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GEOTECHNICAL news

• **Jet Grouting:**
Tunnel excavation in Stans, Austria, beneath the high speed railway line

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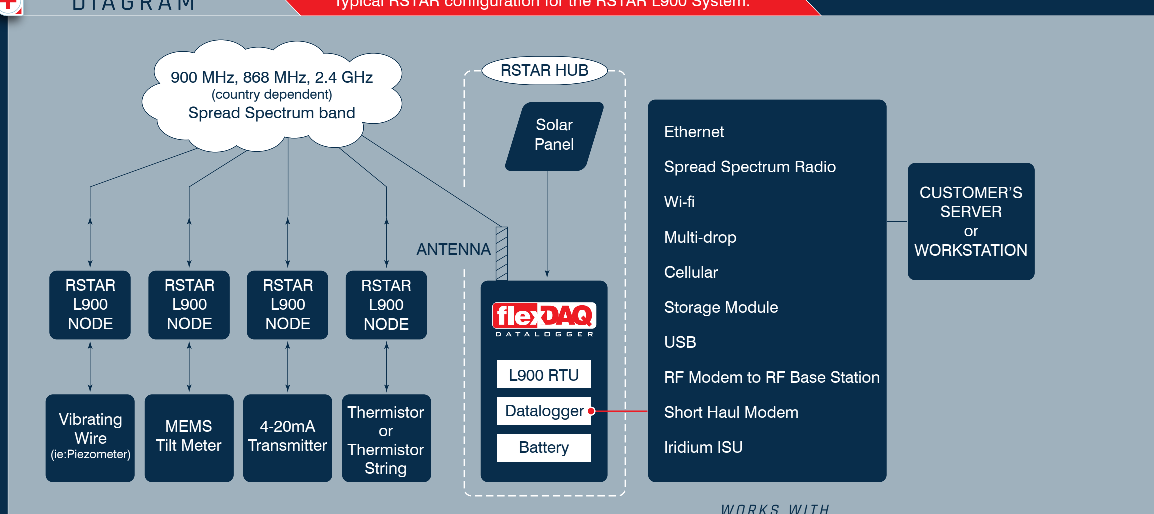
DIAGRAM

Typical RSTAR configuration for the RSTAR L900 System.



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FEATURES

- Excellent Hub-Node range - up to 14 km in open country.
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- Simple star routing - no mesh overhead.
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PUBLISHER John W. Gadsby

MANAGING EDITOR Lynn Pugh

Editors

Robert Chapuis
John Dunnicliff
Jonathan Fannin
Paolo Gazzarrini
Don Lewycky
Ward Wilson

Managing Editors and Advertising

BiTech Publishers Ltd.
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Canadian Editorial Office

Canadian Geotechnical Society

Don Lewycky, Editor, CGS News • email: *don.lewycky@edmonton.ca*

Membership Information : Canadian Geotechnical Society

Gibson Group Association Management

Wayne Gibson, 8828 Pigott Road • Richmond, BC V7A 2C4 • tel: 604-277-7527 • email: *cgs@cgs.ca*

United States Editorial Office

Geo-Institute of the American Society of Civil Engineers

Linda R. Bayer, 1801 Alexander Bell Drive, • Reston, VA 20191-4400 • tel: 703-295-6352
fax: 703-295-6351 • email: *lbayer@asce.org*

Editors

Groundwater

Robert P. Chapuis, Dept. CGM, Ecole Polytechnique, PO Box 6079, Sta. CV Montréal, QC, H3T 1J4
tel: 514-340-4711 • fax: 514-340-4477, • email : *robert.chapuis@polymtl.ca*

Instrumentation

John Dunnicliff, Little Leat, Whisselwell, Bovey Tracey, Devon TQ13 9LA, England
tel: +44 1626-832919 • email: *john@dunnicliff.eclipse.co.uk*

Geosynthetics

Jonathan Fannin, Professor of Civil Engineering, University of British Columbia, 6250 Applied Science Lane, Vancouver, BC, V6T 1Z4 • tel: 604-822-3557 • email: jonathan.fannin@ubc.ca

The Grout Line

Paolo Gazzarrini, 11-2246 Folkestone Way, West Vancouver, BC, V7S 2X7 • tel: 604-913-1022
fax: 604-913-0106 • email: *paolo@paologaz.com*

Waste Geotechnics

G. Ward Wilson, Professor, Geotechnical and Geoenvironmental • University of Alberta, Dept. of Civil & Environmental Engineering, 3-069 NREF, Edmonton, AB T6G 2W2 • tel: 780-492-2534
fax: 780-492-8198 • email: *wwilson2@ualberta.ca*

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CONTENTS

Cover *Rigs working on the two sides of the existing railway line in Stans (Austria). (For article, see page 28).*

Message from the President

Richard J. Bathurst, President of Canadian Geotechnical Society

This will be my last message to you as your president since my two-year term will finish the end of the year. Your Executive Committee, Board of Directors, Secretary General and CGS Administrator have accomplished much and I would like to take this opportunity to summarize our accomplishments over the past two years.

- The French version of the **4th Canadian Foundation Engineering Manual** was finalized, printed and distributed.
- The plan for the **5th Canadian Foundation Engineering Manual** was formulated. Future versions will be in e-book format and will be updated chapter by chapter to ensure that the content reflects current practice in Canada and that revised chapters are made available to our members in a timely manner.
- The name of the CGS **Hydrogeology Division** was changed to the CGS **Groundwater Division** to better reflect its scope. The CGS Computing Committee was retired and its mandate collapsed into that of the other Committees and Divisions. The CGS **Sustainability Committee** was formed with **Dr. Dipanjan Basu** as chair.
- The Award Rules for the joint **Schuster Medal** of the CGS and the Association of Engineering and Engineering Geologists (AEG) were finalized. This award recognizes in alternate years, the

accomplishments of a CGS member and AEG member in the area of geohazards.

- In partnership with the Canadian Foundation for Geotechnique, **Dr. Dennis Becker** (Chair), announced the renaming of the national graduate scholarship to the **Canadian Foundation for Geotechnique Michael Bozozuk National Graduate Scholarship.** The renaming was in honour of **Dr. Michael Bozozuk** for his lifetime support of the younger members of our Society.
- A succession plan for our retiring Secretary General, **Dr. Victor Sowa**, was successfully executed. Our new Executive Director starting in 2015 will be former CGS President, **Michel Aubertin**. Note that the title of Secretary General has been changed to Executive Director. In concert with this transition, there is a plan to move all CGS documents into the "cloud" to facilitate access by Executive Committee members and for archival purposes.
- Memorandums of Understanding (MOU's) between CGS local sections and CGS headquarters for the **GeoQuebec2015** (Quebec City) and **GeoVancouver2016** conferences were finalized and the Ottawa Geotechnical Group was invited to prepare a final proposal for **GeoOttawa** to be held in 2017. Our Secretary General has worked tirelessly to develop a set of MOU templates to facilitate the timely drafting of future MOU's with local sections and partner societies.
- Two very successful annual CGS conferences (**GeoMontreal2013** and **GeoRegina2014**) were held during the time of this administration. These successes were in large part due to the local sections involved and also the excellent support by our Administrator (Gibson Group) in the person of **Wayne Gibson, Lisa McJunkin** and **Brendan Crosby**.
- Student attendees at GeoMontreal and GeoRegina conferences were given free CGS student membership for the following calendar year. This resulted in a marked increase in student members from 94 to 259 over the last two years. Excluding student members our total CGS membership has remained constant at about 1220. Membership fees have remained constant for all membership categories over the last two years.
- The CGS negotiated a 20% discount for its members on selected publications by Balkema.
- Blue, Bronze, Silver and Gold CGS Service pins were given to CGS members recognizing continuous membership in our Society for less than 10, 10-24, 25-49 and more

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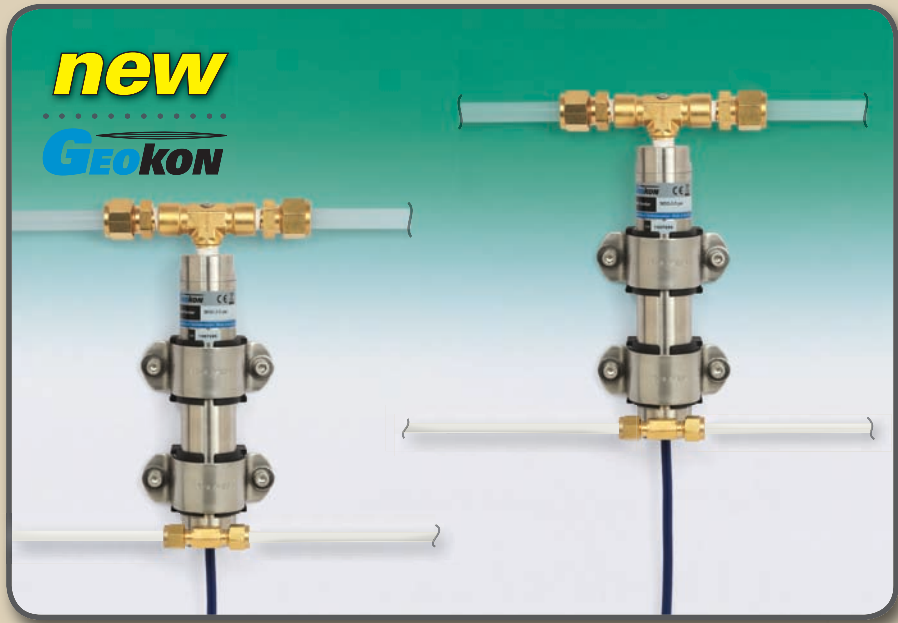

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than 50 years, respectively. This program was smoothly executed by **Paul Dittrich**.

In other news, the annual CGS Board of Directors meeting was held in Regina on September 28, immediately before the **67th Annual CGS Conference** (GeoRegina2014). Some of the highlights of this meeting appear as bullet items above, but the full **2014 CGS Annual Report** will be available on the CGS website, *www.cgs.ca* by the end of the calendar year.

GeoRegina was held from September 28 to October 1, with the theme *Engineering for the Extremes*. The conference featured over 185 papers and presentations from authors from across Canada and around the world. Over 450 delegates attended the conference and **Dr. Wayne Clifton** (Conference Chair) and his organizing committee did an outstanding job. Their efforts were recognized during the conference closing ceremony with certificates of appreciation from the CGS.

The first plenary session of the conference was the CGS Hardy Address by **Dr. Lee Barbour** of the University of Saskatoon on the topic of *Tracking Water Movement in Oil Sand Mine Closure Landforms – Extending the Temporal and Spatial Monitoring Scales*. The 2014 CGS Colloquium was given by **Dr. Scott McDougall** of BGC Engineering on the topic of *Landslide Runout Analysis – Current Practice and Challenges*. The CGS members are reminded that the 2015 Colloquium Speaker is **Dr. Greg Siemens** from the Royal Military College of Canada, who will give his talk at GeoQuebec2015 in Quebec City next fall.

CGS awards were given to some of our outstanding members at the conference Awards Banquet. The most senior award of the CGS is the R.F. Legget Medal. The 2014 Legget Medal was given to Dr. Peter Byrne, Emeritus Professor at the University of British Columbia. His former PhD student Dr. Ernest Naesgaard introduced the Leggettee to the CGS membership and gave the following quote "One of Dr. Byrne's great strengths is his ability to identify the key aspects of a problem, and develop engineering solutions that are practical and effective because they efficiently focus on the critical mechanisms. He has impressed many with this singular skill." The complete Legget Medal Award introduction and response follows later in this issue.

The winners of the **2013 R.M. Quigley Award** for the best paper published in the Canadian Geotechnical Journal in 2013 were **Z.J. Westgate, D.J. White** and **M.F. Randolph** for their paper titled "*Modelling the embedment process during offshore pipe-laying on fine-grained soil*". The **Robert N. Farvolden Award**, which is a joint award of the (IAH-CNC) and the CGS, was won by **James F. Barker.** Other important awards given out were the **Thomas Roy Award** to **Franklin D. Patton**, the **G. Geoffrey Meyerhof Award** given to **Alan Macnab**, and the **Roger J. E. Brown Award** to **Isabelle de Grandpré**, **Daniel Fortier** and **Eva Stephani**. The **Geoenvironmental Award** was given to **Michel Aubertin**.

A.G. Stermac Awards, which recognize special service to the CGS, were presented at the CGS Awards banquet to **Mario Ruel**, **Sylvain Roy**, **Ariane Locat**, **Matthew A. Perras** and **Victor A. Sowa**. A special tribute was paid to our outgoing Secretary General at this banquet, Dr. Victor Sowa, in recognition of his dedicated service to our Society (see the full tribute to Victor elsewhere in this issue of Geotechnical News).

Younger members of our geotechnical fraternity were also recognized. The

Best Graduate Student Paper Presentation was given by **Osama Salem Abuhajar** from Western University on "*Static and Seismic Soil Culvert Interaction*". The **Best Undergraduate Student Report** winner was **Matthew Dugie** from the Civil and Resource Engineering Department, Dalhousie University for "*A Practical Review of Empirical Methods for Estimating Rockfill Shear Strength*" and **Matthew Gray, Carlin Horkoff**, **Robert Kaplen**, **Jamie Loughlin** "*Unobtainium and eludium mining limited, prefeasibility level slope design*" from the Geological Engineering Department at the University of British Columbia (Vancouver) in the group submission category. Finally, **Kristen Tappenden** at the University of Alberta was the inaugural recipient of the **Canadian Foundation for Geotechnique Michael Bozozuk National Graduate Scholarship.** I am delighted that **Dr. Bozozuk** was able to make the scholarship presentation to Kristen in person. Congratulations to all the winners identified above.

A summary of all Award winners and recognitions that were made during the CGS events at GeoRegina can be found later in this section of the Canadian Geotechnical Society News.

The Wednesday luncheon on the last day of the conference featured the **Saskatchewan Geotechnical Pioneers Program** which recognized geotechnical engineers who have made important contributions to geotechnique in the province of Saskatchewan, Canada and internationally.

In closing, I wish to thank my Executive Committee (VP Technical – **Angela Küpper,** VP Finance - **Dharma Wijewickreme** and VP Communications – **Catherine Mulligan**) for their dedication and teamwork over the last two years and the support of the CGS Board of Directors. The logistical support of **Wayne Gibson** (CGS Administrator) and his able assistant **Lisa McJunkin**, has made the last two years an enjoyable experience. Finally, special thanks to **Victor Sowa**, our outgoing Secretary General, for his wise counsel, tireless dedication to our society and his friendship.

I wish all our members the very best for 2015.

Provided by Richard Bathurst
President

Message du président

Comme mon mandat de deux ans prendra fin à la fin de l'année, ce message sera mon dernier à titre de votre président. Votre comité exécutif, votre conseil d'administration, votre secrétaire général et votre administrateur de la SCG ont accompli beaucoup de choses, et j'aimerais profiter de cette occasion pour résumer nos réalisations des deux dernières années.

- La version française du **4e Manuel canadien d'ingénierie des fondations** a été finalisée, imprimée et distribuée.
- Le plan pour le **5e Manuel canadien d'ingénierie des fondations** a été élaboré. Les versions ultérieures seront en format de livre électronique et seront actualisées un chapitre à la fois pour garantir que le contenu correspond à la pratique actuelle au Canada et que les chapitres révisés sont rapidement offerts à nos membres.
- La **Division de l'hydrogéologie** de la SCG a été renommée la **Division des eaux souterraines** afin de mieux refléter sa portée. Le **Comité de l'informatique** de la SCG a été dissout, et son mandat a été intégré à celui d'autres comités et divisions. Le **Comité de la durabilité** de la SCG a été créé, et le **Dr Dipanjan Basu** en est le président.
- Les règles d'attribution de la **Médaille Schuster**, prix commun de la SCG et de l'Association of Engineering and Engineering Geologists (AEG), ont été finalisées. Ce prix souligne chaque année, en alternance, les réalisations d'un membre de la SCG et d'un membre de l'AEG dans le domaine des géorisques.

- En partenariat avec la Fondation canadienne de géotechnique, le **Dr Dennis Becker** – président, a annoncé que la bourse nationale pour études supérieures a été renommée la **Bourse nationale pour études supérieures Michael Bozozuk de la Fondation canadienne de géotechnique**. Ce nouveau nom est en l'honneur du **Dr Michael Bozozuk** pour le soutien qu'il a offert aux jeunes membres de notre Société tout au long de sa vie.
- Un plan de relève pour notre secrétaire général, le **Dr Victor Sowa**, qui prend sa retraite, a été exécuté avec succès. Notre nouveau directeur général à compter de 2015 sera l'ancien président de la SCG, **Michel Aubertin**. Veuillez noter que le titre de secrétaire général a été changé pour celui de directeur général. De concert avec cette transition, il est prévu de transférer tous les documents de la SCG dans le « nuage » pour en faciliter l'accès par les membres du Comité exécutif et à des fins d'archivage.
- Les protocoles d'entente (PE) entre les sections locales et le siège social de la SCG pour les conférences **GéoQuébec 2015** (ville de Québec) et **GéoVancouver 2016** ont été finalisés, et le Groupe géotechnique d'Ottawa a été invité à préparer une proposition finale pour **GéoOttawa** qui se tiendra en 2017. Notre secrétaire général a travaillé inlassablement pour créer un ensemble de modèles de PE afin de permettre d'ébaucher rapidement les prochains PE avec des sections locales et des sociétés partenaires.
- Deux conférences annuelles de la SCG qui ont connu un très grand succès (**GéoMontréal 2013** et **GéoRegina 2014**) ont eu lieu pendant le terme de cette administration. Ces succès sont en grande partie dus aux sections locales participantes et à l'excellent soutien de notre administrateur (Gibson Group), en la personne de **Wayne Gibson**, **Lisa McJunkin** et **Brendan Crosby**.
- Les étudiants qui ont participé aux conférences GéoMontréal et GéoRegina ont reçu une adhésion gratuite à la SCG pour l'année civile suivante. Cette initiative a entraîné une augmentation notable des membres étudiants, passant de 94 à 259, au cours des deux dernières années. Excluant les membres étudiants, le nombre total de membres de la SCG est resté constant, à environ 1 220. Les frais d'adhésion sont restés inchangés pour toutes les catégories de membres au cours des deux dernières années.
- La SCG a négocié un rabais de 20 % pour ses membres sur certaines publications de Balkema.
- Des épinglettes de service bleues, bronze, argent et or de la SCG ont été remises à des membres de la SCG, reconnaissant leur adhésion continue à notre Société depuis moins de dix ans, de 10 à 24 ans, de 25 à 49 ans et de 50 ans et plus, respectivement. Ce programme a été exécuté sans problème par **Paul Dittrich.**

Par ailleurs, la réunion annuelle du conseil d'administration de la SCG a eu lieu le 28 septembre à Regina, immédiatement avant la **67e conférence annuelle de la SCG** (GéoRegina 2014). Certains des faits saillants de cette réunion apparaissent sous forme de puces ci-dessus, mais le **rapport annuel 2014 de la SCG** sera affiché au complet sur le site Web de la SCG, *www.cgs.ca*, d'ici la fin de l'année civile.

