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Volume 31 • Number 3 • September 2013

GEOTECHNICAL news

Automated MEMS based in-place inclinometers

In Memoriam
Earle Klohn

innovation

DIGITAL MEMS INCLINOMETER SYSTEM

in MEMS Digital Inclinometer Systems

How the best just got better.

For measuring any lateral movement down in the earth, via inclinometer casing, the Digital MEMS Inclinometer System from RST Instruments Ltd. was the first, and is still the best, Digital MEMS Inclinometer System available.

Over the last 10 years, RST's Inclinometer systems have had the shortest overall length available for a given base length compared to competitive inclinometers. Undaunted, we've forged ahead and improved on our very own industry-leading specifications. With a new minimum negotiable casing radius of 1.93 m, RST's Digital MEMS Inclinometer can still traverse a smaller radius bend than all other inclinometers available in the industry.

OTHER INCLINOMETERS VS. RST

Other Inclinometers → **RST Inclinometer**

Interference

Interference at connector is visibly inherent in other inclinometers (left) while RST's Digital MEMS Inclinometer (right) can clearly traverse a smaller radius bend (1.93 m) than all other inclinometers.

Minimum Negotiable Casing Radius

Other Inclinometers:
3.12 m

RST Inclinometer:
1.93 m

0.5 m wheelbase probes shown in 70 mm OD inclinometer casing.

RST's newly developed connector is by far the industry leader for the least amount of connector interference.

RST also provides the most robust cable on the market with a breaking strength of 5.90 kN (1325 lbs.) Also, our new, non-slip, swaged cable marks are unmatched in grip strength.

The compact reel system with 50 m cable weighs a very manageable 4.7 kg and can be easily held with one hand. A padded carrying case is included.

Above, the RST Digital MEMS Inclinometer Probe with industry leading system accuracy of ±2 mm per 25 m, shown connected to the cable. Below, the Ultra-Rugged Field PC functions as the data collector. It provides a high-level user interface, "at-the-borehole" data analysis and graphical comparison to previous data sets.

MEMS TILT & INCLINATION SERIES

SYSTEM INCLUDES:

MEMS Digital Inclinometer probe, cable system, reel with battery power, and an Ultra-Rugged Field PC that functions as a wireless readout, analysis, and data storage device. Includes all accessories, as shown at left. Please contact the RST sales team for complete details.

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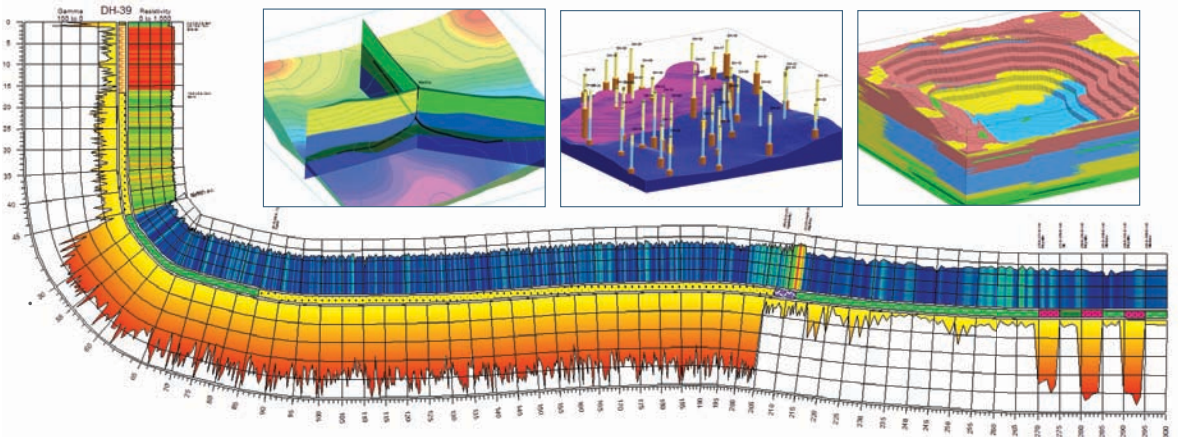

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Cable

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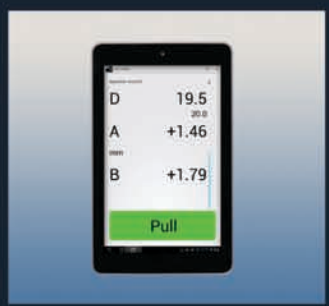
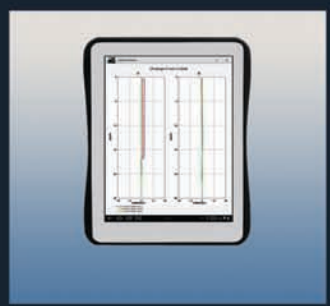
Compact Cable Gate

Compact cable gate aligns cable at top of casing and makes depth control



Nexus© tablet

Convenient hands-free mode records readings when you pull the cable.



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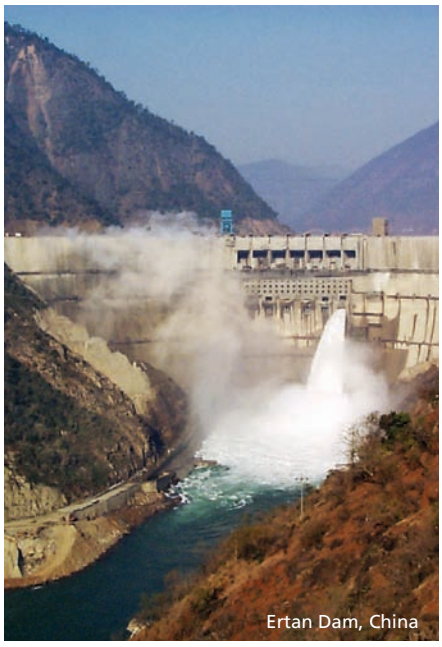
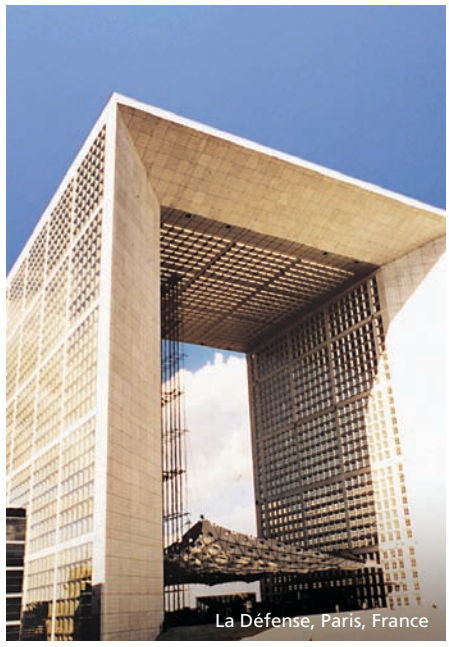


Ertan Dam, China



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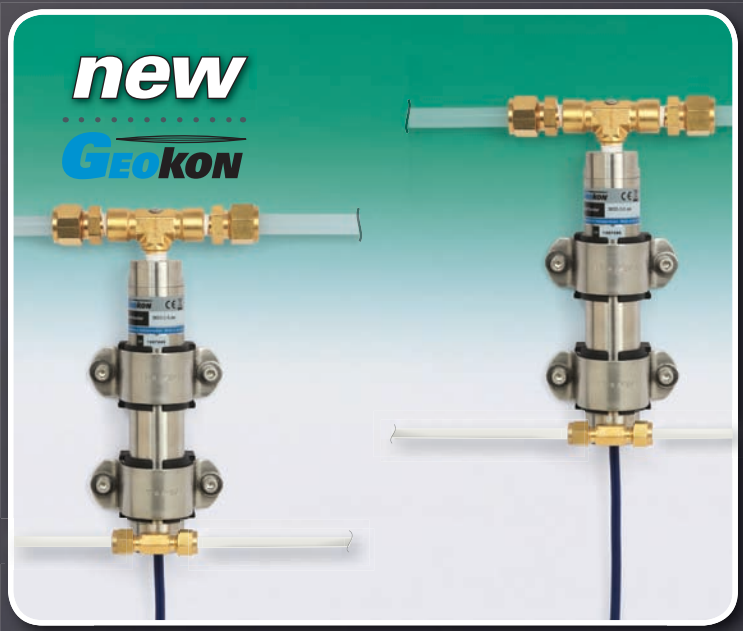

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Message from the President

Richard J. Bathurst, President of Canadian Geotechnical Society

This is my third message to the members of the Society and by the time you read this, the **66th Annual CGS Conference** (GeoMontreal - September 29th to October 3rd) will be upon us. It will be followed immediately by the **4th Canadian Young Geotechnical Engineers and Geoscientists Conference** in Mount Tremblant (October 3rd to 6th).

Considerable effort has been expended by the local organizing committee of GeoMontreal 2013 to make this a memorable event, headed by **Mario Ruel, Sylvain Roy** and the conference management team headed by **Wayne Gibson**. The conference promises a broad technical program made possible in part by our partnering societies for this conference; the **International Association of Hydrogeologists – Canadian National Chapter (IAH-CNC)** and the **North American Geosynthetics Society (NAGS).**

A notable CGS event that will be held during the conference will be a celebration of the 50th year of the *Canadian Geotechnical Journal*. In addition, the French version of the *4th Canadian Foundation Engineering Manual* has been published and will be available at the conference. **Jean Lafleur**, the lead editor of the translated version of the manual, along with his contributing team, will be honoured at the Awards Banquet on Tuesday night. Please check the conference website for information regarding other events including the Legget Luncheon, CGS Colloquium Speaker, Hardy Address and Best Graduate Student Paper presentation.

Another upcoming CGS activity of note is the 2013 Fall CGS Cross

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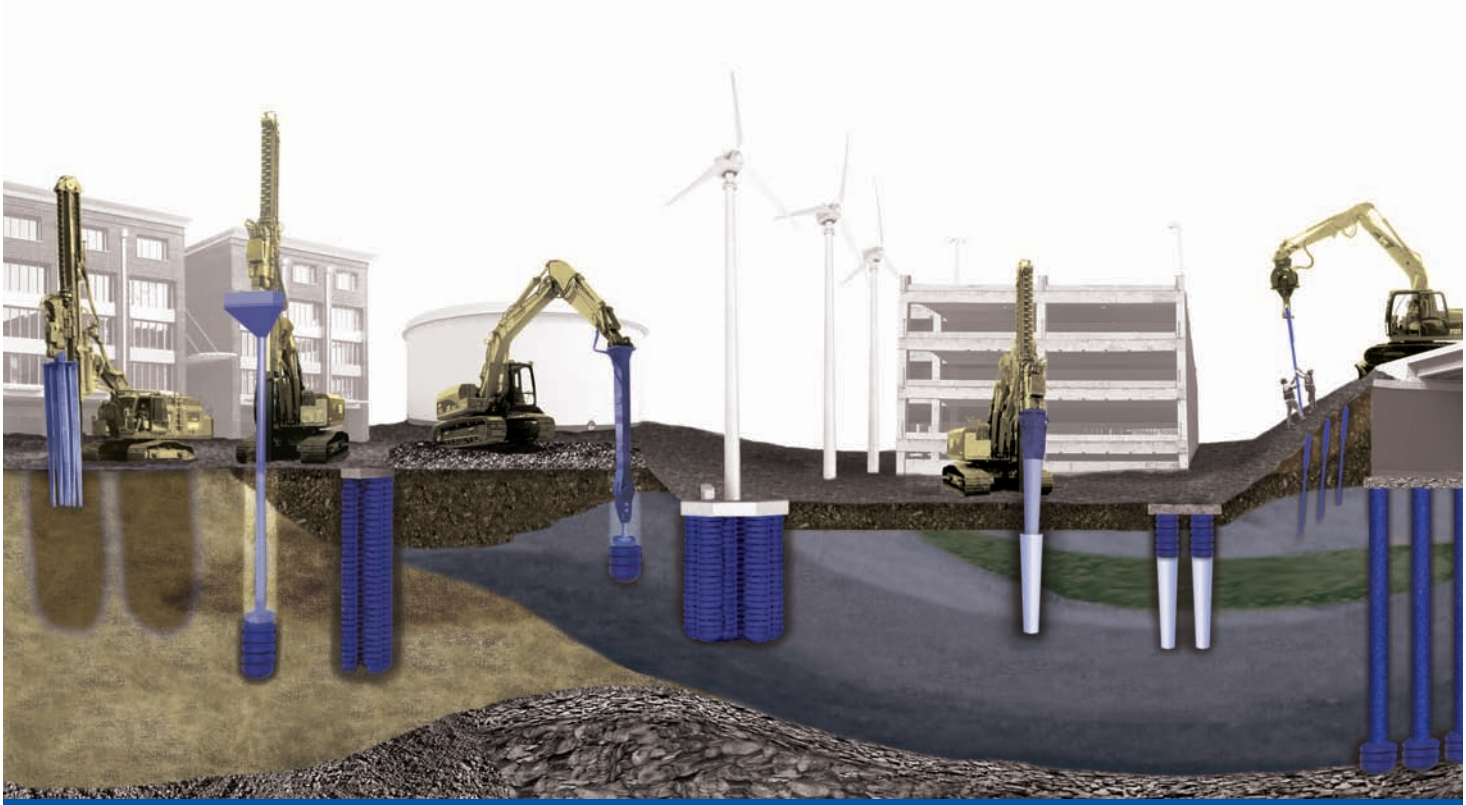

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Canada Lecture Tour. This year will feature **Dr. Ed Kavazajian** from Arizona State University. Dr. Kavazajian has prepared a selection of four different presentations for his tour which crosses Canada between October 8 and 23. You are encouraged to contact your local section, to see if he has been scheduled to speak to your group.

I had the pleasure of attending the **18th International Conference on Soil Mechanics and Geotechnical Engineering** of the ISSMGE in Paris. This conference is held every four years. In addition to participating in a number of technical sessions and workshops, I represented the CGS at the ISSMGE Council Meeting, held the day before the conference, and will provide a summary of important news from this meeting in my next message. I am delighted to report that there were a large number of CGS members at this conference. One proud moment was the presentation of one of the two **ISSMGE Young Member Awards** to **Greg Siemens**, Chair of the CGS Education Committee. Congratulations to Dr. Siemens. Dr. Siemen's Award was truly remarkable since the competition was open to all young members of the 80 Member Societies of the ISSMGE. In addition I was also proud of two young engineers, **Nicholas Beier** (University of Alberta) and **Vincent Goreham** (Dalhousie University) who won a CGS competition to attend the **5th International Young Geotechnical Engineers Conference** in Paris, immediately followed by attending the first two days of the 18th International Conference on Soil Mechanics and Geotechnical Engineering in Paris. Their travel and living expenses were paid by funds provided by the Canadian Foundation for Geotechnique and the Education Committee of the CGS.

I hope to see you all at **GéoMontréal 2013**.

Provided by Richard Bathurst – President

Message du président

Voici mon troisième message aux membres de la Société et, lorsque vous le lirez, la **66e conférence annuelle de la SCG** (GéoMontréal - du 29 septembre au 3 octobre) aura presque commencé. Elle sera immédiatement suivie de la **4e conférence canadienne des jeunes géotechniciens et géoscientifiques** au Mont-Tremblant (du 3 au 6 octobre).

Le Comité organisateur local a déployé des efforts considérables pour faire de GéoMontréal 2013 un événement mémorable. Ce comité est dirigé par **Mario Ruel** et **Sylvain Roy**, alors que l'équipe de gestion de la conférence est dirigée par **Wayne Gibson**. La conférence promet un programme technique d'envergure, rendu possible en partie par les sociétés partenaires de cette conférence, l'**Association internationale des hydrogéologues – Section nationale canadienne (AIH-SNC)** et la **North American Geosynthetics Society (NAGS)**.

Pour la SCG, l'un des événements marquants de la conférence sera la célébration du 50e anniversaire de la *Revue canadienne de géotechnique*. De plus, la version française de la 4e édition du *Manuel canadien d'ingénierie des fondations*, a été publiée. Elle sera disponible durant la conférence. **Jean Lafleur**, chef de l'équipe de traduction du manuel, sera honoré lors du banquet de remise des prix de mardi soir, avec les membres de son équipe. Pour vous renseignement sur les autres événements, dont le dîner Legget, le Colloque de la SCG, le discours Hardy et la présentation du Prix de la SCG pour étudiant diplômé, veuillez consulter le site Web de la conférence.

La prochaine activité de la SCG d'importance est la Tournée des conférences panacadiennes (TCP) de l'automne 2013. Cette année, le conférencier sera **Ed Kavazajian, Ph. D**., de l'Arizona State University. Il a préparé une sélection de quatre présentations différentes pour sa tournée canadienne qui se déroulera du 8 au 23 octobre. Pour savoir s'il fera une présentation à votre groupe, veuillez communiquer avec votre section locale.

J'ai eu le plaisir d'assister au **18e congrès international de mécanique des sols et de géotechnique** de la Société internationale de mécanique des sols et de géotechnique (SIMSG) qui avait lieu à Paris. Ce congrès a lieu tous les quatre ans. En plus de participer à plusieurs sessions et ateliers techniques, j'ai représenté la SCG à la réunion du Conseil de la SIMSG, qui se tenait la veille du congrès. Dans mon prochain message, je résumerai les points saillants de cette réunion. Je suis ravi de mentionner qu'un grand nombre de membres de la SCG étaient présents à ce congrès. L'un des grands moments fut la remise de l'un des deux **Prix de la SIMSG pour les jeunes membres** à **Greg Siemens,** président du Comité de l'éducation. Nous le félicitons chaleureusement. Le fait qu'il ait remporté ce prix est véritablement remarquable, car le concours était ouvert à tous les jeunes membres des 80 sociétés membres de la SIMSG. De plus, je suis également fier de deux jeunes ingénieurs, **Nicholas Beier** (Université de l'Alberta) et **Vincent Goreham** (Université Dalhousie) qui ont remporté le prix de la SCG leur permettant d'assister au **5e congrès international des jeunes ingénieurs géotechniciens** qui avait lieu à Paris, juste avant le 18e congrès international de mécanique des sols et de géotechnique, qui avait lieu aussi à Paris. Leurs frais de voyage et de subsistance avaient été assumés avec des fonds versés par la Fondation canadienne de géotechnique et le Comité sur l'éducation de la SCG.

Au plaisir de vous voir à **GéoMontréal 2013.**

De la part de Richard Bathurst – président

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From the Society

Upcoming Conferences and Seminars

GéoMontréal 2013
September 29 - October 3, Montreal, Quebec

The Canadian Geotechnical Society (CGS) in collaboration with the International Association of Hydrogeologists (IAH/CNC) and the North American Geosynthetics Society (NAGS), invite you to **GéoMontréal 2013**, the 66th Canadian Geotechnical Conference and the 11th Joint CGS/IAH-CNC Groundwater Conference. The conference will be held at the Hilton Montreal Bonaventure Hotel, Montreal, Quebec, Canada from Sunday, September 29 to Thursday October 3, 2013.

