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Volume 35 • Number 1 • March 2017

GEOTECHNICAL news

A formal comparison of the geotechnical vane shear strength of food and soft tailings

RST Instruments Ltd. offers 2 Wireless Data Collection Systems to quickly get you connected to your data: **RSTAR** and **DT LINK**. Both systems offer **minimum per channel cost, extra long battery life** and **long distance data transmission.**

WIRELESS DATA COLLECTION

for Geotechnical Monitoring Instrumentation

FULLY AUTOMATED COLLECTION (REMOTELY)

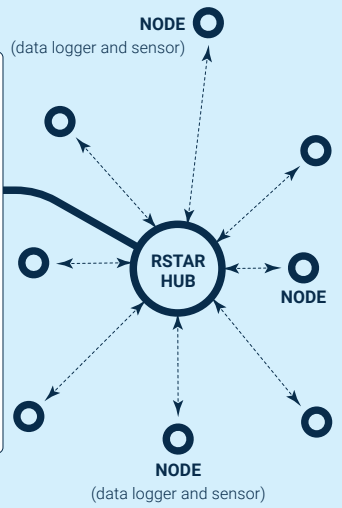
An RSTAR System uses data loggers (nodes) at the sensor level, deployed in a star topology from an active RSTAR Hub containing an RST flexDAQ Data Logger.

rstar ARRAY RADIO SERIES

FEATURES

- Up to 10 years of battery life from 1 lithium 'D' cell.
- Up to 14 km range from Hub to Node in open country. (depending on antenna type)
- Up to 255 nodes per RSTAR Hub.
- Based on 900 MHz , 868 MHz and 2.4 GHz spread spectrum band. (country dependent)

The RSTAR Hub shown left contains a flexDAQ Data Logger System with an antenna and battery. Collected data is saved to the flexDAQ memory where users can access it remotely, either on-site or off-site.



>>> Watch the video for both systems at: www.rstinstruments.com/Wireless-Data-Collection.html <<<

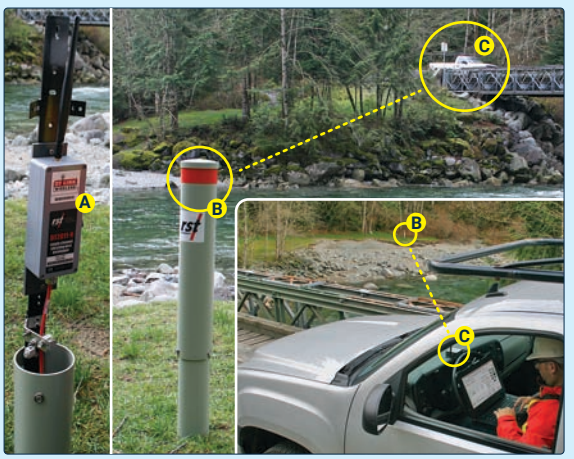
SEMI-AUTOMATED COLLECTION (ON-SITE)

DT LINK is an on-site wireless connection to RST data loggers for quick data collection. Ideal for hard to access areas where the data logger is within line of sight.

DT LINK WIRELESS

FEATURES

- Safely & easily collect data from data loggers that are in areas with poor access, trespass issues and hazardous obstacles.
- Years of battery life from 1 lithium 'D' cell.
- Range up to 800 m (900 MHz) and up to 500 m (2.4 GHz).
- Collect data in seconds with a laptop connected to DT LINK HUB.



Pictured: (A) DT LINK WIRELESS data logger, connected to a vibrating wire piezometer and housed in a (B) protective enclosure, has its data collected from a laptop connected to the (C) DT LINK HUB - all within seconds from the convenience of your vehicle.

DT SERIES DATA LOGGERS

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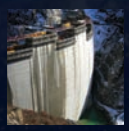
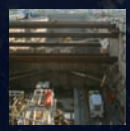
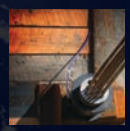
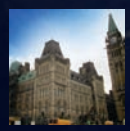
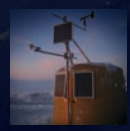


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Message from the President

Dharma Wijewickreme, President of Canadian Geotechnical Society

It is a great pleasure and honour to write this message to the CGS membership as I begin my two-year role as the President of the Canadian Geotechnical Society effective January 1st, 2017.

Let me begin by congratulating and thanking our outgoing CGS President **Doug VanDine** and his team for their numerous accomplishments over the past two years. Doug and his team contributed to the Society on many fronts including: streamlining Society activities, refining protocols, formalizing many administrative and affiliation agreements; the operational efficiencies generated from these improvements are genuinely appreciated by the incoming team. The new website that we have is a direct result of Doug's relentless effort supported by the CGS Executive and Administration, in close collaboration with the CGS National Office.

It is important to introduce and appreciate the new team who will be working hard to lead and support the CGS activities through key volunteer roles in the CGS Executive, Sections, Divisions, Committees, external representations. As mentioned during the last Annual Business Meeting in Vancouver in October, our new Executive Committee members are: VP Technical **Suzanne Powell** (Geotechnical Engineer, Thurber Engineering Ltd.); Vice President Financial **Kent Bannister** (Senior Geotechnical Engineer, Trek Geotechnical Inc.); Vice President Communications and Member Services **Jean Côté** (Professor, Laval University); Technical Division Rep **Richard Brachman** (Professor, Queen's University); Section Rep **Seán Mac Eoin** (Senior Geotechnical Engineer, AECOM); and Young Professionals Rep **Ariane Locat** (Professor, Laval University). Richard, Seán and Ariane served in the same capacities in the previous administration, and they have kindly agreed to continue for another year.

The CGS is further strengthened due to the extensive volunteering by our membership to serve as Section Directors, Division Chairs, Committee Chairs and Chair of the Geotechnical Research Board, and their respective executives and members.

The other key strength is mobilized from our enthusiastic CGS National Office administration team: **Michel Aubertin** (Executive Director), **Wayne Gibson** (Director, Administration and Finance) and **Lisa McJunkin** (Director, Communications and Member Services). The Society is well served by Michel, Wayne and Lisa, their strengths derived from already gathered wide experience and familiarity with the CGS organization.

Let me take the opportunity to highlight some of the points I mentioned in my brief President's message in the January issue of the CGS GIN. With our strong financial position, we will be undertaking a number of major initiatives in the coming months. The engagement and involvement of membership are some key elements that our CGS team will be promoting over the next two years. Let us work together to identify ways for the CGS to effectively receive the viewpoints of the membership, and certainly to enhance the opportunities for the members to readily contribute to and participate in the Society's activities.

I would also like to update you on the initiatives that are underway with respect to the Canadian Foundation Engineering Manual (CFEM). We will soon have the Errata for the existing CFEM 4th Edition completed and posted on the CGS website. We are now fully geared up for work on the next edition of the CFEM, which is going to be a full online version; two Advisory Committees have been formed to attend to the technical and publication aspects, respectively. I will keep you informed as we make progress on this task.

Finally, I would like to invite you to attend our 70th Annual CGS Conference in Ottawa (please visit the conference website ***http://www.geoottawa2017.ca/*** for more details). GeoOttawa 2017 will be an exciting event in our National Capital, since this key CGS milestone is going to be celebrated along with the 150th anniversary of Canadian Confederation.

Provided by Dharma Wijewickreme
CGS President 2017 - 2018

Message du président

C'est un grand plaisir et un honneur d'écrire ce message aux membres de la SCG alors que j'entame mon rôle de président de la Société canadienne de géotechnique d'une durée de deux ans à compter du 1erjanvier 2017.

Permettez-moi de commencer en félicitant et en remerciant notre président sortant de la SCG, **Doug VanDine**, et son équipe pour leurs nombreuses réalisations au cours des deux dernières années. M. VanDine et son équipe ont contribué à la Société sur de nombreux fronts, notamment en réorganisant certaines activités de la Société, en améliorant les protocoles et en officialisant de nombreux documents administratifs et ententes d'affiliation. L'efficacité opérationnelle découlant de ces améliorations est vraiment appréciée par la nouvelle équipe. Notre nouveau site Web est un résultat direct des efforts inlassables de M. VanDine, soutenu par le Comité exécutif et l'équipe administrative de la SCG, en étroite collaboration avec le Bureau national de la SCG.

Il est important de présenter et de reconnaître les membres de la nouvelle équipe qui travailleront fort pour mener et soutenir les activités de la SCG en assumant des rôles de bénévole au sein du Comité exécutif, des sections, des divisions et des comités de la SCG, ainsi que comme représentants externes. Comme mentionné durant la dernière assemblée annuelle à Vancouver en octobre, les nouveaux membres de notre Comité exécutif sont: la vice-présidente technique **Suzanne Powell** (géotechnicienne, Thurber Engineering Ltd.); le vice-président aux finances **Kent Bannister** (géotechnicien principal, Trek Geotechnical Inc.); le vice-président aux communications et aux services aux membres **Jean Côté** (professeur, Université Laval); le représentant des divisions techniques **Richard Brachman** (professeur, Université Queen's); le représentant des sections **Seán Mac Eoin** (géotechnicien principal, AECOM); et la représentante des jeunes professionnels **Ariane Locat** (professeure, Université Laval). M. Brachman, M. Mac Eoin et Mme Locat assumaient les mêmes fonctions dans l'équipe précédente, et ils ont aimablement accepté de poursuivre pendant une autre année.

La SCG est avantageusement renforcée par la forte participation bénévole de nos membres à titre de directeurs de section, de division et de comité, ainsi que de président du Conseil de recherche en géotechnique, en plus des membres de ces organisations et leur Comité exécutif.

Une autre force de la SCG réside dans notre équipe administrative enthousiaste du Bureau national de la SCG : **Michel Aubertin** (directeur général), **Wayne Gibson** (directeur, Administration et finances) et **Lisa McJunkin** (directrice, Communications et services aux membres). La Société est bien servie par MM. Aubertin et Gibson, ainsi que par Mme McJunkin, dont les forces découlent d'une très bonne connaissance de l'organisation de la SCG et de l'expérience qu'ils ont acquise au fil des ans.

Permettez-moi de profiter de l'occasion pour souligner certains des points que j'ai mentionnés dans mon court message du président dans le numéro de janvier du RIG SCG. Grâce à notre excellente situation financière, nous entreprendrons un certain nombre d'initiatives importantes au cours des prochains mois. L'engagement et la participation des membres sont certains des éléments clés dont l'équipe de la SCG fera la promotion au cours des deux prochaines années. Travaillons ensemble pour trouver des façons pour que la SCG puisse recevoir efficacement les points de vue des membres, et pour favoriser leur contribution et leur participation aux activités de la Société.

J'aimerais également vous informer des initiatives en cours en ce qui concerne le *Manuel canadien d'ingénierie des fondations (MCIF)*. L'erratum pour la quatrième édition actuelle du MCIF sera bientôt achevé et affiché sur le site Web de la SCG. Nous sommes maintenant prêts à travailler sur la prochaine édition du MCIF, qui sera une version complètement en ligne. Deux comités consultatifs ont été formés pour veiller respectivement aux aspects techniques et relatifs à la publication. Je vous tiendrai informé de la progression de cette tâche.

Finalement, j'aimerais vous inviter à assister à notre 70e conférence annuelle de la SCG à Ottawa (veuillez consulter le site Web de la conférence, ***http://www.geoottawa2017.ca/index.php?lang=fr***, pour de plus amples renseignements). GéoOttawa 2017 sera un évènement passionnant dans notre capitale nationale, car cet important jalon de la SCG sera célébré en même temps que le 150e anniversaire de la Confédération canadienne.

Fourni par Dharma Wijewickreme
SCG Président 2017-2018

From the Society

Call for Nominations CGS President-elect

The next President-elect for the Canadian Geotechnical Society will be appointed January 1, 2018 and this individual will become the CGS President for 2019 and 2020. The process leading to this appointment, which will be confirmed at the 70th CGS Annual Conference (GeoOttawa 2017) in October 2017, has now begun.

In accordance with the CGS Bylaws, a Nominating Committee was formed in 2016 to nominate a suitable candidate. The Committee consisted of then-President of CGS **Doug VanDine** (Chair), **Bryan Watts** and **Suzanne Lacasse** (Past Presidents of CGS) and **Wayne Clifton**, **Robert Chapuis** and **Andrea Lougheed** (general members of CGS).

The Nominating Committee has provided the name of **Mario Ruel** as a candidate for the position of President-elect in 2018. Mario Ruel has agreed to be a candidate. You will find elsewhere in this issue a statement that outlines his objectives for the Society.

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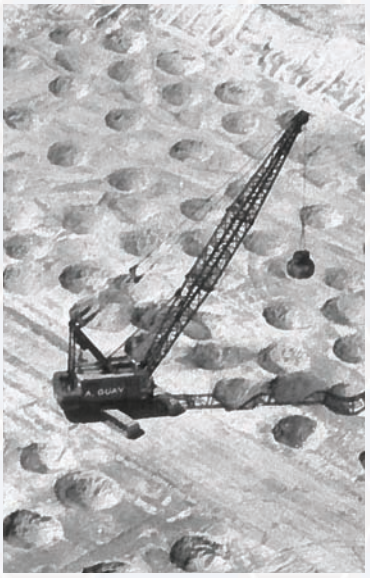

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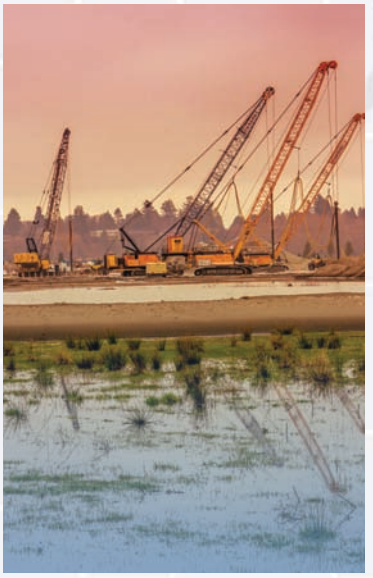

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Mario Ruel has been practicing railway geotechnical engineering throughout Canada, literally from coast to coast in nearly all provinces for the past 35 years. He strongly believes in the development and communication of engineering and science, and has been an active participant on several scientific organizations for this purpose. He has contributed to the affairs of the Canadian Geotechnical Society as Co-Chair of the successful Géo-Montréal 2013 Annual Conference and he is the current Chair of the Transportation Geotechnique Committee. Over the years, he has made presentations at CGS annual conferences and to local CGS sections across the country. He has been a promoter of practical research programs, as co-founder and past Chair of the Railway Ground Hazard Research Program (RGHRP; an efficient scientific research program with collaborative effort of the rail industry, academic institutions and federal government) and was involved in the initiation of the research Chair Canadian Rail Research Lab (CaRRL).

M. Ruel has contributed in scientific organizations within Canada, including the Tunneling Association of Canada (TAC, as past VP-East) and Association of Engineering Geology (AEG), and also abroad as active leader in the Technical Advisory Group (TAG) on Foundations for the Association of American Railroad (AAR), the Transportation Research Board (TRB) committee on Track Structure, and as guest speaker and session chair for GeoRail in France and Permanent Way Institution (PWI) in the UK. M Ruel is passionate about enhancing safety with risk management of ground hazards and has contributed to the Canadian Technical guidelines and best practices related to landslides. Mario Ruel has also been teaching foundation engineering for foreign professionals immigrating in Canada and he is a regular university lecturer on ground hazard management at ETS in Montreal. Mr. Ruel received the CGS's A. G. Stermac award and three President`s Award of Excellence at CN.

While Mario Ruel is the candidate proposed by the Nominating Committee, other nominations are also welcomed. Any general member of CGS may nominate a candidate for the position of President-elect. Nominations must be received in writing by the CGS National Office by June 15, 2017 (***admin@cgs.ca***). Nominations must include the printed names, signatures and membership numbers of at least 18 general members of CGS, and a statement by the candidate expressing a willingness to serve as President-elect and then President, if elected. For further information, contact the CGS national office.

If there is no additional candidate, Mario Ruel will be acclaimed at the CGS Board of Directors meeting in Ottawa this fall. If additional candidates are nominated, the selection of the President-Elect will be made by a general members' ballot during the summer of 2017.

Submitted by Michel Aubertin
Executive Director of CGS

Appel de candidatures Président-élu de la SCG

Le prochain Président-élu de la Société canadienne de géotechnique entrera en fonction le 1er janvier 2018; la personne choisie deviendra ensuite Président de la SCG en 2019 et 2020. Le processus devant mener à cette sélection, qui sera confirmée à la 70e Conférence annuelle de la SCG (GéoOttawa 2017) en octobre prochain, est présentement en cours.

