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CONTENTS

COVER *Displacement sensor (see article starting on page 43).*

GEOTECHNICAL news

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Printed in Canada

Message from the President

Bryan Watts, President of Canadian Geotechnical Society, 2011-2012.

Several important issues were resolved at the Board of Directors Meeting on the day before the start of the 65th Canadian Geotechnical Conference (CGC) in Winnipeg. Firstly, we are pleased to report that Quebec City has been successful in its bid to host the 68th CGC in 2015 and secondly that CGS members from Queen's University will host the 6th Geohazards Conference in Kingston in 2014. The 68th Conference will follow the 67th CGC in Regina in 2014 and the 66th in Montreal next year in 2013. The 2016 conference has yet to be named but we expect that the venue will rotate back to the West. The Board of Directors also approved the Articles of Continuance and revised CGS By-Laws for submission to Corporations Canada for continuance of the CGS as a Technical Society under the new *Canada Not-for-Profit Corporations Act (NFP Act).*

These conferences, the Articles of Continuance, and By-Laws were each ratified by a unanimous vote at the AGM in Winnipeg. The AGM also approved a gift of $60,000 to the Canadian Foundation for Geotechnique (CFG) which is to be part of a scholarship fund. The CFG also funds the Cross Canada Lecture Tour, the Colloquium, the striking of the Legget Medal, and all other CGS awards.

Our VP Finance, **Mr. Peter Gaffran**, presented the financial results for 2012 which predicts a small positive contribution to our balance sheet. The financial forecast for 2013 shows a loss but this is typical at this stage of budgeting when revenues are always more uncertain than expenses. The bottom line is that membership dues will remain constant in 2013 except that student fees will be reduced from $70 to $45. This reduction was proposed and ratified by the Board and then by the membership at the AGM.

The 65th CGS Conference in Winnipeg at the beginning of October was a big success. The Conference Chairman, **Mr. Gil Robinson**; his Co-Chair, **Mr. Kendall Thiessen**, his Program Chair, **Mr. Kent Bannister**, and the rest of the Organizing Committee did a great job and even arranged for balmy weather! The conference started, as is tradition, with the **R. M. Hardy Keynote Address**, delivered by **Dr. Rob Kenyon** of KGS. His lecture was a comprehensive review of flooding on the Red River with emphasis on the measures taken in 2011 to protect the citizens of Winnipeg from that record flood. Not only were we treated to rapid and innovative solutions to immediate and serious dyke raising requirements, but we heard about the critical interactions between government officials, the armed forces, and consultants. On Tuesday morning, **Dr. Andy Take** of Queens University delivered a thought-provoking **2012 Canadian Geotechnical Colloquium** lecture on the use of time lapse digital photography in advanced geotechnical laboratory and field experimentation.

We look forward to publication of this lecture in a future edition of the Canadian Geotechnical Journal which celebrates its 50th anniversary next year. Following, Dr. Take's Lecture on Tuesday morning, we were treated to the **Graduate Student Paper Award** presentation by **Mr. Fawzy Ezzein**, Royal Military College, on the use of transparent granular sand for geotechnical modelling.

Dr. Ed McRoberts of AMEC was awarded the **R. F. Legget Award Medal,** the most prestigious award in our society. His charming, movie producing daughter from Los Angeles accompanied him during the medal ceremony. **Dr. McRoberts** received the Legget Medal because of his significant contributions to the fields of oilsands geotechnique, liquefaction assessments, and permafrost engineering. His address focused on judgement in geotechnical engineering. This is published in this same issue of Geotechnical News and is well worth reading.

I have thoroughly enjoyed representing the Canadian Geotechnical Society as its President for the past two years. I was ably assisted by my Executive Committee; **Mr. Peter Gaffran**, VP Finance; **Dr. John Sobkowicz**, VP Technical; and **Dr. Jean-Marie Konrad**, VP Communications. Representing the Divisions in 2012 were **Dr. Lukas Arenson** and the Sections, **Dr. Baolin Wang**. Behind the scenes were the ever present **Dr. Vic Sowa**, our Secretary General, **Ms. Lisa McJunkin** and **Mr. Wayne Gibson**, both of the Gibson Group.

The CGS is world class technical organization that does many things very well. If improvement is needed, it is for more of our members to nominate their fellow members for our awards. See the list of distinguished engineers in another part of the Geotechnical News regarding who won our major division and other awards this year just to appreciate the depth of talent in our Society. There are many more deserving, talented people in our CGS community.

And, finally, **Gordon McRostie** attended his 63rd conference this year in his 90th year. He started attending conferences in 1947 and has only missed two. If one of our young members tries to break the record, they will have to attend every conference until the year 2074!

Le message du président

Plusieurs dossiers importants ont été traités lors de la réunion du conseil d'administration qui avait lieu la veille de la 65e conférence canadienne de géotechnique (CCG) à Winnipeg. Tout d'abord, nous sommes heureux d'annoncer que la ville de Québec a été retenue comme hôte de la 68e CCG en 2015. Ensuite, nous annonçons que les membres de la SCG qui sont à l'Université Queen's organiseron la 6e conférence sur les géorisques

à Kingston, en 2014. La 68e CCG succèdera à la 67e CCG de Regina en 2014 et à la 66e CCG qui aura lieu à Montréal en 2013. L'emplacement de la CCG de 2016 doit être déterminé, mais nous nous attendons à ce qu'elle ait de nouveau lieu dans l'Ouest. Le conseil d'administration a également approuvé les statuts de prorogation et les règlements généraux révisés qui seront envoyés à Corporations Canada pour proroger l'existence de la SCG à titre de société technique, en vertu de la nouvelle *Loi canadienne sur les organisations à but non lucratif.*

Ces conférences, les statuts de prorogation et les règlements généraux ont été ratifiés à l'unanimité lors de l'AGA à Winnipeg. L'AGA a également approuvé un don de 60 000 $ à la Fondation canadienne de géotechnique (FCG). Il sera intégré à un fonds générant des bourses d'études. La FCG subventionne aussi la Tournée pancanadienne de conférences, le Colloque et la Médaille Legget, ainsi que tous les prix décernés par la SCG.

Notre v.-p. des finances, **M. Peter Gaffran,** a présenté les résultats financiers de 2012, dans lequel il prévoit une petite contribution positive à notre bilan. Les prévisions financières de l'exercice 2013 accusent une perte, mais cela est typique à ce stade de l'établissement du budget, alors que les revenus sont toujours moins certains que les dépenses. L'important est que les taux d'adhésion seront maintenus en 2013, exception faite du taux d'adhésion des étudiants, qui sera réduit de 70 $ à 45 $. Cette réduction a été proposée et ratifiée par le conseil d'administration et ensuite par les membres présents lors de l'AGA.

La 65e CCG, qui a eu lieu à Winnipeg au début d'octobre, a remporté un franc succès. Le président de la conférence, **M. Gil Robinson**, le coprésident, **M. Kendall Thiessen**, le président du programme, **M. Kent Bannister,** et les membres du Comité organisateur ont non seulement fait un excellent travail mais avait aussi « organisé » du temps doux! Comme le veut la tradition, la conférence a débuté par la **conférence d'honneur R. M. Hardy,** qui a été prononcée par **Rob Kenyon, Ph. D**., de KGS. Il a fait une analyse approfondie de l'inondation de la rivière Rouge et a présenté les mesures prises en 2011 pour protéger les citoyens de Winnipeg lors de cette inondation record. Nous avons non seulement tout appris sur les solutions rapides et novatrices concernant l'édification immédiate et efficace des digues, mais aussi sur les interactions essentielles avec les représentants gouvernementaux, les

Forces armées et les experts-conseils. Mardi matin, **Andy Take, Ph. D.**, de l'Université Queen's, a présenté une conférence fort intéressante lors du **Colloque de géotechnique canadienne de 2012**, sur l'utilisation de la chronophotographie dans les laboratoires géotechniques de pointe et les expériences sur le terrain. Nous attendons avec impatience la publication de cette conférence dans un prochain numéro de la *Revue canadienne de géotechnique*, qui célébrera son 50e anniversaire l'an prochain. Après la conférence d'A. Take de mardi matin, nous avons eu le plaisir d'entendre la présentation du lauréat du **Prix pour étudiant diplômé. M. Fawzy Ezzein**, du Collège militaire royal, a traité de l'utilisation du sable granulaire transparent dans la modélisation géotechnique.

La Médaille R.F. Legget, le plus prestigieux des prix décernés par notre société, a été remise à Ed McRoberts, PH. D., d'AMEC. Lors de la cérémonie de remise de la médaille, il était en compagnie de sa charmante fille, une réalisatrice de films établie à Los Angeles. Cette distinction lui a été décernée en raison de son importante contribution aux domaines de la géotechnique des sables bitumineux, des évaluations de liquéfaction et de l'ingénierie du pergélisol. Son discours portait sur l'interprétation en ingénierie géotechnique. Il devrait être publié dans ce numéro de la revue Geotechnical News et vaut certainement la peine d'être lu.

J'ai beaucoup apprécié mon mandat de président de la Société canadienne de géotechnique lors des deux dernières années. J'ai été très bien soutenu par mon Comité exécutif; **M. Peter Gaffran**, v.-p. des finances; **John Sobkowicz, Ph. D.**, v.-p. technique; et **Jean-Marie Konrad, Ph. D.**, v.-p. des communications. En 2012, les divisions étaient représentées par **Lukas Arenson, Ph. D.**, alors que les sections étaient représentées par **Baolin Wang, Ph. D**. Il convient de souligner la présence constante, dans les coulisses, de notre secrétaire général, **Vic Sowa, Ph. D.**, ainsi que de **Mme Lisa McJunkin** et de **M. Wayne Gibson**, tous deux de la société Gibson Group.

La SCG est une société technique de classe mondiale qui compte de nombreuses réalisations fort intéressantes à son actif. La seule amélioration digne de mention est le besoin de recevoir, de la part de nos membres, un plus grand nombre de nominations de leurs collègues aux prix que nous décernons. Pour vous rendre compte du bassin de compétences des membres de notre société, vous n'avez qu'à consulter la liste des ingénieurs distingués qui ont remporté nos prix et bien d'autres honneurs cette année. La liste figure dans ce numéro de Geotechnical News. Mais la SCG compte de nombreux autres membres, tout aussi compétents et méritants.

Fait intéressant en guise de conclusion, Gordon McRostie a assisté à sa 63e conférence cette année. Il est âgé de 90 ans. Il a commencé à assister à des conférences en 1947 et n'en a manqué que deux. Si l'un de nos jeunes membres tentait de battre ce record, il lui faudrait assister à chaque conférence jusqu'en 2074!

From the Society

Canadian Geotechnical Society - Awards and Honours 2012

R.F. Legget Award: Edward C. McRoberts

R.M. Quigley Award: Pete E. Quinn, Mark S. Diederichs, R. Kerry Rowe and D. Jean Hutchinson. *"A new Model for Large Landslides in Sensitive Clay using a Facture Mechanics Approach"* (Vol. 48: (8) pp.1151-1162)

Honourable Mention: Xue-Yu Geng, Buddhima Indraratna, and Cholachat Rujikiatkamjorn. *"Effectiveness of Partially Penetrating Vertical Drains under a Combined Surcharge and Vacuum Preloading"* (Vol. 48: (6) pp. 970-983)

Paul J. Vardanega and Malcolm D. Bolton. *"Strength Mobilization in Clays and Silts"* Vol. 48 (10) pp. 1485-1503)

G. Geoffrey Meyerhof Award: Delwyn G. Fredlund, Professor Emeritus, University of Saskatchewan

Thomas Roy Award: Oldrich Hungr, Professor, University of British Columbia

Roger J. E. Brown Award: James M. Oswell, Principal Consultant, Naviq Consulting Inc.

John A. Franklin Award: Not scheduled for 2012

Geoenvironmental Award: Shahid Azam, Associate Professor, University of Regina

Geosynthetics Award: Jonathan Fannin, Professor, University of British Columbia

Robert N. Farvolden Award: D. Allan Freeze, President, R. Allan Freeze Engineering Inc. (**Joint award with IAH-CNC**)

Graduate student paper award

1st Prize: Fawzy M. Ezzein, *"A Transparent Granular Sand for Geotechnical Modelling"* Department of Civil Engineering, Royal Military College of Canada; Advisor, Dr. Richard Bathurst

2nd Prize: Fady B. Abdelaal, *"Cracking of HDPE Geomembranes"* Department of Civil Engineering, Queen's University; Advisor, Dr. Kerry Rowe

Undergraduate student report (individual)

1st Prize: David Flynn, *"Large Scale Interface Shear Testing ABC Twin WaterBloc Material Enhancing Flood Protection"*. Department of Civil Engineering, University of Manitoba; Advisor, Dr. James Blatz

2nd Prize: Lee-Ann Sills, *"Use of transparent soil to investigate discontinuous gas flow in heterogeneous*

porous media" Department of Civil Engineering, Queen's University: Advisor, Dr. Kevin Munford

Undergraduate Student Report (Group)

1st Prize: Hubert Péloquin, Leila Pike, Adham Kalila, and Mamoun Essakalli, *"Europa Creek Hydroelectric Project: High Pressure Penstock Pipeline"* Department Civil Engineering and Applied Mechanics, McGill University: Advisor, Dr. Mohamed Meguid

2nd Prize: Jessy Counter, Dylan Conners, Brendan McAuley, Carl Mohammadi, *"Foundation Design for Canadian Embassy Structures (Using the Mechanics of Saturated and Unsaturated Soils)"* Department of Civil Engineering, University of Ottawa: Advisor, Dr. Sai Vanapalli

Canadian Foundation for Geotechnique National Graduate Scholarship: Michael Callaghan, University of Calgary

A.G. Stermac Awards

Andrew Drevininkas (Chief Geotechnical Engineer, Toronto Transit Commission)
Charles Kwok (Senior Geotechnical Engineer, Senior Principal, Stantec)
Dwayne D. Tannant (Professor, University of British Columbia, Okanagan Campus)
Stéphanie Perret (Lecturer, College (CEGEP de Sherbrooke)

CGS R.M. Hardy Keynote Address: R. M. (Rob) Kenyon, KGS Group, Manager
CGS Keynote Address: Not scheduled for the 2012 CGS Winnipeg Conference
Canadian Geotechnical Colloquium: W. Andy Take, Associate Professor, Queen's University
Cross Canada Lecture Tours: Lee Barbour (Spring 2012), Mike Jefferies (Fall 2012)

Awards from Engineering Institute of Canada (EIC)

Sir John Kennedy Medal: R. Kerry Rowe, Professor, Queen's University
Julian C. Smith Medal: M.A.J. (Fred) Matich, Consultant, Private Practice
John B. Stirling Medal: C. Derek Martin, Professor, University of Alberta
Fellowship of the Institute (FEIC): Doug Stead, Professor, Simon Fraser University
Fellowship of the Institute (FEIC): Hesham El Naggar, Professor, University of Western Ontario

CGS Certificates of Appreciation

The following were awarded Certificates of Appreciation for their individual valued contributions to the CGS during 2012.

2012 retiring Canadian Geotechnical Society directors and chairs

Bryan Watts: President
John Sobkowicz: Vice-President Technical
Peter Gaffran: Vice-President Finance
Jean-Marie Konrad: Vice-President Communications
Davide Elmo: Chair, Engineering Geology Division

Uthaya M. Uthayakumar: Section Director, Vancouver Geotechnical Society
Deyab Gamal El-Dean: Section Director, Vancouver Island Geotechnical Group
Doug Dewar: Section Director, Prince George Geotechnical Group
Baolin Wang: Section Director, Ottawa Geotechnical Group
Daniel R. Babcock: Section Director, London Group
Arash Zakeri: Section Director, Newfoundland Chapter
James Blatz: Chair, Geotechnical Research Board
Phil Bruch: Editor, CGS News, in Geotechnical News

Peijun Guo: Chair, Computing Committee
Corey R. Froese: Chair, Landslides Committee

2012 retiring associate editors – Canadian Geotechnical Journal

Hai-Sui Yu
Doug Stead
Kent Novakowski

2012 Annual Canadian Geotechnical Society Conference – Winnipeg Organizing Committee

Gil Robinson: Chair
Kendall Thiessen: Co-Chair
Kent Bannister: Technical Program Chair
Anne-Marie Hamilton: Treasurer
Neil Privat: Technical Tours
Alexandria Beveridge: Short Courses
Alena James: Social Activities and Partners Program
Wing Keat Wong: Volunteer Co-ordinator

Organizing Committee – 11th International Landslides Symposium and 2nd North American Landslides Symposium

Corey Froese: Chair
Erik Eberhardt: Chair, Technical Committee
Réjean Couture: Field Trip Coordinator
Serge Leroueil: Technical Committee
A. Keith Turner: Technical Committee
Roger Skirrow: Secretary/Member-at-Large
Michael Porter: Secretary/Member-at-Large
Oldrich Hungr: Technical Committee
Peter Bobrowsky: Chair, International Advisory Committee
Vernon Schaefer: Technical Committee

Call for nominations – The Canadian Geotechnical Colloquium, 2014

The Canadian Geotechnical Colloquium is a commissioned work financially supported by the Canadian Foundation for Geotechnique (CFG). It is awarded annually to a member of the Canadian Geotechnical community. The purpose of the Colloquium is to provide information of a particular interest to Canadian geotechnique and to provide encouragement to a younger member of the Society in pursuing studies in the Colloquium's preparation. The Colloquium is presented at the CGS-SCG Annual Conference and must be suitable for publication in the Canadian Geotechnical Journal. It must be prepared in the format established by the Journal; however, the decision to publish in the Journal is exclusively the responsibility of the Journal Editor. The choice of the individual and topic is made by the Society's Selection Committee of the Geotechnical Research Board based on the nominations received. The successful candidate receives an honorarium of $5,000 and a framed certificate.

Each nomination letter must provide an introduction to the candidate and their main accomplishments. It must be accompanied by an abstract of about 2000 words of the proposed lecture, emphasizing the importance of the topic to the Canadian geotechnical community, a brief review of the state-of-the-art on that problem, an outline of the significance of the candidate's contribution, and a curriculum vitae listing the nominee's practical experience relevant to the topic and the nominee's publication record. Information on the nomination criteria can be obtained from Item C-2 of the "Awards and Honours Manual 2012, or the latest edition. To find this Manual, CGS members can log-in at http://cgs.ca/login.php then proceed to Online Member Resources, and find the Awards and Honours Manual.

Nominations should be submitted prior to January 31, 2013 to Dieter F.E. Stolle, P. Eng., Past Chair, Geotechnical Research Board, at Civil Engineering Dept., McMaster University, 1280 Main Street W., Hamilton, ON, L8S 4L7, stolle@mcmaster.ca or in care of: Victor Sowa, Secretary General, at vsowacgs@dccnet.com.

Membership Registration for 2013

Visit the Canadian Geotechnical Website at www.cgs.ca to renew your membership.

Membership Benefits include:

- Keep up with local, national and international developments
- Share insights, visions and experience
- Present projects and research to peers
- Record Continued Education Unit (CEU) and Professional Development Activities (PDAs)
- Attend lectures, Cross Canada Lectures, short courses, workshops, seminars and conferences etc. organized locally or nationally at membership rates
- Eligible to participate as Executives in local or national committees and boards
- Meet, socialize and know colleagues with common interests, potential employers or employees
- Develop contacts with colleagues across Canada
- Sponsorship and mentorship initiatives
- Membership fee includes free internet access to all early Canadian Geotechnical Journal plus 12 new issues per year
- Geotechnical News - 4 issues per year
- Website www.cgs.ca, CGS News, CGS e-News

We look forward to your membership renewal or joining as a new member soon. We also ask that all current members to invite a friend or colleague to join the Canadian Geotechnical Society. With your help, we can continue to provide the benefits the society brings to our profession.

Conference summary: 65th Canadian Geotechnical Conference

The 65th Canadian Geotechnical Conference (CGC) was hosted by the Manitoba Region at the Fairmont Hotel in Winnipeg from September 30 to October 3, 2012. The conference was very successful thanks to the efforts of the Local Organizing Committee (LOC), under the leadership of the Chair, **Gil Robinson** and the Conference Managers, **Wayne Gibson** and **Lisa McJunkin** of the Gibson Group Association Management. The conference was well attended by about 400 delegates and featured the **Hardy Lecture** given by **Dr. Robert Kenyon** of the KGS Group, the **Geotechnical Colloquium** by **Dr. Andy Take** of Queen's University and a plenary session on Professional Practice with presentations by **Fred Matich** of MAJM Corporation and **John Seychuk** of Golder Associates. All lectures were well attended as well as the 2012 GEOpardy Student Competition and the Trade Show. The conference also included two well attended short courses and technical tours arranged by the LOC.

2012 Legget Medal Award

Introduction for 2012 Legget Medal Recipient: Dr. E.C. McRoberts, AMEC

Introduction by: Dr. Angela Kupper, AMEC

Dr. Edward McRoberts is a geotechnical engineer with a razor-sharp mind who has covered a broad range of geotechnical engineering aspects during a career that has involved an impressive list of projects. Throughout his 40 year career, Dr. McRoberts has played a key role in Western and Northern Canada's resource development.

Ed McRoberts graduated in Civil Engineering from the University of Alberta in 1967, and was commissioned as a Lieutenant in the Corps of Royal Canadian Engineers. He was awarded an Athlone-Vanier Engineering Fellowship by the Engineering Institute of Canada, which allowed him to go to the Imperial College of Science and Technology in London where he obtained an M.Sc. in Geotechnical Engineering in 1968. Returning from the UK, Ed served in two engineering units at Canadian Forces Base in Winnipeg, and as an Assistant Professor at the Royal Military College in Kingston, Ontario.

He retired from the Army as a Captain and started a Ph.D. at the University of Alberta in September 1971 where he worked on slope stability in permafrost under Professor Morgenstern. Dr. McRoberts joined R.M. Hardy and Associates (one of AMEC's predecessor companies) in December 1973 in Calgary working on arctic pipelines. He made significant contributions in this area. Quoting Dr. Morgenstern "While Dr. McRoberts has not been particularly active in this area of late, the geotechnical skills that he brought to bear on this class of problems has stood the test of time and both the geotechnical profession in Canada and the nation as a whole, in developing its technological capacity, have and continue to benefit from his contributions".

In 1978 Ed moved to the Edmonton office to focus on oilsands, initially assisting Dr. R.M. Hardy, who was the engineer of record for all the first tailings containment structures at Suncor and Syncrude. Ed's work in the oilsands eventually encompassed essentially the full range of activities and in one capacity or another for all the active mines and current lease holders. His focus has been on the design and construction of tailings dams and the associated tailings management issues. In the late eighties he was Chief Geotechnical Engineer for Western Canada. As the company grew, he became the Chief Technical Officer and a Senior Vice President.

Ed has an uncanny ability to see through complex problems and achieve creative, innovative solutions that reflect his solid technical basis. His love of the subject and his intellectual curiosity can't be missed by those working with him. His leadership, mentorship and guidance have had a profound impact on the careers of numerous engineers, who have benefitted from his sharp critical thinking process and technical insight. This is demonstrated by many of the best geotechnical engineers practicing today, who at some point in their career worked under Dr. McRoberts' direct supervision.