The theme for **GéoMontréal 2013** is "Geoscience for Sustainability" and will examine how our three associations invest in the progress necessary to create an innovative and prosperous economy that is ecologically and socially responsible. The organizers intend to weave the conference theme throughout the technical program and social activities and to remind delegates of this important goal in our professional work. The official languages for the conference will be French and English.

Montreal is a city of contrasts, situated on an island with a unique character. Both cosmopolitan and cozy, our metropolis is a window to the world. Full of flavour, it is a mix of deep-rooted traditions, diverse cultures, and languages. The charms of old Europe and the energy of modern North America both radiate from the heart of the city, but it is Montreal's cultural blend that give it such a unique feel.

The Hilton hotel in downtown Montreal borders the city's economic hub as well as the iconic old port. Sights like the Museum of Fine Arts and the Notre-Dame Basilica are within walking distance. Delegates and their guests may also choose to visit numerous tourist attractions during their stay, such as Saint-Joseph's Oratory, the Casino de Montréal, the Olympic Park, the Biodome, the Insectarium, and the city's brand new Planetarium.

For more information, go to *www.geomontreal2013.ca*

Canadian Young Geotechnical Engineers and Geoscientists (cYGEGC)
October 3 to 6, 2013
Mont Tremblant, Quebec

Join us in Mont Tremblant for the 4th Canadian Young Geotechnical Engineers and Geoscientists Conference (cYGEGC) from October 3 to 6, 2013, a gathering of young engineers and geoscientists sharing technical knowledge and career experiences.

Conference Highlights include:

- exciting technical presentations from the delegates
- 5 keynote speakers with diverse career paths
- A field trip highlighting applications of geoengineering

More information is available at *www.cygegc2013.ca*

1st International Workshop on Landslides in Sensitive Clays
October 28 to 30, 2013
Laval University, Quebec City, Quebec

The 1st International Workshop on Landslides in Sensitive Clays (IWLSC) aims to provide an international perspective of landslides in sensitive clays and their consequences by bringing together state-of-the-art contributions from international researchers in academia and in industry, as well as planners working on land-use and hazard mapping. The workshop will provide broad coverage of the scientific and engineering aspects of geo-hazards related to sensitive clays.

Workshop themes will include:

- Sensitive clays: source, nature, development, characterization and extent
- Slope development and processes
- Triggering of landslides
- Post-failure behaviour and landslide morphology
- Modeling and slope stability assessment
- Geotechnical and geophysical investigations
- Susceptibility mapping
- Hazard assessment, risk management, regulations and policies
- Landslide precursors and early warning systems
- Stabilizing methods in sensitive clays

For more information, email: *iwlsc@mtq.gouv.qc.ca*

Tailings and Mine Waste 2013
November 3 to 6, 2013
Banff, Alberta

Mine waste managers, engineers involved with tailings management and reclamation, regulators and researchers are invited to Tailings and Mine Waste 2013.

Conference participants will have opportunities to present ideas, learn of new developments and technologies, make professional contacts and discuss issues related to the impact of mine wastes on the environment. The program will include sessions by practitioners and experts on the general themes of the conference.

The following general topics and themes are within the scope of the conference:

Tailings and Mine Waste Management

- Restoration and Rehabilitation
- Special Sessions
- Oil Sands Tailings and Mine Wastes
- Northern Issues with Tailings and Mine Wastes

For more information, contact the conference chairs, **Dr. David Sego** at dave.sego@ualberta.ca, or **Dr. Ward Wilson** at *wwilson2@ualberta.ca*.

Heritage Committee

The history of the local chapters of the Canadian Geotechnical Society

The Heritage Committee believes that the history of the local chapters of the Canadian Geotechnical Society to be valuable part of the Society and its members. The CGS Heritage Committee would like to assemble if at all possible, a collection of historical summaries of all the chapters. As an example, the CGS Heritage Committee is pleased to provide the history of two prominent local chapters, the Vancouver Geotechnical Society and the Geotechnical Society of Edmonton. This month, we present the history of the Vancouver Geotechnical Society. In December, we will highlight the history of the Geotechnical Society of Edmonton. Hopefully these stories will encourage other local chapters of the CGS to gather their archives and write their own history.

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

A Brief History of the Vancouver Geotechnical Society

The Vancouver Geotechnical Society (VGS) was formed in 1953 under the original name of the "Vancouver Soils Group" by Charles F. Ripley, P. Eng., founder of one of the first geotechnical engineering consultant companies in Vancouver. He formed the group at the urging of Dr. Robert F. Legget of the National Research Council of Canada. Starting in 1947, Dr. Legget organized an annual meeting of professionals involved in soil, ice, and snow mechanics that was sponsored by the Division of Building Research under the National Research Council of Canada. These annual meetings were first held in Ottawa and later at various locations across the country. Mr. Ripley was asked to represent British Columbia at the annual meetings when he moved to British Columbia in 1951.

The 9th Canadian Soil Mechanics Conference (later known as the Canadian Geotechnical Society (CGS) Conference, was the first national conference that was held in Vancouver in December, 1955. The conference was organized by the Vancouver Group and chaired by Charles Ripley. In time, the annual conferences have evolved to become part of a national organization, the CGS, which continues to have an annual general meeting each fall, combined with a three-day technical conference. Vancouver has also hosted the annual CGS Conferences in 1966, 1976, 1983, 1995 and 2006.

The original participants in the VGS included practitioners in engineering, soil mechanics, agronomy and geology. Initially informal meetings were typically held several times a year at the University of British Columbia. Today, the VGS membership includes geotechnical engineers, engineering geologists, geoscientists, and others interested in the many facets of geotechnical engineering. Members include professionals employed by consulting firms, local and provincial governments and agencies, industry, academics and students of geotechnical engineering.

Currently, the VGS meetings are held in the evenings approximately 8 to 9 times a year, with presentations by local practitioners and visitors. Themes range from engineering of foundations, dams, slope stability of both soil and rock slopes, tunnelling, as well as earthquake engineering, geology, and environmental engineering. The meetings also include the distinguished Cross-Canada Lectures supported by the Canadian Foundation for Géotechnique - a charitable organization independent of the CGS. One of the highlights of the year for the VGS is an annual one-day symposium, which typically attracts well over 100 registrants and is held in the late spring. Proceedings of the symposium are published and distributed to all registrants, with additional copies made available to the public through BiTech Publishers Ltd. of Richmond, British Columbia. Nowadays, most of the VGS Symposium proceedings are available freely in the VGS web site. Available archives indicate that the "Peat Symposium" held on February 27, 1967 may be the first of such events.

In 1996 the VGS replaced the annual $400 Vancouver Geotechnical Society Prize at the University of British Columbia, and instituted an annual $1,000 Vancouver Geotechnical Society Scholarship at the University of British Columbia for a post graduate student studying in the field of geotechnical engineering. Also, in 1996 the VGS initiated the Vancouver Geotechnical Society Award, which is given annually to a VGS member that has contributed significantly to the Vancouver Geotechnical Society, and the practice of géotechnique in the Vancouver area. The VGS Award is accompanied with a lifetime VGS membership for the recipient.

Another major initiative by the VGS was the coordination and sponsorship of the Commemorative Issue of the Geotechnical News magazine as part of the Jubilee celebrations at the 50th CGS Conference held in Ottawa in 1997. The Commemorative Issue featured the history of geotechnical engineering in Canada and was entitled "Geotechnical Engineering in Canada – An Historical Review". The articles on the history of geotechnical engineering in the 150 page Commemorative Issue were written by eminent Canadian geotechnical engineers, and the document was edited by Cyril E. Leonoff, P. Eng. The Commemorative Issue was sent, free of charge, to all members of ·the CGS in 1997 as a contribution by the VGS in recognition of the 50th anniversary of the CGS Conferences.

Members in the News

Dr. Kerry Rowe

Dr. Kerry Rowe Elected a Fellow of the Royal Society

The Canadian Geotechnical Society would like to congratulate Queen's University professor Kerry Rowe (Civil Engineering and Geo-Engineering Centre at Queen's-RMC), who has been elected a Fellow of the Royal Society in the United Kingdom. Dr. Rowe is one of only four Canadians, and the world's only civil engineer, elected to the prestigious institution in 2013.

Founded in 1660, the Royal Society is made up of the most eminent scientists in the world and has included the likes of Isaac Newton, Charles Darwin and Stephen Hawking amongst its Fellows. Fellows are elected in recognition of their exceptional contributions in the fields of science, engineering and medicine. Its mission is to recognize, promote, and support excellence in science and to encourage the development and use of science for the benefit of humanity.

"I am absolutely delighted with this recognition which really acknowledges my wonderful colleagues in the Geo-engineering Centre at Queen's-RMC and my past and present graduate students, without whose collaboration it would not have been possible to have achieved this distinction," says Dr. Rowe.

Dr. Rowe, a former vice-principal (research) at Queen's, was described by the Royal Society as one of the most distinguished civil engineers of his generation. For 30 years he has made contributions to the investigation of landfill development, soft-ground tunnelling and the reinforcement of embankments. In an era where public infrastructure design is increasingly subjected to economic, social, health and environmental considerations, Dr. Rowe has provided scientifically justified, environmentally responsible and economically sound solutions.

During his time as vice-principal, Dr. Rowe was integral in leading the promotion and development of research and training programs at Queen's. These programs have and will continue to facilitate collaboration between academics, governments and industry on research issues and projects that are advancing the scientific development of this country.

Dr. Rowe has been recognized previously with many of Canada's and the world's highest honours for his work, including: the Killam Prize in Engineering (2004), a Killam Fellowship (2012), a Steacie Fellowship (1989), and the Ontario Ministry of the Environment's Award of Excellence for Research and Development (1999). He is a Fellow of both the Royal Society of Canada, the Canadian Academy of Engineering and the Royal Academy of Engineering.

Dr. Rowe was formally inducted into the Royal Society in London on July 12, 2013.

Editor

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Check these sources for breaking G-I news:

- The G-I webpage at *www.asce.org/geo*
- The G-I monthly eUpdate newsletters.
  Twitter at *http://twitter.com/GeoInstitute*
- Facebook at *www.facebook.com/GeoInstitute*
- G-I LinkedIn at *http://www.linkedin.com*

According to LinkedIn's Geotechnical Engineering Experts: Here's what's been on people's minds

- How do you face the problem of vibrations generated by the falling of a tree nearby a house?
- Have geologists finally figured out how Death Valley's 'sailing stones' move across the desert all by themselves?
- Calculating soil resistance for laterally loaded pile based on pile deflection.
- What is most important parameter for soil nailing application :
  - Tensile load?
  - Shear strength?
  - Bending?
- Filter design criteria for protection of dispersive clay core.
- Which software of these three: PLAXIS 3D, midas GTS, FLAC 3D is the most technically capable and user friendly?
- Has anyone used SAFE for numerical modeling of piles?
- Looking for self-drilling rock bolt hand held machine - help needed
- What can you do as a student geotechnical engineer to make yourself stand out to the big mining companies and get their attention?

G-I News

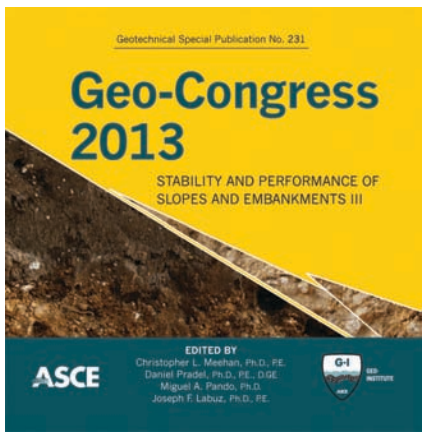
G-I Board looks to the future

The G-I Board of Governors hosted its Strategic Planning Meeting in Philadelphia, PA on June 18-19, 2013. The major goals for the meeting were to determine how to best meet the needs of Geo-Institute members now and in the future and the best ways to continue the advancement of the geo-profession.

Watch for the outcomes of the planning session in the December issue of *Geotechnical News* or on the Geo-Institute website at *www.asce.org/geo*.

2013 Geo-Congress photos and proceedings still available

Looking for someone you met at the 2013 Geo-Congress? Were you caught on camera by our roving photographer? Enjoy the 2013 Geo-Congress experience at http://visualnaturreimages.photos*helter.com/gallery-collection/2013-GEO-Congress/C00006x.YYamectY*. If prompted, enter the password: GEO2013



You can order the complete 2013 Geo-Congress proceedings on CD-ROM. It contains 229 peer-reviewed technical papers and case studies focusing on the stability, performance, and rehabilitation of slopes, embankments, and dams. To order: *www.asce.org/BookSearch.aspx?id=2147487208* and enter 41278 in the Stock No. box.

A contested election for a new G-I Governor

The G-I contested election for one open governor position on the G-I Board beginning in October 2013 is open. As this issue of *Geo-Strata* went to press, there were possibly three candidates on the ballot for the open position. Check the G-I website at *www.asce.org/geo* for candidate information and if you are a Geo-Institute member, be sure to cast your vote.

Wanted: Ethics articles for *Geo-Strata* Magazine

The *Geo-Strata* Editorial Board is on the lookout for ideas about geo-ethical topics to include in upcoming issues of the magazine. If you have an idea or two, or would like the opportunity to write a brief article or case history regarding an ethical topic, send your ideas and/or article to *Geo-Strata* at *geo-strata@asce.org*.

Sites selected for Cross Country Lecture

The five sites selected to host the 2013-2014 Cross Country Lecturer, Thomas D. O'Rourke, PhD, PE, Hon.D.GE, GE, are the Geo-Institute Chapters of Georgia, Hawaii, Oregon, and St. Louis, and the University of Washington. Dr. O'Rourke, the

VDV 2013 for Big Data in Geotechnical– and Mining projects

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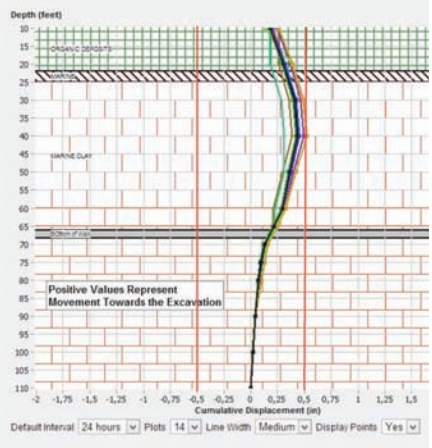

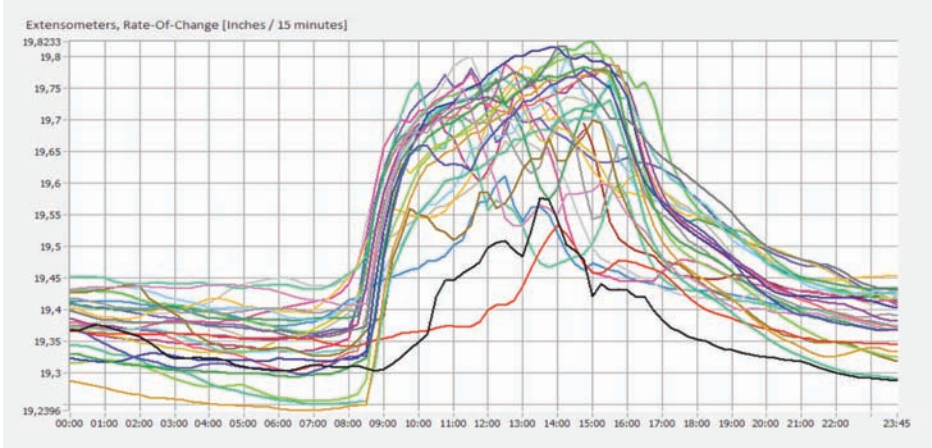

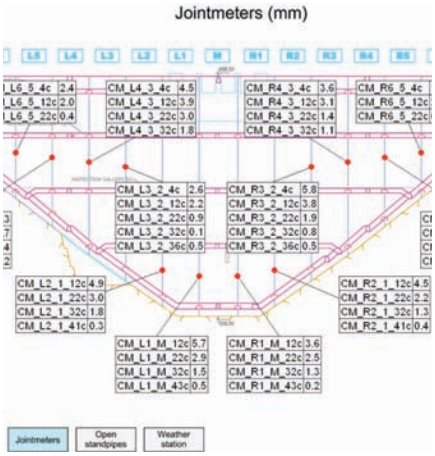

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Thomas R. Briggs Professor of Engineering in the School of Civil and Environmental Engineering at Cornell University, will provide each group with a choice of one or more lecture topics and the group will jointly decide the topic to be presented at its location. For information,

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Luis Babler, PE, M.ASCE, Chair
(770) 426-7100

Hawaii Chapter
Tim (Xiaobin) Line, PE, M.ASCE, Chair
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Oregon Geo-Institute Chapter
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St. Louis Geo-Institute Chapter
Shawnna Erter, PE
(314) 699-9660

University of Washington
Lorne Arnold
Graduate Student Organization
lorne87@uw.edu

Distinguished ASCE Member 2014 Election

The G-I was proud to announce the election of three of its members to the grade of Distinguished Member in the May/June 2013 Geo-Strata and now announces that nominations for the 2014 elections will close on October 1, 2013. For information about the selection process and a link to the nomination form and a worksheet to guide you through the nomination process, see *www.asce.org/awards*. For more information, contact Jane Moran Alspach, ASCE Honors and Awards, at 1.800.548.2723 ext.6382 or *jalspach@asce.org*

G-I Co-Sponsored Conferences

2013 Texas Section Fall Conference and Centennial Celebration
September 11-14, 2013
OMNI Dallas
Dallas, TX
http://texas.ci-asce.org/

For the first time, the Texas Section is partnering with ASCE's Architectural Engineering Institute, Construction Institute, Coastal Ocean Port & River Institute, Environmental & Water Resources Institute, Geo-Institute, Structural Engineering Institute, and Transportation & Development Institute at the same time. The Section is also partnering with the Texas Department of Transportation, US Army Corps of Engineers, Federal Highway Administration, City of Dallas, Fort Worth Transportation Authority, North Texas Tollway Authority, Dallas Area Rapid Transit, and many other local and state agencies. These partnerships are laying the groundwork for a conference that will provide a truly diverse yet progressive technical and professional program that represents the best of the profession.

The 2013 program for the conference will include 10 concurrent technical tracks including a variety of sessions that will demonstrate processes and present projects that are redefining civil engineering in all disciplines. Attendees can share ideas with their peers and learn how other companies have adapted to changes in today's global economy. The Conference presents a tremendous opportunity to earn PDHs and gain new knowledge.

IACGE 2013
October 25-27, 2013
Chengdu, China
www.iacqe2013.org

The 2nd International Symposium on Advances in Foundation Engineering conference will focus on "Challenges and Recent Advances in Geotechnical and Seismic Research and Practice."

This international symposium will gather designers, consultants, contractors, regulators, researchers, and other stakeholders together in a single forum to address all aspects of foundation engineering, including present state of art/practice and challenging issues facing the foundation engineering profession. The basic goal is to share information on how to do the job most effectively with the lowest risk and impact on the environment. This symposium will be held in conjunction with the Sixth Annual General Meeting of the Geotechnical Society of Singapore.

