2011 Newsletter

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Fifth Victor Milligan Lecture

Dr Scott Sloan delivered the fifth **Victor Milligan Lecture** titled Geotechnical stability analysis on September 20. Scott Sloan is the Laureate Professor and Director of the Australian Research Council Centre of Excellence in Geotechnical Science and Engineering at the University of Newcastle in New South Wales, Australia, and was the 2011. Rankine Lecturer for the British Geotechnical Association.

Funding for the Victor Milligan Lecture series is generously provided by **Golder Associates**. The Distinguished Lecture Series was named in honour of Dr Milligan in 2009, one of the founders of Golder Associates. The lecture series brings the Rankine and Terzaghi Lecturers to Kingston each year to speak to Centre members, undergraduates and visitors. Amongst many honours, Dr Milligan was a Terzaghi Lecturer for the American Society of Civil Engineers.

2011 Casagrande Lecture at PanAm Conference

The Canadian Geotechnical conference was held this year in Toronto in conjunction with the Pan Am conference of the International Society of Soil Mechanics and Geotechnical Engineering (held once every four years). Each Pan Am conference opens with the Arthur Casagrande Lecture. This year, the International Society selected **Dr. Kerry Rowe** to deliver the 2011. **Casagrande Lecture,** Short and Long Term Leakage Through Composite Liners

Golder Associates sponsors the GeoEngineering Seminar Series

In May 2011, **Paul Dittrich,** Principal of **Golder Associates** and **Ian Moore**, Executive Director of the GeoEngineering Centre, announced that funding for the Centre's weekly seminar series for 2011-2014 will be provided by Golder Associates.

The GeoEngineering Seminar Series features about 25 presentations each year by leading scholars and consultants, as well as students and faculty members from the Centre, and is a key component of the GeoEngineering Graduate Program. Speakers in the Fall of 2011 included Dr Tom Zimmie (Rensselaer Polytechnic Institute) and Cory Froese (Alberta Geological Survey).

The Natural Sciences and Engineering Research Council of Canada (NSERC) awarded Discovery Grants to our two new Centre members

Dr Kevin Mumford was awarded $90,000 over five years to study "Remediation of non-aqueous phase liquid wastes in groundwater systems containing trapped gas". Many of the tens of thousands of abandoned properties in Canada remain unused due to the contamination of soil and groundwater by industrial chemicals. There is a need to better understand contamination under realistic conditions. One common condition is the presence of gas bubbles in the subsurface near contaminant sources, created as the water table rises and falls through the year or as a byproduct of remediation-based chemical reactions. Kevin is leading international efforts to investigate the formation of gases during the application of clean-up technologies, how gases transfer contaminants to the groundwater, and the effect of contaminant mixtures on gases. Research results will lead to more accurate predictions of risk due to site contamination and improved strategies for the application of clean-up technologies. This will provide new insight and tools to the environmental engineering community, benefiting site owners, developers, and practitioners.

Dr Nicholas Vlachopoulos will receive $106,000 over five years for his "Investigation into optimization of support elements associated with tunnelling for civil infrastructure". Nicholas is studying tunnelling through weak and fractured rock as part of infrastructure works such as road construction, railways, and intakes for power stations.

Weak rocks present unique challenges to the geotechnical and geological engineer, as misjudgments in the design of support systems can lead to costly failures if under-designed or high tunnelling costs if over-designed. His new grant will fund investigations of the mechanics of anisotropic and weak rock materials in the complex deformation regime in advance of a tunnel face, and integrate these into current design models. The work will permit optimization of civil infrastructure tunnel support design, balancing safety and cost, examine the behaviour, influence and effect of specific support elements within a multi-element, interactive tunnel support system, and further develop analytical and modelling tools for weak geomaterials and support systems.

Two other team members had Discovery grant renewals, both at increased levels: **Heather Jamieson** and **Kent Novakowski.** These latest awards mean that fourteen of our centre members now receive Discovery Grants, an excellent result given the highly competitive nature of this funding program.

Awards and Honours

Jean Hutchinson, has been named a Fellow of the Engineering Institute of Canada. The Institute connects the activities of learned societies representing eleven engineering subdisciplines, including the Canadian Geotechnical Society, and elects up to twenty engineers annually to the grade of Fellow for their exceptional contributions to engineering in Canada (out of more than 100,000 professional engineers across Canada).