Conformément aux règles internes de la SCG, un Comité de mise en nomination a été formé en 2016 afin de proposer un candidat approprié. Ce Comité était formé du Président en fonction de la SCG **Doug VanDine** (Président du comité), **Bryan Watts** et **Suzanne Lacasse** (anciens Présidents de la SCG), ainsi que de **Wayne Clifton**, **Robert Chapuis** et **Andrea Lougheed** (membres de la SCG).

Le Comité a proposé le nom de **Mario Ruel** comme candidat au poste de Président-élu pour 2018. Mario Ruel a accepté d'être candidat. Vous trouverez ailleurs dans ce numéro de la revue un texte qui décrit ses objectifs pour la Société.

Mario Ruel pratique depuis 35 ans le génie ferroviaire géotechnique à travers le Canada, littéralement d'un océan à l'autre, dans presque toutes les provinces. Il croit fermement au développement et à la communication de la science et de l'ingénierie, et il a participé activement à plusieurs organisations scientifiques en ce sens. Il a contribué aux activités de la Société canadienne de géotechnique comme Co-Président de la très réussie conférence annuelle Géo-Montréal 2013, et il dirige actuellement le comité sur la Géotechnique des transports. Au fil des ans, il a fait des présentations à la conférence annuelle de la SCG et pour diverses sections de la SCG à travers le pays. Il a aussi agi comme promoteur de programmes de recherche appliquée, comme co-fondateur et ancien Directeur du programme Railway Ground Hazard Research (RGHRP; un programme de recherche scientifique efficace impliquant les efforts de l'industrie ferroviaire, des institutions académiques et du gouvernement fédéral), et il a participé à la mise sur pied de la Chaire de recherche Canadian Rail Research Lab (CaRRL).

M. Ruel contribue à des organisations scientifiques au Canada, incluant l'Association canadienne des tunnels (ACT-TAC, en tant qu'ancien VP-Est) et l'Association de géologie de l'ingénieur (AGI-AEG), et également à l'extérieur comme leader du Technical Advisory Group (TAG) on Foundations, Association of American Railroad (AAR),et pour le Transportation Research Board (TRB) Committee on Track Structure, ainsi que comme conférencier invité et président de session pour les conférences GeoRail en France et Permanent Way Institution (PWI) en Grande-

Bretagne. Mario Ruel est passionné par l'amélioration de la sécurité à partir de l'analyse des risques geotechniques (ou géo-risques) et il a contribué aux lignes directrices et aux meilleures pratiques canadiennes sur les glissements de terrain. Mario Ruel a enseigné l'ingénierie des fondations aux professionnels ayant immigrés au pays, et il donne également des cours universitaires à l'ÉTS à Montréal. M. Ruel a reçu le prix A. G. Stermac de la SCG et trois President`s Award of Excellence du CN.

Bien que Mario Ruel soit le candidat proposé par le Comité de mise en nomination, d'autres candidatures sont aussi acceptées. Tout membre de la SCG peut proposer une candidature pour le poste de Président-élu. Les propositions doivent être envoyées par écrit au Bureau national de la SCG avant le 15 juin 2017 (***admin@cgs.ca***). La proposition doit inclure le nom, les signatures et le numéro d'au moins 18 membres de la SCG, avec un énoncé de la personne proposée qui exprime sa volonté de servir comme Président-élu, et ensuite (si élue) Président de la SCG. Pour plus d'information, prière de vous adresser au Bureau national de la SCG.

S'il n'y a pas d'autre candidat, Mario Ruel sera reçu par acclamation lors de la réunion du Conseil de direction de la SCG à Ottawa cet automne. S'il y a des candidatures additionnelles, la sélection du Président-élu se fera par un vote des membres de la SCG durant l'été 2017.

Soumis par Michel Aubertin
Directeur général de la SCG.

Objectives and Nomination Statement
Mario Ruel - President-Elect

I am a strong believer in the CGS and I am honoured to have been selected by the Nominating Committee of our Canadian Geotechnical Society as the President-Elect in 2018. I accept this nomination "avec grand plaisir". If elected, I will be eager to serve our Society as your President for a two-year term starting January 2019.

I have been practicing geotechnical engineering both in French and English throughout Canada and the United States for the past 35 years. Graduating as a Geological Engineer in Montreal, I started my career in Western Canada in 1981 and then completed an M.Eng in Geotechnical Engineering in Edmonton in 1988. For most of my career I have been interested in the development and communication of geo-science as I have actively participated in numerous scientific organizations as outlined in Dr. Aubertin's preceding text. Passionate about landslide problems, I strive to apply our unique geo-expertise to enhance risk management of ground hazards. I have contributed to the Canadian Technical Guidelines on landslides and am participating in the development of geotechnical manuals and geotechnical courses. I am also involved in ground breaking research collaborations as co-founder and past Chair of the Railway Ground Hazard Research Program (RGHRP), a unique partnership among industry, academia and the federal government. I am proud to have contributed to the success of the Canadian Geotechnical Society as Co-Chair of the GÉO-Montréal 2013 Annual CGS conference and I am the current Chair of the Transportation Geotechnique Committee. I had the honour of receiving the A.G. Stermac Award in 2014.

The CGS has consistently been a well managed, technically strong and financially healthy organization. Our Society is continuing to progress, for instance, with recent enhancements of our website, CGS Geotechnical Info Net (E-News) and manuals. Building from our strengths we shall continue to adapt at an even faster rate in the coming years, to better serve our Society and the evolving needs of our members.

I believe more participation from young engineers and geo-scientists will help us meet this challenge. Although student participation is already strongly encouraged in the CGS, we also need to attract and integrate more geo-professionals early in their careers. They need to see that the CGS is a dynamic organization which truly welcomes "new blood" with open arms. I remember my first CGS annual meeting; I was feeling intimidated at a luncheon table, surrounded by senior CGS members. One of them took some time with me to talk about his career, asked about my goals, gave me a few tips, then introduced me to the group and invited me to a committee meeting. He made me feel like I belonged and showed me that I was part of the group, truly part of the CGS. I think more of us, the seasoned members, should have a similar sense of duty to approach young members to make them feel part of our CGS team: Let's invite them to attend meetings and encourage them to take on leadership roles both for the benefit of their career and the future of our Society.

We are all pleased to see a growing number of women joining the ranks of geo-professionals bringing important contributions to our Society. Recent surveys confirm that Geoscience is one of the specialties attracting the highest rate of women in Canada (~40% vs ~20% in other engineering programs). I am also glad to note that women have a strong leadership presence within the CGS Executive Committee. We shall continue to encourage their participation in the success of our Society and welcome their leadership at the Board of Directors level and at the local level.

Although the vast majority of our membership speaks English, I am proud that the CGS is providing bilingual services and I am very pleased with the French version of the Canadian Foundation Engineering Manual. Although communication efforts in French are appreciated by CGS's Francophone members, I believe more can be achieved to make everyone feel part of the CGS's family, particularly

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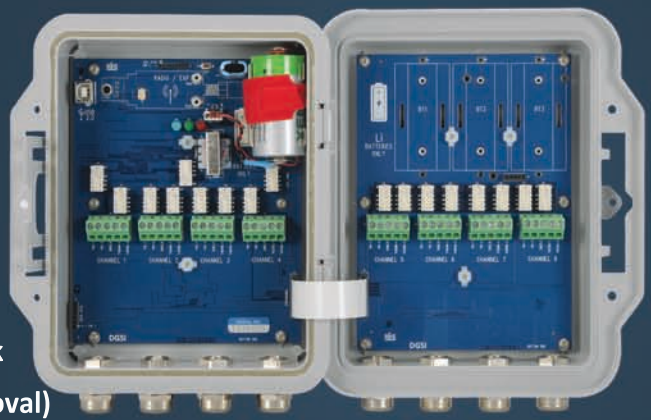

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those who are not fluent in English. Francophone members should be given opportunities and be encouraged to communicate their research and practice in French.

The CGS enjoys a great international reputation thanks in large part to our high caliber scientific publications. Even though we need to continue to count on University research communications, I intend to promote further participation from our exceptionally strong geo-professionals in practice. Sharing our successes and challenges, learning from each other with short papers on case histories will help raise our standard of practice and make our industry stronger. For elaborate projects, consultants, contractors and owners should "team-up" with our young academics who have expertise in publishing comprehensive analysis but are hungry for data and practical applications. If elected, I would use my experience on collaborative R&D to develop a framework which could simplify and encourage partnership between the industry and academics.

Our founders created the Canadian Geotechnical Society 70 years ago and generations of passionate volunteers worked hard to develop it into one of the best learned society in the world. I am thankful towards our predecessors who have invested their time on past Executive Committees for leaving us such great heritage. I strongly believe in this Society. If elected, I will do my share and lead a passionate team to work from its solid foundations to develop it for the future and ensure a great legacy for our successors.

Submitted by Mario Ruel, Nominated CGS President-Elect, 2019-2020

Objectifs comme Président élu: Déclaration de mise en nomination de Mario Ruel

Je suis un fervent partisan de la Société Canadienne de Géotechnique (SCG) et c'est un honneur pour moi d'avoir été choisi par le Comité de nomination de la SCG pour le poste de président élu en 2018. C'est avec fierté que j'accepte cette nomination. Si je suis élu, c'est avec plaisir que je servirai notre société comme président pour un mandat de deux ans à compter de janvier 2019.

Depuis plus de 35 ans, je pratique la géotechnique dans des milieux francophones et anglophones sur l'ensemble du territoire canadien ainsi qu'aux États-Unis. Après l'obtention de mon diplôme en 1981 en génie géologique à l'École Polytechnique de Montréal, j'ai débuté ma carrière dans l'Ouest canadien. J'ai également complété une maîtrise en ingénierie géotechnique à l'Université d'Alberta en 1988. Tel que décrit par Dr Aubertin dans le texte précédent, le développement et le transfert des connaissances en géosciences ont toujours été au centre de mes préoccupations. C'est avec enthousiasme que je me suis impliqué dans diverses associations scientifiques tout au long de ma carrière. Les problèmes liés aux glissements de terrain me passionnent particulièrement et je m'efforce d'appliquer notre géo-expertise unique afin d'améliorer la gestion des risques géonaturels. À cette fin, j'ai contribué à la rédaction des lignes directrices du «Canadian Technical Guidelines on Landslides» et je participe activement à l'élaboration de manuels et de cours sur la géotechnique. Je me suis aussi intéressé à la recherche appliquée en géotechnique en tant que cofondateur et ancien président du programme de recherche sur les géorisques ferroviaires (RGHRP). Cet organisme est un partenariat unique qui combine les efforts de l'industrie ferroviaire, des universités et du gouvernement canadien. Enfin, je suis fier d'avoir contribué au succès de la SCG en tant que coprésident de la conférence annuelle GÉO-Montréal 2013 et, aussi, comme président du comité sur la géotechnique des transports (TGC). J'ai été heureux d'avoir reçu le prix A. G. Stermac en 2014.

La SCG a toujours été une organisation bien gérée, techniquement solide et financièrement saine. Notre Société est en constante progression comme le démontrent, entre autres, les récentes améliorations apportées à notre site Web, au réseau d'information géotechnique de la SCG (ENews), ainsi que plusieurs manuels. Tout en nous appuyant sur ces fondations solides, nous devrons continuellement chercher à nous améliorer à un rythme encore plus rapide afin de mieux servir nos membres et de nous adapter à leurs demandes en constante évolution.

Je crois qu'une participation accrue de jeunes ingénieurs et géoscientifiques dans nos rangs nous aiderait à relever ce défi. Bien que la contribution des étudiants soit déjà fortement encouragée à la SCG, nous devons également stimuler l'implication des jeunes professionnels en début de carrière. J'aimerais leur prouver que notre Société est une organisation dynamique et inclusive qui a besoin de « sang neuf ». Elle doit donc accueillir de nouveaux membres à bras ouverts. Je me souviens de ma première conférence annuelle de la SCG. J'étais intimidé par ce grand rassemblement de professionnels seniors jusqu'à ce que l'un deux prenne le temps de me décrire un peu sa carrière et de s'intéresser à mon cheminement professionnel. Après m'avoir présenté au groupe assis à notre table, il m'a invité à une réunion d'un comité. J'ai vraiment eu l'impression d'avoir ma place à la SCG, de faire partie de l'équipe. Je crois que nous devrions faire de même avec nos nouveaux membres: invitons-les à assister aux réunions techniques et offrons-leur des rôles de leadership au sein de la Société. Cela sera bénéfique autant pour leur carrière que pour l'avenir de la SCG.

Des études récentes ont confirmé que les géosciences sont parmi les spécialités qui attirent la plus grande proportion de femmes au Canada (~ 40% contre ~ 20% dans d'autres programmes en ingénierie). Le nombre croissant de géoprofessionnelles rejoignant nos rangs est encourageant et je suis particulièrement ravi de

constater une forte présence féminine au sein du comité exécutif de la SCG. Nous devons continuer à encourager la contribution des femmes au succès de la SCG et à accueillir leur leadership au Conseil d'administration ainsi que dans les sections locales.

Bien que la majorité de nos membres soient anglophones, je suis fier que la SCG soit une association bilingue et que plusieurs services puissent aussi être offerts en français. Les efforts de traduction sont grandement appréciés des membres francophones et je suis particulièrement satisfait de la version française du Manuel canadien d'ingénierie des fondations. Toutefois, des efforts supplémentaires sont requis afin d'améliorer le sentiment d'appartenance des francophones à la SCG, particulièrement pour les membres dont la compréhension de l'anglais est limitée. Plus d'occasions devraient être offertes à ces membres afin de partager leurs projets de recherche et leurs cas pratiques en français.

La SCG jouit d'une excellente réputation internationale, grandement tributaire des communications scientifiques de haut calibre provenant du milieu universitaire. L'expérience pratique et le jugement sont aussi des qualités importantes dans le domaine des géosciences et, à cet égard, j'aimerais promouvoir une participation accrue des géopraticiens à la SCG. Nous avons la chance de pouvoir compter sur des professionnels exceptionnellement compétents dans les domaines pratiques. Apprendre les uns des autres, en partageant nos réussites sous forme de brèves présentations lors de conférences et d'ateliers, aiderait à améliorer notre niveau de pratique et à rendre notre industrie encore plus forte. Les grands projets, ayant des volets géotechniques élaborés ou complexes, pourraient être une occasion d'association entre les professionnels de l'industrie et les jeunes universitaires déjà habiles en communication scientifique, mais désireux d'obtenir de nouvelles données provenant de projets réels. Si je suis élu, je mettrai à profit mon expérience en projets collaboratifs de recherche et développement afin de déployer une structure simple visant à faciliter et encourager des partenariats entre le milieu académique et celui de l'industrie.

Il y a maintenant 70 ans que nos fondateurs ont créé la Société canadienne de géotechnique. Des générations de bénévoles passionnés ont travaillé fort afin d'en faire l'une des meilleures sociétés scientifiques au monde. Je suis reconnaissant envers nos prédécesseurs de nous avoir légué un si vaste patrimoine. Je crois fermement en la valeur de cette Société. Si je suis élu, je dirigerai avec enthousiasme une équipe passionnée et motivée aux succès de notre SCG et assurer un aussi grand héritage à nos successeurs.

Soumis par Mario Ruel,
Président 2018-2020 de la SCG.

Call for Nominations for CGS Awards

Look around. We all know at least one deserving geotechnical professional deserving of recognition!

The CGS wishes to again recognize the considerable contributions and achievements by geotechnical professionals in Canada and abroad in a family of awards, many of which will be presented during the Awards Ceremony at the CGS Annual Conference in Ottawa, ON – GeoOttawa 2017 (October 1 - 4, 2017). Funding for many of these awards is provided by the Canadian Foundation Geotechnique, so remember to also support your Foundation! The various awards are summarized below. You can also go to ***www.cgs.ca/awards.php?lang=en*** for more information and the list of past recipients, or contact CGS Headquarters.

If you know of someone deserving of any of the CGS Awards, nominate them by **May 15, 2017**. If you wish to make a submission for a Student Award, it must be received by **May 15, 2017**. Send your nominations to CGS Headquarters at:

The Canadian Geotechnical Society
8828 Pigott Road
Richmond, BC
V7A 2C4, Canada,
Fax: (604) 277-7529
E-mail: ***admin@cgs.ca***

Nominations should include the name and contact information of the nominator, a resume or curriculum vita of the nominee, and a letter highlighting the contributions and achievements that make the nominee a worthy candidate for that specific award. Letters of support from others, CGS members and non-members, are encouraged. If possible, nominations should include an appropriate head and shoulders photo of the nominee.