The American Society of Civil Engineers will publish the conference proceedings with 100 selected and peer-reviewed papers. The ASCE papers must be written in English and meet ASCE paper format. The ASCE papers will be indexed by Engineering Index. Other peer-reviewed non-ASCE papers will be published in the *Journal of Southwest Jiaotong University*.

International Symposium on Advances in Foundation Engineering (ISAFE2013)
December 5-6, 2013
Furama RiverFront Hotel
Singapore

This international symposium will gather designers, consultants, contractors, regulators, researchers, and other stakeholders together in a single forum to address all aspects of foundation engineering, including present state of art/practice and challenging issues facing the foundation engineering profession. The basic goal is to share information on how to do the job most effectively with the lowest risk and impact on the environment. Contributions on all aspects of foundation engineering that advance the state of art/practice case histories, particularly innovations in practice and technology, are most welcomed. This symposium is held in conjunction with the Sixth Annual General Meeting of the Geotechnical Society of Singapore.

Professional Development Corner

ASCE/G-I Co-Sponsored Online Webinars

Geosynthetic Reinforced Mechanically Stabilized Earth Wall
September 24, 2013
11:30 am-1:00 pm

To Bayes or Not to Bayes? A Scenario-Based Approach for Using (or Not) Bayesian Methods
September 26, 2013
11:30 am-1:00 pm

Load and Resistance Factor Design (LRFD) for Geotechnical Engineering Features - Design for Extreme Event Loading
September 30, 2013
11:30 am-1:00 pm

For more webinar information: *www.asce.org/geo/Continuing Education/Webinars/Webinars*

ASCE/G-I Co-Sponsored Seminars

Design and Construction of Micro-tunneling Projects
September 25-27, 2013
Secaucus, NJ

Soil and Rock Slope Stability
September 26-27, 2013
Denver, CO

Deep Foundations: Design, Construction, and Quality Control
October 24-25, 2013
San Diego, CA

For more seminar /information: *www.asce.org/geo/Continuing-Education/Seminars/Seminars/*

Student News

Two New Graduate Student Organizations

The G-I welcomed its newest 18th and 19th Graduate Student Organizations (GSOs) — North Carolina State University (NCSU) and the University of Wisconsin, Madison effective May 7, 2013.

NCSU's mission statement is that its GSO "…is the platform through which geotechnical engineering students can build up their academic and professional experience. The GSO will help geotechnical engineering students by improving their awareness of geotechnical issues within society as they become geo-professionals." For information, contact Brina Montoya at *bmmorten@ncsu.edu.*

The UW-Madison Graduate Student Organization (UWGSO) states that it will function "…to enrich the educational and personal experiences of students interested in the various facets of geotechnical engineering, including foundation design, retention structures, ground improvement, geoenvironmental, geological, and geophysical engineering. The organization is committed to growing both the awareness of geotechnical engineering as well as UW-Madison's reputation as a leader in geotechnical engineering education." For information, contact William J. Likos at likos@wisc.edu

2014 Geo-Challenge

Hope you're having a great summer and following the G-I on Facebook and Twitter.

It's not too soon to start thinking about the G-I's 2014 Geo-Challenges: the GeoWall, GeoPrediction, and Geo-Poster challenges that will take place during the 2014 Geo-Congress in Atlanta, GA, February 23-26, 2014. For details, *https://sites.google.com/site/geochallengecompetition/?invite=CLzXzrcE&pli=1or contact Jennifer Canning at jcanning@asce.org.*

Student Internship Opportunities

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

G-I Chapter News

Geoconfluence 2013
November 7, 2013
St. Charles Convention Center
St. Charles, MO

The St. Louis Chapter of the Geo-Institute is joining with the University of Missouri-Columbia and the Missouri University of Science and Technology to host this year's Cross U.S. Geo-Institute Lecturer, Dr. Tom O'Rourke, for its third annual Geo-Confluence. The conference is the St Louis Region's annual geotechnical engineering and geo-environmental conference and will include technical topics and case histories focused on the geotechnical engineering and geo-environmental industry. For additional information or to register, visit the St.

Louis Chapter web page at *http://sections.asce.org/stlouis/GEI/GEI.htm*.

GeoVirginia 2013
September 30 – October 2, 2013
Williamsburg, VA
***www.virginiageoinstitute.org*.**

The second GeoVirginia "Lessons Learned in Geotechnical Engineering" Conference will be hosted at the Williamsburg Lodge in Williamsburg, VA. The conference opens with a golf tournament Monday morning, followed by an evening reception in the Exhibit Hall. The technical portion of the conference begins Tuesday with a full day of presentations by invited leaders of the profession. Tuesday evening is open for you to enjoy historic Williamsburg immediately adjacent to the Lodge. Presentations continue on Wednesday until noon.

Geo-Institute welcomes new CA and VA Chapters

The Geo-Institute is proud to announce formation of its 34th and 35th Chapter – the SoCal Inland Empire Geo-Institute Chapter and the Chattanooga Geo-Institute Chapter. The formation was authorized by the San Bernardino- Riverside Counties Branch of ASCE on May 7, 2013. The new Chapters' purpose is to advance the geo-professional community through a collaborative and a mutually-beneficial affiliation with the Geo-Institute. For SoCal information: *http://asce-sbriv.org/Geotech_Committee/* or contact President of the Geotechnical Committee **William Kitch, PhD, PE, M.ASCE** at *wakitch@csupomona.edu*. For Chattanooga information, contact President **Mark Harrison, A.M.ASCE** at *mark@mail.hamiltontn.gov*

Call for Posters for PA Conference
Deadline: September 20, 2013

The 27th Central Pennsylvania Geotechnical Conference has issued a "Call for Posters" open to students enrolled in a civil engineering program at a U.S college or university during the winter / spring 2014 semester. The conference is scheduled for April 23-25, 2014 in Hershey, PA. The Conference Planning Committee asks interested authors to submit a 300-500-word abstract for review and consideration of acceptance. Poster abstracts must focus on geotechnical case histories and advances in geotechnical engineering. Successful authors will be notified by October 14, 2013 of their acceptance. Authors of accepted abstracts will be sent a poster template to create a "draft" poster to be submitted by February 3, 2014 for review and approval.

For conference information: *www.central-pa-asce-geotech.org/index.php*

Submit poster abstract by following on-line instructions at: *http://precis2.preciscentral.com/Link.aspx?ID=BA7F3255EDAEE30B*

How to become a Geo-Institute Chapter

Looking for a more extensive way to get your section and/or branch message out to prospective and existing members? Then become a Geo-Institute Chapter. ASCE encourages this effort. There are no fees or chapter dues required by the G-I. There is just one short Memorandum of Understanding (MOU) that is needed. You can increase your membership recruitment efforts and event marketing by converting your ASCE Geotechnical Group to a G-I Chapter or by forming a new G-I Chapter. Download the MOU from the G-I Web site at *http://content.geoinstitute.org/groups/index.html*. Discover the benefits of affiliation.

Industry News

Bertha is star of Seattle Highway's Tunnel Project

Seattle's $2 billion Highway 99 tunnel project is underway using the giant tunnel-boring machine, known as Bertha. It is the world's largest-diameter tunnel-boring machine.

Crews began assembling the 326 ft-long tunneling machine at the south end of the pit shortly after it arrived in April from Osaka, Japan. Once the 57.5-ft-diameter drilling machine was completed, tunnel boring was scheduled to begin as this issue went to press. A 10-ft-long interactive model of Bertha is displayed at Milepost 31, the project's information center in Pioneer Square.

1,450 pre-cast concrete rings will be fabricated for lining the tunnel in Frederickson, near Tacoma. The rings will be installed by the boring machine just behind the cutting head, forming a tunnel structure as the machine makes it way under Seattle.

New Bay Bridge. Safer than the old?

New eastern span of California's Bay Bridge. (Credit: Karl Mondon/ Bay Area News Group)

If the 1989 Loma Prieta earthquake with a magnitude of 7.1 were to happen again, the new eastern span of the Bay Bridge in California would be substantially safer than the 1936 cantilevered truss span motorists currently use, according to new analysis recently presented to Bay Area legislators. It was stated that 80 years ago, engineers didn't understand or fully respect vibrations generated by an earthquake, but the design of the new bridge incorporates a greater understanding of vibration theory.

Engineers designed the 1936 bridge to withstand maximum ground accelerations of 10 percent of 1 G, a measurement of the force of gravity on a moving object, within a 5-second period. Compare that with the new bridge, which has been designed to survive equivalent Gs of up to 180 percent.

The three agencies overseeing construction of the $6.4 billion Bay Bridge presented the new seismic comparison data to the Bay Area Caucus. Along with Senate Transportation Committee Chairman Mark DeSaulnier, the Bay Area lawmakers requested the briefing in the wake of mounting public concerns about the span's seismic safety.

Much of the worry stems from the failure of 32 high-strength steel bolts embedded in seismic stabilizers that snapped in early March, forcing Caltrans and the contractor, American Bridge/Fluor Joint Venture, to scramble to repair the damage and reassure the public that the other steel components are sound.

The bridge opening could be postponed if Caltrans, the Bay Area Toll Authority, and the California Transportation Commission cannot complete the bolt retrofit, or if ongoing tests reveal problems with other steel fasteners on the span.

National Cooperative Highway Research Program

The National Cooperative Highway Research Program (NCHRP) conducts research in problem areas that affect highway planning, design, construction, operation, and maintenance nationwide.

Each year, the American Association of State Highway and Transportation Officials (AASHTO) refers a research program to the Transportation Research Board consisting of high-priority problems for which solutions are urgently required by the states. The AASHTO program for FY 2014 is expected to include 15 continuations, 50 new projects, and 2 projects contingent on additional funds becoming available

The NCHRP announced its FY 2014 NCHRP Project for Potential Contractors program at *www.trb.org/Main/Blurbs/168954.aspx* To be notified of new NCHRP requests for proposals, send an email to *listserv@lsw.nas.edu* with SUBSCRIBE NCHRP_ANNOUNCE in the body of the email. To stop the emails, substitute UNSUBSCRIBE for SUBSCRIBE. For information: *www.trb.org/NCHRP/NCHRP.aspx*.

Economic impact of hydraulic fracturing for gas & oil

The Manhattan Institute for Policy Research recently published the paper "The Economic Effects of Hydrofracturing on Local Economies. A Comparison of New York and Pennsylvania" by Diana Furtchgott-Roth

and Andrew Gray. The paper's executive summary report states:

"In 2013, New York's state government will decide whether to permit extraction of natural gas by hydraulic fracturing or, instead, turn its current moratorium into a permanent ban on this technology. In weighing their choice, New York officials have an abundance of useful data from neighboring Pennsylvania. There, nearly 5,000 wells have been [hydraulically] fractured since 2002. If New York lifts its moratorium, companies will be drilling the same type of wells to exploit the same subterranean source of gas—the Marcellus Shale. Pennsylvania's experience is a good guide to what would happen in New York.

In this paper, we analyze the effect of [hydraulic] fracturing—at modest, moderate, and high levels—on jobs and income growth in Pennsylvania counties. We then use these data to project the benefits that New York counties stand to gain if the state again permits [hydraulic] fracturing.

The entire paper can be viewed at *www.manhattan-institute.org/pdf/gpr_1.pdf*

Editor

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Introduction by John Dunnicliff, Editor

This is the seventy-fifth episode of GIN. Three quarters of a century! Two articles this time:

- "Automated MEMS-based In-place Inclinometers". Margaret Darrow reports on successful use of MEMS (Micro-Electro-Mechanical Systems)-based in-place inclinometers for monitoring a landslide in a remote location in northern Alaska. This article adds to our confidence in these recently developed instruments.
- The second article, anonymous at the author's request, is in response to my repeated plea, "Lessons learned. I need you". It provides more lessons learned from unexpected events in the field.

Discussions

In my earlier pleas for contributions to GIN I didn't mention discussions. I welcome discussions of articles previously published in GIN, and authors' replies will be included in the same episode. I have one of these in the pipeline for December GIN. **More please!**

Continuing my plea for contributions

If you've written a paper for a conference, journal or other publication that fits within the scope of GIN, please consider sending me a version that fits within the GIN guidelines. See http://www.geotechnicalnews.com/instrumentation_news.php, and click on "How to submit articles …". Minimum effort for you!

Continuing education courses

In the previous GIN I said that there will be no more of these courses in Florida, but perhaps elsewhere. Plans are now underway to start a new series in beautiful Tuscany, Italy, in June next year. The venue will be Poppi Castle, www.castellodipoppi.it. How's this for a contrast to Cocoa Beach? Good wine too! Details and a website later.

Important new publication about monitoring slope stability

Allen Marr of Geocomp Corporation, Acton, MA has written an outstanding state-of-the-art paper: Marr, W.A. (2013) Instrumentation and Monitoring of Slope Stability. Geo-Congress 2013: pp. 2224-2245. Here's the abstract:

> Instrumentation and monitoring of earth structures has experienced phenomenal change and growth since the last [ASCE] slope stability conference some twenty years ago. This paper gives an overview of the current state-of-practice of instrumentation and monitoring for slopes and embankments and other structures that involve global instability considerations. Reasons to monitor performance, technological revolutions in instrumentation and monitoring over the past 20 years and some recommended practices are presented and discussed. A principal theme of this paper is the important role of instrumentation and monitoring in helping to identify and manage risk. When considered as a part of a risk management program, the role and value of instrumentation

and monitoring program becomes much clearer to all involved.

The full paper is copyrighted by ASCE, and can be downloaded for a fee of US$30, from http://ascelibrary.org/doi/abs/10.1061/9780784412787.222 Click on the Permalink, then the PDF tab, scroll to Download Options, Buy Now. Yes, I appreciate that $30 may seem a lot, but it's worth it!

An attitude worth repeating

I included this in GIN five years ago. Time for a reminder: the great jazzmaster Humphrey Lyttleton (Humph) died recently. In his own words: "As we journey through life discarding baggage on the way, we should keep an iron grip, to the very end, on the capacity for silliness. It preserves the soul from desiccation". What a wonderful attitude!

Sheep for monitoring slope stability

During the few days before the disastrous landslide at Vaiont Dam in Italy in 1963, grazing animals apparently moved off the future landslide area. They knew something that humans didn't!

In the early 1990s, many large slow-moving potential landslides were discovered in the slopes around the future Clyde reservoir in New Zealand. At great expense, geotechnical monitoring was adopted as an early warning system for disaster risk reduction. However, New Zealand has an enormous number of sheep. I suggested fencing off the slopes, with a single small opening in each fence (ensuring that there were lots of sheep inside), and installing at each opening an instrument for counting the rate of flow of sheep, and automatic data acquisition systems transmitting to the office, with trigger levels.

Nobody took me seriously!

Closure

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

Cin Cin! (Italy)

Automated MEMS-based In-place Inclinometers

Margaret M. Darrow

Introduction

Inclinometers are used in geotechnical engineering to measure ground movement. A relatively new form of inclinometer instrumentation incorporates Micro-Electro-Mechanical Systems (MEMS) accelerometers. MEMS-based in-place inclinometers (M-IPIs) consist of a series of accelerometers that are connected with flexible joints and encased in a watertight housing. Although these devices have been evaluated previously in some areas of the contiguous US, the author evaluated two different M-IPIs for their applicability in frozen ground applications. The overall research project consisted of four different sites within Alaska. The M-IPI were installed both vertically and horizontally, and their measurements of ground movement and temperature

Figure 1. INC500 modules, staged with centralizers attached and ready for installation.

Figure 2. Installing the INC500 within the guide casing (photograph courtesy of J. Simpson).

were evaluated against those obtained using traditional instruments. This article presents the results of the fourth site, where an INC500 Series In-Place Inclinometer (INC500) from GEO-DAQ was installed vertically to obtain data from a landslide in a remote location along the Dalton Highway in northern Alaska.

Research site and installation

Geology and background

In recent years a new permafrost-related hazard has affected Alaska's Dalton Highway in the southern Brooks Range. Near Mile Post (MP) 219, an elongated lobe of frozen soil, rock, and debris – termed a frozen debris lobe (FDL) – is encroaching on the highway. Many FDLs are present within the Dalton Highway corridor; however, near MP 219, the critical FDL-A is less than 60 m from the highway shoulder. Analysis of remotely-sensed imagery indicated that FDL-A moved at an average rate of 1.0 cm per day between 1955 and 2008, and reconnaissance site visits suggested several movement mechanisms, such as permafrost creep, debris flows along the over-steepened toe, and basal sliding (Daanen et al., 2012). Prior to a 2012 field program, however, we did not know anything about the lobe's internal structure, nor did we have any in situ movement measurements. We also suspected that FDL-A might move quickly enough so as to make retrieval of the M-IPI device impossible. Thus, the reasons for this installation were 1) to collect important data to determine FDL-A's mode, location, and rate of movement, and 2) to determine how much movement the INC500 device could withstand before it no longer functioned.

Instrument installation

The author, working with colleagues from the Alaska Department of Transportation and Public Facilities

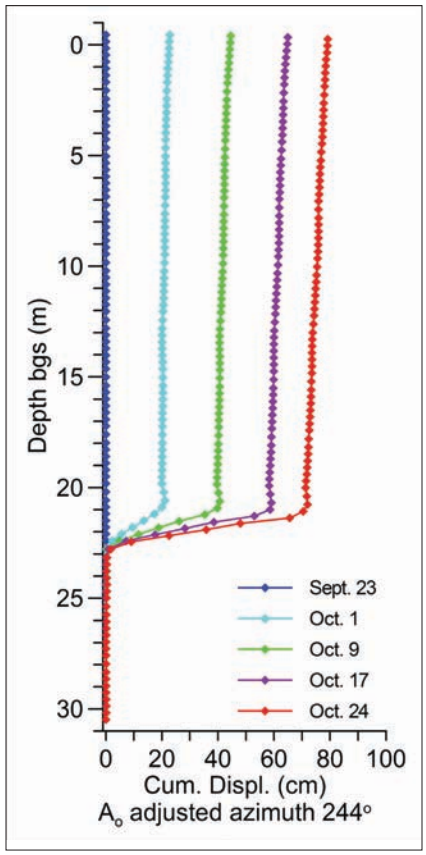

Figure 3. Cumulative displacement measurements for the boring through FDL-A until the INC500 began to demonstrate signs of failure.

(ADOT&PF) and the University of Alaska Fairbanks (UAF), installed the INC500 in September 2012. Where drilled, FDL-A was fairly homogeneous, mostly consisting of silty sand with gravel. The boring in which the INC500 was installed intercepted white mica schist bedrock at 26.4 m below ground surface (bgs). We attached two vibrating wire (VW) piezometers and a thermistor string to the outside of the guide casing, and backfilled the boring using cement-bentonite grout.

The INC500 device consists of 2.4-m long modules that contain a series of MEMS-based accelerometer sensors. In a standard module, these biaxial sensors are located every 30.5 cm, along with a temperature sensor that has a reported accuracy of ±1.7°C (GEODAQ, 2010) and is not calibrated unless specified by the customer. The modules are joined by underwater electrical connectors with connections that are stiffened by a coupler assembly to give the entire length a uniform rigidity. Additionally, three to four centralizers are mounted along the length of each module (see Figure 1). Each centralizer contains four stainless steel wheels that are designed to guide and orient the device within a slotted guide casing. Because of its modularity, an INC500 device can be lengthened or shortened to accommodate the geometry of a given installation.