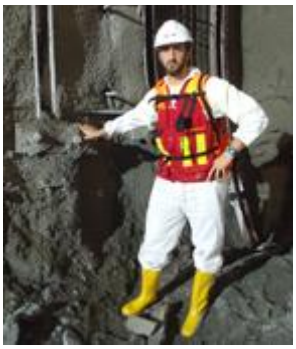
Mr Kazi Rahman won the **35th Annual Michael Bozozuk Student Forum**, a competition for graduate students at Carleton, Ottawa, Queen`s and RMC for his presentation titled *Numerical Analysis of the Response of Adjacent Pipelines during Static Pipe Bursting.* **Kazi** was also awarded the Michael E. Argent Memorial Scholarship by the North American Society of Trenchless Technology at the **20th Annual North American NoDig Conference** in Washington D.C.

Ms Azadeh Hoor won the two yearly graduate student competition for the best student paper competition at the **ASCE Geo-Institute/IFAI/GMA/ NAGS** · Geo-Frontiers 2011. conference in Dallas, Texas. Queen's students have won this competition every time since 2005: Rebecca McWatters in 2009, Melissa Chappel in 2007, and Karina Lange in 2005.

Congratulations to **Greg Siemens** and **Richard Bathurst** for their **Honourable Mention for the best paper published in Geotextiles and Geomembranes** in 2010. The paper "Numerical parametric investigation of infiltration in one-dimensional sand–geotextile columns", is in Volume 28, Number 5, on pages 460-474. Geotextiles and Geomembranes is the geoengineering journal with the highest impact factor, and published 50 articles during 2010.

Richard Bathurst was selected at the annual board meeting as **President-elect of the Canadian Geotechnical Society**, to start a two year term as President on January 1st, 2013.

Dr Bathurst has previously served as President of the International Geosynthetics Society and President of the North American Geosynthetics Society.



Mr. **Jeffrey Oke**, PhD candidate with supervisors Dr. Nicholas Vlachopoulos and Dr. Mark Diederichs, won second place at the Canadian Geotechnical Society's Graduate Student Presentation Competition.

Jeff, Tunnel in Patras, Greece.

Former student **Heather McLeod** as well as **Richard Brachman**, **Ian Moore** and **Andy Take** were awarded the **R.M. Quigley Award of the Canadian Geotechnical Society** at the Pan Am conference for their paper titled Brachman, R.W.I., McLeod, H.A., Moore, I.D. and Take, A.W. 2010. Three-dimensional ground displacements from static pipe bursting in stiff clay, Canadian Geotechnical Journal, 47(4), 439-450.

Congratulations also to **Paul Dittrich**, **Kerry Rowe**, **Dennis Becker** and **Kwan Yee Lo** who received an honourable mention for the Quigley award for their paper Influence of exsolved gases on slope performance at the Sarnia approach cut to the St. Clair Tunnel, Canadian Geotechnical Journal, Volume 47, No. 9, pp. 971–98.

The Quigley award recognizes the best papers in the Canadian Geotechnical Journal each year, as judged by members of the Editorial board (without the Editor). Formerly called the 'Best paper award', it was renamed in 1995 to honour Bob Quigley, a past Editor of the journal, whose high standards and breadth of geotechnical and geoscience scholarship and practice set exemplary benchmarks for the Canadian and international communities.

Ian Moore received the **John R. Booker Medal** of the International Association of Computer Methods and Advances in Geomechanics in recognition of his work on analysis and testing of buried infrastructure. The award was made at the 13th IACMAG conference in Melbourne Australia. This award honours the outstanding contributions to computational geomechanics made by the late Professor John Booker, in particular, solutions to nonlinear and time-dependent problems with mathematical rigor and elegance, leading to fundamental understanding and insight into engineering and physical phenomena.

Congratulations to **Paul Dittrich** and **Dennis Becker** of Golder Associates, **Kerry Rowe**, and **Kwan Yee Lo** of the University of Western Ontario who were awarded the **Casimir Gzowski Medal** at the annual conference of the Canadian Society for Civil Engineering in Ottawa. Drs Dittrich, Rowe, Becker and Lo won for their paper titled *Influence of exsolved gases on slope performance at the Sarnia approach cut to the St. Clair Tunnel*, Canadian Geotechnical Journal, Volume 47, No. 9, pp. 971–98.