GéoRegina, dont le thème était l'*ingénierie des conditions extrêmes*, a eu lieu du 28 septembre au 1er octobre. La conférence comportait plus de 185 articles et présentations d'auteurs de partout au Canada et dans le monde. Plus de 450 délégués ont participé à cette conférence, et le **Dr Wayne Clifton** (président de la conférence) et son comité organisateur ont fait un travail exceptionnel. Leurs efforts ont été reconnus pendant la cérémonie de clôture de la conférence, avec des certifications d'appréciation de la SCG.

La première séance plénière a commencé par la Conférence d'honneur R.M. Hardy, donnée par le **Dr Lee Barbour**, de l'Université de Saskatoon, et intitulée Tracking Water Movement in Oil Sand Mine Closure Landforms – Extending the Temporal and Spatial Monitoring Scales. Le Colloquium canadien de géotechnique été donné par le **Dr Scott McDougall**, de BGC Engineering, et était titré *Landslide Runout Analysis – Current Practice and Challenges*. Je rappelle aux membres de la SCG que le conférencier du Colloquium 2015 est le **Dr Greg Siemens**, du Collège militaire royal du Canada, qui donnera sa conférence dans le cadre de GéoQuébec 2015, dans la ville de Québec, l'automne prochain.

Lors du banquet de remise des prix, les prix de la SCG ont été décernés à certains membres exceptionnels. Le prix le plus prestigieux de la SCG est la **Médaille R.F. Legget**. La médaille Legget a été remise au **Dr Peter Byrne**, professeur émérite de l'Université de la Colombie-Britannique. Un des anciens étudiants au doctorat du récipiendaire, le **Dr Ernest Naesgaard**, l'a présenté aux membres de la SCG en faisant la citation suivante : « *Une des grandes forces du Dr Byrne est sa capacité de déterminer les principaux éléments d'un problème et d'élaborer des solutions d'ingénierie qui sont pratiques, car elles sont axées de manière efficace sur les mécanismes cruciaux. Il a impressionné de nombreuses personnes avec cette aptitude unique.* » La présentation complète de la médaille Legget et le discours de remerciement de son gagnant suivent plus loin dans ce numéro.

Les gagnants du **Prix R.M. Quigley**, qui souligne le meilleur article publié dans la *Revue canadienne de géotechnique* durant l'année 2013 étaient **Z.J. Westgate**, **D.J. White** et **M.F. Randolph** pour leur article intitulé *Modelling the embedment process during offshore pipe-laying on fine-grained soil*. Le **Prix Robert N. Farvolden**, un prix commun de l'Association internationale des hydrogéologues (AIH-SNC) et de la SCG, a été remporté par **James F. Barker**. Parmi les autres prix importants remis, citons le **Prix Thomas Roy** à **Franklin D. Patton**, le **Prix G. Geoffrey Meyerhof** qui a été attribué à **Alan Macnab** et le **Prix Roger J. E. Brown** à **Isabelle de Grandpré** à **Daniel Fortier** et à **Eva Stephani**. Le **Prix du géoenvironnement** a été décerné à **Michel Aubertin**.

Les **Prix A.G. Stermac**, reconnaissant un service particulier rendu à la SCG, ont été présentés lors du banquet de remise de prix de la SCG à **Mario Ruel**, à **Sylvain Roy**, à **Ariane Locat**, à **Matthew A. Perras** et à **Victor A. Sowa**. Un hommage spécial a été rendu à notre secrétaire général sortant, le **Dr Victor Sowa**, pendant ce banquet, en reconnaissance de son service dévoué à notre Société (voir l'hommage complet à M. Sowa plus loin dans ce numéro de *Geotechnical News*).

Les jeunes membres de notre fraternité géotechnique ont également été honorés. **Le Prix de l'étudiant diplômé** a été décerné à **Osama Salem Abuhajar** de l'Université Western pour l'article *Static and Seismic Soil Culvert Interaction*. Le gagnant du **Prix de l'étudiant non diplômé** a été **Matthew Dugie**, du Département du génie civil et des ressources de l'Université Dalhousie, pour *A Practical Review of Empirical Methods for Estimating Rockfill Shear Strength*, et le prix collectif a été présenté à **Matthew Gray**, à **Carlin Horkoff**, à **Robert Kaplen** et à **Jamie Loughlin**, du Département du génie géologique de l'Université de la Colombie-Britannique (Vancouver), pour *Unobtainium and eludium mining limited, pre-feasibility level slope design*. Finalement, **Kristen Tappenden** de l'Université de l'Alberta a été la première lauréate de la **Bourse nationale pour études supérieures Michael Bozozuk de la Fondation canadienne de géotechnique**. Je suis heureux que le **Dr Bozozuk** ait pu présenter en personne la bourse à Mme Tappenden. Je félicite tous les gagnants.

La liste des gagnants de tous les prix et distinctions qui ont été décernés durant les événements de la SCG pendant la conférence GéoRegina se trouve plus loin dans cette section des actualités de la Société canadienne de géotechnique.

Le dîner du mercredi, la dernière journée de la conférence, présentait le Programme des pionniers de la géotechnique en Saskatchewan qui reconnaissait les géotechniciens qui ont contribué grandement à la géotechnique dans la province de la Saskatchewan, au Canada et dans le monde entier.

Pour terminer, je désire remercier les membres de mon Comité exécutif (la vice-présidente technique – **Angela Küpper**, le vice-président des finances – **Dharma Wijewickreme** et la vice-présidente aux communications – **Catherine Mulligan**) pour leur dévouement et leur esprit d'équipe au cours des deux dernières années, et le conseil d'administration, pour son soutien. Le soutien logistique de **Wayne Gibson** (administrateur de la SCG) et de son assistante chevronnée, **Lisa McJunkin**, a fait des deux dernières années une expérience agréable. En conclusion, j'aimerais remercier tout spécialement **Victor Sowa**, notre secrétaire général sortant, pour ses conseils avisés, son inlassable dévouement envers la Société et son amitié.

Meilleurs vœux à tous nos membres pour l'année 2015.

Del la part de Richard Bathurst - président

From the Society

Canadian Geotechnical Society Awards and Honours for 2014

R.F. Legget Award
Peter Byrne – Professor Emeritus, University of British Columbia.

R.M. Quigley Award
Z.J. Westgate, D.J. White and M.F. Randolph *"Modelling the Embedment Process During Offshore Pipe-laying on Fine-grained Soils"*.

Honourable Mentions
Liang Cheng, Ralf Cord-Ruwisch and Mohamed A. Shahin. *"Cementation of Sand Soil by Microbially Induced Calcite Precipitation at Various Degrees of Saturation"*.

Divya S.K. Mana, Susan Gourvenec and Mark F. Randolph *"Experimental Investigation of Reverse End Bearing of Offshore Shallow Foundations"*.

M.S. Hosney and R. Kerry Rowe, *"Changes in Geosynthetic Clay Liner (GCL) Properties After Two Years in a Cover Over Arsenic-rich Tailings"*.

G. Geoffrey Meyerhof Award
Alan Macnab, Macnab Consultants.

Thomas Roy Award
Franklin D. Patton, retired.

Roger J. E. Brown Award
Isabelle de Grandpré, Université de Montréal, Daniel Fortier, Associate Professor, Université de Montréal and Eva Stephani, University of Alaska.

John A. Franklin Award
Not scheduled for 2014.

Geoenvironmental Award
Michel Aubertin, Professor, Department of Civil, Geological and Mining Engineering, École Polytechnique de Montréal.

Geosynthetics Award
No award issued in 2014.

Robert N. Farvolden Award
James F. Barker, Professor Emeritus, University of Waterloo.

Graduate Student Paper Award

1st Prize:
Osama Salem Abuhajar. *"Static and Seismic Soil Culvert Interaction"*. Department of Civil and Environmental Engineering, Western University; Advisor, Dr. Hesham El Naggar.

2nd Prize:
Daniel Jones. *"Evaluation of Geosynthetics for Hydrocarbon Containment in Antarctica"*; Civil Engineering, Queen's University; Advisor, Dr. Kerry Rowe.

Undergraduate Student Report (Individual)

1st Prize:
Matthew Dugie. *"A Practical Review of Empirical Methods for Estimating Rockfill Shear Strength"*; Civil and Resource Engineering, Dalhousie University; Advisor, Dr. Craig Lake.

2nd Prize:
Ryan Lavich. *"Evaluating the Performance of Thermosyphons Along a Railway Line in Permafrost Regions of Northern Manitoba"*; Civil Engineering, University of Manitoba; Advisor, Dr. Marolo Alfaro.

Undergraduate Student Report (Group)

1st Prize:
Matthew Gray, Carlin Horkoff, Robert Kaplen and Jamie Loughlin. *"Unobtainium and Eludium Mining Limited, Pre-feasibility Level Slope Design"*; Geological Engineering, University of British Columbia; Advisor, Susan W. Hollingshead.

2nd Prize:
Kevin Azocar, Derek Ernst, Hugh Gillen and Tim Packulak. *"Design of an Underground Light Rail Transit Station and Tunnel Network in Ottawa, Ontario, Canada: A Detailed Design of Rideau Station Segment of the Confederation Line"*; Geological Sciences and Geological Engineering, Queen's University; Advisor, Dr. Mark Diederichs.

Canadian Foundation for Geotechnique Michael Bozozuk National Graduate Scholarship – Kristen Tappenden, University of Alberta.

A.G. Stermac Awards

Mario Ruel, System Senior Manager, CN Rail.

Sylvain Roy, Vice-président expertise géotechnique chez, LVM.

Adrian Locat, Professeure adjointe, Université Laval.

Matthew A. Perras, Graduate Ph.D. Student, Queen's University.

Victor A. Sowa, Secretary General, Canadian Geotechnical Society

CGS R.M. Hardy Keynote Address
Lee Barbour, Professor, University of Saskatchewan.

Canadian Geotechnical Colloquium
Scott McDougall, Geotechnical Engineer, BGC Engineering Inc..

Cross Canada Lecture Tours – Jim Graham (Spring 2014), Ryan Phillips (Fall 2014).

CGS Certificates of Appreciation

The following individuals were awarded Certificates of Appreciation for their valued contributions to the CGS.

2014 Retiring Canadian Geotechnical Society Directors and Chairs

Richard J. Bathurst - President

Angela Küpper, - Vice-President Technical

Dharma Wijewickreme - Vice-President Financial

Catherine N. Mulligan - Vice-President Communications

Myint Win Bo - Chair, Geoenvironmental Division

Jim Hazzard - Chair, Rock Mechanics Division

Eric Mohlmann - Chair, Prince George

Frank Magdich - Chair, Southern Alberta

Eltayeb Mohamedelhassan - Chair, Thunder Bay

Paul Dittrich - Chair, Toronto Group

Annick Bigras - Chair, Montreal

Janet Williams - Chair, Newfoundland Chapter

Mustapha Zergoun - Chair, Heritage Committee

Michel Aubertin - Chair, Mining Geotechnique Committee

Victor A. Sowa - Secretary General

2014 Retiring Associate Editors – Canadian Geotechnical Journal

Murray Grabinsky
Chris Haberfield
Jayantha Kodikara

2014 Annual Canadian Geotechnical Society Conference – Regina Organizing Committee

Wayne Clifton - Chair

Heather Duncan - Organizing Committee Administrator

Darrell Mihial - Vice Chair and Chair, Volunteers Committee

Cate Hydeman - Vice Chair

Steve Harty - Treasurer and Chair, Social Committee

Shahid Azam - Chair, Technical Committee

Lynden Penner - Chair, Sponsorship

Jasyn Henry - Promotion and Communication

Kyle Mason - Promotion and Communication

Harpreet Panesar - Chair, Tours and Technical Committee Member

Dave Kent - Chair, Seminars-Workshops and Technical Committee Member

Maki Ito - Technical Committee Member

Jon Gillies - Chair, Geotechnical Pioneers Program

Anna Torgunrud - Sponsorship

Allen Kelly - Tours, Seminars and Workshops

Dean Milton - Volunteers Committee

Jody Scammell - Geotechnical Pioneers Program

Amy Swerid - Geotechnical Pioneers Program

Jody Schafer - Geotechnical Pioneers Program

Bret Dundas - Technical Commmittee

6th Canadian Geohazards Conference – Organizing Committee

Dave Gauthier, Chair - Organizing Committee

Andy Take, Co-Chair - Technical Committee

Jean Hutchinson, Co-Chair - Technical Committee

Leif Burge - Technical Committee

Heather Crow - Technical Committee

Vanessa Cuervo - Technical Committee

Rick Guthrie - Technical Committee

Michael Hendry - Technical Committee

Bruce Jamieson - Technical Committee

Kathy Kalenchuk - Technical Committee

Matt Lato - Technical Committee

Ariane Locat - Technical Committee

Renato Macciotta - Technical Committee

Scott McDougall - Technical Committee

Michael Porter - Technical Committee

Mélissa Ruel - Technical Committee

Baolin Wang - Technical Committee

Awards from the Engineering Institute of Canada (EIC)

Fellowship of the Institute (FEIC)
Regis Bouchard, Lead Geotechnical Engineer, Lower Churchill Project, SNC-Lavalin.

Fellowship of the Institute (FEIC)
Gordon Ward Wilson, Principal Investigator, Oil Sands Tailings Research Facility.

Provided by Lisa McJunkin
Administrator

Victor Sowa
Secretary General

Call for Nominations – The 2016 Canadian Geotechnical Colloquium

The Canadian Geotechnical Colloquium is a commissioned work financially supported by the Canadian Foundation for Geotechnique. 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 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 (in two payments) and a framed certificate.

Each nomination letter must provide an introduction to the candidate and his/her main accomplishments. It must be accompanied by an abstract of about 2,000 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.

Nominations should be submitted prior to January 31, 2015 to **Murray Grabinsky**, P.Eng., Department of Civil Engineering, University of Toronto, 35 St. George Street, Toronto ON, M5S 1A4, or emailed to *murray.grabinsky@utoronto.ca*, or in care of the CGS Executive Director at *cgs@cgs.ca*.

Submitted by Murray Grabinsky

Appel de mises en candidature Le Colloquium canadien de géotechnique 2016

Le Colloquium canadien de géotechnique est la présentation d'un travail de recherche, à l'invitation de la Fondation canadienne de géotechnique (FCG). Cet honneur est décerné tous les ans à un membre de la communauté géotechnique canadienne. Le but du Colloquium est de documenter un sujet d'intérêt particulier dans le domaine de la géotechnique et d'encourager un jeune membre de la société canadienne de géotechnique à poursuivre les recherches nécessaires à sa préparation. Il est présenté lors de la conférence annuelle de la SCG et doit pouvoir être publié dans la Revue canadienne de géotechnique, selon le format établi par la revue. La décision de le publier relève toutefois exclusivement du rédacteur en chef de la revue. Un comité de sélection formé par le Conseil de recherche en géotechnique de la société choisi l'individu et le sujet à partir des nominations reçues. Le candidat retenu reçoit des honoraires de 5 000.00 dollars (en deux versements) et un certificat encadré.

Chaque lettre de nomination doit présenter le candidat et ses principales réalisations. Elle doit être accompagnée d'un résumé d'environ 2 000 mots sur la présentation proposée, en soulignant l'importance du sujet pour la communauté géotechnique canadienne, avec un bref survol de l'état des connaissances et de la contribution du candidat; il faut aussi inclure 'un curriculum vitæ faisant état de l'expérience du candidat liée au domaine ainsi que d'une liste de ses publications. Pour obtenir des renseignements sur la mise en candidature, consultez l'édition 2012, ou ultérieure, du manuel sur les prix et les distinctions (Awards and Honours Manual 2012, en anglais seulement), à la section C-2. Pour y accéder, les membres de la SCG peuvent ouvrir une session à *http://www.cgs.ca/login.php?lang=fr*, et aller à la section ressources en ligne à l'intention des membres.

Les mises en candidature doivent être envoyées avant le 31 janvier 2015 à **Murray Grabinsky**, P.Eng., Department of Civil Engineering, University of Toronto, 35 St. George Street, Toronto ON, M5S 1A4, ou par courriel à *murray.grabinsky@utoronto.ca*, ou encore aux soins du secrétariat de la SCG, à *cgs@cgs.ca*.

Del la part de Murray Grabinsky

Upcoming Conferences and Seminars

68th Canadian Geotechnical Conference
7th Canadian Permafrost Conference
September 20 – September 23, 2015
Québec City, Quebec

Call for Abstracts

The **Eastern Quebec Section** of the Canadian Geotechnical Society and the **Canadian National Committee for the International Permafrost Association (CNC-IPA)**, invite you to GéoQuébec 2015, for the joint 68th Canadian Geotechnical and 7th Canadian Permafrost Conference. The conference will be held from September 20 - 23, 2015 in the Convention Center in Québec City, Québec. It will cover a wide range of topics, including speciality sessions that are of local and national relevance to the fields of geo-engineering, permafrost and engineering geology. In addition to the technical program and plenary sessions, the conference will include a complement of workshops, short courses, technical excursions and local tours.

The official languages for the conference will be English and French. The Convention Center is located in the historic downtown area of Québec City, a UNESCO World Heritage Site, facing onto Québec's Parliament Hill. Old Québec City, which is the cradle of French civilization in North America, is best explored on foot and September is the best time of the year with a typically warm, dry weather and the maple trees just beginning to take on their colourful fall foliage.

The conference theme **Challenges from North to South**, reflects the diverse and complex challenges that the geotechnical, cold regions engineering and permafrost communities will need to address in order to support sustainable economic development. The Local Organizing Committee invites members from the Canadian and international communities to contribute papers on their recent research and advancements in geotechnical, geo-environmental and cold regions engineering, as well as permafrost science.

Authors are invited to submit abstracts of a maximum 400 words through the conference web site, *www.geoquebec2015.ca*. The abstracts should generally fall within the following topics, but sessions will be added for groups of abstracts which share a common theme but are not listed below:

- **Fundamentals**

  Soil and Rock Mechanics, Foundation Engineering, Groundwater Hydraulics, Physical and Numerical Modelling, Geocryology, and Periglacial Processes
- **Soil and Terrain Characterization**

  Laboratory Testing, In Situ Testing, Instrumentation, GIS and Remote Sensing
- **Geohazards**

  Climate Change, Permafrost Degradation, Earthquakes, Landslides
- **Infrastructure Design and Operation**

  Transportation, Pipelines, Embankments and Dams, Harbour and Shoreline Geotechnique, Infrastructure performance in Cold Regions
- **Problematic Soils**

  Permafrost Soils and Ground Ice, Collapsible Soils, Expansive Soils, Ground Improvement
- **Mining Waste Management and Environmental Geotechnology**

  Mine Waste Disposal, Contaminated Soils, Landfills and Barriers, Restoration of Derelict Lands, Mining in Cold Regions
- **Sustainable Development**

  Policy and Regulation, Risk and Reliability, Northern Communities
- **Case Studies and Case Histories**

The deadline for abstract submission is **January 15, 2015**. Authors whose abstracts are accepted by the conference's Technical Committee will be notified by **February 21, 2015** and invited to submit full papers. The submitted papers, which can be in either English or French, will be reviewed prior to final acceptance and inclusion in the conference proceedings. At least one author of an accepted paper must register for the conference for its inclusion in the proceedings.