For this installation, the INC500 device consisted of 12 modules and was installed to 30.5 m bgs (see Figure 2). Due to the difference between the casing and assembled M-IPI lengths, approximately 0.5 m of the uppermost INC500 module was above the ground surface within the casing. The guide casing was filled with propylene glycol to prevent freezing of any water that might accumulate due to condensation and/or leaks. All instruments were wired into an automated data acquisition system (ADAS) powered from a battery bank recharged by a solar panel. A data logger within the ADAS recorded measurements every six hours.

Results and Discussion

Figure 3 contains plots of cumulative displacement from the M-IPI device. The data were corrected using vector summation (Cornforth, 2005), and for the cumulative change in depth of the sensors. Originally at 0.5 m above the ground surface, horizontal movement within the shear zone pulled the M-IPI down within the casing to 0.1 m bgs, correlating well with visual observations. These adjusted readings indicated movement within a well-developed shear zone between 20.2 m and 22.8 m bgs. The M-IPI device recorded at total of 79.2 cm at the surface in 31 days.

On October 24, the M-IPI began to record apparent "retrograde motion" upslope between 20.4 m and 21.4 m bgs (see Figure 4a). Considering the

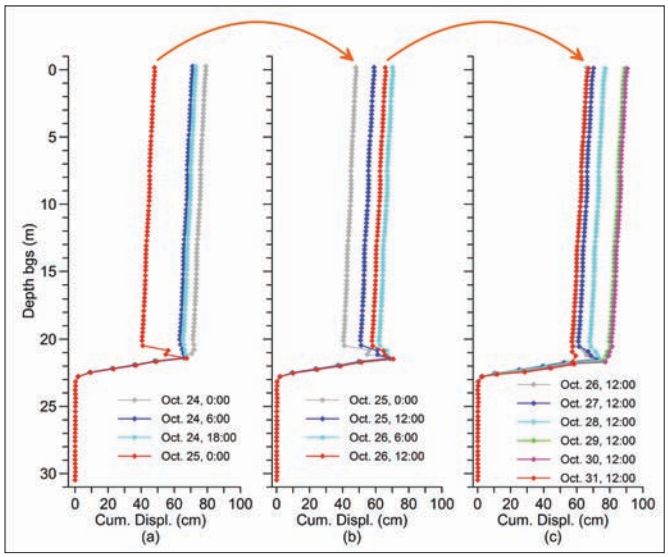

Figure 4. Evidence of failure of the INC500 at FDL-A. (a) Apparent "retrograde motion" began at 6:00 on October 24, with major "retrograde motion" at 0:00 on October 25. (b) The lobe above the shear zone continued to move downslope, with another episode of "retrograde motion" on October 26 at 12:00. (c) Final readings of the INC500 until failure of the lower modules after October 31 at 12:00. For each plot, the set of readings in gray represents the last reading from the previous plot (for (a), this is the last reading shown in Figure 3). The sequence of readings is given the same color scheme, with red indicating "retrograde motion".

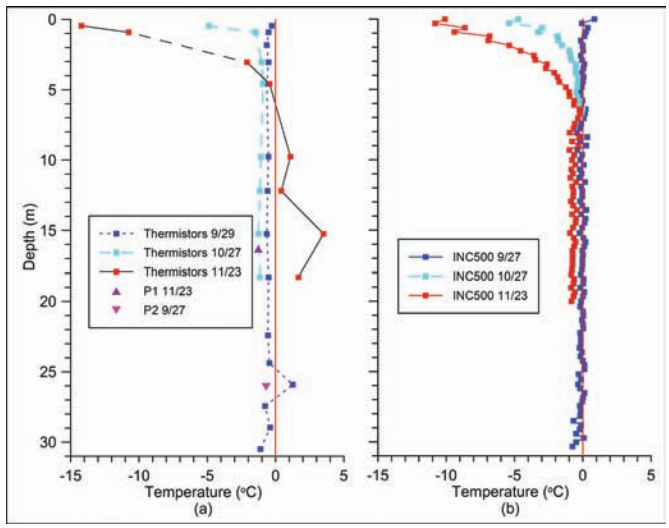

Figure 5. Temperature readings from the boring through FDL-A. (a) Temperature readings from the thermistor string and two VW piezometers attached to the outside of the casing; "P1" and "P2" are readings from the vibrating wire piezometers installed at 16.3 and 26.1 m bgs, respectively. (b) Temperature readings from the INC500. Nearest pairs of readings were averaged to reduce the scatter. For both plots, the phase-change temperature is indicated by the vertical red line.

failures of thermistors and a piezometer below this depth, we suspected that a few INC500 sensors were damaged in the shear zone. The manufacturer of the device agreed, indicating that the sensors "probably deformed or rotated within the housing" (J. Lemke, pers. comm., Nov. 2012). The M-IPI continued to record downslope motion above the shear zone, with episodes of "retrograde motion" intermixed (see Figures 4b and 4c). Then on October 31, the INC500 sensors below 20.2 m bgs ceased reporting data. The manufacturer suggested that either the cable was physically severed or that an underwater connector between modules pulled apart (J. Lemke, pers. comm., Dec. 2012). The sensors above the shear zone, however, continued to report movement and temperature data.

Scheduling allowed the author and colleagues to return to the site every two to three weeks for manual inclinometer probe measurements. Considering the movement rate, only one or two additional sets of readings would have been obtained before the inclinometer probe could no longer pass the shear zone. Thus, the M-IPI device at this site delivered much more data than we otherwise would have collected.

The M-IPI device provided additional data in another way. Figure 5a contains a temperature profile of the boring. Thermistor measurements collected on September 29 demonstrated elevated temperatures due to the drilling process (having not yet reached a pseudo-equilibrium). Most of these temperatures, however, fit the trend that developed with depth during the equilibrating process, with the exception of the malfunctioning thermistor at 25.9 m bgs. All thermistors and the VW piezometer below 18.3 m bgs failed on October 11 and October 26, respectively. Starting on November 9, the lowest remaining thermistors began reporting a steady increase in temperature resulting in above-freezing values, as indicated by the erratic temperature profile from November 23; yet the VW piezometer located at 16.3 m bgs (i.e., "P1") measured -1.3ºC, matching the previous temperature trend. Figure 5b is a plot of temperatures obtained from the M-IPI device. The M-IPI stopped reporting accurate temperatures below 20.0 m bgs on October 24; however, the data above this depth are sufficient to indicate below freezing temperatures. Thus, the M-IPI data confirmed that the thermistors below 4.6 m bgs began to malfunction on November 9, likely the result of propylene glycol entering the cable and affecting the measured resistance.

Conclusion

The in situ measurements from the Dalton Highway site indicated that FDL-A moved at approximately 2.5 cm per day during the measurement period, more than twice the historic rate. The M-IPI device continued to read during shearing and provided meaningful temperature data after shearing. Its presence in the continually moving landslide provided much more data than we otherwise would have collected due to the remoteness of the site. The M-IPI temperature readings served as a check of potentially faulty readings from other temperature sensors, an unexpected benefit of this device.

Acknowledgements

This project was jointly funded by ADOT&PF and the Alaska University Transportation Center. The author thanks her UAF colleagues and ADOT&PF personnel for their expertise, hard work in the field, and support; and J. Lemke for his willingness to address concerns and his patience with insistent questions.

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Lessons learned from unexpected events in the field

Anonymous

Introduction

This contribution is in response to John Dunnicliff's repeated plea, "Lessons learned. I need you".

Field monitoring may require special installations or simple visual inspections to determine whether specified criteria are met or there is need for corrective action. The examples of problems encountered with lightning and with inadequate planning of observations for a cofferdam on the foreshore of a lake are described. Some unusual water levels are noted.

As the Scottish poet Robert (Robbie) Burns wrote, "The best laid schemes o' mice an' men gang aft a-gley [often go awry]"!

These examples have been derived from the experience of working with supervisors, associates and other colleagues in an organization which was closed around 1999.

These cases are being written with their contributions in mind from which the writer has benefited. Some are no longer with us. Others are retired. The writer has therefore requested his name to be withheld from publication.

Lightning and destruction of electronics

A chimney, about 100 m high, had been planned for construction on a very dense till deposit about 9 m thick over relatively flat bedrock. Tests on soil samples in the laboratory had been carried out to determine the usual parameters and also the response to cyclic loading related to wind effects.

The expected behaviour of the foundations suggested no long term consolidation settlement of the structure would occur and the calculated lateral forces would not result in a cumulative tilt. This project provided an opportunity to observe and document the data which could be compared with the assumptions used in the design and a proposal for instrumentation was approved.

During construction, within the area to be covered by the foundation, pressure pads were installed on the surface of the soil. An anemometer was located at the top of the chimney. Initial readings indicated that the installations were functional.

Soon after, there was a storm with severe lightning. The electronics installed for data collection were zapped and destroyed. No repair was possible and none was attempted.

Lessons learned

In retrospect, the disruption by lightning was a likely occurrence against which the protection provided at that time, four decades ago, was not effective. The increase in use of electronics in many applications has probably resulted in improvements in shielding for preventing damage by lightning. Specialists in this field should be consulted.

A cofferdam on the foreshore of a lake

A docking area was to be constructed on the foreshore of a lake where the bedrock surface was visible in shallow water at the shoreline and the overburden was about 2 m thick. The bedrock surface sloped gently away from the shoreline and soundings had reported negligible overburden. Bedrock was described as a shaley limestone.

The depth of water to be provided for the equipment for docking was about 4 m. To facilitate excavation of the rock for the for the docking area, a cofferdam was constructed to enclose a rectangular area extending 150 m along the shore and about 100 m into the water where the depth was about 5 m.

First, a rockfill embankment was built on the three sides of the perimeter of the area, extending into the water with material from excavations in bedrock for foundations for other structures at the site. The impervious till material from the overburden was then dumped on the inner slope of the rockfill and spread with a bulldozer to a top width of about 5 m and a freeboard about 1 m above the lake water level.

It was the practice to observe the abutments and downstream areas of dams, during the first flooding of a reservoir, for evidence of seepage or any unusual conditions while the water level is rising. The monitoring is continued for some time after the maximum operating level is reached. Lowering of the water level in an area enclosed by a cofferdam creates a comparable situation but the project had arranged only for the checks on the water levels during the pumping. The opportunity to detect, by inspection of the cofferdam, any location where a leak may have occurred was missed.

It was reported that the pumping for dewatering had started and progressed very well on the first day when the submerged inner soil slope was partly visible and appeared intact. Pumping continued, but on the second day the water surface had started to rise. Additional pumping did not produce any decrease in the water level.

The geotechnical engineering department was called in to investigate and find a solution. It was early winter. A diver was sent down to inspect the areas near the toe of the impervious fill for any unusual signs of leakage. He described observing possible movement of material from crevices in the rock surface where characteristic ridges caused by piping were noted on the rock surface near the toe of the impervious fill. In one location, he was able to insert a piece of wood about 50 mm thick which was secured as a marker by covering with small boulders.

It is likely that if observations had been made during the initial pumping, the locations of the piping would have been noticed, and time would have been saved.

A bedrock grouting program was initiated with priority where the diver had noted major crevices near the toe of the fill. Check grouting was carried out in the remaining sections.

Standpipe piezometers were installed in the impervious fill at several locations for checking the water levels during the resumption of pumping.

After some weeks of grouting operations, pumping was resumed. At this time the condition of the inside slope during the drawdown of the water level in the enclosed area was frequently checked. The area was dewatered, and the inner slope of the impervious zone was intact. The water levels in the standpipes were generally below lake level except for one case where the water in the standpipe was higher than lake level. The small ridge-like features where piping had

occurred and where grout intrusion into the crevices had taken place to seal these openings were clearly visible. Minor seepage from joints which could be tolerated was recorded.

Lessons learned

Information on the geology of the bedrock and any relevant case histories in a location could be of much help in the planning and design of a water retaining structure.

Unless the bedrock surface at the location of a proposed water retaining structure can be thoroughly examined and, if necessary, treated, the presence of joints or fissures should be expected. Grouting should be included in the planning, scheduling and costing.

Scheduling of the project should try to avoid winter conditions for grouting to achieve savings in the cost. A list of contacts for resources which may be needed at short notice may be useful.

Unusual water levels

Many projects are concerned with the water levels or pressures in specific locations, and use observation wells or piezometers for measurements. Unusual water levels noted in three locations are described.

In the dumped impervious fill described in the above section 'A cofferdam on the foreshore of a lake', observation wells were installed in drilled boreholes from the crest of the fill with the bottom of the pipes estimated to be close to the bedrock surface. In all but one case, the water levels observed were below the lake level, which was about 1m below the crest elevation. The tops of the pipes were about 1 m above the crest. In one pipe, the water level was higher than the crest and more than 1 m above the lake water level. The cofferdam was removed after the dock was completed.

On another site, observation wells were installed in boreholes for exploration of the site on the bank of a lake where an extensive excavation of the approximately 30 m thick overburden to the limestone bedrock was planned for site preparation. The groundwater profile was fairly consistent with a gradient toward the lake but in a few wells in which the bottom of the pipes was close to the bedrock surface, the water levels were some 2 m above the groundwater profile. Almost all of the observation wells were destroyed when the extensive excavation of the overburden to bedrock was completed.

The third example is a location on high ground on the bank of a river on which a generating station was built. The reservoir associated with the station necessitated the construction of a relatively low earth dam over a depression and a small stream which flowed into the river. The embankment, about 200 m long, was built on the surface of a deep deposit of sensitive clay. The structure had been monitored for settlement of the crest and water levels were determined in open standpipe piezometers installed from the crest of the dam. The depths of the piezometer tips ranged between 15 m and 25 m below the crest. There was no problem with the rate and amount of settlement because the freeboard adopted about 3 m, was adequate. The tops of standpipes were about 1 m above the crest and protected by a larger diameter pipe with a cover for each standpipe. Although the water levels in most of the standpipes had stabilized at around elevations which could be related to the reservoir level, water could be observed at a few locations slowly flowing over the tops of the standpipes. Monitoring of the dam over a period of many years had shown that the settlement, stability and routine maintenance of the dam were all satisfactory.

Lessons learned

These examples of unusual water levels remain unexplained puzzles. Other than notes for the records, no investigation to seek an explanation had been carried out. *[But perhaps the lesson learned is to delve deeper at the time so that explanations are found – JD].*

IN MEMORIAM

Earle J. Klohn 1927-2013

Earle J. Klohn passed away on July 22, 2013 in his 86th year surrounded by his family. In the mid-1950s, Earle was one of the founders of Ripley, Klohn and Leonoff in Vancouver. He was a pioneer of geotechnical engineering in Western Canada. Earle obtained a Bachelor's Degree in Civil Engineering with Distinction in 1950 and a Master's Degree in 1952 both from the University of Alberta where he was taught soil mechanics by the late Dr. Robert Hardy. Earle's skills encompassed the full range of geotechnical engineering from foundations to embankments to tailings dam engineering. He won many awards for his contributions to our field including the Leggett Award in 1990 which was presented to him by Dr. Leggett personally. Earle took his experience in designing dams in the steep, wet and seismic terrain of British Columbia to many projects around the world. He served on boards of review in virtually every province and territory in Canada and in many countries. He authored over 60 technical papers and delivered many state-of-the-practice lectures on the analysis, design, and construction of building foundations and large dams. Earle inspired several generations of civil engineers and influenced the design of thousands of projects in Canada and abroad in his 46 years of professional life.

Collaborative research at Diavik Mine provides environmental considerations for Canada's next northern mining projects

Vivian Giang

On July 19, 2013, Northwest Territories' Mackenzie Valley Environmental Impact Review Board approved the Gahcho Kue Diamond Project, with some environmental conditions. If approved by the federal government, Gahcho Kue will become Canada's fourth diamond mine, joining Ekati, Diavik and Snap Lake.

As more northern mine projects are being proposed in Canada, many wonder what the environmental impact of such projects may be and how best to mitigate any risks. In 2003, researchers at Canada's leading universities teamed up with industry and engineering consulting firms to investigate the environmental impact of waste rock at the Diavik Diamond Mine. Ten years later, this collaborative, multidisciplinary research provides many insights into the special considerations that must be taken into account when mining in permafrost regions.

During excavation, mine operations create waste rock that has to be stock piled and has the potential to generate acid rock drainage (ARD) when oxidized minerals and dissolved metals are released or are carried into groundwater and surrounding lakes through rain or snowmelt. This can cause great environmental harm to northern Canada's fragile ecosystems.

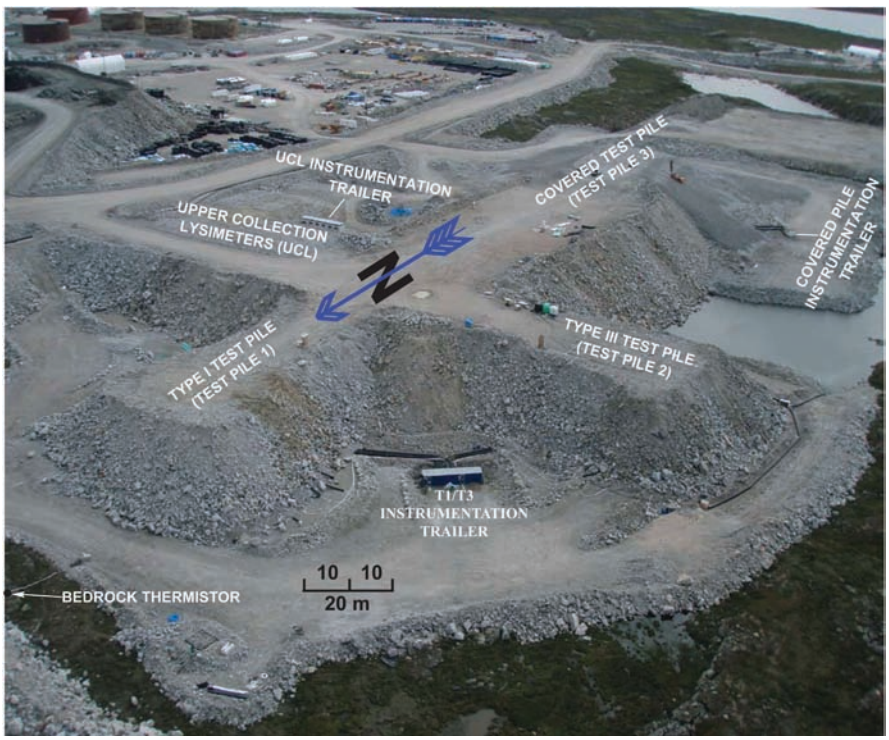

Figure 1. Aerial view of the test piles at Diavik Diamond Mine (Pham 2013).

In hopes of reducing such environmental risks, Diavik Diamond Mines Inc., a subsidiary of Rio Tinto, the University of Alberta, University of British Columbia and University of Waterloo began discussions on the design, construction and instrumentation of field-scale experimental waste rock piles at Diavik as mine operations began in 2003.