Submission details for Student Awards are available on the CGS website at ***www.cgs.ca/student_comp.php?lang=en***, or contact **Dr. Sumi Siddiqua**, Chair of the CGS Student Awards Selection Committee, at ***sumi.siddiqua@ubc.ca***

Appel de mise en candidatures pour les prix de la SCG

Regardez autour de vous. Nous connaissons tous au moins un professionnel en géotechnique méritant d'être reconnu!

La SCG souhaite de nouveau reconnaître les importantes contributions et réalisations des professionnels en géotechnique au Canada et à l'étranger, à l'aide d'un ensemble de prix, qui seront pour la plupart présentés durant la cérémonie de remise de prix lors de la conférence annuelle de la SCG à Ottawa, Ontario, GéoOttawa 2017 (du 1er au 4 octobre 2017). La Fondation canadienne de géotechnique finance un grand nombre de ces prix, n'oubliez donc pas de soutenir également votre Fondation! Les différents prix sont résumés ci-dessous. Vous pouvez également consulter le site ***www.cgs.ca/awards.php?lang=fr*** pour obtenir de plus amples renseignements et la liste des précédents lauréats, ou communiquez avec le siège social de la SCG.

Si vous connaissez quelqu'un méritant l'un des prix de la SCG, posez sa candidature d'ici le 15 mai 2017. Si vous souhaitez soumettre une candidature pour un prix pour les étudiants, elle doit être reçue d'ici le 15 mai 2017.

Envoyez vos candidatures au siège social de la SCG, à :

CGS Awards	
Award	**Brief Description/Comments**
CGS Society Awards	
Legget Medal	For significant lifelong contribution to the geotechnical field in Canada. The most senior and prestigious CGS award.
R.M. Quigley Award	For the best paper published in Canadian Geotechnical Journal in the preceding year. Two runners-up are also recognized. CGS membership is not required.
Honorary Life Member	For longstanding exemplary service to the CGS, and/or exemplary technical cosntributions to the geotechnical field in Canada or abroad. Only awarded occasionally.
CGS Division Awards	
G. Geoffrey Meyerhof Award	**Soil Mechanics & Foundation Division.** For outstanding contribution to soil mechanics and foundation engineering.
Thomas Roy Award	**Engineering Geology Division**. For outstanding contribution (publication or otherwise) to engineering geology.
Roger J.E. Brown Award	**Cold Regions Geotechnology Division**. For outstanding contribution (publication or otherwise) to permafrost science or engineering. Awarded biannually. Not to be awarded in 2017.
John A. Franklin Award	**Rock Mechanics Division**. For outstanding publication in rock mechanics and/or rock engineering. Awarded biannually. Will be awarded in 2017.
Geosynthetics Award	**Geosynthetics Division**. For outstanding publication in the application of geosynthetics to civil, geotechnical or geoenvironmental engineering. Awarded biannually. Will not be awarded in 2017.
Geoenvironmental Award	**Geoenvironmental Division**. For outstanding contribution (publication or otherwise) in geoenvironmental engineering. Awarded biannually. Will not be awarded in 2017.
Joint Awards	
Robert N. Farvolden Award	Joint award of the CGS **Groundwater Division** and the **Canadian National Committee of the International Association of Hydrologists**. For outstanding contribution to the disciplines of earth science or engineering, by an individual or group, that emphasize the role or importance of groundwater.
Schuster Medal	Joint award of the CGS **Geohazards Committee** and **Engineering Geology Division** and the **Association of Environmental and Engineering Geologists.** For outstanding contribution to geohazards research in North America. Awarded biannually to a CGS member.
CGS Student Awards	
Graduate Presentation	For best 15-minute technical presentation on video submitted by a graduate student at a Canadian university. One runner-up is also recognized. CGS membership is not required.
Undergraduate Individual Report	For best undergraduate student report by an individual in Canada. One runner-up is also recognized. CGS membership is not required.
Undergraduate Group Report	For best undergraduate student report by a group in Canada. One runner-up is also recognized. CGS membership is not required.
CGS Service Awards	
A.G. Stermac Award	For outstanding service to the CGS by a member at the local, national or international level. More than one award can be presented each year.
Certificates of Appreciation	For deserving CGS members recognized by the President or others as having contributed noteworthy service to the CGS.

Prix ou distinction	Courte description/Commentaires
Prix de la SCG	
Médaille Legget	Pour avoir contribué de manière importante au domaine de la géotechnique au Canada tout au long de sa vie. Le plus haut et prestigieux prix de la SCG.
R.M. Quigley	Pour le meilleur article publié dans la *Revue canadienne de géotechnique* durant l'année précédente. Deux finalistes sont également reconnus. Il n'est pas nécessaire d'être membre de la SCG.
Membre honoraire à vie	Pour un service exemplaire de longue date à la SCG et/ou des contributions techniques incomparables au domaine de la géotechnique au Canada ou à l'étranger. Décerné occasionnellement seulement.
Prix des divisions de la SCG	
Prix G. Geoffrey Meyerhof	**Division de la mécanique des sols et des fondations** – Pour une contribution exceptionnelle au domaine de la mécanique des sols et de l'ingénierie des fondations.
Prix Thomas Roy	**Division de la géologie de l'ingénieur** – Pour une contribution exceptionnelle (dans une publication ou autrement) au domaine de la géologie de l'ingénieur.
Prix Roger J.E. Brown	**Division de la géotechnique des régions froides** – Pour une contribution exceptionnelle (dans une publication ou autrement) au domaine de l'ingénierie ou de la science du pergélisol. Décerné tous les deux ans (pas de remis en 2017).
Prix John A. Franklin	**Division de la mécanique des roches** – Pour une publication exceptionnelle sur la mécanique et/ou l'ingénierie des roches. Décerné tous les deux ans. Sera remis en 2017.
Prix de la géosynthétique	**Division de la géosynthétique** – Pour une publication exceptionnelle sur l'application de la géosynthétique en géotechnique, ou en génie civil ou géoenvironnemental. Décerné tous les deux ans (pas de remis en 2017).
Prix du géoenvironnement	**Division du géoenvironnement** – Pour une contribution exceptionnelle (dans une publication ou autrement) au domaine du génie géoenvironnemental. Décerné tous les deux ans (pas de remis en 2017).
Prix communs	
Prix Robert N. Farvolden	Prix commun de la **Division des eaux souterraines** de la SCG et de **l'International Association of Hydrologists – Canadian National Chapter.** Pour une contribution exceptionnelle d'une personne ou d'un groupe dans les domaines des sciences de la terre et du génie qui met l'accent sur le rôle ou l'importance des eaux souterraines.
Médaille Schuster	Prix commun du **Comité sur les géorisques** et de la **Division de la géologie de l'ingénieur** de la SCG, ainsi que de l'**Association of Environmental and Engineering Geologists**. Pour une contribution remarquable à la recherche sur les géorisques en Amérique du Nord. Décernée tous les deux ans à un membre de la SCG.
Prix de la SCG pour les étudiants	
Présentation d'un étudiant gradué	Pour la meilleure présentation technique de 15 minutes sur vidéo soumise par un étudiant gradué d'une université canadienne. Un finaliste est également reconnu. Il n'est pas nécessaire d'être membre de la SCG.
Rapport d'un étudiant de premier cycle	Pour le meilleur rapport d'un étudiant de premier cycle au Canada. Un finaliste est également reconnu. Il n'est pas nécessaire d'être membre de la SCG.
Rapport d'un groupe d'étudiants de premier cycle	Pour le meilleur rapport d'un groupe d'étudiants de premier cycle au Canada. Un finaliste est également reconnu. Il n'est pas nécessaire d'être membre de la SCG.
Prix de service de la SCG	
Prix A.G. Stermac	Pour un service exceptionnel rendu à la SCG par un membre, au niveau local, national ou international. Plus d'un prix peut être présenté chaque année.

La Société canadienne de géotechnique
8828 Pigott Road
Richmond, C.-B.
V7A 2C4, Canada
Télécopieur: 604-277-7529
Courriel: ***admin@cgs.ca***

Les candidatures doivent comprendre le nom et les coordonnées de la personne qui les soumettent, un curriculum vitæ du candidat et une lettre soulignant les contributions et les réalisations qui font en sorte que le candidat mérite ce prix. Des lettres de recommandation d'autres personnes, qu'elles soient membres ou non de la SCG, sont les bienvenues. Si possible, les candidatures doivent inclure une photo en buste du candidat.

Les détails pour la soumission d'une candidature pour les prix pour les étudiants sont disponibles sur le site Web de la SCG, à http://www.cgs.ca/student_comp.php?lang=fr, ou communiquez avec Dr Sumi Siddiqua, directrice du Comité de sélection des prix pour les étudiants, à sumi.siddiqua@ubc.ca

Call for Nominations for 2018 Awards and Fellowships Engineering Institute of Canada (EIC)

As a constituent Society of the **Engineering Institute of Canada** (EIC), CGS members are eligible for awards and fellowships of the EIC which are summarized below. CGS members are encouraged to submit EIC nominations of fellow members to CGS Headquarters by **July 15, 2017**.

Nominations must include:

1. a completed EIC Nomination Form which is available from ***http://eic-ici.ca/honours_awards/***)
2. a nomination letter
3. supporting letters from colleagues, preferably Fellows of the EIC (FEIC).

Past CGS member recipients of EIC Awards and Fellowships can be found on the CGS website ***www.cgs.ca/awards.php?lang=en***. It is recommended that nominators review the awards details and criteria prior to preparing nominations. For more information, contact CGS Headquarters at:

The Canadian Geotechnical Society
8828 Pigott Road
Richmond, BC
V7A 2C4, Canada,
Fax: (604) 277-7529
E-mail: ***admin@cgs.ca***

Appel de candidatures pour les prix et médailles 2018 Institut canadien des ingénieurs (ICI)

À titre de société membre de l'**Institut canadien des ingénieurs** (ICI), les membres de la SCG sont admissibles aux prix et aux médailles de l'ICI décrits ci-dessous. Les membres de la SCG sont encouragés à soumettre des candidatures de collègues membres pour l'ICI au siège social de la SCG d'ici le **15 juillet 2017**.

Les mises en candidature doivent inclure :

Award of Honour	Brief Description/Comments
Sir John Kennedy Medal	For outstanding service to the profession or for noteworthy contributions to the science of engineering, or to the benefit of the EIC. EIC's most distinguished award (given every two years).
Julian Smith Medal	For achievement in the development of Canada.
John B. Stirling Medal	For leadership and distinguished service at the national level within the EIC and/or its member societies.
CP Rail Engineering Medal	For leadership and service at the regional, branch and section levels by members of EIC member societies.
K.Y. Lo Medal	For significant engineering contributions at the international level, such as promotion of Canadian expertise overseas; training of foreign engineers; significant service to international engineering organizations; and advancement of engineering technology recognized internationally.
Fellowship of the EIC	For excellence in engineering and services to the profession and to society.
Honorary Member	For non-members of the EIC and its member societies, and on occasion non-engineers, who have achieved outstanding distinction through service to engineering and the profession of engineering in Canada.

1. un formulaire de candidature de l'ICI dûment rempli qui est disponible sur le site ***http://eic-ici.ca/honours_awards/)***;
2. une lettre de mise en candidature;
3. des lettres de recommandation de collègues, préférablement des fellows de l'ICI.

Il est recommandé que les personnes qui soumettent des candidatures examinent les détails et les critères des prix avant de les préparer. Pour obtenir de plus amples renseignements, communiquez avec le siège social de la SCG à:

La Société canadienne de géotechnique
8828 Pigott Road
Richmond, C.-B.
V7A 2C4, Canada
Télécopieur: 604-277-7529
Courriel: ***admin@cgs.ca***

Les noms des membres de la SCG qui ont déjà reçu des prix et des bourses de recherche de l'ICI sont affichés sur le site Web de la SCG à ***www.cgs.ca/awards.php?lang=fr.***

Canadian Foundation for Geotechnique 2017 Michael Bozozuk National Graduate Scholarship

Dr. Dennis Becker, President of the Canadian Foundation for Geotechnique (la Fondation canadienne de géotechnique), is pleased to announce the call for nominations for its annual **Michael Bozozuk National Graduate Scholarship.**

The scholarship, valued at $5,000, was established by the Canadian Foundation for Geotechnique in 2007, on the occasion of the 60th Canadian Geotechnical Conference in Ottawa. The 2017 scholarship will be presented this fall at the Canadian Geotechnical Conference in Ottawa, Ontario.

Any Canadian or permanent resident, entering or registered in a Canadian university Masters or PhD program that is directly related to an identified field of geotechnique, is eligible. Programs include geotechnical engineering, geological engineering, mining engineering, geoenvironmental engineering or geoenvironmental geoscience, engineering geology and hydrogeology. Nominees must have high academic standing and preference will be given to those who have some practical experience and are active, or show leadership, in the geotechnical community.

Nominations are limited to **one per academic department** and require a letter, accompanied by rationale, written and signed by the graduate supervisor. Rationale should include evidence of academic standing, research output, contributions to practice, and leadership/activity in the geotechnical community. A nomination package is limited to **five pages**. For award ceremony purposes, the nomination package should also include a digital image (300 dpi) of the nominee.

Nominations for the 2017 Scholarship will be accepted by the Selection Committee Chair, **Dr. Paul Simms** (c/o Carleton University, Department of Civil and Environmental Engineering, 1125 Colonel By Drive, Ottawa

Prix ou distinction	Courte description/Commentaires
Médaille Sir John Kennedy	Pour un service exceptionnel rendu à la profession ou pour des contributions dignes de mention au domaine de la science de l'ingénierie, ou au profit de l'ICI. Plus prestigieux prix de l'ICI.
Médaille Julian Smith	En reconnaissance d'une contribution au développement du Canada.
Médaille John B. Stirling	Pour des qualités de chef et des services émérites rendus à l'ICI et/ou à ses sociétés membres, à l'échelle nationale.
Médaille CP Rail Engineering	Pour les qualités de chef et le service rendu dans les régions et les chapitres de membres des sociétés membres de l'ICI.
Médaille K.Y. Lo	Pour des contributions remarquables au domaine de l'ingénierie au niveau international, comme la promotion de l'expertise canadienne à l'étranger, la formation d'ingénieurs étrangers, un service exceptionnel rendu à des organisations d'ingénierie internationales et l'avancement d'une technologie d'ingénierie reconnu sur la scène internationale.
Titre de Fellow	Pour l'excellence en ingénierie et des services rendus à la profession et à la société.
Membre honoraire	Pour les non-membres de l'ICI et de ses sociétés membres, et occasionnellement pour des personnes qui ne sont pas des ingénieurs, qui se méritent cette remarquable distinction en raison de services rendus au domaine de l'ingénierie et à la profession de l'ingénierie au Canada.

ON. K1S 5B6, telephone (613) 520 2600 ext. 2079, ***paul_simms@carleton.ca)*** up until **May 1, 2017**. If submitted by email, nominations **must be signed** by the supervisor and include the words "Canadian Foundation for Geotechnique National Graduate Scholarship" in the subject line.

For further information, refer to the Foundation's website ***www.cfg-fcg.ca*** or contact Dr. Dennis Becker, (403) 260 2253, ***dennis_becker@golder.com***

Provided by Dennis Becker, President of the Canadian Foundation for Geotechnique

Bourse nationale pour études supérieures Michael Bozozuk 2017 de la Fondation canadienne de géotechnique

Le **Dr Dennis Becker**, président de la Fondation canadienne de géotechnique, est heureux de lancer un appel de candidatures pour la Bourse nationale pour études supérieures qui est décernée annuellement.

D'une valeur de 5 000 $, la bourse a été établie par la Fondation canadienne de géotechnique en 2007, lors de la 60e conférence canadienne de géotechnique qui a eu lieu à Ottawa. La bourse de 2017 sera décernée lors de la prochaine conférence canadienne de géotechnique, qui aura lieu dans la ville de Ottawa, ON cet automne.