For more information regarding sessions, topics and the technical program, please contact **Jean Côté** (Conference Co-Chair - geotechnical) at *jean.cote@geoquebec2015.ca* or **Michel Allard** (Conference co-Chair - permafrost at *michel.allard@geoquebec2015.ca*. For geotechnical contributions, please contact **Didier Perret** (Technical Program co-Chair) at *comtec_geot@geoquebec2015.ca* and for permafrost and cold region engineering contributions, Richard Fortier (Technical Program co-Chair) at *comtec_perg@geoquebec2015.ca.*

68e conférence canadienne de géotechnique
7ième conférence canadienne sur le pergélisol
20 - 23 septembre 2015
Québec, Québec, Canada,

Appel à contributions

La Société canadienne de géotechnique (SCG), la Section régionale de l'Est-du-Québec de la Société canadienne de géotechnique et le Comité national canadien de l'Association internationale du pergélisol (CNC-AIP) vous invitent à participer à GéoQuébec 2015; il s'agit de la 68e conférence canadienne de géotechnique et de la 2e conférence conjointe SCG/CNC-AIP sur le pergélisol. Cet événement se déroulera au Centre des congrès à Québec (Québec), Canada, du 20 au 23 septembre 2015. Le thème de GéoQuébec 2015 – Des défis du Nord au Sud - reflète la diversité des défis complexes auxquels font face les spécialistes en géotechnique, en géotechnique des régions froides et en pergélisol pour assurer le développement durable des communautés canadiennes. Les langues officielles de la conférence sont le français et l'anglais. Le Centre des congrès se trouve à quelques pas du quartier historique de la ville de Québec, un joyau du patrimoine mondial de l'UNESCO, et fait face à la colline parlementaire de Québec. Le mois de septembre à Québec est le meilleur moment de l'année, avec une température clémente et des érables qui se parent de leur feuillage coloré.

Le Comité local d'organisation de la conférence invite les membres des communautés canadiennes et internationales en géotechnique, en géotechnique des régions froides et en pergélisol à contribuer à la conférence en soumettant les résultats de leurs travaux et découvertes dans ces domaines. La conférence couvrira un large spectre de thèmes incluant des séances spéciales d'intérêt local et national dans les domaines de spécialisation de la géo-ingénierie, du pergélisol et du génie géologique. En plus du programme technique et des séances plénières, la conférence comprendra des ateliers, des cours intensifs, des excursions techniques et des visites guidées.

Les auteurs sont invités à soumettre des résumés de 400 mots au plus en utilisant le site internet de la conférence (*www.geoquebec2015.ca*) qui sera disponible à la mi-septembre 2014. Les résumés peuvent être rédigés en français ou en anglais. La date limite pour soumettre un résumé est le 15 janvier 2015. Une invitation pour la soumission d'articles sera envoyée avant le 21 février 2015 aux auteurs dont les résumés auront été acceptés par le Comité du programme technique. Les articles soumis, soit en français, soit en anglais, seront révisés avant leur acceptation pour publication sur clé USB dans les actes de conférence. Au moins un des auteurs d'un article accepté doit s'inscrire à la conférence pour la publication de cet article.

Les résumés devraient normalement se rattacher à l'un des thèmes suivants. Les thèmes des séances techniques pourront cependant être modifiés en fonction des résumés reçus.

- Aspects fondamentaux

  Mécanique des roches et des sols, Fondation, Hydraulique des eaux souterraines, Modélisation physique et numérique, Géocryologie, Processus périglaciaires
- **Caractérisation des sols et de sites d'étude**

  Essais en laboratoire, Mesures in situ, Instrumentation, SIG et télédétection
- **Risques naturels**

  Changements climatiques, Dégradation du pergélisol, Séismes, Glissements de terrain
- **Conception et opération d'infrastructures**

  Transports, Gazoducs et oléoducs, Remblais et barrages, Géotechnique marine, Performance des infrastructures en régions froides
- **Sols problématiques**

  Pergélisol et glace de sol, Sols susceptibles aux affaissements, Sols gonflants, Techniques d'amélioration des sols
- **Gestion des résidus miniers et géotechnique environnementales**

  Entreposage des résidus miniers, Sols contaminés, Sites d'enfouissement et barrières imperméables, Restauration de sites contaminés, Exploitation minière en régions froides

- **Développement durable**

  Politique et réglementation,
  Géorisques et fiabilité,
  Communautés nordiques

Les études de cas sont sollicitées. Les articles sur de nouvelles techniques d'analyse, des solutions innovantes à des problèmes et des projets de recherche sont aussi encouragés.

Toutes questions relatives aux sessions, aux thèmes et au programme technique peuvent être posées aux membres du comité local d'organisation de la conférence:

Pour information générale, **Jean Côté**, Coprésident de la conférence (géotechnique) *jean.cote@geoquebec2015.ca*, **Michel Allard**, Coprésident de la conférence (pergélisol) *michel.allard@geoquebec2015.ca*. Pour les contributions en géotechnique, **Didier Perret,** Coprésident du programme technique *comtec_geot@geoquebec2015.ca*. Pour les contributions en géotechnique des régions froides et sur le pergélisol, Richard Fortier, Coprésident du programme technique *comtec_perg@geoquebec2015.ca*.

Membership Registration For 2015

Your Canadian Geotechnical Society membership is expiring! You are encouraged to visit the Canadian Geotechnical Society website at www.cgs.ca, to renew your membership for 2015 as soon as possible.

Membership benefits include:

- Online access to the electronic version of *the Canadian Geotechnical Journal* (published monthly) including all past issues;
- Member pricing for print subscriptions to the *Canadian Geotechnical Journal*;
- A complementary print subscription to *Geotechnical News* (four issues annually);
- Online member access only to past CGS conference electronic proceedings;
- Member pricing for the CGS-sponsored professional development opportunities, including the Society's popular Annual Conference, to be held in Quebec City in 2015;
- Preferred member information on CGS's spring and fall Cross Country Lecture Tour featuring recognized National and International speakers;
- Membership in one of CGS's technical divisions – Soil Mechanics and Foundations, Engineering Geology, Geoenvironmental, Rock Mechanics, Geosynthetics, Groundwater and Cold Regions;
- Complementary membership in the International Society related to your Division of choice, i.e., ISSMGE, IAEG, ISRM, IGS or IPA. Additional memberships at preferred second society member pricing (CSCE, IAH, NAGS, etc.);
- Access to information from CGS's technical committees – Professional Practice, Education, Landslides, Transportation Geotechnique, Heritage and Mining Geotechnique.

We welcome all new and renewing members and look forward to your participation in 2015. We are planning several new programs this year and encourage you to recommend a friend or colleague to join the Canadian Geotechnical Society so that we can continue to improve upon the benefits the Society offers our profession.

Members in the News

Dr. Victor Sowa, PEng, PGeo (BC), FEIC
Canadian Geotechnical Society Secretary General
2007 to 2014

The Secretary General of the Canadian Geotechnical Society is the individual responsible for the effective and efficient management of the Society's affairs. Since 2007, that individual has been Dr. Victor Sowa, the third Secretary General of the Society. During his tenure he has provided long-term knowledge and guidance in his characteristic behind-the-scenes and thorough manner to four Presidents, Vice Presidents, Executives Committees, Boards of Directors, and conference organizing committees. Victor has kept the Society on an even keel and moving forward. The Society is where it is today, in part, due to Dr. Sowa's hard work and dedication. Victor is retiring as Secretary General at the end of 2014, and at GeoRegina 2014 was briefly recognized and presented with a CGS **A.G. Stermac Award**. The following is a little background about our soon-to-be-retired Secretary General.

Victor Sowa.

Professionally, Victor received his BSc in Civil Engineering from the University of Alberta and then, as an Athlone Fellow, went on to graduate studies at Imperial College of Science and Technology in 1959, obtaining a DIC from the Imperial College, and then obtaining his PhD in Soil Mechanics from the University of London in 1963. His thesis was *"A Comparison of the Effect of Isotropic and Anisotropic Consolidation on the Shear Behaviour of a Clay"*, supervised by Dr. Skempton.

During his professional career, Victor worked as a geotechnical consultant with Acres International, Niagara

Falls, Hardy Associates and AMEC in Edmonton, and with Klohn Crippen, SRK-Robertson and Jacques Whitford in Vancouver. He worked as a Senior Geotechnical Engineer, Principal Geotechnical Engineer, Corporate Geotechnical Engineer and Manager of Engineering for these consulting firms. He consulted on numerous projects associated with oil refineries and petrochemical plants, pipelines, dams and tailings impoundments and industrial plants and a number of geoenvironmental projects. In addition to Canada, Victor also worked in the US, Bangladesh, Ethiopia and St. Kitts.

He is the author or co-author of over 30 professional papers and presentations.

Victor joined the CGS in 1965. His position of Secretary General is just the culmination of a long list of CGS professional service work that Victor has been involved with over the years:

Executive Member of both the Geotechnical Society of Edmonton (1975-1982) and the Vancouver Geotechnical Society (1993-1996). Victor served as President and is a Life Member of both of these regional societies.

- CGS Directorship for Northern Alberta (1983-1985) and for British Columbia (1997-1999).
- Member of seven conference organizing committees between 1965 and 2005.
- Author of Chapter 4 "Site Investigation" of the Canadian Foundation Engineering Manual (3rd Edition, 1992).

Victor was elected a **Fellow of the Engineering Institute of Canada** in 1999, received the A.G. Stermac Award in 2000 and was awarded the **EIC's Canadian Pacific Railway Engineering Medal** in 2006 for his leadership and service to the CGS.

As Secretary General he worked closely with CGS Presidents **Peter Wu, Michel Aubertin, Bryan Watts** and **Richard Bathurst**, and closely with CGS Administrators **Sarah Watson, Wayne Gibson** and **Lisa McJunkin.**

When asked for a few thoughts about Victor, **Michel Aubertin** responded:

"I am pleased to acknowledge the important role that Victor Sowa has played in the Canadian Geotechnical Society since he became Secretary General. Vic started in that position shortly before I became President-Elect in 2008 and made a tremendous effort to master the various tasks and responsibilities of the Secretary General in a short period of time. With me as the new President in 2009, and with many new members on the Executive Committee and Board of Directors, Vic worked very hard to make sure that everything ran smoothly. I personally benefitted from his dedication, support and collaboration. Over the years, Vic has continued to help all volunteers that devote their time and energy for the benefit of the CGS.

I have also gotten to know Vic better over the years and found him to be a nice man to work with. I would like to thank Vic and wish him the best of success with his upcoming projects."

Bryan Watts responded:

"My association with Vic started with Hardy and Associates in 1975 when Vic was my supervisor for the construction of the starter dams at Syncrude. To this day, his paper on the foundation conditions at a portion of the starter dam over highly compressible peat and silty clay is one of the best technical papers ever written on foundation soils in the oil sands. My next encounter with Vic was during his tenure at Klohn Crippen in the late 1980s and early 1990s. I sought his advice many times because of his experience on a wide variety of projects in our industry.

During my tenure as President, Vic worked tirelessly… at first to educate me about the workings of the CGS, then to coach me on the manuals, procedures, and all of the other stuff that Presidents don't really grasp. Without Vic, many of us would have had a much more difficult time performing our duties in the CGS. He has always worked behind the scenes to improve our profession.

So, to Vic, many thanks, and enjoy your retirement, finally!"

Richard Bathurst responded:

"Vic has been the 'Wizard of Oz' behind the CGS stage for the last eight years. As Secretary General, he has provided four Presidents and Boards of Directors with outstanding guidance on the day-to-day affairs of the Society, and wisdom on matters of policy. The volume of CGS business that passes through the office of the Secretary General is difficult to appreciate unless one has had the experience of being President. Vic has performed each task with the welfare of our Society and each CGS member in mind. For this dedication we can all be grateful.

I wish Vic the best for the future and salute him for a job well done."

Lisa McJunkin responded:

"Having worked closely with Vic since 2009, I have come to appreciate his keen eye for detail. This has helped keep the CGS on track during his term as Secretary General. He leaves the Society in good shape to take on new challenges in the ever-changing and evolving engineering community. Victor, you will be missed!"

Victor, all of us in the CGS family thank you for your efforts and wish you all the best in your retirement.

Submitted by Doug VanDine
CGS President Elect 2015/2016

Heritage Committee

New Publication

The CGS Heritage Committee would like to let you know about the Edmonton Geological Society's newest publication **John Allan: The Founding of Alberta's Energy Industries** by **Willem Langenberg** and **Dave Cruden**.

This book of photographs shows us the beginning of Alberta's energy industries through the eyes of **Dr. John Andrew Allan**, Professor of the University of Alberta, first Chairman of the Department of Geology, first Director of the Alberta Geological Survey (AGS), founding member of technical organizations and societies, such as the Scientific and Industrial Research Council of Alberta (now Alberta Innovates - Technology Futures), the Association of Professional Engineers and Geoscientists of Alberta (APEGA), and the Canadian Society of Petroleum Geologists (CSPG). John Allan played a founding role in the development of the mineral resources of Alberta.

The views presented in this book follow John Allan's fieldwork throughout the province and beyond. They show us what he and his contemporaries saw with their own eyes in times past. They document how he saw the development potential of Alberta's mineral resources, as do his numerous reports and papers, a selection of which is listed at the end of this book. In a talk on CKUA radio in 1927, he predicted the oil boom, which began in 1947 with the discovery of the Leduc oil field. John Allan's leadership and foresight greatly contributed to the success of the energy industries in Alberta, which changed the fortunes of the Province of Alberta and its citizens.

The Edmonton Geological Society offers the book for $20/copy (retail). Bulk order discounts and wholesale pricing available upon request. To order, or for more information, contact the EGS publications manager.

Matthias Grobe, Publications Manager
Edmonton Geological Society
Ph. (780) 427-2843
Email: matt.grobe@aer.ca

History of Local Chapters of the Canadian Geotechnical Society

The Heritage Committee believes that the history of the local chapters of the Canadian Geotechnical Society to be valuable part of the Society and its members. The CGS Heritage Committee would like to assemble if at all possible, a collection of historical summaries of all the chapters.

If you have any questions or have other historical information that you wish to share or know of any opportunities to acquire material that is at risk of being lost, please contact the Chair of the CGS Heritage Committee, **Dr. Mustapha Zergoun**, at *mzergoun@thurber.ca* .

Submitted by Mustapha Zergoun
Chair of the CGS Heritage Committee

Engineering Institute of Canada Seeking Executive Director Applications due December 15, 2014

The **Engineering Institute of Canada** (EIC) is inviting applications for the position of **Executive Director,** to be filled by **April 15, 2015**, with the new incumbent taking up the position on June 15, 2015. The Executive Director is a paid, half-time position with the EIC, reporting to the President.

The Executive Director is responsible for the effective and efficient management of the Institute's affairs. The EIC is seeking a person with the following attributes:

a) Able to provide leadership in the ongoing development of the EIC in pursuit of its vision and objectives.

b) Experienced in the management and governance of not-for-profit organizations such as the Engineering Institute of Canada and its member societies.

c) Available to work half-time, possibly from his or her own office, using computer and internet communications.

d) Able to oversee the work of an office administrator who may also be working from his or her own office.

e) The ability to communicate in both English and French is desirable.

Vision of the EIC: "Engineering, for a prosperous, safe and sustainable Canada."

Mission: Develop and promote **continuing education**; Initiate and facilitate **interdisciplinary activities and services**; Lead member societies in defining and **building the future** of engineering and Advocate the **values and benefits of engineering**

Objectives: Continuing Education, Awards, History and Archives, Conferences, Promote Engineering as a Career and Services to Member Societies:

Applicants are invited to submit a short resume of relevant experience, no later than **December 15, 2014**, to *jplant1@cogeco.ca*

For a complete job description, see link on *www.eic-ici.ca*.

Cherchant Directeur exécutif Institut canadien des ingénieurs Applications à échéance le 15 Décembre 2014.

L'Institut canadien des ingénieurs (ICI) sollicite des candidatures pour le poste de directeur général, à remplir avant le **15 Avril 2015**, avec le nouveau titulaire de prendre le poste le 15 Juin 2015.

Le directeur exécutif est titulaire d'un poste à mi-temps payé comme un employé de l'EIC, qui relève du président. Le directeur exécutif est responsable de la gestion efficace et efficiente des affaires de l'Institut. Le CPN est à la recherche d'une personne avec les attributs suivants:

a) Capable d'assurer un leadership dans le développement continu de l'EIC dans la poursuite de sa vision et ses objectifs.

b) Expérimenté dans la gestion et la gouvernance des organismes sans but lucratif comme l'Institut en génie du Canada et de ses sociétés membres.

c) disponible à travailler à mi-temps, peut-être de son propre bureau, en utilisant les communications informatiques et Internet.

d) Capacité à superviser le travail d'un administrateur de bureau qui peut aussi travailler à partir de son propre bureau.

e) Aptitude à communiquer en français et en anglais est souhaitable.

Vision de l'EIC: "Ingénierie, pour un Canada prospère, sûre et durable."

Mission: Développer et promouvoir l'éducation permanente; Initier et faciliter les activités et services interdisciplinaires; Sociétés membres de plomb dans la définition et la construction de l'avenir de l'ingénierie et Défendre les valeurs et les avantages de l'ingénierie

Objectifs: formation continue, Prix, Histoire et Archives, conférences, promotion de l'ingénierie comme une carrière et des Services aux sociétés membres:

Les candidats sont invités à soumettre un court résumé de l'expérience pertinente, plus tard le **15 Décembre 2014**, à *jplant1@cogeco.ca*

Pour une description de l'emploi voir le lien sur *www.eic-ici.ca* .

Submitted by John Plant

Executive Director of the Engineering Institute of Canada

Editor

Don Lewycky, P.Eng.

Director of Engineering Services, City of Edmonton
11004 – 190 Street NW
Edmonton, AB T5S 0G9
Tel.: 780-496-6773
Fax: 780-944-7653
Email: don.lewycky@edmonton.ca

2014 Legget Medal Award

Introduction of Dr. Peter Byrne 2014 Legget Medal Award Recipient

Introduction delivered by Dr. Ernest Naesgaard

It is a great honour to be invited to introduce Dr. Peter Michael Byrne for the Canadian Geotechnical Society Legget Award. This is the most senior and prestigious award of the Society and Dr. Byrne is a much deserving recipient. Dr. Byrne has led a distinguished life on many fronts: academia, research, consulting, mentoring, sports, and family.

Dr. Byrne grew up in Ireland where, in 1959, he obtained a Bachelor of Engineering from University College Dublin and was awarded top student in structural analysis. He worked as a structural engineer for George Wimpy in London for a year before seeing his calling and moving to British Columbia to work as a "Soils Engineer".

In Vancouver, Dr. Byrne met his wife, Jane, (a school psychologist, librarian, superb cook and maker of fabulous Welsh cakes), and raised their two sons, Craig and Sean. Like their parents, the boys desired to travel and now one is a lawyer living in Italy and the other an architect in Australia.