In December 2009 Ed transferred from Edmonton to AMEC's Burnaby BC office where he still maintains a full workload, primarily on oil sands projects, as well as technical review of a variety of other projects.

He is a Fellow of the Canadian Academy of Engineering and of the Engineering Institute of Canada. In 2004 he was awarded the Engineering Institute of Canada's Julian C. Smith Medal.

I again quote Dr. Morgenstern "The contributions of Geotechnical Engineering to the successful development of the Alberta Oil Sands are enormous and it is most appropriate that the Canadian Geotechnical Society recognizes our leading practitioner in this area with the R.F. Legget Medal."

L to R. - Doug VanDine, Ed McRoberts, Angela Kupper, Bryan Watts

2012 Legget Medal Award acceptance speech: Dr. E.C. McRoberts

I am honored to have been selected by the Canadian Geotechnical Society to receive their most prestigious reward, the R.F. Legget Medal. This measure of professional recognition by one's colleagues is indeed a great and heartfelt pleasure. My thanks are also due to the awards committee, and to those who nominated and supported my award. My colleagues past and present in one way or the other have contributed to my being here today. And most important of all, I must acknowledge the many clients who have entrusted me with responsible charge on their projects.

It is customary at the Legget award to also pass on some thoughts. Let us follow up on the issue of "judgment" most appropriately put forward by Legget (1979) who in the 13th Terzaghi Lecture expressed the view:

> *"No computer is ever going to decide when a suitable foundation bed is reached, or when tunnel supports are necessary. In the final analysis it is human judgment that makes possible the safe uses of the earth. And judgment is based on sound experience that, whether recognized or not, includes an instinctive appreciation of all geological factors".*

This is echoed by Peck (1980) in the 5th Bjerrum Memorial Lecture who asks "Where has all the judgment gone?" and comments:

> *"as long as the myth persists that only what can be calculated constitutes engineering, engineers will lack incentive or opportunity to apply the best judgment to the crucial problems that cannot be solved by calculation"*

Both Legget and Peck were warning against too much emphasis on analysis. Today these cautions are as sound as they were more than three decades ago. Even more so, given the increasing and often illusory sophistication of models. So what is judgment? In his paper Peck tended to define judgment by what it is not. And to paraphrase Vick (2002), judgment is not the last refuge of the analytically inept, nor some geotechnical metaphysics necessarily only possessed by senior citizens. Vick has an interesting quote apparently attributable to Mark Twain:

> *"Good judgment comes from experience. And where does experience come from? Experience comes from bad judgment."*

This sounds just about right, and the ability to learn from mistakes is vital, but even better to learn from the mistakes of others so as to limit your own. For this, reading of case records is so important but it is a challenge for our profession to get these lessons published in the face of legal constraints and secrecy limitations that constrain discourse.

Vick (2002) refers to judgment as "good thinking". More recently Marr (2006) emphasizes that judgment equates to "critical thinking". Marr observes:

> *It is fascinating that the definition of critical thinking by prestigious intellects of our time equates critical thinking to judgment. Is critical thinking the same as that elusive term we all draw upon and call "engineering judgment"? Is critical thinking what Peck was questioning in his 1980 paper on where has the judgment gone?*

So today we arrive at a clear answer; judgment is "critical thinking". Marr cites education studies that define the elements of critical thinking as: interpretation, analysis, evaluation, inference, explanation, and self regulation. On first reading, I found many of the points made by Marr lining up well with all my hard earned perspectives, and learned more besides. Marr also takes an appropriately less nihilistic line than Peck as to the inter-relationship and importance of analysis in arriving at judgment. So if you are currently a sorcerer's apprentice in a consulting organization, read the references appended, take what you find to heart and practice what is preached.

As explained by Marr, this educational research has found critical thinking to be an essential skill and one that can be developed in the education process. This is a very important point; elements of judgment can be taught. But I think to nurture judgment in others you have to be able to exercise it. Therefore it will largely remain, with notable exceptions, up to consultant groups to continue to run our "finishing schools". And by consultants I mean both the independent firms as well as the "in-house" geotechnical teams found in a few large organizations.

Reflecting on what I have been doing for the past four decades or more – and how I got here today – I must conclude that as a consultant, geotechnical engineering is as much an avocation as it is a vocation. For me the vocation part was and remains the business side and what we consultants call fully chargeable. To a consultant, profit is not a four letter word, but loss is. Contributing to keeping a large and growing consultancy profitable year after year is no easy matter. The avocation part describes all the effort required to stay technically current in an exponentially growing literature, apart from pleasure to be gained in finding a mystery resolved. What has changed for me is in the beginning I needed to haunt the library, now it is mostly the internet. Of course the vocation part has always adamantly resisted doing anything that was obviously going to be boring so one must keep current. But there was a synergy to this as one enables the other. But the bottom line for those interested in advice is that it was never a 40 hours a week effort.

Finally, I must reflect on what we call the observational method as this was a lodestone to my career. Proposed by Terzaghi and formalized by Peck (1969) it fully clarified for me how to proceed in the face of the many uncertainties and risk that characterizes projects in our geotechnical world. It provides a vital vehicle by which predictions embracing the range of possibilities can be organized, and judgment exercised. I would say that arguably another definition of judgment is managing uncertainty and the observational method gives us the framework for doing just that. And to be clear, the root cause origin of this uncertainty is the variability of the geology at each and every project site we work on, as was so well described in Legget's 1979 lecture.

The observational method is far from just collating observations, and it is not "learn as you go" either, as some think. If you have not read and comprehended this basis for the observational method I can only say that your geotechnical education has been deficient. It is all about getting to an optimum solution, not the most conservative one, unless the client has a schedule or other constraints that demand a high degree of conservatism. Basically, expect the likely as you have established it to be, but plan for the worst by knowing beforehand what contingency measures could be taken. Observe critical elements of performance, being prepared to execute fall-backs in a timely manner – having predetermined that there will be the resources and schedule to do so. If these conditions cannot be met, then one must revert to a design based on the least-favorable conditions. Now there are a few "potential" clients out there that really only want you on their project to use your liability insurance to underwrite their risks. Avoid them like the plague, but if you cannot, the observational method properly deployed is a greater shield than all the boiler plate and exculpatory clauses the lawyers can dream up in both your contracts and reports; and such clients will not like it. But the well-informed client will understand and appreciate what you are doing.

To conclude: to the next generation of aspiring practicing geotechnical engineers and consultants here today at the 65th Canadian Geotechnical Conference – study and apply the elements of critical thinking, and good fortune in your careers should follow.

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Legget R.F. 1979 Geology and geotechnical engineering. ASCE JGED 105(GT3)

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Peck R .B. 1969 Advantages and limitations of the observational method in applied soil mechanics. Geotechnique , 19(2).

Peck R.B. 1980 Where has all the judgment gone? CGJ 17, pp584-590

Vick S.G. 2002 Degrees of belief subjective probability and engineering judgment. Reston VA. ASCE Press, 978-0-7844-0598-7

Upcoming conferences

Visit the CGS website (www.cgs.ca) for information on a variety of local, regional, national and international conferences.

66th Canadian Geotechnical Conference - GeoMontreal 2013 - Call for Abstracts

The Canadian Geotechnical Society (CGS) in collaboration with the International Association of Hydrogeologists (IAH-CNC) and the North American Geosynthetics Society (NAGS) invites you to the joint annual conference "GéoMontréal 2013" at the Hilton Montreal Bonaventure Hotel, Montreal, Quebec, Canada, from Sunday, September 29th to Thursday, October 3rd, 2013.

The conference organizing committee calls for members of the Canadian and international geotechnical, hydro-geological and geosynthetics communities to contribute recent research developments and advancements in their respective fields of interest and practice. Case studies and papers dealing with risk management and revitalization of aging infrastructures and with regional aquifer characterization studies are especially sought. Presentations illustrating analysis, techniques and innovative solutions as well as research on recent trends or future prospects, are highly encouraged.

Authors are invited to submit abstracts of a maximum of 400 words through the Online Submission page of the conference web site www.geomontreal2013.ca. Abstracts can be written either in French or English. The deadline for abstract submission will be January 14, 2013.

Invitations for submission of full papers will be sent to authors whose abstracts are accepted by the conference's Technical Committee by March 1, 2013. The submitted papers will be reviewed prior to final acceptance for inclusion in the conference proceedings. At least one author of an accepted paper must register for the conference in order to be invited to make a presentation in a technical session.

New CGS News editor in 2013

This column marks my completion of 6 years as the editor of CGS News. This has been a very enjoyable experience, and I would like to thank all of the contributors to this column over the years. I would also like to acknowledge the excellent support that I have received from the various members of the CGS Board of Directors over the years.

Starting in 2013, Don Lewycky will be taking over for me as editor. I wish Don the best of luck in this position, and I hope that you will give him the same level of support that I have received over the years.

Editor

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What's on viewers' minds:

- What are vertical elevation tolerances for a total station?
- Does anybody know about FLAC 3D software?
- Capital Funding for Geotech Startup
- How is the latest development of Green Materials for Slope Protection?
- Retaining Wall Details

G-I News

ASCE national election results

President-elect Elect (2012-2013):

Randall S.Over, P.E., F.ASCE. Mr. Over assumes the role of president-elect during the Society's Annual Business meeting in Montreal, Quebec, Canada.

***A*t-Large Director-Elect (2012-2014)**
James A. Rispoli, P.E., BCEE, F.ASCE
Region Directors-Elect (2012-2015)
Region 3: John A. Frauenhoffer, P.E., S.E., M.ASCE
Region 4: David B. Peterson, P.E., F.ASCE
Region 8: Kristina L. Swallow, P.E., M.ASCE
Technical: Brian R. Manning, P.E., F.ASCE

Region Governors-Elect (2012-2015)
Region 1: Anthony L. Cioffi, P.E., M.ASCE
Shawn P. Kelley, Ph.D., M.ASCE
Region 2: Thomas J. Imholte, P.E., M.ASCE

Region 3: Carl C. Sutter, P.E., C.C.S., M.ASCE

Region 4: Jonathan D. Keeling, P.E., CFM, M.ASCE
Aaron K. Robinson, P.E., P.S., M.ASCE

Region 5: Eric S. Czerniejewski, P.E., M.ASCE
Anthony L. Palmer, P.E., M.ASCE

Region 6: Elvidio V. Diniz, P.E., D.WRE, M.ASCE
Kenneth A. Rainwater, Ph.D., P.E., BCEE, D.WRE, CFM, M.ASCE

Region 7: Aaron M. Frits, P.E., M.S., M.ASCE
Loras A. Klostermann, P.E., M.ASCE

Region 8: Douglas D. Knapp, P.E., M.ASCE
Michael J. Wilhelm, P.E., M.ASCE

Help students with a voluntary contribution

ASCE/G-I Members. When renewing your 2013 membership, please consider including a voluntary contribution which goes directly into a restricted fund for G-I 2013 student activities.

Last year's contributions helped to partially fund MSE Wall team travel to 2012 Geo-Congress, Geo-Prediction and Poster Competitions; grants to Graduate Student Organizations (GSOs); travel grants, and more.

Send your success stories for the 2013 ASCE report card

While the 2009 Report Card for America's Infrastructure showed that there is much work to be done to raise the grades, we know there are countless examples of projects and programs from across the country that demonstrate progress is being made. The 2013 Report Card will feature these "success stories" to demonstrate how public and private organizations have addressed specific infrastructure problems with some creativity and determination.

As ASCE develops the 2013 Report Card, we need your help to tell these stories. We would like to identify a diverse set of success stories for each of the 16 categories that will be covered in the 2013 Report Card: Aviation, Bridges, Dams, Drinking Water, Energy, Hazardous Waste, Inland Waterways, Levees, Public Parks and Recreation, Rail, Roads, Schools, Solid Waste, Transit, Wastewater, and the new category of Ports. Projects or programs cited as success stories should be integrate at least one of ASCE's Five Key Solutions:

- Increased federal leadership
- Promotion of sustainability and resilience
- Develop federal, regional, and state infrastructure plans
- Address life-cycle costs and ongoing maintenance
- Increase and improve infrastructure investment from all stakeholders

Tell us about the success stories that we should include in the 2013 Report Card for America's Infrastructure. Complete the online form on the ASCE website Include photos or web links with your submission. Questions? Contact Aaron Castelo at *acastelo2asce.org*.

Visit the new G-I ethics web page

Earn PDH's by viewing current and future videos by visiting the G-I website's new ethics page at *www.asce.org/geo/Ethics/Ethics/*.

The Academy of Geo-Professionals hosted its inaugural ethics session during the 2012 Geo-Congress in Oakland, CA. During the session, **Ron Smith, P.E., D.GE, F.ASCE**, provided real-life examples of business ethics situations. His presentation was recorded and is available for viewing on the ethics page. Highlights of the recorded lecture include:

- Personal, Business and Professional Ethics
- ASCE Fundamental Ethical Practices
- ASCE Cannons of Ethics
- ASCE Bylaws Regarding Ethics

You can earn up to 2.0 PDHs when combined with a review of the case history presentations on the AGP website at *www.geoprofessionals.org/ethics2.html.* Upon completion, send an email to *info@geoprofessionals.org* to receive your credit.

An AGP-organized ethics course is planned for the 2013 Geo-Congress and is tentatively scheduled for Sunday, March 3, 2013.

Members: Are you reading Geo-Strata online?

Geo-Strata online offers a new page-turning format which makes reading current and past issues of the magazine easier. ASCE/G-I members or G-I only members can access *Geo-Strata* magazine online with its new format at *www.asce.org/geo/Members-Only/View-Geo-Strata-Magazine/*. Let us know what you think by sending your comments to geo-strata.org.

Know an award-winning colleague?

While the 2012 ASCE/G-I awards cycle is winding down, it's a great time to consider the variety of awards available for members and non-members. Get a jump on thinking about which of your colleagues deserve these renowned honors. Note, the Geo-Institute Board of Governors are ineligible to receive awards (i.e., the Terzaghi Lecture and the Cross-USA Lecture) while serving on the Board, and for a period of one year following their term of service.
View the awards list at: *www.asce.org/geo/Awards/Geo-Institute-Awards/*

A calendar for bridge lovers

A must-have for bridge lovers, the ASCE Bridges 2013 calendar continues to delight and inform. With a visually stunning, elegant design, this full-size wall calendar showcases 12 extraordinary bridges from the United States and around the world.
To order: *www.asce.org/Content.aspx?id=25769811198*

G-I monogrammed golf shirts, caps and bags

You can now order everything G-I from Land's End. Have the G-I logo stitched on everything from baseball caps and shirts to towels and coolers. Shop the Land's End website at www.landsend.com/Geo and ask to have the G-I logo added to most items.

ASCE/G-I co-sponsored online webinars

Sharpen your skills and add to your working knowledge online or in person.

LRFD Design of Ground Anchors and Anchored Wall Systems
Tue. Dec 11, 2012
11:30 AM - 1:00 PM Eastern Time

Geosynthetic Reinforced Mechanically Stabilized Earth Walls
Thu. Dec 20, 2012
11:30 AM - 1:00 PM Eastern Time

Load and Resistance Factor Design (LRFD) for Geotechnical Engineering Features - Two Part Series
Mon. Jan 07, 2013
11:30 AM - 1:00 PM Eastern Time
hu. Jan 24, 2013
11:30 AM - 1:00 PM Eastern Time

For more webinars and information: *www.asce.org/Continuing-Education/Webinars/Live-Webinars/*

ASCE/G-I co-sponsored seminars

Earthquake-Induced Ground Motions
Dec. 6-7, 2012
New Orleans, LA

Design and Construction of Microtunneling Projects
December 12-14, 2012
Miami, FL

For seminar information: *www.asce.org/Continuing-Education/Seminars/Face-to-Face-Seminars/*

AGP announces election results

The Academy of Geo-Professionals (AGP) held its annual election for the Board of Trustees during its August 6, 2012 annual meeting in Rosemont, IL.

The Nominations Committee convened twice via teleconference prior to the meeting to discuss future leadership positions on the Board of Trustees.

After careful deliberation, the committee recommended a one-year freeze for all Trustee positions. Each officer will remain in their current role for an additional year. The Board also will recruit qualified candidates willing to serve on the Board and as an officer and eventual President.

Following a unanimous vote by the Board, the Academy's 2013 Officers remain as follows:

Steve Thorne, P.E., D.GE, M.ASCE – President
John Anderson, Ph.D., P.E., G.E., D.GE, M.ASCE – President-Elect
T. Michael McMillen, P.E., D.GE, F.ASCE – Immediate Past-President

In addition to the election, the Board continued its development of AGP's Strategic Plan which had been initiated in Tempe, AZ earlier in the year. On August 5, the Board assigned volunteers to various committee roles to help AGP make the next steps in obtaining the D.GE designation the power and recognition it deserves. Thank you to all the volunteers for your willingness to serve.

Would you like to help AGP in further its initiatives or have questions or suggestions? Then, send an email to: *info@geoprofessionals.org*.

Connect with myASCE

ASCE members can easily connect with other members and interact virtually with groups and committees with *myASCE*.

myASCE makes online communication, collaboration, and networking easy by bringing a variety of tools and features into a single community. Features include a personal profile for all members which includes spaces for photos, as well as documents. You can post status updates, blog posts on your message board for virtual conversations. There's a brief tutorial video to help you navigate your way through your profile at *www.asce.org/Member-Benefits/myASCE-Video-Tutorial/*.

Access *myASCE* at *www.asce.org/myasce* or from the "myASCE" link at the top of most pages on the website. Once you have logged in, you can begin editing your profile by adding a profile picture or updating your status.

Members

Cadden selected for distinguished Virginia Tech alumni

Allen Cadden, P.E., D,GE, M.ASCE, was recently selected for induction as a member of the Academy of Distinguished Alumni for the Virginia Tech Via Department of Civil and Environmental Engineering. This honor recognizes the career contributions to the profession of engineering, to the communities, and to the nation.

Cadden currently serves as Director of Strategic Development for the firm, responsible for formulation and implementation of the strategic direction of the firm, including oversight of emerging technical trends and supervision of firm wide business development and marketing support services. His experience includes geotechnical investigations, design, instrumentation, and construction monitoring services. As a Designer, Project Manager, and Senior Reviewer, Cadden has worked on a variety of geotechnical challenges ranging from commercial developments to water resource and infrastructure projects that involve shallow and deep foundations, geostructural engineering and ground improvement.

As an active member of the Geo-Institute Board of Governors, ADSC, ASCE, and DFI, and chairman for the International Society for Micropiles, he is positioned on the cutting edge of the state of practice in these specialty areas and has become a distinguished speaker for these societies.

Meehan awarded Fulbright U.S. scholar grant

Christopher L. Meehan

Professor Christopher L. Meehan, M.ASCE, a faculty member in the Department of Civil and Environmental Engineering at the University of Delaware, is a recipient of a 2012-2013 Fulbright U.S. Scholar Grant. The "Fulbright-Tampere University of Technology Scholar Award" will allow Professor Meehan to teach and conduct research for one year as a visiting faculty member at Tampere University of Technology in Finland.

Meehan said he selected Finland because while the energy consumption patterns are higher for Finnish industrial and construction industries, the country possesses a greater focus on renewable energy technologies than is typical in the U.S., particularly in its use of geothermal heat pump (GHP) systems.

Meehan plans to combine GHP technology with building foundation systems to reduce these up-front costs. Making use of building foundations, which are always installed in the ground, he intends to use the foundations as a means to exchange heat with the ground for cooling in the summer and for heating in the winter. If successful, the technology could lead to the construction of "heat-exchanging" foundations that will enhance a building's sustainability.

"Energy consumption is among the most significant problems facing humanity in the next century. It is imperative that civil engineers consider the direct and indirect costs associated with heating and cooling over the useful life of a structure as part of any sustainable building design," Meehan said.

Teaching geosynthetics by Bob Koerner (Drexel/GSI)

A new 6th edition of the textbook "Designing With Geosynthetics" became available on January 2012. It is a two-volume, 914-paged set. Xlibris is the "on-demand" publisher.

The volumes are available in hardback, softback, and e-book. The current price, compared to the more than $155 for the 5th Edition from a traditional textbook publisher, is favorable, particularly the e-book version. The 6th edition volumes sell for approximately $19 - $35 each as a hardbook; $14 - $24 as softback; and $3.39 as an e-Book.
To facilitate faculty use, particularly for students using the e-book version, GSI is offering a FREE CD containing approximately 1,000-slides in PowerPoint format of the entire book.

Faculty could teach from it while students follow along on their PC using the e-book version. The PowerPoint CD is not encrypted to make modifications possible.

To order your free CD, with no added shipping cost, send your name and address to Bob Koerner at *robert.koerner@coe.drexel.edu* with your complete mailing address.

ISSMGE News

A USUCGER in-memoriam

Professor Chih-Kang Shen, 79, passed away on July 17 2012 in Davis, CA. He will be remembered for his integrity, kindness, scholarship, and forward-thinking leadership.

Shen earned his B.S, M.S. and Ph.D degrees in 1956, 1960, and 1965 from the National Taiwan University, the University of New Hampshire and the University of California at Berkeley, respectively, all in Civil Engineering. He served as a faculty member at Loyola Marymount University in Los Angeles prior to joining the Department of Civil Engineering at the University of California, Davis in 1967. In his 24-year career at Davis, he served as assistant, associate and full professor, and department chair.

He retired from Davis in 1991 to join the founding faculty at HKUST and established the Department of Civil and Structural Engineering. During his four-year tenure as the department head, he assembled a top-quality faculty and shaped the department into a highly visible academic unit envied by many civil engineering departments around the world. He retired from HKUST and returned to his home in Davis in 1998.

Professor Shen spent most of his academic years investigating soil mechanics and foundation engineering and was the author of many articles in geotechnical journals and conference proceedings. He made important contributions in soil characterization and improvement, pavement analysis and design, soil nailing and reinforced earth, laboratory testing, constitutive modeling and numerical analysis, and to the establishment of major geotechnical centrifuge facilities in both Davis and Hong Kong. His pioneering work with Kenneth Lee on horizontal movements related to subsidence earned him the 1970 ASCE Collingwood Prize.

Shen also made remarkable contributions to professional services. In Hong Kong specifically, he chaired the Geotechnical Division of the Hong Kong Institute of Engineers (HKIE) and served as a consultant to California's Departments of Transportation and Water Resources, the U.S. Naval Civil Engineering Laboratory and Corp of Engineers, and Geotechnical Engineering Office of Hong Kong.

News from ISSMGE President, Jean L. Briaud

The ISSMGE 2013 Terzaghi Orator is **Dr. Suzanne Lacasse, D.Eng., P.E., F.ASCE**. Dr. Lacasse has worked in three difference countries as president, member of the National Academy of Engineering, and director. She exemplifies the very best in geotechnical engineering and we are very excited that she has accepted this invitation.

Do you know...

Why the 12th Baltic Sea Geotechnical Conference, "Infrastructure in the Baltic Sea Region" held in Rostock, Germany this Spring was the most important geotechnical event for the Baltic Sea Region?

Why global sustainability is the greatest long-term challenge of our time?

Why more than 70 young geotechnical engineers from over 40 countries attended the 2ndInternational Young

Geotechnical Engineers' conference held in Romania last September?

…You would if you were a ISSMGE member and kept up with geotechnical world news. Join ISSMGE today.