Slopes adjacent to original St Clair tunnel

Slopes adjacent to new St Clair tunnel

As superintendent of public works, Colonel Sir Casimir Stanislaus Gzowski (1813–1898) was responsible for improving waterways and canals and constructing roads, harbours and bridges. Later, he was involved in railroad construction and the international bridge at Fort Erie. A founder of the CSCE in 1887, he was president from 1889 to 1891. Established by Sir Casimir in 1890, the Casimir Gzowski Medal is awarded annually by the CSCE for the best paper on a civil engineering subject in the area of surveying, structural engineering, and heavy construction.

Congratulations also to **Heather McLeod**, **Richard Brachman**, **Ian Moore** and **Andy Take** who received an honourable mention for the **Casmir Gzowski Medal** for their paper titled Brachman, R.W.I., McLeod, H.A., Moore, I.D. and Take, A.W. 2010. Three-dimensional ground displacements from static pipe bursting in stiff clay, Canadian Geotechnical J., Vol. 47(4), pp. 439-450.

Heather, Richard (top left), Ian (bottom left), Jon Foster (bottom right) and representatives from TT Technologies in Aurora, IL, 2008 at the site of the pipe bursting field tests reported in their paper

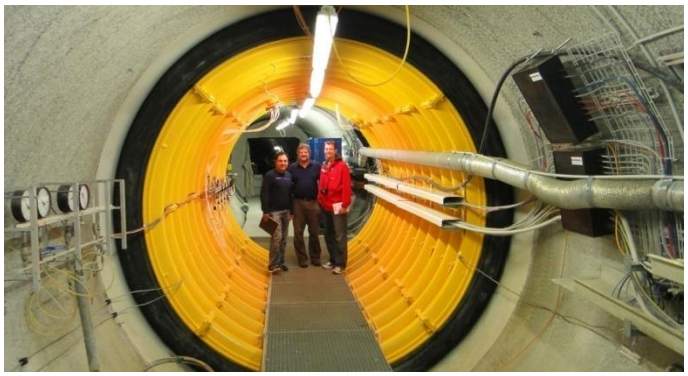
Cross Canada Lecture Tour 2011

Dr Mark Diederichs was selected by the Canadian Geotechnical Society to undertake the Cross Canada Lecture Tour during April, making 14 presentations in 14 locations across Canada (Kingston, Kelowna, Prince George, Victoria, Vancouver, Calgary, Edmonton, Winnipeg, Ottawa, Toronto, Sudbury, Montreal, Quebec and Halifax). Mark is speaking on three topics:

1) Laser Scanning for Rock Mass Characterization on Slopes and Tunnels
2) Tunnelling in Rock Under High Stress Conditions
3) Geotechnical Performance of a Deep Geological Repository for Nuclear Waste

The tour is a highlight of the technical programs offered by the Canadian Geotechnical Society each year, and each tour features a leading GeoEngineering expert from Canada or abroad. The tour is supported through the Canadian Foundation for Geotechnique with the assistance of industrial sponsors (this year: BGC, EBA, Geo-Slope International and the Reinforced Earth Company).

Some of Dr Diederichs graduate research team in the Niagara Beck Tunnel in March - 1 week before breakthrough. From Left to Right: Gary Kramer (Hatch Mott Macdonald), Mark Diederichs, Connor Langford (MSc Candidate), Nicholas Vlachopoulos (RMC), Anna Crockford (MSc) and Matthew Perras (PhD).