Dr. Byrne is an avid sailor. He competed in the Flying Dutchmen class for Canada in the 1967 Pan American Games (Bronze medal winner) and in the 1972 Olympics in Germany. He also, more than once, was a strategist on the grueling Victoria-Maui Swiftsure Yacht race. Many summers, Peter, Jane and the boys, and later Peter and Jane, could be found on their own sailboat "Excalibur" plying the coast of British Columbia. This was Peter's summer office.

In 1965 Peter returned to school and obtained a M.A.Sc. and Ph.D. at University of British Columbia where he stayed on to become Professor and later Professor Emeritus. His research was primarily in numerical analysis but also in the fields of liquefaction, interpretation of laboratory and centrifuge testing, and soil-structure interaction. Dr. Byrne has made many significant contributions to engineering practice. He developed hyperbolic soil models with Prof. Duncan, programs for lateral pile analyses (LAT-PILE), several analysis programs and constitutive models (NLSSIP, SOIL-STRESS, UBCTOT, UBCHYST and UBCSAND) and more. Probably the most important is the development of the effective stress constitutive model UBCSAND. Dr. Byrne's incorporation of this model in the commercially available software FLAC, and his willingness to share this approach openly and freely, was instrumental to the current adoption of advanced, effective stress analyses in North America. These analyses have now become standard practice for dams and other critical public infrastructure.

Dr. Byrne has co-authored over 160 journal and conference papers, has made numerous invited presentations, served on international code committees, and chaired task forces. For several years he has held a NSERC Strategic Grant examining “Earthquake induced damage mitigation from soil liquefaction”. His work has been acknowledged: he is a Fellow of the Engineering Institute of Canada (EIC), has received the Vancouver Geotechnical Society Award, the Geoffery Meyerhoff Award, the Gzowski Medal for best paper (CSCE), the Julian C. Smith award (EIC) “for achievement in the development of Canada”, has given the R.M. Hardy Keynote Address and more.

As a mentor, Dr. Byrne was always approachable and freely shared his ideas and time, both with his students and practicing engineers. His enthusiasm for his work was obvious; he would gladly spend hours talking about his latest ideas and developments, and would openly share his latest programs.

As a consultant, Dr. Byrne has been in demand for many years as a specialist consultant and reviewer on major projects. These have included dams for BC Hydro, Hydro Quebec, US Corps of Engineers; seismic upgrades for major Bridges in Greater Vancouver, soil cover for oil-sands tailings, numerical modelling for seismic upgrade of the Bart Tunnel in San Francisco, and the design of numerous tailings dam facilities around the world.

I should acknowledge Dr. Michael Beaty, another of Peter’s former students, in helping to formulate this introduction. In closing I quote Michael; “One of Dr. Byrne’s great strengths is his ability to identify the key aspects of a problem, and develop engineering solutions that are practical and effective because they efficiently focus on the critical mechanisms. He has impressed many with this singular skill.” This skill and the willingness to share his ideas and work are key attributes that accentuate Dr. Byrne within our profession.

And again, I thank you for allowing me to introduce Dr. Peter Michael Byrne as the 2014 Legget medal recipient.

2014 R.F. Legget Medal Award Acceptance Speech

Dr. Peter M. Byrne

Peter Byrne.

Thank you Ernie for that introduction.

Mr. President, fellow engineers, ladies and gentlemen:

I am profoundly humbled to have been recognized and nominated by my colleagues for the prestigious R.F. Legget Medal, and I am sincerely grateful to the Canadian Geotechnical Society for choosing me as its 2014 recipient. Considering the list of previous medal winners, it is truly an honour to be in the company of so many outstanding individuals, and to be considered worthy of such recognition.

Among previous winners of this medal is my friend and colleague, Dr. W.D. Liam Finn, who was instrumental in my decision to join the Faculty of Applied Science at the University of British Columbia. When I had completed my Ph.D. degree, he approached me to join the Department as an Assistant Professor. That decision very much shaped my career, and I remain forever grateful to him.

In 1959, after graduating in Civil Engineering from the University College Dublin, Ireland, I began my engineering career as a Structural Engineer for George Wimpey in London, UK. A year later, in 1960, I came to Canada and was hired as a Soils and Hydraulics Engineer for CBA Engineering, in Vancouver.

I worked for CBA for 3 years on two major projects: construction of the original Port Mann Bridge across the Fraser River, and the Hugh Keenleyside Dam on the Columbia River. From time to time when various

L to R: Richard Bathurst, Ernest Naesgaard accepting for Dr. Peter Byrne, Dennis Becker.

problems arose, specialist consultants would arrive on site, such as Dr. Arthur Casagrande. I was so impressed by their contribution that it spurred my interest in obtaining a higher degree in geotechnical engineering. As such, I obtained a MASc degree in 1965 and then a PhD degree in 1967, both from the University of British Columbia.

At this time, my interest became numerical modelling of soil liquefaction for the analysis and design of earth structures. The stress-strain and strength of the soil are a key aspect in such analyses.

In 1967, I joined the Department of Civil Engineering as Assistant Professor. At that time, my colleague Dr. Richard Campanella was in the process of developing a world class soils laboratory to test monotonic and cyclic loading of sands and clay. Drs. Yogi Vaid and Dharma Wijewickreme further developed the soils laboratory. The lab equipment in addition to the lab tests provided me with the stress-strain behaviour data which I used to produce my numerical model for analysis.

In 1976-1977 I spent a sabbatical year at the University of Berkeley, California, working with Dr. Mike Duncan on nonlinear analysis of long span soil metal arches. A number of these structures had failed during construction and there was a need to know the reason why these were failing.

In 1986, I spent three months at the University of Sydney, Australia, and learned much about plasticity from Dr. John Booker (who passed away unexpectedly in 1998). I came to realize that a simple plasticity model could capture much of the stress-strain response found in the laboratory monotonic and cyclic tests.

In early 2000, Dr. Ryan Phillips and I held an NSERC Strategic Grant with industry partners. We were to examine seismic liquefaction response of Fraser River sand from cyclic direct simple shear (DSS) tests conducted in the UBC Soils Laboratory. Centrifuge tests that were conducted on the same sand were carried out at C-Core, Newfoundland. Fraser River sand was trucked from Vancouver to C-Core. Numerical models were first calibrated from the DSS tests and used to predict the response of the dynamic centrifuge tests. The predicted responses from the numerical analyses were generally in good agreement with the measured responses from the dynamic centrifuge tests.

In addition to being a faculty member at the University of British Columbia for many years, I have had the opportunity to be involved on a wide range of projects, including bridges, tunnels, dams, including mine-waste dams both in Canada and many others parts of the world. All these projects involved the stress-strain and strength relations of the soil under monotonic and cyclic loading.

During my tenure as Professor of Geotechnical Engineering at UBC I had the privilege of supervising many exceptional graduate students who pursued research in state-of-the-art numerical analyses and modelling liquefaction effects on soil structures against seismic loading. Two of these outstanding students, Drs. Ernie Naesgaard and Mike Beaty continued in this area after graduation and further developed the model (UBCSAND). This model continues to evolve and is recognized and used world-wide.

Canada has a combination of challenging soil and seismic conditions which has required great expertise from our area of geotechnical engineering. I have worked with engineers from many countries, but in my view our group in Canada is among the very best. It is a pleasure to work with such high quality professionals, and to have been selected from this group for this medal is truly an honour.

I also want to thank my wife, Jane, whose love and support have sustained me over the years.

In conclusion, I want to again say how grateful I am to receive this award. Thank you very much.

Paolo Gazzarrini

Overture

Christmas is approaching, and for the 37th episode of the Grout Line, I present to you an article related to a jet grouting job carried out in Austria few years ago.

I have long been looking for the world's biggest jet grouting job, and a few weeks ago, participating in a jet grouting workshop in Italy, I watched a presentation that just might have solved my problem.

The following article, prepared by Marco Ziller (Overseas Department-mziller@trevispa.com), Maurizio Siepi, (Head of Technological Office -msiepi@trevispa.com) and Marco Angelici (Technological Department-mangelici@trevispa.com), writing from TREVI SpA, describes a case history of jet grouting, where 15,300 columns where installed for a total of 210,000 meters (690,000 ft) drilled.

Is this the biggest jet grouting job ever carried out in the world?

Let me know if you know of anything bigger!

Merry Christmas, and I wish, every one of you who has the perseverance to read this Grout Line, a FANTASTIC 2015!

A challenging jet grouting project for the construction of the railway tunnel in Stans (Austria)

Introduction

The new Munich-Verona high speed railway line is part of the Trans-European Transport Network rail link, connecting Berlin to Palermo (TEN-T, see Figure 1). The network also encompasses the future Brenner Base tunnel which, with its twin 55 km long tubes, is slightly shorter than the 57 km Swiss Gotthard Base Tunnel.

To manage the design and engineering processes of the works on the Austrian side, the Austrian government formed the Austrian Brenner Railway (Brenner Eisenbahn Gesellschaft, BEG) company. Consulting services for the geotechnical design were assigned to ILF-Geoconsult ZT-iC, and Studio HBPM was the jet grouting expert consultant.

In the proximity of Innsbruck, the new railway line runs parallel to the Inn River, to the A12 motorway, and to the railway to Munich (see Figure 2).

Eventually BEG designed a series of projects aimed at minimising the environmental impact on the area adjacent to the line, both during and after construction. At design stage, BEG defined methodologies to deal with the diverse situations, selecting either excavation and covering of trenches or the use of TBMs.

However, close to the small village of Stans, where the new line is situated close to the river, close to a motorway viaduct and close to the existing railway line, an alternative solution was necessary; the 750m long tunnel passes some 30 metres under the river bed in difficult ground conditions.

In order to minimize the disruption to existing lines, the BEG designers foresaw for the tunnel a 2 m thick jet grouted protective shell, which would be watertight and strong. Moreover, as a second line of defence, the use of compressed air was foreseen to neutralize any residual permeability.

BEG entrusted the job to Alpine/GPS, which in turn subcontracted to Trevi the execution of the specialized works for soil improvement.

Figure 1. The Trans-European Transport Network, with Berlin-Rome line highlighted.

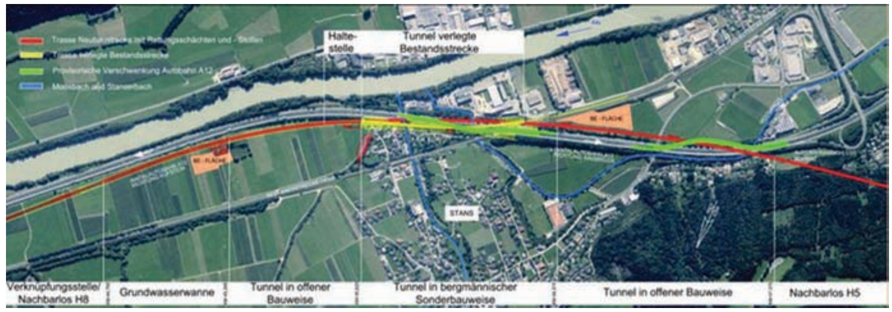


Figure 2. Aerial view of the tunnel site, where motorway and railway are crossing each other close to the Inn River.

Requirements of the project

The Stans tunnel is 750 m long, and has a polycentric section 12 m high, and 13 m wide. The minimum thickness of the jet grouting shell was designed 2 m thick, with the jet grouted soil designed for a minimum strength of 5 MPa.

The entire tunnel was divided into 38 compartments, each 20 m long. The division into compartments allowed testing of the residual water inflow, with a maximum flow of 5 liters/second.

The design specified also allowed displacements for each of the existing works. For the motorway bridge and the railway a vertical and horizontal displacement of ± 2 mm, was set.

One of the main problems was the presence of a high velocity groundwater table, created mainly by the Inn River and by two perpendicular creeks. The presence of these underground flow conditions created turbulence and continuous changes in direction of the flow with possible wash-out of the grout mix used for the jet grouting. For this reason Trevi designed and patented an innovative technique, in which the cells created by the columns are tightly interlocked. This technology has been considered reliable in responding to the technical problems.

The works

A preliminary full scale test using a double fluid jet grouting system (air and cement slurry) has been performed to confirm the jetting parameters necessary for the design assumptions (Figure 3).

The test involved the installation of some columns using the spacing, parameters, and sequence devised for the entire work. After the hardening, the set of columns was cored to assess the strength of the jet grouted soil.

Based on the results of the test, the final design was prepared for the improvement of a total volume of 120,000 cubic metres of soil.

Trevi 's method created a structure composed of three different series of vertical and/or inclined columns, overlapping each other by at least 100 mm.

A special sequence of installation was studied and patented to grant the features of water tightness and strength of the jet grouting ring requested by the design.

Initially, the most permeable layers of soil were saturated with cement slurry before commencement of the jetting process. Then, for each area, the primary columns were installed. The secondary columns were then installed midway between primaries, resulting in a hexagonal cell lattice. After the columns hardened, the tertiary columns were installed in the centre of the cell, closing the structure (Figure 4). The

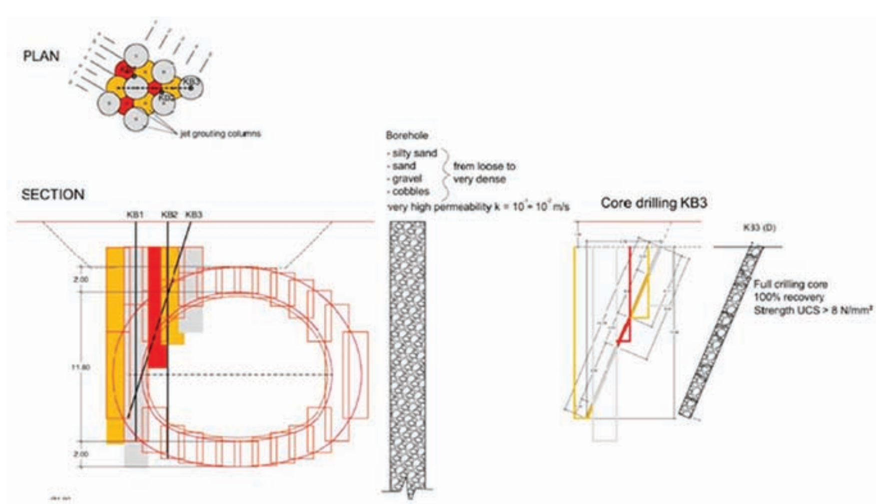


Figure 3. A full scale test (section and plan view) was performed to assess the constructability.

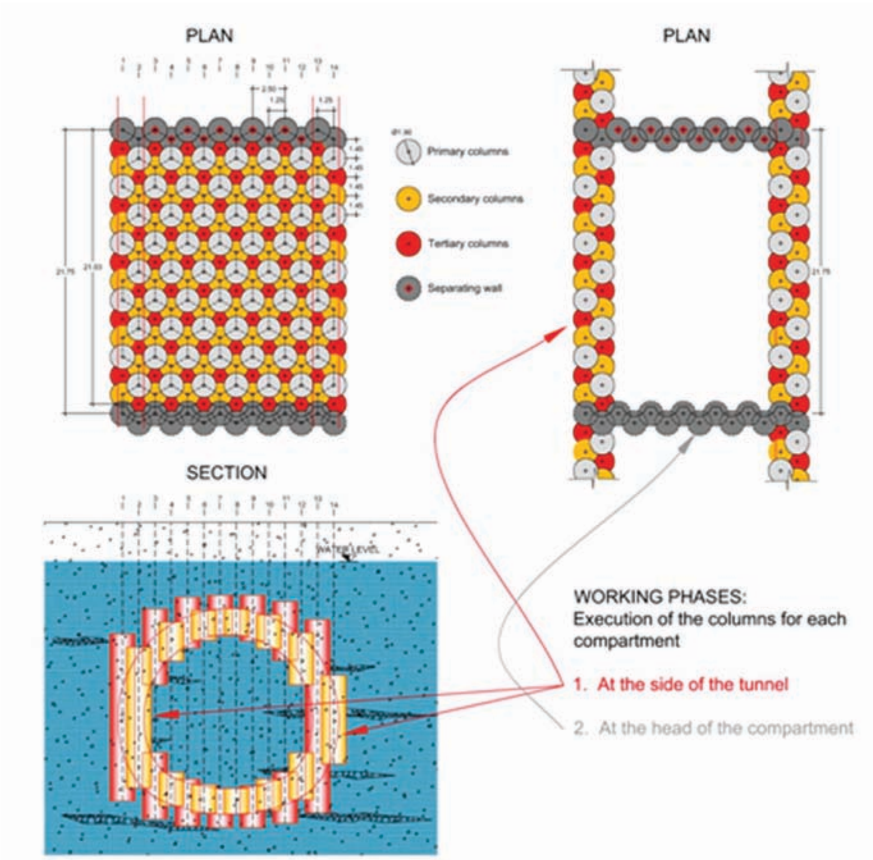


Figure 4. Pattern of columns for each compartment (typical).

tertiary columns were lengthened so as to create plugs that sealed any residual imperfections between the primary and secondary columns. Each compartment was separated from the successive one by buffer columns.

Each of the 38 compartments consisted of approximately 400 vertical columns (see Figure 4). Where constraints at the surface exist, i.e. next to the motorway junction, the columns were inclined. For this reason, a special QA/QC program was implemented to assure that each single column was drilled at the correct angle, in the correct position, and using the correct parameters.

In total 9,000 boreholes were drilled, for the construction of 15,300 jet grouted columns positioned in the upper part of the tunnel, in the lower part and at the sides. In total, 210,000 linear meters of holes were drilled, with a maximum length of 35 m. The total consumption of dry binder was 160,000 tonnes, i.e. up to 800 tons of binder per day.

Quality control

Quality control was particularly strict to comply with the rigid tolerances allowed by the project, both during the project phase and the execution of the jet grouting. Before work began, TREVI developed a 3D-modelling system (see Figure 5), to assess the overlap of each column with the adjacent one. During the execution phase, the axis of the columns was determined with a topographical device, and its positioning was monitored by the a down-the-hole probe. All data were subsequently conveyed to the technical office and to quality control.

To this end, a series of devices were used:

1. Topographical instrumentation for the accurate installation of the equipment;
2. Automatic recording device to record the data of drilling and jetting;
3. Down-the-hole survey probe to measure the actual direction of drilling axis.

The data collected from each device were used for the modelling of the geometrical data. Finally, using the actual diameters of the columns, the 3D-model was checked to measure the actual overlapping of the columns. The different length of each column, determined by its location and its position in the sequence, just added complication to the system.

In order to speed up the process, without impairing the accuracy, a system was created to guarantee a quick management of parameters obtained from the devices, involving the management of two databases. Each drilling rig was equipped with 2 prisms located at the mast's top and base, so as to allow a careful positioning by focusing them thanks to an automatic total station. The starting coordinates of each hole had to be entered into the software of the borehole survey probe.

Database 1 contained the design data, and it was used at the planning stage of each working day. It contained the relevant data of each column: positioning coordinates according to different local systems, the treatment's depth data (top and bottom depths of each jetting interval), jetting parameters, etc. Said data made it possible to set up the automatic parameters recording device. In order to supply each team with the relevant information for the correct execution of each column in a timely manner, a tag was automatically generated for each column by the database 1, by selecting the column number in the computer.