ASCE members: Your $15 ISSMGE membership is *in addition* to your ASCE and G-I membership. Log in to your member account at or contact ASCE Member Services at 1.800.548.2723 to renew your ISSMGE membership.
Geo-Institute members, but not an ASCE member? Your ISSMGE membership is included in your G-I membership. If you haven't renewed your G-I membership for 2012, contact ASCE Member Services at 1.800.548.2723.

Not a member of the Geo-Institute? ASCE members can add the G-I as a primary or secondary Institute of Interest. Discover the benefits of G-I membership on the G-I website at *www.asce.org/geo*

Students

A message from the G-I

Keep up with G-I news and relevant geo information by following the G-I on Facebook and Twitter

It's not too soon to start thinking about the G-I's 2013 Geo-Challenges: the GeoWall, GeoPrediction, and Geo-Poster challenges that will take place during the 2013 Geo-Congress in San Diego, CA, March 3-6, 2013. Check the G-I website for upcoming details or contact Jennifer Canning at *jcanning@asce.org.*

Student internship opportunities

Looking for as internship opportunity? Then explore the positions listed on the ASCE website at http://careers.asce.org/jobs#/results/keywords=internship&resultsPerPage=12/1,false to help further your career path. Come back often since new positions are added all the time.

The Colorado Chapter of the Geo-Institute, the Rocky Mountain Section of the Association of Environmental & Engineering Geologists (AEG), and the Colorado Association of Geotechnical Engineers (CAGE) is hosting a one-day geotechnical seminar with the theme of the 2012 seminar "GeoChallenges: Rising to Geotechnical Challenges in Colorado." The seminar will focus on case histories of challenging geotechnical projects in Colorado and the Rocky Mountain Region.

The papers accepted for the seminar will again be published by ASCE as a Geotechnical Practice Publication (GPP) and distributed at the seminar.

Students will be awarded 10 PDHs (Professional Development Hours) for attendance at the 3- day event.

To Register: *www.central-pa-asce-geotech.org/registration.php*

Geo-Institute Annual Congress Calendar

2013 Geo-Congress
"Stability and Performance of Slopes and Embankments"
March 3-6, 2013
Town & Country Resort
San Diego, CA
www.asce.org/geocongress

2014 Geo-Congress 2014
February 23-26, 2014
Westin Peachtree Plaza Hotel
Atlanta, GA

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Introduction by John Dunnicliff, Editor

This is the seventy-second episode of GIN. Two articles this time.

Remote methods for monitoring deformation

In the March and June 2012 episodes of GIN there were seven one-page articles about different remote methods for monitoring deformation. I promised a "concluding article with a comparative analysis of the various techniques". Yer tiz (here it is), as they say in this rural part of southwest England. The author, Paolo Mazzanti, was the winner of the "Forum for Young FMGM Engineers" ("young" defined as under 35) at the 2011 Eighth International Symposium on Field Measurements in GeoMechanics (FMGM) symposium in Berlin, for his paper on *Temporal prediction of landslides failure by continuous TInSAR monitoring*. He wrote on the same subject for June 2011 GIN, and again for the one-pager in March 2012 GIN. For his contributions, in particular for his article in **this** GIN, I'm awarding him the informal "Winner of the Forum for Young GIN Engineers". Congratulazioni Paolo!

Field monitoring for improved mine backfill systems

The article by Murray Grabinsky, Ben Thompson and Will Bawden is the first in GIN by mining engineers. Why has it taken so long? As a non-mining engineer, I found it very interesting and educational—we've tried to cross-pollinate by including enough text to clarify mining terms and procedures. I recommend that we **all** pay attention to the lessons learned—I very much welcome the text on training and empowering the workforce.

The next continuing education course in Florida

This is scheduled for April 7-9, 2013 at Cocoa Beach. Details are now on www.conferences.dce.ufl.edu/geotech. Also see the announcement on page 33. The deadline for the early registration discount expires on March 1, 2013.

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*.

Za vashe zdorovye! (Russia)

Remote monitoring of deformation. An overview of the seven methods described in previous GINs

Paolo Mazzanti

Introduction

During the past 10 years there have been rapid developments of remote sensing methods for monitoring deformation, creating significant applications in the geotechnical field. Following the seven one-page articles that were published in March and June 2012 GIN, this article provides a general overview of the methods. I'm conscious that a comprehensive coverage of this large and complex subject would require an entire book instead of a short article, hence please accept that significant simplifications have been introduced.

Contact versus non-contact (remote) monitoring

Traditional geotechnical monitoring is based on a "contact" approach. In other words, the sensors are installed directly in contact with the ground/structure, both on the surface (e.g. crackmeters) or inside (e.g. inclinometers). In contrast, most remote methods are based on a "non-contact" approach, i.e. the data collection is based on sensors that are installed far away from the monitoring site. However, based on the degree of interaction with the ground/structure, remote monitoring methods can be divided in two main subcategories:

- ***Partially remote***. Defined as those methods that, even if based on a remote sensor, require the installation of some additional sensors or targets at the monitoring site (e.g. antennas for D-GPS, prisms for total stations).
- ***Fully remote***. Defined as those methods that do not require any installation at the monitoring site.

When moving from contact monitoring to fully remote monitoring, the following changes must be considered:

- A progressive reduction of interaction with the ground/structure.
- An increasing size of the investigated area.
- A progressive reduction of the localization precision of the monitoring point (spatial resolution).
- An increasing of the spatial information density.

Furthermore, for remote methods, noise related to wave propagation through the atmosphere must be accounted for. Hence, when moving from contact to non-contact monitoring an increased complexity in data processing and care in the data analysis and interpretation is required.

Remote methods: a quick overview

A brief description of the basic operating principle of the seven methods is presented below, together with a classification based on the following main features:

- Type of platform. The type of platform will be divided on the basis of the sensor location:
  - "ground based" when the sensor is installed on the ground surface;
  - "aerial based" when the sensor is installed on an airplane;
  - "satellite based" when the sensor is installed on a satellite.
- Type of wave. The type of wave that the sensor collects will be divided on the basis of the following categories:
  - visible (wavelength range: 400nm – 700nm);
  - infrared (wavelength range: 700nm – 1mm);
  - microwaves (wavelength range: 1mm – 1m);
- Type of sensor. Sensors will be divided between active and passive:
  - "active sensors", emit a wave and receive the reflection of the emitted wave from the ground/structure;
  - "passive sensors" receive the wave naturally emitted by the ground/structure following a "natural" emission (e.g. the sun).

Terrestrial laser scanning (TLS)

TLS is a ground based fully remote technique that uses a visible and near infrared wave active sensor. TLS collects the coordinates of several points, thus achieving 3D models of the ground/structure. By comparison of point clouds collected at different times, ground/structure deformation is detected. The main fields of application are slope instabilities, dams and mines.

Terrestrial interferometric synthetic aperture radar (TInSAR)

TInSAR is a ground based fully remote technique that uses a microwave active sensor. TInSAR collects 2D images of large areas (few km^2) with a high sampling rate. By comparison of SAR images collected at different times, ground/structure deformation is detected. The main fields of application are slope instabilities, dams, mines, heritage structures and civil buildings.

Robotic total station (RTS)

RTS is a ground based partially remote technique that uses a visible or near infrared active sensor. RTS collects the precise position of several prisms installed on the ground/structure. By comparison of the prism positions at different times, ground/structure deformation is detected. The main fields of application are slope instabilities, dams, mines, civil buildings and heritages structures.

Reflectorless robotic total station (RRTS)

RRTS is a ground based fully remote technique that uses a visible or near infrared active sensor. RRTS collects the precise position of several natural targets on the ground/structure. By comparison of the natural target position at different times, ground/structure deformation is detected. The main fields of application are tunneling in urban areas, civil buildings and heritages structures.

Satellite interferometric synthetic aperture radar (SInSAR)

SInSAR is a satellite based fully remote technique that uses a microwave active sensor. It is based on the collection (since 1992) of 2D images of large areas (several km^2) with a low sampling rate. By comparison of images collected at different times, ground/structure deformation is detected. The main fields of application are fluid extraction/pumping, tunneling in urban areas, civil buildings and slope instabilities.

Digital photogrammetry (DP)

DP is a ground, aerial or satellite based fully remote technique that uses a visible passive sensor. DP collects 2D optical images from different positions of the ground/structure, thus achieving 3D ground models. By comparison of the 3D models at different times, ground/structure deformation is detected. The main field of application is slope instabilities.

Differential global positioning system (D-GPS)

D-GPS is a satellite based partially remote technique that uses a microwave active sensor. D-GPS collects the precise position of GPS sensors installed on the ground/structure. By comparison of the GPS sensor positions at different times, ground/structure deformation is detected. The main fields of application are fluid extraction/pumping, tunneling in urban areas, slope instabilities, dams and civil buildings.

How to evaluate a remote sensing method

In evaluating a remote sensing method for monitoring purposes several parameters and features must be considered. In what follows a brief description of the main relevant features is presented:

- ***Precision***: maximum repeatability of measurements.
- ***Temporal resolution***: maximum frequency in data collection.
- ***Spatial resolution***: maximum resolution of pixels at the ground/structure, i.e. minimum size of the area where deformation value is provided.
- ***Information density***: the density of information in terms of number of pixels and their areal distribution.
- ***Deformation geometry***: geometrical information of the deformation measurement (e.g. unidirectional predefined, unidirectional, bidirectional, 3D, etc).
- ***Degree of interaction with the ground/structure:*** interaction with the monitored area (from zero for the fully remote techniques, to high for techniques that required the installation of sensors on the ground/structure).
- ***Size of the monitored area***: maximum size of the area that can be monitored simultaneously by a single sensor.
- ***Data reliability and validity***: reliability of achieved results.
- ***Maximum operability range***: maximum distance to which the deformation of a target (artificial or natural) can be determined.
- ***Atmospheric noise***: degree of sensitivity to the atmospheric noise.
- ***Budget***: cost required for the monitoring.

For each of the above mentioned features there is a very wide range of variability among the techniques discussed in this article (Figure 1). Figure 2 presents a qualitative rating of the above features. However, it must not

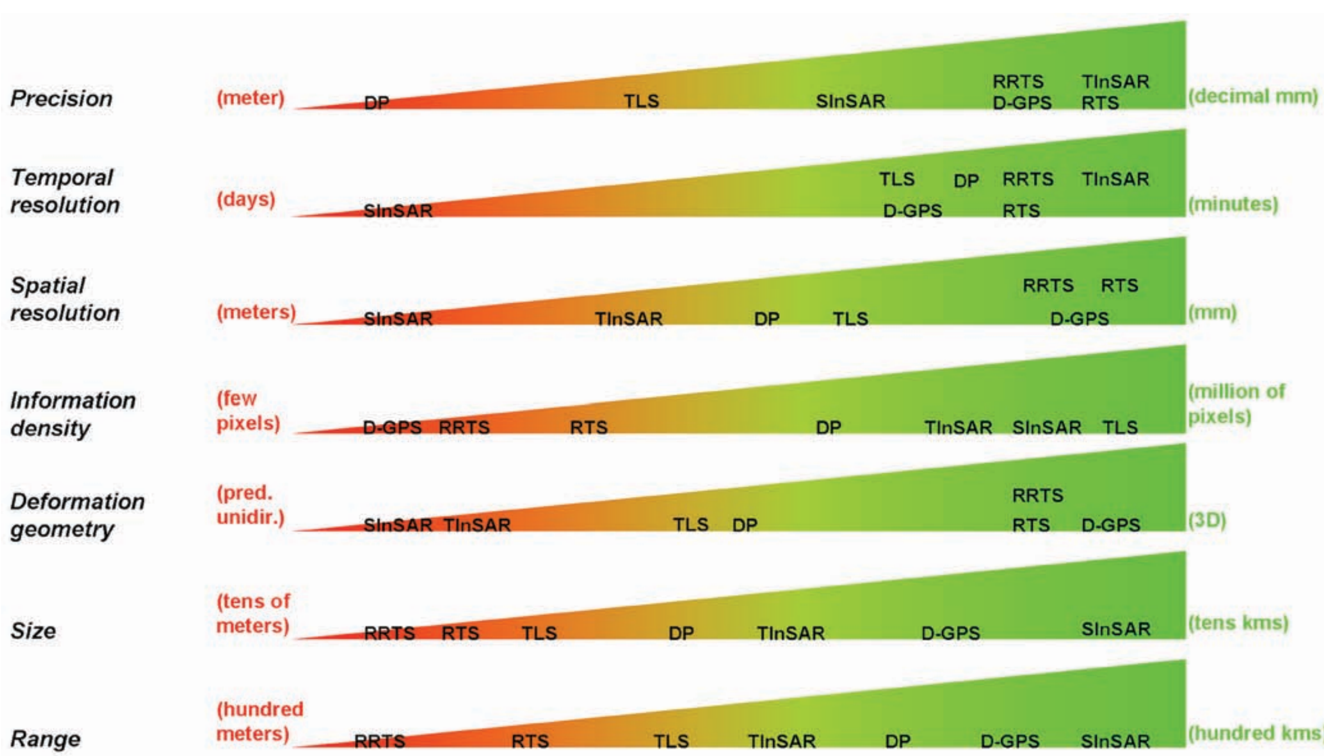

Figure 1. Range of variability of some features described in the text with respect to each method. The values in the parentheses identify the "end members" (in red the worst values, in green the best values).

	Precision	*Temporal resolution*	*Spatial resolution*	*Density*	*Deformation geometry*	*Interaction*	*Size monitored area*	*Operability range*	*Data reliability*	*Atmospheric noise*	*Costs*
TLS	Medium	Medium	High	Ext. High	Medium	Ext. High	High	Medium	High	Low	Low
TInSAR	Ext. High	Ext. High	Medium	High	Low	Ext. High	High	High	High	High	Low
RTS	Ext. High	High	High	Medium	Ext. High	Medium	Medium	Medium	High	Medium	Medium
RRTS	High	High	High	Medium	Ext. High	Ext. High	Low	Ext. Low	Medium	Low	High
SInSAR	Medium	Ext. Low	Low	Medium	Ext. Low	Ext. High	Ext. High	Ext. High	Medium	Low	Low
DP	Low	Medium	Medium	High	Medium	Ext. High	High	High	Low	Ext. Low	Ext. High
D-GPS	High	High	Ext. Low	Ext. Low	Ext. High	Ext. Low	High	Ext. High	High	High	Medium

Ext. Low | Low | Medium | High | Ext. High

Figure 2. Qualitative evaluation of remote techniques based on the features describe in this article. From red color to green color (see at the scale bar) there is an increasing performance of the technique (e.g. increasing precision, temporal resolution, spatial resolution, density, geometric information, monitoring area, operability range, data reliability) and decreasing (e.g. atmospheric noise, cost, and interaction).

be forgotten that some of the features are strongly influenced by the type of monitoring, the specific site conditions, the monitoring purpose etc.

The right solution for the right application

I'd like begin this section by quoting some classic words of wisdom by Ralph B. Peck, since they are the essence of observational method and monitoring:

- *An instrument too often overlooked in our technical world is a human eye connected to the brain of an intelligent human being.*
- *The observational method, surely one of the most powerful weapons in our arsenal, is becoming discredited by misuse. Too often it is invoked by name but not by deed.*
- *There is a danger that instrumentation may be discredited because of indiscriminate use.*
- *We need to carry out a vast amount of observational work, but what we do should be done for a purpose and done well.*

These four quotations are highly relevant when a person considers using of any of the methods described in this article. The rapid development

	ADVANTAGES	LIMITATIONS
TLS	▪High density of information ▪Good view of results thanks to the 3D models ▪Long distance measurement	▪Low accuracy ▪Difficult data management ▪Not effective in rainy and cloudy weather
TInSAR	▪High density of information ▪High accuracy and precision ▪Effective in any weather conditions	▪Difficult data processing ▪Unidirectional measurement of deformation ▪Phase ambiguity
RTS	▪High accuracy and precision ▪3D monitoring ▪Easy to use	▪Interaction with ground/structure (target required) ▪Not effective in some lighting and weather conditions (fog, rain etc) ▪Low accuracy at large distances
RRTS	▪Cost effective ▪3D monitoring ▪Easy to use	▪Limited range and incidence angle ▪Not effective in some lighting and weather conditions (fog, strong sun, rain etc) ▪Limited number of investigated points
SInSAR	▪Monitoring at regional scale (large areas) ▪Analysis of historical deformation (since 1992) ▪High information density	▪Low temporal frequency ▪Unidirectional measure of deformation ▪Low spatial resolution
DP	▪Simultaneous monitoring of large areas ▪Cost effective ▪Analysis of historical deformation	▪Not effective in some lighting and weather conditions (fog, strong sun, rain etc) ▪Low accuracy and precision ▪Low temporal frequency
D-GPS	▪Monitoring of deformation along the three main directions ▪Effective in any weather conditions ▪Easy to use	▪Strong interaction with the ground/structure ▪Low precision in the short term analysis ▪Low information density

Figure 3. Main advantages and limitations of the methods for remote monitoring of deformations.

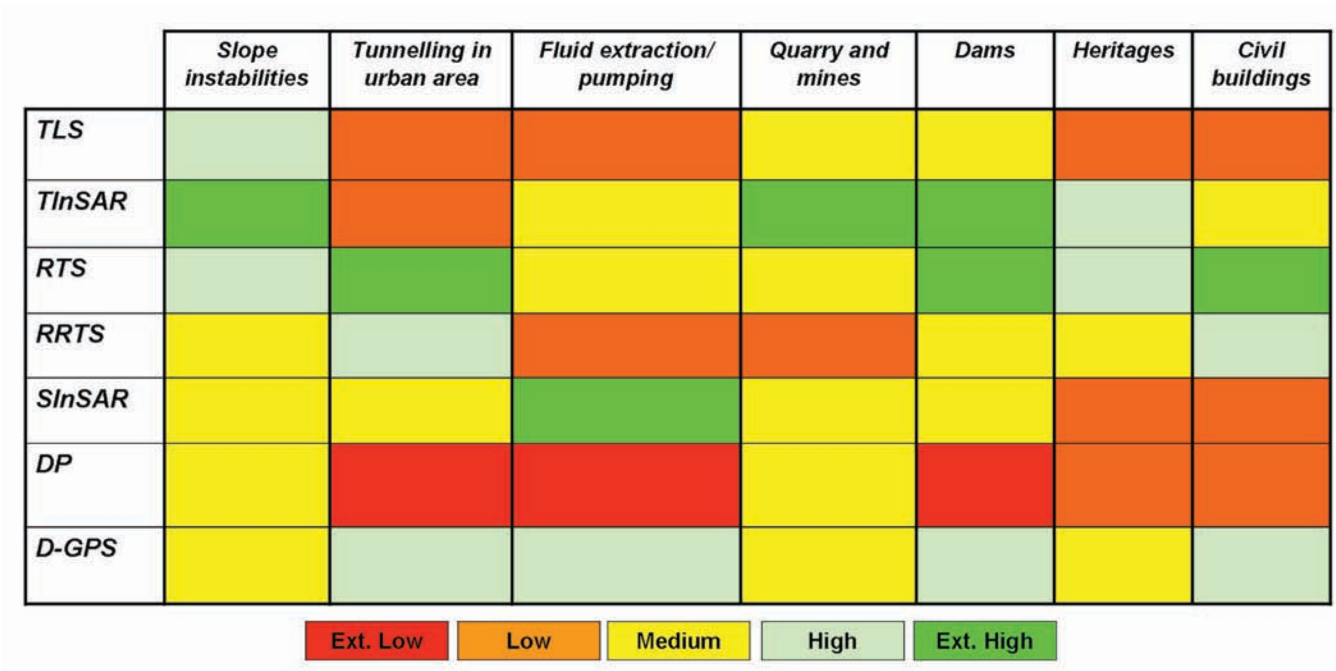

Figure 4. Qualitative evaluation of the performance offered by all the remote methods for different geotechnical applications. From red color to green color (see at the scale bar) there is an increasing performance of the method.

of these somewhat complex methods runs the risk of a person being carried away by the excitement of innovation while ignoring the above words of wisdom.

In what follows I will try to give some suggestions applicable to "doing well" with these seven methods for remote monitoring of deformation.

First, the main advantages and limitations of each method are summarized in Figure 3, thus identifying the main opportunities offered by the methods, but also providing an understanding of constrains. For example, if you are looking for a short time 3D monitoring of deformation at a specific location with high data sampling frequency, it can be seen that SInSAR is not suitable, while RTS is more appropriate. If you are interested in monitoring past deformations of a large area with high accuracy, you can see that SInSAR is probably the only available method.

Focusing on the geotechnical applications is more difficult, since the number of cases to be considered is very wide, and each one is likely to be characterized by specific site conditions that require a unique evaluation. However, the following general applications are identified below and in Figure 4.

- ***Slope instabilities***: monitoring of unstable slopes for both investigating purposes and continuous control.
- ***Tunneling in urban areas***: monitoring of local deformation induced by underground excavation.
- ***Fluid extraction and pumping***: monitoring of topographic changes related to fluid or gas extraction variation both at local and regional scale.
- ***Quarries and mines***: real time monitoring of slope instabilities during mines exploitation.
- ***Dams:*** monitoring of dams deformation for testing and control purposes.
- ***Heritage structures:*** monitoring of high value cultural heritage for safety purposes.
- ***Civil buildings:*** monitoring of standard buildings for safety purposes.

To emphasize with rating provided in Figure 4 is appropriate only for 'standard' applications. The suggestions are not applicable for 'non-standard' applications, where only a specific and advanced design can provide the best solution. For example, for the periodic monitoring of fast-moving landslides, DP or TLS can be more appropriate than TInSAR and other methods, while for the real-time monitoring of localized subsidence related to fluid extraction, TInSAR can be more appropriate than SInSAR (thus contradicting Figure 4).

Conclusions

Methods for remote monitoring of deformation are gaining popularity within the geotechnical community because they offer several new opportunities. Sometimes they can be alternatives to traditional contact methods, but more frequently they can be integrated with them. They are also opening new opportunities in the geotechnical field, such as monitoring for "investigative purposes. Features such as high information density, monitoring historical deformation, simultaneously viewing large areas without interaction with the ground/structure are very important if you use deformation as a tool for "understanding" geotechnical or geological processes. In this way, monitoring of deformation can be a useful additional tool for use during the preliminary design phases of projects.

However, adoption of these fascinating opportunities can lead to expensive equipment, complex data processing, difficult interpretation of results, and some limitations that may lead to misleading conclusions. To repeat, *we need to carry out a vast amount of* observational work [also *using remote methods], but what we do should be done for a purpose and done well.*

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Field monitoring for improved mine backfill systems

M.W. Grabinsky, B.D. Thompson, W.F. Bawden

Introduction

The large voids created by underground mining are backfilled to provide regional ground support. Our understanding of backfill behaviour has improved significantly using elaborate field monitoring techniques[1]; however this article will instead focus on simplified systems for routine monitoring. A brief explanation of the engineering problem is first provided for those readers unfamiliar with mining processes and terminology.

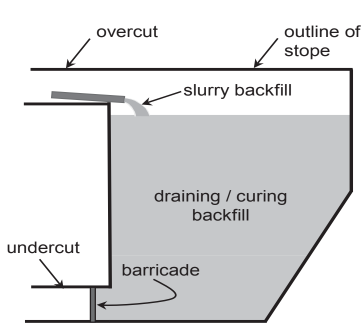

Figure 1. Vertical cross section through a mined area of the mineralized zone.