Toute personne détenant la citoyenneté canadienne ou la résidence permanente au Canada, qui s'inscrira ou est inscrite dans un programme d'une université canadienne de maîtrise ou de doctorat directement lié à un domaine de la géotechnique est admissible.. Au nombre de ces programmes, mentionnons le génie géotechnique (mécanique des sols ou des roches), les génies civil, géologique et des mines, le génie géoenvironnemental ou la science géoenvironnementale, la géologie de l'ingénieur et l'hydrogéologie. Les candidats doivent avoir des notes élevées. La préférence sera accordée à ceux qui ont de l'expérience pratique et sont actifs ou font preuve de leadership dans la communauté géotechnique.

Les candidatures sont limitées à une par département. Elles doivent être accompagnées d'une lettre avec justification, rédigées et signées par le directeur de recherche. La justification devrait inclure des informations sur les résultats académiques ainsi qu'une description de ses résultats de recherche, de ses contributions à la pratique et de son leadership ou de ses activités dans la communauté géotechnique. Le dossier de mise candidature est limité à cinq pages. Le dossier de candidature devrait aussi comprendre une image numérique (300 ppp) du candidat pour la cérémonie.

Les candidatures présentées pour la bourse de 2017 seront acceptées par le président du Comité de sélection de la bourse de la Société canadienne de géotechnique, le **Dr Paul Simms** (a.s.de: Université Carleton, Département de génie civil et environnemental, 1125, chemin Colonel By, Ottawa, ON K1S 5B6, téléphone 613-520-2600, poste 2079, ***paul_simms@carleton.ca)*** **jusqu'au 1er mai 2017**. Les dossiers de candidature envoyés par courriel **doivent être signés** par le directeur de recherche et comprendre la mention «Bourse nationale pour études supérieures de la Fondation canadienne de géotechnique» dans la ligne objet.

Pour plus de renseignements, consultez le site Web de la Fondation, à ***www.cfg-fcg.ca***, ou communiquez avec le Dr Dennis Becker, au 403-260-2253 ou à ***dennis_becker@golder.com***

Fourni par Dennis Becker, Président de la Fondation canadienne de géotechnique

2016 CGS Corporate Sponsors

The CGS would like to once again thank all of its 2016 Corporate Sponsors.

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If you would like to renew your sponsorship for 2017, or like to become a CGS Corporate Sponsor, please contact **Lisa McJunkin *(admin@cgs.ca)***.

CGS Membership Registration for 2017

If you haven't already renewed your Canadian Geotechnical Society membership for 2017, or want to join...now's the time. Visit ***www.cgs.ca <Membership>***. There are no increases in membership fees for 2017.

Membership benefits include:

- online access to the monthly Canadian Geotechnical Journal, including all past issues, and special price for the printed Canadian Geotechnical Journal
- online and printed copies of the quarterly Geotechnical News, including CGS News
- the monthly electronic CGS Geotechnical Information Net
- online access to all past CGS Conference proceedings and some special lectures
- special price for all CGS conferences
- information on the spring and fall CGS Cross Country Lecture Tours
- membership in one or more of 7 CGS technical divisions and associated international societies
- involvement in one of 20 CGS local sections
- involvement in any of the 7 CGS standing committees

- involvement in THE society for all Canadian geotechnical professionals

We welcome all new and renewing members and look forward to your participation in 2017. And, we encourage you to recommend the CGS to a friend or colleague. Let's continue to improve the benefits that the CGS offers our profession.

Adhésion à la SCG pour 2017

Si vous n'avez pas encore renouvelé votre adhésion à la Société canadienne de géotechnique pour 2017 ou désirez y adhérer pour la première fois... c'est le temps de le faire. Consultez la section <Devenir membre> du site ***http://www.cgs.ca/index.php?lang=fr***. Il n'y a pas d'augmentation des cotisations pour 2017.

Les avantages de l'adhésion comprennent:

- un accès en ligne à la Revue canadienne de géotechnique mensuelle, y compris à ses numéros précédents, et à un tarif spécial pour sa version imprimée;
- des versions en ligne et imprimée de la publication trimestrielle Geotechnical New, qui comprend CGS News;
- le bulletin électronique mensuel Réseau de l'information géotechnique de la SCG;
- un accès en ligne à tous les comptes-rendus des précédentes conférences de la SCG et à certaines conférences spéciales;
- des prix spéciaux pour toutes les conférences de la SCG;
- de l'information sur les Tournées de conférences transcanadiennes du printemps et de l'automne de la SCG;
- une adhésion à une ou à plusieurs des sept divisions techniques de la SCG et aux sociétés internationales associées;
- une participation dans l'une des 20 sections locales de la SCG;
- une participation à l'un des sept comités techniques de la SCG;
- une participation dans LA Société pour tous les professionnels en géotechnique canadiens.

Nous souhaitons la bienvenue à tous les nouveaux membres ainsi qu'à ceux qui renouvellent leur adhésion et sommes impatients de vous voir participer en 2017. Nous vous encourageons également à recommander la SCG à un ami ou à un collègue. Nous continuons à améliorer les avantages que la SCG offre à notre profession.

Upcoming Conferences and Seminars

70th Canadian Geotechnical Conference and the 12th Joint CGS/IAH-CNC Groundwater Conference October 1 to 4, 2017 Ottawa, Ontario www.geoottawa2017.ca

Response to the **GeoOttawa 2017** Call for Abstracts was excellent and as of the end of the day on January 15, 2017, we had received over 475 submissions. To provide the most comprehensive conference, the Organizing Committee had decided to extend the abstract submission deadline to January 31, 2017. As this is the *70th Canadian Geotechnical Conference* and the 12th Joint *CGS/IAH-CNC Groundwater Conference*, abstracts were submitted under either the **Geotechnical** or **Hydrogeological** themes. All technical papers must be submitted by **May 15, 2017**, accompanied by at least one paid delegate registration.

GeoOttawa 2017 will recognize the Best Case Study Papers and the Best Student Papers with awards. There will be a checkbox on the final paper submission screen to indicate if you would like to be considered for these awards. Up to three case study papers will be recognized at the conference. The lead authors of the Best Case Study Paper should come from consulting or industry (not academia).

The conference program will include daily plenary sessions, featuring keynote speakers of interest to all delegates, followed by technical and specialty, as well as poster sessions, to meet the diverse needs of attendees. Confirmed speakers currently include: **Dr. Richard Bathurst** (R. M. Hardy Lecture), **Dr. Kamini Singha** (Darcy Lecture), **Dr. Greg Brooks** (CGS Lecture), and **Dr. Michael Hendry** (CGS colloquium). Details on our confirmed speakers and their talks are available on the conference website. In addition to the oral and poster presentations, the conference's technical program will include local technical tours, short courses, and industry presentations by our exhibitors.

We're pleased to announce that response to exhibition space has been very high. By the time this magazine arrives, we may already be sold out. Please refer to the conference website for the latest details ***www.geoottawa2017.ca*** and to view the complete list of Confirmed Exhibitors. The trade show runs from October 1 – 3, 2017, and will take place at the Shaw Centre in downtown Ottawa. With an expected attendance of over 750 delegates, the trade show featuring the participation of firms in the geotechnical, hydrogeological and geosynthetics fields will be an exciting and valuable component of the conference. To register for the **GeoOttawa 2017** trade show, please contact the Conference Administrator directly at ***sponsors@geoottawa2017.ca.***

Interest in sponsorship for GeoOttawa 2017 is also strong and currently includes (as of publishing deadline): Platinum; **BGC Engineering**, **Clifton Associates**, **ConeTec Investigations**; **Reinforced Earth**, **DST Consulting**; **Thurber Engineering**; **Menard Canada Inc.**; **Nilex Inc**.; **Trek Geotechnical**; **Klohn Crippen Berger**; and **Golder Associates**; Gold; **GHD** and Lanyard Sponsor; **Rocscience**. Please, contact the Conference Administrator directly at ***sponsors@geoottawa2017.ca*** to register your company or find

out more information about sponsorship of **GeoOttawa 2017**.

GeoOttawa 2017 will be held at the **Shaw Centre** in downtown Ottawa. This spectacular facility is one of Canada's premier conference venues and recently received a top 3 ranking by the International Association of Congress Centres. We have arranged accommodation for conference delegates at four surrounding hotels: The **Westin Ottawa**, **The Lord Elgin**, **Novotel**, and **Les Suites**. All hotels are just a short walk away from the Shaw Centre. Further information and online reservation links for each location can be found on the **GeoOttawa 2017** website.

Please address any questions to the Conference Chair: **Mamadou Fall** at ***mfall@uottawa.ca***

Submitted by Mamadou Fall
Conference Chair – GeoOttawa 2017

70e conférence de canadienne de géotechnique et la 12e conférence conjointe SCG/AIH-SNC sur les eaux souterraines 1 – 4 octobre 2017 Ottawa, Ontario

La réponse à l'appel de résumés pour GéoOttawa 2017 a été excellente. Plus de 475 résumés ont été soumis en date du 15 janvier 2017. Afin d'offrir un programme technique le plus exhaustif possible, le comité d'organisation a prolongé la date limite de soumission des résumés jusqu'au **31 janvier 2017**. Comme Il s'agit de la 70e conférence canadienne de géotechnique et la 12e conférence conjointe SCG/AIH-SNC sur les eaux souterraines, les résumés pouvaient être soumis soit sous les thèmes géotechniques ou hydrogéologiques. Tous les articles techniques devront être soumis d'ici le 15 mai 2017, accompagnés d'une inscription complète de délégué.

GéoOttawa 2017 reconnaîtra les meilleures études de cas et le meilleur article d'un étudiant en octroyant des prix pour ceux-ci. Il y aura une case à l'écran de soumission de l'article final pour indiquer si vous désirez être considéré pour ces prix. Jusqu'à trois histoires de cas seront reconnues à la conférence. Les auteurs principaux des histoires de cas devraient provenir de sociétés d'experts-conseils ou de l'industrie (pas du milieu universitaire).

Le programme de la conférence comprendra des séances plénières quotidiennes, présentant des conférenciers qui intéresseront tous les délégués, suivies de sessions techniques et spécialisées ainsi que de sessions de présentation d'affiches, pour répondre aux besoins diversifiés des participants. Les conférenciers suivants sont actuellement confirmés: Dr. **Richard Bathurst** (Conférence d'honneur R. M. Hardy), **Dr. Kamini Singha** (Conférence Darcy), **Dr. Greg Brooks** (Conférence de la SCG), and **Dr. Michael Hendry** (Colloquium 2017 de la SCG). En plus des présentations orales et d'affiches, le programme technique de la conférence comprendra des visites techniques locales, des cours intensifs et des présentations de l'industrie de nos exposants.

Nous sommes heureux d'annoncer que la demande pour les espaces d'exposition a été très forte. Lorsque cette revue vous arrivera, les espaces seront peut-être déjà tous attribués. Veuillez consulter le site Web de la conférence ***www.geoottawa2017***.ca pour voir la liste complète des exposants. Ce salon professionnel aura lieu du 1er au 3 octobre 2017, au Centre Shaw, au centre-ville d'Ottawa. Comme plus de 750 délégués sont attendus, le salon professionnel présentant des sociétés dans les domaines de la géotechnique, de l'hydrogéologie et des géosynthétiques sera un élément intéressant et profitable de la conférence. Pour vous inscrire au salon professionnel de GéoOttawa 2017, veuillez écrire directement à l'administratrice de la conférence, à s***ponsors@geoottawa2017.ca.***

L'intérêt des commanditaires pour GéoOttawa est aussi très marqué; il inclus actuellement (à la date de tombée): Commanditaires Platine **BGC Engineering**, **Clifton Associates**, **ConeTec Investigations**; **Reinforced Earth**, **DST Consulting**; **Thurber Engineering**; **Menard Canada Inc.**; **Nilex Inc**.; **Trek Geotechnical**; **Klohn Crippen Berger**; et **Golder Associés**; Commanditaires Or: **GHD** et Lanyard; Commandite: **Rocscience**. Pour inscrire votre société en tant que commanditaire de **GéoOttawa 2017** ou pour obtenir plus d'informaiton, veuillez écrire directement à ***sponsors@geoottawa2017.ca.***

GéoOttawa 2017 se déroulera au Centre Shaw, au centre-ville d'Ottawa. Cet établissement spectaculaire est l'un des principaux lieux de conférence au Canada et a récemment été classé parmi les trois premiers par l'International Association of Congress Centres. Nous avons pris des dispositions pour que les délégués de la conférence puissent être hébergés dans quatre hôtels à proximité: le Westin Ottawa, le Lord Elgin, le Novotel, et Les Suites. Ces hôtels se trouvent tous à une courte distance de marche du Centre Shaw. De plus amples renseignements sur chaque hôtel et des liens pour y réserver une chambre en ligne se trouvent à la page www.geoottawa2017.ca/venue.

SVP, veuillez acheminer toutes questions au président de la conférence: **Mamadou Fall** à ***mfall@uottawa.ca***

Division News

Engineering Geology Division

Soliciting Input for an Engineering Geology Monograph

As discussed at the highly successful GeoVancouver Engineering Geology Division Executive meeting, the CGS Engineering Geology Division will be pursuing the publication of an **Engineering Geology Monograph** based on the Canadian experience. We would like to solicit input in terms of the content to include as well as suggestions for topics, etc. It is envisioned

that the monograph will capture the history, significant events, innovations and contributions of Canadians to the field of engineering geology. We would to have as many people as possible to contribute to this active, living archive. As such, we are soliciting the CGS membership (and beyond) for their ideas in terms of topics, articles, papers, historical perspectives and people to include. If you would like to contribute to the monograph, please contact me, **Nicholas Vlachopoulos**, at ***vlach@rmc.ca.*** or at (613) 541-6000 x 6398. We require any and all feedback as it can become available.

Soliciting Input for GeoOttawa Workshop/Specialty Conference

After a very successful joint session with the **Professional Practice Committee** in Vancouver, we are in the preliminary stages of determining if there is enough interest in co-sponsoring a workshop or speciality session with the **Rock Mechanics Division** and/or the **Education Committee** (two different sessions). I would welcome your input as to the type of workshop or speciality session that would be of interest to you as well any suggested speakers. I will then contact the appropriate conference organizers to schedule the sessions. Please contact me, **Nicholas Vlachopoulos**, at ***vlach@rmc.ca***. or at (613) 541-6000 x 6398

Submitted by Nicholas Vlachopoulos Division Chair – Engineering Geology Division

Committee News

Heritage Committee

Canadian Geotechnical Society Virtual Archives

There are rich but rarely used resources in Canada that consist of files containing historical information on geotechnical laboratory and field research, geotechnical investigations, work of committees and geotechnical expertise. Ways to identify and use these resources have been developed by the Heritage Committee of the Canadian Geotechnical Society in the form of virtual archives on the CGS web site, where the location and content of accessible historical geotechnical material are given.

CGS members and others are invited to submit candidate material for consideration. The submission should give the location of the material, a description of its nature and content, its historical significance and the conditions under which it can be accessed. Do not submit physical archival material as the Society has no space to store it, however electronic copies of photographs or materials are welcome.

Your contribution to the CGS Virtual Archives web page should be sent to the Chair of the Heritage Committee, Heinrich Heinz, P.Eng. at ***hheinz@thurber.ca***

History of Local Sections of the Canadian Geotechnical Society

The Heritage Committee believes that the history of the local sections 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 sections. Hopefully every local chapter of the CGS will take the time to gather their archives and write their own history.

Please contact the Chair of the CGS Heritage Committee, **Heinrich Heinz**, at ***hheinz@thurber.ca*** if you have any questions.

The information in the following tables was current at the time of preparation, but individuals and their contact information may change over the course of the year. The most current contact information for the various positions shown below is located on the CGS website at ***http://www.cgs.ca/index.php?lang=en&***.

Les renseignements ci-dessous étaient à jour au moment où ils ont été préparés, mais les personnes et leurs coordonnées peuvent changer au cours de l'année. Vous trouvez les plus récentes coordonnées pour les différents postes présentés ci-dessous sur le site Web de la SCG, à ***http://www.cgs.ca/index.php?lang=fr&***.

Editor

Don Lewycky, P.Eng.
Edmonton, AB
Tel.: 780-478-4156
Email: don.lewycky@gmail.com

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CFEM Editor Le directeur de la rédaction de le MCIF	Richard Bathurst, P.Eng. bathurst-r@rmc.ca

70TH CANADIAN GEOTECHNICAL CONFERENCE
70E CONFÉRENCE GÉOTECHNIQUE CANADIENNE

GEO OTTAWA 2017

October 1-4 / 1-4 octobre
Ottawa, Ontario
www.geoottawa2017.ca

Join us in Ottawa this October for the Canadian Geotechnical Society's 70th annual conference. In 2017 we are collaborating with the International Association of Hydrogeologists (IAH/CNC) to also present the 12th Joint CGS/IAH-CNC Groundwater Conference.