The second database contained the as-built data of each column, collected from the data returned by the recording devices. This database, thanks to an automatic calculation system, was capable of checking the minimum dimensions of the overlapping area

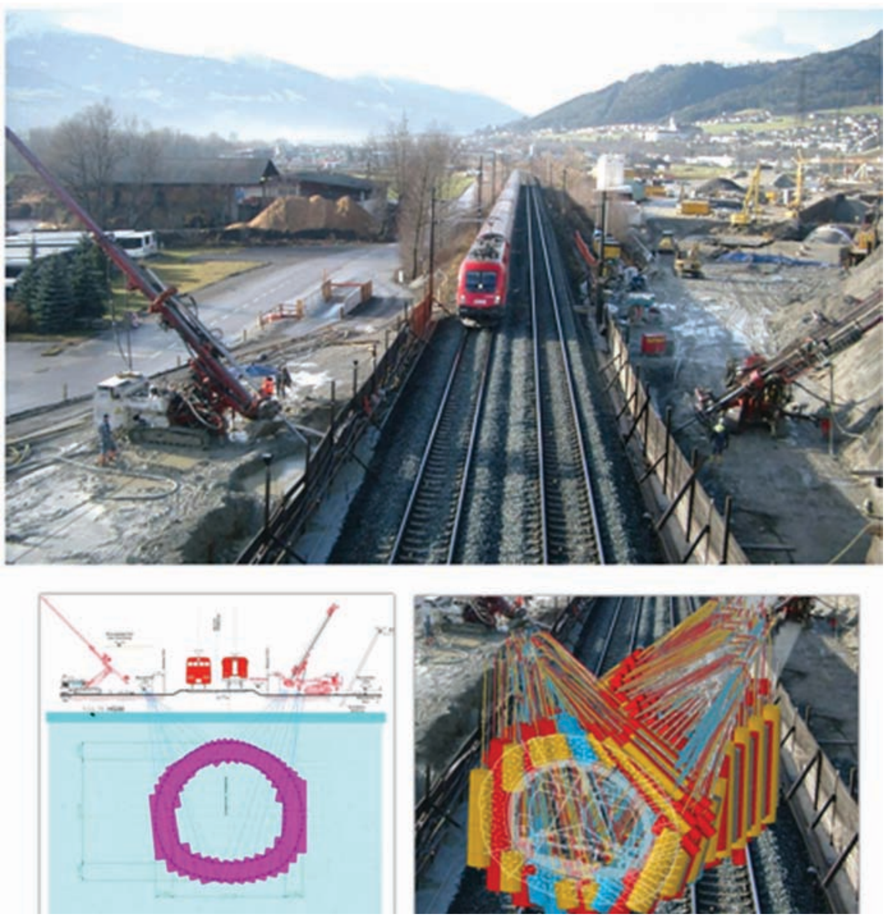


Figure 5. Panorama of two rigs working on the two sides of the existing railway line. At the bottom, the cross section (left) and a 3D view of the final shell created by the jet grouting (right).

between pairs of columns. Moreover it allowed for the calculation of the starting coordinates of a possible additional column, in case the target was not reached.

The data contained in the database were used to create the 3-D model of the installed columns. Starting from the model, a plan view with four transverse sections and a longitudinal section for each section was created.

A 3-D drawing was created for each compartment, allowing the extrapolation of some sections at different depths.

Final control and results

The final controls were focused on assessing the strength of the jet grouting bodies, and the final permeability. To this end, corings were used to collect samples to be tested for crushing tests, and pumping tests were performed to measure the resulting quantity of water.

As said, the design was asking for a minimum uniaxial compressive strength of 5MPa: the tests gave a minimum strength of 8MPa.

The compartments were all successfully tested using pumping tests. The average water flow was measured in 2.5 liters per second (compared to the 5 liters per second tolerated by the design).

Conclusions

The method proposed by Trevi enabled the achievement of the desired features in terms of water tightness and strength requested by the design.

In spite of the complex geology, where the groundwater was running at high velocity, the excavation of the tunnel 20 m below water table and 32 m below grade, has been performed safely without major difficulties, in dry conditions.

Last but not least, to be noticed that the railroad was continuously operating 365/7/24 during the execution of the jet grouting works with only a slight reduction in the speed of the trains. For safety purposes, potential movement of the railroad tracks were monitored in real time and no issues were observed during the execution of the jet grouting works.

References

Greeman, A., 2009: *Cutting through Austria's Inn Valley*. Tunnels & Tunnelling International, November, pp.16-19.

AA.VV., 2010: *From the ground down*. World Tunnelling, March, pp.10-11

And, as usual, the same request, asking you to send me your grouting comments or grouting stories or case histories. My coordinates are: Paolo Gazzarrini, paolo@paologaz.com , paologaz@shaw.ca or paolo@groutline.com.

Ciao! Cheers!

Introduction by John Dunnicliff, Editor

This is the 80th episode of GIN. Two articles this time.

Wireless monitoring

The first article, by Simon Maddison, is titled "The Fundaments of Wireless Monitoring – Things to Consider". The idea for this title came from David Cook's excellent article in the December 2010 episode of GIN, "Fundamentals of Instrumentation Geotechnical Database Management – Things to Consider". It seems to me that this format creates a very user-friendly guideline for the practitioner who is faced with the task of deciding what to do. Three of the sessions at the second International Course on Geotechnical and Structural Monitoring in Italy (see below) will have this format:

- Vibration monitoring
- Wireless monitoring
- Automatic data acquisition systems

If you'd like to have a Word file of Simon Maddison's article so that you can create a checklist of things to consider, by copying and pasting, please let me know. The same applies to David Cook's article.

Widespread misconceptions involving …

How's that for an eye-catching title? The second article (another by Glenn Tofani─his earlier one was in the previous episode of GIN, titled "Resolving unexpected monitoring results") provides yet more support for using the fully-grouted method for installation of piezometers. It also guides us in avoiding widespread misconceptions involving soil gas sampling probes installed above a sub-slab vapor barrier.

Interest in the fully-grouted method for installing piezometers

In their Summer 2014 Quarterly Newsletter GKM Consultants, Quebec, Canada (www.gkmconsultants.com) wrote the following, under a heading "Did You Know?":

> *The fully–grouted borehole method simplifies the installation of piezometers (vibrating wire and other diaphragm transducers), provides quick and reliable response readings, lends itself to nested installation and can reduce the costs by up to 75% compared to the conventional method (sand pack filter and bentonite plug). Although some of our clients still question this method, it is interesting to know that it is gaining in popularity. Supporting documentation on this subject can be found in the June 2012 edition of Geotechnical News [Contreras et al]. Other very interesting articles are available online at www.geotechnicalnews.com/instrumentation_news.php.*

GKM Consultants can receive from their mailing portal the number of clicks (opens) for the Contreras et al article. The latest count is more than 3000 clicks!

To clarify: in my view the fully-grouted method is suitable for vibrating wire, diaphragm piezometers with electrical transducers and fiber-optic piezometers, but not for pneumatic piezometers. But see my editor's note in Glenn Tofani's article, with "**Does anybody have anything to contribute to this**" – the question as to whether the fully-grouted method is suitable for pneumatic piezometers.

Second International Course on Geotechnical and Structural Monitoring in Italy, June 4-6, 2015

Planning for the second course in Tuscany, Italy is well underway, and registration is open. Visit www.geotechnicalmonitoring.com. The list of 14 speakers includes **John Burland** of Imperial College London, **Michele Jamiolkowski** of Technical University of Turin (both of whom were leaders on the International Committee for the Safeguard of the Leaning Tower of Pisa), and **Elmo DiBiagio** of Norwegian Geotechnical Institute.

More information is on page 34.

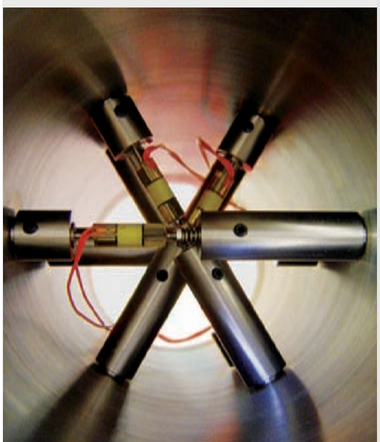
Substantial coverage will again be provided on remote methods for monitoring deformation─it seems to me that these methods are more widely accepted in Europe than in North America, so my North American colleagues may want to join us to get up to speed. As John Gadsby wrote in the previous issue of this magazine, "Travelling to Tuscany just for a three-day engineering course may seem onerous, but you can always extend your visit by adding a vacation and joining one of the nearby world famous cooking schools or wine schools".

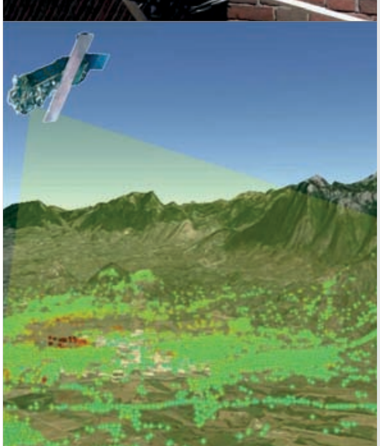
The first course, in June this year, was a great success─it was sold out two months before the beginning of the course, with 100 participants from 27 countries.

Closure

Please send an abstract of an article for GIN to *john@dunnicliff.eclipse.co.uk* —see the guidelines on *www.geotechnicalnews.com/instrumentation_news.php*

Kassutta: "Let our glasses meet"! (Greenland).





The fundaments of wireless monitoring – Things to consider

Simon Maddison

Introduction

Although wireless sensors have been around for some time, the take up in the geotechnical world has been very low to date. It is technically challenging to develop a truly robust solution with precise and stable sensing, long battery life and seamless mains-power free data transmission to the user. There are many companies and solutions in the market claiming they can achieve the above, but in reality many market offerings are still immature. Nonetheless wireless is now being recognised as a practical and robust option for geotechnical monitoring. There are many factors to consider with the design of any geotechnical monitoring system, and this article is a guide for users that specifically applies to the use of wireless sensors and enabling robust communication links. As a background, and without getting unduly technical, it includes a general guide to the different architectures of wireless systems with the aim of helping the industry pose the right kinds of questions.

Proven and robust wireless solutions offer important advantages in many situations, by reducing costs, dramatically cutting installation manpower and eliminating reliability and other issues associated with cabling. Furthermore proven wireless is now beginning to be recognised for opening up monitoring opportunities which would otherwise either be very difficult if not impossible to achieve. This article rounds off with some discussion as to these possibilities, to show that wireless can be much more than an efficient and cost saving alternative to wired systems.

Generic wireless architecture

First let's explore the principal elements of a generic wireless sensor network. This is shown in Figure 1. A sensor is connected to (or integrated within) a wireless sensor node. One or more of these communicate via radio to a data collection unit, in order to send back the measurement data.

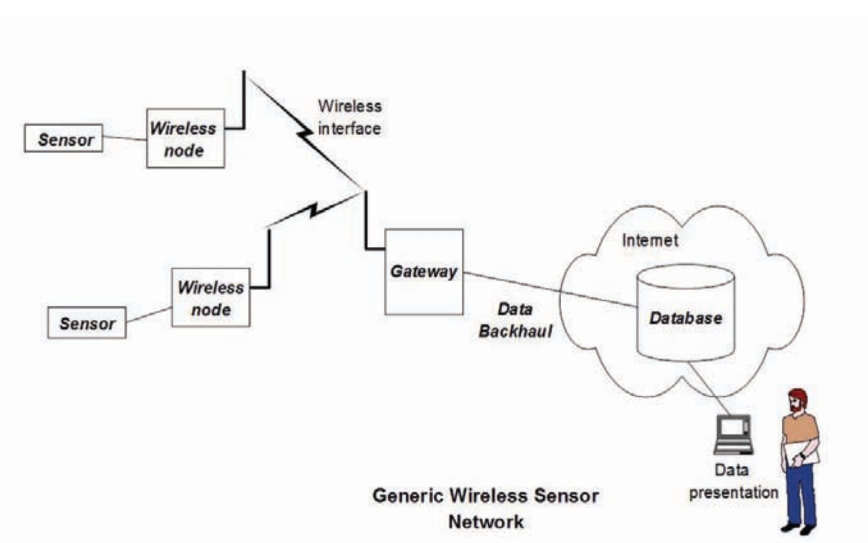


Figure 1. Generic wireless sensor architecture.

This could be simply a data logger, where the data is stored and manually collected, or it could be automatically passed back to a remote data storage location, in which case it is commonly described as a ***gateway***. The data link back to the remote storage is commonly described as ***data backhaul***. Data backhaul can be effected using one of many different mechanisms, for example: dial up modem; ADSL; GSM/GPRS/3G or via a satellite link. The solution chosen will very much depend on the resources available in the environment where it is installed, which will be discussed below. Data are then stored in some form of data base (which could be a data warehouse in the 'Cloud' or simply on a PC). It can then be accessed by the user, either for semi manual processing (e.g. in a spreadsheet application such as Microsoft Excel) or rendered graphically and dynamically by a dedicated software package.

Other than to note that there are some well-established commercially available data visualisation and management packages, and that there continues to be rapid evolution in graphical power and flexibility, it is beyond the scope of this article to go further into data rendering; the focus will be on the wireless elements. Additionally, although as indicated above there may be situations where a wireless node is simply connected to a data logger, for the purposes of this article a full end to end arrangement as in Figure 1 will be assumed.

Wireless architectures for geotechnical sensing

There are three principal wireless architectures for sensing networks, and these are shown in Figure 2. This is not intended to be exhaustive, but to

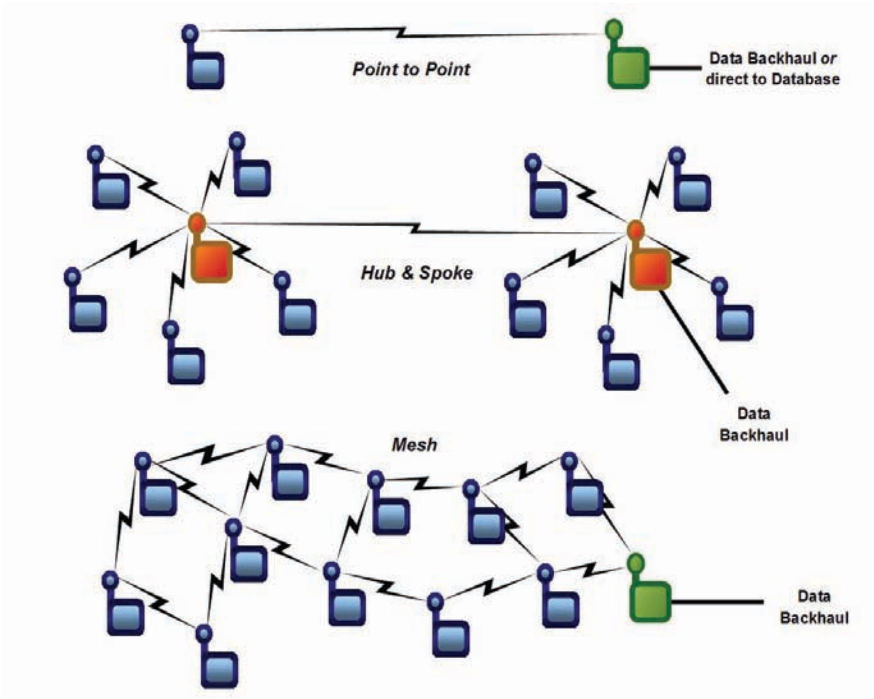


Figure 2. Wireless architectures for sensing.

identify the main types. These will be discussed in turn.

Point to point

Point to point is the simplest wireless architecture. This comprises a remote sensor node that communicates via radio directly with a gateway. The gateway provides the data backhaul to the database, but it could be collocated with the main data storage system. This architecture is suitable for single or widely dispersed monitoring points, and might typically use GSM/GPRS as the wireless link, or satellite for very remote locations.

Hub & spoke

In a hub and spoke system wireless sensor nodes communicate directly with a 'relay' or 'controller' node. Each sensor node needs to be within range of such a node. The relay nodes then in turn communicate (directly or indirectly) with a primary controller node, which acts as a gateway. This then forwards the data to the data storage system via a data backhaul. This is often characterized as a hierarchical network, as the nodes act as 'slaves' to the controller or relay nodes. Typically these systems use low power, short range wireless for sensor node communications and are suitable where clusters of sensors are required. However the relay and controller nodes have significant additional power requirements associated with their need to relay messages; in practice these must be provided with an external power source.

Mesh

In a mesh network, each node communicates with one or more of its neighbours. All the nodes in the network are equal in status, and this is often characterized as a non-hierarchical network architecture. The nodes forward data via their neighbours, using the most efficient route in the direction of the gateway. The gateway then collects the data and sends it on to the user via the data backhaul. This architecture allows for the network to be self-configuring, which makes it self-healing and robust, as well as easy to extend and amend.

Project considerations

As with any monitoring project, a number of questions need to be answered, explicitly or implicitly. This will influence the choice as to whether to use wireless or not, and the type of wireless system to be used if this option is selected.

What to measure and how often?

How many monitoring points are required? Are they close together or widely spaced? How often are readings required? I mean REALLY how often are data points required? Wireless is not generally suited to continuous or very frequent data readings as this places heavy demands on the battery power of the sensor node. As an example, in many long term structural applications, one reading an hour is more than sufficient.

It may be required to adjust the reporting rate of the sensors, for example when intense construction activity takes place or significant movements are observed. Some systems can support this. If so is it simple or does it require local intervention? Can it be done remotely via the backhaul?

Location & access

Where are the sensors to be deployed? Are they clustered in a limited space, or are they widely scattered? Is it in open outdoor space or a restricted space or even confined underground, such as a tunnel or basement? What facilities are available for power? What communications facilities are available to get the data out of the location? Is GSM or satellite possible? If not, then is there access to the telephone network, a data communications network, and/or the internet?

Is the location difficult to reach, and/or hazardous to access? What time restrictions and permissions apply to accessing the location? Are there maintenance liabilities with running cables to sensors, or are they prone to damage by engineering crews or rodents? Is flexibility required in the deployment of sensors? Is it required to extend, adapt, move or redeploy them during the monitoring period?

Network topology

If you only need one, two or a very small number of sensor points, and they are not clustered, then a simple point to point system may be quite sufficient. However these days with even a relatively few sensors, a network based solution will be equally cost effective in comparison. Networks are invariably more flexible and allow for adaptation and extension through the life of the monitoring project.

Both hub & spoke and mesh architectures provide solutions that readily support multiple sensors; however there are significant differences in configuration, flexibility, robustness and power requirements across the installation, depending on the architecture and the specific product selected.

Important considerations in the choice of architecture and supplier do require careful teasing out, as parts of the industry are still very immature. How easy is it to configure the network? Is configuration required on a sensor by sensor basis? This can particularly be an issue with hub and spoke type networks where the controller and relay nodes may require configuring as nodes are added/removed.