[1] see cover photos on the September 2009 and June 2012 issues of Geotechnical News, and the free technical article at http://www.nrcresearchpress.com/doi/abs/10.1139/t2012-040

Brief overview of underground mining procedures and terms

The mineralized zone to be exploited is called a stope (Figure 1). Undercut and overcut access tunnels are created so that the ore in the stope can be drilled and blasted, with the blasted ore being extracted through the undercut. A steel reinforced shotcrete barricade is then constructed within the undercut and slurry backfill is delivered through the overcut. The backfill typically contains silt to sand size granular material at up to 70% solids content, and also contains Portland cement binder. Some of the water in the slurry must drain, and the binder must cure (hydrate) so that the backfill gains the stiffness and strength required to support the surrounding rock mass during subsequent mining of adjacent stopes.

Purpose and approach of the monitoring program

Design concerns and what needs to be monitored

The immediate mine design concerns are (i) to determine the pressures acting on the barricade, and (ii) to assess if the backfill is properly curing. These concerns are addressed by monitoring total pressure, pore water pressure, and temperature. It is also necessary to estimate backfill height within the stope as a function of time. This is done by conducting a cavity monitoring survey (CMS) to determine stope geometry prior to filling, and then using the volume-rate of backfill delivery to calculate the average backfill elevation as a function of filling time. Instrument locations within the void must also be determined using standard survey techniques.

Expected results

Backfills deposited as slurries will initially generate an isotropic total pressure equal to the unit weight of the backfill x depth below the deposition surface. In this case both piezometers and total earth pressure cells (TEPCs) will register the same total pressures. The primary mechanisms believed to be responsible for pore water pressure dissipation are drainage and water consumption during binder hydration (i.e. chemical shrinkage or self-desiccation). When either mechanism occurs the measured pore water pressure will become lower than the total pressure, indicating the onset of effective stress and therefore enhanced backfill stiffness and strength. In addition, exothermic binder reactions are reflected in rising temperatures. It is therefore desirable to see effective stress and temperature rise occurring simultaneously. An example of such a data trend is shown in Figure 2. Note that Figure 2 also includes vertical total stress as a matter of interest, although this would not generally be required for barricade monitoring.

Suggested instrumentation strategy

Transducer types

Although measuring pore water pressure is relatively straightforward, there are many well documented issues associated with measuring total pressures in a granular material. One significant issue is matching the stiffness of the TEPC with that of the surrounding medium. This is all the more difficult when the stiffness of the material is changing, as is the case for backfill.

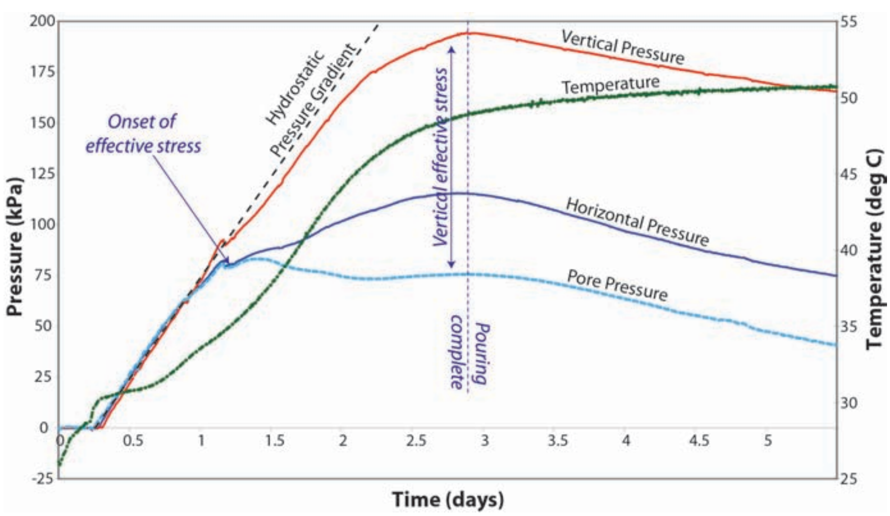

Figure 2. Ideal monitoring data showing temperature increase and development of effective stress (i.e., total pressure exceeding pore water pressure).

Interpretation of results

The monitored parameters are interpreted both quantitatively and qualitatively. The total pressure acting on the barricade must remain below its rated safe limit, otherwise backfilling must be stopped so that pressures can subside before backfilling resumes. Ideally, the onset of effective stress and temperature rise should be observed before the backfill reaches the full barricade height, as this condition indicates that the barricade is now beginning to interact with solid to semi-solid material.

The approach taken in this work was to use TEPCs with the highest practical aspect ratio (diameter:thickness) and stiffness possible. The merits of this approach can be debated but such details, while important, are beyond the scope of the current article.

TEPCs and piezometers of the vibrating wire type have been used, supplied by two leading manufacturers. The TEPCs used have been about 250 mm (10 in.) diameter with sensing surface on one side (also called “contact cells”) and about a 20:1 aspect ratio. All of the transducers have thermistors and provide a temperature data channel. During the initial filling stage, while the backfill is still a fluid, both manufacturers’ TEPCs have given pressure readings consistent with the piezometer up to the onset of effective stress, which is one of the critical indicators of good backfilling practice. Subsequently, there appear to be TEPC response differences that cannot be currently adequately explained, and therefore further research is needed into the performance of these cells in curing backfill where the stiffness changes with time.

Transducer calibration

Manufacturers provide calibration sheets for their vibrating wire piezometers and TEPCs. The thermal and fluid pressure calibrations have been found consistently reliable for many hundreds of transducers used in the field to date. However, as explained above, TEPC calibration is much more problematic when the stiffness of the material changes with time, and it is therefore not advised that mine-specific TEPC calibration be attempted at present. Indeed, there are other logistical considerations that can be far more influential on the output of TEPCs, and so attention to detail in the construction and deployment of the system is a more important consideration.

Building and deploying a system

At least one TEPC and one piezometer are recommended for routine barricade monitoring. These transducers should be installed at the same elevation so that piezometer readings can be directly subtracted from TEPC readings to obtain effective stress. Mounting the transducers directly to the back of the structural barricade is not recommended, as variations in barricade stiffness and drainage conditions make measurements there too localized. Instead, it is recommended that the transducers be placed within the backfill about 2 m behind the barricade and at about one-third barricade height. Ideally the mine should work with the instrumentation supplier to have an instrumentation module pre-built so that the two transducers are delivered on a frame that can be easily

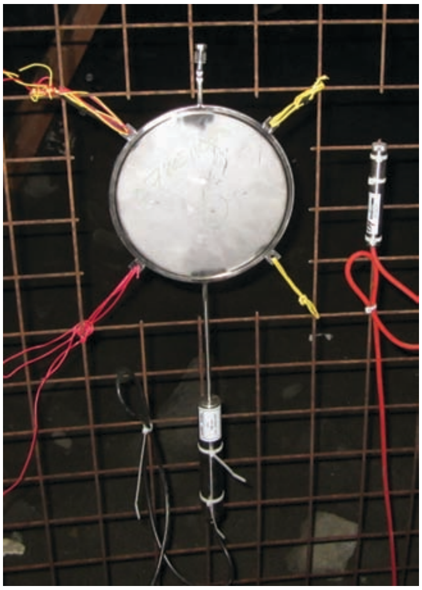

Figure 3. A pre-built instrumentation module with single connection to the data acquisition system.

and quickly erected and anchored (Figure 3). The transducers should be pre-wired with a single connector that attaches to a portable data acquisition system. The data acquisition system should then be configured to the mine's data backbone so that the information is fed to the backfill plant on the surface. Plant operators must be trained to interpret these results and decide if and when a plant shutdown is required.

Visual monitoring

In addition to the pressure and temperature monitoring, it is valuable to provide a camera feed to the backfill plant so that the operators can also visually monitor the overall barricade response to backfilling (Figure 4). There have been instances where a small construction defect has led to localized barricade failure and release of backfill, and such localized response would probably not be picked up by the instrumentation system. Had the barricade been monitored visually the operators would have seen cracks developing and leakage from these cracks, and a plant shutdown to investigate and possibly remediate the barricade could have prevented its ultimate failure.

Lessons learned

In addition to the recommendations already mentioned, the following should be considered by mines embarking on routine backfill monitoring programs.

Have a supplier build a system

The essential components of the system have already been mentioned: instrumentation module; dedicated data acquisition system; data networking to surface; camera feed. Ideally the mine should work with a supplier who can build a suitable system to the mine's specification and then support that system in the field. It has been extremely valuable to have the supplier's technician on site for the first instrumentation installation and monitoring, to train mine personnel in verifying system performance and trouble-shooting any problems prior to backfilling.

Figure 4. Backfill plant operator monitoring barricade pressures and video feed in real time, in order to optimize stope filling.

Transducer range, resolution, and accuracy

Barricades typically have a safe pressure rating in the range of 100 – 200 kPa, although the trend is towards better barricades with increased safe pressure ratings. One of the manufacturers supplies a 1 MPa vibrating wire TEPC with a quoted resolution of 0.25 kPa minimum which is certainly sufficient for barricade monitoring. One must be careful when interpreting a manufacturers' claims of TEPC accuracy, however, as such figures do not reflect the performance of the entire TEPC installed in the field, where the accuracy of the transducers output can be influenced by factors such as stiffness of the surrounding medium.

Protect the data cables

Once the instrumentation has been installed, the connecting data cables need to be covered with a protective sand berm. The sand berm can extend through the base of the structural barricade and will actually act as a drain/filter which is marginally beneficial to barricade performance.

Zero the instruments

A TEPC that is built and calibrated (zeroed) near sea level will register an initial positive pressure underground, reflecting the increased air pressure arising from the mine's ventilation system. This initial reading needs to be zeroed out for engineering calculations that are based on gauge pressures (i.e. relative to the ambient pressure). Also, the piezometer tip needs to be saturated (following the manufacturer's recommendations) and the initial reading zeroed.

There has also been an instance where a problem with a data acquisition unit occurred during filling, and a second unit was connected to the transducers while the fill proceeded. In this case the second unit needs to be calibrated to start pressure readings where the previous unit left off (i.e. if this second unit is zeroed then the accumulated pressures to that point will not be accounted for).

Train and empower the workforce

The best results have been obtained when all involved mine personnel are made fully aware of why the instrumentation is being installed and how it is supposed to operate. Underground construction crews have developed novel, site-specific ways of best deploying the instruments. Backfill plant operators and underground inspection personnel have been trained in the expected system performance and also in the signs that might suggest undesired backfilling behaviour, and a protocol has been established for reporting early warning signs and invoking an emergency shutdown.

Develop a site-specific database

It is critical that the mines keep records of each fill and correlate the filling performance with relevant operating parameters such as backfill material properties (mineralogy, water chemistry and content, and binder type and content), ambient temperature and humidity, and backfill rise rates. Regular comprehensive engineering reviews of these experiences will then allow fine-tuning of the backfilling operation to optimize the costs and benefits.

Summary

Attention to detail in the design, construction, deployment and monitoring of underground mine backfill systems can result in robust and reliable monitoring programs that provide both qualitative and quantitative information. Careful engineering interpretation of monitoring results over a wide range of backfilling conditions can then help the engineering team to optimize the mine's backfill operations.

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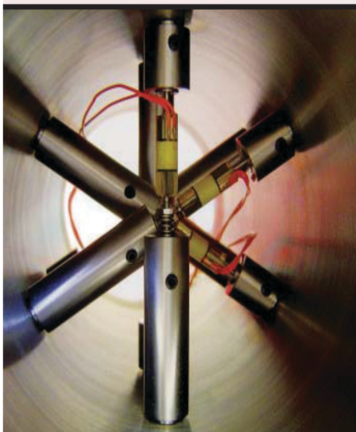

The University of Florida

Geotechnical Instrumentation (GI) for Field Measurements

April 7-9, 2013

Doubletree Hotel • Cocoa Beach, Florida

Course Director: John Dunnicliff, Consulting Engineer

COURSE EMPHASIS: is on why and how to use GI to monitor field performance. The course will include planning monitoring programs, hardware and software, recent developments such as web-based and wireless monitoring, remote methods for monitoring deformation, case histories, and lessons learned. Online sources will be included, together with an open forum for questions and discussion.

AUDIENCE: engineers, geologists and technicians who are involved with performance monitoring of geotechnical features of civil engineering projects and project managers and other decision-makers who are concerned with management of RISK during construction.

OBJECTIVE: to learn the who, why, and how of successful geotechnical monitoring while networking and sharing best practices with others in the GI community.

INSTRUCTION: provided by leaders of the GI community, respresenting both users and manufacturers:

Marcelo Chuaqui, Monir Precision Monitoring
Loic Galisson, SolData Group
Pierre Gouvin, GEO-Instruments
Aaron Grosser, Barr Engineering
Daniele Inaudi, Roctest/Smartec
Allen Marr, Geocomp
Paolo Mazzanti, NHAZCA
Justin Nettle, Federal Energy Regulatory Commission
Tony Simmonds, Geokon
Rodolfo Saavedra, DG-Slope Indicator
Robert Taylor, RST Instruments

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Influence of element size in numerical studies of seepage: Unsaturated zones, transient conditions

Robert P. Chapuis

In an unsaturated zone above the water table, the hydraulic conductivity (K) can vary by several orders of magnitude over a small suction (u) range, or over short vertical distances. In numerical models of unsaturated seepage, small height elements are needed: a previous paper examined the convergence issues under steady–state conditions (Chapuis 2012a). This paper examines how the size of time steps may influence the numerical solution for a simple one–dimensional (1D) transient example. It suggests a procedure to select the time steps so as to converge not only numerically, but also towards the correct solution.

Background

A first paper (Chapuis 2010) explained the problems with large elements, especially when trying to study a regional groundwater problem. A second paper (Chapuis 2012a) provided basic rules for assessing the influence of small details especially in engineering projects. A third paper (Chapuis 2012b) explained how to select the height of finite elements for unsaturated zones under steady state conditions. This paper is thus the fourth dealing with the influence of element size. General concluding remarks are provided for the four short papers.

The example here is that of a vertical column under transient conditions. This 1D problem can be solved numerically using many codes, but correctly only by those using the real conservation equation (Richards 1931), and not a simplified, linearized, or modified equation. However, each code has its own ways of treating the Darcy and conservation equations, to select element sizes and time steps, using more or less automatic procedures. These internal features of each numerical code are not discussed hereafter. The results of this paper were obtained using the same finite element code as in the steady–state paper (Chapuis 2012b). Similar results can be obtained using any unsaturated seepage code, although built–in specific procedures of a code may obscure our understanding of convergence and oscillation issues for transient conditions.

The numerical study of unsaturated seepage is more difficult than that of saturated seepage. This happens because seepage equations involve the volumetric water content $\theta(u)$ and unsaturated hydraulic conductivity $K(u)$ versus pore water pressure u, which are described by highly non–linear functions. Of course, a few numerical codes still make simplifications, and either use constants for these functions, or strongly linearized equations for highly non–linear physical phenomena that require highly non–linear equations for their correct description. To obtain correct solutions (e.g., Chapuis and Dénes 2008; Chapuis et al. 2005), the mesh must be refined vertically in the vadose zone to avoid convergence problems and to overcome the difficulties associated with the non–linearity of the equations and hydraulic parameters.

Start with the mesh refinement before refining the mesh step

The first action, when using any code for unsaturated seepage, is to reduce the element size in the unsaturated zone to avoid potential numerical oscillations, and ease the convergence process. This is verified first using steady–state (time independent) conditions (Chapuis 2012b). As a rule of thumb for meshing unsaturated zones, the element height must not exceed the value giving a maximum change of one order of magnitude for K under a no–flow condition.

The second action is to reduce the time step to ensure proper convergence towards the correct solution, and not towards an incorrect solution. This paper examines only the second action, reducing the time step for transient conditions.

Example and numerical results

A 2 m high vertical column contains a single soil with the functions of Fig.1, the same functions as in Chapuis (2012b) where a convergence study under steady–state conditions has shown that the element height must be 10 cm or smaller to have small numerical errors. For the transient study, the initial conditions are steady–state with the following boundary conditions (BCs): the BC at $z = 0$ m is $h = 0$ m; the BC at $z = 2$ m is $h = 1$ m. For the following transient–state, the BCs are as follows: the BC at $z = 0$ m is $h = 0$ m; the BC at $z = 2$ m is a periodic sinus–like imposed hydraulic head with a period of 2 hours (Fig. 2).

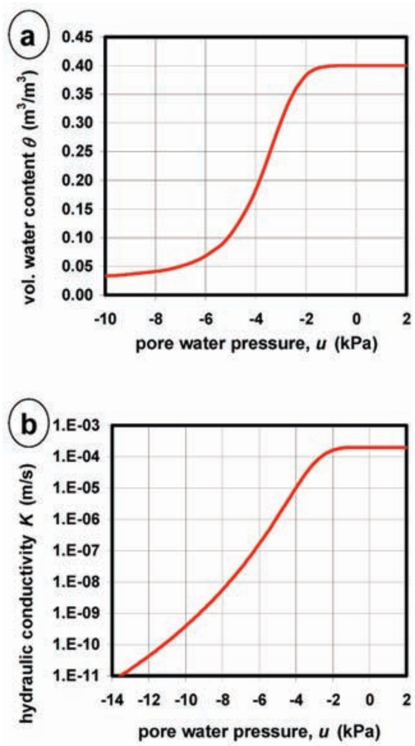

Figure 1. Unsaturated functions for volumetric water content θ and hydraulic conductivity K. These functions are used in the 1D column example.

Hereafter, we examine only how the time step influences the numerical solutions, for columns with element heights of 10, 5, 2 and 1 cm respectively. Elements larger than 10 cm were not retained because they have been shown to yield inaccurate numerical solutions in the previous steady–state study of unsaturated seepage.

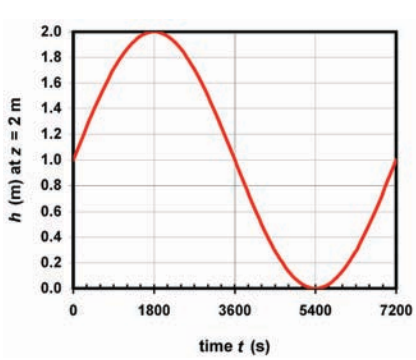

Figure 2. Boundary condition at z = 2 m: sinus function for the hydraulic head h versus time t.

This type of problem, with a cyclic BC, after many cycles tends towards a cyclic stable solution having the same period as the BC. The numerical solutions in this short paper are only the final solutions obtained after many cycles.

Note that we do not know a priori the true solution because there is no closed–form solution to this problem. For assessing the errors made in each numerical solution, it is assumed hereafter that the correct solution is provided numerically with elements of 1 cm and time steps of 6 s.

A few numerical results are given in Figs. 3–4. It is observed first that large time steps of 600 and 200 s provide a poor evaluation of the periodic variation of *h* (*z* = 0.5m) versus time *t* (Fig. 3). With the 10 cm–elements, the peak of the hydraulic head is markedly underestimated for large time steps, but the numerical solution with 10 cm–elements and 6 s–time steps is very close to that obtained using 1 cm–elements and 6 s–time steps. Note also that, although the only BC that varies with time is sinusoidal, the response within the column is cyclic but not sinusoidal due to the highly non–linear properties of the unsaturated soil within the column. Note also that, for this example, using elements of 5 cm instead of 10 cm does not improve the numerical transient solution as shown with the case of equal time steps of 200 s.

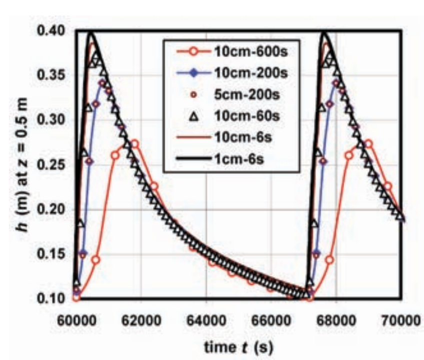

Figure 3. The numerical solution for h (z = 0.5 m, t) is regular for element sizes below 10 cm (limit provided by the steady–state study) and approaches the correct solution when the element size and time step are decreased. The caption "10cm–600s" means element size of 10 cm and time step of 600 seconds.

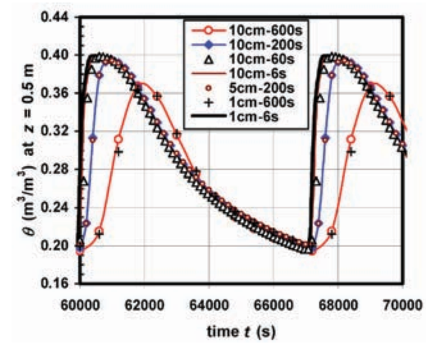

Figure 4. The numerical solution for θ (z = 0.5 m, t) is regular for element sizes below 10 cm (limit provided by the steady–state study) and approaches the correct solution when the element size and time step are decreased.

However, the finding may be different for another transient problem, in which the grid may need to be more refined than the minimum required for the steady–state problem being used for initial conditions.

The volumetric water content θ at elevation *z* = 0.5 m, versus time *t*, is also cyclic but not sinusoidal (Fig. 4). With the 10 cm–elements, the peak of θ is underestimated for large time steps, but the numerical solution with time steps of 6 s is very close to that obtained using 1 cm–elements. The same remarks apply for Fig. 3 and Fig. 4, but the relative error on θ (*z* = 0.5 m, *t*) is smaller than that on *h* (*z* = 0.5 m, *t*).

A detailed study of errors is outside the limited scope of this short paper. When the algorithms used in a code are known, the errors and convergence characteristics of the finite element equations can be studied mathematically.

Finally, it is worth underlining that all numerical solutions have converged in the numerical sense for this 1D example. This illustrates again that the code numerical convergence does not mean convergence towards the physically correct solution.

Conclusion to this paper

This paper has examined a simple 1D case of a vertical column under transient conditions, using uniform meshes, the variable being the time–step size. The code took several steps to converge numerically but it always converged. The numerical convergence criterion was a relative error on the modulus of the pore pressure vector below 10^{-6}. The numerical convergence was slower than for saturated problems, due to the highly non–linear equations for unsaturated conditions.

Different numerical solutions were obtained, one for each element size and time step. In short, the finer the mesh and the smaller the time step, the more correct the solution. However, this does not mean that we should finely discretize any problem in space and time. A few basic principles should be observed. They are provided hereafter.

First, we must have a preliminary idea of how the hydraulic head varies within our study domain. For a first appraisal we can use a coarse mesh, which will give us a first rough solution. We must examine this first solution and find out the zones with high variations of h, θ, and K. These zones are those where our mesh must be refined. For a second appraisal, we can use finer meshes in the zones of high variations. For unsaturated zones, a rule–of–thumb is to restrict the element height to the value giving a maximum change of one order of magnitude for K in a no–flow condition. When examining the second solution we may find that some local refinements are still needed. Once we are satisfied with the last refinement and believe that further refinement would add nothing, we should not be satisfied with our belief, but prove it. We can prepare a verification mesh in which all elements are half the dimension of what was thought to be the last mesh. The verification mesh should give the same results (heads, gradients, velocities, flow rates, etc.) as our last mesh. If this is the case, then we have proved that we had designed and retained the correct mesh. Note that the computing time for the verification mesh will be about four to nine times longer than the time for our final and correct mesh. Thus, we must use the verification mesh firstly for faster–to–solve steady–state problems.