The Diavik Project is located 300 km north of Yellowknife, NWT, in a region characterized by continuous permafrost. Three 15 m high waste rock test piles of various sulphur content levels were constructed between 2004 and 2007. Two of the piles were uncovered, and one pile was covered with a 1.5 m layer of till and then a 3 m layer of non-acid generating waste rock. These piles were heavily instrumented to measure water flow and water chemistry; internal pile gas composition; temperature within the test pile; and thermal conductivity and air permeability. A series of comprehensive research papers regarding the Diavik Waste Rock Project, its set up and the experiments conducted on the waste rock piles has been published in *Applied Geochemistry* and can be accessed online (see references; many other papers were published in other journals and conference proceedings, but are not listed).

Dr. Nam Hoang Pham remembers the first time he set foot in Diavik in April 2007. "We had just finished the winter season in Edmonton, and I was looking forward to experiencing spring in the Northwest Territories. But it was -30°C!"

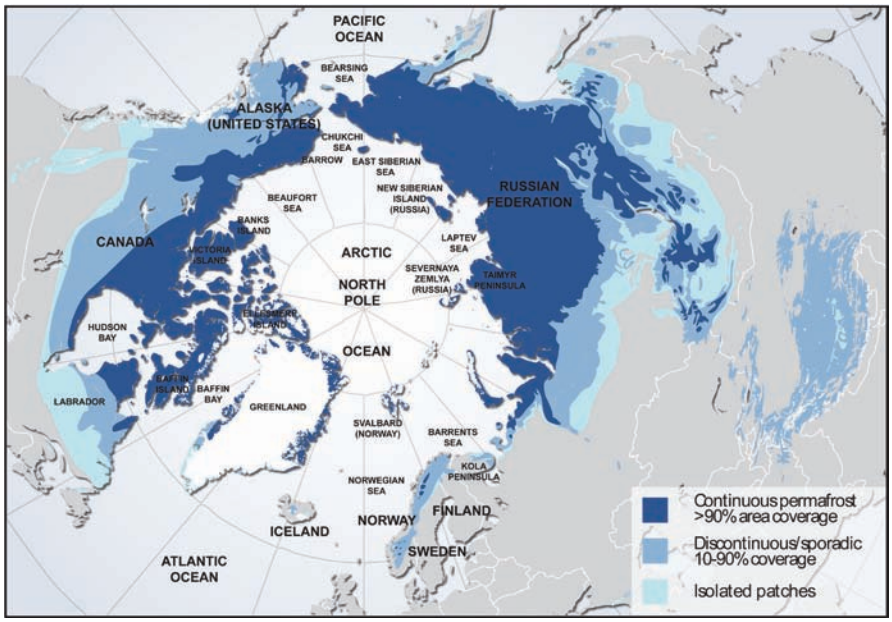

Figure 2. Permafrost distribution (modified by Rekacewicz 2005).

Pham's doctoral research at the University of Alberta investigated the impact of heat transfer within the sulphide waste rock piles on ARD. "The chemical reactions of the sulphuric minerals in the [Diavik] waste rock depend on temperature due to bacterial activity," says Pham. "The lower the temperature, the fewer the chemical reactions." The research team found that chemical reactions in the waste rock piles also release heat into the environment and thaw the permafrost beneath the piles, which have implications for ARD. "For example," Pham says, "if a waste rock pile is placed in a discontinuous permafrost area, the increase in ground temperatures due to warming can trigger the oxidation of sulphide minerals causing ARD."

Figure 3. Location of Diavik Diamond Mine (Pham 2013).

Most solutions to mitigate ARD are designed for mines in temperate regions. However, permafrost regions experience phenomena such as freeze-thaw cycles, frost heave, thaw consolidation and the presence of ground ice (e.g. in the form of ice wedges) which have a significant impact on how northern mining projects must address ARD. Air convection cover (ACC) is one method to produce rapid cooling in waste rock piles and to reduce ARD, which was investigated during the research project.

In an ACC system, a waste rock pile is covered with a low permeability soil layer with high moisture content (e.g. fine-grained soils) and overlaid with a high permeability coarse non-acid generating rock layer that is relatively dry. The moist soil layer constrains the heat from the active waste rock within the pile, while the coarse rock layer allows cold air to penetrate and cool the pile via natural air convection during the cold winter. During the summer, the coarse rock layer and the frozen fine-grained layer act as insulators, keeping the pile cool, relative to outside temperatures. Pham conducted numerical simulations to understand the ability of ACC to keep waste rock piles cool in the order of several decades. Based on his simulations for an 80 m high waste rock pile, ACC can maintain frozen conditions on a waste rock pile for 100 years, considering climate warming, which can aid in reducing the risks of ARD. "We're using natural processes to mitigate the environmental impact of mining," says Pham.

Other research studies in the Diavik Waste Rock Project focused on the geochemistry of the waste rock piles, water flow through the waste rock into the surrounding terrain and wind-induced gas transport. Many findings from this extensive research program hold important lessons and considerations for planning future mining projects in northern Canada.

Acknowledgements

The Diavik Waste Rock Project was a joint research program between the University of Waterloo, University of British Columbia and the University of Alberta supported by the Natural Sciences and Engineering Research Council of Canada, the International Network for acid Prevention, the Mine Environment Neutral Drainage Program, the Canadian Foundation for Innovation and Rio Tinto (Diavik Diamond Mines Inc.).

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Paolo Gazzarrini

Overture

Welcome to the 32nd episode of the Grout Line. As usual at this time of the year, I have prepared a brief summary of the recent Grouting Fundamentals and Current Practice Short Course (34th year!), held at the Colorado School of Mines in Golden, CO from June 17 to June 21, 2013.

I also received an article from Mohamed El Tani (a returning contributor who is very active in the Grout Line), related to different closing procedures in rock grouting, that I am sure you will find interesting and which can open new discussions on the matter.

34th Grouting Fundamental and Current Practice Short Course

This unique course attracted more than 80 attendees, including contractors, consultants, owners, and government employees. A broad geographic presence stimulated detailed discussions of grouting means and methods, with attendees originating from Europe (Sweden, Norway, Switzerland and Austria), Japan, Canada, and throughout the United States. I had the opportunity to talk with several participants, some of whom were attending the short course for the third or fourth time. They explained that many seasoned grouters return to the course periodically to keep abreast of the latest developments in grouting technology.

Jim Warner (the gentleman who instigated myself in taking care of this Grout Line (a favour for which he will someday be repaid) kicked off the course with an overview of grouting materials and applications, and he was joined by Fred Goodwin on the subjects of grout rheology and cementitious admixtures. The first day was rounded out by presentations by Jim Warner and Joe Harris on the subject of low mobility grouting.

The second day was dedicated mainly to rock grouting, with Scott Kiefer

covering rock investigation and characterization methods. Different philosophies for rock grouting were covered by Trent Dreese (US pratice), Trevor Carter (aperture controlled grouting) and myself (GIN method). The second day also included a presentation/demonstration by Brian Iske on chemical grouts.

On the third day, case histories of Dam Foundation grouting were presented by Trent Dreese, and George Burke delivered a detailed presentation on jet grouting. The (always much anticipated) field demonstration took place Wednesday afternoon, and it was a fantastic show! The field demonstration was organized by Bill Warfield and was hosted at the facilities of Hank Baski (Baski, Inc.) I would like to give recognition here and to thank publically the companies that supported this very "unique" demonstration:

- Aerix Industries,Golden, Colorado (foaming agents)
- Atlas Copco CMT – Ground Engineering Products Roseville, California (overall organization, grout plant and data recording system)
- Avanti International, Webster, Texas (chemical grouting products)
- Bandimere Grouting Consulting Services, Denver, CO. (compaction grouting test with drilling, grouting and real time monitoring of the grouting parameters)
- BASF Beachwood, Ohio (colloidal silica, bleed tests, basic grout tests, admixtures)
- Baski, Inc. Denver, Colorado (inflatable packers)
- ChemGrout, Inc.La Grange Park, Illinois (grout plant, sand column experiments)
- Con-Tech Systems Ltd. British Columbia, Canada (data recording system)
- De Neef Construction Chemicals/ Grace, Inc. Waller, Texas (polyurethane injection, microfine cement)
- Graz University of Technology, Austria (sand column experiments)
- Hayward Baker, Inc. Broomfield, Colorado (annular grouting, sand column experiments, anchor grouting)
- NCFI Polyurethanes Fort Worth, TX (chemical grouting for slab lifting)
- Rio Grande Co., Denver, Colorado (catered BBQ, provided materials for sand column experiments)
- RST Instruments Ltd., British Columbia, Canada (data recording system, low mobility grouting)
- Surecrete, Inc. Seattle, Washington (with their partner Nittetsu from Japan, showing the new HNP-1500 nano cement and microfine cements)
- US Grout, Malad City, Idaho (microfine cement)
- Williams Form Engineering, Golden, Colorado (anchor grouting and testing)

Thanks to all of you for a very interesting and entertaining afternoon!

Presentations recommenced on Thursday with a series of excellent lectures by Donald Bruce. Topics included: evolution of drilling, grouting of rock anchors and micropiles, cutoff walls, composite walls, and crisis management strategies. The day was rounded out by presentations on foaming agents (Rich Palladino), grouting equipment (Bill Warfield), and a case history of jet grouting for the Zeballos Lake IPP (Paolo Gazzarrini).

The final day began with a presentation on grouting instrumentation ("avec mon ami", Pierre Choquet), followed by a series of lectures dealing with grouting in underground construction (Scott Kieffer, Hans-Olaf Hognestad, Scott Wimmer, and Niels Kofoed). Slab jacking was then covered by Joe Harris, and "dulcis in fundo" Jim Warner and Sam Bandimere concluded the course.

What I found really interesting is that while it was my 4th consecutive year at the course, I always find something new to learn and to share with my grouting colleagues!

In closing, I wish to extent thanks to Scott Kieffer of the Graz University of Technology in Austria, for his organization, leadership, and dedication to this unique and valuable course. It was an intensive but productive 5 day course for everybody interested in grouting!

I hope to see you next year in Golden!

Grouting Emancipation

Mohamed El Tani

Diversity is the new grouting order. Actually, there is a general trend in grouting practice for rock fractures to move towards tailored and personalised methodologies. This fact is shared by many professionals. López-Molina [1] asserts from experiences made in areas of varying geology that "any methodology can equally be useful as long as assessment and adjustment" are made to attain the target. The increasing experience in rock fractures grouting, as well as the technological developments and advances in grouting science favour such an orientation. All the known grouting schemes are questioned and reconsidered. Strangely enough, the North American Refusal Criterion (NARC) remains the ultimate phase of all the known new or old, or personalised grouting procedures and methodologies. Recent developments in grouting science changed the status of NARC from an empirical criterion to a reliable one, making it an essential tool among the numerous means for grouting enhancement. Two complementary tools are the zero flow path (ZFP) for hierarchical grouting and the waiting time (WT). An introductory description of NARC, ZFP and WT will open the way to discuss some grouting models, which use them or which may be improved, by incorporating them in their schemes. No details are given on the success or failure of these models. When it is deemed necessary their fundaments are examined in the light of the recent developments.

ACG practice

The "Aperture Control Grouting" is a methodology that was presented by Carter et al. [2] and Bonin et al. [3] at the New Orleans 2012 conference. Its slogan is: the best of GIN and the best of Aussie! In practice, the designer specifies the grout's volume to be injected depending on the Lugeon value at that stage and the mixes to be used on a feed-back monitoring basis. Apparently this is not sufficient. At the ultimate phase of the ACG decision chart NARC comes into play to decide over closure, i.e. with a flow rate limit (per unit stage length and pressure) that is arbitrarily fixed at 0.1 l/min/m/bar for a 10 minute time period. The arbitrariness in deciding on the flow rate limit is pointed out in many Swedish publications that qualify NARC as an empirical criterion with no foundation in physics ([4], [5] and [6]).

NARC

The "North American Refusal Criterion" is known in Western Europe as the "Minimal Flow Criterion". It states that grout injection is stopped when the flow rate is smaller than a pre-definite flow rate limit at a given grouting pressure for a definite time interval. The purpose of the time interval is to ascertain that the current flow rate is stable and follows a real decreasing trend, neither being accidental nor volatile. It is a criterion that was used by many generations of practitioners. It still is and will probably continue to be so for a long time.

Currently, the hefty criticism concerning NARC does not apply anymore. The flow rate limit was parameterized on a physics basis by the author [7] in 2012. Before elaborating on how this limit is parameterised, some basic properties of grouting and cement based mixes are recalled.

Figure 1 gives a schematic representation of grout advancement in a planar fracture. The mix rheology is defined in terms of viscosity η and yield stress c. The grout filled space is defined by the diameter of the injection hole 2r and the fracture thickness 2H. The current grout advance is denoted d. The specified advance D is the target to where the practitioner should drive the grout. The span S is the maximal distance that a grout may travel at a given excess pressure P. The span is calculated using the following equation

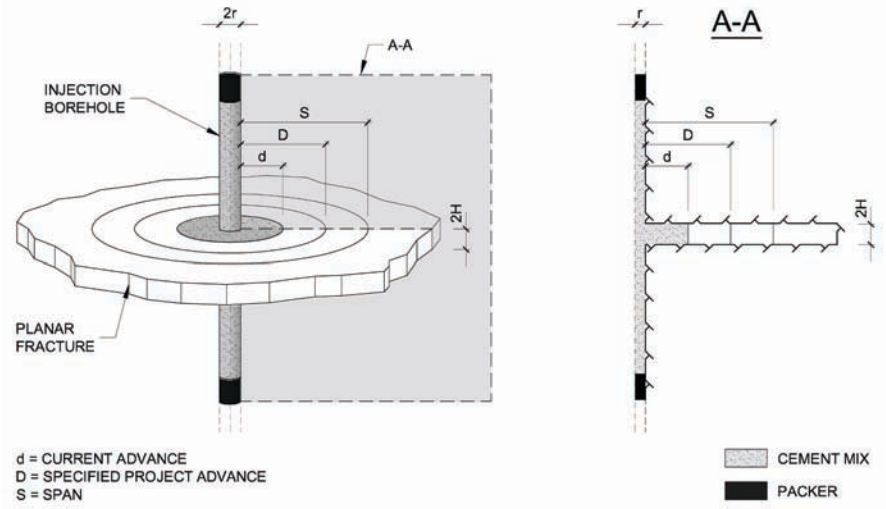

Figure 1. Schematic representation of a cement mix advance in a planar fracture.

$$S = \frac{PH}{c}$$

Attaining the span means attaining a zero flow rate at that excess pressure. The time the grout advance will take before attaining the span is very long and exceeds every imaginable waiting time. Since the span cannot be attained, it has to be greater than the specified advance. If not, the target will never be achieved. If there is a pressure limitation, the corresponding span should be greater than the specified advance. A correct selection of the grouting sequence and distances between the injection holes will take this fact into consideration.

The difference between the specified advance and the span is the grouting margin. Denoting δ the margin ratio, then

$$\delta = \frac{S - D}{S}$$

The margin ratio is an important quantity that enters the parameterised form of the flow rate limit. This latter is denoted L and is given by the following equation

$$L = \frac{4\pi}{3\eta} \frac{H^3 \delta^2 P}{\ln(1+\frac{S}{r})}$$

Based on energy considerations and the properties of Bingham's material, it is proven that if the flow rate, denoted Q, is smaller than the flow rate limit then the relative difference of the current grout advance to the span is smaller than the margin ratio. Abbreviating, for an advancing grout with a span larger than the specified advance, if Q<L then d>D.

The recurring question formulated by Shuttle et al. [8] on "how small an injection rate should be?" now has a parametric response. There is no small or large flow rate to stop grouting. The closure requirement is that the flow rate be smaller than the limit, which depends on the selected parameters. The refusal terminology is no more satisfactory since no zero flow rate is ever required. Therefore, no zero flow rate should be expected. Furthermore, there is no past or history limitation to check the closure inequality. It is independent of the anterior pressure or flow rate.

ALT practice

The "Applied Lugeon Theory" is, according to Bruce [9,10], a generalized US practice and a pillar of the North American methodology. The basic argument of ALT is that complete refusal is synonymous to a zero apparent Lugeon value. Since ALT closure is a difficult objective to attain, it is explained that when a stage is brought to refusal, grout consumption at target pressure is less than 0.1 gpm over a period of 5 minutes. This explanation alludes to NARC with an arbitrary grout consumption. Practitioners are also warned against a wrong interpretation of the grout consumption. On one hand the grout consumption is arbitrarily fixed and on the other hand it can be misinterpreted. The real problem with ALT is that the target is a zero flow rate. This means that the grout advance should attain the span that corresponds to the grouting pressure, which in ALT is the maximal admissible pressure at that stage. This is impossible and the target cannot be attained whatever the stage or the maximal pressure . Bruce confirms this fact based on his personal experience, noting that "relentless unthinking pursuit (to attain a zero flow rate) involves lengthy periods of(...)frustrations". Hence, ALT needs to be modified and completed, by upgrading it into NARC, for instance.

GIN practice

GIN is a popular grouting model with a simple modus operandi [11,12] The development in grouting experimentation and simulation revealed difficulties in attaining the GIN target. This problem is discussed in length by Rombough et al. [13], Shuttle et al. [8] and El Tani [7,14]. It is now well established that: 1- There are as many GIN targets as the number of fractures with different thicknesses and 2- None of the targets can be attained without infringing the GIN rules. The second point stems from the fact that GIN is a constrained model: the specified advance and the span are equals independently of the fractures. This clarification is useful to turn the second point around without going into complex details or elaborating sophisticated grouting schemes: when a target is identified, grout injection is stopped before attaining the span within a given margin. This implies modifying the GIN rules and procedure by incorporating NARC. The span and the specified grout advance needs to be separated to create a margin. More information are required to proceed than was before. As well, it is necessary to know the number of fractures and their thickness in advance to identify the different targets. With this, GIN "lovers" can continue to use it safely and efficiently.

Swedish practice

The time evolution is a basic element of the "Swedish Practice" that includes in its jargon new terms such as the characteristic time and dimensionality [4,5,6,15,16]. But its fundament, which is grouting at a constant excess pressure, is generally not formally dealt with or ignored. The Swedish practice was promoted by Gustafson and Stille [4] after Gustafson and Claesson [15] had deduced a graphical representation of the advancement versus time using non-dimensional variables. Since the applicability of this practice is limited to a constant excess pressure, Kobaysahi and Stille [5] studied a possible extension to a succession of pressure steps.

Gustafson and Claesson used the extended flow rate equation of Dai and Bird [17] to plot the graphical representation of the time evolution. A new radial flow rate equation that satisfies the energy balance is currently available [7,14]. An update of the graphical representation is obtained using the

new flow rate equation and presented in the next section. In practice, the graphical representation is used to monitor and control the grout advance. This may explain why this practice is often called the "Real Time Grouting Control Method".