In a multi-hop network, such as a mesh network, how many 'hops' can be supported? If this is small, then this could considerably limit the area over which the sensors can be installed.

Power

What power is required, and how is this different for different parts of the system? Typically sensor nodes should be battery powered and give a long operational life of 5-15 years. The life however will depend on the type and make of sensor, the frequency with which readings are taken, the size of the battery cell, but it can also be influenced by where the node sits in a network. In some mesh networks for example, where there are many nodes, those nearer the gateway may use up their batteries slightly faster.

In hub & spoke systems the relay and control nodes will need external power, as they need to be on all the time. In a mesh network, typically the only item to require power will be the gateway. Is it possible to use energy harvesting to provide power where needed, for example with a solar panel? This will depend on the system supplier, and the type of backhaul used. In some implementations the power requirement for the gateway and backhaul is such that solar power is not practicable. If not, is a suitable source of mains power available in the locations required?

Data robustness

How reliable is the data transmission? Does the system retransmit 'lost' data readings? Are data readings buffered on the nodes? If so, how many readings can be stored? If a communication link is lost temporarily, does the system retransmit them when communication link is re-established? This applies to individual sensor nodes, but also to relay/controller/ gateway nodes.

Sensor stability

It may seem self evident, but of course the quality of the data is paramount, and needs to be fit for purpose. This applies particular to systems with integrated sensors, as well as those connected to external sensors. Is the resolution of the data sufficient for purpose? How stable is the data over time and temperature? Is the data liable to noise, spikes or anomalous readings?

Installation

How easy is it to install the system? Is a lot of configuration required, either before, during or after the installation? Is an intervention required on the nodes themselves? Is it possible to determine network wireless performance at the time of installation, so that the installer can be confident of system operation before leaving site? Can a contractor, surveyor or any reasonably trained individual install without significant help or support?

Wireless range

Range capability can vary considerably not just with type of system but placement and height of the wireless nodes. Key factors depend on the site, where the gateway can be located, how far the sensor deployment needs to extend and what obstructions may exist.

What is the range of each wireless node? How is this affected by local environmental factors, such as height, obstructions and vegetation? Does the system need repeaters to get around obstructions and do those repeaters need to be powered on all the time? What sort of obstructions can the wireless signal pass through? Note that generally speaking the higher the position of the antenna, the better the wireless range that can be achieved.

Frequency bands

Generally speaking wireless sensor systems (not the backhaul) operate on the internationally agreed Industrial, Scientific and Medical (ISM) radio bands, typically in the 2.4GHz or 900MHz bands. These should be license exempt, but it is important to check this against the individual country where they are to be installed, and what local restrictions there may be on wireless power or indeed the sort of application to be used.

Data backhaul

Data backhaul will depend very much upon the facilities available where the system is to be installed. In most parts of Western Europe, GSM is of good quality and available, although it should be checked in more remote locations. At its simplest, data can be stored at the gateway and collected manually, but this is clearly less desirable. For very remote locations where GSM is not available then Satellite may be a good alternative.

For confined and underground locations, then the only viable solution may be to use a wired communication link. Again the actual option will depend on the location, and a wired 'hop' to a GSM modem could be possible, a DSL link via a phone line, or an Ethernet connection, but this will very much depend on local circumstances.

The potential of wireless

The common drivers for the use of wireless for geotechnical monitoring have been cost, low maintenance and the ease of installation. Wireless sensors should typically always be cheaper to install than wired systems, as they don't need wires and should be much quicker to deploy. That has collateral benefits in terms of hazardous locations where access is time restricted, and may incur access and additional personnel costs. The elimination of wires itself may incur savings through reduction in support and maintenance during the life of the deployment.

However there are further potential benefits to using wireless. Using wireless for backhaul gives remote access to data. But the use of wireless mesh sensors allows for much more flexibility in terms of system deployment. It should be possible to add sensors to a system, irrespective of sensor type, to extend the specific application as well as reconfiguring the system as needs dictate, with a minimum of effort and without the need for specialised skills.

Wireless also offers the possibility of monitoring where wired or other systems, such as optical based (robotic total station) systems are not feasible, because of space and other constraints. Wireless also lends itself to tactical deployment where sensing is required in a dynamic environment, as engineering and construction works move over an asset. Again this should be possible without specialised skills.

Finally, the evolution of electronics is going to continue to drive evolution of wireless sensing, with units becoming ever more energy efficient, smaller so they are simpler and less obtrusive to deploy, and falling in cost so that it will be ever more economically viable to deploy sensors comprehensively on assets where it has not be considered possible in the past.

Simon Maddison
Chief Operating Officer,
Senceive Ltd.
Hurlingham Studios, Ranelagh Gardens, London SW6 3PA, England
Tel: +44 7679 5720
email: smaddison@senceive.com

Widespread misconceptions involving liquid or vapor flow in geotechnical monitoring applications

Glenn Tofani

This article presents examples of two geotechnical monitoring scenarios where liquids or gases are transmitted across what are commonly perceived to be relatively impermeable barriers. The first case involves the transmission of groundwater hydrostatic pressure to a pressure transducer embedded within a column of cement/bentonite grout. The second case involves the transmission of vapors (Volatile Organic Compounds or VOCs) across an engineered barrier placed below a floor slab that is intended to block their transmission. In both cases, there have been widespread misconceptions within the engineering and regulatory communities regarding the degree to which transmission occurs.

Fully-grouted piezometers

The first case involves the development of fully-grouted installation procedures for pneumatic or vibrating wire piezometers during the 1980s and 1990s. During the early 1980s, piezometer installations in southern California typically consisted of open standpipes or, less frequently, pneumatic or vibrating wire transducers embedded in sand backfill. It was generally recognized that open standpipes could give misleading results at stratified sites where multiple zones of groundwater occur, or where significant vertical flow gradients are present. The use of transducers to measure piezometric levels at discrete points or within relatively isolated zones was found to produce more reliable and useful data. However, the construction of multi-stage installations with transducers embedded within sand intervals isolated by bentonite seals was difficult, time consuming, and often resulted in damage to the transducers, bridging of the borehole during backfilling, or other installation problems.

Fully-grouted installations were considered as a means of eliminating these installation problems. However, many clients, consultants, and regulatory agencies were reluctant to utilize

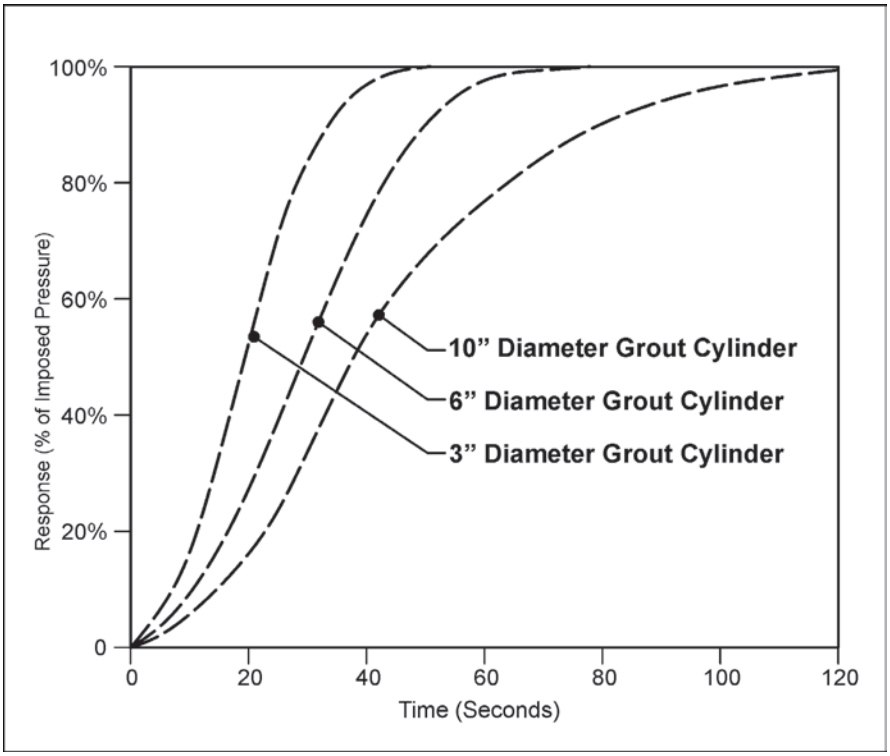


Figure 1. Response time lag for pressure transducers cast in grout cylinders.

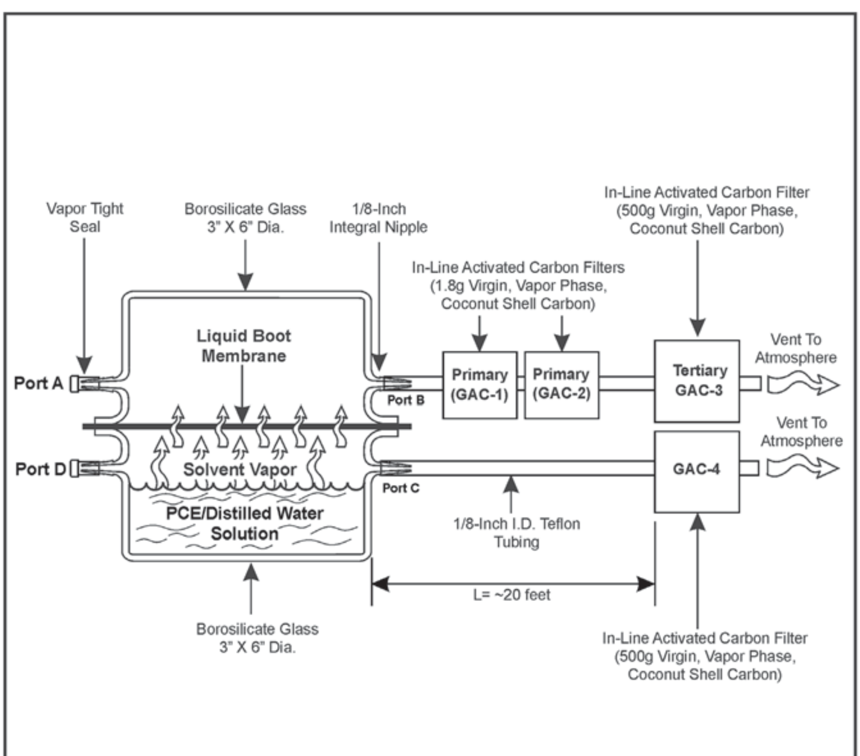


Figure 2. Vapor barrier diffusion test configuration.

fully-grouted installations. There was often a strong perception that the groundwater pressure outside of the grout column would not be fully transmitted through the grout to the embedded sensors. The low permeability of a typical grout mixture (about 1 x 10^{-6} cm/sec) contributed to this perception. Simple one-dimensional calculations suggested that an extended period of time (i.e. hours to days) could be required for a transducer embedded in low permeability grout to respond to pressure changes outside of the grout column. These calculations contributed to the skepticism.

In order to evaluate the transducer response and associated time lag, several pneumatic and vibrating wire transducers were cast in grout cylinders ranging from 3" to 10" in diameter. Each of the transducers was fitted with a 0.4" diameter by 1" long porous polypropylene filter tip. The length of each test cylinder was twice its diameter. After curing for at least 24 hours, the test cylinders were lowered into a 1 foot diameter by 8 foot long standpipe that was filled with water. The test cylinders were typically lowered two feet at a time and monitored continuously until steady state pressures were recorded. The results of a typical test series with pneumatic piezometer transducers are shown in Figure 1. As indicated, the transducers were found to respond rapidly to the pressure changes. In each case, steady state readings were obtained within 60 seconds, or less, of moving a test cylinder to a deeper or shallower depth. The stabilization time was found to be more or less linearly proportional to the diameter of the test cylinder. For all tests, the steady state readings were found to correspond to the depth of the tip of the sensor within the accuracy of the measurement (±0.5"). These testing results, and real time demonstrations, were used to convince clients, consultants, and regulators that the fully-grouted installation procedure

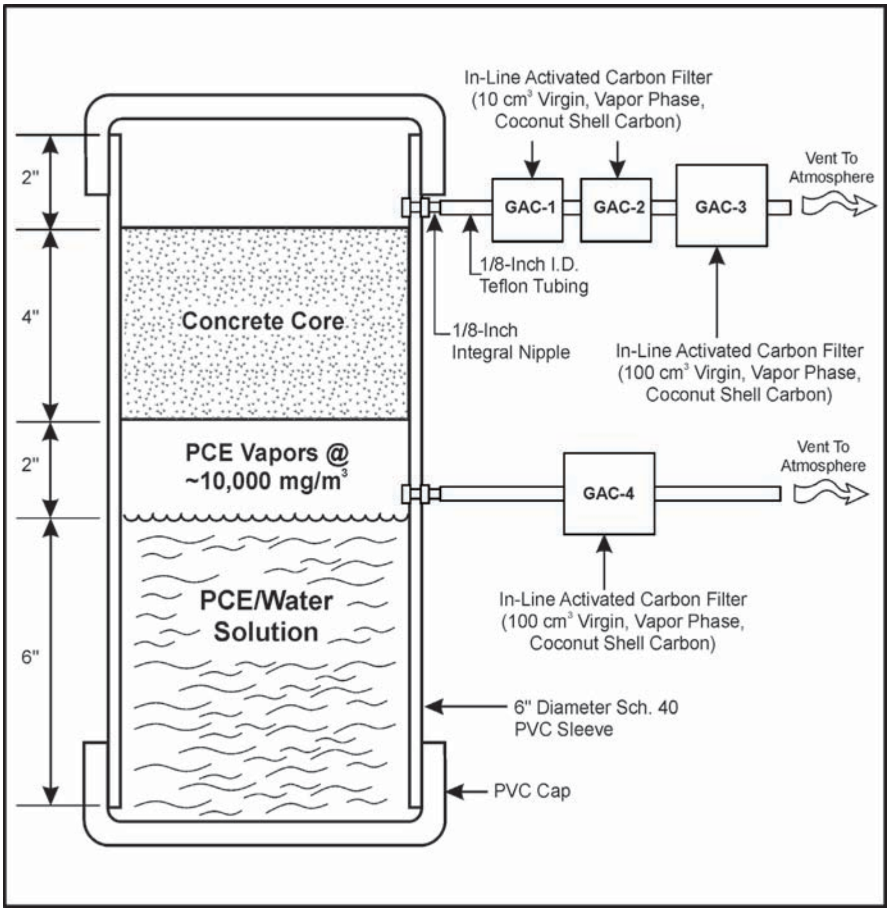


Figure 3. Concrete slab diffusion test configuration.

was a viable, and typically superior, alternative.

[I'm concerned about this apparent green light for installation of pneumatic piezometers by the fully-grouted method. There are several types of pneumatic transduces, including those that are read as gas is flowing past the diaphragm and, very preferably, those that are read under a condition of no gas flow immediately after the flow is stopped. In the latter case a volume change occurs in the pore space at the instant of reading (red book Section 8.3). I've always contended that this feature negates the use of the fully-grouted installation method for installation of pneumatic piezometers. I made this point to the author of this article, who replied: "With respect to the diaphragm displacement issue with the pneumatic transducers, we can create a situation where the pressure response oscillates as the diaphragm opens and closes (but gradually converges on a stable reading) if we cast the transducer without a filter tip. With a filter tip, we have never experienced that type of oscillation – out of several hundred installations. We have read the grouted-in-place pneumatic transducers both ways – with a slow constant air flow through a needle valve and by over-pressurizing the tip and allowing the pressure to drop and stabilize – both yield the same results within about an inch of water column". Despite this reply, I'm reluctant to change my contention and support the green light. **Does anybody have anything to contribute to this?** *J.D.]*

Sub-slab vapor barriers

The second case involves the monitoring of soil gas sampling probes installed above a sub-slab vapor barrier. Engineered vapor barriers are frequently installed beneath buildings that are constructed at sites where Volatile Organic Compounds (VOCs) such as solvents, gasoline, or other hydrocarbons are present in the subsurface. The barriers are intended to reduce the rate at which VOCs would otherwise migrate to the interior air spaces of buildings. Post-installation monitoring and evaluation of the performance of sub-slab vapor barriers is becoming an increasingly common requirement at contaminated properties. Soil gas sampling probes are often installed above and below a vapor barrier to confirm that it is functioning as expected. There is a common perception that vapor concentrations above a barrier should be very low - if not below detectible levels. The presence of elevated vapor levels in the space above a vapor barrier and below a floor slab is frequently taken as an indication that the barrier is not functioning properly. This interpretation is not necessarily correct. All vapor barriers will transmit VOCs to some extent. The purpose of the barrier is to limit the rate of VOC transmission to the interior of a building such that acceptable risk thresholds are not exceeded. High quality, intact concrete also provides considerable resistance to the transmission of many organic vapors. Although a concrete floor slab can typically not be relied upon to function as a vapor barrier for a number of reasons, the characteristics of the floor slab need to be considered when data from sub-slab vapor probes is to be used to evaluate the performance of an underlying barrier.

The diffusion coefficients for a number of vapor barrier materials have been measured for various VOCs using the test configuration illustrated in Figure 2. Similar tests have been performed to measure the vapor diffusion coefficients for concrete (Figure 3). As shown, for both the membrane and concrete tests, a water reservoir is maintained in the lower test chamber. VOCs are dissolved in the water to provide and maintain a specified VOC vapor concentration in the lower test chamber in accordance with Henry's Law. A granular activated carbon (GAC) filter is attached to the upper test chamber to absorb VOCs that diffuse across the membrane or concrete core. Both the upper and lower chambers are vented to the atmosphere to prevent the development of a pressure differential between the upper and lower chamber. Typical results obtained for one solvent (tetrachloroethylene or PCE) are shown in Table 1.

Table 1		
Material	PCE Vapor Concentration	Diffusion Coefficient
Concrete (2,500 psi)	10,000 mg/m^3	1.4 x 10^{-8} m^2/day
Concrete (5,000 psi)	10,000 mg/m^3	3.0 x 10^{-9} m^2/day
60-mil HDPE	6,000 mg/m^3	1.1 x 10^{-9} m^2/day
60-mil Spray-Applied Membrane	6,000 mg/m^3	2.4 x 10^{-9} m^2/day

Although the diffusion coefficients measured for the concrete core samples are higher than those of the membrane samples (i.e. the VOCs can diffuse more readily through the concrete), the intact concrete would actually provide a higher overall level of resistance to diffusion of the VOCs due to its greater thickness. The resistance to diffusive transmission, or impedance, is represented by the thickness of the barrier divided by its diffusion coefficient for the compound in question. Based upon a typical 4-inch floor slab thickness, the relative impedance of the materials outlined previously (normalized to 60-mil HDPE) would be as shown in Table 2.