Once this choice of mesh has been proven to be adequate for steady–state condition, it can then be used in transient conditions for which the time increments must then be selected to ensure proper convergence at each time. In some cases however, the mesh must be locally finer for transient conditions than for steady–state conditions, a situation which is not examined in this short paper.

General concluding remarks for the four papers

The four short papers on numerical convergence have not made reference to, and not used semi–automatic and automatic meshing refinement methods, which are very useful utilities available in several groundwater codes (e.g., SoilVision 2012, Comsol 2011). The short papers' goal was to introduce, as simply as possible, the h–convergence tests (e.g., Roache 1994, 2009) to finite element users who, most often, have not had advanced mathematical courses on finite elements.

The four papers have proposed simple convergence tests that can be done by deactivating the automatic meshing system if there is one, in order to find the optimal element size for a given problem (optimal for an accepted level of relative error). Once the optimal size is found, then the automatic meshing method can be reactivated, using the optimal uniform grid as the starting reference: the meshing system will reduce the total number of nodes and elements (mesh refining and coarsening), thus reducing the calculation time for next calculations with the same grid.

The mesh coarsening is essential for huge parametric studies using large grids, such as steady–state saturated problems with 10^5–10^6 elements, and transient unsaturated problems with 10^4–10^5 elements, the latter being much more complicated (mathematically and numerically) to solve, due to the highly non–linear partial differential equations (PDEs). However, this was not important for the examples in the four short papers, because there was no parametric study (except for the uniform element size) and the calculations times did not exceed a few seconds for saturated steady–state problems and a few minutes for unsaturated transient problems.

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Benefits of adaptive automatic mesh refinement

Igor Petrovic, Murray Fredlund

Semi-automatic mesh generation is a time-consuming and error-prone process. This is particularly true for engineering computations where the mesh requires varying levels of complexity. This paper studies two numerical models that produce converged solutions with the assistance of automatic adaptive mesh refinement, AMR. The studies illustrate how automated adaptive mesh refinement can reduce modeling time as well as errors during the modeling process. The AMR solutions were performed using the SVFlux / FlexPDE software. The results are discussed in the contexts of the solutions published by Chapuis (2012). Chapuis (2012) analyzed the same example problems while using user-controlled mesh design when performing the numerical solutions.

Types of errors that occur in finite element analysis

The mathematical type of errors introduced into the finite element solution of a given differential equation can be attributed to three basic sources (Reddy, 2006):

1. domain approximation errors –due to approximation of domain,
2. quadrature and finite arithmetic errors – these are errors due to the numerical evaluation of integrals and the numerical computation on a computer,
3. approximation errors – these are errors due to the approximation of the solution through interpolation functions.

This list does not consider errors in programming, and differences between the numerical model and the real physics. For more complete list see for example Oberkampf et al. (1995) and Roache (2009).

Convergence

The main problem in any numerical model which needs to be addressed consist of the questions of *how good the approximation is and how it can be systematically improved to approach the exact answer*. The answer to the first question presumes knowledge of the exact solution.

The second question can be answered from studies in interpolation theory. The finite element approximation is known to converge in the energy norm when $\|e\| < Ch^p$, for $p > 0$, where h is the distance between nodes on a uniform mesh (the characteristic element length), p is called the rate of convergence. The rate depends on the degree of the polynomial used to approximate true solution u the order of the highest derivative of u in the weak form, and whether there are local singularities in the domain. The constant, C, is independent of u and will be influenced by the shape of the domain and whether Dirichlet or Neumann boundary conditions are employed. Typically $p = k + 1 - m > 0$ where k is the degree of the highest complete polynomial used in the interpolation and m is the order of the highest derivative of u in the weak form. The above equation for the error would be a straight line plot for a log-log plot of error versus mesh size. In that case the slope of the line is the rate of convergence, p (Akin, 2005).

Finite element adaptive mesh refinement, AMR

An adaptive mesh refinement procedure measures the adequacy of the mesh and refines the mesh wherever the estimated error is large. The system iterates the mesh refinement and solution until a user-defined error tolerance is achieved. The most common criterion in general engineering use is that of prescribing a total limit of the estimated error computed in the energy norm as described in previous chapter. Often this estimated error is specified to not exceed a specified percentage of the total norm of the solution. An adaptive mesh refinement procedure is used to reduce estimated errors once a finite element solution has been obtained. The procedure is referred to "adaptive" since the process depends on previous results at all stages.

Various procedures exist for the refinement of finite element solutions. Broadly these fall into two categories (Zienkiewicz et al., 2005).

1. The *h*-refinement in which the same class of element continues to be used but it is changed in size, in some locations while being made larger in some locations and smaller in others, to provide maximum economy in reaching the desired solution,
2. The *p*-refinement in which the same element size is used and there is a simple increase, generally hierarchically, in the order of polynomial used in the definition of the elements.

It is occasionally useful to divide the above categories into subclasses, as the *h*-refinement can be applied and thought of in different ways. Three typical methods of *h*-refinement are:

1. Element subdivision – if existing element show too large an estimated error, the elements are simply divided into smaller elements while keeping the original element geometry boundaries intact,
2. Mesh regeneration (remeshing) – on the basis of a given solution, a new element size is predicted in all the domains and a totally new mesh is generated,
3. *r*-refinement – keeps the total number of nodes constant and adjusts their position to obtain an optimal approximation. This method is difficult to use in practice and there is little reason to recommend its usage.

The *p*-refinement subclasses are:

1. one in which the polynomial order is increased uniformly throughout the entire domain,
2. one in which the polynomial order is increased locally while using hierarchical refinement.

Occasionally it is efficient to combine the *h*- and *p*- refinements and call it the *hp*- refinement. In this procedure both the element size and the polynomial degree, *p* is altered.

Advantages of using automatic adaptive mesh generators (numerical examples)

Advantages of using automatic adaptive mesh generators are illustrated through comparison of results obtained on the numerical models analyzed by Chapuis (2012). Chapuis (2012) presented two examples problems where he created finite element meshes semi-automatically and solved the seepage problems. The same example problems were solved using automatic mesh refinement using the SVFlux / FlexPDE finite element code.

Cut-off example

The geometry of the model (i.e., dam with partial cut-off wall; $k_{sat,\ homogenous\ soil} = 8.13\times10^{-3}$ m/day) analyzed is presented in Figure 1.

In the reference article, convergence of the solution was obtained using a uniform mesh with an element size of 0.5 m. From Figure 1 it can be seen that the converged solution obtained when using the automatic adaptive mesh refinement has larger elements in most parts of the analyzed domain. The exception is found around the cut-off wall where the element size is significantly smaller than the overall average element size. For the mesh presented in Figure 1, the calculated flow rate was 6.82×10^{-7} m^3/s. Calculation time for the mesh presented at Figure 1 was 0.01 minutes. Comparison of results obtained with manually-controlled meshes and automatic-controlled adaptive meshes are presented in Figure 2. Calculation computational times associated with using a disabled mesh generator with a specified maximum element size of 0.5 m, increased to 7.37 minutes while the flow rate solution remained the same (note that an older computer was used for this study). The consequence of further reductions in the element size to 0.3 m was an increased calculation time from 7.37 minutes to 36.03

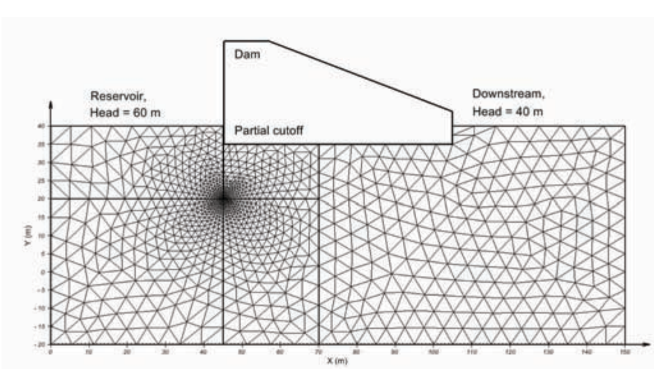

Figure 1. Partial cut-off wall model geometry with mesh generated using the automatic adaptive mesh generator.

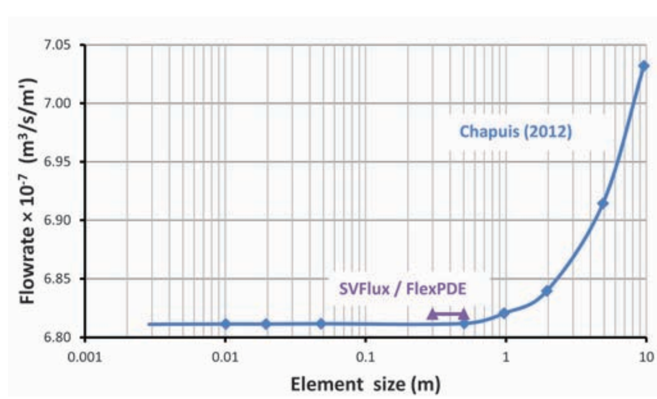

Figure 2. Converged leakage flow-rate for the cut-off example.

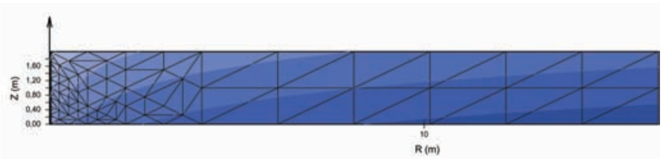

Figure 3. Pumping well (confined aquifer) model geometry with mesh generated by adaptive mesh generator; take a note that few triangles have an angle higher than 90 degrees, which means a poor shape for calculations (axisymmetric problem, radius of confined aquifer was 600 m).

minutes while the flow rate remained unchanged.

Confined aquifer example

The geometry of the second model (i.e., pumping well in confined aquifer; ksat, homogenous soil = 4.0×10-4 m/s) is presented in Figure 3.

In the reference article (Chapuis, 2012) the solution converged using a uniform mesh with an element size of 0.1 m. From Figure 3 it can be seen that converged solution obtained with use of the automatic adaptive mesh has larger elements in most parts of the analyzed domain, except around the pumping well where the element size is significantly smaller than the overall average (0.2 m in average). For the mesh presented in Figure 3 the computed flow-rate was 369.17 m^3/day. The calculation time for the mesh presented in Figure 3 was 0.02 min.

Comparison of flow-rate and total head obtained when the mesh was manually-controlled and when the mesh was automatically generated using an adaptive mesh generator is presented in Figure 4 and Figure 5. Calculation time for disabled mesh generator with a specified maximum element size of 0.1 m (in the region which covers area from pumping well to the 20.15 m in the radial direction), has increased to 1.15 minutes while the flow-rate solution decreased to 366.54 m^3/day. The size of the elements in the remainder of the domain was 1 m.

Conclusion

In the reference article author stated that finer grid provides a more accurate solution. However, the solutions converged only after the mesh was refined to an element size of 0.5 m (in the cut-off example) and 0.1 m (in the confined aquifer example), uniformly distributed across the problem domain. From Figure 1 and Figure 3 it can be seen that mesh obtained when using automatic adaptive mesh generators can have much larger elements in most parts of the domain while the accuracy of the solution is preserved as presented in Figure 2, Figure 4 and Figure 5.

Chapuis (2012) suggested the creation of a final confirmation/verification mesh (i.e., a finer mesh) to verify that solution has actually converged (this is done to define the true solution as accurately as possible when closed-form solution is unknown). It was also stated that this final verification step might be a time consuming process (for long transient problems computing time can take hours or even days). For lengthy, transient problems, it was suggested that final verification mesh could be omitted in order to save time. With use of automatic adaptive mesh refinement generators, this final verification step is not necessary since the mesh generator refines the mesh in various parts of the domain until the solution converges within user specified tolerance limits. Since the accuracy of the solution depends on these tolerance limits, it is necessary that user have a clear understanding of the finite element method when using adaptive mesh generators in an efficient manner. It can't be emphasized enough that it is the engineer who must check the numerical tools and their solutions. However, is should be also noted that for the default error limits should result in a converged solution for most standard geotechnical problems defined in Eurocode 7 as Geotechnical Category 1 and 2.

In summary, automatic an adaptive mesh generator can also result in the following benefits.

- A optimized (locally finer and locally coarser) mesh means fewer number of equations,

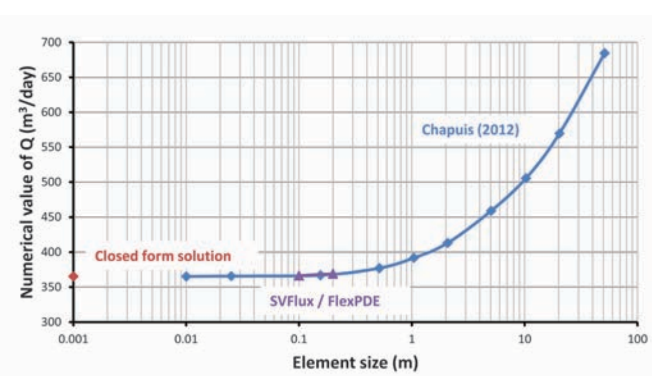

Figure 4. Converged numerical flow-rates.

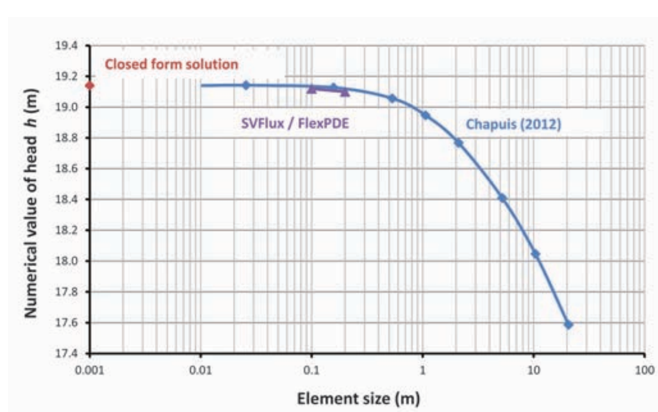

Figure 5. Converged total heads at r = 20.15 m.

- Lesser number of equations means less time needed for calculation,
- Less time needed for calculation means that employee productivity is increased.

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Paolo Gazzarrini

Overture

29th edition of the Grout Line, and for this issue, I have something a bit different to share with you, outside of the "real" grouting industry.

We will talk about micropiles, mainly regarding the 11th International Society for Micropiles (ISM) Workshop held in Milano (Italy) this past month of October.

The topic is not completely outside of the Grout Line's "scope of work" considering that grouting is a very important part of the execution of a micropile, giving the adequate bond between the rock/soil and the structural element.

I would like to remind the "few" (I trust) people who don't know what the ISM is, that the International Society for Micropiles, is "a consortium of international representatives involved in the design, construction, research/development and instruction/promotion of micropile technology. ISM seeks to provide an international forum for debate, advice, problem-solving and support to micropile specialists and non-specialists throughout the world".

This definition was transcribed from ISM's web page: *www.ismmicropiles.org*.

I recommend, if anyone is interested in the topic, that you visit the web page. You will find a lot of literature about micropiles, with very interesting information, articles and other references.

The current Chair of the ISM is Allen Cadden, P.E., D.GE, Principal, Director of Strategic Development at Schnabel Engineering - (*acadden@schnabel-eng.com*). Other key people in the ISM organization are ISM Technical Leads Mary Ellen C. Bruce, P.E., D.GE,Technical Activities Manager for the Deep Foundations Institute (*mebruce@dfi.org*) and Dr. Antonio Marinucci, P.E., MBA, Director of Operations for the ADSC: the International Association of Foundation Drilling, (*tmarinucci@adsc-iafd.com*). They prepared the following article for this issue of Grout Line.

The second article I would like to present to you is .... mine! (Sorry about that, and it is only the second time in more than 6 years that I am using my Grout Line department to bother you with my experiences!). I presented this paper at the previously mentioned workshop and I have received permission from ISM to reproduce it here. The topic is related to the use of continuous monitoring and recording during micropile/anchor tension/compression tests that I carried out in Vancouver-Canada. As some of you know my "maniac passion" in improving QA/QC in our industry is quite obsessive. I hope you will read the following article carefully and with interest and I will be happy and curious to know whether any of you have had similar experiences, during your testing, to share. Comments are very welcome!

Last but not least Merry Christmas to everybody and a marvelous 2013 to you and your families!

ISM-ADSC-DFI cooperative alliance
11th International Workshop on Micropiles

The International Society for Micropiles (ISM) held their 11th international workshop on micropiles in Milan, Italy in October. The workshop marked the 60th anniversary of the *pali radici* (root pile) technology developed in Italy and was the first event organized under the ISM-ADSC-DFI cooperative alliance established in 2012. Over 60 delegates from 16 countries participated in the technical presentations and lively discussion on all aspects of micropile technology. The workshop coincided with the GeoFluid 2012, the annual small diameter drilling exhibition held in Piacenza, Italy approximately 80 km south of Milan.

In addition to long-standing ISM delegates from the USA, Canada, Finland, UK, Germany, Australia and Austria, new delegates from Italy, Saudi Arabia, Israel, Nigeria, Brazil, the Netherlands, Chile, Poland, Norway, and Estonia joined the workshop. Technical sessions covered cultural and regional applications, equipment and testing innovations, research initiatives, successful and challenging case histories, and slope stabilization and foundation support applications. Researchers from around the world discussed ongoing field, laboratory, and numerical analyses aimed at advancing the use of groups and networks of micropiles for a variety of applications.

ISM gratefully acknowledges the support and generosity of the workshop's host sponsor, Soilmec S.p.A., and other workshop sponsors. A full listing of workshop sponsors is provided on ISM's website at *www.ismicropiles.org*. The international technical program committee members included Allen Cadden (USA), Dr. Changho Choi (Korea), Allan Herse (Australia), Dr. Antonio Marinucci (USA), Fed-

Participant to the 11th ISM workshop.

erico Pagliacci (Italy), Mike Turner (UK), Jim Bruce (Canada), and Mary Ellen Bruce (USA).

Paul Woodfield, ISM Steering Committee member and Managing Director of Technik Ground Solutions Limited in the UK, delivered the 7th Lizzi Lecture, titled "The Good, The Bad, and the Ugly (Part 2)". This lecture is named in memory of the late Italian engineer, Dr. Fernando Lizzi, who developed and patented the *pali radici* technique for the stabilization and restoration of historic monuments. Woodfield's Lizzi Lecture was a continuation of the interesting and entertaining presentation he made at the 2006 ISM Workshop in Schrobenhausen, Germany, which covered his most exciting experiences (both good and bad) working within the micropile industry. He discussed candidly the considerable capital needs of running a micropile construction company, the criticality of workmanship and training of site personnel, the benefits of using the observational method, the fundamental necessity of perseverance, and the appreciation of luck. Three past Lizzi Lecturers also joined the workshop, Dr. James Mason (University of Tennessee), Dr. Thomas Herbst (retired Dywidag Systems International), and Ernst Ischebeck (Fried. Ischebeck GmbH).

The full social program began with a welcome reception held in the Winter Garden of the conference venue, the Grand Visconti Palace, just south of Milan's city center. On the second workshop day, delegates and companions toured either the GeoFluid 2012 drilling exhibition or took in the sights in Piacenza prior to the Awards Dinner. ISM's Chairman, Allen Cadden of Schnabel Engineering, Inc., served with his usual warmth and spontaneity as Master of Ceremonies acknowledging the contributions of numerous ISM delegates and sponsors and workshop organizers. ISM also recognized outgoing Steering Committee member, Dr. Thomas Herbst, for his dedication and commitment to the success of ISM since its inception in 1997 and his work in populating the ISM's database of micropile documents. Dr. Herbst is succeeded on the Steering Committee by Ernst Ischebeck (Germany).

The ISM-ADSC-DFI cooperative alliance was pursued by ISM leadership to leverage the extensive technical, administrative, and networking resources with these two influential organizations in the industry. Through this united front, all three organizations have better positioned themselves to address the global needs related to the micropile industry and further the pursuit of ISM's mission of being the preeminent world-wide center of knowledge for the development and advancement of micropile technology.

Please contact ISM technical leads Mary Ellen Bruce (*mebruce@dfi.org*) and Dr. Antonio Marinucci (*tmarinucci@adsc-iafd.com*) to obtain the workshop proceedings, and please visit *www.ismicropiles.org* for more information on micropile technology and activities.

Use of the real time monitoring for micropile/ anchor testing and stressing

Paolo Gazzarrini P.Eng.

Abstract

The use of computers and real time monitoring in the grouting industry has become very popular, useful and nearly mandatory in the last two decades. Can we say the same for the micropile/anchor industry?

This paper will describe some preliminary tests carried out in micropile/anchor projects in Vancouver, Canada, with the use of commercially available instruments, recording in real time the testing and stressing of the micropiles/anchors. The system used allows recording and printing in real time the behaviour of the micropiles/anchors, to automatically create movement/load graphs in performance tests, creep tests and proof tests.

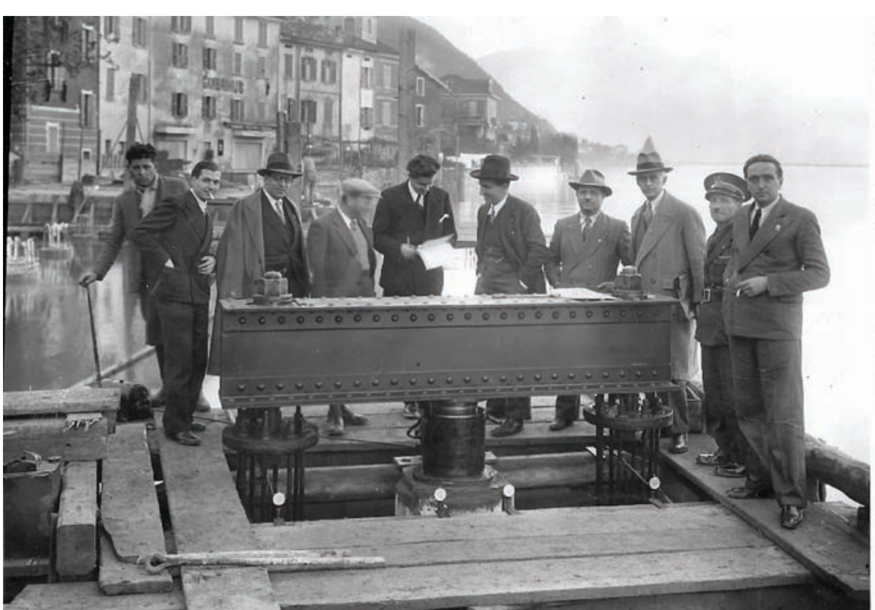
In the tests that were carried out the system proved reliable, indicating a great opportunity for the micropile/anchor industry to increase its level of quality control and quality assurance.

Introduction

Testing of micropiles (tension/compression/lateral) and anchors (tension) follow very strict standards and acceptance criteria. Literature for testing is available, for example, in:

- FHWA Micropile Manual
- FHWA Ground Anchors and Anchored Systems
- PTI Recommendations
- Eurocode 7

This paper does not analyze/discuss the different kinds of tests (ultimate, verification, proof or creep) or the acceptance criteria, but only the apparatus used and results obtained in a couple of preliminary tests carried out in Vancouver.