Closure in the Swedish practice is asserted when the grout advance in the smallest fracture is above a certain minimal value or in the largest fracture before a maximal value. The latter condition is always satisfied and needs to be amended otherwise grouting is stopped right from the beginning. Anyhow, the real problem with this practice is that maintaining a constant pressure all along cannot be guaranteed. In case of uncertainties, NARC should be considered. Indeed, the Swedish practice is predisposed to incorporate NARC since the closure criterion is based on the achievement of a specified grout advance, at least, in the smallest fractures.

Waiting time

The time versus advancement curves when grouting at a constant pressure are shown on Figure 2 using non-dimensional variables. Every curve is labelled with the ratio of the radius of the injection hole to the span. The non-dimensional time τ, current advance ξ and radius ξ_r are defined as:

$$\tau = \frac{c^2 t}{2\eta P}$$

$$\xi = \frac{d}{S}$$

$$\xi_r = \frac{r}{S}$$

A precise approximation that captures the main features of the grout advancement is compared to the exact advancement using a dot representation in Figure 2. The approximation is

$$\tau = (1+\frac{\xi_r}{\xi})ln(1+\frac{\xi}{\xi_r})[\frac{\xi}{1-\xi}+\frac{2}{3}ln\frac{2(1-\xi)}{2+\xi}]$$

The calculated time will be affected by delays due uncertainties such as unexpected cavities, hydro-jacking or hydro-fracturing. Also, the pumping material cannot always react instantaneously to maintain a constant pressure. These delays will break up the correspondence between the time and grout advance. Therefore, the calculated time will be considered a waiting time before expecting the grout front to be in proximity to the target. At this point NARC inequality comes into play.

A practical example concerning grouting at constant pressure is given here. Two professionals are asked to grout a fracture with a given mix. The specified advance, fracture thickness, injection hole radius and grout mix properties are:

- D=12 m
- H=0.4 mm (thickness is 0.8 mm)
- r=30 mm
- c=5 Pa
- η=0.02 Pas

The excess pressure needs to be greater than 0.15 MPa to be able to grout further than the specified grout advance. The first professional selects a 0.18 MPa excess pressure and obtains the following quantities:

- S=14.4 m
- δ=0.167
- ξ=0.833 for d=D
- ξ_r=0.0021
- L=0.7 l/min

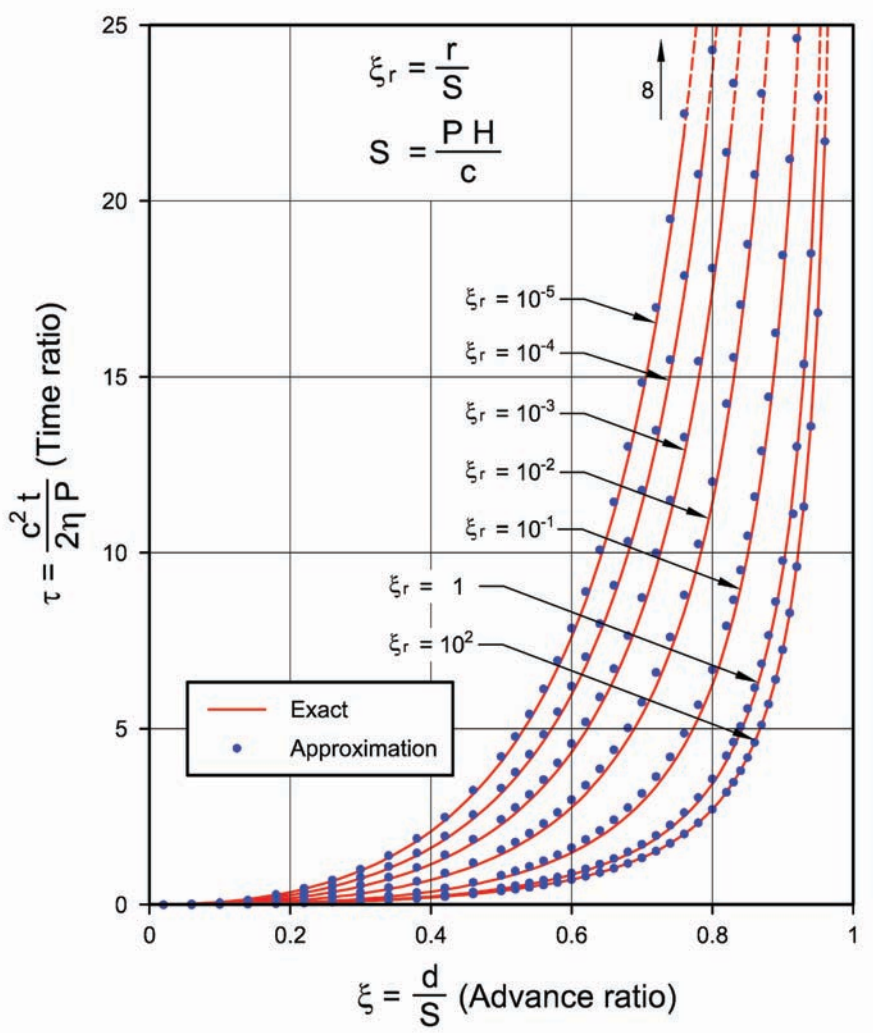

Figure 2. Time ratio versus advance ratio and radius ratio.

- τ=21.5
- t=103 min

The second professional selects 0.24 MPa and obtains:

- S=19.2 m
- δ=0.375
- ξ=0.625 for d=D
- ξ_r=0.0016
- L=4.2 l/min
- τ=5.0
- t=32 min

The flow rate limit of the first professional is six times smaller than the second one and the waiting time three times longer.

Zero flow path

In a stage with multiple fractures, the fracture with the largest thickness will be grouted first. This hierarchy is a well known fact. The split-spacing sequence has long been used by practitioners to grout the fractures with the major thickness first, increasing the excess pressure at every following sequence. A sequential decrease of grout consumption is generally observed. If not, this may be due to unexpected events or the use of an inappropriate mix according to López-Molina and Espinosa-Guillén [18].

The "Zero flow path" is the basic concept that explains the hierarchical grouting sequence. Every fracture has its own ZFP that delimits the rest and advance phases of the grout in the energy diagram. When the grout path enters the rest phase, grout is immobilised in that fracture. Grout is also immobilised in fractures with smaller thickness, even though the excess pressure is not zero. It will continue to flow in larger fractures.

Preliminary investigations are essential to identify the fractures and get their ZFP. This is necessary to define a grouting strategy and calculate the correct flow rate limit at every stage and sequence.

"La Yesca" practice

The "La Yesca" practice is a tailored methodology that was involved to dive the grout curtains at the "La Yesca" hydroelectric project in Western Mexico [19,20]. It is based on recommendations that were published in the column of Grout Line [14] when discussing the GIN target. And, for the first time, ZFP was used in a grouting project. Two energy levels were selected to dilute the target. An active grouting optimisation was considered controlling alternatively the flow rate and pressure steps to drive the grouting path towards the target. Refusal was asserted, depending on a feedback monitoring basis of the decreasing trend of the grout consumption, when penetrability lied between 1 and 5 l/min/bar. These values were probably selected based on field experience since at that time the flow rate limit was not yet parameterized.

Conclusions

Grouting without collecting data on the geometry of fractures is no more conceivable. The technological advance changed the grouting and pre-grouting data acquisition and eased their representation in order to be analysed in the light of the new developments of grouting science.

The parameterisation of the flow rate limit turned the "North American Refusal Criterion" into an important decision tool that will definitively mark a new era of tailored and personalised grouting methodologies.

The "Zero Flow Path" is an essential concept, which is used to get the right grouting hierarchy and to calculate the correct specific flow rate limit at every stage and sequence.

The "Waiting Time" is a complementary tool where preference is given to grouting at constant pressure.

The next challenge will be experimenting the new tools in field practice.

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P.S. The statements, developments and conclusions in this note are those of the author and not necessarily those of Lombardi SA.

For grouting stories, case histories or only to comment, you can write to me @ Paolo Gazzarrini, *paolo@paologaz.com* , *paologaz@shaw.ca* or *paolo@groutline.com.*

Ciao! Cheers!

GEO-INTEREST

An Investigation of Anchored Steel Pile Wall as a Retaining Structure in Slope Stability

Ramli Nazir, Wong Teck Loon, Hamed Niroumand

Abstract

Hillside development has became an issue among geotechnical engineers to deal with the unstable slope and to find out the most effective and economic solution. A research was conducted to assess the effectiveness of an anchored steel sheet pile wall as a slope stability technique and its construction cost on a failed slope at Malaysia. Two sets of design with same design parameters has been carried out to represent the existing contiguous bored pile (CBP) wall and the proposed anchored steel sheet pile wall. Analysis was conducted using Two-dimensional Finite Element Modeling tool PLAXIS to compare the effectiveness of anchored steel sheet pile wall with existing CBP wall in term of factor of safety (FOS) of the repaired slope. Comparison also was made based on the construction cost of both methods. Results indicated that the FOS of repaired slope using anchored steel sheet pile wall was slightly lower than those of using CBP wall at each specified groundwater level considered but its construction cost was found comparatively economical than CBP wall.

Keywords: *Anchored steel sheet pile wall, CBP wall, Factor of safety (FOS)*

Introduction

Landslides are a natural land degradation process, it is happening everywhere, every time. In Malaysia, there has been a tremendous increase in construction on sloped area over the last 15 years due to depleting of available flat land. Hill-site development is often related to landslides. The stability of the slope cannot be determined

perfectly because there are many factors that may influence its stability from time to time. Therefore, the stability of the slope should be analysed with various approach so that the most critical situation can be determined. There are various types of slope repairing methods that have been established by the specialist and researchers dealing with different types of slope failure. In practice, the method to be used is normally confronted with the local practical constraints mostly its effectiveness, construction time and cost. This paper will looked into the effectiveness of anchored steel sheet pile wall as a slope repairing technique in term of FOS of the repaired slope and its construction cost.

Methodology

Three sets of analysis were carried out using PLAXIS in which each indicated the original slope profile, repaired slope profile with CBP wall and repaired slope profile with anchored steel sheet pile wall respectively to obtain FOS of the slope and comparison is made. Besides, the cost analysis of proposed anchored steel sheet pile wall was developed with the information of a quantity surveyor from Puchong, Selangor. Cost comparison is made with the CBP wall to define which is more economical.

Case Study

The low-lying ground generally consists of alluvial deposits and at relatively higher ground. This typically represents an unstable mass, relatively weak material and found burying very weak alluvium soils. The soil generally consists of sandy silt, clayed silt and silty sand. It was predicted that the collapsed was likely triggered by the extremely heavy rainfall. Ten boreholes, six observation wells, three inclinometers and one standpipe piezometer were planned and implemented to investigate the cause of failure. The overburden material was found to be generally weak with SPT-N value ranging from 0 to 15. Inclinometers are suggested at the slope to determine slip surface and detect the slope creep movement. Two slip surfaces have been identified as shown in Figure 1.

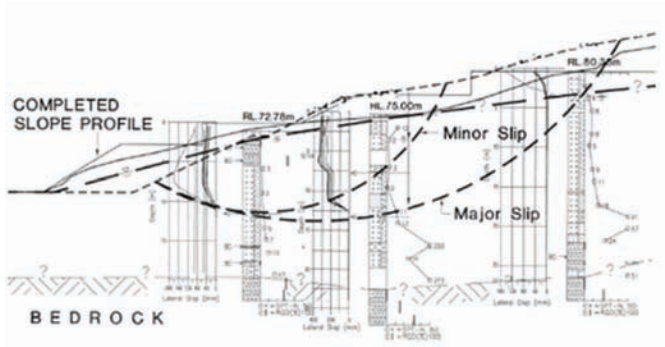


Figure 1. Slip surface plane.

Results

Atterberg Limit Test and Particle Size Distribution

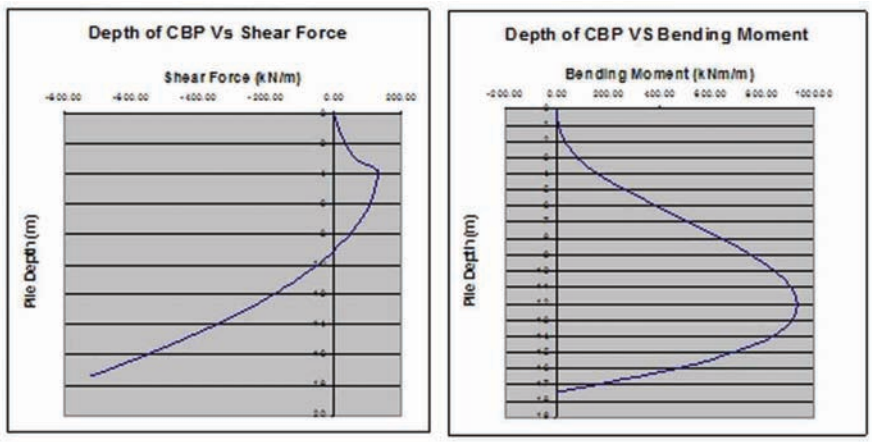
This classification was based on British Soil Classification System. Most of the soil samples collected near the slip surface is clayey silt of intermediate to high plasticity.

Subsoil and Groundwater Level

Based on the data of exploratory borehole obtained, the subsoil layers and its properties can be determined. The top layer generally composes of clayed silt with SPT N value ranging from 3 to 10. Following layers compose of sand with some gravel. Six numbers of observation wells and a standpipe piezometer were used to monitor the groundwater level. The critical groundwater table within the failed slope was found ranging from 2.89m to 2.77m (from OW-3) below ground level which can consider high.

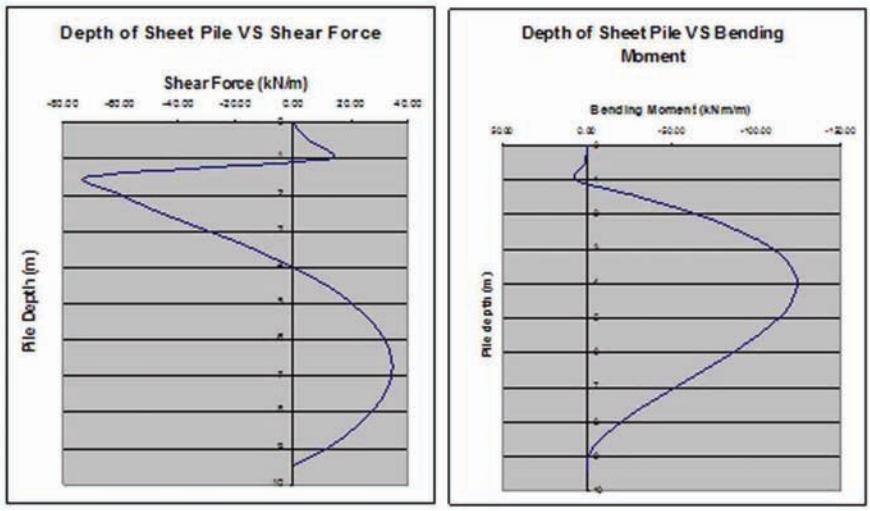
Design and analysis

Two sets of design will be carried out, one for the CBP wall and other for the proposed anchored steel sheet pile wall. Both designs were using the same FS of 1.5. All design parameter used are based on the subsoil data and some considerable assumptions. Wall friction, $\delta = 18.7°$ and ϕ'design = 23.9° according to BS 8002:1994 clause 3.2.6. soil cohesion, c' = 0 kN/m2 as recommended by ASTM Steel Manual Design, for permanent steel structure. While the design retained height, H = 3.0m and critical groundwater level was assumed as 3.0m below ground surface. The lateral earth pressure coefficient is calculate based on Coulomb's theory in which the friction between soil and the wall is take into account. Ka (horizontal component) = 0.461 and Kp (horizontal component) = 2.100. Introduce a



(a) Depth of CBP wall Vs Shear force (b) Depth of CBP wall Vs bending moment.

Figure 2. Shear force and bending moment acting on CBP wall.



(a) Depth of anchored steel sheet pile wall Vs shear force. (b) Depth of anchored steel sheet pile wall Vs bending moment.
Figure 3. Shear force and bending moment acting on anchored steel sheet pile wall.

FS = 1.5 on the passive earth pressure coefficient, thus Kp(design) = 1.4.

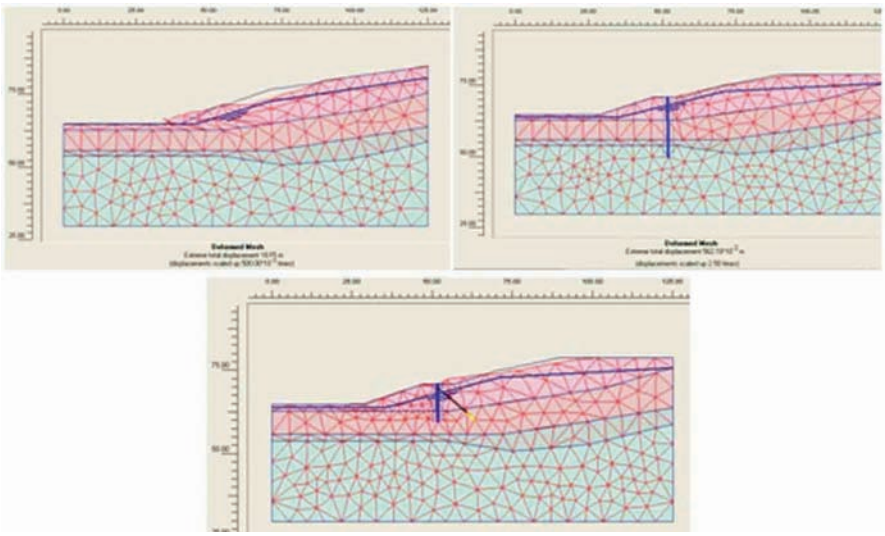
Design of CBP Wall

By taking the summation of moment of the base of the wall equal to zero, the required embedded length of the contiguous bored pile (CBP) is 14.44m. In practice, additional 20% of the embedded length is provided which gives the total pile length = 3.0 + 1.2 (14.44) = 20.33m. Use bored piles with diameter, D = 1200mm.

Shear force and bending moment acting on the CBP wall was shown in Figure 2.

Design of Anchored Steel Sheet Pile Wall

Design of anchored steel sheet pile wall carried out using the free earth support method. All other condition is similar as design of CBP wall. By taking the summation of the moment at point where tie rod is tied, the required embedded depth is 6.5m. Additional 20% of the embedded length is provided which gives the total pile length = 3.0 + 1.2 (6.5) = 10.8m and tension in tie rod, T is found to be 94.48 kN/m length of the wall. From Figure 3(b), Mmax = 124.07 kNm/m and the elastic modulus, Z is found equal to 460 cm3/m. Use U-section with the nearest elastic section modulus of 600 cm3/m. Tie rods will be installed at every 5 piles (spacing, s = 3.0m c/c of each rod). Tie rods will be installed at 50° to the wall in order to provide full passive resistance from the anchor where the passive zone in front of the anchor system is located completely outside the active zone. By introducing a factor of safety of 2.0 as suggested by Littlejohn, 1970, the tensile force in the rod is 94.48x3x2/ sin 50° which gives 740 kN. The result allows the use of tie rod of 60mm diameter. The fixed anchor length, L and diameter of the anchor, D for ground anchor system need to be determined in order to provide adequate soil resistance (principally skin friction) against pulling force of T = 740kN. Using equation suggested by Littlejohn, 1970 Obtained B = 0.6m and L = 3.0m.