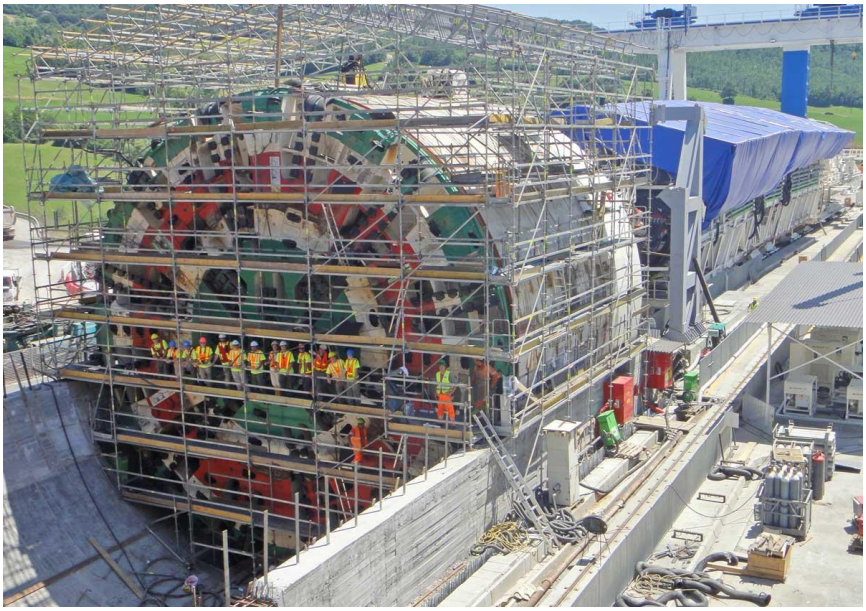


Ehsan Ghazvinian (PhD Candidate), Dr. Diederichs and (right) Matt Perras, standing inside a Mega-Packer fault migration experiment in the Grimsel Granite Laboratory under the Swiss Alps. This is a lab for nuclear waste storage geomechanics and hydrogeology. Both students are working on this topic for their doctoral projects.

Graduate Field Trip: Engineering Geology and Geomechanics

Geological Engineering is a challenging discipline combining an understanding of the geological makeup and history of an area with engineering skills to remediate natural hazards, to manage earth resources and to build with, on, over and through earth materials. Twelve graduate students from the Department of Geological Sciences and Geological Engineering at Queen's spent much of this past June travelling over 3300km through Switzerland, Italy, France, Austria and Germany, visiting and studying key geo-engineering project sites, numerous natural hazard examples and learning about Alpine geology. This technical tour, supervised by Queen's Professors Mark Diederichs and Jean Hutchinson, was part of a graduate field course related to engineering geology and rock engineering. The graduate students are involved in research projects related to tunnelling, mining, landslides, rockfall remediation and other railway geomechanics, rock characterization using remote sensing and nuclear waste related rock mechanics and rock engineering.

Students at two of the sites visited during the field trip.



The STEWARD Program

The STEWARD (Systems Training and Education in Water Assets Research and Development) program funded by a $1.65M CREATE grant from NSERC is a collaboration between the Civil Engineering Departments at Dalhousie University and Queen's University. The first annual symposium for the STEWARD program was held in Halifax, Nova Scotia in April of 2011 (see below). The second symposium will be held in Kingston in April 2012.

The STEWARD project involves GeoEngineering Centre members **Richard Brachman**, **Ian Moore**, **Kerry Rowe**, **Greg Siemens**, and **Andy Take**, with Queen's colleagues Yves Filion and Pascale Champagne, and collaborators Craig Lake, Graham Gagnon and others at Dalhousie University. GeoEngineering research being supported focuses on Buried Infrastructure Design, Assessment and Repair and Landfill Barrier Design, as well as the stabilization of contaminated ground. Industrial partners for the project include Halifax Water, Utilities Kingston, and Stantec.

One of the objectives of the program is to integrate new and existing training experiences and opportunities in a variety of Civil Engineering sub-disciplines associated with municipal water and waste water systems. Graduate students participate in the Annual Symposia, short courses, monthly seminars, and each student benefits from a significant industrial training experience associated with industrially sponsored research or a work term with one of the industrial partners.

Graduate students from Dalhousie & Queen's in Halifax for the first STEWARD Symposium in April 2011.

Geosynthetics in Antarctica

The First Antarctic Biopile Treatment Cells Employing Geosynthetic Barrier Systems

Rebecca McWatters[1,2,3], R. Kerry Rowe[1], A. Malek Bouazza[3] and Ian Snape[2]

[1]*GeoEngineering Center at Queen's-RMC, Kingston, ON, Canada*
[2]*Australian Antarctic Division, Kingston, TAS, Australia*
[3]*Dept. Of Civil Engineering, Monash University, Melbourne, VIC, Australia*

Hydrocarbon contamination in Antarctic environments can pose potential toxic and long-term effects on the sensitive ecosystems. A 1999 fuel spill at Australia's Casey Station (66°17' S 110°31' E) in Antarctica resulted in contaminant migration downstream through permafrost. Elevated hydrocarbon levels were detected in over 600m^3 of soil surrounding the source. The clean up approach required a low cost remediation technique suitable for the Antarctic conditions and to allow signatory nations to the Antarctic Treaty to meet obligations under Annex III of the Environmental Protocol. This was the first major instance in Antarctica of a comprehensive remediation strategy which involves managing the contaminated site using a Permeable Reactive Barrier (PRB) which was installed in 2005.