Picture 1. Compression test done in 1947 at Campione d'Italia (Lugano Lake).

Conventional testing

What is used generally for micropile/anchor testing?

- Hydraulic jacks,
- Dial Gauges,
- Load cells (sometimes),
- Reaction anchors/ frames for compression test.

What is the difference between a load test done in 1947 (see picture #1) and a test done today?

The same, or similar, dial gauges, same hydraulic jack, sometime today also with a hand pump, a shiny steel beam (I doubt today!), shine and elaborated reaction anchors. Not much difference today, 65 years later! The only notable difference from today is, definitely, the approach to safety (please note the picture), much dirtier shoes and a slightly different fashion on site!

Monitoring of the testing in real time

So, what can be done today to increase the level of QA/QC in testing micropiles and anchors?

The use of computers and real time monitoring in the drilling and grouting industry has become very popular, useful and nearly mandatory in the last two decades. Electronic instruments are now available on the market that allow the monitoring, recording and plotting of tension/compression tests in micropiles/anchors in real time.

The apparatus used for the test in Vancouver is composed of:

- Main recording unit with printer, keyboard and electrical junction box. See picture #2.

Picture 2. Main recording unit.

Picture 3. Displacement sensor.

Picture 4. Pressure sensor

Picture 5. Seismic anchor installed.

- Displacement sensors connected with the main unit and attached to the micropile/anchor with a magnetic plate. See picture #3. Usually two sensors are available. One for the micropile/anchor head and the other for the micropile reference on the ground or the wall for the anchor.
- Pressure sensor to be installed in the circuit of the hydraulic oil and connected with the main unit. See picture #4.
- Memory card reader.
- Software.

The apparatus allows measurement, visualization in real time, as well as printing and recording of all the parameters used in a tension/compression test such as:

- Load (tension or compression),
- Micropile/anchor displacement,
- Ground/ wall displacement,
- Stressing time.

Picture 6. Testing.

Picture 7. Detail of the testing.

Examples

Surrey, BC, Guilford Mall. Seismic anchors.

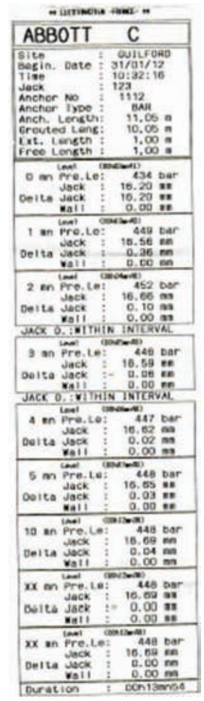
The design called for the installation of 12 #18 DCP seismic anchors in 2 footings, 6 each, as per picture #5. The anchors were proof tested using the recording apparatus, and conventional measuring as shown in picture #6 and #7.

Picture #8 shows the printout obtainable in the field with all the relevant data of the proof test. Pictures #9 and #10 show the printouts from the software; the classic tension/elongation graph and the graphics displacement vs. time with the creep.

All the tests were conducted using the conventional dial and pressure gauge in order to be able to compare the results. The results were comparable and the behaviour of the anchors was similar. Small differences in reading of hydraulic jack pressures and displacement were observed. Additional investigation into these aspects shall be conducted.

New Westminster, BC. multi-use civic facility center

The design called for the installation of 25 micropiles and all the micropiles will be tested in tension only due to space constrains and impossibility of installing reaction anchors



ABBOTT C

Site : GUILFORD
Begin. Date : 31/01/12
Time : 10:32:16
Jack : 123
Anchor No : 1112
Anchor Type : BAR
Anch. Length: 11,05 m
Grouted Leng: 10,05 m
Ext. Length : 1,00 m
Free Length : 1,00 m

0 mn Pre.Le: 434 bar
Jack : 16.20 mm
Delta Jack : 16.20 mm
Wall : 0.00 mm

1 mn Pre.Le: 449 bar
Jack : 16.56 mm
Delta Jack : 0.36 mm
Wall : 0.00 mm

2 mn Pre.Le: 452 bar
Jack : 16.66 mm
Delta Jack : 0.10 mm
Wall : 0.00 mm

JACK D.:WITHIN INTERVAL

3 mn Pre.Le: 446 bar
Jack : 16.59 mm
Delta Jack :- 0.08 mm
Wall : 0.00 mm

JACK D.:WITHIN INTERVAL

4 mn Pre.Le: 447 bar
Jack : 16.62 mm
Delta Jack : 0.02 mm
Wall : 0.00 mm

5 mn Pre.Le: 448 bar
Jack : 16.65 mm
Delta Jack : 0.03 mm
Wall : 0.00 mm

10 mn Pre.Le: 448 bar
Jack : 16.69 mm
Delta Jack : 0.04 mm
Wall : 0.00 mm

XX mn Pre.Le: 448 bar
Jack : 16.69 mm
Delta Jack : 0.00 mm
Wall : 0.00 mm

XX mn Pre.Le: 448 bar
Jack : 16.69 mm
Delta Jack : 0.00 mm
Wall : 0.00 mm

Duration : 00h13mn54

Picture 8. Print-out in the field.

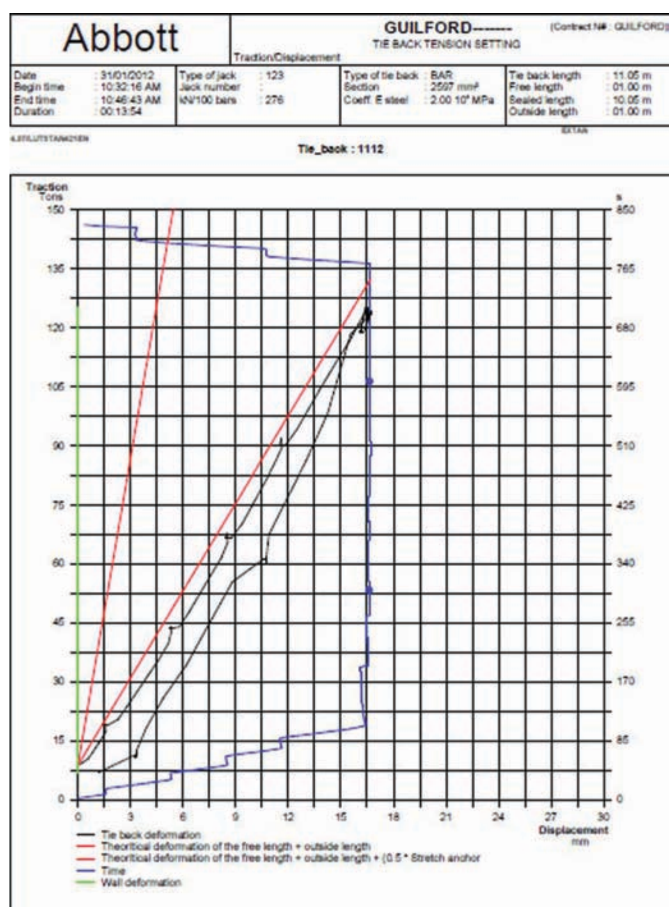
for compression testing. The work, at the time of the writing of this article, is currently under construction and only one sacrificial micropile has been installed and tested.

The site arrangement is similar to picture #6 and in picture #11 the results of the performance test carried out are shown.

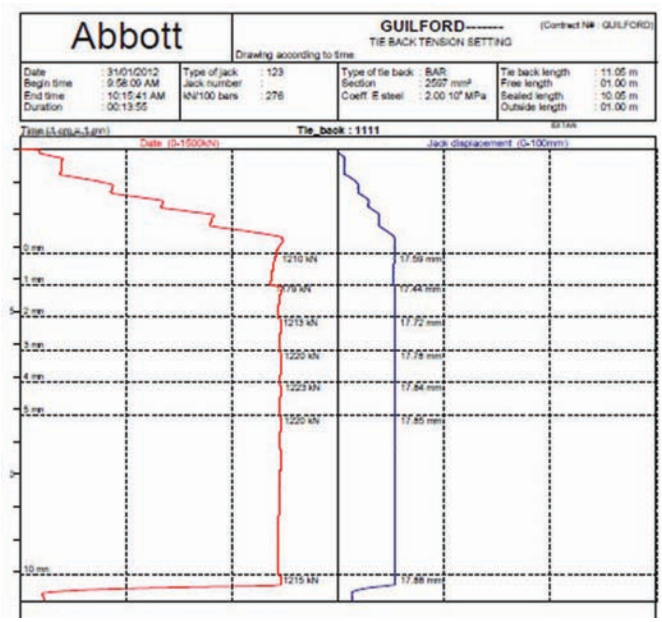
Also in this site the results obtained with the electronic apparatus and the "conventional" readings were comparable.

Conclusions

To the author's knowledge no literature is available related to the use of electronic apparatus for continuous monitoring and recording of the testing of micropiles/anchors. Not knowing the reason for this lack of information, the author found that the testing apparatus used for this prelimi-



Picture 9. Printout from the software.

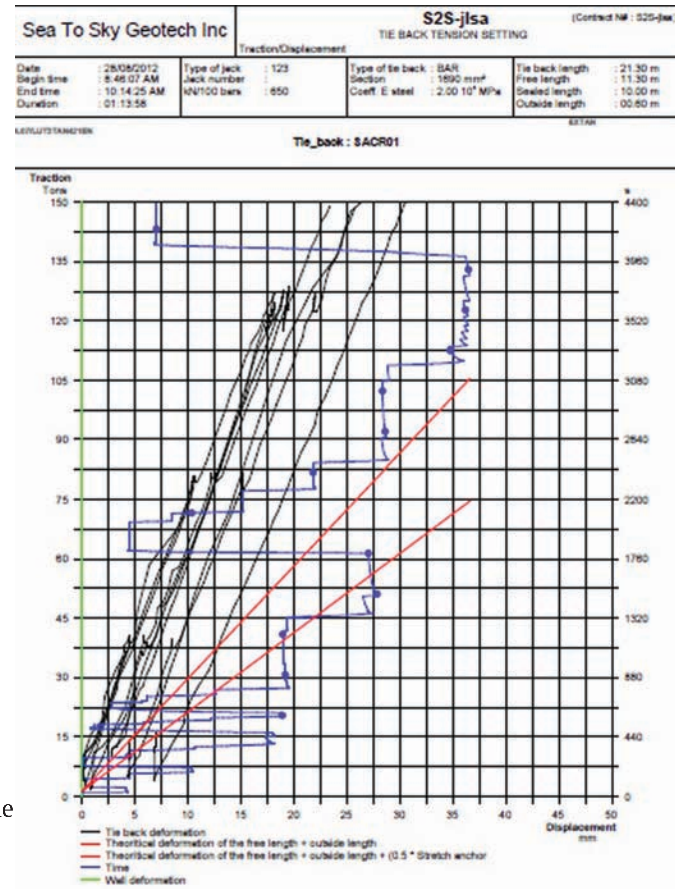


Picture 10. Printout from the software.

nary experience proved to be reliable with good and dependable results comparable with the results obtained with a "conventional" system.

The apparatus was practical to use and did not cause any delay in the execution of the tests simultaneously with the "conventional" system (despite the initial doubts of the contractors involved in the tests). The level of the data presentation and analysis can elevate the standard of the testing of micropiles and anchors considerably.

An additional advantage, subject to further study by the writer, is that the instrument can be used for long term monitoring tests in order to understand the behaviour of the micropile/anchor in say, 1 day -or more- test, without unnecessary waste of resources and it can be economically advantageous.



Picture 11. New Westminster- Performance test graph.

Additional research and testing of small discrepancies between displacement data and pressure recorded shall be carried out as "work in progress".

A final question to the participants of the workshop: Can the level of QA/QC in the micropile/anchor industry be increased using simple devices which can also simplify the life of Engineers and contractors?

For grouting stories, case histories or only to comment, you can write to me:
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Ciao!

Managing fluid fine tailings: Collaboration in Canada's oil sands industry

Alan E. Fair and Nicholas A. Beier

Introduction

The development of our oil sands in Northern Alberta is a relatively new venture. We have enjoyed an enterprise filled with pioneering, innovation and exciting growth in the creation of a great new industry. Some believed the oil sands would never be successful. Fortunately, that thinking proved to be incorrect. The Canadian oil sands deposit is host to an estimated 170 billion barrels of recoverable bitumen. The CBC National News recently reported that these reserves could meet Canada's oil needs for more than 400 years. While this new undertaking has seized worldwide attention, both positive and negative, it has also created significant challenges with respect to tailings management.

...these reserves could meet Canada's oil needs for more than 400 years.

The Oil Sands Tailings Research Facility (OSTRF) recently hosted the 3rd (Bi-Annual) International Oil Sands Conference in Edmonton (December 2 to 5, 2012). One might ask, who would come to Edmonton in December? Well, more than 350 delegates from around the world attended (including: China, France, the Netherlands, Switzerland, the US and more). The following article is extracted from a Keynote Address that was presented at the conference and is intended to provide an update on the collaborative progress being made by the oil sands in tailings management.

Managing oil sand tailings continues to be one of the key environmental challenges facing the industry. During the early years of operation, industry efforts to manage tailings focused on ensuring safe containment of growing volumes of fluid fine tailings (FFT). As it became apparent that FFT volumes could not be well managed in above ground structures, industry efforts shifted to tailings management methodologies whereby the fines were recombined with the coarse tailings and placed in the mined-out pit. Current industry attention is focused on developing methods to dewater the FFT such that they can be incorporated into the final mine closure landscape

Three fundamental issues for managing fluid fine tailings throughout the operating period of oil sands mines must be addressed to create sustainable landforms for mine closure. These can be summarized as follows.

1. The volume of mature fine tailings (MFT) produced is substantial. At the time of writing there are approximately 850 million m3 of fluid tailings held in above-grade containment dams.
2. The methods for transformation of fluid tailings into stable, sustainable elements of a closure landscape are all in various states of development, from preliminary research to commercial practice. None can be considered as mature (i.e. proven practice) with performance fully demonstrated for operation and closure.
3. Until recently, full commercialization of methods for fluid fine tailings management was slow. This has resulted in progressive reclamation respecting fluid tailings volumes being less than desirable to date.

managing fluid fine tailings... must be addressed to create sustainable landforms for mine closure

In addition, the resulting process-affected water must also be managed. This will necessitate the commercial development of water treatment technologies that will ultimately enable the reuse and release of water back into the environment. Finally, the dewatered tailings deposits must be reclaimed such that they can be integrated into the final landscape.

The oil sands tailings consortium

A "coalition of the willing" came together in May of 2010 with an overall objective to jointly develop technologies that would reclaim oil sands tailings ponds more rapidly. The coalition used a "principle-based" approach to put an agreement together to create the Oil Sand Tailings Consortium (OSTC). By December 2010, the OSTC was announced with the official agreement signed March in 2011. All of the companies currently engaged in or considering surface mining of the oil sands are members of OSTC, including: Suncor Energy Inc., Syncrude Canada Ltd., Shell Canada, Canadian Natural Resources Ltd., Imperial Oil, Total E & P Canada Ltd. and Teck Resources Ltd. Various collaborative projects have been undertaken since the early 2000's. However, none of them were of the magnitude of the commitment envisaged by the current OSTC Agreement. The core of the OSTC Agreement is founded on four principles: Eliminate monetary and intellectual property (IP) barriers; Share knowledge and support public transparency; Collaborate on tailings R&D; and Equitable cost sharing.

Under the OSTC Agreement, participating companies have agreed to share all past, present and future tailings technology IP. True collaboration, as employed by the OSTC members, is not a common industry practice and this decision is a significant departure from the typical oil and gas industry practice. It required the more established companies (Suncor, Syncrude and Shell) who possess the majority of the industries' tailings IP and have collectively invested over $400 million over the 5 years leading up to the creation of the OSTC, to endorse the arrangement. Participation from all seven companies required a lower threshold dollar amount that the newer companies would contribute in order to support future tailings R & D.

Under the OSTC Agreement, companies have agreed to share all past, present and future tailings technologies...

Tailings technical guide for fluid tailings management

In support of improving the governance of oil sand tailings, the OSTC set out technical guidelines for managing FFT. This document entitled "Tailings Technical Guide for Fluid Tailings Management" was developed with oversight and guidance provided by two expert panels. The first panel was convened to review the technical content of the document. The panel members were David Carrier III, Richard Dawson, Ross Eccles, Norbert Morgenstern and John Sobkowicz. A second panel reviewed the document from a regulatory perspective. The panel members were Richard Dawson, Gerry DeSorcy, John Errington, Barry Hurndall, Bernie Roth and John Sobkowicz.

The Technical Guide is intended to support the Government of Alberta in developing a consistent policy for tailings regulation. It also provides a detailed up-to-date technical review of current practice for managing the different types of tailings deposits using best available technology. Of most importance, the document proposes that site-specific volume profiles of FFT be established for each mine site. This approach provides a direct method to manage and steward the volume of FFT. Furthermore, it will limit the accumulation and provide containment of FFT in a manner consistent with the goals of progressive reclamation as well as the desired reclamation and closure outcomes.

Under this proposal, oil sand operators would employ adaptive management to remain within their committed volumes. Adaptive management deals with inherent uncertainties associated with FFT generation, allowing operators to deploy available methods (and newly developed ones like those identified in the Tailings Roadmap Study) as required. Different technologies are available that form combined suites to meet various performance objectives within the overall tailings plan for a project.

Oil sand tailings processing and deposition

Various process methods are currently being utilized to release water from FFT. The FFT must attain a solids content of 75% to 80% (by weight) to develop sufficient long-term stiffness and strength (in the range of 50 kPa to 100 kPa), thus losing 67% to 75% of its water in the process. For tailings treatment technologies involving drying, FFT might further dewater as far as the shrinkage limit. At present there are five primary techniques being evaluated for dewatering of FFT. These include: i) Centrifugation of FFT, ii) Thin Lift Dewatering, iii) Thick Lift Dewatering, iv) Thickened Tailings, and v) CT or NST Tailings. Each of these are described below.

One process to dewater FFT uses flocculation and processing of FFT through a solid-bowl scroll centrifuge. Adding a coagulant such as gypsum can also assist the process. Solids contents of about 55% are produced in the centrifuge "cake." The cake is placed in relatively thin lifts with about 2 t/m2-y deposited in cells constructed in a manner similar to the handling of soft, wet overburden soils. Left for a winter freeze-thaw cycle, the cake will attain peak shear strengths of 5 kPa to 10 kPa, before an additional lift is placed. Alternatively, the cake is continuously deposited, at higher annual rates per area, into deep, in-pit deposits, relying on self-weight consolidation to effect further water release and volume reduction.

A second method employs in-line flocculation of FFT and discharge of the flocculated slurry in thin lifts into cells, where initial dewatering, effected by flocculation and drainage, can increase the solids content to around 60%. Further water removal is accomplished via evaporation and freeze-thaw effects. The volumes associated with oil sands mining and the low net evaporation rates in northern Alberta result in large area requirements to meet dewatering targets for reclamation. The dewatered material can be relocated to overburden cells after initial dewatering (similar to centrifuge cake), or alternatively, allowed to dewater further with evaporation or freeze-thaw to a point where it has sufficient strength to form an integral part of a disposal structure.

In-line flocculated FFT can also be utilized to form deep deposits (e.g., in a large in-pit cell). Water expressed from the deposit and precipitation is decanted from the surface. Surface dewatering can be assisted by rim-ditching the perimeter of the deposit or creating channels on the surface to direct water to a decant sump. Self-weight consolidation progressively increases the solids content of the deposit, driving water upward through the deposits (or both upward and downward if there is bottom drainage).

A fourth dewatering method draws FFT directly from the extraction process (e.g., cyclone overflow), and then flocculates and thickens the FFT in a mechanical thickener. Thickening is generally employed to recover thermal energy but also has the benefit of partially dewatering the FFT, producing thickened tailings (TT). The TT can be placed in deep deposits, relying on consolidation for dewatering. Alternatively, it could be discharged in thin lifts, in a similar manner to that described previously.

Blending of sand slurry (typically at high solids contents) with FFT, using flocculants or coagulants to attain a non-segregating mix can also be used to promote fines capture and dewatering. Once mixed, the material is then discharged into a deep deposit. Where the fines are sourced as MFT, the resulting product is referred to as composite or consolidating tailings (CT). Alternatively, where fines are sourced as TT, the resulting product is referred to as non-segregating tailings (NST). The key objective of both methods is to reduce the water content and produce a sand-dominated mix, at a moderately high sand to fines ratio (SFR). This results in a relatively quick volume reduction and increase in deposit strength (compared to lower SFR tailings deposits).

There are essentially four deposit types that can be created from the fines management methods under active development and commercial use. These deposits include: thin-layered, fines dominated deposits; deep, fines dominated deposits; fines-enriched sand deposits; and water- capped fine deposits. The full keynote paper (Fair and Beier, 2012) describes the different ways in which these four oil sands tailings deposit types are produced, their principal performance factors and how the deposit performance can be assessed through the period of their placement to their readiness for reclamation.

The Tailings Technical Guide sets out guidelines for managing FFT through appropriate treatment and disposal in a DDA. For each site, operators must consider land availability and disturbance, geotechnical conditions, resource distribution, general site geology, containment availability and mine advancement to develop the optimum tailings management strategy.

Conclusions

The OSTC's Tailings Technical Guide provides an up-to-date technical overview of current practice in oil sand tailings management orientated towards the different types of deposits formed and managed using best available technology. These deposit types include: thin-layered, fines-dominated deposits; deep, fines-dominated deposits; fines-enriched sand deposits; and water-capped fine deposits.

The Technical Guide also suggests updates that would promote better tailings management given recent technology developments and changes in current practice. These changes are proposed in the context of the original intent to provide a performance-based regulation that builds on a foundation of continuous improvement.

Detailed site-specific mitigation plans are important to the proposed adaptive management approach. In many cases, the contingencies are still in a research or developmental stage. Hence the need for an adaptive management plan, whereby new insights are continuously incorporated in future designs and applications.

Acknowledgements

The authors wishes to acknowledge the support of the seven member companies who form the OSTC (Suncor Energy Inc., Syncrude Canada Ltd., Shell Canada, Canadian Natural Resources Ltd, Imperial Oil, Total E&P Canada Ltd., and Teck Resources Ltd.) and the expert panel members for the development of the Technical Guide (David Carrier III, Richard Dawson, Gerry DeSorcy, Ross Eccles, John Errington, Barry Hurndall, Norbert Morgenstern, Bernie Roth and John Sobkowicz).

Reference

Fair A. and Beier, N. 2012. Collaboration in Canada's Oil Sands: Fluid Fine Tailings Management. 3rd International Oil Sands Tailings Conference, December 2 -5, 2012, Edmonton, Alberta.

Alan E. Fair and Nicholas A. Beier

OSTC/COSIA Tailings EPA, Edmonton, Alberta, Canada

Top 5 Highlights of the New Geoengineer.org Website!

After months of development, Geoengineer.org officially launched its completely redesigned, new Geoengineer.org website! And this was only the beginning: further significant improvements and additions will be introduced gradually in the course of the coming months! Stay tuned, by visiting *www.geoengineer.org*, following us on GeoWorld *(www.myGeoWorld.info)* & social media, and subscribing to our email list.