(a) Deformed mesh of original slope profile. (b) Deformed mesh of original repaired slope using CBP wall.
(c) Deformed mesh of repaired slope using anchored steel sheet pile wall.
Figure 4. Deformed mesh of original and repaired slope.

Finite Element Modeling and Analysis

PLAXIS software was used to analyze the behavior of the failed slope before and after slope repairing works. The soil properties used in the analysis were taken from the previous analysis done by Teo, 2003. Factor of safety, FOS of the slope was determined using phi-c-reduction approach available in PLAXIS.

Analyses were carried out for three different conditions which include the modeling of original slope and repaired slope using CBP wall and anchored steel sheet pile wall respectively for various groundwater level. The deformed mesh for each analysis was shown in Figure 4. Results are shown in Table 1 and Figure 5.

Conclusion

The conclusions that can be drawn

Table 1. FOS of original and repaired slope for various groundwater level			
Groundwater level below ground surface (m)	Factor of Safety (FOS)		
	Original slope	Repaired slope (CBP wall)	Repaired slope (anchored steel sheet pile wall)
0.15	0.905	-	-
2.8	1.456	-	-
3.0	1.643	2.495	2.450
6.0	1,755	2.629	2.596
9.0	1.829	2.661	2.631
12.0	1.873	2.753	2.669

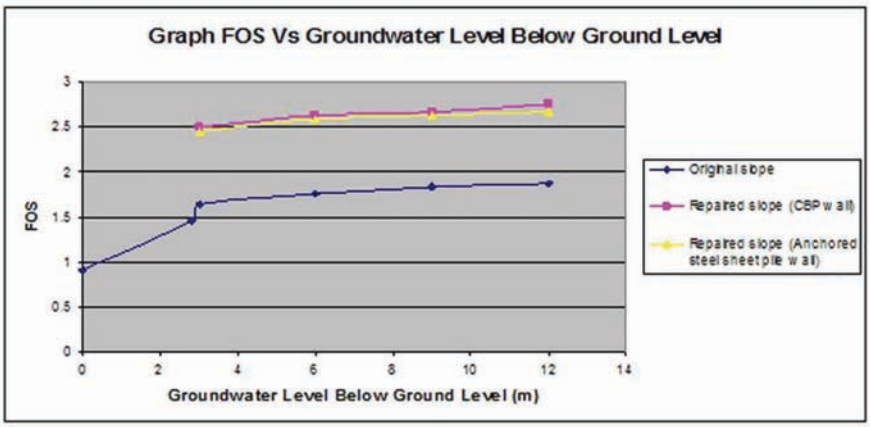


Figure 5. Graph FOS versus groundwater level below groundwater surface.

from this research were as follows:

1. Increase in groundwater level was the main factor that contributes to the slope failure. The raise of groundwater level mainly cause by infiltration of rain water. As earthworks proceed, large area of land was cleared on the slope thus led to large amount of infiltrated water in the slope during rainfall due to lack of vegetation covers. Besides, steep gradient and weak soil materials of the slope also contribute to the failure.
2. The FOS for the repaired slope at every groundwater level considered using anchored steel sheet pile wall is slightly less than those using CBP wall but the values were higher than FOS of 1.5 which is considered safe.
3. The construction cost of anchored steel sheet pile wall was found economical than CBP wall.

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GeoWorld: The geoprofessional network

With over 3,000 active members, GeoWorld- founded less than 2 years ago by the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE) and Geoengineer.org (The International Information Center for Geoprofessionals)- has grown into a large online community of geotechnical engineering and other geoprofessionals, who use this free online platform to easily create and maintain a professional image online, but also exchange ideas and learn from each other's knowledge and experience. More and more individuals and organizations who share the vision of ISSMGE and Geoengineer.org to advance the geoprofession, have adopted and supported GeoWorld, including renowned geo-experts, both academicians and practitioners.

One of the reasons GeoWorld is used by more and more geoprofessionals, companies and organizations worldwide, is that it is not only built to connect you on a professional level to the people you already know, but to also aid you to expand your network. The related benefits can help you advance your career, find new employees or partners, and most of all to truly learn from other geo-experts.

The technical forums

A great example of a learning tool developed just a few months ago by the GeoWorld team, are the New Technical Forums (www.mygeoworld.info/forum). The Forums are the place to ask geo-technical questions and get meaningful answers, and also provide you the opportunity to showcase your expertise while helping others.

Among the advantages of the New GeoWorld Technical Forums are their unique focus on technical issues and the fact that all postings are tied to each individual's or company's/organization's GeoWorld account. Thus, members of GeoWorld can establish a professional reputation by actively participating in the forums and providing useful feedback to colleagues worldwide. What is more, as opposed to forums available elsewhere, as well as social media groups, these forums are shared with all members (i.e., each group does not have its own forum) so that there is one central location where all questions are asked and answered!

GeoMap: Find a geo-expert near you

Another useful innovative tool created by GeoWorld, is a worldwide interactive map, depicting the location of all GeoWorld members, companies and organizations, as well as recent industry news, events and case histories. GeoMap (www.mygeoworld.info/map) is being upgraded constantly with data points that are of interest to geoprofessionals and has proven to be a key facilitator for the office, or while on business/field trips or conferences.

New tools coming up!

New online tools that are valuable to the geoprofession will be launched soon, as part of the constant improvements and additions made in GeoWorld. Stay tuned and if you are not already a member, you can sign up easily and at no cost at all at www.mygeoworld.info!

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ASFE

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

Damage control

A front-page article in the *July/August 2012 ASFE NewsLog* alerted readers to a peer-reviewed paper delivered live as a keynote lecture at GeoCongress 2012, then published in the proceedings. Titled "The State of the Practice in Foundation Engineering on Expansive and Collapsible Soils" and authored by William N. Houston, Ph.D., P.E. and John D. Nelson, Ph.D., P.E., the paper, left as is, could have been a boon for hired-gun experts by virtue of an obviously incorrect definition of the standard of care applicable to professionals, and the findings of research whose origins are questionable and whose currency has long since passed. The only way ASFE could neuter the potential damage was to develop "discussions" – actually, rebuttals – for publication in ASCE's *Journal of Geotechnical and Geoenvironmental Engineering.* The Board of Directors assigned the task to ASFE's Geotechnical and Legal Affairs Committees. **Dennis Shallenberger, G.E.** (Earth Systems Pacific) did the heavy lifting for the Geotechnical Committee. Ji H. Shin, Esq., (Earth Systems, Inc.) and ASFE Consultant Member Michael J. Byrne, Esq., a partner in the Gogick, Byrne & O'Neill, LLP law firm, did likewise for the Legal Affairs Committees. Now, after not just a little *sturm und drang*, good news: The *Journal of Geotechnical and Geoenvironmental Engineering* has said it will publish both discussions, presumably with a commentary from Drs. Houston and Nelson. We'll keep you posted. *Let your attorneys know!*

New corps study suggests geoprofessionals will be kept busy for years to come

America's vast network of levees, dams, navigation structures, and hydroelectric-power facilities – overseen by the U.S. Army Corps of Engineers – will decay into oblivion if the president and Congress cannot develop new ways to pay for its maintenance and operation. That's the grim conclusion of a new National Research Council report that suggests expanding revenues and strengthening partnerships among the private and public sectors as options for managing the Corps' aged water infrastructure.

"Today, the Corps focuses mainly on sustaining its existing structures, some of which are in states of significant deterioration and disrepair," said Carnegie Mellon University's David A. Dzombak, Ph.D., P.E., chair of the committee that wrote the report. He continued, "Funding for maintenance and rehabilitation of the Corps' water-resources infrastructure…has been inadequate for decades." (An earlier study found that Congress has greatly broadened the scope and extent of the Corps' water-resource and infrastructure responsibilities during the last few decades, a period during which Congress has dramatically decreased funding for those projects, Dr. Dzombak said.)

The Corps' infrastructure consists of some 700 dams, 14,000 miles of federal levees, and 12,000 miles of river-navigation channel and control structures. Its worth in the 1980s was estimated at $237 billion. Today? $164 billion. "We now have a scenario where the water infrastructure is wearing out faster than it is being replaced or rehabilitated. Some components could be decommissioned or divested, but the Corps does not have the authority to do this."

The Corps has projects in several mission areas: navigation, flood-risk management, ecosystem restoration, hurricane- and storm-damage reduction, water supply, hydroelectric-power generation, and recreation. The Corps' successes in addressing maintenance and rehabilitation issues in one mission area do not often transfer to other mission areas.

The Corps' division and district offices set some budget priorities for maintenance and rehabilitation of existing projects, the report states, but – when it comes to prioritizing the national water-infrastructure maintenance-and-rehabilitation budget – distribution of responsibility among Congress, the Office of Management and Budget (OMB), and the Corps remains undefined. For major rehabilitation projects, Congress and OMB share responsibility for funding decisions.

Some traditional management practices will have to be abandoned to establish a more systematic approach to water-infrastructure maintenance and rehabilitation, the committee said. For example, for Congress and OMB to place higher priority on maintenance issues, they'll have to develop fewer new projects (via the Water Resources Development Act). Likewise, if the Corps' is to sustain its high-priority and most valuable infrastructure, the executive branch and

Congress will have to provide better guidance about maintenance priorities. Decommissioning or divesting some components should also be considered, the committee said.

The committee said that partnerships with states, communities, and the private sector could yield new resources and more efficient methods, especially in hydropower generation, flood-risk management, and port and harbor maintenance. The committee said the Corps could increase its hydropower revenues by rehabilitating and upgrading existing facilities to improve the efficiency of their turbines and related power-generation and distribution systems. According to the report, "Total generation from Corps hydropower projects decreased by 16 percent from 2000-2008. By contrast, the [Tennessee Valley Authority] increased hydropower generation 34 percent with the same water availability through efficiency improvements in the 1980s and early 1990s."

With regard to flood-risk management, reducing federal funding for traditional, structural projects would present opportunities to apply nonstructural flood control options that often are more efficient, cost less, and provide more environmental benefits. They also offer a chance for the Corps to extend its partnerships with local communities in providing technical advice and other support. The report cited Davenport, Iowa as an example. The largest city along the Mississippi River without a flood control levee, Davenport "made the decision that it did not want a levee that would wall the city off from the Mississippi River and its aesthetic, historical and cultural values" the report states. "Over the years, the city has bought out structures to create parks and open spaces, limiting development in order to limit possible flood losses."

In Cedar Rapids, Iowa, hit by devastating river flooding in 2008, officials are implementing a similar plan that calls for building structures to protect higher-value property (private investors are shouldering part of the cost), and relocating other facilities out of the floodplain. However, as the report points out, the Corps' existing programs and sponsorship agreements lack provisions to require or even encourage local sponsors to implement land-use zoning or other nonstructural measures.

Maintaining the inland-navigation system presents especially formidable challenges and choices for the Corps. Federal resources for construction and rehabilitation have declined steadily; proposals to generate additional revenue by charging lockage fees to system users have, historically, gone nowhere. Parts of the system could be decommissioned, but Congress must make that decision. Keeping the *status quo* – i.e., steady deterioration – would lead to significant service disruptions, the committee said.

The report calls for an independent investigation of the opportunities for additional partnerships for operations and maintenance of Corps water infrastructure. Examples of such partnerships include those developed with private entities by state and local governments for port operation. The report does not address the Corps' somewhat-new (since 1996) role as an environmental restoration agency.

All things considered, the nation soon will have no choice but to inspect, evaluate, prioritize, and begin work on restoring and rehabilitating existing Corps infrastructure. The vast majority of the services required are geoprofessional.

Brace Yourself: The Talent War has Begun

"A 'war for talent' is brewing. Economic difficulties have depressed morale in many firms, and, as the economy improves, the likelihood of voluntary turnover will increase significantly. This is particularly the case in a day when loyalty to an employer is being supplanted by loyalty to the personal network that is nurtured by the connectivity derived from the changes in how we communicate. Understanding the 'employee value proposition' – the interplay of intrinsic and extrinsic factors that motivate job satisfaction and employee engagement – is more important than ever to retain existing personnel and attract new staff, an outcome that will be critical to profitability in the short term, and leadership and ownership succession in the long term."

So said ASFE's Emerging Issues and Trends Committee in ASFE Practice Alert 53, "The Crystal Ball Workshop: Ten Certain Trends To Consider Now." Prescient? Well, consider a new report from WANTED Analytics, a leading source of real-time business-talent intelligence. During September-November 2012, employers posted more than 22,000 on-line advertisements for civil engineers (the most of any engineering occupation), a 16% jump compared to the same 90-day period in 2011. Houston, New York, Los Angeles, the District of Columbia, and Denver were the metropolitan areas where civil engineers were in most demand. While Houston and New York employers placed the highest number of ads, Denver experienced the biggest jump, an 80% year-over-year increase.

According to the report, "Some of the most commonly advertised job titles were civil engineer, structural engineer, project engineer, geotechnical engineer, and design engineer." The most commonly required skills were project management, Autodesk AutoCAD, construction management, oral and written communication skills, Microsoft Office, Bentley Microstation, business development, and self-motivation. Demand for civil engineers is outpacing the supply in many areas, the report said, noting that recruiters across the United States spend an average of six weeks advertising jobs and sourcing candidates for these positions. The best areas for recruiting civil engineers? Boston and Seattle, the report said, where demand

is lower while the talent supply is somewhat large.

Business 101

According to Symantec, hackers launched 36% of their first-quarter 2012 cyber-attacks at businesses with 250 or fewer employees. They regard these smaller organizations – especially professional firms – as "easy pickings." Regrettably, effective preventive systems can be complex and costly to develop, implement, and maintain. And even if you have one – and especially if you don't – you'd probably be well advised to look into a cyber-liability insurance policy. Typical coverages include network liability as well as first-party coverages related to:

- privacy liability,
- regulatory liability, and
- expenses stemming from a security breach.

An article in *Insurance Journal* noted that additional exposures come from outsourced service providers for Web hosting, credit-card processing, call centers, document storage, and data warehousing.

A typical policy provides coverage for:

- unauthorized access;
- unauthorized computer-system use;
- data theft or destruction;
- hacker attacks against third parties;
- denial-of service-attacks;
- malicious code;
- privacy liability arising from a network-security breach;
- security breaches involving personal information in any format, including nonelectronic;
- violations of state and/or federal privacy regulations; and
- violations of security-breach notification laws.

Because cyber-liability insurance is relatively new, each insurer's policy forms are unique; coverages and exclusions vary significantly from one carrier to the next. Speak with your insurance professional to be sure you understand what you are purchasing.

Dr. English

One of the nicer features of ASFE's webinars is the speakers' willingness to answer questions. An important question came in after the webcast of "Think. Be Accurate.", a John Bachner-led presentation focusing on commonly used words and phrases that can be dangerous. What follows is an edited version of the Q&A exchanges involved.

Tim wrote:

Good afternoon, John.

We just finished watching "Think. Be Accurate." at our office and I have a question with regard to one of the phrases you brought up. We often use the phrase "in general accordance with project plans and specifications" in our field reports. We aren't typically on site full-time and we therefore don't want to make a guarantee that the work we observed was performed in full accordance with the project plans and specifications. However, it seems reasonable that we ought to tie our observations to the project plans and specifications, because if not, why are we even out there? In your experience, is there a phrase that is more suitable than "in general accordance with"?

Thanks for the lively presentation. I appreciate the ways you push the geo community towards excellence.

– Tim

John's response…

Thanks for writing, Tim. Here's how I see it.

If you were on the witness stand and opposing counsel asked, "What exactly does 'in general accordance with project plans and specifications' mean?" what would you say? I guess it would have to be along the lines of, "Well, it means we don't have enough knowledge to know if full compliance was achieved, because we are not on site to look over everyone's shoulder 24/7." Fact is, though, what you do is a far cry from that. You are providing that level of service the owner selected to satisfy the owner's desire to assess whether or not a constructor is fulfilling its QC obligation to achieve certain specified conditions. I believe "in general accordance with project plans and specifications" creates an unwarranted sense of security and, therefore, is something you should not be saying. And why are you making that assessment when, in reality, it is the client who should draw the conclusions, because the client specified the extent of security it wants?

I believe a better statement might be:

> "Our [observation and/or testing], as documented via the daily field reports included in Appendix A, indicate that the specific work portion we [observed and/or tested] met specifications of the contract. Please recognize that construction observation and testing conducted for quality-assurance purposes customarily involves direct observation and/or testing of less than one percent of the overall work that the observation and testing data are applied to evaluate. As such, you must base your conclusions about the overall work's compliance with specifications on inferences you draw from the data we have developed, in accordance with the scope of service you authorized. If you believe the data we have developed are insufficient, we will be pleased to recommend and conduct additional observation and/or testing."

Bearing in mind that I am not an attorney, Tim, this may be enough to get the point across. The conclusions to be reached should be reached by the client, not you. You're there to provide data. The client has restricted the amount of data it wants, based on its own risk/cost evaluation. If you say "general compliance" and it's not in compliance – general or otherwise – I believe you would be creating a risk

for yourself that doesn't really belong to you.

To which Tim responded…

Thanks for your thoughts on this topic, John, I agree with you that trying to defend that phrase on the witness stand would be uncomfortable, to say the least. Often, both the local municipality and the owner are looking to us for confirmation that the work was completed according to plans and specifications. If we put in too many limiting phrases, it's likely the municipality would balk and direct us to complete enough field observation to be able to make a conclusive statement. We'll need to talk about this internally and see how we can more accurately portray our work. Thanks for taking the time to get back to me.

John then offered…

Hi, Tim. Feasibly you could try something like what follows. It's shorter but still explains the risks involved; i.e., you are doing what doctors do when they obtain informed consent from a patient. Your clients need to know that they DO NOT want you to say anything stronger, because that could make you liable for the contractor's work, something for which you are not insured.

> "Based upon inferences we have drawn from our [observation and/or testing], as documented by the daily field reports included in Appendix A, it is our professional opinion that the constructor is achieving specified conditions. Please recognize that construction observation and testing are sampling functions that involve direct observation and/or testing of less than one percent of the overall work that the observation and testing data are applied to evaluate."

Professional selling

Imagine, if you will, that the world's automobiles were manufactured by 25,000 companies, each one building one car at a time, to meet the preferences of each specific buyer. And by preferences, we don't mean just two-door, four-door, or SUV. We mean everything: length, width, wheelbase, engine, number of doors, and so on; i.e., no two even remotely the same. While some of these companies might build, say, 10,000 cars each year, most would build no more than 100. The buyer would select the company, agree on what was needed, review the budget, make modest compromises as required, pay for the vehicle in increments, and then wait for delivery while hoping for the best. Imagine, further, that you're in the market for a new car. Knowing that you would not take delivery until long after you make the purchase decision, how would you make that decision? What would be a really important factor? We submit that testimonials could be extremely helpful, and not just written ones: How about video testimonials linkable via a company's website? Imagine clicking to one of the dozens available and seeing a woman looking into the camera and saying…

> "Hi. My name is Jane Doe. If you're like me, you're always nervous about buying a car, because you really have no idea what it will look like or perform like, except by virtue of the promise made by the company. I'm on my third Smith Associates car. I have been delighted by each and every one. They look like they promise, and I love the looks. They've performed exactly like I want them to. They delivered each one on time for exactly the price we agreed to. I'm truly happy with my Smith. I'll be a Smith fan forever."