Construction of new biopile. Installing geomembrane over GCL liner

Construction of the biopile. Filling biopile with excavated contaminated soil

The approach also employs active treatment techniques (biopiles, nutrient addition and aeration systems) specifically tailored to the site, soil conditions and risks associated with Antarctic operations and the environment. Contaminated soil was excavated over two summer seasons (2011, 2012) and placed in lined biopile treatment cells. These cells employ geosynthetic composite liner system using different varieties and combinations of geosynthetic clay liners (GCLs), high density polyethylene (HDPE) geomembranes and geotextiles. Research is also focused on the long-term performance of these geosynthetics to impede advective and diffusive contaminant migration with exposure to

the Antarctic's cold and dry climatic conditions and freeze-thaw cycling.

Beck McWatters on the job site in Antarctica

All six biopiles site after a snowfall

Contaminant migration through the biopile barrier system was monitored in the field using a system of monitoring pipes and sample extraction areas. Results after the first season of biopile operation show low levels of hydrocarbon migration below the geomembrane liner and no hydrocarbon migration below the GCL liner. Samples of the geomembranes, GCLs and geotextiles were exhumed after one year in the field. These geosynthetics will undergo physical, diffusive and permeation testing conducted in the laboratory to investigate changes in diffusive properties with age or exposure to freeze-thaw cycling and cold region environmental conditions.

During the 2012 season, a sixth biopile was constructed to contain the remaining contaminated soil to be excavated. The Antarctic boast the title of the driest continent on earth and therefore can influence the hydration and performance of GCL liners. This biopile was heavily instrumented with sensors to investigate the moisture uptake/loss in the GCL liner during construction, through freeze-thaw cycles and throughout the lifespan of the cell.

Remediation site at Casey, Antarctica showing biopile treatment cells covered in black geotextile and PRB (right)

It is expected that the biopiles will operate for a number of years with bioremediation predominantly occurring during only the warmer summer months where temperatures on station range from -5^{o}C to 5^{o}C. In these periods, the field team is on site for increased monitoring and sampling.

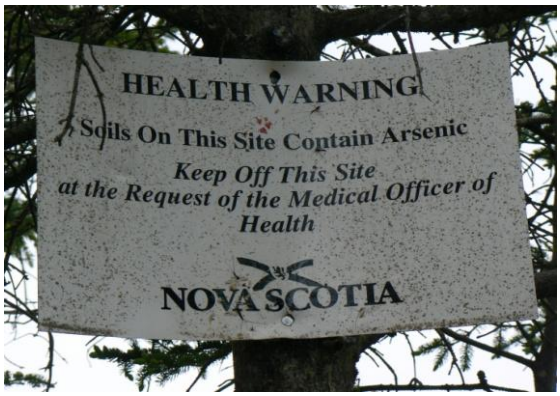
The final stage of the remediation approach includes building a comprehensive method of establishing set endpoints for soil using ecotoxicological studies as there are no set guidelines for hydrocarbon levels in soil and groundwater in Antarctica. Soil is precious resource on the Antarctic continent that is dominated by snow and ice.

Optimal Remediation of Arsenic-Contaminated Mine Sites

Mohamed Hosney, PhD candidate, *Geo*Engineering Centre at Queen's-RMC

Supervised by **R. Kerry Rowe** in collaboration with **Heather Jamieson**

One serious environmental issue in Canada is the leaching of hazardous metals and metalloids, such as arsenic, from abandoned gold mine tailings. Because arsenic often occurs naturally in the rock form which gold is extracted, it can usually be found in the mine tailings in concentrations much higher than the recommended Canadian soil quality and water quality guidelines. For publicly accessible gold mine sites, where arsenic is highly elevated, placing a geosynthetic clay liner (GCL) as part of a cover system over the mine tailings may provide a means of minimizing the release of arsenic by limiting the infiltration of rain into the underlying waste. This research focuses on the performance of geosynthetic clay liners (GCLs) used in covers over mine tailings under both field and laboratory conditions. This involves the design, construction, and monitoring of a test cover comprised of two GCL layers constructed at Montague gold mine site, Nova Scotia, in August 2009. GCL samples are being exhumed periodically to examine changes in its physical and chemical properties. In addition a parallel laboratory programme has been initiated to examine the effect of a number of variables including type of GCL, tailings composition, and other design details to help establish an optimal cover design for gold mine tailings.