So what's new?

Geoengineer.org offers an abundance of relevant and fresh geo- content presented in a modern, simple design and clear structure. **We chose our Top 5 Highlights to share with you:**

1. *News Center*. Our News Center includes daily news items, Press Releases, geo-business news, and breaking news that are of interest to the international community of geoprofessionals, tagged and categorized, so that you can stay up-to-date with the latest in the geo-industry.
2. *Events database* of geo-conferences, webinars and short courses, easy to view by type, date and also positioned in a map!
3. *Highlighted Projects* by companies with lots of explanations, photos and videos.
4. *An unprecedented collection of Publications*, including papers, case histories, magazines, journals and featured books, indexed by main geo-specializations.
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Hydrogeological and geotechnical considerations of construction dewatering and drainage systems

Mori H. Mortazavi

In-construction and post-construction dewatering like other water takings in Ontario is regulated under the Ontario Water Resources Act, and a Permit-To-Take-Water (PTTW) should be obtained from the Ministry of the Environment (MOE) if the discharge rate is greater than 50,000 L/day (or 0.6 L/s). The PTTW application should be supported by a hydrogeological site assessment prepared for the shoring, excavation, temporary dewatering and/or permanent drainage needs of a development project. Presented here are regulatory objectives and principles, ground water flow principles, site investigation needs, a typical conceptual model, potential dewatering interferences and the pertinent design and construction considerations of development projects. Keywords: temporary dewatering, permanent drainage, aquifer, aquitard, ground water strike, hydrostatic ground water level, hydraulic conductivity and gradient, dewatering discharge rate and zone-of-influence, baseflow, and ground subsidence.

Introduction

Water is the world's most life-giving and critical resource. The future world security lies on the water quality, quantity, conservation and democracy. Is water a human "right" or a "commodity"? If water is a commodity and traded, then who will pay the nature's water needs!?

Only 2.5% of the "blue planet" earth water is fresh of which only 30% (less than one percent of the total earth water) is available for use and 70% is locked in permafrost. About 30% of the fresh water is ground water (Figure 1). About 20% of the world fresh water exists in Canada and one third of the Canadians rely on ground water.

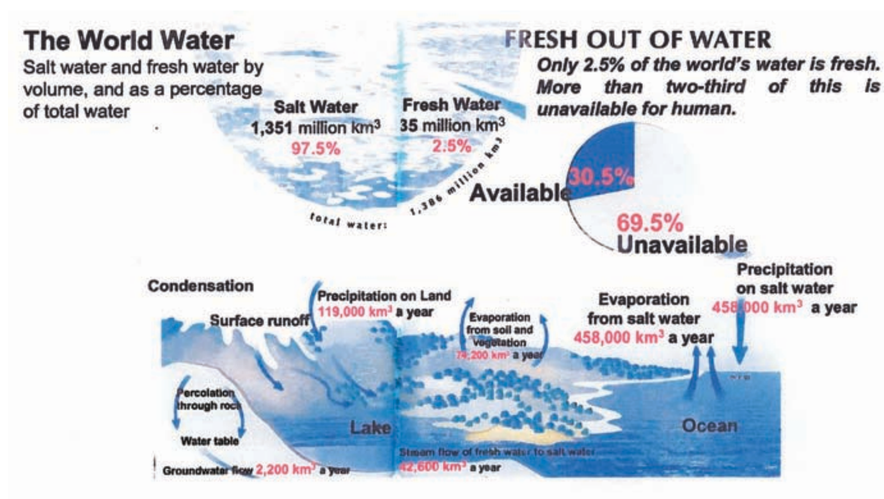

Figure 1. World hydrologic cycle (R. Clarke & J. King, 2004).

Since 2000, thanks to the Ontario Walkerton water tragedy (Justice O'Connor's two-part report of 2002) regulations, policies and guidelines have been developed under the Clean Water Act (CWA) [1] to protect drinking water from the source to the tap in a multibarrier approach including source protection plans, wellhead protection areas and intake protection zones, vulnerable areas and potential threats for municipal water systems and watersheds.

For surface water and ground water source studies, nine guidance modules have been developed under the CWA for watershed characterization including water budget and vulnerability analyses, threat inventories, water quality and quantity risk assessments as well as municipal water supply strategy and information management [1].

Under the CWA and Ontario Water Resources Act (OWRA), regulations (O.Reg. 387/04 and O.Reg. 327/07) and guidelines have also developed for water takings more than 50,000 L/day (0.6 L/s) and the PTTW. These regulations and guidelines describe objectives, principles, permit categories, the hydrogeological studies required for Category 3, permit application, application review process and the permit conditions including monitoring and contingency/mitigation requirements. The MOE has prepared a PTTW Manual [2] and Technical Guidance

Table 1. Permit-To-Take Water Principles	
1	Ecological approach
2	Prevention and resolution of unacceptable interferences
3	Adaptive management for better response to the evolving environmental conditions
4	Addressing cumulative impacts of water takings
5	Incorporation of precautionary principles (Table 2); and
6	Promotion of the public and local agency involvement

Table 2. Precautionary Principles	
1	Demonstrate that all aspects of the project have been examined and planned in a careful and precautionary manner in order to ensure that they do not cause serious or irreversible damage to the environment and/or the health of current or future human generations
2	Outline and justify the assumptions made about the effects of all aspects of the project and the approaches to minimize these effects
3	Evaluate and compare alternative means of carrying out the Project in light of risk avoidance, adaptive management capacity and preparation for surprise
4	Demonstrate that in designing and operating the project, priority has been and will be given to strategies that avoid the creation of adverse effects
5	Provide that contingency plans explicitly address worst-case scenarios and include risk assessments and evaluations of the degree of uncertainty
6	Identify and propose follow-up and monitoring activities, particularly in areas where scientific uncertainty exists in the prediction of effects; and
7	Present public views on the acceptability of all of the above

for Hydrogeological Site Assessment (HSA) [3] for technical assistance of the Qualified Person (QP), P.Eng. or P.Geo.

The PTTW's objective is to implement the MOE's water management policy for fair sharing, conservation and sustainable use of Ontario water resources without water allocation but preventing unacceptable interferences.

The PTTW hydrogeological study and application are based on six principles listed on Table 1. Included in these six principles is incorporation of the precautionary principles summarized on Table 2.

Ground water flow principles and equations

The water in soils (porous media) exists in three forms of adsorbed (hydroscopic or pellicular), capillary (or matric) and gravitational (or free). The free or gravitational water in soils is usually referred to as the ground water. The ground water bodies can exist in perched condition in sand seams/lenses within silty/clayey soils and in regional condition within aquifers (in sand and gravel, confined or unconfined) that may be separated by aquitards (clayey soils).

The ground water flow varies with space, time, boundary conditions, medium (soil or rock) properties and behaviour as well as the fluid (permeant) temperature, density and viscosity. The ground water flow types in relation to time can be steady or transient; in relation to space uniform or varied and in relation to the driving force laminar or turbulent. The driving force or free energy for ground water flow can be expressed in terms of "potential" (Φ: free energy per unit mass of fluid) or "total head" (h: free energy per unit weight of fluid), or "pressure" (p = free energy per unit volume of fluid).

The laminar ground water flow in saturated soils is usually analyzed by Darcy's law which is based on linear relationship between the rate of flow and the driving forces. It is important to note that Darcy's law is valid as long as the Reynold's number based on an average grain size does not exceed some value between 1 and 10 which is indicative of linear laminar flow. The ground water flow in fractured rock mass is usually nonlinear.

The Reynold's number for flow through porous media is:

$$\mathrm{Re} = \frac{pvd}{u} \; or \; \frac{vd}{v} \qquad (1)$$

Where ρ and μ are the fluid density and viscosity, *v* is kinematic viscosity, v is specific discharge, and d is a representative length dimension for the porous medium, variously taken as a mean pore dimension, a mean grain diameter, or some function of the square foot of the permeability K.

The most commonly encountered Darcian ground water flow equation is

$$Q = KiA \qquad (2)$$

Where Q is the flow rate L^3/T); i is the hydraulic gradient (dimensionless); A is the total cross-sectional area of flow (L^2); and K is the constant of proportionality (L/T), which is termed the hydraulic conductivity; or

$$q = Ki \qquad (3)$$

$$v = Ki/n \qquad (4)$$

Where q is the specific discharge or flux and v is the average linear velocity of the flow in a porous medium with a volumetric porosity of n.

The "specific yield" (Y_s) of a porous medium is the drainable water and the "specific retention" (R_s) is the undrainable water. The porosity of a saturated soil n, which is a function of void ratio (e), is the sum of specific yield and specific retention (Table 3).

$$n = Y_s + R_s \quad (5)$$

$$e = n/(1-n) \quad (6)$$

Table 3. Typical Soil-Water System Parameters

Soil Type	Gravel	Sand	Silt	Clay
Y_s (%)	23	30	18	3
R_s (%)	9	12	29	47
n (%)	32	42	47	50
e	0.47	0.72	0.89	1.00

In a watershed, depending on the topographic and hydraulic gradient conditions, areas or zones of recharge and recharge can exist with the ground water flow downwardly and upwardly respectively; or otherwise horizontally (Figure 2).

Other ground water flow form by non-body forces are matric or capillary flow in unsaturated soils (Φ_m), osmatic or diffusion (Φ_s) (versus advection where driving force is the body force or primarily gravitational force (Φ_g)), and coupled flows where the driving force is due to a temperature or chemical concentration gradient in addition to other driving forces noted above.

In contaminant hydrogeology, it is important to note that through a 1.0 m thick clay soil barrier with a hydraulic conductivity (K-value) of 10^{-8} cm/s, the advective flow takes about 100 years, whereas the diffusive flow takes only about 5 years! [4].

The equations for flow of ground water under gravitational body forces, which is usually the case for dewatering or drainage systems, consist of condition, motion and solution equations.

The condition equations determine boundary conditions by a conceptual site model, hydraulic conductivity K-values of soil strata and flow type (steady or transient, uniform or varied, laminar or turbulent).

The motion equations consist of mass conservation (water budget analysis for example), energy conservation (Bernouli equation) and Darcy's law.

The solution equations may consist of analytical (simplified two-dimensional), pictorial (flow nets) and numerical (ground water modeling) solutions.

The above-noted equations are utilized to assess the water quantity and quality, potential aquatic and terrestrial adverse effects, and the monitoring program and contingency/mitigative measures commensurate to the proposed development construction dewatering and post-construction drainage needs in compliance with the water-taking regulatory requirements.

For a water-taking quantity assessment, both the "source" and the "sink" should be characterized. The source can be either ground water or surface water or a combination of both. The sink can be an existing natural feature of the site and surrounding hydrogeologic setting, a construction dewatering scheme that may include well points and eductor wells, or a post-construction drainage facility.

For a water-taking quantity risk assessment, the construction dewatering or post-construction drainage discharge rate and zone-of-influence and/

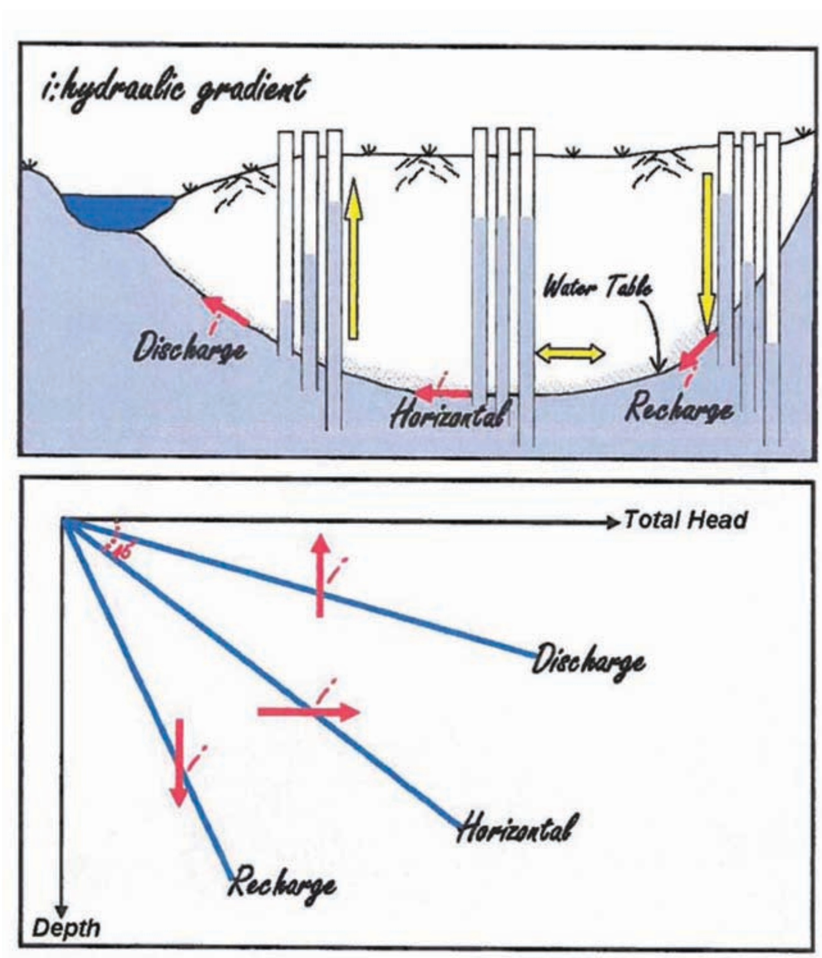

Figure 2. Vertical and horizontal ground water flow gradients.

or perturbation in the water regime are compared with those of the existing (baseline) conditions to assess potential adverse effects of the proposed water taking.

For a water-taking quality assessment of the dewatering and drainage projects, the primary concern is the discharge receiving facility available near the project site, such as a natural sink (a creek, a river or a lake) or a city sewer for which water quality objectives or sewer-use bylaw criteria should be met. The water quality assessment should be based on historical and existing land use activities and discharge point quality standards, objectives or criteria in relation to the physical or aesthetic, chemical, microbiological and radiological parameters.

For a water quality risk assessment, the concerns are contaminant loading of the receiving natural or man-made sinks and perturbance of any contaminant plume existing within the dewatering or drainage zone of influence and the pertinent environmental and liability issues.

Hydrogeological field investigations and laboratory testing

To conduct a hydrogeological site assessment and prepare a report as the geoscientific support to the PTTW application, the following main tasks are usually undertaken under a QP's supervision:

i. A desk-top review of the site background information including topographic, physiographic and geologic maps, water well records and other previously compiled data.

ii. A site reconnaissance to survey the historical and functional water wells within 500 m radius of the site boundaries and recording of the existing features and potential on-site and off-site sources of ground water contamination.

iii. Subsurface exploration by installing boreholes, multi-level piezometers and monitoring wells, concurrently with the geotechnical field investigation to assess soil stratigraphy and ground water conditions, including records of ground water strike level (first encountered during drilling) and hydrostatic ground water level by subsequent monitoring for summer low and annual average flow.

iv. Borehole permeability testing and ground water sampling in selected monitoring wells, and a typical pumping test, if required.

v. Laboratory testing of representative soil samples for grain-size distribution and ground water samples for determination of the ground water baseline quality.

Hydrogeological conceptual site model

In general, a conceptual site model (CSM) is an assessment tool which represents qualitative and quantitative field date to understand how the real system under study is likely to work under certain assumptions. The simplified model is usually both descriptive and pictorial (plans and profiles). The hydrogeological CSM usually consists of the following components:

i. Proposed development features, construction dewatering and permanent drainage needs.

ii. Physiography (including biosystems), topography, geology and soil stratigraphy.

iii. The site and surrounding hydrogeologic setting, recharge and discharge areas.

iv. Existing land and water uses (water well records).

v. Potential on-site and off-site sources of ground water contamination.

vi. Ground water regime characteristics such as ground water strike level, hydrostatic ground water level, flow direction and hydraulic gradient.

Dewatering and drainage conceptual model

The proposed development features related to shoring, excavation and ground water control needs are superimposed on the hydrogeological CSM to represent the construction dewatering or permanent drainage model to quantify the following:

i. The height of the ground water level to be lowered for purposes of dry working condition and excavation base and sides stability;

ii. The temporary (construction) dewatering or permanent (post-construction) drainage discharge rates and zone-of-influence for the required ground water level lowering;

iii. The ground water discharge quality control measures, such as decantation of suspended solids, on-site or off-site treatment of contaminants, a monitoring program and contingency/mitigative measures for potential adverse effects; and

iv. Considerations of ground water level lowering dewatering or drainage discharge quantity and quality to provide information for selecting the shoring type, dewatering scope and excavation sequence of events as well as installation of the drainage facilities.

The scope and cost of a construction (temporary) dewatering task depend very much on the size and depth of excavation, excavation support or shoring type, soil stratigraphy, hydraulic conductivity and gradients, ground water strike and hydrostatic levels, ground water quality and discharge receiving facility.

The shoring type, depending on the excavation and ground water conditions, may vary from box trenching or hydraulic shoring or cross-trenching with walers and struts to sheet piling, soldier piles with tiebacks and lagging, rakers, or secant concrete caisson walls with tiebacks. Among these excavation support types, the secant concrete caisson shoring has particularly the following advantages:

i. The wall relative impermeability will minimize and facilitate the construction dewatering rate inside the shored area of excavation.

ii. The dewatering zone-of-influence and potential impacts in the vicinity, such as ground subsidence or settlement of the structures and migration of contaminant plume, if any, will be reduced.

The scope and cost of a permanent (post-construction) drainage system required, in addition to the above-noted factors except shoring, depend very much on drainage aggregate, wrapping filter fabric, perforated subdrain pipes, header solid pipes and pumping the collected ground water to a discharge receiving facility.

A typical hydrogeological and dewatering conceptual model is depicted on Figure 3 for a caisson-walled shoring system with two optional depths of 25 and 35 m in relation to the soil stratigraphy and upper and lower aquifer and aquitard conditions.

Estimation of dewatering discharge rate and zone-of-influence

Based on the hydrogeological and geotechnical factors described above, the dewatering and drainage requirements primarily depend on:

i. Hydrostatic ground water level;

ii. The ground water level lowering required for dry working conditions during construction and stability of the shoring augered holes bottom, excavation base and underside of the footings; and

iii. Soil stratigraphy and aquifer hydraulic conductivity K-value and hydraulic gradients.

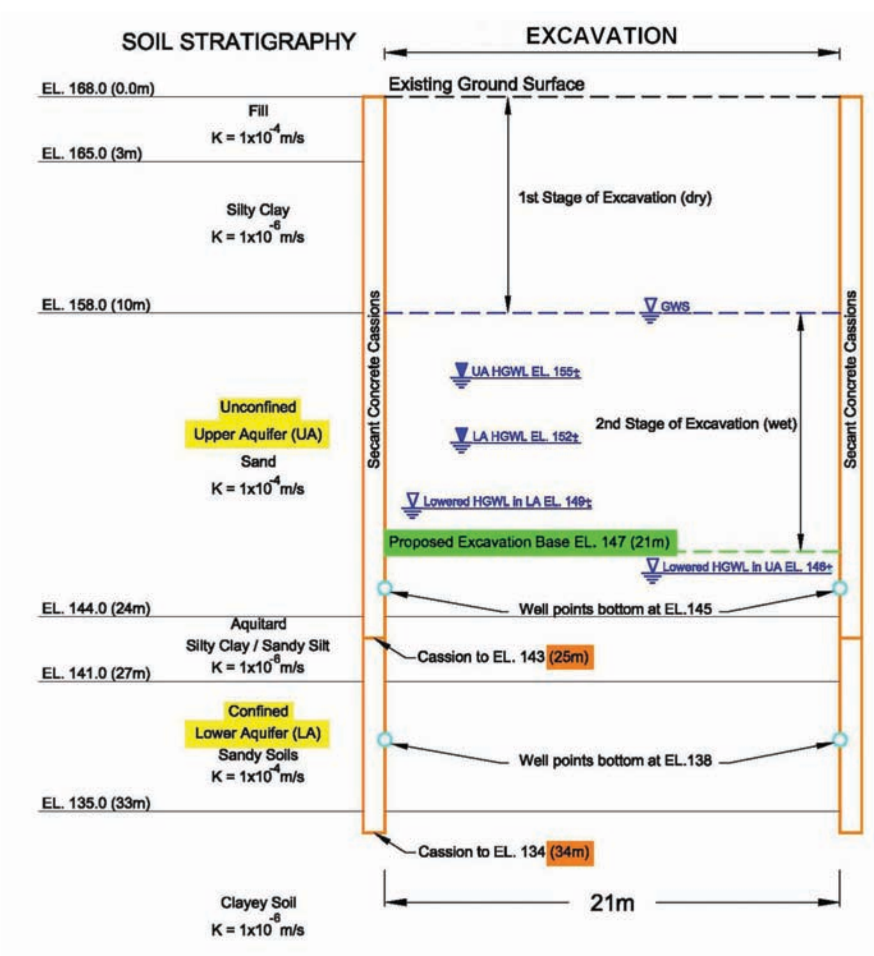

Figure 3. Typical hydrogeological and dewatering conceptual model.

The estimation of the construction (temporary) dewatering and post-construction (permanent) drainage discharge rates, construction duration and the water-taking zone-of-influence for assessment of adverse effects are the important data for the PTTW application.

The dewatering discharge rate can be estimated by one of the following methods depending on the soil stratigraphy, ground water and boundary conditions such as the confinement created by a shoring system:

i. Application of the Darcy's equation: Q = KiA, where K is hydraulic conductivity, i is hydraulic gradient of dewatering flow for lowering the hydrostatic ground water level to a desired level and A is seepage area in the excavation, for a simplified two dimensional model within the dewatering zone-of-influence. Another method of calculating Q of this simplified category would be by constructing deliberately a flow net of the dewatering model;

ii. Simple volumetric calculation of the aquifer drainable water content where the aquifer is confined by a rather impervious shoring system such as secant concrete caissons and underlying rather impervious clayey soils;

iii. Application of Forchheimer's formula to dewatered excavation as a large circular (or equivalent) well (Suzuki and Yokoya, March 1992); or

iv. Numerical ground water modelling by using a finite-element software.

The zone-of-influence (R_o) for the required ground water level lowering or drawdown (D_d) can be estimated by one of the following methods:

i. The W. Sichart and W. Kyrieleis (1930) empirical relationship [5] that gives R_o (in m) as a function of D_d (in m) and hydraulic conductivity (K-value in mm/s);

$$R_o = 3D_d \sqrt{K} \quad (7)$$

ii. A pumping test for the required drawdown as compared with that of the actual dewatering wells; or

iii. A numerical ground water modeling by using a finite-element software where R_o is determined equivalent to the distance from the dewatering wells where the drawdown is insignificant.

It is important to note that construction dewatering can only be terminated after the foundation and perimeter subdrains and sump pump are installed and functional to undertake the depressurization and collection of ground water for discharge to an approved facility in lieu of the construction dewatering wells. The dewatering wells should be abandoned in accordance with the regulatory requirements.

The sizing and layout of the free draining aggregates, filter fabric wrapping, perforated pipes, header solid pipes and the drainage pump for the subdrains are usually finalized after a review of the in-construction ground water conditions. The permanent drainage zone-of-influence under gravitational flow can also be determined by one of the methods described above.