*The GeoOttawa 2017 theme **70 Years of Canadian Geotechnics and Geoscience** will build on the extensive contributions of geotechnical and hydrogeological practitioners to Canada's built form since the Canadian Geotechnical Society was founded 70 years ago.*

GeoOttawa 2017 conference program highlights will include:

R.M. Hardy Address presented by Dr. Richard Bathurst (Royal Military College)
Darcy Lecture presented by Dr. Kamini Singha (Colorado School of Mines)
Comprehensive Industry Trade Show with over 65 exhibitors
Over 750 delegates and more than 350 technical and special presentations over three days!

TENTATIVE TECHNICAL SESSIONS

PRIMARY GEOTECHNICAL
- Soil Mechanics and Foundations
- Rock Mechanics and Engineering Geology
- GeoHazards and Landslides
- Mining Geotechnics and Hydrogeology
- Geoenvironmental Engineering
- Transportation Geotechnics
- Geosynthetics
- Cold Regions
- Sustainable Geotechnics
- Professional Practice

SPECIAL GEOTECHNICAL
- Tunnelling and Deep Excavations
- Geohazards in Linear Infrastructure
- Remote Sensing
- Innovative Foundation Systems
- Foundations for Renewable Energy
- Trenchless Technology
- Risk Management in Geotechnical Projects
- Reliability Analysis for Geotechnical Design
- Radioactive Waste Management
- Shallow Geothermal Energy Exchange
- Seismicity and Sensitive Clay

PRIMARY HYDROGEOLOGICAL
- General Hydrogeology
- Source Water Protection (including implementation of policy)
- Groundwater and the Ecosystem
- Groundwater and Climate Change
- Groundwater Resources and Management
- Fractured Rock
- Hydraulic Fracturing
- Application of Geophysics to Hydrogeology in Fractured Rock
- Groundwater Contamination by Human Activities
- Quantitative Assessment and Performance of Contaminant Remediation
- Professional Practice
- Public Consultation of Groundwater Issues

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This tailings has the consistency of chocolate pudding: a formal comparison of the geotechnical vane shear strength of food and soft tailings

Gord McKenna, Vanessa Mann, Bereket Fisseha, Nick Beier, Nicolas Olmedo

Introduction

"This tailings pours like chocolate milk, but when you add flocculant, it becomes more like blueberry pie filling."

We often compare the unusual geotechnical properties of soft tailings to common foods. Soft tailings shear strengths are much lower than most geotechnical people are accustomed – indeed many tailings are better described using fluid mechanics than soil mechanics. So people describe the consistency (mainly strength, but also sensitivity and density) of soft tailings using informal comparisons to foods such as chocolate milk, yogurt, porridge, cottage cheese, and peanut butter.

Lacking is an accessible reference that provides a more direct, more authoritative comparison of tailings and foods. So with two hours at the grocery story, two days of hard work in the University of Alberta laboratory, and two weeks of crunching the data and writing it up for a recent oil sands tailings publication (see McKenna et al 2016a) we're pleased to share the results with a wider geotechnical audience.

To allow a direct comparison of tailings and food, we measured the peak and remolded strength of 75 samples of soft tailings, soft foods, and household products using the geotechnical laboratory vane test, specifically the ASTM D4648 test method for vane strength of saturated fine-grained soils. We also performed some other informal tests on each sample as described below.

While our comparison of tailings to foods is meant to be perhaps a bit lighthearted, it also has point. Many mines (most notably the oil sands) have major issues with the technical and operational challenges of managing soft tailings – stabilizing or reprocessing or the tailings to allow mine reclamation to produce useful post-mining landscapes. Soft tailings by definition have such low strengths and densities that they cannot be trafficked by typical earthmoving equipment, which severely limits reclamation. The presence of soft tailings, and the cost to reclaim them, usually comes as a surprise to mines. That one can directly compare soft tailings to common foods highlights the challenge of converting these soft or fluid tailings to solid landscapes. Oil sands mining operations in northeastern Alberta have produced over one billion cubic metres of soft tailings which are challenging to stabilize and reclaim to boreal forest landscapes (CCA 2015) and the subject of billions of dollars of research and development and commercialization (see CTMC 2012). Many metals mines worldwide have similar issues, but at smaller scales.

Background

Soil consistency descriptors, available in most soil mechanics textbooks, have been used for over a century. Very soft soils can be extruded between the fingers when squeezed (shear strength <12 kPa). Soft soils can be molded with light finger pres-

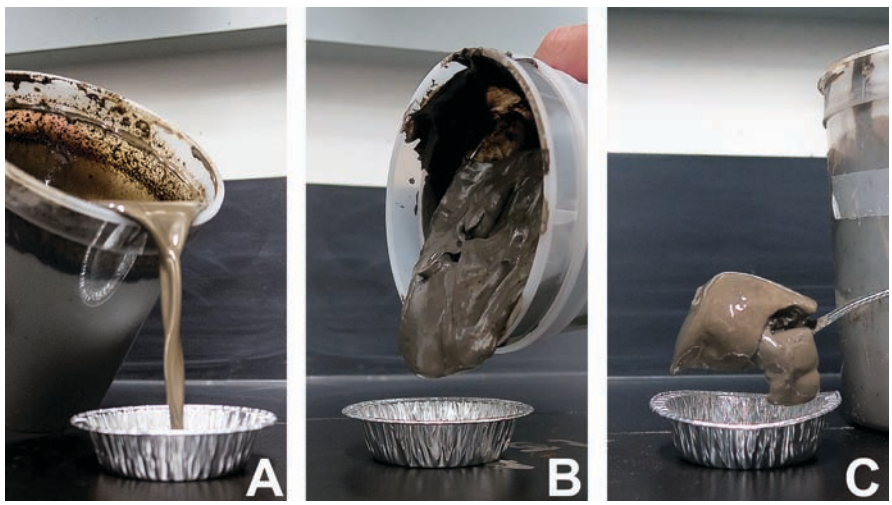

Figure 1. Three oil sands soft tailings. A - fluid fine tailings; B - centrifuged fluid fine tailings; C - thickened tailings (TT) + fly ash.

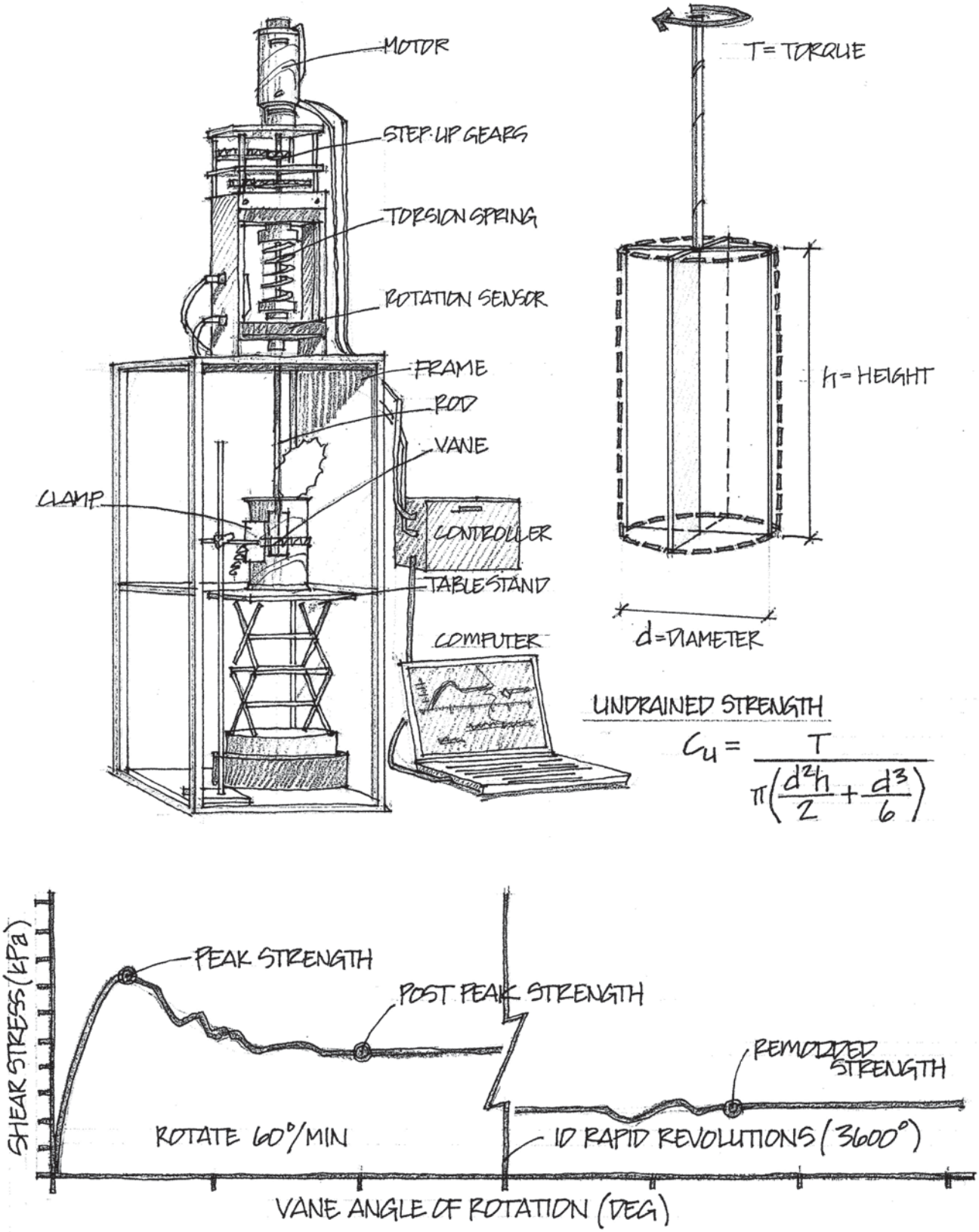

Figure 2. UofA Vane Device, calculation details, and typical output. Illustration by Derrill Shuttleworth.

sure – easily penetrated several inches by thumb (12 to 25 kPa). And so on. Once you reach firm (25 to 50 kPa) to stiff (50 to 100 kPa) one reaches the realm of trafficable materials. For comparison, soils at their liquid limit have shear strengths of 2 to 5 kPa.

Oil sands soft tailings (Figure 1) have been studied by many people over the past 50 years (see McKenna et al 2016b). Tailings vane strengths are highly correlated to the geotechnical moisture contents and also to the liquidity index. High void ratio tailings (e=3, 150% geotechnical moisture) have strengths of less than 0.2 kPa. At a void ratio of 1.1 (43% geotechnical moisture) the strength is about 0.2 to 5 kPa. It's not until you get to about 25% moisture do you start to get strengths more akin to those in soil mechanics (5 to 50kPa). Low strengths (<2 kPa remolded) are good for processing and pumping but difficult to cap or reclaim terrestrially due to low bearing capacity and very large consolidation settlements.

The shear strength of soft foods is not news to food process engineers and technicians – they use strength measurements every day for design and quality control. There are about a dozen common methods to measure the shear strength (or yield strength) of processed foods, including the vane test.

Methods and results

Foods and household products were selected to provide a broad range of strengths and consistencies with an attempt to cover a large range of common foods and condiments including some iconic processed foods.

The vane test

The vane test followed ASTM D4648 as noted above. Following food industry norms, foods were tested undisturbed in their product container. To minimize edge effects, the vane was carefully inserted to middle of the sample, with an insertion depth of at least two vane heights while keeping the vane at least one diameter away from the edges of the container. In some cases, these constraints could not be met (for example the half-banana in its skin) and a notation was made.

A high-resolution vane shear device designed at the University of Alberta to conduct field vane tests with a soft ground rover (Olmedo and Lipsett 2016) was used (Figure 2). The design consists of a DC motor, a gearbox, three angular position sensors, and a torsional spring. A DC motor was selected to provide continuous rotation of the vane while permitting precise speed control. A reconfigurable gearbox was designed to control the rotational speed of the vane. Most of the measurements were made with a 13 mm diameter (D) and 25 mm high (H) vane. For foods with a high moisture content and lower strength (32 total samples), a larger vane was required (up to 34 mm diameter and 69 mm high).

The vane was rotated at 60 degrees per minute (as per ASTM D4648). The angular displacement of the vane was recorded along with the torque and plotted on a computer in real time. After the peak strength is reached, the torque drops, then starts to level. The vane was then rotated rapidly five times through 360 degrees, then the test restarted at 60 degrees per minute again to determine the remolded shear strength. Figure 3 presents the results.

The sensitivity is the ratio of the peak vane strength to the remolded vane strength. In nature, sensitive clays have a sensitivity of 4 to 8. Quick clays have sensitivities greater than 16. Most foods tested had a sensitivity between 4 and 8. A few materials had sensitivities greater than 16 (peanut butter, banana, refrigerated butter and margarine, car wax and candle wax). Tailings had similar sensitivities.

Geotechnical moisture contents

Subsamples (Figure 4) were oven dried at 110°C following ASTM D2216. Moisture testing didn't prove that insightful as many of the foods

Figure 4. Geotechnical moisture test samples ready for the oven.

contained large quantities of oils that didn't evaporate; many samples didn't change in appearance even after a few days in the oven. A Dean-Stark extraction test would have been more appropriate in hindsight.

Will a spoon stand in it?

"You can stand a spoon in this tailings!" The spoon test (Figure 5) is an informal tailings test often used at the lunchroom table during tailings field pilots. A steel teaspoon (154 mm long, 53 mm wide, 17 g mass) was inserted vertically into the sample and observed. If there was no movement, the sample was tipped until the spoon tilted. We found that the spoon stood vertically where the peak vane strengths were more than about 0.2 kPa. The spoon remained in position horizontally where the samples had strengths more than 0.4 to 0.8 kPa. Strong to a process engineer concerned with pumping this material, nothing to celebrate for a geotechnical engineer concerned with capping.

Will it stay in the cup if I tip it over?

"You can put the treated tailings in a cup and tip it over and it won't come out!" The pour test (Figure 6) is another lunchroom tailings test.

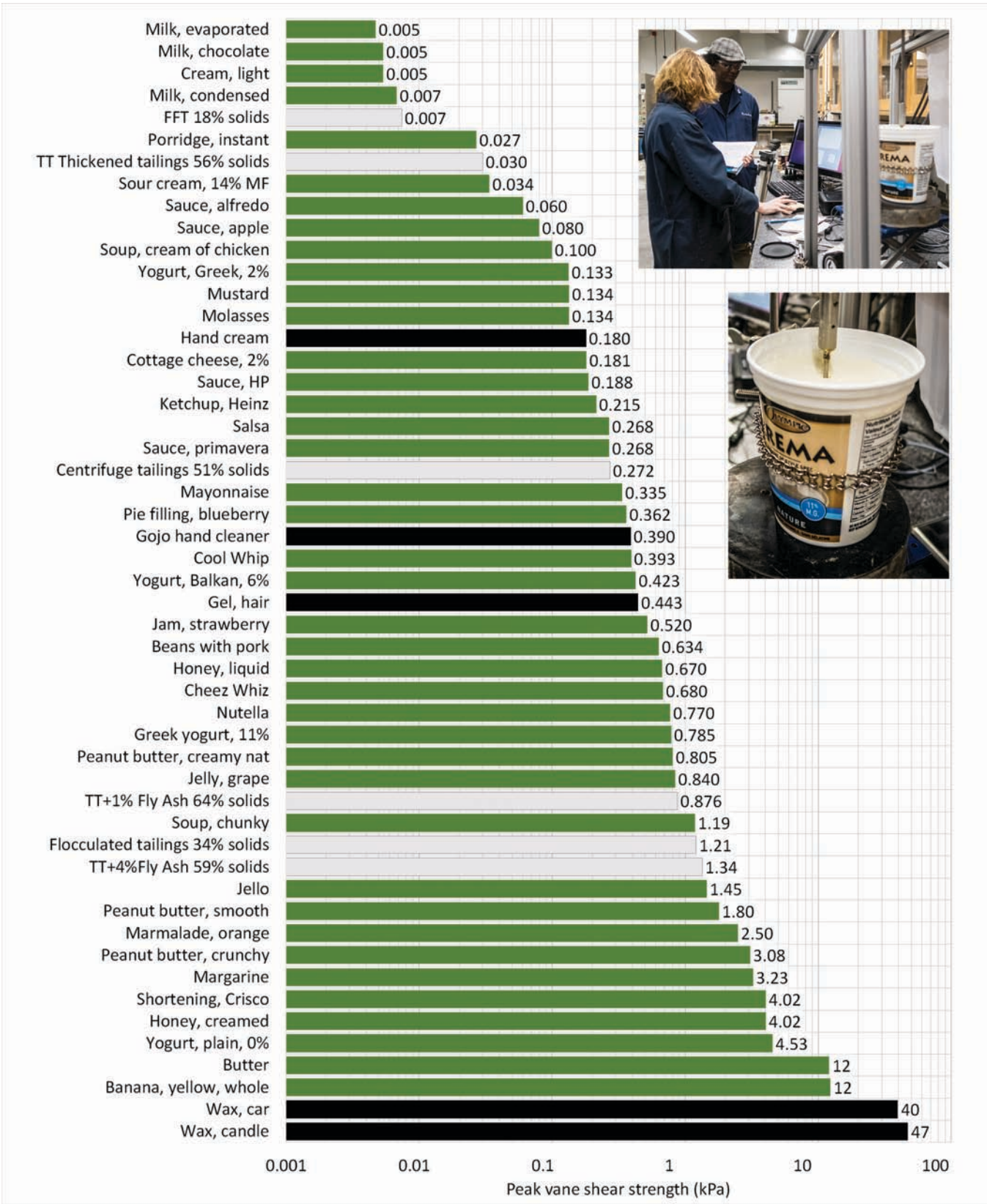

Figure 3. Geotechnical vane strength of soft tailings compared to soft foods and household products.