GCL test cover construction at Montague mine

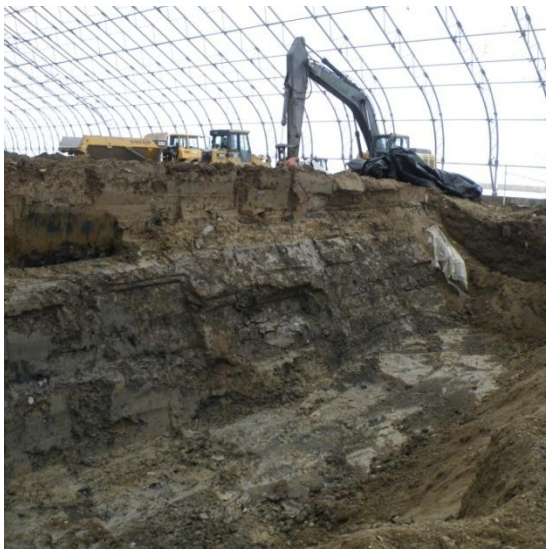
Pottersburg Creek PCB Storage Facility

Evaluating the effects of Polychlorinated Biphenyls (PCBs) on geomembrane liners, as well as evaluating the diffusive properties of the clay liner and geomembranes with respect to PCBs

Daniel Jones, PhD Student, GeoEngineering Centre at Queen's-RMC
Edwin Safari, Rebecca McWatters Post Doctoral Fellows, GeoEngineering Centre at Queen's-RMC

Supervised by **R. Kerry Rowe in collaboration with Allison Rutter**

The Pottersburg Creek PCB Storage Facility was a set of four engineered landfills to contain PCB contaminated soil and sediment constructed in the early 1980's. The landfills were decommissioned in 2009 (after being in service for about 25 years) so that the PCB contaminated waste could be incinerated. The project is novel in that that the performance of clay and geomembrane liners for retaining contaminants, and the effect on their performance after about 25 years use has never been examined before. The migration of PCBs through the liner has been found to be negligible and the liner system has worked extremely well. The exhumed geomembranes (and geotextiles) have been evaluated for the effects of aging. Current research also is focusing on evaluating the diffusive properties of the clay liner and geomembrane with respect to PCBs. Although PCBs are no, longer produced, the research will also provided insight regarding the effectiveness of modern liners for containing other contaminants of emerging concern.
The PCB analyses are being conducted in the Analytical Services Unit of Queen's University. The excavation of the site was conducted by the Ontario Ministry of the Environment and managed by **Jeff Markle**, along with the help of Quantum Murray, and CH2M Hill.



Decommissioning of the site

NCHRP 15-38 Structural Design of Culvert Joints

David Becerril Garcia, PhD Student and **Yu Wan**, MSc student
Graeme Boyd, Civil Technologist
Supervisor: **Ian Moore**
Funding: Sponsor: The **National Cooperative Highway Research Program** of the Transportation Research Board (see http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2510) of the US Academy of Sciences.

This research is developing the first structural design requirements for joints in flexible and rigid culverts to withstand variations in construction, support, and loading conditions. These requirements shall be suitable for consideration for adoption by the AASHTO Highway Subcommittee on Bridges and Structures, and should also influence joint design in sewers and other gravity flow pipes. The work features field-scale testing in the GeoEngineering laboratory at Queen's, field testing in Ohio, 3D finite element analyses, and development of design equations for the AASHTO LRFD Bridge Design Specifications.

Graeme Boyd and Yu Wan testing pipe joints

Activities during 2011. included completion of the laboratory test program, development of simplified design equations for vertical shear force, longitudinal bending moment, and joint rotation, and use of a new joint testing frame to measure joint strength. The draft final project report has been completed, and will be published by NCHRP in 2012.

Surface load test on a 0.9 m diameter corrugated steel pipe

1.2 m diameter reinforced concrete pipe before burial

Behaviour and design of deep corrugated metal culverts

Tamer Elshimi, PhD Student and **Andrea Lougheed**, MSc Student
Graeme Boyd, Civil Technologist
Supervisors: **Richard Brachman** and **Ian Moore**
Funding: **Armtec Ltd** and the **Natural Sciences and Engineering Research Council of Canada.**

During 2011, a four year project examining the behaviour of large span, deep corrugated metal culverts was completed. The project commenced with work by Andrea Lougheed to undertake full scale laboratory testing of a 10m span structure using the buried infrastructure test facilities at Queen's West Campus. In particular, the project featured a series of service load tests on the ground surface over the culvert, as well as testing up to the ultimate limit state.