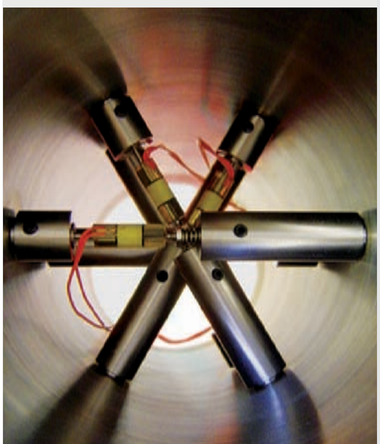
Table 2	
Material	Relative Impedance
Concrete (2,500 psi)	5.2
Concrete (5,000 psi)	24
60-mil HDPE	1.0
60-mil Spray-Applied Membrane	0.6

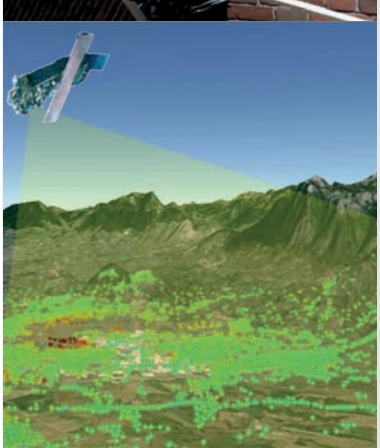
Accordingly, even low strength concrete (when intact) can provide significant resistance to the transmission of VOCs to the interior of a building. While a concrete floor slab can generally not be relied upon to function as a vapor barrier due to the potential for cracks to form within that material, the effects of the concrete floor slab on vapor probe monitoring results must be considered if the slab is in good condition.

One such example involved a former dry cleaning facility in San Diego, California where a 4-inch thick floor slab constructed of 2,500 psi concrete was present above a 60-mil spray-applied vapor barrier. PCE vapors were measured at a concentration of 5,000 ppm in a gas probe installed below the vapor barrier, and at a concentration of 350 ppm in a gas probe above the vapor barrier. The local regulatory agency initially concluded the vapor barrier was not functioning properly due to the elevated VOC levels measured above the barrier. Upon investigating the condition of the floor slab, it was found that it was in good condition with some minor localized cracking. The total area of the open cracks was found to be 0.018% of the area of the floor slab. Based upon that ratio and the testing results described previously, the impedance of the concrete floor slab was calculated to be 8% of that of the vapor barrier. It was shown that the PCE vapor concentration above the barrier, assuming the barrier was intact and functioning as intended, should be 350 ppm under that condition. This was consistent with the measured value and the barrier was approved by the regulatory agency.

Both of the cases involve common engineering monitoring problems where there are (or were) widespread misconceptions regarding the transmission of liquids or vapors across relatively impermeable barriers. In both instances, modeling and simulation of the barrier systems provided a means of understanding and quantifying the behavior and performance of those systems.

Glenn D. Tofani
Principal Engineer
GeoKinetics
77 Bunsen, Irvine, California 92618
Tel: (949) 502-5353
email: glenn@geokinetics.org





Supporting the assessment of water recovery for mines in Northern Chile

Eduardo Salfate

Northern Chile is one the driest areas in the world. Evaporation largely exceeds precipitation, in some cases by as much as 2,000 times, and availability of surface water is limited. The area holds some of the largest copper mines, an activity with high water consumption. A single mine in this area typically requires 60,000 to 70,000 m3/day of make-up water for mineral processing. As can be expected, sourcing these flows in the context of an extremely dry climate constitutes a significant challenge. The challenge is so substantial that the associated costs for obtaining this water could become the key driver of project feasibility.

The use of seawater has gained significant ground in recent years as it ensures a constant water supply for the mines and reduces the impact on limited fresh water supplies. The downside is that seawater often needs to be pumped over 100 km and over 2,000 m in elevation, which translates to high capital and operational costs.

Mining companies have focused their efforts on reducing the amount of water that needs to be sourced (pumped) from outside of the mine through the recovery of process water. If properly implemented, experience has shown that recirculation rates can range from 40% to as much as 80% of the water used in the process. In mines where copper is recovered through flotation, most processing water is discharged along with the tailings, and as such, they generally constitute the primary source for this recovery. Although thickening provides opportunities for recovering between 50% and 80% of the water in the tailings, experience shows that the lowest water make-ups are achieved in mines that also manage tailings deposition to maximize water recoveries from the impoundment. Losses due to evaporation and rewetting of dry tailings (through infiltration) are crucial for estimating this recovery and are typically predicted with unsaturated numerical models, which in the absence of proper calibration may have limited accuracy.

This article provides an overview of laboratory testing procedures that have been used to validate the results of these numerical models and increase the confidence in water balance calculations developed for the estimation of potential water recoveries from tailings impoundment in dry climates.

Tailings deposition planning and its role in water recovery

Tailings deposition is often planned and managed to meet the design objectives set for the tailings impoundment, which can include:

- Optimizing storage capacity;
- Optimizing water recovery from the impoundment;
- Minimizing operational costs and energy consumption;
- Minimizing capital investments required for the construction of start-up infrastructure; and
- Minimizing land use due to environmental or space constraints.

Deposition strategies can vary significantly depending on which of these objectives are to be prioritized, and in some cases, some of them need to be sacrificed for the benefit of others. For example, in mines with limited storage area for tailings placement, the design objective of the facility may be set towards maximizing storage volume for a given impoundment area. In such cases, tailings are deposited so that densities can increase rapidly in the impoundment. The sequencing of a large number of deposition points to control discharge rates, promote thin layer deposition and enhance evaporation and drying of the tailings could be the desired strategy under these circumstances. The outcome of such a deposition strategy (enhanced evaporative drying) would not be desired in a facility designed for maximizing water recovery, as is the case in northern Chile.

In a region with high evaporation rates and large areas of dry tailings beaches (as illustrated in Figure 1), designing a deposition strategy that enhances water recovery may require:

- Depositing the tailings to achieve impoundment geometries that result in tailings ponds with small surface areas to reduce evaporation losses from the pond;
- Controlling tailings deposition rates so that surface runoff is enhanced and travel times of tailings and water to the pond are reduced;
- Selecting deposition points that are close to the pond to reduce water losses through evaporation and rewetting as the tailings travel over dry areas; and

- Sequencing discharge points to avoid prolonged drying times of tailings beaches that could result in cracking or significant increases in rewetting losses once deposition is re-activated in dry areas.

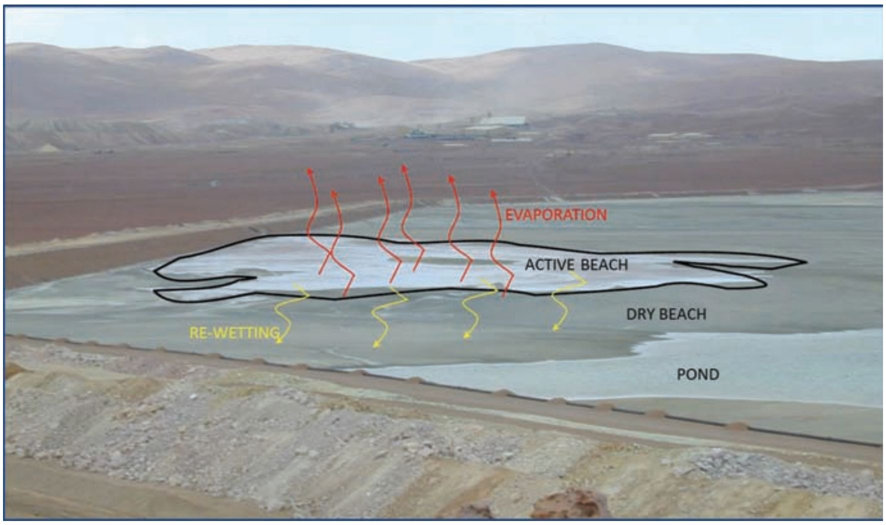


Figure 1. Tailings deposition in a dry climate.

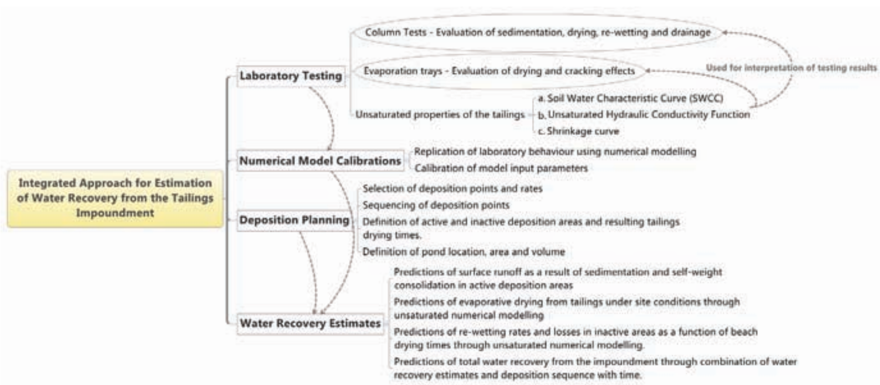


Figure 2. Integrated approach used for the prediction of water recoveries from tailings impoundments in dry climates.

The impact of these deposition strategies on water recovery in a tailings impoundment can be significant. As an example, the make-up water for one of the biggest mines in Chile was reduced by approximately 40,000 m3/day as a result of changes to the tailings deposition strategy.

Overview of the laboratory testing procedure

Although there is a general understanding of the deposition strategies that maximize water recovery in a tailings impoundment, the question that usually needs to be addressed during design is: how significant will this recovery be for the proposed deposition plan? The answer is required to determine the size of reclaim systems and seawater pumping systems, and is generally a key component of the overall mine water balance.

In dry climates, quantifying water recovery relies on developing accurate predictions of evaporation and infiltration from freshly deposited tailings as these losses dictate the amount of water that will be available in the reclaim pond for recirculation. This is often addressed through the unsaturated soil mechanics theory, which is complex and relies on numerical models that can be of limited accuracy if not properly calibrated. The laboratory testing discussed in this article has been developed to provide a basis for calibration and validation of such

Figure 3. Typical drying column setup.

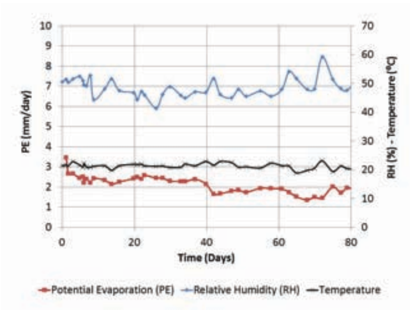


Figure 4a. Potential evaporation (PE), relative humidity (RH) and temperature versus time.

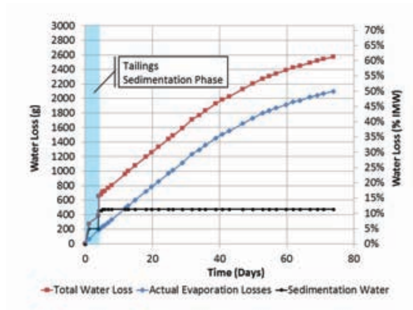


Figure 4b. Total water losses from tailings (sedimentation and evaporation).

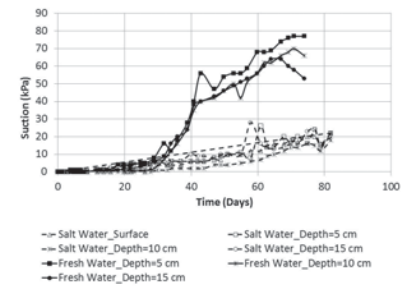


Figure 4c. Suction within the tailings versus time.

models and to increase confidence in their results. The laboratory tests are integrated into the process for water recovery estimates using the approach shown in Figure 2.

The laboratory testing procedure allows for the assessment of sedimentation and evaporation from the tailings and consists of columns that are built using acrylic cylinders as shown in Figure 3. The columns are nominally 15.24 cm in diameter, 40-cm high and equipped with:

- Measuring tape to track settlement of tailings in the column;
- Piezometers to track pore water pressures;
- Tensiometers to track negative pore water pressures (suction); and
- Ports to collect drainage and tailings samples to determine moisture content.

The tailings are placed in the columns at the target solids content dictated by mill processing, and water losses are tracked for several days by measuring the weight of the column and water outflows. Weight measurements with time determine the water losses from sedimentation (or potential surface runoff) and evaporation from the tailings or actual evaporation (AE).

Relative humidity (RH) and room temperature (under laboratory conditions) are measured throughout the test and the weight loss of a column filled with water is used to determine the rate of potential evaporation (PE) during the test. These data serve as the climatic input for validation of the numerical models.

Typical laboratory test results are shown in Figures 4a, b and c and include PE, RH, temperature, water losses in grams or as a percentage of initial mass of water (%IMW) and suction at different depths with time.

Calibration of models and predictions of tailings drying under field conditions

The results obtained from the laboratory tests are used for calibration of the numerical models required to predict evaporation and infiltration from the tailings. Calibration is carried out by comparing the AE from the tailings to modelled results using material properties and climatic data (PE, RH and temperature) measured in the laboratory. The calibration process generally considers:

- Determining the initial condition of the tailings at the time evaporative drying begins (in terms of their average density) based on the results of the sedimentation stage;
- Adjusting unsaturated properties such as soil water characteristic curves and more importantly hydraulic conductivity functions; and
- Developing appropriate considerations in the model to address the effect of crusts at the surface (crusts due to accumulation of salt at the surface result in a decrease of evaporation due to the increase of osmotic suction as shown in Figure 5a).

Computed results for AE are compared to those measured in the laboratory, and calibration is completed once computed and measured values agree (as shown in Figure 5a).

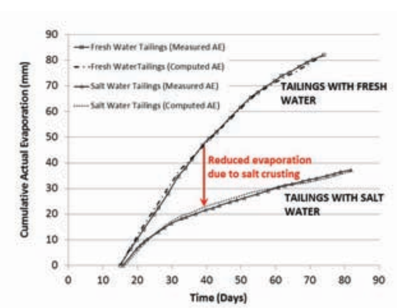


Figure 5a. Computed and measured evaporation for tailings prepared with fresh water and seawater under the same laboratory conditions.

The calibrated unsaturated models are then used to predict the expected response of tailings layers under average field climatic conditions, and the results are combined with the deposition plan to determine water recovery from the surface of the impoundment. The numerical models to predict field conditions are developed to obtain

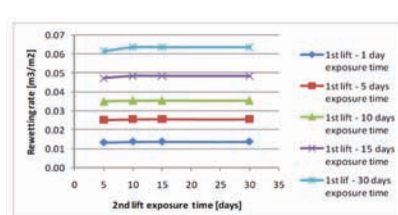


Figure 5b. Expected rewetting losses (m3/m2) as a function of tailings drying time (days).

estimates of the rate of evaporation from a freshly deposited tailings lift (1st lift), the degree of surface drying of this lift as a function of drying time (exposure time) and the associated rewetting losses upon deposition of additional tailings (2nd lift) over previously dried areas (as shown in Figure 5b). Ultimately, the modelled results for evaporative drying and rewetting losses are combined with tailings lift exposure times provided by the deposition plan to determine the overall water recoveries that result from the selected tailings deposition sequence during the life of the facility.

Conclusion

Estimates of the evaporation, drying and rewetting of tailings under field conditions are generally addressed using unsaturated soils theory and models. The accuracy of such models can be difficult to judge in the absence of information that can serve as basis for comparison and validation. Column tests have been developed to fill this gap and support the assessment of evaporation, drying and rewetting losses during the planning and design stages of a tailings deposition plan, when field scale data is not available. The approach involves measuring water losses from the tailings under controlled laboratory conditions and comparing them to those predicted by unsaturated models. Data obtained from the laboratory tests are used to calibrate the models by adjusting the tailings material properties and input parameters required to assess evaporation and drying. The tests are intended to increase confidence in the representativeness of numerical model results and to support estimates of water recovery from tailings under field conditions during the early stages of project development. Refinement of water recovery predictions and adjustments to the deposition plan should continue during all stages of design and most importantly into operations when measurements of evaporation from the tailings surface become possible.

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Eduardo Salfate
Geotechnical Engineer with Golder Associates S.A.
esalfate@golder.com

Introduction by Jonathan Fannin, Editor

Professor of Civil Engineering, University of British Columbia

Geofilters

Jonathan Fannin

In marking the return of this column in the GN:June 2014 issue, I reproduced the quotation attributed to Albert Einstein that "the value of a good education is not the learning of many facts, but the training of the mind to think of something that cannot be learned from textbooks". In the subsequent GN:September 2014 issue, I noted that we have an extensive body of technical and case-study information on geosynthetics, in the form of conference papers and peer-reviewed journal articles, much of which has been published through the auspices of the International Geosynthetics Society (IGS) and its joint USA-Canadian chapter, The North American Geosynthetics Society (NAGS). The body of technical and case-study information on geosynthetics represents a valuable source of knowledge. As Karl Terzaghi noted of knowledge development in soil mechanics and foundation engineering, such information allows us to "to discriminate between what we really know and what we merely believed". The underlying premise of Terzaghi's observation informs this column on the subject of Geofilters.

In Geofilters: Part 1, I compare the origins of current practice for the specification of a geotextile filter with those for the specification of a granular filter. I make the comparison now because the South African National Committee on Large Dams (SANCOLD) has just finished preparing, in September 2014, a very substantial revision of the 1985 ICOLD Bulletin 55 on "Geotextile Filters in Dams". The new draft bulletin, which is currently in a review-consultation process, reaches the conclusion that "Geotextiles can thus be used in non-critical aplications as primary filters and can be used as adjuncts to granular filters in critical applications to form a composite filter material". This latter statement represents a significant advance in geosynthetics engineering practice. Accordingly, it is timely to contrast the path-of-discovery through which our practice in granular filters has evolved, with the origins and development of our practice in specifying a geotextile filter. The comparison of these two materials provides an opportunity to discrimate between what we really know, and what we merely believed, about the development and relative merits of using a geotextile filter.

The companion Geofilters: Part 2 that will appear in the GN: March 2015 issue will review select guidance that is currently used for geotextile filters, and also that for granular filters, placing specific emphasis on laboratory tests recommended for evaluation of soil-filter compatibility, as well as considerations for material placement and durability. Thereafter GeoFilter: Part 2 will describe the SANCOLD activities and outline the contents of the revised bulletin. The objective is to place in context the proposed use, in dam engineering, of a geotextile filter as an adjunct to a granular filter in critical applications.

Granular filter: origins of current practice

The principle of using a filter material to control groundwater seepage and protect against subsurface erosion was first studied in a systematic manner by Karl Terzaghi, for whom it had become a special interest through some of his early consulting experience on seepage control for small weirs, most notably the weir at Hallein in Austria (Fannin, 2008). He first completed a series of fundamental laboratory permeameter tests (Terzaghi, 1922) to examine the concept of a graded granular filter. Thereafter, his laboratory testing was conducted in partnership with industry in order to establish empirical design rules for larger weirs and zoned earth fill dams, most notably the Bou Hanifia dam in Algeria (Terzaghi, 1939). Over time,

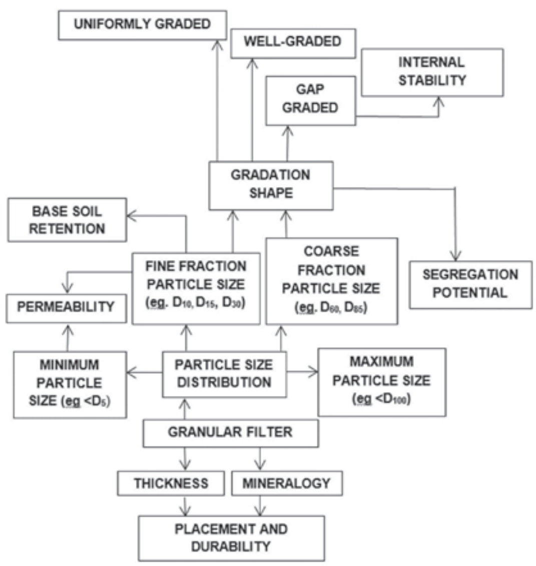

Figure 1. Functional requirements of a granular filter (adapted from Fannin and Moffat, 2002).