To perform this test, the sample was simply tipped to pour out (or not) and photographed. We found samples would pour from the jar if they had less than about 0.3 kPa peak strength.

Summary and conclusions

Indeed, unamended oil sands fluid fine tailings has a consistency like chocolate milk. Thickened tailings can be compared to sour cream and various sauces poured from a jar. Centrifuge tailings are similar to mayonnaise and ketchup. Flocculated tailings and thickened tailings amended with flyash are similar in consistency to grape jelly, peanut butter, and jello. Such foods are designed to be easy to manufacture, easy to get out of the bottle or container, easy to spread, and easy to eat.

Fluids and fluid mechanics are poor substitutes for soils and soil mechanics for building tailings deposits, landforms, and landscapes that provide bearing capacity, slope stability, and acceptable consolidation settlements. There is a need to introduce tailings technologies that produce strengths more like firm to stiff soils to make tailings capping and reclamation reliable, safe, and economical.

Next steps

If you've got vane strengths of some foods from your region or strengths of soft tailings from your mine, please let us know and we'll add them to our database for an upcoming journal publication.

Recommended reading

CCA (Council of Canadian Academies). 2015. Technological Prospects for Reducing the Environmental Footprint of Canadian Oil Sands. The Expert Panel on the Potential for New and Emerging Technologies to Reduce the Environmental Impacts of Oil Sands Development. Council of Canadian Academies. Ottawa. 252p.

Figure 5. Spoon test: A - condensed milk (0.07 kPa fail); B - ketchup (0.22 kPa pass vertical); C - peanut butter (1.8 kPa pass horizontal). Spoon will stand vertical if >0.2 kPa, horizontal if >0.4 to 0.8 kPa.

Figure 6. Pour test. A - fluid fine tailings (0.07kPa); B - chocolate milk (0.05 kPa); C - yogurt (0.4 kPa). Materials pour if <0.3 kPa.

CTMC (Consortium of Oil Sands Tailings Management Consultants). 2012. Oil Sands Tailings Technology Deployment Roadmaps Project Report. Consultant's Report to Alberta Innovates – Energy and Environment Solutions and the Oil Sands Tailings Consortium. June 29, 2012. Calgary. 4v

McKenna G, Mann V, Fisseha B, Beier N, & Olmedo N. 2016a. The geotechnical vane strength of soft tailings compared to soft foods. Fifth International Oil Sands Tailings Conference, December 4-7. Lake Louise, Alberta. University of Alberta Geotechnical Group, Edmonton.

McKenna G, Mooder B, Burton B, & Jamieson A. 2016b. Shear strength and density of oil sands fine tailings for reclamation to a boreal forest landscape. IOSTC International Oil Sands Tailings Conference. Lake Louise. Dec 4 to 7. University of Alberta Geotechnical Group. Edmonton.

Olmedo NA & Lipsett MG. 2016. Design and field experimentation of a robotic system for tailings characterization. Journal of Unmanned Vehicle Systems. 4:3 169-192.

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New Scholarship Announced at International Oil Sands Tailings Conference '16

Vivian Giang

The University of Alberta Geotechnical Centre and Oil Sands Tailings Research Facility (OSTRF) hosted the International Oil Sands Tailings Conference at the Fairmont Chateau Lake Louise between December 5 and 8, 2016. Two hundred delegates representing six countries attended IOSTC '16, including mine waste managers,

engineers, regulators and researchers. Exhibitors were also present at the conference to showcase their technologies and services.

The conference had special keynote addresses from Alberta's Energy Regulator (AER) and representatives from the oil sands industry. Mr. Tim Eaton and Ms. Tania De Silva from AER outlined the current approach to fluid tailings management regulation and associated tailings containment facilities. Then John Brogly, Director of COSIA's Tailings EPA, as well as Mr. Paul Cavanagh from Imperial Oil outlined their path forward to meet the requirements of the Oil Sands Tailings Management Plan recently put forward by the Alberta Government. The presentations and conference proceedings highlighted the industry's extensive research efforts since the issuing of the Alberta's Tailings Management Framework for Mineable Athabasca Oil Sands in 2015.

At the conference, the University of Alberta Geotechnical Centre was proud to announce a new scholarship in honour of one of the founding members of the International Oil Sands Tailings Conference series. The first recipient of the Dave Sego Graduate Award in Innovative Research was Mr. Ralph Burden, a full-time PhD candidate in the Geoenvironmental Engineering program at the University of Alberta.

The OSTRF would like to thank ConeTec, Alfa Laval, BGC Engineering, Hayward Baker Canada, NAIT, Norwest Corporation and SRK Consulting for their invaluable sponsorship of the conference. The University of Alberta Geotechnical Centre will next host Tailings and Mine Waste '17 in Banff, Alberta, November 5-8, 2017.

Brian Ernest Hall February 4, 1953 to December 25, 2016

Optimistic and pragmatic to the end, Brian died after an exhausting tussle with pancreatic cancer, aged 63. He is survived by his wife Vivienne (nee Roberts), the love of his life and his very best friend, and their two sons Andrew and Robert, of whom he was immensely proud. He was predeceased by his mother and father, Mavis (nee Appleton) and Ernie Hall.

Brian was born in Ladysmith, South Africa and spent his childhood in his beloved home town of Colenso. He paid tribute to the town in a piece he wrote called "Memories of a Colenso Childhood". After his military service, he studied at the University of Natal where he discovered his lifelong interest in geotechnical engineering. In 2000 he completed an M.Eng. at the University of British Columbia.

Brian's work experience was broad, ranging from railway, harbour and geotechnical engineering at the SA Railways to consulting geotechnical engineering in five different firms in three countries. In his final role he was Chief Engineer at Tetra Tech EBA. Brian was passionate about his profession and got huge pleasure from mentoring others and sharing his broad and diverse knowledge in numerous technical publications.

He had a curious and creative mind and had many interests extending beyond his work. He loved exploring new places and had a fascination for the local history wherever he lived. He enjoyed collecting art, especially Black South African art, and built up an impressive book collection covering his many and varied interests.

True to his character, he met the cancer challenge head on, and it became his last and biggest project. He kept himself positive by having goals stretching out to 2020. He epitomized the Cecil Rhodes death bed quote, "so much to do, so little time".

In addition to his immediate family, Brian leaves behind his brother Kenneth (Ina), his extended family in South Africa, Canada, and England, and many friends and colleagues in South Africa, the US, Canada and elsewhere.

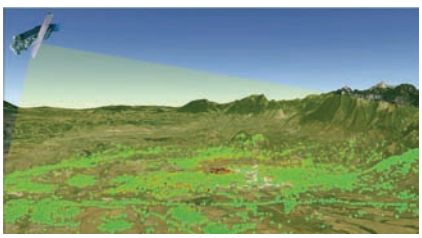
Introduction by John Dunnicliff, Editor

This is the 89th episode of GIN. Just one article this time.

Remote monitoring of deformation

During the 2011 Symposium on Field Measurements in Geomechanics (FMGM) in Berlin there were a large number of papers describing remote methods of monitoring deformation. I was so confused by the many acronyms that I invited various colleagues to contribute explanatory articles for GIN. This resulted in seven articles in March and June 2012 GIN (remember that you can read these by clicking on the appropriate month on www.geotechnicalnews.com/instrumentation_news.php):

- Terrestrial laser scanning (TLS), by Matthew Lato, March.
- Terrestrial interferometric synthetic aperture radar (TInSAR), by Paolo Mazzanti, March.
- Robotic total station (RTS), by Rob Nyren, Ryan Drefus and Sean Johnson, March.
- Reflectorless robotic total station (RRTS), by Damien Tamagnan and Martin Beth, March.
- Satellite interferometric synthetic aperture radar (SInSAR), by Francesca Bozzano and Alfredo Rocca, June.
- Digital photogrammetry (DP), by Raul Fuentes and Stuart Robson, June.



Differential Satellite SAR Interferometry. Graphic by Alfredo Rocca, HHAZCA.

- Differential global positioning system (D-GPS), by Jason Bond and Rob Nyren, June.

In December 2012 GIN, Paolo Mazzanti contributed an overview of those seven methods. His article included comparative evaluations of the seven methods, a table of advantages and limitations, and a table indicating applicability of each method for various project-type applications. In my view this octet formed one of the most reader-friendly groups of articles in the history of GIN.

Here's a ninth, with yet another acronym – manual reflectorless total station monitoring (MRTS), by Colin Hope and Stephen Dawe of Monir Precision Monitoring. This article shows that, under typical site conditions, accuracies can range from +/-4mm to +/- 2mm.

Please be aware that my colleagues who organize the annual monitoring courses in Italy (see below) have great expertise in the various remote methods for monitoring deformation, and many will be covered during the June course in Rome.

Fourth International Course on Geotechnical and Structural Monitoring, June 13-15, 2017 in Rome, Italy.

The course schedule is now on www.geotechnicalmonitoring.com. Registration for the course can be made on **www.geotechnicalmonitoring.com/en/registration.**

Registration for the June 12 Master Classes can be made on the same site. Master Classes and leaders will be:

1. Piezometers: Tony Simmonds, Geokon Inc., USA
2. Inclinometers: Erik Mikkelsen, GeoMetron Inc., USA
3. Extensometers: Giorgio Pezzetti, SMAK s.a.s., Italy
4. Total stations: Martin Beth, SIXENSE Soldata, France
5. Global navigation satellite system (GNSS): Stefano Gandolfi; University of Bologna, Italy
6. Terrestrial Radar: Paolo Mazzanti, NHAZCA, Italy

Each class will cover the following main topics: installation, data acquisition, data processing, tricks and tips from everyday experience.

During the main course we will again have sessions on "New Monitoring Trends" and "Case Histories and Lessons Learned", with presentations given by practitioners and exhibitors.

Come and join us in magnificent Rome - a city of huge historical and cultural interest!

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**

L'chaim ('To life') – Hebrew

Manual reflectorless total station monitoring (MRTS)

Colin Hope and Stephen Dawe

Introduction

MRTS is most commonly used to monitor deflections of shoring and structures where it is not possible to install targets, most commonly due to safety or access issues. It provides a safer, easier and more cost effective way to manage the risk associated with working close to sensitive buildings, structures and infrastructure. Under typical field conditions, if work is carried out methodically with a high standard of care, accuracies can range from +/-4mm to +/- 2mm depending on atmospherics, line of sight clearance and the background surface that the measurements points are on. The background surface will impact the reflectivity of the Electronic Distance Measurement (EDM) technology used. Measurements have less background scatter when they are taken to flat surfaces while rough surfaces will cause more scattering.

History

Some of the more recent advances in distance measurement technologies occurred in the twentieth century with the introduction of radar in the 1940s, and then in the 1960s with advances in laser technology we saw the emergence of Electronic Distance Measurement (EDM) technologies. Until recently, the only means of measuring a distance electronically was by combining EDM technology with a retro prism. In the past 20 years, one of the most significant advancements in EDM technologies has been the introduction of MRTS.

The following is a partial list of some of the questions that need to be answered when planning to use a MRTS (this is in addition to any other steps carried out for the monitoring):

- Is it repeatable?
- Is the correct instrument for the job available?
- How far away or how close are the points to be monitored?
- What is the background surface to be monitored?
- What colour is the background surface?
- Is the background surface smooth or rough, are there holes in the surface?
- Will the same geometry be useable for the life of the project?
- What are the tolerances for the project and what sort of accuracies are needed?
- Is it doable?
- What sort of affects will the atmospheric conditions have on the readings?
- Has this type of structure been monitored before?
- Are there objects that lend themselves to becoming monitoring points?
- Do you have traditional controls or reflectorless controls?

In this article we discuss MRTS in regards to when it should be used and when it shouldn't be used. Some of the important considerations include:

- Instrument selection
- Background noise and scatter
- Selecting and initializing the monitoring points
- Accuracy and precision
- Measurement on two faces
- Perpendicularity
- A precise versus a MRTS experiment

Instrument selection

It is important to understand that most MRTS instruments are not suitable for precision monitoring. A precision MRTS instrument is generally one with published specifications of 2 mm + 2 ppm or less in the Electronic Distance Measurement (EDM) and one second or less in the angular measurement. The instrument used in the writing of this article was a Leica TS30. Ideally, instruments manufactured for precision monitoring will offer the best accuracy for the measurements, as they are purpose built for the job and come with on-board compensators and specialized MRTS measurement technology.

Background noise and scatter

By background noise we generally mean the scattering of the laser as it hits the measurement surface and bounces back towards the instrument. A stucco wall will have much poorer reflectivity than a smooth concrete surface. Also, the lighter the surface, the better the return of the laser will be. Some other forms of background noise are taking readings over distances greater than 80 meters, which tended to fall within an error bar of +/-4mm while closer readings were observed to be more accurate and fell within the +/-2mm range. High humidity, fog, precipitation of any kind, bad lighting, vibration, dust, smoke and strong winds will all impact the accuracy of the measurements. Figure 1 shows a poor surface for MRTS monitoring due to the rough texture of the background surface.

Selecting and initializing the monitoring points

To gain the most reliable repeatability, it is vitally important to select points that are readily identifiable through

Figure 1. Shows a poor surface for reflectorless monitoring.

the telescope with as small a chance of ambiguity as possible. Some examples of these are: paint marks already on structures and buildings, flat bolts, ink marks, nail heads, imperfections in color or marks on bricks and masonry. Keep in mind that the points may have to be read during rainy periods so they should also be visible when wet.

When the initial readings are taken, it is important to keep in mind that the geometry used for the initial readings has to be repeatable going forward. Large changes in the geometry can introduce significant ambiguity into the readings, causing them to become suspect. Bad data are worse than no data. Taking the initial and subsequent readings from a safe, stable and secure location is strongly advised. With a little bit of planning and forethought, it is possible to take accurate and precise readings from a pre-planned location(s).

Accuracy and precision

Accuracy is the truthfulness of the targets location while precision is the repeatability of measurements to the same point each time it is measured.

One of the best ways to guarantee precise results is to use the same geometry, instrument and operator for all of the readings. While this is not always possible in reality, using the same geometry as much as possible is one of the most important steps to follow. While MRTS instruments can measure to inaccessible locations, it can be hard to know what happens to the laser as it travels to and from the monitoring point or even if it is hitting the right point. Measuring to the wrong type of surface, not understanding the properties of the laser and how it is affected by atmospheric conditions and the impact of those conditions on the measurements all have varying effects. It is also important to understand what the instrument is capable of and under what conditions it operates at its best.

Measurement on two faces

Using the instrument in both faces will control any calibration errors in the instrument and is needed for the accuracy it provides for MRTS readings. By taking readings on both faces of the instrument multiple times then averaging the initial measurements of the controls and the monitoring points the measurements can be kept within a tolerable range as long as the correct procedures are followed. If large differences are noted between readings on either face of the instrument then a change in geometry to a more perpendicular location is recommended.