Andrea before burial of her test culvert

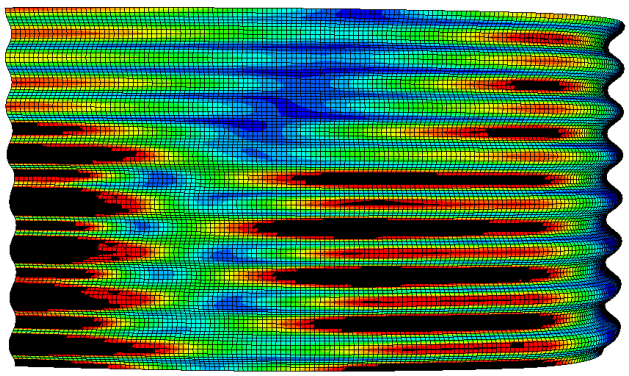
After completion of the culvert tests, Tamer Elshimi developed and used three dimensional nonlinear ABAQUS models to simulate the laboratory experiments, and used those models to determine the performance of a range of other culvert geometries and burial depths. Tamer undertook complete parametric studies for two classes of deep corrugated culverts: box culverts where design is dominated by the bending moments that result from both earth and vehicle loads, and arch culverts, where design is controlled by the compressive thrusts that result from earth and vehicle loads.

Surface load simulating tandem axle loads using the lab's 2000 kN actuator

Armtec Ltd has changed their designs to reflect the significant reserve capacity demonstrated in both the tests and analysis, partly resulting from three dimensional attenuation of surface loads.

Yield (black) in the corrugated steel plates

Tamer's finite element analysis represented both the backfill and the corrugated geometry of the steel plates. This permits detailed modeling of the two types of material failure that control the collapse mechanism: shear failure in the soil and complex patterns of yield in the corrugated steel plates.



Recent Graduates and Postdocs

The following GeoEngineers associated with the Centre have recently completed their training, and have moved on to the next phase of their career:

Branscombe, Laura, MSc (supervised by Mark Diederichs), Consulting Engineer, Golder Associates.

Bromstad, MacKenzie, MSc, (supervised by Heather Jamieson), mineral exploration, Nunavut

Drysdale, Jess, MSc, (supervised by Heather Jamieson and D. Fortin, U of Ottawa), Woods Hole, MA

Elmhirst, Laura, MSc, (supervised by Kent Novakowski)

Elshimi, Tamer, PhD (supervised by Richard Brachman and Ian Moore), Thurber Engineering, Edmonton, AB

Foster Jon, MSc (supervised by Andrew Take), BGC Engineering, Vancouver, BC

Grell, Stephanie, MSc, (supervised by Kent Novakowski)

Hoor, Azadeh, PhD (supervisor Kerry Rowe), Technip USA, Houston, Texas

Hume, Colin, MSc (supervised by Mark Diederichs and Jean Hutchinson) Consulting Engineer MDE.

Jaggard, Heather, MSc, (supervised by Heather Jamieson), Golder Associates, Sudbury, ON

Kozuskanich, John, PhD, (supervised by Kent Novakowski)

Martin, Eric, MSc, (supervised by Bernard Kueper), now studying for PhD

McLaughlin, Julienne, MES, (supervised by Heather Jamieson and G. Whitelaw), now in M.Ed program

Oldroyd, Chris, MASc (supervisor Greg Siemens, RMC), Dept National Defense, 1CE, Moncton, NB

Peters, Stephen, MASc, (supervisors Greg Siemens, RMC and Andrew Take), Thurber Engineering, Oakville, ON.

Sabir, Ali, Postdoctoral Fellow, (supervisor Richard Brachman), University of Calgary, AB

Safari, Edwin, Postdoctoral Fellow (supervisor Kerry Rowe), Department of Environmental Engineering, Faculty of Environmental Studies, University of Tehran, Iran

Saiyar Sarai, Massoumeh, PhD (supervised by Andy Take & Ian Moore), Golder Associates, Calgary, AB

Sealey, Heather, MSc, (supervised by Heather Jamieson), O'Connor Associates, Winnipeg, MB

Smith, Reid, MSc, (supervised by Kent Novakowski)

Taechakumthorn, Chalermpol (Bon) PhD (supervisor Kerry Rowe) Research Fellow, Faculty of Engineering, University of Wollongong, Australia

Trimper, Shawn, MASc, (supervised by Kent Novakowski), now studying for PhD

Yang, P., Postdoctoral Fellow (supervisor Kerry Rowe) Associate Professor, Key Laboratory of Geotechnical and Underground Engineering of Ministry of Education, Tongji University, Shanghai, People's Republic of China.