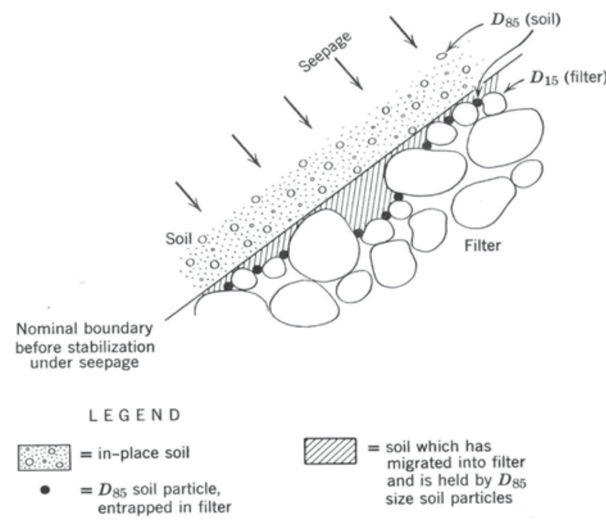

Figure 2. Base soil filter interface (from Cedergren, 1989).

a sequence of laboratory studies by other investigators led to the development and verification of the empirical rules that now govern the specification of a granular filter for different types of base soil (including, amongst other notable contributions, the laboratory findings of Bertram, 1940; Karpoff, 1955; Lafleur, 1984; and Sherard et al., 1984a and 1984b).

A granular filter material comprises one or more select gradations of cohesion less soil, for which characteristic grain sizes (Dn) are established from sieve and hydrometer testing. In effect, for a granular filter, by specifying directly the grain size distribution, the corresponding opening size distribution in the porous medium is determined indirectly. Accordingly, the properties of a granular filter are specified with reference to the range and shape of the particle size distribution curve, with additional consideration given to the mineralogy of the grains and also to the thickness at which the filter layer is placed. A schematic illustration of the causal relations between characteristics of a granular filter and functional requirements against which performance is assessed, is given in Fig. 1 (after Fannin and Moffat, 2002). Those functional requirements are:

- Base soil retention
- Permeability
- Internal instability

The characteristic grain size of the finer fraction (for example, Dn = D15) is believed to influence the pore size distribution, or more strictly the pore constriction size distribution, of the filter and, hence, the capacity for retention of the base soil (see Fig. 2). The quantity and size of the smallest particles also exert a major influence on the hydraulic conductivity, or permeability, of the granular filter. Lastly, the shape of the grain size distribution governs the potential for any seepage-induced migration of the finer fraction through the interstices of the coarser fraction, a form of erosion attributed to internal instability of the filter gradation curve (as suggested by de Mello, 1975, Kezdi, 1979; Kenney and Lau, 1985 and 1986; Burenkova, 1993; Li and Fannin, 2008; Wan and Fell, 2008; and Moraci et al. 2012, amongst others).

In addition, it can be argued there are functional requirements against which the ease of construction and serviceability are assessed, namely:

- Segregation potential
- Placement and durability

The quantity and size of the largest particles are believed to exert an influence on the potential for segregation of grains during placement of the filter, as does the shape of the gradation curve (Ripley, 1986; Kenney and Westland, 1992). Mineralogy of the granular material, and thickness to which it is placed, act to control the durability and construction method respectively (Wittman, 1979).

The causal relations illustrated in Fig. 1 are commonly described by a series of design criteria that must be satisfied by the granular filter (see for example, USDA, 1994). The specification criteria used in design are empirical, insomuch as the criteria were established from interpretation of a limited number of experimental observations, in studies conducted by different investigators, over a number of years, with occasional consideration given to aspects of theoretical analysis.

Geotextile filter: origins of current practice

Consider now the companion experience with geotextiles in filtration applications. Writing on the innovative use of woven monofilament polyvinylidene chloride and monofilament polypropylene textiles in coastal structures, Barrett (1966) reported a wide variety of filters applications that included drainage systems for vertical bulkheads and behind seawalls, use as a bedding material beneath rock-fill scour protection and breakwater structures, and placement in combination with rock fill or concrete-block revetments. In fact, the use of a woven synthetic "filter cloth" can be traced back to early product development in 1958, with innovative applications in a variety of countries including the United States, the Caribbean, the Netherlands and Spain. Reflecting on this early use, Barrett (1966) identified the benefits that were found to accrue from this new type of filter material, noting in particular:

"There are several advantages... of plastic filters... common to most types of structures

- The filtering ability is factory-controlled, and cannot be altered due to careless placement by labor.
- ... the... filter... has ... tensile strength...
- Quick, visual inspection assures ... the filter is in-place, as designed...
- It permits greater opportunity for consistency in filter design.
- Geographic location and availability of materials (sand and gravel) are eliminated as economic considerations in the design of the filter system."

The US Army Corps of Engineers (USACE) had begun using synthetic filter cloth in 1962, with recognition given to two commercially-available products in 1967, a number that had increased to about ten products by 1972, the same year in which an extensive field and laboratory study reported on material specification and companion design criteria (Calhoun, 1972). Early applications in Canada date back to the same time. USACE fieldwork at five project locations (involving applications beneath riprap bank protection and paving block protection, and around sub-drain collector pipes) established a generally excellent performance, and confirmed no significant loss of strength at locations where the synthetic filter was buried and therefore not exposed to UV light. A very extensive companion laboratory study examined five woven monofilament products, one composite monofilament and multifilament woven product, and one composite needle-punched and heat-bonded nonwoven product. Two of the woven monofilament products were identical to those used at the majority of the field sites.

The laboratory evaluation of durability was conducted with reference to low-temperature brittleness, UV light exposure, oxidation and chemical immersion, with the findings used to tabulate a series of minimum physical and chemical requirements of a textile for use in filtration applications. In addition, laboratory strength testing was conducted to determine values of grab, burst, puncture and abrasion resistance, with the findings used to establish three categories of minimum strength requirement: a category (A) for severe dynamic loading, associated with dropping of rip-rap stone at the time of installation, and continued abrasive from wave action over the service life of the structure; an intermediate category (B); and a category (C) for static loading associated with wrapping collector pipes and beneath concrete structures. Most importantly, filtration compatibility was evaluated from laboratory permeameter testing with unidirectional flow in order to investigate factors governing soil retention and permeability for applications including revetments with "relatively high seepage velocities or rapid fluctuations in the differential hydrostatic pressures" (Calhoun, 1972). The overall recommendations addressed criteria for the specification of synthetic woven textiles, and were subsequently extended to include additional criteria for nonwoven geotextiles (USACE, 1977).

At the same time, the question of material durability and filtration mechanism was the subject of companion investigations in Europe. The need for careful evaluation of minimum strength requirements was confirmed by the Norwegian Geotechnical Institute, from laboratory permeameter testing of three heat-bonded nonwoven textiles (NGI, 1974). The Delft Hydraulics Laboratory gave specific attention to filtration compatibility, conducting laboratory permeameter tests on a variety of 30 woven and nonwoven fabrics (Ogink, 1975). The importance of an intimate contact between fabric and soil was emphasized, for which observations with unidirectional flow established "a natural... filter had built up under the fabric" accompanied by an "arch effect of the grains around the pores in the fabric". For conditions of steady unidirectional flow, experimental findings were used to establish a criterion for soil retention by a woven fabric and, separately, a retention criterion for a nonwoven fabric. Where conditions act to eliminate the combined benefits of a natural filter and arching, such as may occur with reversing flow, then a more conservative soil retention criterion was recommended along with recognition of the need for additional research in support of engineering practice.

In 1977, a conference was organised in Paris by the Ecole Nationale des Ponts at Chaussées and the Laboratoire Central des Ponts at Chaussées. It was the first international conference on the use of fabrics in geotechnics, and it had a technical session on filtration at which McKeande (1977)

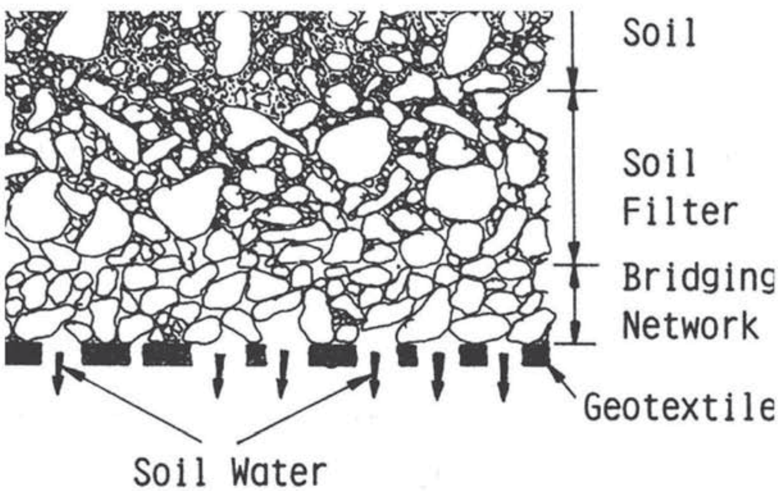

Figure 3. Base soil filter interface (from Lawson, 1982).

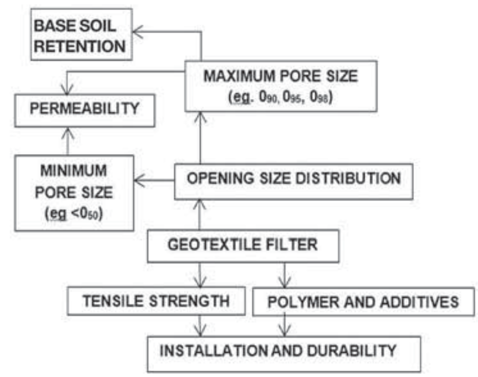

Figure 4. Functional requirements of a geotextile filter.

presented results from longer-term laboratory flow tests that supported filter design criteria established from shorter-term testing, and Giroud et al. (1977) reported on observations over a period of 6 years on the performance of geotextile filters at the Valcros Dam in France.

The general findings of early laboratory work led Hoare (1982) to note that "for unidirectional laminar flow conditions, particle retention and permeability criteria... are well established. All the approaches currently adopted tend to give similar answers and are dependent on the fabric being the 'catalyst' in the formation of a 'self-induced' filter within the soil". Lawson (1982) further observed that research had validated the underlying assumption that "a geotextile having an indicative pore size equal to the average pore size of an 'equivalent granular filter' gave similar performance", and affirmed the concept of a self-induced filter by means of a bridging network in the soil-geotextile composite zone (see Fig. 3).

In contrast to a granular filter, the opening size distribution of a geotextile is controlled directly through the process of manufacturing. Accordingly, the properties of a geotextile filter are specified with reference to a characteristic value of opening size (On) in the fabric that is established by means of an inverse-sieve analysis, with additional consideration given to the polymer type and also to the strength of the fabric. For ease of comparison, the schematic illustration of Figure 4 depicts the causal relations between characteristics of a geotextile filter, and functional requirements against which performance is assessed.

Geofilters: Part 1 - Concluding Remarks

The path-of-discovery through which the use of granular filters has evolved in engineering practice shares many similarities with the origins and development of practice for the specifation of a geotextile filter. Comparison of Figs. 1 and 4 readily identifies the common functional requirements of (i) base soil retention, (ii) permeability, and (iii) placement/installation and durability. The same comparison also draws attention to the fact that, by virtue of its manufacturing process, a geotextile does not exhibit the susceptibility to material segregation, during construction, nor internal instability, arising from seepage-induced migration of finer grains, that can occur in a granular filter. Indeed, it has been argued that segregation, together with seepage-induced internal erosion of a granular filter, constitute one of the greatest risks to be managed in dam safety engineering (ICOLD, 2014). In this regard, the potential for a geotextile to serve as an adjunct to a granular filter in critical applications, wherein the two materials provide a composite filter layer, may yield significant benefit and is deserving of careful consideration.

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A note on Review Engineer assignment for dam safety review in British Columbia

Ali Ameli

Preamble

In British Columbia (BC), Dam Safety Review studies are based on the “Health, Safety and Reclamation Code of Mines” (2008) for mining dams and the “BC Dam Safety Regulation” (2011) for dams regulated under Water Act. The studies generally refer to Dam Safety Guidelines of Canadian Dam Association (CDA) as well as provincial guidelines including BC Dam Safety Review Guidelines (2012) and the Association of Professional Engineers and Geoscientists of BC (APEGBC) Professional Practice Guidelines (2013). CDA and AEGBC Guidelines were recently updated to include items specific to mining dams.

Dams are primarily classified based on consequence of failure in terms of the risks to people, property, infrastructure, cultural values and the environment. These criteria are of public interest and thus the safety of dams would be a concern for regulatory authorities.

The dams are classified as low, significant, high, very high or extreme failure consequence. The recommended minimum frequency of dam safety activities is dictated by the dam classification. Among these activities are Dam Safety Inspection (DSI), often called Annual Inspection or Annual Review, and Dam Safety Review (DSR). The frequencies of dam safety activities are depicted in the following table, per the BC Dam Safety Regulation.

This article does not discuss the DSI, which is assigned by the owner (representative) to a qualified professional engineer or to the facility’s Engineer of Record. The reference to DSI herein is for comparison purposes only.

DSR Studies

The intent of DSR studies is to provide an independent systematic review and evaluation of all aspects of design, construction, operation, maintenance, processes and other affecting systems, such as dam safety management. These studies are carried out by a Review Engineer and the results are submitted to the owner as a DSR report. The owner will then submit a copy of the DSR report to the relevant regulatory authority.

Activity	Frequency of Activity			
	Extreme Classification	Very High and High Classification	Significant Classification	Low Classification
Formal Inspection (DSI)	Semi-Annually	Annually	Annually	Annually
Dam Safety Review (DSR) and reporting	Every 7 years*	Every 10 years**	Not Applicable***	Not Applicable

*CDA Guidelines suggest every 5 years.

**CDA Guidelines suggest every 7 years for ‘High’ and every 5 years for ‘Very High’ consequences.

***CDA Guidelines suggest every 10 years.

Review Engineer

The Review Engineer, an individual or a multi-disciplinary team, has a significant role in assessing the safe performance of existing dams. Some of the highlights of the APEGBC and CDA Guidelines on the selection of a Review Engineer follow:

- The provincial legislation requires that a professional engineer qualified in dam safety analysis carry out dam safety reviews with an awareness that the regulatory authority will ultimately review his or her DSR report. A qualified professional engineer establishes an agreement for professional services with the client. Typically the dam owner or the operator of the dam, on behalf of the dam owner, is the client.
- The owner is responsible to ensure that the findings of the Review Engineer will not be influenced by his or her prior participation in the design, construction, operation, maintenance or inspection of the dam under review. The guidelines also advise that the same Review Engineer not carry out two consecutive safety reviews of the same dam. The objective is to ensure that the review findings are independent of any conflict of

interest and also to encourage dam owners to benefit from a range of perspectives, which can lead to identification of previously undetected performance issues.

The above established arrangements and provisions are part of the best practice to control dam stewardship activities and to minimize adverse dam safety issues that would impact the public.

Comment

The guidelines have provisions in place to attain an impartial review for DSR studies. However, the retention of the Review Engineer by the owner for a DSR may lead to a conflict of interest, which would be contrary to the intent of an independent review. Due to budgetary restrictions, not all owners put a high priority on the safety of their own dams. Also business incentives could make the Review Engineer beholden to the owner. The DSR report would thus often encourage owners to follow best practices but it does not force the owner to do so should the recommendations involve great efforts or expenditures. The danger therefore is that the DSR practice may turn into a formality; when in fact it should be a guarantor that the dam design and performance are sound.

Recommendation

The DSR is regarded as a milestone review of the dam, normally applicable every 5 to 10 years for dams with an extreme to significant classification. Under the present system, the owner retains the Review Engineer. To enhance the review system and ensure an unbiased study, it is recommended that the regulatory authority appoint the Review Engineer, who will then interact with the owner or owner's engineers for harmony in review tasks. It is thus advised to revisit the current guidelines on the above requirement.

Ali Ameli, PhD, PEng, PE
email: aameli@geoengineeringltd.com.

The author is a principal with Geo Engineering Ltd. based in Vancouver. He has over 20 years of practice in engineering and project management related to variety of infrastructure projects including (tailings) dams.

IN MEMORIAM

Gordon Eric Green 1936 - 2014

Gordon was born in Newcastle-Under-Lyme, England to Eric & Jessie Green on May 25th, 1936. He died peacefully at his home in Seattle on June 23rd, after a five year battle with multiple myeloma. He leaves behind Gabrielle, his wife of 41 years, son Andrew (wife Patti) & grandchildren Chris, Quinten, Kayla & Zackery.

A well known and highly respected geotechnical engineer, Gordon obtained a 1st class honours degree in Civil Engineering (King's College, Durham). Gordon was awarded a 2 year Fulbright scholarship in the USA where at Northwestern University he obtained an MS in Soil Mechanics in 1962. He completed his stay by working briefly for Shannon & Wilson in Seattle, then resuming his studies in England at Imperial College, London. By the time Gordon obtained a PhD in Soil Mechanics in 1969 he held the position of Lecturer in Soil Mechanics until his departure from Imperial College in 1974. Additionally, during this period Gordon served as a consultant to several European firms including Soil Instruments, the leading British manufacturer of geotechnical field instrumentation, the design & installation of which became Gordon's specialty.

Shortly after meeting & marrying Gabrielle in 1972, the Green family decided to emigrate and in 1974 settled in Seattle. Gordon rejoined Shannon & Wilson as a senior associate & later principal engineer from 1974 – 1987, where upon he joined Golder Associates. In 1988 Gordon became an independent Geotechnical Engineering & Instrumentation Consultant working in this capacity until 2011.

As a teenager, Gordon was an avid biker; then hiking & rock climbing became his passion especially the Alps where he scaled Mont Blanc & the Matterhorn mountains. Walking the entire English Pennine Way was another achievement. This love never waned & in later years Gordon & Gabrielle spent many summer vacations in the Alps or walking segments of the 600+ miles of the English Southwest Coastal Path with sadly about 300 miles to go.

Gordon loved his home where he had a well equipped & organized workshop for house or car repairs & his woodworking hobby. No dripping taps in this house! After retirement as his disease progressed, Gordon regularly tackled Sudoku & cross word puzzles in the Seattle Times over a lengthy breakfast. Cycle racing, especially The Tour de France on TV was a not-to-be-missed event. Gordon eagerly awaited the 2014 Tour which started in Yorkshire on July 5th; I'm sure he'll be watching it in spirit.