Potential dewatering adverse effects

As shown on Table1, one of the PTTW principles is prevention and resolution of acceptable interferences or adverse effects. The adverse effects of the ground water level lowering by temporary dewatering or permanent drainage are postulated as follows:

i. Potential ground water level lowering in the existing (functional) water wells

ii. Reduction of baseflow in the creeks adjacent to the subject site (ecological effect)

iii. Movement of contaminant plume(s)

iv. Potential ground subsidence in the adjacent structures

The adverse effects under Items (i), (ii) and (iii) above can be assessed by a background information review, site observations and baseflow evaluation in comparison with the proposed temporary dewatering or permanent drainage rates and zones-of-influence. If a serious migration of contaminant plume into the excavation is anticipated, a barrier system should be incorporated into the shoring and retaining walls. In this case a secant concrete caisson shoring system may be preferable due to its advantages described above.

The ground water level drawdown-induced settlement underneath the structures existing within the dewatering zone-of-influence can be geotechnically evaluated by assessing the drawdown-induced increase in effective stresses, total and differential settlements which are to be reviewed by a structural engineer with respect to the structures deformation tolerance.

PTTW application and monitoring

Based on the PTTW objectives and principles, the PTTW application comprises 12 parts and 3 schedules [5]. In addition to the administrative and processing fee payment information, the project technical information and source(s), volumes and rates of water taking should be provided. The water conservation, best management practices and QP's certification are included in the schedules. More importantly, the application should be supported geoscientifically by a comprehensive report of hydrogeological site assessment (HSA).

The PTTW processed, reviewed and issued by the MOE will contain site-specific conditions that should be implemented during dewatering by the PTTW holder under the QP's supervision. One of the conditions is about the site-specific monitoring requirements and contingency/compensatory measures that are usually included in the HSA report and are generally outlined as follows:

i. Measuring (by a flow meter) and recording daily dewatering rate and volume for annual reporting to the MOE's water taking reporting system (WTRS) before the end of March following dewatering completion.

ii. Periodical water level readings and quality assessment of the samples taken from monitoring wells and discharge pipe.

iii. Periodical surveying of the settlement monuments installed at the structures existing within the dewatering zone of influence.

Prior to implementation of a construction dewatering system or a post-construction subdrainage system, the plans and details of these systems proposed by the project contractor should be reviewed and accepted by the project hydrogeologist or geotechnical engineer for compliance with the HSA recommendations and the PTTW's terms and conditions.

In conclusion, it is hoped this article provides a better understanding of the water-taking regulatory criteria, scientific information of the ground water flow principles and technical requirements of typical hydrogeological and dewatering conceptual models. Once the hydrogeological site assessment report is prepared and the water-taking permit is obtained during the design phase, prior to construction and concurrently with the geotechnical site investigation, potential construction complications, delay and liabilities of the ground water control measures can be avoided.

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BOOK REVIEW

Slope Engineering for Mountain Roads

Hearn, GJ (editor). 2011. Geological Society, London, Engineering Geology Special Publication No 24.

Reviewer, DF VanDine, VanDine Geological Engineering Limited, Victoria, British Columbia, Canada, vandine@islandnet.com

One of my fields of specialty is debris flow mitigation, and therefore when I received Slope Engineering for Mountain Roads, opened it up, and the first thing that dropped out was an erratum sheet for Figure C7.31, entitled "Some options for debris flow control and fan crossings", I had a good feeling about this book. It turns out that the original figure in the book was not incorrect, but some of the lines on the figure were shown thicker than intended. It nice to know that the publisher cared enough about the book to issue this erratum sheet.

As the title suggests, the focus of the book is the slope stability aspects of design, construction and maintenance of roads in mountainous terrain. What the title does not indicate is that the book is directed to regions of the world that are in the humid tropics and subtropics (primarily residual soils), and is typically directed to low-cost and low-volume roads. Neither of these omissions in the title, however, detract from the book because most of the principles and techniques described can be applied elsewhere and in other situations.

Slope Engineering for Mountains Roads evolved from a document prepared for the UK Department for International Development by a team of consulting engineering geologists, geomorphologists, geotechnical engineers and hydrologists, employed or retained by URS Scott Wilson Ltd in the UK. It draws upon the extensive practical experience gained both by these individuals and by this firm while carrying out consulting, construction and maintenance projects in many developing countries. Therefore, the book tends to be a practical guide, not an academic textbook. And although presumably the projects were carried out over an extensive period of time, the book includes current investigation techniques such as LiDAR, current slope treatment techniques such as bioengineering, and current references. The many case histories included do not appear to be dated.

Dr Gareth Hearn, an engineering geomorphologist, is the editor and one of the prime authors. Tim Hunt, a geotechnical engineer, has contributed to many of the chapters. I get the impression that these two individuals have worked closely together as team members on many international projects and as a result, the geological and engineering topics in the book are integrated very well. The fact that Dr Hearn was both the editor and a prime author has resulted in a consistent writing style and consistent technical terminology throughout the book, which make for easy reading.

Slope Engineering for Mountains Roads is divided into four main parts: background information on mountain roads and landslides, including project planning, slope materials, hazard and risk, all in the context of the humid tropics and subtropics; description and review of site investigation techniques, from desk studies to field mapping, to ground investigations to monitoring; discussion on issues related to the design and construction of road alignments, rock and soil slope stabilization, retaining structures, drainage and erosion protection; and introduction to issues related to slope management, maintenance, inspection, risk management, work prioritization, and emergency management. Each of the four main parts, are further subdivided. In total there are 17 chapters, plus a glossary and a comprehensive index. I feel that the book contains most topics that I think it should, and in fact many of the topics in the fourth part (slope management) are not typically addressed in other textbooks on slope stability.

For those readers who only wish to focus on certain topics, four flow charts at the beginning of the book direct readers to specific sections related to the topics of: new roads and slope stability; design and construction of new slopes; maintenance of existing slopes; and slope or retaining wall failure during road construction.

The book is very well and clearly illustrated with a numerous useful and descriptive tables, maps, line drawings and photographs, many of which are in colour. All the maps and drawing were prepared by a single individual, and again the book benefits from consistency in format. A number of specific important and useful topics are highlighted by means of shaded "text boxes".

The contribution has a few minor shortcomings. For example, I would have liked the photo captions to identify the country and region of the photo (although that omission may have been on purpose), and Table A3.4 is missing a heading, "Avalanche". But these don't distract from the presentation. And until there is world-wide agreement on the classification and terminology associated with topics such as landslide classification, hazard and risk, and engineering soil and rock classification, readers will have to be flexible in their interpretation of some of the terms and terminology used.

Overall, I think most geologists and engineers who practice in the areas of landslides, not only landslides related to low-cost and low-volume mountain roads in humid tropical and subtropical regions, would benefit by reading or referring to Slope Engineering for Mountains Roads. As most books these days, this one is pricy, but I think it's worth it.

Unsaturated Soil Mechanics in Engineering Practice

Delwyn G. Fredlund, Harianto Rahardjo, Murray D. Fredlund
John Wiley & Sons, New York, 2012

Foreward

In 1993, Professors Fredlund and Rahardjo published the first textbook solely concerned with the behavior of unsaturated soils. It had the title "Soil Mechanics for Unsaturated Soils". That volume maintained the framework of classical soil mechanics, but extended it to incorporate soil suction phenomena as an independent variable that is amenable to measurement and calculation. It marked a major milestone in the evolution of Unsaturated Soil Mechanics.

Professors Fredlund and Rahardjo have now collaborated with Murray Fredlund to publish their successor volume, "Unsaturated Soil Mechanics in Engineering Practice".
Murray Fredlund adds computational skills to the team and, in the view of the authors, these are essential to meet their objectives of presenting a volume that not only covers our present knowledge of unsaturated soil behavior, but also provides guidance on the manner in which practical problems involving unsaturated soil behavior are formulated and solved. Many flux-related problems in unsaturated soil behavior require the solution of non-linear partial differential equations with associated boundary conditions and the volume adds guidance on these computational issues as applied to the formulation of water, air and heat flow through unsaturated soils. Separate chapters concentrate on the shear strength of unsaturated soils and its application to earth pressure, bearing capacity and stability problems, as well as the formulation of stress-deformation behavior and its application to heave and stiffness related problems.

A fundamental distinction between saturated and unsaturated soil behavior is the need to express the relationship in the latter between water content and soil suction, i.e., the soil-water characteristic curve. Since 1993, there has been an explosion of studies into the measurement of soil suction and the development of soil-water characteristic curves. A particular effort has been made here to synthesize these developments in a manner that facilitates applications.

While most readers will concentrate on the technical contents of this book, I urge students of the subject to also reflect on the contents of Chapter 1 related to the emergence of unsaturated soil mechanics in a coherent form and the assessment of challenges to its implementation. The guiding spirit of this welcome volume is to give the reader confidence that all of these challenges can be addressed in a consistent and rational manner.

Understandably, given current research efforts in the field of unsaturated soil mechanics, not all researchers and practitioners will accept the total contents of this book in an uncritical manner. Science is the search for truth, predominantly by hypothetico-deductive methods, which drive its progression. However, Engineering is the pursuit of functionality and it progresses by incremental improvements to enhance intended function. It is particularly in the latter context that the Authors have made an important contribution to Geotechnical Engineering. I expect that "*Unsaturated Soil Mechanics in Engineering Practice*" will remain an essential reference for educators, researchers and practitioners for a long time to come.

N.R. Morgenstern
University of Alberta
Distinguished University Professor (Emeritus) of Civil Engineering, and Past President, International Society of Soil Mechanics and Geotechnical Engineering, (1989-1994)
August, 2011

ASFE

A not-for-profit association established in 1969, ASFE's purpose is to help geoprofessionals maximize their importance and value to the marketplace, achieve business excellence, and manage risk. ASFE creates more awareness of geoprofessionals' value through outreach activities targeted to organizations of clients and those that influence them. It increases the supply of trusted geoprofessional advisors through high-impact programs, services, and materials it creates for the personnel of ASFE-Member Firms.

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ASFE President's 2011-12 Annual Report

What a year! Things have progressed so quickly, and as we approach the end of our fiscal year, it is great to see how far we've come. As a volunteer organization supported by a great staff, the accomplishments are amazing. Thank you for your dedication to ASFE.

Three years ago we embarked on an ambitious strategic plan. Among other things, it represented a major change to our former planning approach by focusing on three-year bites of the future as opposed to one year at a time. The 2009-2012 strategic plan was ambitious, to say the least, even including an overhaul of our committee structure. We got it all done (and I use "all" advisedly!).

One of the highlights of the plan was a new focus on external matters; an effort to achieve a long-held aspiration of just about all our members: Recognition of how much geoprofessionals contribute to project success when they are wisely selected, engaged, and deployed, as it's set forth in our value proposition. To make that happen over the long term, we realized we would need to grow and expand our influence. For that to happen, we'd need to do more to retain our existing members and attract new ones. Toward that end, we expanded our staff by bringing on board an individual to focus on membership retention and growth. Our new staff was also charged with outreach to allied organizations and organizations comprising clients and those who influence clients. Our external expansion was made possible principally by the generosity of those firms and individuals who joined our Fund for the Future program, agreeing to pay four years' worth of dues over a three-year period. This fund is priming the pump.

Our new Membership Director/Organizational Relations Director Colleen Knight has been on board close to one year. I am delighted to report that, by year's end, we will have added about 25 firms to our membership. That's almost a 10% increase. At the same time, our membership attrition has been the lowest in many years, despite the economy and despite mergers and acquisitions. We have many additional prospects for membership. As the economy improves, I expect even larger gains will occur.

Insofar as our external focus is concerned, we started by allowing more outside groups to enter our tent by expanding our membership categories to include geoprofessional contractors without a design capability, government employees, and students. And thanks to the efforts of our External Relations Committee, we have engaged and energized more than a dozen allied organizations and, together, we are launching The Geoprofessional Foundation, a multi-organization collaboration designed to spread the word about the importance and value of geoprofessionals. And not just the value of geoprofessionals in private practice, but also those in industry, in government, in education as both instructors and students, and in the world of construction. Our mantra? Save time, save money, and reduce risk by wisely selecting, engaging, and deploying geoprofessionals, a thought I recently heard expressed in the very apt expression, "Cheap geoprofessional services are expensive."

This year we completed our second strategic plan for the fiscal years 2012-13 through 2014-15. I commend the Board for its great work. The new plan clarifies ASFE's purpose by putting it all into one statement: "Help geoprofessionals maximize their importance and value to the marketplace, achieve business excellence, and manage risk." Our new plan has four strategic goals: (1) increase membership; (2) develop outreach to alliances, clients, and influencer groups; (3) achieve deeper and broader engagement of member firms; and (4) enhance educational resources. It's as ambitious as the first and I have every faith that, three years from now, our president will be saying, "We did it again."

All of the above are hardly the only jewels in this year's crown. Let me highlight a few more.

- We initiated a new class of New Leaders who bring as much enthusiasm and creativity to the task as the "old new leaders," many of whom are now fully integrated into ASFE as leaders of our organization.
- Through our Nondues Income Task Force, we expanded our meeting sponsorship efforts based on members' reports that they found the exhibits informative and helpful.
- We've acted on another Nondues Income Task Force recommendation and are planning to accept advertising in NewsLog and on our website, as most other groups do, to make members aware of what's available and also to help us generate additional funding sources.
- Through our Education Committee, we are initiating a video-education effort at our Annual Meeting in Orlando. We'll make videos of key presentations available to all members.
- The Education Committee and Membership Committee combined to establish a new series of ASFE webinars that have proven to be extraordinarily popular. We plan to do 18 of these in the coming year.
- The Education Committee also published our outstanding new *ASFE Resource Catalog*. Not only is it easy to use, its table of contents alone explains why ASFE is such an amazing business-focused organization. There's no other organization out there that even comes close to doing what ASFE has done and continues to do.
- The Construction Materials Engineering and Testing Committee once again performed yeoman service. It developed *Important Information about Quality Assurance* for insertion into ASFE-Member Firms' CoMET reports and other quality-assurance deliverables. It prepared *Project Quality Assurance: A Message to Owners* and *Project Quality Assurance: A Message to Architects, Civil Engineers, and Structural Engineers*, in the process creating a whole new approach to preparing our message flyers; an approach we'll use this coming year to update them all. The Committee also prepared *ASFE Practice Alert 52: Initial Curing of Concrete Test Specimens in the Field: Who Is Responsible for What?* and recently published the newest version of its model agreement.
- The CoMET Committee also developed a PowerPoint presentation template Member Firms can customize to tell clients, those who influence clients, and colleagues about the value to be derived from CoMET consultants when they are wisely selected, engaged, and deployed. The Geotechnical Committee and Environmental Committee have done likewise. We'll unveil the three presentations at our Annual Meeting in Orlando.
- The Emerging Issues and Trends Committee held its Crystal Ball Workshop last summer and has now published *Practice Alert 53: The Crystal Ball Workshop: Ten Certain Trends To Consider Now*. The Committee is working on its next Practice Alert, focusing on trends that are less than certain.
- The Business Practices Committee was hard at work, too, developing meeting programs, conducting the

annual *Financial Performance Survey* as well as our premeeting business snapshot surveys, and publishing *Practice Alert 51: Safety and Your Geoprofessional Practice*.

- In keeping with our efforts to promote sustainability, we have dispensed with almost all the paper associated with ASFE meetings. Earlier in the year we came out with the new ASFE meeting app. It was such an immediate hit that we have now come out with the ASFE app. If you haven't seen it, you need to. It works on iPhones and iPads, Droids, Blackberries, and Microsoft smart phones and tablets. Also for sustainability purposes, we have made *NewsLog* available electronically only, and to boost traffic to our website, we have made it available free of charge to one and all. We have also become a charter member of the Institute for Sustainable Infrastructure and adapted our own statement on sustainability.
- We created a Peer Review Task Force to identify what we needed to do to keep Peer Review in tune with the times. And now we have a new Peer Review Committee that will implement the vision of the Task Force.
- We have created a new Social Media Task Force to help us all get more in tune with the newest methods of communication, and have also established an International Engagement Task Force to explore expanding our outreach to geoprofessionals beyond those in North America. New communications techniques will be helpful in that endeavor, but it was old-fashioned techniques that helped our Member Firms in Pennsylvania achieve a huge victory, when the state reversed a prior ruling and said that, in fact, CoMET personnel are not subject to the commonwealth's prevailing wage regulations.

In undertaking so many of these endeavors, we have reached out to you to provide input; to harvest your ideas and opinions about what you want and need; about the direction in which we are headed. That's exactly as it should be, of course, because ASFE was created to do for all that which all want and need, but are unable to do on their own. We believe we are getting it done.

To say that I have been blessed this year by the willingness of so many others to share their experience, their ideas, and their energy really misses the point. We all have been blessed, for they have made and continue to make the world of private practice a better place to be. To my fellow members of the Board of Directors; to the committee chairs and vice chairs; to the committee members and staff, on my own behalf, and on the behalves of all our members, now and to come, thank you. Together, you have changed this organization in so many ways, and yet – in its soul – it retains the fundamental uniqueness that is ASFE. So while it may no longer be our founding fathers' ASFE, I cannot help but believe that our founders would quickly recognize what they saw, and be tremendously proud of what they put into motion.

Thank you for this extraordinary opportunity.

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

ASFE elects David Schoenwolf President

David A. "Dave" Schoenwolf, P.E. was installed as the new president of ASFE/The Geoprofessional Business Association at ceremonies conducted at ASFE's annual meeting in Orlando, Florida. Mr. Schoenwolf is the 42nd individual to serve as ASFE's president and chair the group's Board of Directors. Other officers and directors-at-large who will serve during ASFE's 2012-13 fiscal year are:

- President-Elect Kurt R. Fraese, L.G. (*GeoEngineers, Inc., Seattle, WA*);
- Secretary/Treasurer Steven D. Thorne, P.E., D.GE (*GEI Consultants, Inc., Montclair, NJ*);
- Joel G. Carson (*Kleinfelder Group, Omaha, NE*);
- Mark K. Kramer, P.E. (*Soil and Materials Engineers, Inc., Plymouth, MI*);
- Gordon M. Matheson, Ph.D., P.E., P.G. (*Schnabel Engineering, Glen Allen, VA*);
- Laura R. Reinbold, P.E. (*TTL, Inc., Nashville, TN*), and
- Woodward L. Vogt, P.E. (*Paradigm Consultants, Inc., Houston, TX*).

Mr. Schoenwolf is a senior vice president/principal consultant of Haley & Aldrich, Inc., one of the ten firms that founded ASFE in 1969. Located at the firm's McLean, Virginia office, Mr. Schoenwolf has been with Haley & Aldrich, Inc. for more than 34 years. He serves as the firm's water/wastewater market-segment leader and is also the client leader for several major national infrastructure clients as well as the officer-in-charge forgeotechnical engineering and environmental evaluations for a broad range of projects. Mr. Schoenwolf has been the designer of record for the geotechnical-engineering aspects of numerous Mid-Atlantic and East-Coast projects, including several of the firm's largest Washington, DC-area infrastructure projects. Licensed in a dozen jurisdictions, Mr. Schoenwolf earned both his Bachelor of Science degree (in civil engineering) and Master of Science degree (in geotechnical engineering) from the University of Illinois. He is active in several professional societies, is a frequent speaker and lecturer, and has been published extensively over his career.

FOPP 21 survey results

Fundamentals of Professional Practice (FOPP) offers a unique learning experience for geoprofessional firms' rising stars. Offered just once a year, the upcoming FOPP – FOPP 22 – is now forming. (Enrollment is strictly limited. Reserve space now without obligation or having to pay a deposit. Call 301/565-2733 or e-mail sara@asfe.org.) Before deciding on whether or not to take advantage of FOPP, consider what some of the FOPP 21 participants had to say. For example, when asked, "Based on your experience, would you recommend FOPP to someone else in your position?" 68 of 68 respondents said, "Yes." Respondents were also asked to identify some of the benefits the course provided. Typical comments were:

- Writing skills, professional role/understanding of profession(s), communication implications and consequences, and business skills.
- Improved communication. Project liability awareness. Met with great geoprofessionals. Dispute resolution.
- Pride in my profession. Improved my writing skills. Good opportunity for social networking in the profession.
- Reinforcement of business risks knowledge. Awareness of possibilities for outreach. Interaction with other professionals. Re-affirmation of how much I, we, am/are worth.
- Expand the goal of my career beyond producing billable hours. Active listening introduction was extremely helpful to me.
- Community is the key. Get involved in your organization. Be professional and be proud. Be a change in the world.
- Active listening and solutions based approach. Awareness about improvement in writing skills for professional communication. Risks that professionals face in routine work.
- The critical importance of communication (as a shy person this has been a big hurdle). The power of professionalism. Renewed inspiration to be proactive and structured about making changes I'd like to see in my world.
- Professional liability insurance (my research assignment). The importance of professional writing. The need to promote our profession through community involvement.
- Seminar group activities. Seminar presentations. Research project. Practice Management… book.
- It has been a great exercise in teaching me professionalism and aspects of conducting business in different situations. I have been able to learn valuable lessons without having to make the mistakes myself, but learning case histories. Expanded my professional network.

Another important question: "Has participation in the program changed your attitudes in any way?" For the 62 who said "Yes," these comments are typical:

- I have changed my attitude about the content of my writing and the implications of my writing. I have become more critical of all aspects of professional life and understand the importance of community involvement.
- Attitude toward professional liability. Communication. Importance of community involvement.
- My attitude on continuing education has drastically changed for the better. Before/during this course, my attitude was, "I didn't want to do continuing education because it was too difficult/time consuming. Now I have the motivation to actively engage in continuing my education.
- Pride in what I do. (I had but it's been quite a boost.) Awareness of our possibilities.
- Being aware of how and what I write. Need to be involved in community to better the future of geoprofessional practice.
- The critical importance of communication. Also, I had no real sense of professionalism before this course. I have not only a firm concept of it, but also a sense of community and pride in my fellow engineers and geoscientists.
- The importance of professionalism. By reading about it, I began to think about it. By thinking about it, I began acting more professional. By acting more professional, I will become more professional.

Read the complete survey report and get more details about FOPP at http://www.asfe.org/index.cfm?pid=10284

New app puts ASFE in the palm of your hand

Keep up to date with ASFE/The Geoprofessional Business Association by downloading the new *ASFE-TGBA* app. See news, descriptions of coming events, a list of members, the ***ASFE NewsLog*** newsletter (40 years' worth!), and much, much more!

Continuing ASFE's commitment to sustainability, the new *ASFE-TGBA* app is the only complete source of information and materials for ASFE meetings. The app provides the latest information about schedules, activities and their locations, attendees, topics, and speakers. It also provides links to speaker presentations and hand-outs. The app will be updated as changes are received; a benefit paper materials cannot provide.

According to ASFE Executive Vice President John P. Bachner, "The new app builds on the tremendous success of our previous *ASFEFall11* meeting app, by broadening content to include information relevant to ASFE as a whole. Members will find it a useful guide to resources available to them, and nonmembers can see all that ASFE has to offer."

ASFE-TGBA is available free for Android, Blackberry, iOS (iPhone and iPad), and Windows Mobile devices at http://www.asfe.org/index.cfm?pid=12855 (for Androids, in the Google Play store as well). Download it. Use it. Then let us know what you think…and what you think can be improved. ASFE is on the move when you are!