Zarnani, Saman, PhD (supervisor Richard Bathurst, RMC) Geotechnical Engineer with BCG, Vancouver

Publications for 2011

Abdelaal, F.B., Rowe, R.K., Smith, M. and Thiel, R. 2011. OIT depletion in HDPE geomembranes used in contact with solutions having very high and low pH, 14th Pan-American conference of Soil Mechanics and Geotechnical Engineering, Toronto, October, paper #483 , CD-ROM, 7p.

Acikel, A. S. Singh, R. M. Bouazza, A. Gates, W. P. and Rowe, R.K. 2011. Water retention behaviour of unsaturated geosynthetic clay liners 12th International Conference of International Association for Computer Methods and Advances in Geomechanics (IACMAG), Melbourne, May, 2011, 626-630.

Azad, F., Rowe, R.K., El-Zein, A. and Airey, D. 2011. Laboratory Investigation of Thermally Induced Desiccation of GCLs in Double Composite Liner Systems, Geotextiles and Geomembranes, 29 (6):534-543.

Bailey, B., Hutchinson, D.J., Gordon, D., Siemens, G., and Ruel, M. 2011. Field and laboratory procedures for investigating the fouling process within railway track ballast. Proc. of Pan-Am CGS Geotechnical Conference 2011, Toronto, 8 pages, Paper #718.

Bailey, B., Hutchinson, D.J., Siemens, G., and Ruel, M. 2011. Assessment of embankment fouling from geotechnical testing of railway ballast samples. Proc. of Pan-Am CGS Geotechnical Conference 2011, Toronto, 8 pages, Paper #748.

Basso, T. and Vlachopoulos, N. 2011. Investigation into Sustainable Development Strategies for the Department of National Defence. Canadian Society of Civil Engineering Conference, June 2011, Ottawa, Ontario, Canada.

Bathurst, R.J. and Zarnani, S. 2011. Recent research on EPS geofoam seismic buffers, 4th International Conference on the use of Geofoam Blocks in Construction Applications (EPS 2011) Lillestrom, Norway, 6-8 June 2011, 10 p.

Bathurst, R.J., Hatami, K. and Alfaro, M.C. 2011. Geosynthetic-reinforced soil walls and slopes - seismic aspects, (S.K. Shukla Ed.): Geosynthetics and Their Applications, Thomas Telford Ltd., London, UK, 47 p.

Bathurst, R.J., Huang, B. and Allen, T.M. 2011. Interpretation of installation damage testing for reliability-based analysis and LRFD calibration, Geotextiles and Geomembranes, Vol. 29, No. 3, pp. 323-334

Bathurst, R.J., Huang, B. and Allen, T.M. 2011. Load and resistance factor design (LRFD) calibration for steel grid reinforced soil walls, Georisk, Vol. 5, Nos. 3-4, pp.218-228.

Bathurst, R.J., Huang, B.Q. and Allen, T.M. 2011. LRFD Calibration of Steel Reinforced Soil Walls, Geofrontiers 2011, March 2011, Dallas, TX, USA pp. 3429-3438.

Bathurst, R.J., Miyata, Y. and Konami, T. 2011. Limit states design calibration for internal stability of multi-anchor walls, Soils and Foundations, Vol.51 No.6, 1051-1064

Bathurst, R.J., Nernheim, A. and Allen, T.M. 2011. Response to Discussion of Predicted Loads in Steel Reinforced Soil Walls Using the AASHTO Simplified Method by Bathurst, R.J., Nernheim, A. and Allen, T.M. 2009; 135(2): 177-184, Vol. 137, No. 6, pp. 1307-1310

Beddoe, R.A., Take, W.A. and Rowe, R.K. 2011. Water retention behaviour of geosynthetic clay liners, ASCE Journal of Geotechnical and Geoenvironmental Engineering, 137(11): 1028-1038.

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Mark Diederichs	Geotechnical and Geomechanics
Jean Hutchinson	Geotechnical and Geomechanics
Heather Jamieson	Geochemistry and Geoenvironmental
Bernard Kueper	Geoenvironmental and Hydrogeology
Steve McKinnon	Geomechanics and Geotechnical
Ian Moore	Geotechnical, Geosynthetics, and Geomechanics
Kevin Mumford	Hydrogeology and Geoenvironmental
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Vicki Remenda	Hydrogeology and Geoenvironmental
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Andy Take	Geotechnical and Geomechanics
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Ken Reimer	Environmental Assessments and Biotechnology
Allison Rutter	Environmental Remediation and Analysis
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