Perpendicularity

By keeping measurement angles within an 80 degree range as much as possible, the laser will return an accurate and precise measurement of the location of the point. A way to think of this is to stay as perpendicular to as many monitoring points as is possible. Any monitoring or control point should be within 40 degrees of the perpendicular for the most consistent and accurate readings. Figure 2 shows a graphical representation of perpendicularity.

Precise mode versus reflectorless mode experiment

The same geometry is used for each set of readings along with the same

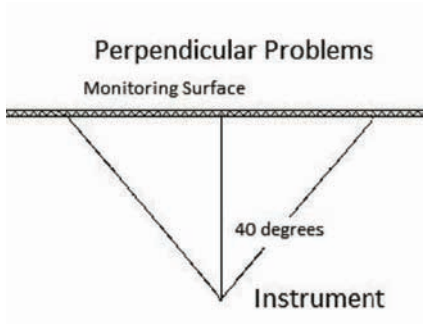


Figure 2. Shows a graphical representation of perpendicularity.

operator and instrument. All of the points being monitored were re-initialised in both precise and MRTS mode with the MRTS points also being read on two faces. Precise Mode is the method used when reflective targets are available; however, the laser is subject to deflection when objects are within close proximity of its line of flight. (Approx. 50mm) Reflectorless mode uses the changes in the phase shift as one way to calculate positons while also using the time of flight method for calculations. During the monitoring, most of the readings were taken through temporary fences which can cause problems in precise mode, as noticeable deflections occur when the precise laser travels too closely to any objects along the line of sight. Figure 3 shows a colour coded graph with reds being MRTS measurements and greens being precise measurements.

Conclusions

When there is a good geometry, when readings are taken with a high standard of care and you have the right instrument, it is a good alternative to use MRTS monitoring, especially if traditional methods are difficult or impossible.

A good geometry is a system of controls installed on at least two axes with at least five targets spread as evenly as possible, while staying as perpendicular to as many points as possible and not exceeding forty degrees from the perpendicular when taking measurements.

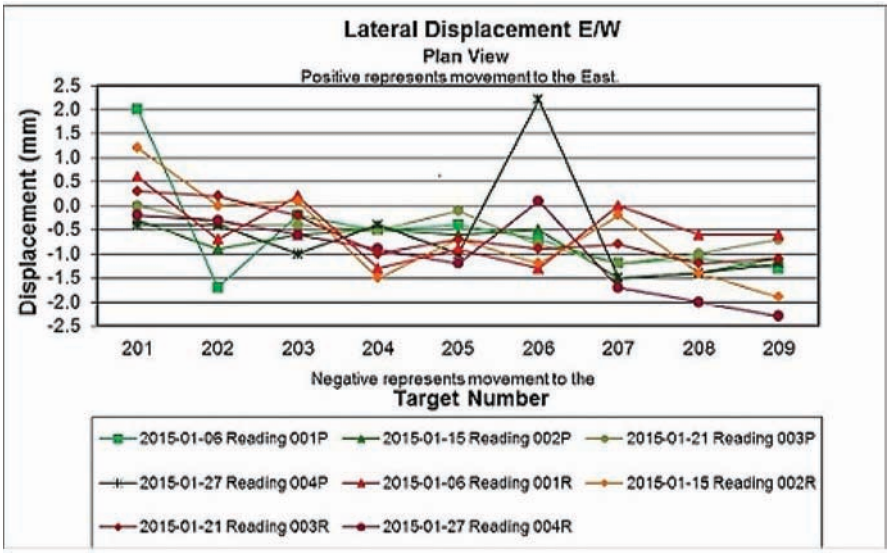


Figure 3. Shows a colour coded graph with reds being MRTS measurements and greens being precise measurements.

The right instrument is built for the job of monitoring, both in precise and MRTS measurement with compensators, a robust microprocessor for performing calculations, an easy to use interface and the right type of reflectorless laser for taking fast and accurate measurements. A sighting laser is also a very helpful tool for measuring past obstructions and helps locate objects close to or blocking line of sight.

We have determined in this experiment that through parallel using both the precise and MRTS mode monitoring, that when the conditions are right, we can achieve an accuracy of +/- 2mm, which is the same as what we achieve in precise mode. A further option is to combine the two methods when taking measurements so that background noise can be cleared out further in the field.

Colin Hope

Survey Specialist
and

Stephen Dawe

Survey Manager
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IV INTERNATIONAL COURSE ON GEOTECHNICAL AND STRUCTURAL MONITORING

June 13-15, 2017 (Master Classes on June 12) - Rome (Italy)


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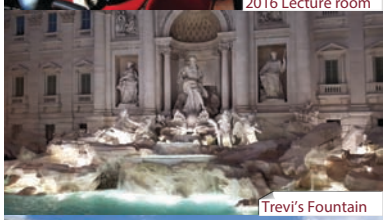
Trevi's Fountain


Sapienza University's entrance


The Statue of Minerva (Sapienza University of Rome)

Course Director: John Dunnicliff, Consulting Engineer
Organizer: Paolo Mazzanti, NHAZCA S.r.l.

THE COURSE: attendance at the course is a great opportunity to establish a valuable network with colleagues from all over the world, to meet manufacturers and see the most recent and innovative instrumentation, thanks to a large exhibition area.

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WHO: engineers, geologists and technicians who are involved with performance monitoring of geotechnical features of civil engineering, mining and oil and gas projects. Project managers and other decision makers who are concerned with management of RISK during construction.

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Paolo Gazzarrini

Overture

46th episode of the Grout Line and for this issue only some news related to our grouting industry that can be of some interest to you.

The 38th annual installment of the renowned ***Grouting Fundamentals & Current Practice*** short course will again be hosted by UT Austin, from May 15-19, 2017. This course has a long tradition of excellence concerning the education of practicing grouters and the scope and depth of subjects covered is unparalleled worldwide. Joining the distinguished international course faculty this year are:

- Clif Kettle, Principal Engineer at Bachy Solentanche, United Kindgom. Clif will be presenting on state-of-the-art practices for compensation grouting and permeation grouting.
- Dr. Devon Mothersille, Managing Director of Single Bore Multiple Anchor Ltd., Geoserve Global Ltd., and AnchorTest Ltd. Devon is a renowned rock anchoring and soil nailing expert, and will be joining the course from the United Kingdom to share his expertise concerning high capacity anchors in weak rock based on the SBMA concept.
- Stéphane Gonichon, Product Manager of Eqiom Cement, Levallois-Perret, France. Stéphane is a recognized authority concerning ultrafine grouts and will be covering the subject of cementitious grout materials and mix design.
- Ken Ivanetich, Special Projects Manager, Hayward Baker Inc., USA. Ken leads the international jet grouting product group for Hayward Baker's parent company, Keller. Ken will be contributing to the subject of jet grouting, concentrating on how to implement best practices worldwide.

For further information and course registration, please visit: *www.groutingfundamentals.com*

Here is the detailed schedule of the week:

Course Agenda

Monday, May 15, 2017

8:00 – 8:10 a.m. Opening Remarks – Kieffer / El Mohtar

8:10 – 9:40 a.m. Introduction to Grouting - Warner

9:50 – 11:20 a.m. Grout Types and Rheology - El Mohtar

11:30 – 12:30 p.m. Cementitious Grout Materials & Mix Design – Gonichon

12:30 – 1:30 p.m. Lunch

1:30 – 3:10 p.m. Chemical Grout Materials and Applications – Warner / Anderson

3:20 – 3:55 p.m. Foaming Agents and Cellular Grouts – Gomez

4:00 – 5:00 p.m. Engineering Geologic Considerations for Rock Mass Grouting –Kieffer

5:15 – 6:45 p.m. Icebreaker Reception

Tuesday, May 16, 2017

8:00 – 9:40 a.m. Cement Grouting in Rock – Dreese

9:50 – 10:50 a.m. Cement Grouting in Rock - the GIN Concept – Katterbach/ Gazzarrini

11:00 – 11:45 a.m. Aperture Controlled Grouting – Carter

11:45 – 12:45 p.m. Lunch

12:45 – 1:30 p.m. Quantitative Design of Grout Curtains – Dreese

1:40 – 2:30 p.m. Recent Advantages in Grouting Technology – Dreese

2:40 – 3:30 p.m. Case Histories - Dam Remediation Projects – Dreese

3:40 – 5:30 p.m. Limited Mobility Grouting – Warner

Wednesday, May 17, 2017

8:00 – 9:00 a.m. Compaction Grouting – Harris

9:10 – 9:50 a.m. Slab Jacking and Grout Jacking – Miluski

10:00 – 11:20 a.m. Compensation Grouting – Kettle

12:00 – 5:00 p.m. Field Demonstration

Thursday, May 18, 2017

8:00 – 9:30 a.m. Permeation Grouting of Soils – Kettle

9:40 – 10:40 a.m. Drilling for Grouting Operations – Bruce

10:50 – 11:50 a.m. Rock Anchors for Dams – Bruce

11:50 – 12:50 p.m. Lunch

12:50 – 1:35 p.m. High Capacity Anchors in Weak Rock (SBMA) – Mothersille

1:45 – 2:30 p.m. Micropiles – Bruce

2:40 – 4:10 p.m. Cutoff Walls & Composite Seepage Barriers – Bruce

4:20 – 5:00 p.m. Crisis Management – Bruce

Friday, May 19, 2017

8:00 – 9:20 a.m. Jet Grouting – Ivanetich

9:30 – 10:05 a.m. Jet Grouting (continued) – Gazzarrini

10:10 – 11:00 a.m. Grouting Instrumentation – Choquet

10:00 – 11:00 a.m. Structural Grouting – Warner

11:10 – 12:30 p.m. Pre-Excavation Grouting in Rock Tunnels – Hognestad

12:30 – 1:00 p.m. Lunch

1:00 – 1:50 p.m. Post-Excavation Grouting in Underground Construction – Kieffer

2:00 – 3:00 p.m. Grouting for Ground Control in Underground Construction – Schmall

3:00 – 3:10 p.m. Closing Remarks – Kieffer / El Mohtar

ASCE G-I Grouting Committee Jet Grouting Task Force Jet Grouting Guide Specification

Another important piece of information for the grouting industry and specifically for the jet grouting engineers is that the new updated Jet Grouting Guide Specification is available on line at *http://grouting.geoinstitute.org/publications*.

The first version of the guide specification was prepared in 2008 by a Task Force comprised of members of the ASCE-GI Grouting Committee. After 9 years an updated version has been released.

As usual, I make the same request, asking you to send me your grouting comments or grouting stories or case histories. My coordinates remain: Paolo Gazzarrini, *paolo@paologaz.com*, *paologaz@shaw.ca* or *paolo@groutline.com*.

Ciao! Cheers!

Introduction by Richard Guthrie, Editor

Welcome to the inaugural episode of Geohazards! It will become, I hope, a place holder for interesting stories, advancing technologies, case studies and scientific inquiry where Geohazards take centre stage as the primary subject.

At the 69th CGS conference in Vancouver, the Geohazards committee meeting was so well attended that one of the conference executive actually began to back out of the room before realizing that he was indeed in the correct place. We decided that the interest in Geohazards was sufficient and widespread enough to warrant a larger communication effort. Oldrich Hungr suggested that Geotechnical News was the best venue to reach CGS members, and I volunteered to lead the effort.

John and Lynn were kind enough to be enthusiastic and John specifically asked that we begin this journey by looking back to understand how Geohazards evolved into it's own discipline. And that, my friends, is what follows for this quarter.

Richard Guthrie

Geohazards defined

Formally, a Geohazard is a destructive event caused or exacerbated by Earth processes with the potential to negatively impact humans or things that humans value (health, the environment, economy, and infrastructure).

Geohazards include:

- Landslides,
- Floods,
- Subsidence,
- Coastal Erosion,
- River Erosion,
- Slope Erosion, and
- Outburst Floods (glacial lake outburst floods, landslide dam outburst floods)
- Thermokarst (melting of permafrost)

Solicitation of articles

Please send me your articles, news, stories or case histories on topics related to Geohazards or Geohazards and Risk. What are you working on the members of the CGS should know about? We want to hear.

Send abstract submissions to:

richard.guthrie@stantec.com

News

A reminder that the 7th GeoHazards Conference will be held in Canmore June 3-6 2018. Sign up for the Geohazards 7 Newsletter here *http://geohazards7.ca/*

About the Editor

Dr. Richard Guthrie (Rick) is an Engineering Geomorphologist with an overriding interest in landslides (pun intended). Rick obtained a BSc from the University of Calgary (Geomorphology), an MSc from University of Victoria (Quaternary Geology – landslide characterization) and a PhD from Waterloo (Engineering Geology – landslide behavior) and is alumni of the first Landslide Risk Assessment and Mitigation class held annually in Italy. He spent 15 years with the BC Ministry of Environment as a regional and ultimately the provincial geomorphologist before moving to private practice in 2010. Rick has also been fortunate enough to visit and participate in Geohazards projects around the world including the USA, Hong Kong, Republic of Georgia, Philippines, Italy, Panama, Colombia, Peru, Russia, and Switzerland for NATO, Canadian Foreign Affairs, Hong Kong GEO office, University of Basel, major industrial companies (typical of consulting), and several legal teams. Career highlights include investigating the deadly Guinsaugon landslide in the Philippines, the 100 Mm^3 Kolka landslide in the Northern Caucuses, Canada's own Mount Meager land-

slide (48.5 Mm^3) and the many west coast landslides associated with steep terrain. He has over 70 publications in books, journals, government research and conferences and was the editor of Island Geoscience for almost 7 years *(https://www.for.gov.bc.ca/hfd/LIBRARY/Island_Geoscience.htm)*.

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The emergence of geohazards as a profession in North America

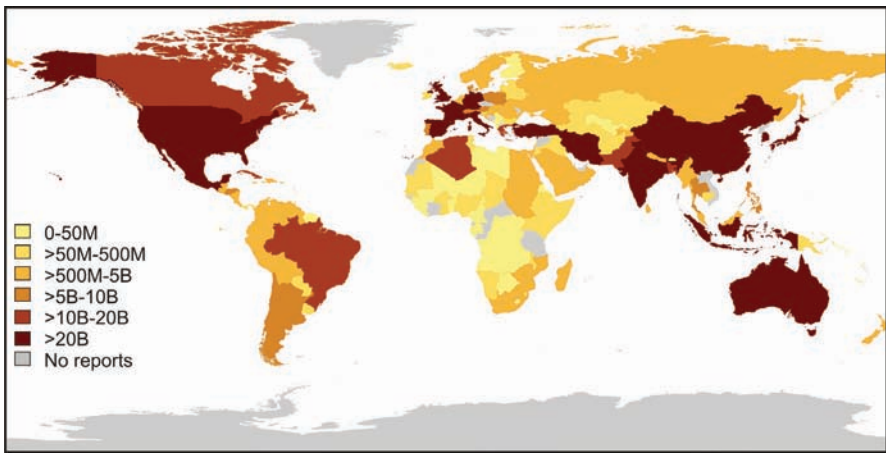

Figure 1. Global costs of disasters related to geohazards from 1900-2009 (Guthrie, 2013).

Introduction

Geohazards are destructive events caused or exacerbated by Earth processes with the potential to negatively impact humans or things that humans value (health, the environment, economy, and infrastructure). They include earthquakes, tsunamis, volcanos, landslides, erosion, floods (including outburst floods), coastal erosion and subsidence.

Geohazards exert an enormous toll on society. Recorded worldwide costs from disasters (ten or more people killed, one hundred or more people affected, a state of emergency is declared, or a call for international assistance is made) related to geohazards between 1900 and 2009 exceed 1.6 trillion US dollars (Figure 1) and almost 30 million lives (Guthrie, 2013). As populations grow, those costs are increasing. Disasters related to geohazards are historically the most expensive (compared to hydrological, climatological, meteorological, and biological) and 2011 was the most expensive year on record with geophysical disasters totaling more than 240 billion US dollars (EM-DAT, 2016).

