remember: Meeting management requires you to have all promises fulfilled, even when those who make the promises don't deliver.

Editorial

You may be familiar with Herbert Hoover's 1954 article in Engineer's Week where he wrote:

> *To the engineer falls the job of clothing the bare bones of science with life, comfort, and hope. No doubt as years go by people forget which engineer did it, even if they ever knew. Or some politician puts his name on it. Or they credit it to some promoter who used other people's money with which to finance it. But the engineer himself looks back at the unending stream of goodness which flows from his successes with satisfactions that few professions may know. And the verdict of his fellow professionals is all the accolade he wants.*

Great advice, huh? Come up with something really amazing, let everyone else take credit for it, and be blissfully satisfied with your public anonymity. And this from an engineer who in his earlier years had three full-time PR professionals on staff, vying to see who would issue the news release announcing that Mr. Hoover had recently sneezed.

Do as he did, not as he wrote, because what he wrote is justification for exactly the kind of behavior that has turned the 500-pound engineering gorilla into a 97-pound weakling. In fact, why do others get credit for something you did? *Because you let them*. I'm not suggesting that you give ultimatums – "Name this tunnel after me or wind-surf to work" – but, certainly, if you've performed the geoprofessional services for a significant structure, your name should be on the plaque honoring all those who clothed "the bare bones of science with life, comfort, and hope." Nor is it unrealistic to make such appropriate recognition an element of the consideration you require for rendering your services, especially given that, as President Hover also wrote:

> *The great liability of the engineer compared to men of other professions is that his works are out in the open where all can see them…. If his works do not work, he is damned.*

Some will contend that the risk of failure or alleged failure and the liability associated with it make not having one's name on a plaque preferable to recognition, in case someone wants to sue. How silly. Public records make hiding from a claim impossible and, that being the case, anonymity does not help geoprofessionals and most certainly does not help the geoprofessions.

Now consider the opposite approach. Imagine what would happen were the geoprofessionals of a community to actively court the news media, including the bloggers and Tweeters. The geoprofessionals could educate by addressing the importance of what they do in construction design and quality assurance, in cleaning and preserving the environment, and in the support of sustainability and material reuse. They could develop robust news release distribution lists to keep all media representatives apprised of developments. And they could use their news releases to also reach out to client representatives, profession and industry colleagues, and other businesspeople in the community. After all, if you fail to treat yourself and what you do as a "big deal," why should anyone else treat you and your accomplishments as a big deal?

Getting started in the PR realm is easy. Bearing in mind the dictum "News is what an editor thinks is news," take some editors to lunch. Ask, "What would you consider newsworthy? What kind of additional information might make even a somewhat humdrum news release – about a new hire, a promotion, the award of a new commission, etc. – more usable?"

Self-serving? Sure it is, but it's profession-serving, too, because every geoprofessional is a representative of the geoprofessions. Admittedly, when just one geoprofessional issues one news release, it's just a professional squeak. But when 20 geoprofessionals issue news releases on a regular basis, they create a roar that puts geoprofessionals on the local media's map. And the media then bring it to "the people," helping geoprofessionals get credit where credit is due.

Now imagine that happening in every community across the nation where geoprofessionals live and work. The results would be pretty amazing. And don't forget that your efforts to advance the geoprofessions in this manner would be a valuable byproduct of your efforts to advance yourself and your organization.

The notion that "the verdict of his fellow professionals is all the accolade [the geoprofessional] wants" is malarkey that justifies – if not glorifies – anonymity. And Hoover himself never believed it for a second! He was a self-promoter *par excellence* and, because of that, he created an outstanding image for himself and a now-lost luster for *all* engineers.

You are a geoprofessional. You are a big deal. That's why you, like Hoover, should let *everyone* know who you are and what you do. It's about time you got the recognition you deserve from your fellow man, not just your fellow professionals.

Your response is welcome. Send it to info@asfe.org.

Upcoming meetings

Mark your calendar! You don't want to miss any of the upcoming meetings of **ASFE/The Geoprofessional Business Association.**

April 19-21, 2012
ASFE Spring (Annual) Meeting
Disney's Contemporary Resort
Orlando, Florida

October 26-28, 2012
ASFE Fall Meeting
Sheraton Denver Downtown Hotel
Denver, Colorado

Geotechnical, Environmental and Marine Site Investigation Services

Geotechnical

- Cone Penetration Testing
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- Mud Rotary Drilling and Coring
- Auger Drilling
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- Borehole and Surface Geophysics
- PDA Services
- Software:
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- Well Installations
- ORC / HRC Injection
- Hydraulic Fracturing
- Limited Access Drill Rigs
- Membrane Interface Probe (MIP)

Tracked CPT Rig

Mud Rotary Drill Rig

Marine, Ports and Harbors

- Jack-up Platform
- Drill Ships and Barges
- Sectional Barges
- CPT and Seismic CPT
- Deep Water Mini-CPT
- Mud Rotary Drilling and Coring
- Vibro Core Sampling
- Gravity Core Sampling
- Clam Shell Sampling

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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

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