Then you click to another and a man says…

> "Hello. My name is Edward Green. I've been purchasing Smith vehicles for 20 years. I know that I could get another type of vehicle for less, especially if I haggle, but let's face it: These vehicles are built one at a time; each is custom. If I pay less, will I get less? If I pay less, will the people I deal with work just as hard to deliver the highest quality they can, or will they make – shall we say – adjustments, so they make the amount of profit they need to. How could I tell? With Smith, I know I get true value: just what I bargained for, delivered when I want it. You can't do better than that."

Now imagine that instead of automobiles, the deliverable is an instrument of geoprofessional service. That shouldn't be too hard to imagine, should it? Now imagine that you can visit a geoprofessional firm's website and link to video testimonials. Hmmmm. From what we've seen, that's a real stretch.

Human resources management

Time and time again we hear stories about the employee who should have been fired, but was kept on until the situation became so toxic there was no alternative to dimissal. And then, guess what? Dismissal was best for the employee as well as the firm. That being the case, separation before that point would have been far easier and far more beneficial to the company. This applies even to top performers, as when they seem to feel the company and all other employees somehow owe them, and the company "would never even think about firing me, because I'm so good." The real problems with these toxic employees is the damage they do to morale. Others on staff – especially the rising stars – disrespect the managers who are afraid to take meaningful action, leading to creation of a widespread "us vs. them" atmosphere, and a workplace that can become a dreaded morning destination. The result: Keeping the toxic superstar on staff can result in damage whose value far exceeds whatever benefit is involved, as when others leave for greener, better-managed pastures. Ironically, when that happens,

the person in charge has to rely on the toxic employee even more, magnifying and accelerating the damage being done.

Here are some warning signs that an employee is becoming toxic and needs to be dismissed, assuming regular meetings and discussions don't work:

1. They have problems they need your help with, and the problems are always the same or always different; it doesn't really matter. They need attention; they want help. You've told them, "Don't bring me problems. Bring me your problems and, for each, at least three alternative solutions." But that doesn't happen. Just problems. Bye-bye.

2. They affect overall staff morale with almost-constant complaining, bickering, and general negativity. It's not pleasant to be around such goings-on, especially when they lead to debates where what's wrong gets exaggerated and what's right is overlooked almost entirely. When they're removed from staff, what's wrong becomes far less important, in part because people realize they are at liberty to recommend changes for improvement. Bye-bye.

3. The cost of standing pat becomes too high, because at least one rising star has left and you fear others will follow, possibly moving to the same competitor. If that has happened, or if your fear that it will is eroding your own peace of mind and productivity, the time has come to let the toxic employee move to a competitor, giving you a chance to develop the rising stars still with you, who have stayed because they respect your insight and decisiveness. Bye-bye.

4. They come home with you, because they're in your mind while you're having dinner, playing with the kids, or watching TV. You can't fall asleep because you're thinking about what to do, and that's the first thought in your mind when you awake. Bye-bye.

5. That "little voice" says, "Time to say bye-bye." Act on it! You'll be better off. Others on staff will be better off. The firm will be better off. And, nine times out of ten, toxic employees will be better off, too, assuming they find positions that better meet their needs. (If not, too bad. It's not your problem.) Bye-bye.

Slow and steady doesn't cut it anymore

Two hares are getting ready to race. One of them looks quite fit. The other seems somewhat ungainly; misshapen somehow; an awkward mover. "On your marks." Both assume the position. "Get set." Both tauten. *"Bang!"* And away they go, neck and neck in a five-lap contest. The fitter of the two takes an early lead, but not by much. Going into lap two, they're even. But coming out of lap two, the fitter of the two is revealing himself to be not as fit as he – and we – might have thought. Midway through lap three, the fitter is losing ground; breathing heavily; not using its resources well. Lap four: The penultimate lap, and the ungainly hare is clearly in the lead, moving awkwardly fast. Then the bell lap, with our ungainly friend moving along more efficiently, more wisely, and – ta da! – home the winner.

"How'd you do it?" the better-looking of the two asked, breathing heavily, paws on hips, ears drooping. "Well," said his competitor, "I finally did what I knew I had to do to win. I always had the right attitude, I thought: I've always been steady; never gave up. I just kept plodding away. But then I realized that wasn't enough. As long as you did what you could do, and what with all the new hares in town, I'd get beaten. I just had to move faster and better; it's a new day, y'know? I had to get rid of the negatives and strengthen my hold on the positives. I had to become more efficient. I couldn't rely on past victories to assure more victories in the future. I had to know myself so I could improve myself and outdistance all the competition. And I did it."

"Wow," said the defeated hare, clearly impressed. "How'd you do that?"

"Well," said the other runner, "I had a Peer Review." And with that, he put his hand to his forehead and pulled down a hidden zipper right to his inseam, revealing himself to be none other than the tortoise. "And boy, did it ever help."

Are you ready for the new age of competition sure to be around the corner? Get your firm ready to run the distance, just as Klohn Crippen Berger and Holdrege & Kull did. Ask Alex and Tom how they feel now…assuming you can catch up. And if you do, don't stare at their foreheads!

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Editorial

Service as an expert allows you to serve justice, providing you perform properly. Consensus guidelines for proper performance are related in Recommended Practices for Design Professionals Engaged as Experts in the Resolution of Construction Industry Disputes. Conceived by ASFE and developed by the Interprofessional Council on Environmental Design (ICED), *Recommended Practices…* sets forth 13 recommendations. It is the most extensively endorsed document of its kind. ASCE, NSPE, AIA, ACEC, ASHRAE, and ASME are among the 40-plus organizations that have given it their blessing.

Experts' role is particularly important when a design or environmental professional is accused of negligence. In almost all cases, experts are required to give their opinions about the applicable standard of care, and whether or not the professional met it. Professionals meet the standard of care when a trier of fact (judge or, more commonly, a jury) believes they applied the skill and care ordinarily applied at the time

by the professionals' peers. They are negligent when a trier of fact believes they failed to meet the standard of care and, as a consequence, caused injury or damage. Because triers of fact almost never have background in the technical issues involved, they are forced to rely heavily on experts' testimony.

Recommended Practices…recommendation seven says that experts should render opinions about the standard of care only after they have conducted some credible research to determine what the standard of care actually was; i.e., what was ordinarily being done by the type of professionals involved at the time of the incident in question. Experts should not base their opinions on what they would have done, or what a book or article says should have been done, because that information does not indicate what was ordinarily done. Experts should **never** advocate for "their side" in any way. Experts serve the court, not the plaintiff or defendant. Where experts disagree, disagreement should stem **only** from honest differences of opinions.

What about those experts who lie? Isn't that perjury? No, because expert testimony is so important, courts have made experts virtually invulnerable to claims brought by opposition parties. (In a few states, clients are allowed to sue their experts for certain types of deficient performance.) But that doesn't mean the professions are powerless. Consider *Recommended Practices*…which, to date, is the only weapon available to help deter bad expert testimony. Professional organizations developed it to help curb abuses, and ASFE case histories show it works. Its effective application can help impeach the credibility of those experts who fail to make an honest effort to determine what the standard of care actually was. Your attorneys need to know about it.

There's more we can do: Consider ASCE's "Guidelines to Practice under the Fundamental Canons of Ethics," Canon 3 (c), which states:

> "Engineers, when serving as expert witnesses, shall express an engineering opinion only when it is founded upon adequate knowledge of the facts, upon a background of technical competence, and upon honest conviction."

Unless they perform research, experts cannot have adequate knowledge to testify about the standard of care. But when was the last time an expert was brought up on ethics charges for not performing standard-of-care research? In fact, every design professional organization should have such language in its codes of ethics, should provide education and training to help ensure members know what's right and wrong, and – *most important* – should vigorously enforce the code. So why don't at least a few engineers take action against the notorious hired guns "out there"? What's the hold-up? Apathy, for one. Fear of reprisal, for another; fear that doing the right thing could result in legal action.

Does it matter to you? It certainly should: Apathy is a terminal disease insofar as a profession is concerned. And if it does matter, do something about it. Use the tools that are at the ready. And remember that it's especially important for geoprofessionals to take the lead, because, when they do, history shows, others follow. Eventually.

From the Bench

Not just a few geoprofessionals coming out of college are somewhat stunned to learn that, to be effective practitioners, they need to know about our legal system in general and contracts in particular. True: Many firms have attorneys who take care of contract issues for them. Also true: Many firms wind up in court where they hope a trier of fact will agree that what they thought was so is so. In many of those cases, a dispute could have been avoided if only the contract had been clearer. Experience can be a great teacher in that regard, providing it has good students. The language at issue in this case might be cause for you to reexamine your standard contract language and, of course, the language of contracts your clients ask you to accept. What follows is taken mostly verbatim from the decision in *Wal-Mart Stores, Incorporated, Plaintiff-Appellee, v. Qore, Inc., Defendant-Appellant* (No. 10-60266. United States Court of Appeals, Fifth Circuit).

Wal-Mart hired three firms to assist with the design and construction of a new store in Starkville, Mississippi. The land on which the store was to be built contained a layer of clay just below the surface that was prone to expand when subjected to moisture. Wal-Mart retained a geotechnical services firm, Qore, Inc., to investigate the land and provide a design that would allow for construction on the site. Under this agreement ("the geotechnical services contract"), Qore furnished a preliminary design for preparation and construction of a subsurface base – a buffer of fill-type material placed between the expansive clay and the surface – that would protect against any problems due to the clay and ensure a minimum design life of twenty years for the buildings and pavement placed on the surface.

At the same time, Wal-Mart retained a civil-engineering firm, Sain Associates, Inc. ("Sain"), to provide a critical appraisal of Qore's design and recommendations. If Sain was satisfied with the design, it was to prepare the final plans and specifications to be used for site preparation, including the subsurface grade and base, as well as the final plans to be used in constructing the building and pavement (including the parking areas).

Lastly, Wal-Mart retained a general contractor, Shannon, Strobel & Weaver Construction & Engineers, Inc. ("SSW"), to actually construct the building and pavement as specified by

Sain's plans. By separate agreement ("the testing and inspection contract"), Wal-Mart retained Qore to serve as the testing and inspection firm during construction to make sure that the plans and specifications prepared by Sain were followed.

Two and a half years after all parties finished their work and the new store opened, Wal-Mart began observing signs of stress and failure within the building and parking lot. Wal-Mart sued all three contracting firms for breaches of contract and negligence, seeking over $11.8 million in damages – $5.35 million for the cost of repairing the building and parking lot, and $6.5 million for the diminished value of the new building.

After a twelve-day trial, the district court charged the jury with assessing liability and damages in three categories: damage to the building, damage to the parking lot, and diminution in the building's value. On the issue of damage to the building, the jury found Qore and SSW both liable, assigning 10% of fault to Qore and 90% of fault to SSW. The jury awarded damages in the amount of $486,000 on this issue. Qore was responsible for $48,600 of this amount.

For damage to the parking lot, the jury found SSW 50% liable and Wal-Mart 50% liable. The jury awarded Wal-Mart approximately $1.6 million in damages here. Discounting for Wal-Mart's contributory negligence, SSW was responsible for roughly $797,500 of the total damages award on this claim.

And on the issue of diminution in building value, the jury found that none of the three contracting firms were liable, and thus, no damages were awarded in this category.

The jury rejected all claims of liability brought against Sain. The jury also determined that Qore's 10% liability on the building repair claim was attributable entirely to its work performed under the testing and inspection contract. The jury attributed no fault to Qore for its work completed under the geotechnical-services contract.

Both of the contracts between Wal-Mart and Qore discussed attorney's fees. The geotechnical services contract provided that:

> Each party shall bear its own expenses of litigation (including without limitation attorneys' fees), without regard to which is the prevailing party.

But the testing and inspection contract included an indemnification clause that covered attorney's fees:

> The Testing and Inspection Firm [Qore] further agrees to indemnify and hold Wal-Mart free and harmless from any claim, demand, loss, damage, or injury (including Attorney's fees) caused by any negligent act or omission by the Testing and Inspection Firm, its agents, servants, or employees.

This contract provision is the focal point in this appeal.

By post-trial motion, Wal-Mart sought to recover from Qore all its attorney's fees incurred in this litigation – on all claims, successful and unsuccessful, and against all parties – which amounted to $990,000. In ruling on the motion, the district court opined that "[i]t might appear . . . [that] attributing the entirety of that $990,000 to Qore, who is only liable for $48,600 in damages is unreasonable. However, attributing the whole of the reasonable attorney's fees to Qore is supported by Fifth Circuit case law." (Here, the court was referring to the decision in *Cobb v. Miller,* a case involving the Civil Rights Attorney's Fees Awards Act.) The district court granted Wal-Mart's request for attorney's fees, but reduced the award to $810,00. This appeal followed.

Qore asks us to vacate the district court's fee award on three grounds. First, it argues that the indemnity provision at issue does not apply in this first-party dispute between Wal-Mart and Qore, but is instead limited to claims brought against Wal-Mart by third parties. Second, Qore claims that Mississippi law precludes an award of attorney's fees because Wal-Mart did not present competent evidence by which to allocate its fee request between successful and unsuccessful claims. Third, Qore maintains that the district court erred in holding it liable for the entirety of Wal-Mart's attorney's fees for all matters related to this litigation. We note that Qore's second and third assignments of error present the same basic question: whether, under the facts presented here, Wal-Mart's recovery of attorney's fees should be limited to those claims upon which it prevailed against Qore at trial.

In conducting our review, we examine the record independently and under the same standards that guided the district court. This broad standard of review includes the initial determination of whether the contract is ambiguous.

Qore contends that the indemnity provision in the testing and inspection contract only applies to actions brought against Wal-Mart by independent third parties. Relying on common law indemnity rules, Qore argues that the provision does not authorize an award of attorney's fees in this first-party dispute between Wal-Mart and Qore. In response, Wal-Mart maintains that the plain language of the indemnity provision provides for those attorney's fees incurred in any case, whether brought by one of the contracting parties or otherwise, to the extent that Qore's negligence precipitated the underlying suit. The district court applied a plain reading of the testing and inspection contract and found that, as a threshold matter, it allowed for recovery of Wal-Mart's reasonable attorney's fees. We agree. The testing and inspection contract's plain language allowed for recovery of attorney's fees.

Next, Qore contends that in light of Wal-Mart's multiple claims against

multiple parties, only one of which was successful as to Qore, the district court's fee award should be vacated because Wal-Mart failed to present competent evidence by which to allocate its legal fees among successful and unsuccessful claims as required by Mississippi law. Specifically, Qore complains that the district court's $810,000 fee award erroneously reimburses Wal-Mart for its attorney's fees incurred in pursuit of claims:

- against SSW and Sain (which the jury found not liable on any claim),
- for damages that the jury later attributed to Wal-Mart's own negligence (on the damage-to-the-parking-lot claim),
- on the damage-to-the-parking-lot and diminution-in-building-value claims (for which the jury found Qore not liable), and
- for negligent design under the geotechnical services contract (which explicitly barred the recovery of attorney's fees).

Qore maintains that Wal-Mart's recovery is limited to those fees incurred in prosecuting the single claim upon which it prevailed against Qore. Here, the attorney's fee provision in the testing and inspection contract entitled Wal-Mart to reimbursement for those attorney's fees "caused by any negligent act or omission" on the part of Qore in performing work under the contract. Qore's duty to reimburse Wal-Mart for its reasonable attorney's fees was limited accordingly to those fees proximately and legally "caused by" Qore's negligence, and the matter of causation could only be addressed once the jury made findings on the issue of Qore's negligence. Until then, Qore's legal liability remained latent for indemnification purposes. Because Wal-Mart's indemnification rights were derivative of Qore's negligent acts or omissions, i.e., the fault allocated to Qore on the building-repair claim, Qore is only liable for the reasonable attorney's fees Wal-Mart incurred in enforcing those rights. All other fees were not "caused by" Qore within the meaning of the testing and inspection contract, and could not be awarded thereunder. Wal-Mart's recovery should have been limited to those attorney's fees incurred in proving Qore's liability on the building-repair claim.

In ruling on Wal-Mart's motion for attorney's fees, the district court opined that "[o]n the surface it appeared Wal-Mart had overreached in bringing so many claims against three different parties. However, deeper reflection shows that a small claim against Qore could not have been brought without this larger production." The court then explained why, under our decision in *Cobb v. Miller*, a reduction in fees on account of Wal-Mart's several unsuccessful claims was not required. This case differs from *Cobb* in meaningful ways, however.

First, Qore was found not liable on two of three claims submitted to the jury. Therefore, the relevant question is whether these claims were inextricably tied to the one claim for which Qore was found liable, such that the district court was within its discretion in choosing not to partition. We find that Wal-Mart's attorney's fees could have been easily segregated along two lines: those fees incurred in proving liability relating to planning and design, and those fees dedicated to proving liability relating to construction. Only Sain and Qore were involved in planning and designing the Starkville store. The jury found Sain not liable on any claim in this case, and Qore's work at the planning and design stage was performed under the geotechnical services contract, for which the jury also found no fault. By comparison, the jury's liability findings related to the store's construction, where SSW and Qore were the only two defendants involved. Qore's work at this stage of the project was, of course, governed by the testing and inspection contract.

Second, *Cobb* involved a fee award under the Civil Rights Attorney's Fees Awards Act, which authorizes courts to award reasonable attorney's fees to prevailing parties in any action to enforce provisions of the federal civil rights laws. *Cobb* has no application in this private claim for attorney's fees. The district court's reliance on *Cobb* was error; the court's award cannot stand.

Having found that the testing and inspection contract was the only basis for an award of attorney's fees, we conclude that the district court's fee award was an abuse of discretion. We VACATE the award of attorney's fees and REMAND for further proceedings consistent with this opinion.

Observations: "Qore won. The appropriateness of its indemnity language was vindicated." *Wrong*. Qore lost. We can only guess at the amount of money it had to spend in defense and appeal, and the value of the billable time lost to discovery and related elements of litigation, including aggravation, frustration, and anxiety. And as for the wording of its indemnity, hindsight (always 20/20) reveals it was not sufficient to discourage a challenge. Once again, it may come down to a failure to define terms, either by virtue of a separate contract section conveying definitions (long an ASFE recommendation) or by virtue of a parenthetical definition, as of "attorney's fees," to define what they do and do not comprise.

How well do you define such terms in the agreements you offer and accept? You might want to have them reviewed and, possibly, revised. As this case demonstrates so well, the devil is in the details. It also demonstrates something else ASFE has warned about repeatedly over the years: Always assume that a contract's harshest provisions will be enforced.

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