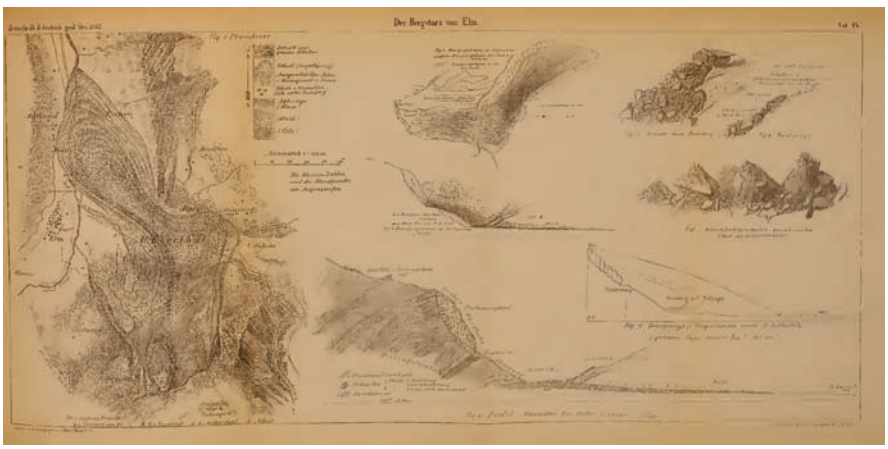

Figure 2. The original geohazard investigation at Elm (Heim, 1882).

Responding to an apparent need, the scientific inquiry of geohazards has resolutely emerged from a background of geotechnical engineering and engineering geomorphology to become a discipline unto itself.

Geohazards, geology and engineering – The early years

The term engineering geology dates back to a series of articles by Henry Penning in 1879 (Penning, Engineering Geology. Part 1, 1879) and a book written by the same author a year later (Penning, Engineering Geology, 1880). It was rapidly becoming clear that there were advantages to the collaboration between engineers and geologists. Both groups brought a unique understanding of the Earth and Earth systems and mechanics to the study of geohazards. This was especially true when trying to articulate and characterize the nature of landslides.

As early as 373 BC (Seed, 1968) the Greek town of Helice was lost to a landslide. China in 1556 experienced

an earthquake that shook the Shaanxi province and killed ~830,000 people, many due to the numerous co-seismic landslides. The landslide at Elm, in 1881, however, was perhaps the subject of the first and seminal landslide investigation (Heim, 1882), and one that considered geology, structure and first tried to address the long runout nature of the event.

In 1904 McConnell and Brock were sent by the Geological Survey of Canada to determine the cause and nature of the Frank Slide in what remains, at the end of 2016, Canada's deadliest single landslide (McConnell & Brock, 1904). Their report continues to be instructive to geohazards specialists today.

By 1925 the University of Alberta taught geology to civil engineers (VanDine, Nasmith, & Ripley, 1992). Texts supporting this work began arriving in the early 20th Century. In 1929, Redlich, Terzaghi and Kemp published their book on engineering geology (Redlich, Terzaghi, & Kemp, 1929) and by 1939 Robert Legget published the first Canadian textbook on the same subject (VanDine, Nasmith, & Ripley, 1992).

In 1928, the St. Francis dam failed in California and killed 426 people (VanDine, Nasmith, & Ripley, 1992). Following that event, civil engineers were unequivocally warned to consider geology as part of the building process. Similarly, a failure of the Chingford reservoir in the UK resulted in England's adoption of geoscience into engineering and the UK's first geotechnical firm, Soil Mechanics Ltd. (Winter & Bromhead, 2016).

By 1945, Karl Terzaghi, an Austrian civil engineer, geotechnical engineer and geologist who would later be known as the father of soil mechanics, came to the west coast of North America. Terzaghi first visited Washington and then British Columbia, where he worked with North American engineers on rails, pulp and paper sites and dams. He was at the time a civil engineering professor at Harvard where he taught engineering geology and lectured on the roles of geology and geomorphology in civil design (VanDine, Nasmith, & Ripley, 1992).

Geomorphology and geohazards

If the science of geology, the structures and nature of the Earth's materials, was incorporated into civil engineering works in the early 20th century, the science of geomorphology, the form and nature of materials currently affected and/or created by water (including ice), wind and gravity, was to take decades longer. Engineering geomorphology is distinct from engineering geology in that while the latter is concerned with how inherited geological properties (structures, mineralization, soil strengths etc…) might impact a design, the former is concerned with how recent landforms and modern processes (the aforementioned wind, water and gravity) might impact a design. The study of geohazards was to ultimately incorporate both.

Quantitative geomorphology emerged, particularly in the US, as a way to understand soil loss (the scourge of the 1930's) and river dynamics. Engineering geomorphology in its broadest sense, however, emerged in the UK with the likes of Peter Fookes (frequently referred to as the father of engineering geomorphology), Denys Brunsden, Ron Cooke, and later Mark Lee and Jim Griffiths and first published as a text in 1986 (Fookes & Vaughan, 1986)

In Canada geomorphology was coming into its own in the late 1970s. Widespread landslides and erosion caused by forest harvesting and road building were deemed preventable through a better understanding of geohazards present in the landscape. As a consequence, by 1976 British Columbia formalized a terrain classification system to systematically describe geomorphology (Environment and Landuse Committee Secretariat, 1976). This system was revised in 1988 (Howes & Kenk, 1988) and again in 1997 (Howes & Kenk, 1997) to include a qualitative prediction of geohazards that might occur following forest activities.

The next pass

Subsequent decades taught Canadians much about Geohazards and landslides in particular. The forestry context provided an epidemiological setting against which experiments could be run and fundamental relationships could be discerned. The contribution of geomorphology was suddenly paramount as pioneers of terrain mapping (Bruce Thomson, Denny Maynard, June Ryder, Terry Rollerson, Terry Lewis and others) began systematically dissecting the country and developing relationships between terrain and geohazards.

At the same time, engineering geologists and geotechnical engineers shared their interests in the geology and geomorphology of specific events and began to unravel the mechanisms behind landslides. The numbers of influential figures in the Canadian history of geohazards grows rapidly at this point but perhaps no one contributed more than the prolific trio of John Clague, Steve Evans and Oldrich Hungr. They (and others) developed key concepts used around the world today including the rock fall shadow, landslide runout mechanisms and

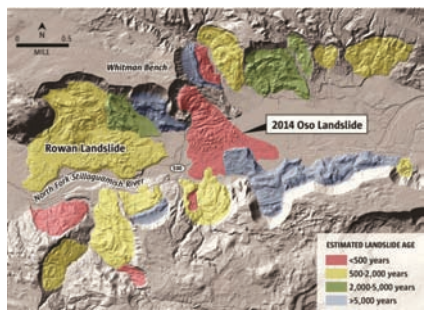

Figure 3. Map of the Oso landslide in the US Publicly available map from the Seattle times (http://old.seattle.times.com/html/localnews/2023244512_mudslidelidarxml.html).

entrainment, and early notions of hazard and risk. Their collective work helped subsequent scientists and engineers understand the critical nature of glacial history on the behavior of ground,

A modern understanding

The 2,000's and beyond brought subsequent generations of scientists and engineers to a growing field of study, influenced by the demanding work of their predecessors and the undeniable improvements in analytical ability and availability of data. It would be hard to underestimate the extent to which modern geohazards studies rely on technological advances in the last two decades. Previously limited by a dearth of data (ameliorated somewhat by a history of terrain mapping and accumulating case studies), suddenly the field of geohazards had an increased ability to measure meaningful changes in the earth at an appropriate scale and with appropriate accuracy. The accelerated pace of technology in the last two decades dramatically changed the scientific landscape and therefore our understanding and our capacity to understand the physical one.

Satellite imagery, LiDAR, heads up 3-D analysis of imagery, complex slope models, time-series analysis are now all routine methods for hazards analysis. Photogrammetry, use of drones, debris flood models and magnitude-frequency analysis are only slightly less common. Geographic Information Systems have gone from the promise of something great, to the fundamental platform of analysis and are quickly moving to open-source background analytics and holders of data.

For the first time in the history of man, large, spatially contiguous, georeferenced tracts of land are accessible at multiple scales over multiple years, at sub-centimeter accuracy. This data is used, for example, to measure the internal deformation of the earth's crust, to record and observe the three dimensional changes in volcanoes, to monitor and predict offshore storms as they approach landfall, and to monitor ice loss in the remote poles.

At the same time, the need has never been greater. At this time of writing, the human population approaches 7.5 billion people. About 10% of people are estimated to live within 10 m of sea level (McGranahan, Balk, & Anderson, 2007). We continue to occupy and develop increasingly steep terrain, to change rivers and to encroach upon shorelines. In doing so, we are increasing the interactions between hazards and humans, and we are changing the nature of the earth processes by ourselves becoming a key driver of earth processes and landforms (Guthrie R. H., 2016).

Consider 2014 Oso landslide, the 2015 M 7.8 Nepal earthquake or the tens of thousands of landslides generated during the 2016 Kaikoura 7.8 earthquake in New Zealand. Each of these was only one of the multitude of geohazards impacting human society in the last few years.

As we move firmly into the 21st Century, when we consider both the social demand and our abilities as geoscientists and geotechnical engineers to meet that demand, it appears clear that the profession of geohazards has come into its own.

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In 1982 members of the Canadian Geotechnical Society conceived the idea of a book recording the development of geotechnical engineering in Canada. Since a number of the early practitioners were still living at the time, foremost among them Bob Hardy and Bob Legget, the approach was intended to create "a living history ... through the eyes and recollections of living engineers, to show the humanity that underlies the development of major geotechnical projects in Canada."

As this book is now out-of-print, we will be publishing excerpts from it over the next few editions of Geotechnical News. Ultimately, a pdf copy will be available.

Geotechnical Engineering in Canada An Historical Overview

Cyril E. Leonoff

Terrain of Canada

The civil engineers charged with the physical building of Canada have faced an awesome challenge. Geographically it is the third-largest country in the world, comprising the northern 40 percent of North America, bounded by three oceans and covering a land area of 3,851,809 square miles. Spanning the continent a distance of 3,842 road miles, between the Pacific at Vancouver, British Columbia and the Atlantic at Halifax, Nova Scotia, Canada has a scant population of some 30 million — barely eight persons per square mile — with 90 percent of these people strung along the southern border. Yet much of the mineral, oil, and water resource base to be exploited lies in the remote north and offshore.

The Pleistocene geology of Canada is prevalent. Canada has the largest glacial soil mantle of any country (indeed an almost complete absence of unglaciated areas and their residual soils) and correspondingly the largest area of enclosed fresh water. The geomorphology ranges from the lowlands of Hudson Bay, the Eastern Arctic, and the St. Lawrence Valley, through the Precam brian Shield where the soil mantle is thin and bedrock exposed, across the interior plain of the Prairie Provinces, to the Cordilleran mountain ranges of the far West.

The diverse, unconsolidated sediments comprising the earth's crust, broadly described as soil, constitute so large a portion of the earth's surface that few civil engineering projects can be carried out without dealing with some type of soil. As well, some of the largest man-made structures ever built - earth dams, dykes, canals, tunnels, railroads, and highways are composed largely of earthwork.

The problems to be solved in Canada by the geotechnical engineer are seemingly endless. About half of the land is underlain by permanently frozen ground, or permafrost. Some 500,000 square miles are covered by sphagnum moss and decayed and fossilized vegetation, popularly called muskeg. Sensitive marine clay of the Champlain Sea — Leda Clay — lies in the St. Lawrence and Ottawa valleys; the lacustrine clay of infilled glacial lakes fills areas such as that around Lake Agassiz in Manitoba. Treacherous clay-shale — Bearpaw Shale — underlies much of the Prairies. Massive rock slides, such as the Frank and Hope slides, occur in the Cordillera, while great landslides also happen in the dry silt benches of the Thompson River railway belt, and "drowned valley clay" covers the floor of the Pacific Coast tidal estuaries and fjords. Moreover more than half of the Canadian population is subject to potential seismic hazard.

Early Civil Engineering Works

The challenges faced by the early 19th century Canadian civil and military engineers involved the construction of canals and locks, used to connect water transportation routes and to provide military defence —Welland Canal (1824-1829) and Rideau Canal (1826- 1832). The construction of railways and their appurtenant works, such as bridges and tunnels, began in the 1830s-40s, serving to connect the scattered segments of the fledging nation — the Grand Trunk between Sarnia and Montreal (1845-1862), the Intercolonial to the Maritime Provinces (1858-1876), and the Canadian Pacific (1881-1886) to the West.

By mid-century, engineered roads were being constructed for communication and transportation between settlements and for resource exploitation — the Cariboo Wagon Road (1862-1866) from Yale, B.C. through the Fraser Canyon to the gold-rush town of Barkerville, and the Daw-

son Road (1868-1870) to connect the missing links of the water route from Fort William to Red River. The former, built by the Royal Engineers, ranks with the greatest engineering achievements of the 19th century.

As the villages and towns grew into cities, dams and water supply reservoirs were required for domestic consumption, water power, and industry. Commensurate with the status of the new Canadian Confederation of 1867, at the end of the 19th — early 20t th centuries, monumental public buildings made their appearance, sometimes with attendant settlement problems — the Empress Hotel, Victoria, and the Victoria Memorial Museum, Ottawa being prime examples.

The science of soil mechanics and the formal practice of geotechnique were to be events of the 20th century. Nevertheless, before the analytical tools invented by Karl Terzaghi, were available, good civil engineers, by empirical methods, were able to devise solutions that were precursors of modern geotechnical engineering practice.

Sir Sandford Fleming (1827-1915) was Canada's preeminent railway engineer of the 19th century. Born in Scotland, where he studied surveying and engineering, Fleming came to Canada in 1845 at the age of eighteen and entered the service of the Northern (Ontario, Simcoe and Huron) Railway. His first great "empire-building" achievement came as chief engineer (1868-1875) of the Intercolonial Railway, which came about as a condition of bringing the Maritime Provinces into the Canadian Confederation.

The most noteworthy engineering work on the line was the construction of two 1,200-foot-long truss-span bridges over branches of the Miramichi River near Newcastle, New Brunswick. Initial test borings arranged by Fleming at the two river crossings, and surface outcropping inferred a sandstone bedrock. However during construction, when settlement of the northwest bridge piers was observed, Fleming stopped construction and ordered a second set of borings. At the southwest bridge, a dense gravel and sand stratum underlain by sandy-silty glacial till, allowed safe construction of the bridge piers to the original design.

However, at the northwest bridge, the bearing stratum was underlain by a thick deposit of clay-silt — the cause of the settlement. Fleming devised the first recorded static penetration tests, using cased iron rods within the bore holes to eliminate friction, in order to determine the loads which the different strata in the riverbed would support.

As a result of the tests, Fleming needed to enlarge the pier bases in order to spread the load, and he preloaded each pier until the settlement stopped.

In 1871 Sandford Fleming was appointed engineer-in-chief to superintend the surveys for the Canadian Pacific Railway through the Rocky and Selkirk Mountains. He surveyed the route through the Yellowhead Pass, which is now followed by the Canadian National Railways, and he was the first to demonstrate the practicability of the CPR route through the Kicking Horse, Rogers, and Eagle passes.

After 1880 Sandford Fleming devoted himself to scientific and literary work. Among his many other achievements, he was the pioneer of the 24-hour system of time reckoning and of standard time, necessary for the scheduling of transcontinental train service. Fleming also designed the first Canadian postage stamp, the three-penny issue of 1851. It depicts the beaver, that ubiquitous resourceful civil engineer of the Canadian wilderness, building his dam.

Now operated by CN Rail, the Grand Trunk Railway initiated the St. Clair Tunnel, built between Sarnia, Ontario and Port Huron, Michigan from 1889- 1891. The tunnel replaced a slow ferry service in providing a primary Canadian link to Chicago, centre of the North American railway universe. After two previous attempts had failed, the Grand Trunk chose the experienced civil engineer **Joseph Hobson,** born in 1834 at Guelph, Ontario, as chief engineer of the tunnel company. Hobson's "combination of daring, tenacity, and engineer ing knowledge" proved to be just the right combination to ensure success of the venture. In investigating the site, Hobson made detailed borings in line with the proposed route, taking 110 soil samples. These revealed that the riverbed consisted of a thin layer of "treacherous blue clay" above a shale bedrock. To execute the large bore tunnel, two huge cylindrical shields with knifelike leading edges were driven from each end by hydraulic rams through the "slippery" clay "like a giant cookie cutter." The clay layer above the crown was so thin — only 10 to 12 feet — that the workers claimed that they could hear the bands playing aboard steamers passing overhead. This first international tunnel in North America, driven subaqueously through such perilous clay, was widely reported in trade journals throughout the world and considered an engineering marvel of the day. Many of the precedent-setting techniques employed in the project have been adopted in modern tunnel engineering practice. Hobson's tunnel survived a century of active service but has recently been replaced, not because of any failure in its engineering, but because its dimensions were made obsolete by inter-modal rail systems such as double-stack container cars and tri-level auto cars.

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